Pilates and String Musicians: An Exploration of the Issues Addressed by the Pilates Method, an Illustrated Guide to Adapted Exercises, and a Pilates Course for University String Players

by

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ABSTRACT

String players have been identified as the most affected group of instrumentalists suffering from musculoskeletal disorders, and most of the problems are related to posture. The high prevalence of injuries among string players suggests that there is room in the music curriculum for a program tailored to this population and that can provide both immediate and long-term solutions. Pilates is a mind-body conditioning method of exercises and a philosophy that shares many similarities with string playing technique and performance, which suggests that its practice can be beneficial to improve not only the posture of string players but also various other areas. Studies about Pilates as a treatment show the varied areas in which Pilates can help, which are all of interest to instrumentalists. However, the application of Pilates into the music curriculum as a way to help string players improve awareness and reduce injuries has not yet been fully explored. This document addresses the similarities between Pilates and string playing, identifies postural tendencies of string players, and demonstrates how specific Pilates exercises can help counteract asymmetries, restore balance, and reduce the number of musculoskeletal injuries of string players. All anatomical drawings included in this document were adapted from other sources, as cited, or originally drawn by the author.

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CHAPTER 1: PILATES IN THE UNIVERSITY MUSIC CURRICULUM

Introduction

In recent years, significant steps have been taken regarding the mental and physical risks associated with high-level music performance. Despite these efforts, the prevalence of musculoskeletal disorders among string players remains alarmingly high, with problems occurring both at the college and professional levels. Various current studies on musculoskeletal disorders of musicians suggest the need for more specific intervention from higher education music institutions, so that problems may be addressed as soon as possible. More long-term and sustainable programs are needed, so musicians can easily maintain their practice through daily life and into their careers. This paper proposes the use of *Pilates* as an effective tool to address problems of string players. *Pilates* is a total mind-body conditioning method that can help improve posture and reduce musculoskeletal disorders. The method is well-suited to string musicians and promises to help posture and various additional areas including proprioception, motor learning, awareness, balance, flexibility, concentration, and performance anxiety. Most importantly, once the fundamental principles and techniques of the method have been learned, *Pilates* can easily be incorporated into a busy schedule through individual practice and group or on-line classes. Additionally, the *Pilates* principles can be incorporated into other activities and exercises, making them safer and potentially more effective.

The idea of this project came from my own experience of practicing *Pilates* regularly for over six years and the positive effects it has had on my posture,

performance, and sound production.[1] Through the practice of *Pilates,* I was able to achieve a better posture, which reduced my discomfort when playing and helped improve my stamina. Strengthening important muscles of my back allowed me to improve my sound and feel more grounded during performances and auditions. I attribute the fact that I have avoided playing-related injuries largely to the practice of *Pilates*. Before practicing *Pilates* the upper trapezius muscle of my bowing arm was over-developed due to weakness of other important muscles of the back and shoulder. Not only was this aesthetically unappealing while playing, but it also contributed to tiring more quickly and a relatively weak sound, since it did not allow me to relax and "sink into the string" correctly. During stressful performances, this muscle would become tense, diminishing my sound quality and ability to control the bow during complex bow strokes, such as *spiccatto*. *Pilates* made me aware of inefficiencies in my body, and by strengthening my weakened and compromised musculature I was able to regain balance, avoid injuries, and improve my sound and overall comfort while playing. I also experienced first-hand that there was something deeper connecting *Pilates* and playing the cello; through my research I discovered it was proprioception and its influence on motor learning. The more I practiced *Pilates,* the easier it seemed to re-learn or improve a technical aspect. Overall, I felt I was playing and practicing more efficiently and avoiding tension as a response to challenging or stressful situations.

The first several chapters of this document provide contexts necessary to the main focus of this paper, which is the presentation of *Pilates* exercises for string players in Chapter 6. The information in the first chapters is necessary for a full understanding of

[1] See biographical sketch for more information about the author.

the ways *Pilates* can help string players, to clarify misconceptions, and to support why it should be integrated into the music curriculum. Chapter 1 provides a literature review of the state of the current health norms in schools and the high rate of musculoskeletal disorders of string players. It also presents studies that show the varied benefits of *Pilates* exercises, all of which are of interest to musicians. Chapter 2 presents the motivations and philosophies of *Pilates*' founder, ways the method has been previously used, particularly among performing artists, and considerations for a *Pilates* class for string players. Chapter 3 explores in detail the relationship between *Pilates* and music; the *Pilates* principles are connected to string playing, and the underlying thread between *Pilates* and music is discussed. Chapters 4 and 5 identify asymmetric postures and common tendencies of lower string players and upper string players, respectively. Furthermore, specific compromised musculature is identified, and a general plan for addressing it is given. Chapter 6 presents exercises from classical and contemporary mat *Pilates* that address the problems identified in Chapters 4 and 5. Each exercise includes a description of the targeted muscle groups, and Appendix B provides detail on which specific muscles belong to each group. The exercises are adapted to fit the needs of string players, and additional modifications are provided. Dynamic illustrations are also provided which show the direction of movement and range of motion of the exercises. Exercises from standing *Pilates* are included as tools allowing the incorporation of *Pilates* into hectic schedules or tours, and can be done virtually anywhere at any time, including between practice sessions, and before or after performances.

This paper suggests incorporating *Pilates* into the college or university music curriculum and presents a syllabus in Appendix A as an example of how to adapt a class

for string players in a university setting. The syllabus includes required readings, which explain some anatomical terms and concepts that are important to understanding how the exercises and the body work. These establish the foundations for long-term benefits.

Literature Review

The Prevalence of Musculoskeletal Disorders and Posture as a Major Contributor

In 2011, the National Association of Schools of Music (NASM) adopted a health and safety standard that holds music schools responsible for informing their students, faculty, and staff about potential mental and physical issues associated with musical practice.[2] This step was taken following the recommendation of the Health Promotion of Schools of Music (HPSM) project. The 2016-17 NASM handbook states that,

> Students enrolled in music unit programs and faculty and staff with employment status in the music unit must be provided basic information about the maintenance of health and safety within the contexts of practice, performance, teaching, and listening.
> For music majors and music faculty and staff, general topics include, but are not limited to, basic information regarding the maintenance of hearing, vocal, and musculoskeletal health and injury prevention.[3]

This generalized standard presents a challenge for music schools in higher education, primarily because there are no specific guidelines or class plans. Schools have the prerogative of deciding how will they promote health, including the topics to be covered,

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[2] Amy Laursen and Kris Chesky, "Addressing the NASM Health and Safety Standard through Curricular Changes in a Brass Methods Course: An Outcome Study," *Medical Problems of Performing Artists* 29, no. 3 (September 2014): 136.

[3] NASM, *NASM Handbook 2016-2017* (December, 2016): 65, accessed February 7, 2017, https://nasm.arts-accredit.org/accreditation/standards-guidelines/handbook.

the methods to be used, and their implementation into the music curriculum. Options for integrating health and awareness into the curriculum include offering a specific health course, or integrating content into pre-existing classes, such as individual lessons, instrumental methods classes, music ensembles, and pedagogy classes.

The HPSM project was created to provide guidelines for schools of music to incorporate health education into their curricula, especially for schools accredited by the NASM.[4] The HPSM came to exist through collaboration between the University of North Texas System and the Performing Arts Medical Association, and included professionals from performing arts medicine and music.[5] HPSM advocates injury-prevention education and intervention in schools of music as primary ways to address the complexity of performance injuries. HPSM stresses the importance of establishing a unified protocol as well as offering relevant experiences for students. As stated in an article by Chesky, Dawson, and Manchester:

> HPSM recognizes the need for a common and unifying framework that consolidates an academic agenda that focuses on individual knowledge, responsibility, and action with a coherent and integrated continuum of experiences for students. In order to be effective, Prevention Education must go beyond simply "delivering" instruction or "disseminating" information and must address issues that affect music students' values, beliefs, and motivations.[6]

As suggested by HPSM, simply delivering instruction to students on health-related issues

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[4] Ibid., 136.

[5] Kris S. Chesky, William J. Dawson, and Ralph Manchester for the Health Promotion in Schools of Music Project, "Health Promotion in Schools of Music: Initial Recommendations for Schools of Music," *Medical Problems of Performing Artists* 21, no. 3 (September 2006): 142.

[6] Ibid., 142.

is not enough, because performance-related issues are multifaceted. This also suggests that a one-time introductory course on occupational health may not be sufficient to address all the issues related to music performance and at the same time include relevant learning experiences for people with different learning styles. The scope of performance-related topics include: stress and performance anxiety management techniques, well-being, mind-body awareness, healthy practice habits, instrument-related injuries, resources for help, physical fitness, posture assessment, anatomy, and more.

Substantial injuries tend to happen during the first year of college, due mainly to an increase of stressors in combination with a significant increase in playing time. In The *Musician's Survival Manual*, Richard Norris explains that the abrupt increase in playing time, often from three to eight hours daily, is perhaps the most common cause of overuse injuries.[7] In *Muscle Management for Musicians,* Elizabeth Andrews points out that peaks of injuries tend to occur either in the first or last year of college. Increased practice hours, a new instrument, new repertoire, or a new professor with a new technique method can lead to problems.[8] Hoppmann and Patrone remark that all levels of musicians are at risk of injuries with an abrupt increase in practice time, including preparation for juries,

[7] Richard Norris, *The Musician's Survival Manual: A Guide to Preventing and Treating Injuries in Instrumentalists*. Ed. Deborah Torch (N.p.: MMB Music and ICSOM, 1993): 2.

[8] Elizabeth Andrews, *Muscle Management for Musicians* (Lanham, Maryland: Scarecrow Press, 2005), 6.

recitals, or music camps.[9] In addition, Hildebrandt, Nübling and Candia believe that the big shift in the student's life, moving from high school to college, where music becomes the primary focus, plays an important causative role in the increase in injuries.[10] Therefore, it is fundamental to provide students with relevant and varied experiences of mind-body knowledge and techniques to help reduce stress, enhance awareness, avoid injuries and become more efficient in the practice room.

Research supports the urgent need to address health issues as soon as possible during college. Alice Brandfonbrener, medical director of the Medical Program for Performing Artists at the Rehabilitation Institute of Chicago, explains, "it is more effective to identify medical problems as they arise rather than once they are established, with the expectation that duration of injury may adversely affect severity and prognosis."[11] The first year of college is a critical time to establish or reinforce healthy practices. Brandfonbrener was interested in identifying whether playing-related issues start at college or even before entering college. In her study of 330 freshman music students at Northwestern University between 2004 and 2007, 79 % reported performance-

[9] Richard A. Hoppmann and Nicholas A. Patrone, "Musculoskeletal Problems in Instrumental Musicians," in *Textbook of Performing Arts Medicine*, Robert Thayer Sataloff, Alice Brandfonbrener and Richard J. Lederman, eds. (New York: Raven Press, 1991), 71.

[10] Horst Hildebrandt, Matthias Nübling, and Victor Candia, "Increment of Fatigue, Depression, and Stage Fright During the First Year of High-Level Education in Music Students," *Medical Problems of Performing Artists* 27, no. 1 (March 2012): 47.

[11] Alice Brandfonbrener, "History of Playing-related Pain in 330 University Freshman Music Students," *Medical Problems of Performing Artists* 24, no. 1 (2009): 30.

related pain before entering college, starting in high school or earlier.[12]

In another study, Hildebrandt, Nübling, and Candia observed 105 first-year music students from three Swiss music schools. By the end of the research, they found elevated levels of exhaustion, depression, and stage fright in the students. According to the researchers, the results support previous findings on the increased levels of strain associated with the first year of higher education of music students.[13] They believe that more involvement from the schools is needed to help the students, for which they recommend "body education and body perception and stress management during stage performances, all of which are aimed at sustaining health among musicians."[14] More programs that teach body knowledge and control should be available in music schools.

An epidemiological study by Ioannou and Altenmuller also supports the need for early health intervention. The study took place at the Prague State Conservatory during three weeks of the academic year 2009-2010. They found that 88.9 % of 180 instrumentalists had experienced playing related pain (PRP) at least once in their lives, and 12.6 % experienced pain every time they played.[15] They also analyzed how students dealt with pain, and the results were alarming: "35 % of the affected students tended not

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[12] Ibid., 30.

[13] Hildebrandt, Nübling, and Candia, "Increment of Fatigue, Depression, and Stage Fright," 47.

[14] Ibid., 48.

[15] Christos I. Ioannou and Eckart Altenmuller, "Approaches to and Treatment Strategies for Playing-Related Pain Problems Among Czech Instrumental Music Students: An Epidemiological Study," *Medical Problems of Performing Artists* 30, no. 3 (September 2015): 135–142.

to seek help at all, whereas those who did tended to seek advice first from their instrument tutor and second from medical doctors."[16] The results point to an inadequate student health support system and that students should be informed where to find help and what procedures to follow. Furthermore, according to the researchers, the students associated PRP with bad posture and indicated an interest in being educated in PRP awareness.[17] Institutions should be able to provide experiences that enhance PRP awareness and help improve postural alignment.

In a qualitative study, Schoeb and Zosso analyzed how professional musicians perceived the role of their bodies in making music and how they dealt with health issues. They found that although musicians were aware of the connection between physical constraints and performance, their experience from previous health problems influenced future preventive actions:

> Even though the link between the body and the quality of the musical performance is accepted by musicians regardless of their past medical history, there is a considerable difference between the ways healthy musicians approach physical problems and the ways those with a history of health issues approach these problems. Musicians in our sample who had previous physical problems focused on certain body parts, especially the hand, while healthy musicians had a more global approach to their body.[18]

The findings, according to the researchers, suggest that people learn best through

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[16] Ibid., 135.

[17] Ibid., 135.

[18] Veronika Schoeb and Amélie Zosso, "You Cannot Perform Music Without Taking Care of Your Body: A Qualitative Study on Musicians' Representation of Body and Health," *Medical Problems of Performing Artists* 27, no. 3 (September 2012): 132.

experience.[19] When music students enter college, they become an at-risk population. Their health knowledge may be limited, which becomes a real issue with the sudden increase of playing time. Their strategies to deal with performance-related issues based on previous experiences might also be misinformed, which can aggravate the problem and potentially lead to permanent damage. Therefore, institutions should provide new and relevant experiences that address the whole body and focus on prevention.

Musculoskeletal disorders have been identified as the most prevalent medical problems of instrumental musicians, affecting all levels of performance, age groups, and different aspects of the person, including their physical, emotional and social well-being.[20] Musculoskeletal injuries affect the musculoskeletal system, and usually involve the upper limbs, scapula, shoulder girdle, neck, and back.[21] Furthermore, string players have been identified as the group with the highest prevalence of musculoskeletal disorders, which suggests the need for more preventive measures targeted specifically to

[19] Ibid., 129.

[20] Hoppmann and Patrone, "Musculoskeletal Problems in Instrumental Musicians," in *Textbook of Performing Arts Medicine*, 71; Schoeb and Zosso, "You Cannot Perform Music Without Taking Care of Your Body," 129.

[21] Geraldo Fabiano de Souza Moraes and Adriana Papini Antunes, "Musculoskeletal Disorders in Professional Violinists and Violists: Systematic Review," *Acta Ortopédica Brasileira* 20, no. 1 (2012): 43-7.

this group.[22]

Widely quoted are the three large surveys from thirty years ago showing a high prevalence of musculoskeletal disorders in instrumentalists from various orchestras and operas around the world. The 1986 survey by Fishbein and Middlestadt, "Medical Problems Among International Conference of Symphony and Opera Musicians (ICSOM)," revealed that of the 2,212 participant musicians from forty-eight different orchestras, 76 % had experienced a medical problem severe enough to affect performance. Most of these were musculoskeletal problems, especially associated with the neck and back, with string players being the most affected group.[23] The study by Fry involving eight orchestras in Australia, United States, and England revealed that 64 % of the musicians suffered from overuse syndrome.[24] Caldron and others found that 59 % of the 378 participant musicians suffered from music-related musculoskeletal problems.[25]

Numerous studies since provide evidence that the percentages of musculoskeletal

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[22] Han-Sung Lee et al., "Musicians' Medicine: Musculoskeletal Problems in String Players," *Clinics in Orthopedic Surgery* 5, no. 3 (2013): 155; C. Zaza and V. T. Farewell, "Musicians' Playing-Related Musculoskeletal Disorders: An Examination of Risk Factors," *American Journal of Industrial Medicine* 32, no. 3 (September 1997): 292-300; Teresia Nyman, Christina Wiktorin, Marie Mulder, and Yvonne Liljeholm Johansson, "Work Postures and Neck–Shoulder Pain among Orchestra Musicians," *American Journal of Industrial Medicine* 50, no. 5 (May 2007): 370-6.

[23] Martin Fishbein and Susan E. Middlestadt, "Medical Problems Among ICSOM Musicians: Overview of a National Survey," *Medical Problems of Performing Artists* 3, no. 1 (March 1988): 8.

[24] Hunter J.H. Fry, "Incidence of Overuse Syndrome in the Symphony Orchestra," *Medical Problems of Performing Artists* 1, no. 2 (June 1986): 51-55.

[25] Paul H. Caldron et al., "A Survey of Musculoskeletal Problems Encountered in High-Level Musicians," *Medical Problems of Performing Artists* 1, no. 4 (December 1986): 137.

disorders in instrumentalists, especially string players, remain high.[26] According to Lee and others, the high prevalence of musculoskeletal problems in instrumentalists ranges from 73.4 % to 87.7 %, with string players being the most affected group.[27] Common problems include upper extremity issues associated with overuse, most frequently involving the shoulders and back.[28]

In a recent study, Leaver, Harris and Palmer reported that 86% of 243 musicians from elite British symphony orchestras suffered from musculoskeletal pain in the last twelve months, and 41% experienced disabling pain.[29] The most common sites for pain included the neck, the low back, and the shoulder. The researchers also found different risks associated with different instruments, which points to the need for specialized treatments for different instrumental groups.

Posture is one of the major contributors to playing-related musculoskeletal disorders (PRMDs). According to Ralph Manchester, editor of *Medical Problems of Performing Artists*, "the field of occupational medicine has long recognized the importance of posture in the development of work-related injuries."[30] Quoted in this

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[26] Schoeb and Zosso, "You Cannot Perform Music Without Taking Care of Your Body," 129.

[27] Han-Sung Lee et al.,"Musicians' Medicine: Musculoskeletal Problems in String Players," *Clinics in Orthopedic Surgery* 5, no. 3 (2013): 155.

[28] Ibid., 156.

[29] R. Leaver, E. C. Harris, and K. T. Palmer, "Musculoskeletal Pain in Elite Professional Musicians from British Symphony Orchestras," *Occupational Medicine* 61, no. 8 (2011): 549.

[30] Ralph A. Manchester, "Posture and PRMDs," *Medical Problems of Performing Artists* 29, no. 1 (March 2014): 1.

article was meta-analysis published in 1997 by The National Institute of Occupational Safety and Health (NIOSH).[31] The review critically evaluated all of the previous relevant research on risk factors for occupational injuries. The researchers advocated that people sustaining extreme postures involving the neck and shoulder muscles were at increased risk for musculoskeletal disorders, especially people working with repetitive flexion or abduction of the shoulder at a sixty-degree angle or higher, for long periods of time.[32] They also found associations between posture and hand/wrist tendinitis, and posture and low back disorders.[33]

In their study Steinmetz, Seidel, and Muche found that 93% of eighty-four musicians suffering from playing-related musculoskeletal disorders had dysfunction of postural stabilization systems. More specifically, 85% had scapular impairments and 71% had lumbo-pelvic impairments.[34] Furthermore, string players were more affected in lumbo-pelvic stabilization than other musicians. The researchers concluded that insufficiencies of the postural stabilization systems play an important role in the cause of

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[31] Bruce P. Bernard et al., *Musculoskeletal Disorders and Workplace Factors: A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back,* ed. Bruce P. Bernard, NIOSH (July 1997), accessed February 7, 2017, http://www.cdc.gov/niosh/docs/97-141/pdfs/97-141.pdf.

[32] Bruce P. Bernard et al., *Musculoskeletal Disorders and Workplace Factors,* quoted in Ralph A. Manchester, "Posture and PRMDs," *Medical Problems of Performing Artists* 29, no. 1 (March 2014): 1-2.

[33] Ibid., 2.

[34] Anke Steinmetz, Wolfram Seidel, and Burkhard Muche, "Impairment of Postural Stabilization Systems in Musicians With Playing-Related Musculoskeletal Disorders," *Journal of Manipulative and Physiological Therapeutics* 33, no. 8 (October 2010): 603.

musculoskeletal disorders of musicians, and they suggested training the stabilization systems for the treatment and prevention of musculoskeletal disorders.[35]

A study by Andrade and Fonseca involved the participation of 400 string instrument students from different musical institutions in Brazil. The researchers reported that 91 % of the students had experienced pain or discomfort possibly related to playing their instrument, 45 % of the students believed playing their instrument was the primary cause for those problems, and 35 % of the students had to stop playing at some point as a consequence of the problems.[36] Furthermore, they identified four major contributors to musculoskeletal disorders. The primary contributor was incorrect posture, not necessarily associated with playing the instrument. Second was poor posture associated with playing an instrument, related to improper fit and inappropriate sizing of the instrument, together with excessive tension during performance. Third was faulty technique that contributed to tension. The last was inherent joint problems. The researchers reported that 90 % of the musculoskeletal problems were due to postural inadequacies.[37]

Chan, Driscoll, and Ackerman sustained that PRMDs in instrumentalists are mainly caused by factors such as awkward postures, maladaptive movement patterns, and

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[35] Ibid.

[36] Edson Queiroz de Andrade and João Gabriel Marquez Fonseca, "O Músico e Seu Corpo," *Fisio&Terapia* 5, no 25. (February, March 2001): 22, accessed February 7, 2017, https://issuu.com/oston/docs/edi____o_25.

[37] Ibid.

repetitive motions.[38] In their study, fifty-three full-time musicians from eight premiere symphony orchestras of Australia participated in an exercise program designed to improve PRMDs. The program lasted ten weeks and consisted of low-load resistive exercises that initially focused on postural muscles and local stability, and progressed to incorporate different functional positions and whole-body movements relevant to musical instrument playing.[39] The musculature that supports instrument-playing movements and postures was strengthened.[40] The results revealed that the exercise program was effective in reducing the frequency and severity of PRMDs after the intervention.

A recent study by Ramella and others analyzed the posture of music performance students at the Giuseppe Verdi Conservatory of Milan. The results revealed that of the 148 students, 73.6 % had non-optimal posture and 66.2 % had an actual postural disorder.[41] Moreover, the study identified that when playing an instrument requiring asymmetric posture, the general posture of the student when not playing was worsened, and there was an association between increased years of playing and worsened posture.[42] More specifically, the researchers identified that the most common postural faults among

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[38] Cliffton Chan, Tim Driscoll, and Bronwen J. Ackermann, "Effect of a Musicians' Exercise Intervention on Performance: Related Musculoskeletal Disorders," *Medical Problems of Performing Artists* 29, no. 4 (December 2014): 181.

[39] Ibid., 185.

[40] Ibid., 181.

[41] M. Ramella, F. Fronte, and R.M. Converti, "Postural Disorders in Conservatory Students: The Diesis Project," *Medical Problems of Performing Artists* 29, no. 1 (March 2014): 19–22.

[42] Ibid., 20.

students were an elevation of the left shoulder (41.2%), a right rotation of the trunk (37.8%), excessive curvature of the thoracic spine (20.3%), and a forward position of the left shoulder (20.3%).[43] The results highlight the need for balancing the body after repetitive, asymmetrical playing and counteracting asymmetric postures with specific exercises.

In another study, Lee and others used current technology to assess posture improvement after an exercise program intervention for students. The physical program included yogic breathing and muscle strengthening and flexibility exercises. Data from fifteen participant students were collected during eight weeks. Additionally, two of the students, a cellist and a flutist, participated in a kinematics motion analysis study in which they were recorded with video cameras in a laboratory.[44] The results revealed that the participant's playing appeared freer after the intervention. The program was successful in improving physical efficacy by increasing awareness of posture and tension. Lee and others help explain how it is possible to correct poor posture through movement classes:

> The awareness of one's body posture and maintenance of good spinal alignment can be improved by re-educating proprioceptive feedback. Body posture, dynamic somatic practices, and motor control are inherently connected, and kinesthetic re-education, which emphasizes both cognitive and kinesthetic awareness of postural reflexes, can influence a lasting change in the way a person controls body-mind behavior.[45]

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[43] Ibid., 20.

[44] Sang-Hie Lee et al., "Intervention Program in College Instrumental Musicians, with Kinematics Analysis of Cello and Flute Playing: A Combined Program of Yogic Breathing and Muscle Strengthening-Flexibility Exercises," *Medical Problems of Performing Artists* 27, no. 2 (June 2012): 85–94.

[45] Ibid., 86.

Since postural faults are the main cause for musculoskeletal disorders, it is necessary to provide movement education classes that help improve dynamic posture by re-educating proprioceptive feedback.

Various somatic and body movement programs have been successful in enhancing awareness in instrumentalists, such as Alexander Technique, Feldenkrais, yoga, and ELDOA. Nevertheless, the prevailing high rate of musculoskeletal disorders among instrumentalists, especially string players, raises some questions such as the following: When are students introduced to these practices? Are students encouraged to try these practices early enough, or only after they experience pain or injuries? Are there sufficient practices that are preventive in nature and address the whole body? Are the practices offered on a regular basis and do they focus on the health maintenance, rather than being isolated experiences?

One explanation for the high rate of musculoskeletal disorders in string players is a lack of duration and continuity of practices that support health, help maintain posture and awareness, and counteract the asymmetric postures of string instruments. Maintaining good posture while playing an asymmetric musical instrument requires specific awareness and strengthening of deep postural muscles. A one-time workshop or class may not be the answer to counteract years of asymmetric postures and faulty tendencies. Achieving and maintaining good posture is a lifetime endeavor. Therefore, the answer may lie instead in long-term or sustainable programs that students can continue to practice and develop well after the class ends, throughout their careers. There is room in the music curricula for a course that can provide string players with specific

exercises and tools that will help them improve posture, both with the instrument and without, and prevent injuries.

An exercise system that targets postural alignment specifically by re-educating proprioceptive feedback is *Pilates*. *Pilates* exercises enhance awareness and efficient body movement. They are designed to improve the functioning of the body through any activity, including playing a string instrument. Despite a lack of extensive research on the subject, several studies show the various areas in which *Pilates* proves to be effective, all of which are of interest to string players. Some of the emerging themes in *Pilates* studies include: studies on the musculoskeletal system, studies on posture and alignment, studies on stabilization and dynamic balance, studies on flexibility and extension, studies on breathing and the abdominals, and studies on brain function and mindfulness.

Studies on the Effectiveness of *Pilates*

Amongst the most popular studies on *Pilates* and the musculoskeletal system are those about chronic low back pain. A study by Anderson compared the effectiveness of an active approach (*Pilates*) versus a passive approach (massage) in treating chronic low back pain. Twenty-one subjects with chronic low back pain (CLBP) and recurrent low back pain (RLBP) participated in a six-week intervention of either *Pilates* or therapeutic massage, twice a week. The therapeutic massage included superficial fluid techniques, neuromuscular techniques and connective tissue techniques.[46] While the findings

[46] Brent D. Anderson, "Randomized Clinical Trial Comparing Active Versus Passive Approaches to the Treatment of Recurrent and Chronic Low Back Pain," PhD diss., University of Miami, December 2005, ProQuest (AAT 3198729), 96.

suggested that both *Pilates* and massage therapies may be effective treatments for CLBP and RLBP, significant improvement was found in the *Pilates* group, specifically in back extension strength and vitality or energy levels.

Natour and others conducted a study to measure the effect of *Pilates* in patients with chronic non-specific low back pain (NSLBP). Sixty people participated in the study and were divided into an experimental group and a control group. The experimental group took fifty-minute *Pilates* classes twice a week over ninety days, while the control group did not participate in any exercise. During the study, the *Pilates* group gradually reduced their intake of pain medication, and by the end of the study the *Pilates* group reported a significant reduction of pain. Additionally, the results revealed an improvement in quality of life measures such as functional capacity and vitality in the *Pilates* group.[47]

Another study on the effects of *Pilates* exercise on chronic NSLBP is one by Miyamoto and others. Eighty-six patients participated in the study, which took place at the outpatient physical therapy department at the University of the City of São Paulo, Brazil. All participants received minimal educational intervention in the form of a booklet containing information about the anatomy of the spine and biomechanics. The participants were divided in two groups. One group participated in twelve sessions of *Pilates* exercise over six weeks, while the other group did no *Pilates* exercise. The results revealed an improvement of low back pain in the *Pilates* group compared to the non-

[47] Jamil Natour et al., "Pilates Improves Pain, function and quality of life in Patients with Chronic Low Back Pain: A Randomized Controlled Trial," *Clinical Rehabilitation* 29, no. 1 (January 2015): 59-68.

Pilates group.[48]

A study by Patti and others measured the effects of *Pilates* on pain perception and balance control on people with chronic NSLBP. Thirty-eight participants were divided into an experimental group and a control group. The experimental group participated in a fourteen-week *Pilates* exercise program, taking fifty-minute mat *Pilates* classes three times a week. The control group participated in a social program. The researchers found improvement in pain perception and balance control in the *Pilates* group.[49]

A leading study on *Pilates* treatment for shoulder and neck issues was conducted by Keays and others. The study, titled "Effects of *Pilates* exercises on shoulder range of motion, pain, mood, and upper extremity function in women living with breast cancer," was one of the first to analyze the effectiveness of *Pilates* in treating shoulder problems. Breast cancer patients who had developed impaired range of shoulder motion participated in the study. Results indicated an improvement in shoulder abduction and shoulder rotation range of motion after three months of *Pilates* intervention.[50]

Another leading study, by Mallin and Murphy, was one of the first to test *Pilates* in the improvement of chronic neck pain. The study supports the relationship identified

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[48] Gisela C. Miyamoto et al., "Efficacy of the Addition of Modified Pilates Exercises to a Minimal Intervention in Patients With Chronic Low Back Pain: A Randomized Controlled Trial," *Physical Therapy* 93, no. 3 (March 2013): 310-320.

[49] Antonino Patti et al.,"Pain Perception and Stabilometric Parameters in People With Chronic Low Back Pain after a Pilates Exercise Program," *Medicine* 95, no. 2 (January 2016): 1-7.

[50] Kim S. Keays et al., "Effects of Pilates Exercises on Shoulder Range of Motion, Pain, Mood, and Upper Extremity Function in Women Living with Breast Cancer: A Pilot Study," *Physical Therapy* 88, no. 4 (April 2008): 494-510.

by previous research between chronic neck pain and abdominal weakness, which is similar to the relationship between core weakness and chronic low back pain.[51] The study consisted of a six-week intervention utilizing *Pilates* mat exercises from a level one matwork program from the Australian *Pilates* and Physiotherapy institute. The researchers found improvement in neck pain and functional ability at the end of the study, at six weeks, and an even greater difference after the study had concluded, at twelve weeks, suggesting that the effects of *Pilates* are long-term. According to the researchers, "[*Pilate*s] involves motor relearning of movement that includes cognitive, associative, and automatic stages. It can take many weeks before movements can be performed subconsciously."[52] The exercises take time to learn and assimilate, but once learned they are invaluable tools with long lasting effects.

The following studies show the effectiveness of *Pilates* on postural balance and alignment. The study by Sun-Myung Lee and others compared the effects of *Pilates* to an exercise program in people with an unhealthy degree of forward head posture. Twenty-eight sedentary women participated in the study and were divided into a *Pilates* group and a combined exercise group. The two groups performed exercise during fifty-minute sessions, three times a week, for ten weeks. The findings revealed significant increases in the craniovertebral angle, which was measured through x-rays, and cervical range of motion in the *Pilates* group. According to Lee and others, "the craniovertebral angle (CVA) is defined as the angle of the horizontal line running through the C7 spinous

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[51] Germaine Mallin and Susan Murphy, "The Effectiveness of a 6-week Pilates Programme on Outcome Measures in a Population of Chronic Neck Pain Patients: A Pilot Study," *Journal of Body Work and Movement Therapies* 17, no. 3 (July 2013): 382.

[52] Ibid.

process [i.e., involving the 7th cervical vertebra] and the line connecting the C7 spinous process to the tragus of the ear"[53] (see figure 1.1). The increased angle (CVA) shows a reduction of FHP. The results suggest that *Pilates* can be recommended for the treatment of forward head posture in sedentary individuals.[54]

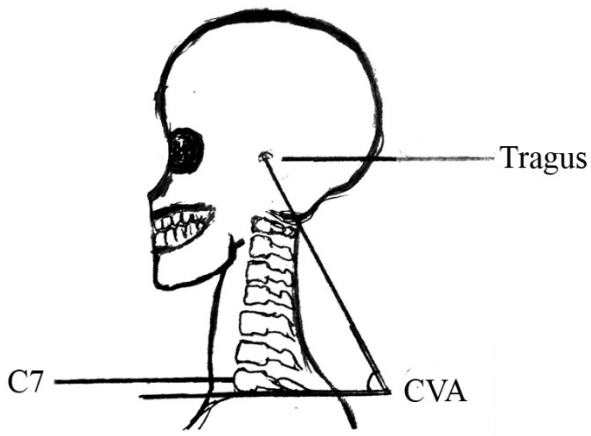

Figure 1.1. Craniovertebral angle, adapted from Lee and others, "Clinical Effectiveness of a Pilates Treatment for Forward Head Posture," 2010.

Hyo Taek Lee and others conducted a study on the effects of *Pilates* on postural alignment and health in middle-age women. Thirty-six participants were divided into an experimental group and a control group. The experimental group took *Pilates* classes three times a week over twelve weeks, while the control group did not exercise. After the study the *Pilates* group showed an improvement of postural alignment.[55] There appeared

[53] Sun-Myung Lee et al., "Clinical Effectiveness of a Pilates Treatment for Forward Head Posture," *Journal of Physical Therapy Science* 28, no. 7 (July 2016): 2009.

[54] Ibid.

[55] Hyo Taek Lee et al., "Effect of Mat Pilates Exercise on Postural Alignment and Body Composition of Middle-Aged Women," *Journal of Physical Therapy Science* 28, no. 6 (June 2016): 1693.

to be a connection between decreased body fat and increased muscle mass in the abdominal region, contributing to better trunk postural alignment. This suggests that proper muscle mass is an important factor for trunk postural alignment.[56]

Another study by Campos de Oliveira and others measured the effects of *Pilates* on muscle strength, postural balance, and quality of life in older adults to determine if *Pilates* can help reduce the likelihood of falls. The group was divided into an experimental group, which participated in *Pilates* sessions two times a week for twelve weeks, and a control group, which performed static stretching during the same period of time. The researchers used a machine called an "isokinetic dynamometer" to measure the muscle strength of the knee extensors and flexors, which helps indicate likelihood for falls. After the study, the *Pilates* group showed a significant improvement of strength in the knee extensors and flexors, dynamic and static balance, and functional mobility. They also reported a significant improvement in quality of life.[57]

Other studies show benefits of *Pilates* on deep muscles responsible for stability and dynamic balance. A study by Phrompaet and others analyzed the effects of *Pilates* exercise on lumbo-pelvic stability and flexibility (control and movement of the trunk and pelvis). The forty participants were divided into an experimental group and a control group. The experimental group performed *Pilates* exercise for forty-five minutes, twice a

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[56] Ibid.

[57] Laís Campos de Oliveira, Raphael Gonçalves de Oliveira, and Deise Aparecida de Almeida Pires-Oliveira, "Effects of Pilates on Muscle Strength, Postural Balance and Quality of Life of Older Adults: A Randomized, Controlled, Clinical Trial," *Journal of Physical Therapy Science* 27, no. 3 (2015): 871.

week for eight weeks. The control group participated in normal activities and was allowed to exercise for no more than twenty minutes, two times a week during the same eight weeks. The results showed significant improvement in lumbo-pelvic stability and flexibility of the lower back and legs in the *Pilates* group. The researchers suggest that *Pilates* may be helpful to prevent and treat musculoskeletal injuries.[58]

The study by Kliziene and others used *Pilates* exercises to improve lumbar stability in women with chronic low back pain. During sixteen weeks, the experimental group participated in a mat *Pilates* program twice a week for sixty minutes. The exercises chosen had previously been used in clinical practice to improve lumbar stability and included: The Pelvic Lift or Bridge, Leg Kick, Half Roll-Down, Roll-Up, Hundred, Rolling, Like a Ball, One Leg Circle and Spine Stretch (see Chapter 6 for exercise descriptions). By the end of the study, there was significant improvement in isometric trunk extension and flexion strength, which has been associated with trunk and pelvis stability and reduced low back pain. Furthermore, there was a reduction of chronic low back pain that persisted for a month after the end of the program.[59]

Johnson and others conducted a study on the effects of *Pilates* on dynamic balance (balance during movement) in healthy adults. Forty participants were divided into two groups. The experimental group completed ten sessions of *Pilates* exercise during five weeks, while the control group did not participate in *Pilates* and was

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[58] Sureeporn Phrompaet et al., "Effects of Pilates Training on Lumbo-Pelvic Stability and Flexibility," *Asian Journal of Sports Medicine* 2, no. 1 (March 2011): 16-22.

[59] Irina Kliziene et al., "Effects of a 16-week Pilates Exercises Training Program for Isometric Trunk Extension and Flexion Strength," *Journal of Bodywork and Movement Therapies* 21, no. 1 (2016): 1-9.

instructed to continue their current activity level without starting a new exercise program. After the study, significant improvement in dynamic balance was observed in the *Pilates* group. Furthermore, the study states that *Pilates* is beneficial for athletes to improve their performance through precise, controlled movements.[60] This indicates that *Pilates* would also benefit string players, because string players constantly work with the balance of their bodies and instruments, and every movement requires control and precision.

A study by dos Santos and others analyzed the effect of *Pilates* on lumbar extension and scapula stabilizer muscles. Twenty-four participants were divided into two groups. The experimental group participated in twelve *Pilates* sessions of fifty to sixty minutes each, three times a week, utilizing the "Reformer" machine. The control group did not participate in any type of exercise. After the twelve *Pilates* sessions they found a significant increase in the strength of the lumbar extension and scapular stabilization muscles in the *Pilates* group.[61]

The study by Campos de Oliveira and others showed benefits of *Pilates* for flexibility. The study compared the effects of static stretching to *Pilates* on the flexibility of healthy women over sixty years old. Thirty-two participants performed either *Pilates* exercises or static stretching for sixty minutes, twice a week, over the course of three months. Flexion and extension of the trunk, hip flexion, plantar flexion and dorsiflexion

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[60] Eric G. Johnson et al., "The effects of Pilates-based Exercise on Dynamic Balance in Healthy Adults," *Journal of Bodywork and Movement Therapies* 11, no. 3 (July 2007): 241.

[61] Núbia Tomain Otoni dos Santos et al., "Increased Strength of the Scapular Stabilizer and Lumbar Muscles after Twelve Weeks of Pilates Training Using the Reformer Machine: A Pilot Study," *Journal of Bodywork and Movement Therapies* 21, no. 1 (June 2016): 1-7.

of the foot/ankle were measured before and after the study with a fleximeter. The results showed that the static-stretching group only gained improved trunk flexion and hip flexion, while the *Pilates* group showed improved flexion in all the areas measured, suggesting that *Pilates* is more effective in improving flexibility in most body segments.[62]

The studies by Barbosa and others and Giacomini and others analyzed the effects of *Pilates* breathing on the deep abdominal muscles and respiratory muscles. Barbosa and others used surface electromyography technology to measure activation levels in the upper rectus abdominis, lower rectus abdominis, and transverse abdominis/internal oblique during *Pilates* exercise with appropriate breathing technique. The results confirm that the breathing technique of the *Pilates* method associated with trunk flexion increases the activation of the transverse abdominis and internal oblique.[63] Giacomini and others found an increase in respiratory muscle strength after *Pilates* exercise by measuring the maximum inspiratory and maximum respiratory pressure. They also found an increase in voluntary ventilation and increased thickness in the transversus abdominis, and internal

[62] Laís Campos de Oliveira, Raphael Gonçalves de Oliveira, and Deise Aparecida de Almeida Pires-Oliveira, "Comparison Between Static Stretching and the Pilates Method on the Flexibility of Older Women," *Journal of Bodywork and Movement Therapies* 20, no. 4 (2016): 1-7.

[63] Alexandre Wesley Carvalho Barbosa et al., "The Pilates Breathing Technique Increases the Electromyographic Amplitude Level of the Deep Abdominal Muscles in Untrained People," *Journal of Bodywork and Movement Therapies* 19, no. 1 (January 2015): 57-61.

and external obliques.[64]

Finally, the studies by Bian and others and Caldewell and others support the *Pilates* effects on the brain and mindfulness. Bian and others studied the effects of *Pilates* on brain function. They measured Alpha rhythm (electrical activity of the brain) changes in the whole brain and in its different regions during *Pilates* training. After the study, it was found that the neural network of the brain was more active and synchronization strength was improved in the frontal and temporal regions of the brain (areas associated with cognition). The researchers suggested that *Pilates* training has the capacity to improve brain function and possibly intelligence. Furthermore they suggested that *Pilates* training is beneficial for recovery in cases of degenerative brain diseases and cognitive dysfunction.[65]

In the study by Caldwell and others, students were recruited from two undergraduate collegiate classes, *Pilates* Method and Special Recreation. Only women were analyzed in the study to hold that variable constant. There were 158 subjects in the *Pilates* Method group and forty-four in the Special Recreation group. By the end of the study, self-reports showed increases in mindfulness and relaxation, as well as a reduction of negative mood, in the *Pilates* group. Furthermore, the researchers reported that the students who experienced increases in mindfulness were more likely to experience

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[64] Mateus Beltrame Giacomini et al., "The Pilates Method Increases Respiratory Muscle Strength and Performance as Well as Abdominal Muscle Thickness," *Journal of Bodywork and Movement Therapies* 20, no. 2 (April 2016): 258-264.

[65] Zhijie Bian et al., "Effect of Pilates Training on Alpha Rhythm," *Computational and Mathematical Methods in Medicine* 2013 (2013): 1-7.

enhanced self-regulatory and self-efficacy levels.[66]

This chapter has presented a literature review of studies on musculoskeletal disorders among instrumentalists, and has identified that string players are the most affected group and that posture is one of the major causes of problems. This chapter has additionally proposed the incorporation of *Pilates* in the music curriculum as a promising tool for musicians to improve posture and reduce the number of musculoskeletal disorders. The review of the literature of *Pilates* studies demonstrates the ample range of areas *Pilates* can help improve, all of interest to musicians. Chapter 2 provides a background of the method, including its founder's motivations and principles, *Pilates'* benefits for performing artists, challenges facing practitioners in maintaining the integrity of the method, and considerations for a *Pilates* class for musicians.

[66] Karen Caldewell et al., "Pilates Mindfulness and Somatic Education," *Journal of Dance and Somatic Practices* 5, no. 2 (December 2013): 141-153.

CHAPTER 2: THE PILATES METHOD

This chapter introduces the *Pilates* method, beginning with its founder's motivation and philosophies. The impact that *Pilates* has had on the dance community is explained, and I show how *Pilates* can help musicians in a similar way to dancers. Next is a discussion of the issues facing practitioners in maintaining the integrity of the method in its many manifestations. Finally, an overview of considerations for a *Pilates* class for musicians is presented. The *Pilates* method has been italicized to distinguish it from its founder, Joseph H. Pilates.

The *Pilates* method was developed by Joseph Hubertus Pilates (1883-1967), based on his extensive research on the human body and the laws of nature. Deeply influenced by his historical context, Pilates was concerned with developing a method that would restore the health of people, which he named a "corrective system of exercises."[67] More than a simply system of exercises, his method has a strong philosophical background, which draws from a rich array of influences. Pilates devoted his life to the study of different exercise methods, combined with a keen understanding of human anatomy and biomechanics, along with Greek and Eastern philosophies. Pilates was also an inventor who designed unique apparatuses to perform his exercises and "corrective" or anatomically improved furniture.

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[67] Joseph H. Pilates, *Your Health: A Corrective System of Exercising that Revolutionizes the Entire Field of Physical Education* (1934), in *The Complete Writings of Joseph H. Pilates*, comp., ed. and rev. by Sean P. Gallagher and Romana Kryzanowska, (Philadelphia: Brain Bridge Books, 2000) 16.

Pilates' Motivations

The only thorough biography of Pilates to date, *Joseph Hubertus Pilates: The Biography,* was written by Javier Pérez Pont and Esperanza Aparicio Romero.[68] This work was released in Spanish, Italian and English in 2013. For their work, the authors consulted an extensive list of official records and documents and compared them to what has been said about Pilates by either people who knew him directly or in magazines and journals of the time. Sources consulted by Pont and Romero include the United States Federal Census, U.S. Public Records, U.S. Citizenship and Immigration Services, the National Circus Archives of Britain, World War I Draft Registration cards, various lists of prisoners of war in different British cities and more. In contrast, much of what has been written and said about Pilates by other sources is inaccurate or misleading, because the authors relied mostly on anecdotal accounts.

The biography by Pont and Romero confirms a few facts that are relevant to this paper and will be discussed here. Those seeking more information about Pilates should consult the Pont and Romero biography. The first fact has to do with how Pilates was able to heal himself through exercise, and how his condition influenced the method. The second has to do with evidence of *Pilates'* effectiveness through its use by police forces and performing artists.

Joseph Hubertus Pilates was born in Monchengladbach (Gladbach), Germany in

[68] Javier Pérez Pont and Esperanza Aparicio Romero, *Joseph Hubertus Pilates: The Bibliography*, English trans. Denise Tobin and Adriana Cañameras Vall (Barcelona: HakaBooks.com, 2013).

December 1883.[69] As a child he suffered from asthma and very weak muscles, especially in his chest.[70] His condition led him to an interest in restoring his own health and strength, and to dedicate himself to the study of human movement. He became interested in creating exercises to gain muscular strength and exercises to improve lung capacity.[71] This is evidenced in most of the *Pilates* exercises which concentrate on breath, but more specifically in exercises in which the back is rolled against the mat in combination with breathing, to help expel all of the air out of the lungs in order to fill them with new air. Pilates also invented an apparatus called the Air-o-Mill, which was designed to improve lung capacity, and was used by several of his clients who were opera singers, including soprano Roberta Peters, who claimed the device helped her improve high notes.[72] The Air-o-Mill or air mill, consisted of a tube into which the person would blow to spin a helix.

By the time Pilates was nineteen years old, not only had he achieved excellent health, but also he had become a boxer and bodybuilder, and it is possible that he had already begun to develop his method, which he first named Contrology. In the years following World War I, his method started to gain recognition for its effectiveness in restoring health and strengthening the body. Around 1924, Pilates started working for the

[69] Pont and Romero, *Pilates: The Bibliography*, 29.

[70] Ibid., 58.

[71] Ibid., 61.

[72] Ibid., 310.

Hamburg police force as head of the physical education program.[73] In 1925 the Nazi party was reconstituted and Pilates was invited to train their military force.[74] That was when he decided to move to the United States and open his own independent studio.

Pilates opened his studio, together with his wife-to-be Clara Zeuner in 1927, at 939 Eighth Avenue in New York, the "Van Dyck" building. According to documentation found by Pont and Romero, the Van Dyck building hosted a broad range of artists including music teachers, illustrators, painters, several dance societies, and possibly the Grand Opera Society of New York. The building was also very close to other centers for artists, such as the Towers of Carnegie Hall, which had 180 studios, including the American Academy of Dramatic Arts and the Ballet Arts studio.[75]

Besides the strategic location, Pilates chose the name "studio" to emphasize the artistic aspect of his corporal work, which was key in attracting artists. Pont and Romero were able to inspect the few of the surviving log books that contain the records of clients of the Pilates' studio. Interestingly, and apparently not well-known in the music community, an impressive number of clients were musicians. Some names that can be found in the surviving books include: composer and conductor John Philip Souza (1854-1932), composer George Gershwin (1898-1937), composer Samuel Barber (1910-1981), violinist Yehudi Menuhin (1916-1999), soprano Maria Callas (1923-1977), violinist and conductor Willem van Hoogstraten (1884-1964), opera singer Ruby Mercer (1906-1999),

[73] Ibid., 68.

[74] Ibid., 172.

[75] Ibid., 201-206.

piano virtuoso Leopold Godowsky (1870-1938), sopranos Roberta Peters (1930-2017) and Patrice Munsel (1926-2016), soprano Risë Stevens (1913-2013), Pianist Jess Meeker (1912-1997), composer and librettist Gian Carlo Menotti (1911-2001), soprano Elaine Malbin (1932), international voice teacher William Pierce Herman, singer Julius la Rosa, accordionist Gipsy Markoff, and German concert pianist Elly Ney, who formed the Elly Ney Trio along with Max Strub and Ludwig Huelscher.[76]

Pilates and Dance: *Pilates* as a Tool for Total Body Conditioning and Rehabilitation

Pilates became particularly recognized in the dance community, with a reputation that has endured until today. *Pilates* has proven to be so beneficial for this population that some people mistakenly believe *Pilates* was created exclusively for dancers. As has been shown, the former success of the method to train the police force in Hamburg make this far from the truth; however, the corrective aspect of *Pilates* helps many problems associated with dance technique and often helps dancers recover from injuries.

Taking a look at how the method has helped many dancers avoid or recover from injuries can help shed some light onto the prevention of musicians' injuries. Dancers put a lot of strains on their bodies, many times beyond what is considered anatomically correct or natural, over extended periods of time. Similarly, string players often spend many hours a day playing in unnatural asymmetrical postures, with misaligned bodies, doing repetitive motions. Many injuries in dancers happen because of improper conditioning. One of the problems is that dance classes often emphasize mechanics,

[76] Ibid., 208-315.

movement, and virtuosity, rather than the body. This also happens in musical training. The emphasis is on sound, musicality, technique and virtuosity, and often not enough on the body itself, correct posture, and prevalence of tension.

Since the major instrument for dancers is the body and many of the emphasized positions in classical dance are not anatomically ideal, such as the overly rotated first-position of the feet, body conditioning and balancing is crucial for this population. In the same way, the body positions of string players are asymmetrical and far from being anatomically ideal, such as the head position in violin and viola playing, or standing with the feet in a "v" position with the left foot placed forward, as will be explained in more detail in Chapter 5. Unfortunately, it is still not sufficiently recognized that such asymmetries in string playing require proper body conditioning and balancing. Important figures in the ballet community such as George Balanchine, Martha Graham and Jerome Robbins quickly recognized the value of *Pilates* for dancers and would regularly send their students for training and rehabilitation. Romana Kryzanowska (1923-2013) was sent to see Pilates by her teacher, George Balanchine, after a heel injury.[77] She would become a disciple of Pilates, and a key figure in maintaining the Pilates' legacy after his death in 1967. She taught the first *Pilates* class required for dancers, "Body Correctives," at the State University of New York, leading the path for the insertion of *Pilates* into the dance curriculum.[78] Another early example of a *Pilates* class for dancers that continues to exist today is the one originally taught by Pilates himself, at the renowned Jacob's Pillow

[77] "Pilates Legacy Project: Romana Kryzanowska," Pilates Anytime, accessed February 17, 2017, httph://www.pilatesanytime.com.

[78] Ibid.

Dance Festival in Massachusetts.

Unfortunately, for musicians, the body is often delegated to a secondary place, after performance on the main instrument, which may be the reason why musicians have not established a tradition of practicing *Pilates*. Sound and specific instrumental techniques are prioritized, failing to acknowledge the musician's body as the main instrument. This type of view continues to produce many injuries in the music community. Like dancers, musicians would benefit enormously from doing more *Pilates*, as this corrective exercise helps balance and restore the asymmetrical and unnatural playing positions that are often associated with pain and injuries.

In a recorded talk between Romana Kryzanowska and Jay Grimes about the life and work of Pilates, Grimes explained that "if your instrument [your body] is tuned, it does not make any difference if you are playing tennis, if you are playing golf, if you are running a marathon, if you are swimming; it is still the same instrument, you are simply using it in different combinations of muscles in a different rhythm."[79] In the same talk Kryzanowska also made reference to Jascha Heifetz and his effortless violin playing through balanced posture.[80]

Another similarity between dance and music is the search for quality and beauty through mastering of technique, organic movement and fluidity. In dance, the body is the main instrument to create art and beauty, and using the body with natural grace and organic movements corresponds to a certain artistic output. Similarly, in music, organic

[79] Krysanowska and Grimes, "Between Friends."

[80] Ibid.

movement and fluidity have a direct correlation to the quality of sound that is produced. Mastery of technique is reflected in fluid motions and mature musicality. Both disciplines are constantly regulating and controlling movement in the search for beauty. *Pilates* also strives for quality of movement in every exercise and its practice aims to subconsciously assimilate a natural grace in the way the body moves; the ultimate goal of *Pilates* is beautiful form and movements. This type of practice can be extremely helpful for musicians to enhance their music performance.

The rehabilitation aspect of *Pilates* not only has been proven successful in the dance community but also in the medical fields. In the 1990s *Pilates* became popular among rehabilitation practitioners with specializations in orthopedics, chronic pain, neurological rehabilitation, geriatrics, and others.[81] *Pilates'* effectiveness in rehabilitation stems from incorporating and assisting movement early in the rehabilitation process, which helps accelerate the process of healing.[82] Pilates designed numerous apparatuses to help people with varied physical problems perform his exercises, and they can be used as safe ways to re-introduce and regulate movement for injured patients. They are especially helpful because they are low impact, allow movement isolation, and also provide a way to work while mitigating the forces of gravity. They offer the options of working while lying on the back or on the side, as well as sitting, kneeling, or standing, thus providing many opportunities for patients who cannot load weight into their hips, knees, or ankles, for example, or patients with neck or back injuries. The ultimate goal, according to

[81] Brent D Anderson and Aaron Spector, "Introduction to Pilates Based Rehabilitation," *Orthopaedic Physical Therapy Clinics of North America* 9, no. 3 (September 2000): 395.

[82] Ibid.

Pilates, however, was to progress to and master the mat program, as he believed it represented the pinnacle of performance. The classical mat program utilizes only the resistance and weight of one's own body.

The *Pilates* Philosophy

Two known sources of Pilates' writings comprise the essence of his method and provide insight into his way of thinking. *Your Health* was published in 1934; it contains the author's ideas about optimal health and introduces his method, which he first named Contrology. *Return to Life through Contrology* was published in 1945; it contains thirty-four exercises from Contrology with detailed instructions on how to perform them and photographs that illustrate the exercises. These exercises represent the foundation of classical mat *Pilates*.

Pilates believed that most ailments, injuries, and premature deaths could be attributed to modern life and were directly traceable to wrong habits, and that optimal health could be achieved through the adoption of natural and normal habits. In his book, *Your Health,* Pilates explains that problems stem from the use of inadequate furniture, such as chairs, that have not been scientifically constructed and do not promote normal health.[83] In this book, he also introduces furniture that he designed according to his ideas. Furthermore, Pilates believed that a fundamental system or standard code should be implemented to help promote normal health and provide a standard foundation of healthy

[83] Joseph H. Pilates, *Your Health: A Corrective System of Exercising that Revolutionizes the Entire Field of Physical Education* (1934), ed. Presentation Dynamics (Incline, NV: Presentation Dynamics, 1998), 55.

physical culture, based on the natural laws of life. In *Your Health*, Pilates states, "only through the attainment of perfect balance of mind and body, can one appreciate what really constitutes normal health."[84]

Pilates' ideas on the optimum balance of mind and body clearly show the influence of ancient Greek philosophy. He claimed that the equal development of these two is needed to assure physical and mental perfection, the "very first law of civilization."[85] Body and mind need to be coordinated, to accomplish the maximum results with minimum mental and physical energy expenditure, and to live a long and healthy life. To achieve this perfect balance of mind and body, the mind first needs to be trained to control the body, until it becomes a natural process; hence the name of his method: Contrology. In *Your Health* Pilates explains the balance between mind and body:

> It is the conscious control of all muscular movements of the body. It is the correct utilization and application of the leverage principles afforded by the bones comprising the skeletal framework of the body, a complete knowledge of the mechanism of the body, and a full understanding of the principles of equilibrium and gravity as applied to the movements of the body in motion, at rest and in sleep.[86]

In *Return to Life through Contrology*, Pilates further explains that through purposefully practicing control of the body, one gradually and progressively acquires the natural rhythm and coordination associated with subconscious activities. He observed that true

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[84] Ibid., 10.

[85] Joseph H. Pilates, *Your Health: A Corrective System of Exercising that Revolutionizes the Entire Field of Physical Education* (1934), in *The Complete Writings of Joseph H. Pilates*, comp., ed. and rev. Sean P. Gallagher and Romana Kryzanowska (Philadelphia: Brain Bridge Books, 2000), 32.

[86] Ibid., 20.

rhythm and control in both domestic and wild animals.[87]

Pilates combined both Eastern and Western philosophies into a well-balanced method. In Western tradition, mind and body are seen as separate entities, with the notion that physical fitness has an effect on mental health. In Eastern tradition, mind and body are part of the same entity and are ideally in complete harmony. Physical discipline is used to achieve spirituality. In *Pilates* there is a deep connection to the physical center and to breathing, and a meditative quality arises from being focused on those aspects throughout a session.

The Original *Pilates* Method, the Present Challenge in Maintaining its Integrity and Considerations for a *Pilates* Class for Musicians

After Pilates died, in 1967, his wife Clara Zeuner and Romana Kryzanowska continued to run the studio. Romana Kryzanowska, along with other direct students of Pilates, became known as the first generation of teachers or "The Elders". They include: Eve Gentry (1910-1994), Carola Strauss Trier (1913-2000), Mary Bowen, Lolita San Miguel, Kathy Stanford Grant (1921-2010), Ron Fletcher (1921-2011) and Jay Grimes. These teachers have been key in passing on the knowledge to the next generations. Additionally, some of them have incorporated *Pilates* in the dance curriculum. Kathy Grant and Eve Gentry taught courses in *Pilate*s for dancers at the New York University, Tisch School of the Arts.[88] Lolita San Miguel founded the "The Conservatory of Ballet

[87] Joseph H. Pilates, *Pilates' Return to Life through Contrology* (1945), 53.

[88] "The Elders," Rolates Pilates: The Original Joseph Pilates Studio, accessed February 13, 2017, http://rolates.com/r.

Concierto" in Puerto Rico, with *Pilates* classes as a prerequisite for all dancers, from four-years-olds to professionals.[89]

One current challenge with the *Pilates* method is to maintain the integrity and quality of the work as it was originally taught by Pilates. One of the reasons why the reputation of *Pilates* continues to suffer is because the method gets changed into something else, and thus loses its vital qualities. Currently a variety of classes use the name *Pilates* but often leave out some of the most important principles of the method. Although not specifically notated as tenets of the method, six principles are commonly recognized that were addressed in Pilates' teachings (concentration, center, control, precision, breath and flow), which must be present throughout the workout since they are essential to its effectiveness.[90] Together with the principles, the emphasis on alignment is vital to the success of the exercises. Contemporary *Pilates* classes that fail to address any of these principles or overlook alignment do not represent the method properly, and might as well be called something else.

In an attempt to consolidate what constitutes the *Pilates* method, the Pilates Method Alliance was formed in 2001. The PMA is both a professional association and a certifying agency.[91] The aim of this organization is to create guidelines and standards for

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[89] Lolita San Miguel, accessed February 13, 2017, http://www.lolitapilates.com.

[90] Rael Isacowitz and Karen Clippinger, *Pilates Anatomy* (Champaign, IL: Human Kinetics, 2011), 1.

[91] "Professional Association and Certification Program," Pilates Method Alliance, accessed February 13, 2017, http://www.pilatesmethodalliance.org/i4a/pages/index.cfm?pageid=1.

certifying *Pilates* schools in order to ensure the quality of the *Pilates* method. Through annual conferences, *Pilates* practitioners around the world gather to share knowledge and information and to preserve the Pilates' legacy. In recent years the PMA has become more involved in research, because this is necessary for the evolution and prosperity of the method.

Learning *Pilates* is similar in many ways to learning an instrument, requiring time and consistent feedback from part of the instructor. It also takes considerable training on the part of the instructor to correctly guide the student in the most efficient way. The success of the method lies on the ability to focus on and master all of the principles while performing the exercises, as well as working from correct alignment. What may seem like a "simple" movement may involve fine motor control skills and fine coordination of principles. Alan Menezes gives an analogy of the importance of the principles in *Pilates.* "Being ignorant of the essentials is akin to attempting to drive a car without the engine: You may cruise down the hills, but driving becomes extremely hard work when you reach the uphills!"[92] An additional challenge in teaching *Pilates* is that one cannot simply learn the motions of the exercises in order to teach them, as may happen in many other types of workouts, and the exercises are not absolutely standardized. Because *Pilates* is based on the idea of "correcting" the body, it must be properly adapted for different people, and therefore requires a highly trained person to "prescribe" the exercises. While some exercises may be highly beneficial for some people, others may be contraindicated and considerably dangerous for others.

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[92] Allan Menezes, *The Complete Guide to Joseph H. Pilates' Techniques of Physical Conditioning* (Alameda, CA: Hunter House Inc., 2004), 21.

Several guidelines are essential to *Pilates*: The class size is usually small (four to six students) so the teacher can focus on each student, make individual corrections and adjust the exercises accordingly. The teacher directs the work mostly through verbal instructions and cues, demonstrating exercises visually only when necessary. There is no music to distract the mind, since it takes a lot of concentration to focus on all the details of the work. Talk among the students is limited or completely excluded during the exercises, as it is also a form of distraction. The entire body is worked and there is a limited number of repetitions for each movement. The intention is not to overwork or exhaust the body but rather to provide circulation to every part of the body, which is also achieved through proper breathing. The objective of the work is to strengthen and stretch the muscles at the same time, providing the right oxygenation to the muscles. After the work one should feel invigorated and relaxed at the same time, with an overall feeling of happiness.

All of these are essential elements in an effective *Pilates* class. Unfortunately, because of lack of proper training among teachers, and marketing devices, some of the benefits are often lost. Examples include classes that target a specific audience (usually women) or that are designed from a superficial standpoint. “Flat abs,” “sculpted six-pack,” “core blasting,” and “abs of steel” are some of the marketing devices that represent a misguided approach to the work of Pilates by overemphasizing one area of the body over the entire body. The emphasis on health and proper functioning of the entire system is lost, and the abdominals become a purely aesthetic part of it.

The *Pilates* method is very effective at working the entire body and core properly. The problem that arises when unnecessarily stressing some areas over others is that the

body is not properly balanced and conditioned as a whole. *Pilates* works the entire body, particularly smaller and deeper muscle groups that support postural balance.

One central concept in *Pilates* is the concept of "powerhouse" or core, which refers to important muscles in the center of the body. The muscles of the powerhouse include: the rectus abdominis, the obliques, the multifidus, the transversus abdominis, the pelvic floor, the diaphragm, the gluteal group and psoas (see figures 2.1 and 2.2).[93] The transversus abdominis is one of the deepest abdominal muscles located around the waist/lower abdomen, and its function is primarily posture. It also assists with breathing, especially when exhaling forcefully.[94] This muscle automatically activates in relation to any limb movement in order to protect the spine.[95] In *Pilates*, the transversus abdominis is consciously activated before each exercise begins, through an isometric contraction by pulling in of the abdomen and a forced exhalation, to enhance its proper functioning.

The deeper muscles of the powerhouse are crucial for spinal stability and lumbo-pelvic stability. The transversus abdominis and the internal and external oblique muscles are crucial for trunk stability and balance.[96] Campos de Oliveira and others explain that *Pilates* strengthens the muscles responsible for lumbo-pelvic stabilization (stabilization of the trunk and pelvis), such as flexors and extensors of the trunk, enhancing postural

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[93] Paul Massey, *The Anatomy of Pilates* (Berkeley, CA: North Atlantic Books, 2009), 12.

[94] June Kloubec, "Pilates: How Does It Work and Who Needs It?" *Muscles, Ligaments and Tendons Journal* 1, no. 2 (April-June 2011): 62.

[95] Ibid., 62.

[96] Eric G. Johnson et al., "The Effects of Pilates-based Exercise on Dynamic Balance in Healthy Adults." *Journal of Bodywork and Movement Therapies* 11, no. 3 (July 2007): 238.

balance and consequently reduce the risk of falls.[97] Phrompaet and others state that the lack of activation or poor control of deep trunk muscles such as the transversus abdominis and multifidus (deep muscle attached to the spinal column), results in lack of control of lumbo-pelvic stability and is an early detecting sign for back problems and musculoskeletal injuries.[98]

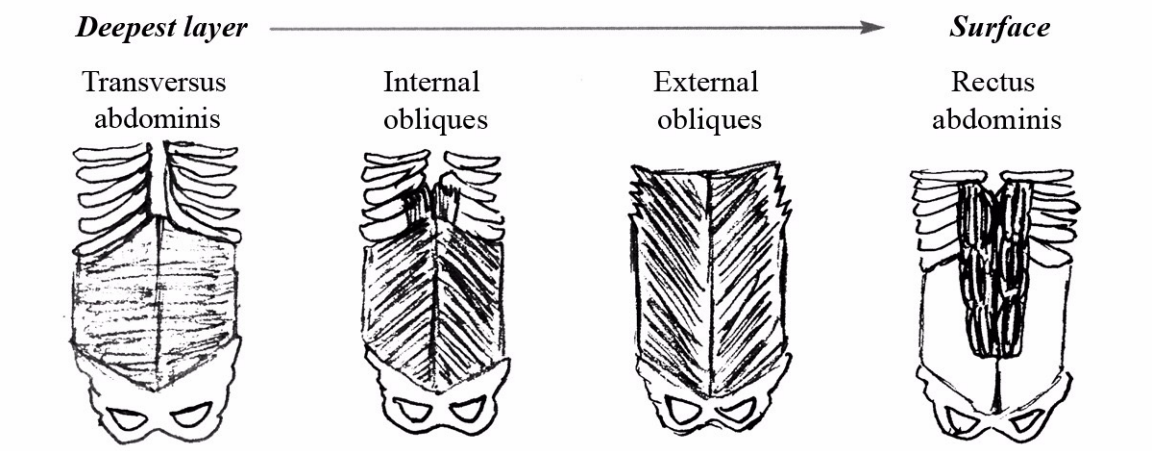

Figure 2.1. Abdominal muscles of the powerhouse, adapted from Menezes, *The Complete Guide to Joseph Pilates' Techniques of Physical Conditioning*, 50.

[97] Laís Campos de Oliveira, Raphael Gonçalves de Oliveira, and Deise Aparecida de Almeida Pires-Oliveira, "Effects of Pilates on Muscle Strength, Postural Balance and Quality of Life of Older Adults: A Randomized, Controlled, Clinical Trial." *Journal of Physical Therapy Science* 27, no. 3 (2015): 874.

[98] Sureeporn Phrompaet et al., "Effects of Pilates Training on Lumbo-Pelvic Stability and Flexibility," *Asian Journal of Sports Medicine* 2, no.1 (March 2011): 16.

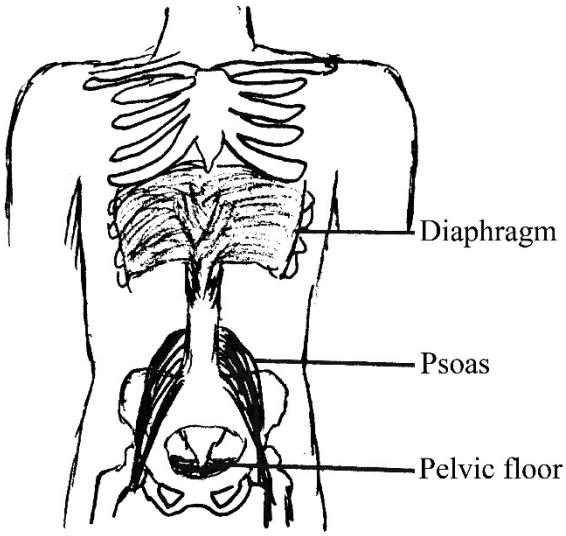

Figure 2.2. Muscles of the powerhouse.

Another important concept particularly emphasized in *Pilates* is that of the "secondary powerhouse", which refers to the stabilization of the shoulder girdle.[99] The function of the second powerhouse is to stabilize and enhance efficient movement around the upper limbs during exercises.[100] These muscles are of particular interest to musicians because they stabilize the joints and assure safe and effective movement. They include: the lower trapezius, serratus anterior, latissimus dorsi, pectorals and deep neck flexors (see figure 2.3).[101]

[99] Massey, *The Anatomy of Pilates*, 12.

[100] Ibid.

[101] Ibid.

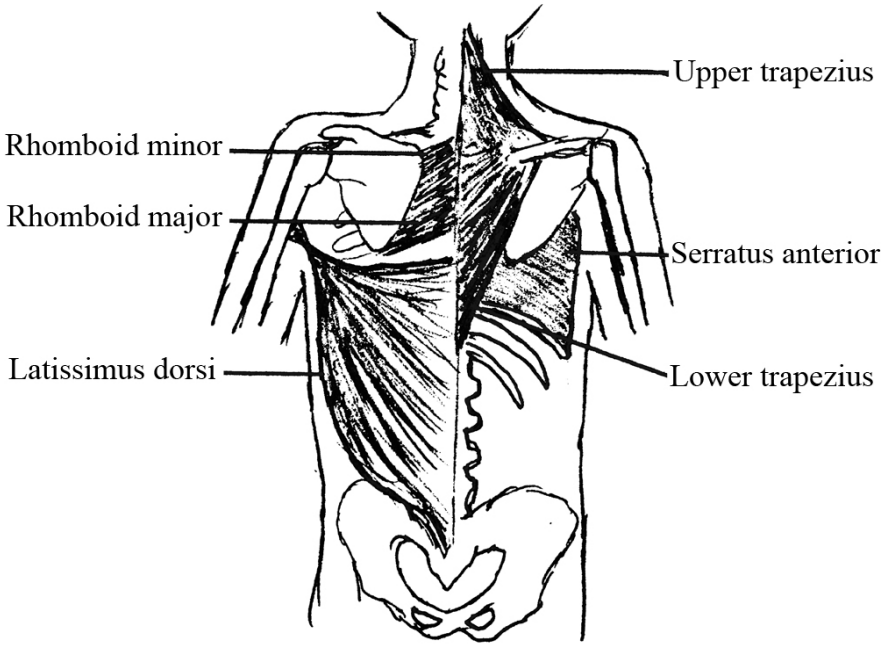

Figure 2.3. Muscles of the secondary powerhouse, adapted from Massey, *The Anatomy of Pilates*, 41.

Steinmetz, Seidel and Muche suggested that insufficiencies of the postural stabilization systems such as the scapular stabilizers and lumbo-pelvic stabilization system, were the main cause for musculoskeletal pain and disorders in string players.[102] According to Mallin and Murphy, *Pilates* encourages correct body mechanics by targeting these muscles, which are often overlooked during traditional workouts.[103]

In non-authentic *Pilates* classes, the transversus abdominis (TA) may not properly be activated, due to poor cueing, lack of concentration, or an excessive number of

[102] Anke Steinmetz, Wolfram Seidel, and Burkhard Muche, "Impairment of Postural Stabilization Systems in Musicians With Playing-Related Musculoskeletal Disorders." *Journal of Manipulative and Physiological Therapeutics* 33, no. 8 (October 2010): 603.

[103] Germaine Mallin and Susan Murphy, "The Effectiveness of a 6-week Pilates Programme on Outcome Measures in a Population of Chronic Neck Pain Patients: A Pilot Study," *Journal of Body Work and Movement Therapies* 17, no. 3 (July 2013): 377.

repetitions, and as a result only the superficial abdominals may be emphasized, such as the rectus abdominis (RA). Failure to properly activate the TA results in losing some of the vital benefits of *Pilates* for lumbo-pelvic stability, spinal stability and balance. Proper scapular stabilization also requires proper cuing along with considerable guidance and assistance from the instructor towards each student. Failure to properly stabilize the scapula often leads to problems.

Other traits of non-traditional *Pilates* classes often include music that distracts from the work and an emphasis on visual rather than verbal cues. While the music takes away from concentration, the visual demonstration takes away from the individual experience of how the work feels inside one's body and becomes more of an external input of what the movement should look like. This can lead to working out of alignment, therefore losing vital qualities of the work by not targeting the exercise's intended muscles, and pushing beyond one's safe range of motion, which can lead to pain or injuries. In addition, by demonstrating the entire class himself or herself, the teacher does not have an opportunity to closely observe the students and make corrections.

In addition to what has been discussed, some considerations should be made for a *Pilates* class for musicians. The *Pilates* classes taught at different universities such as those taught by Romana Kryzanowska, Kathy Grant and Eve Gentry provide a model for the implementation of similar classes for musicians. These classes were larger in size than the traditional *Pilates* classes while still maintaining the integrity of the method. One of the reasons for their success was the unified student population and similar fitness levels and backgrounds. The work was accordingly tailored to such population and emphasized injury prevention. Consequently, the class proposed by this paper is intended

for string players as a unified population. As will be explored in Chapters 4 and 5, lower string players and upper string players have similar asymmetric postures due to playing their instruments, and should emphasize work in certain common areas to avoid injuries.

The mat version of *Pilates*, because of its transportability and efficiency, is the most accessible and suitable form of *Pilates* to incorporate in a class for string players. Once a strong foundation is achieved, an individual could easily maintain the practice beyond the end of the course. Pilates taught exercises routines on the mat to dancers who were constantly on tour, and others who travelled regularly, so that they could continue training with his method.[104] The addition of props to the classical mat repertory is also beneficial for musicians; props offer practical modifications that can accommodate different levels of fitness and provide assistance in the case of injuries or limitations, in a similar way to the *Pilates* apparatuses. The props chosen for this paper and for the design of the class are the TheraBand™ and OverBall, because they are inexpensive, occupy almost no space, and can easily be transported.

Standing *Pilates* is an expression developed after Pilates' original method, which presents a useful alternative for musicians because it requires no equipment other than the body itself and it can be done virtually anywhere. The exercises are adapted from the classical mat repertory and performed while standing on both legs, sometimes transferring the weight onto one leg at a time. Standing *Pilates* can help increase awareness of how the body moves and maintains balance (dynamic balance), which is extremely helpful for string players. It additionally can help improve functional

[104] Pont and Romero, *Pilates: The Biography,* 270.

alignment, which is also important to string players. Joan Breibart, founder of Standing *Pilates* explains, "practice leads to a neuro repatterning that will translate into functional, correct movement in standing, sitting, or bending over to pick up something."[105] The enhanced weight-bearing component of standing *Pilates* can also help improve osteoporosis, which is recommended for the aging population.[106]

This chapter has presented a background of the *Pilates* method, current issues in maintaining the integrity of the method, and considerations for a class for musicians. Chapter 3 describes in detail the *Pilates* principles and further connects them to music performance. The underlying thread between *Pilates* and music performance is discussed, revealing how appropriate the method is for musicians and the incredible potential *Pilates* has to help music performance.

[105] Joan Breibart, *Standing Pilates: Strenghten and Tone your Body Wherever you Are* (Hoboken, NJ: John Wiley & Sons, Inc., 2005), 44.

[106] Ibid., 43.

CHAPTER 3: PILATES AND MUSIC

This chapter presents the most commonly accepted and recognized *Pilates* principles. Their connection with music performance is explored in order to demonstrate how the method is suitable for musicians. The underlying thread between *Pilates* and music performance is discussed, revealing the potential *Pilates* has to help string players.

The Six Pilates Principles in Relation to String Playing Technique and Performance

Concentration

> *Concentrate on the correct movements each time you exercise, lest you do them improperly and thus lose all the vital benefits of their value*.[107]
>
> — Joseph H. Pilates

According to Isacowitz and Clippinger, "concentration can be defined as direction of attention to a single objective, in this case the mastery of a given Pilates exercise."[108] In order to accomplish this, one must focus on the entire body and on keeping alignment through all of the exercises, as well as coordinating the breath with every movement to make it more effective. By focusing the attention on specific muscles as they move, one can start to notice how the body is used effectively through specific movements and aim to refine those movements over time. At first it may be challenging to maintain focus on different aspects at once and successfully control the body, but with practice this becomes easier and the body starts to learn movement patterns subconsciously. As a consequence,

[107] Joseph H. Pilates, *Pilates' Return to Life through Contrology*, 57.

[108] Isacowitz and Clippinger, *Pilates Anatomy*, 2.

there is an improvement in form and execution of daily activities, including playing an instrument.

Playing an instrument requires a high level of concentration on the body and its movements. One of the aims when learning a string instrument is to hold the instrument and the bow in the most natural way, in order to avoid tension and to play as freely as possible. At first there may be tendencies to over-grip both the neck of the instrument with the left hand and the bow with the right hand. Using gravity to assist in dropping fingers down into the string with the left hand, to relax the thumb, and to release weight into the bow while finding balance between the fingers, are challenging concepts. Even though one may seem to have a correct cello bow grip, one may be squeezing or pressing down the bow arm to produce sound, rather than making a connection through the back muscles and the arm and releasing a more natural arm weight into the bow. By making the right internal connections through the arm, using gravity to assist in adding weight into the bow and pronating the forearm, one finds the most natural and efficient way of playing and avoiding pain. On the other hand, applying pressure rather than weight will not only exhaust the player sooner and create extraneous muscle activity that leads to pain, but also will negatively affect the quality of sound.

Pilates requires concentration in order to execute the movements as correctly as possible based on the current skill level of the person.[109] The same concept applies to instrumental playing. When learning to play an instrument, the first steps involve simple motions that become gradually refined and more advanced through consistent practice.

[109] Ibid., 2.

From the very beginning, successful methods of string playing emphasize performing the simplest tasks as correctly possible, based on the individual abilities. For example, some instructors teach young children, between age three to five, to hold the string bow in a simplified manner, by putting the thumb underneath the frog of the bow rather than inside the frog. While the child may not be ready to hold the bow in the standard fashion, he or she may be able to work on important details such as keeping the bow in the right position for each string, playing specific bow strokes or rhythms, and producing a desired sound quality. Although these may seem like basic concepts for a mature player, for the beginner they require a significant amount of concentration and muscle control. As the player becomes more advanced, the basic movements become automatic and less effort is required.

Concentration on the entire body allows us to understand how important alignment is for every movement and to notice how the body parts connect to one another. Alan Menezes explains "the first step in learning to concentrate is realizing that the position of every part of the body is of great importance, and that all of our movements and positions are interconnected."[110] In *Pilates*, every time there is a movement of a limb, the core is activated to stabilize the body and protect the spine. When moving the arms for example, the activation of the core not only protects the spine but also encourages alignment for the spine. With the right alignment of the spine the second powerhouse can better be activated to align the shoulder blades more effectively, and we are able to balance the head properly and avoid neck tension. Proper alignment of the spine, shoulder blades and head is essential for string players' effective arm-usage.

[110] Menezes, *The Complete Guide to Pilates*, 22.

Awareness of the connection of the arms in relation to the center of the body and the back of the body makes it easier to maintain proper alignment while playing, and to draw a bigger sound without unnecessary effort. For string players, it also becomes clearer that the movement does not start at the foremost extremity but rather comes about as the result of a chain reaction. The hand should not lead the bow, but rather than the hand should respond to the movements coming from the scapula, upper arm, elbow, forearm and wrist.

Control

> *Study carefully. Do not sacrifice knowledge to speed in building your solid exercise regime on the foundation of Contrology.*[111]
>
> — Joseph H. Pilates

Concentration in *Pilates* allows for control. Isacowitz and Clippinger define control as "the regulation of the execution of a given action. Refining control is inherent in mastering a skill."[112] Control of every aspect of a determined movement allows for efficiency of movement, while lack of control leads to sloppiness and potential injury. According to Friedman and Eisen, that sloppiness carries over into our everyday life.[113] Similarly, in music we are constantly refining control in order to master technique.

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[111] Pilates, *Return to Life through Contrology*, 57.

[112] Isacowitz and Clippinger, *Pilates Anatomy*, 2.

[113] Philip Friedman and Gail Eisen *The Pilates Method of Physical and Mental Conditioning* (New York: Viking Studio, 2005), 14.

Mastering technique allows for freedom, organic movements, coordination, balance and stamina. Mastering technique streamlines playing and avoids injuries.

Isacowitz and Clippinger further explain that "often a higher level of control is associated with fewer and smaller errors … and greater ability to reproduce the exercise successfully over multiple attempts, using less effort and avoiding excessive muscle tension."[114] The same concept applies directly to musicians. The greater the control of the technique, the more consistent and accurate a performer is. We can observe this in the performances of distinguished musicians; their domain of instrumental technique is very high, allowing them to perform demanding repertoire repeatedly with precision and few errors. This is also the case for orchestral auditions, where the standards are very high and only players with virtually no errors make it to the finals or win the position. Further, it is the ultimate goal for musicians to play with the least effort and avoid muscle tension in order to endure prolonged hours of playing and be able to maintain a career for a long period of time.

Practice of control results in more refined motor programs.[115] According to Isacowitz and Clippinger, the practice of refining control "can allow these motor programs to run with less conscious attention, so that attention can be paid to finer details and to making minute adjustments, only when needed." In the same manner, in music the ultimate goal of control is to gain freedom. Performers aim to advance instrumental technique to such level that it becomes more of a subconscious response to the body. In

[114] Isacowitz and Clippinger, *Pilates Anatomy*, 2.

[115] Ibid., 2.

his book about principles and forms of movement in cello technique, Gerhard Mantel explains that "through frequent practicing the body acquires a movement memory and manages to store quite precise information on any motor experience."[116] The body learns kinesthetic information, allowing the mind to be more relaxed in the process, in an awareness state rather than a single focused state, therefore allowing the mind to concentrate more in other aspects like expression and musicality. Through detailed control early in the process of learning we achieve freedom and enhanced musicality later on. When learning shifting for example, there are many steps involved in creating the right movement of the arm as well as to find the right note and establish consistency. It is common at first, to be inconsistent with the movement in shifts, which produces inconsistency in finding a particular note successfully. Until one gains the control necessary to reproduce a specific shift with accuracy every single time, the preoccupations and tensions associated with missing the shift will take away from musicality.

The ability to make minute adjustments, as pointed out by Isacowitz and Clippinger, is also present in music with refined control. Mantel explains that in a shift, there is not much chance to make corrections after a note has been reached. By the time the player or listener has heard the wrong note, it is too late to fix it.[117] However, it is possible to make corrections through minute adjustments as the process is taking place. Mantel explains; "there is time for a correction while the movement in process and the

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[116] Gerhard Mantel, *Cello Technique: Principles and Forms of Movement (1972),* trans. Barbara Haimberger Thiem (Bloomington, IN: Indiana University Press, 1995), 5.

[117] Ibid., 5.

movement memory are being compared. Since the movement is perceived as an entirety, deviations from it can be noticed and corrected before success or failure has been decided."[118] High levels of awareness and control are needed to play a string instrument, and the practice of *Pilates* offers a chance to enhance these mechanisms.

Precision

> *Contrology only demands that you conscientiously, faithfully and without deviation obey the instructions accompanying the exercises and keep your mind wholly concentrated on the purpose of the exercises as you perform them.*[119]
>
> — Joseph H. Pilates

Isacowitz and Clippinger define precision as "the exact manner in which an action is executed."[120] This principle distinguishes *Pilates* from any other type of exercise. Although the exercise itself is not that different from other exercises systems, optimal execution is.[121] Mental feedback is necessary to understand what the correct movement is and to be able to make adjustments or corrections to achieve precision.[122] A high level of precision in *Pilates* is associated with successfully performing a certain exercise and

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[118] Ibid., 5.

[119] Pilates, *Return to Life through Contrology*, 54.

[120] Isacowitz and Clippinger, *Pilates Anatomy*, 2.

[121] Ibid., 2.

[122] Menezes, *Complete Guide to Pilates*, 29.

obtaining a greater benefit from it.[123] Precision allows one to access and work smaller or deeper muscles, which are often difficult to feel due to the predominance of bigger muscles, which are often emphasized through executing mindless movements. In musical performance, precision also determines the success of a specific aspect and therefore the success of a specific sound. The precision of the *spiccato* bowing technique has to do with several aspects that need to work in perfect coordination to work most effectively. These include a balanced position of the body and more specifically the bow arm, a flexible bow grip, flexible fingers and wrist, relaxation that allows the bow to bounce on the string, a consistent contact point on a specific string, even-sounding strokes on the down and up bows, and consistency with timing and articulation, especially when switching between strings.

Centering

> *Self-confidence, poise, consciousness of possessing the power to accomplish our desires, with renewed lively interest in life are the natural results of the practice of Contrology.*[124]
>
> — Joseph H. Pilates

The concept of centering has physical and esoteric or even mystical connotations. In *Pilates,* centering refers mostly to a physical place in the body, considered the center

[123] Isacowitz and Clippinger, *Pilates Anatomy*, 2.

[124] Pilates, *Return to Life through Contrology*, 34.

of gravity. According to Isacowitz and Clippinger,

> the body center of gravity is the single point about which every particle of its mass is equally distributed—the point at which the body could be suspended and where it would be totally balanced in all directions…When standing upright with the arms down by the sides, the center of gravity of the average person is located just in front of the second sacral vertebra and at about 55 percent of the person's height [from the floor].[125]

The center of the body is referred to as the powerhouse in *Pilates*. Every exercise in *Pilates* engages the powerhouse, and it is necessary that one keeps connecting or directing attention to the center throughout the duration of the session, as well as in daily life and regular activities. By engaging the center, one improves balance, posture and reduces the risk of injuries. As a result, creating an awareness of the center produces effects similar to meditating. Meditation allows one to be in the moment, feel grounded and in control. Mary Bowen, disciple of Pilates, refers to this state or quality as "sensate," while others use the word "mindful." Both reference a calm inner state in which we can just focus on the task at hand and direct the attention to one place only.[126] Therefore, the practice of *Pilates* is helpful to reduce stress and clear the mind.

Being able to concentrate on the task at hand, reduce distracting thoughts and manage stress, are essential qualities for successful musical performance. Don Green M.D., renowned sports psychologist and audition coach, refers to the centering technique as an essential tool for performance and audition preparation, and recommends that every

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[125] Ibid., 2.

[126] Mary Bowen, "Pilates Plus Psyche: Pilates and Chronic Tension Patterns" (presentation, PMA Conference, Phoenix, AZ, October 28, 2016).

performer incorporate the technique to their daily routines.[127] The technique was developed by Robert Nideffer, M.D. in the 1970s and adapted for the performing arts by Green, and it has helped many musicians overcome performance anxiety. According to Green, centering moves the brain's energy focus from left to right, allowing one to become more focused and poised during a performance.[128] He further explains; "Centering is a focusing strategy that helps performers channel energy productively under extreme circumstances […] Centering has great applications for performing artists looking to adjust their Activation levels to within their optimal range."[129] Interestingly, the exact place in the body where the center is located, as described by Dr. Green, is the same as the center in *Pilates*:

> Your center is roughly at the center of your body, your center of gravity. It's approximately two inches below your navel and two inches into your body…Close your eyes and make believe that there is a hula hoop around your waist. Now begin moving your hips. As you imagine the hula hoop staying up, imagine it getting smaller and smaller, but keep the rotation going. Move your hips in smaller and smaller circles, down to a tiny one, the size of a quarter. Find the center of that quarter and then drop it down about an inch. There is your center![130]

This "hula hoop" or cylinder around the waist corresponds to the transversus abdominis, a cylinder-like muscle that runs around the center of the body between the ribs and the hips. This muscle is activated in *Pilates* by an isometric contraction of drawing in the abdominals as well as through correct breathing. Cues that help find this muscle include

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[127] Don Green, *Audition Success* (New York: Routledge, 2001), 55.

[128] Don Green, *Performance Success* (New York: Routledge, 2002), 40.

[129] Ibid., 40.

[130] Ibid., 42-43.

imagining wearing a corset, a tight belt or football gear, as well as breathing cues such as "fog the mirror in front of you through your exhale."

Breathing

Breathing is the first act of life, and the last.[131]

— Joseph H. Pilates

Menezes explains the three major functions of breathing: to carry nutrients to the entire body (renewing energy), to eliminate toxins, and to increase stamina.[132] The cleansing of the body and renewal of energy was described by Pilates as the "internal shower" or "bodily house-cleaning with blood circulation."[133] In *Return to Life through Contrology,* Pilates clearly instructs practitioners to " 'Squeeze' every atom of impure air from your lungs in much the same manner that you would wring every drop of water from a wet cloth."[134] He also explains that "true heart control follows correct breathing which simultaneously reduces heart strain, purifies the blood, and develops the lungs."[135]

Breathing is one of the most fundamental principles in *Pilates*, which connects all of the principles. To breathe correctly we must first learn how to use the full capacity of

[131] Pilates, *Return to Life through Contrology*, 23.

[132] Menezes, *Complete Guide to Pilates*, 25.

[133] Pilates, *Return to Life through Contrology*, 21.

[134] Ibid., 22.

[135] Ibid., 22.

the lungs, which requires concentration, precision and control. Through practice, breathing can become more efficient and fluent, controlling stress and other factors that shorten the breath or interrupt it in any way. Correct breathing engages the powerhouse and it is connected to centering. In the centering technique explained by Dr. Green, breathing is an important part of the exercise;

> After choosing your focus point, close your eyes and pay close attention to your breathing. Eventually you will be able to focus on your breathing with your eyes open…Start to breathe *slowly* and *deeply* throughout your entire torso. Breathe *in through your nose* and *out through your mouth*.[136]

For string instrument performers, breathing is fundamental not only to aid centering in musical performances and reduce stress, but also to encourage proper technique and avoid injuries. Illustrating the importance of breathing for effective technique, Mantel explains that the success of a shift is connected to breathing. Often a cellist will have short breathing spasms right before a shift or a difficult technical passage due to psychological factors.[137] The shortened breathing causes a tension response in the shoulder, which directly affects the shift.[138] It is common for string players to stop the breathing momentarily during a challenging technical passage, creating regular patterns of tension in the neck and shoulders, which leads to musculoskeletal issues. Menezes describes a similar process of interrupted breathing when facing a challenge when exercising:

> People often hold their breath at the most crucial part of an exercise, when

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[136] Green, *Performance Success,* 41-42.

[137] Mantel, *Cello Technique*, 47.

[138] Ibid., 47.

> releasing it could be most beneficial…When we do this, we put our bodies under an enormous amounts of physical tension, especially in the upper thoracic and cervical areas (neck and shoulders). When we hold the breath while exercising, we create a situation similar to that of pressure building inside a pressure cooker. As a result, we waste energy and exert unnecessary effort. The outcome is a less-than-efficient use of the working muscles.[139]

Stopping breathing during a challenge in any activity is a natural response of the body. Therefore, the practice of an exercise that includes focusing on breathing as a major component, as in the case of *Pilates,* is recommended to improve not only music performance but also any other activity in life.

In *Pilates,* breath is intentionally coordinated with specific movements, in order to help or enhance the movement. There is always an inhale to prepare a movement and an exhale generally occurs right before the next movement takes place to activate the core and protect the spine, and to make the movement more effective. An example is rolling up from a lying-down position on the back; by starting the exhale right before rolling up and continuing to exhale for the duration of the roll-up, pushing more air out during the most challenging part of the exercise, the exercise feels easier. Breathing out helps engage the core properly, activating the deep core muscles needed to assist the roll up. In *Pilates,* an inhale is often associated with reaching, extending or elongating, and an exhale is often associated with contracting, pulling in, and flexing, as well as connecting with the core.

[139] Menezes, *Complete Guide to Pilates*, 25.

Flow

> *Contrology is designed to give you suppleness, natural grace, and skill that will be unmistakably reflected in [all you do].*[140]
>
> — Joseph H. Pilates

Isacowitz and Clippinger describe flow as "a smooth, uninterrupted continuity of movement. Flow requires a deep understanding of the movement and incorporates precise muscle activation and timing."[141] The goal of *Pilates* is to achieve a desired flow or "natural grace" in every movement of the body; to achieve that, one must master all of the above principles. Each exercise or movement must be practiced and perfected to find its optimal flow. *Pilates* exercises also aim for an overall flow throughout the entire session; that is, they move seamlessly from one exercise to another and create a deep sense of continuity and a meditation-like state.

According to Kató Havas, "music is the only art from which is a perpetual 'fluid flow' "[142] To make flow happen in the music, flow must also happen in the movements of the body. For string players for example, flowing movements of the bow have an impact on flowing beautiful sound. This flowing movement (and sound) is achieved by proficient control of the bow, including the angle, speed, and weight of the bow

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[140] Menezes, *Complete Guide to Pilates*, 29.

[141] Isacowitz and Clippinger, *Pilates Anatomy*, 3.

[142] Kató Havas, "The Release from Tension and Anxiety in String Playing," In *Tensions in the Performance of Music. A Symposium Edited by Carola Grindea,* ed. Carola Grindea (New York: Alexander Broude, Inc., 1978), 15.

simultaneously. Lack of bow control is usually associated with inconsistent speed or weight, or incorrect angle of the bow, both of which result in uneven or interrupted tone. To have a continuous line or phrase, smooth bow changes are needed. Another example of flow in string technique is maintaining a continuous vibrato, which should not be interrupted when a player switches between fingers of the left hand. At first, learning vibrato can be challenging and it can be broken down and studied into slow and specific motions of the forearm in conjunction with the fingers, but once a player is able to master the concept, vibrato becomes effortless and acquires a certain "flow" quality that is evident in the sound.

In considering the meaning of "flow" as it relates to the mind, the concept put forth by Mihály Csíkszentmihályi applies; "flow is the mental state of operation in which the person is fully immersed in what he or she is doing by a feeling of energized focus, full involvement, and success in the process of the activity."[143] This sense of being completely immersed in one's work is a must for both practice and performance. Full involvement during a practice session ensures productivity and enjoyment of the process, while full involvement during a performance ensures more enjoyment through focus on musical expression, thus reducing negative thoughts and stress related to performance anxiety.

The concept by Mihály Csíkszentmihályi also applies to *Pilates*. Pilates required students who did not have any particular condition or serious problem to memorize his personalized exercise routine. The idea of memorizing the routines was to encourage the students to use their minds in order to develop and improve concentration, memory,

[143] Isacowitz and Clippinger, *Pilates Anatomy*, 3.

common sense, and a constructive character. Furthermore, the classes lasted only forty-five minutes because he believed the mind could not concentrate for longer. Smooth transitions between the exercises emphasized fluidity.

Additional Concepts: Isolation, Routine, Strength with Flexibility, and Nature

Besides the six most standard principles of *Pilates* already discussed, a few additional concepts are worth mentioning because of their close relation to music. Alan Menezes talks about isolation and routine in addition to the six fundamental principles. He explains that after gaining control of weaker muscle groups, one can isolate the muscles more effectively, allowing for greater precision of movement.[144] Just as in *Pilates*, string players rely on both whole body and isolation. Isolation in string playing can be challenging, but it is a necessary tool for good technique. For example, practice in isolating the right hand from the left hand helps coordination challenges such as keeping a smooth and consistent legato bow while articulating the left hand in a faster tempo and tapping the fingers with energy on the string. At first, a student may struggle with this concept, and the bow may not be isolated well which may tend to create accents that imitate the articulation of the left hand. Another example of isolation involves distinguishing different types of vibrato, as Mantel explains in his book *Cello Technique: Principles and Forms of Movements*. He addresses four types of vibrato --finger vibrato, wrist vibrato, forearm vibrato, and pendulum vibrato-- and each require different

[144] Menezes, *The Complete Guide to Pilates,* 30.

isolation principles.[145]

Menezes also includes routine as an essential principle of *Pilates* in order to achieve mental and physical conditioning and to improve the sense of well-being.[146] In *Return to Life through Contrology*, Pilates is very clear about routine and consistency, and he claims that performing the Contrology exercises regularly, four times a week over three months, would lead to developing one's body to an ideal, accompanied by "renewed mental vigor and spiritual enhancement."[147] Although routine is an obvious concept for musicians who practice technique and musicality, taking care of the mind and body has not yet been widely incorporated in their routines as part of their musical training. Participating regularly in the practice of a mind-body discipline such as *Pilates* would have a great impact in their music careers. Mental and body conditioning is not something one learns once and assimilates instantly; it takes time to master. Menezes explains that we are constantly straining our bodies through daily life activities, including playing a musical instrument, and therefore we need to follow mind-body routines. Menezes explains, "our bodies require ongoing conditioning in order to meet the physical demands of everyday living. If we can mentally condition ourselves to perform daily, basic physical-conditioning routines, we will become increasingly mentally capable of enduring the stresses of living," and, therefore, the stresses associated with music

[145] Mantel, *Cello Technique*, 100-101.

[146] Menezes, *The Complete Guide to Pilates,* 31.

[147] Pilates, *Return to Life through Contrology*, in *The Complete Writings,* 53.

performance.[148]

The nature of every exercise in *Pilates* is the perfect balance between strength and flexibility. *Pilates* exercises stand out from other types because the aim is to strengthen a muscle while at the same time stretching it. In weight lifting for example, not enough focus is given to the stretching aspect, and the strengthening aspect is overemphasized. In *Return to Life* Pilates instructs the reader,

> Constantly keep in mind the fact that you are not interested in merely developing bulging muscles but rather flexible ones. Bulging muscles hinder the attainment of flexibility because the over-developed muscles interfere with the proper development of the under-developed muscles. True flexibility can be achieved only when all muscles are uniformly developed.[149]

Similarly, string instrument technique aims for perfect balance between strength and flexibility. Menuhin states that strong sound must be built through a flexible grip, effortlessly, "It is important always to practice pianissimo and to allow the strength and power to build up, as control and balance and flexibility of the joints and muscles improve."[150] Menuhin's approach encourages economy of muscle use, avoiding unnecessary strains when playing with a strong sound.

Strong sound should be achieved through a flexible bow hold. If there is not enough flexibility in the fingers or joints of the arm, the sound will be harsh or dry, because a stiff bow hold does not allow the strings to vibrate and produce a beautiful tone. The left hand should also find balance between strength and flexibility. In order to

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[148] Menezes, *The Complete Guide to Pilates,* 11.

[149] Pilates, *Return to Life through Contrology,* 26.

[150] Menuhin, *Violin and Viola*, 36.

pull the string down to produce a specific pitch, downward pressure should be avoided because it is an unnecessary use of natural resources. Instead, just the right amount of strength to support the shape and structure of the hand allows gravity to assist pulling the string down, minimizing the muscular effort needed. Vibrato also requires the right degree of flexibility and relaxation in the left hand.

Finally, *Pilates* relates closely to music because it is based on natural laws and it is devoted to do what is best for the body. As Frederik Rand Rogers words it, *Pilates* is "kinesiologically proper, physiological sound and, psychologically correct."[151] *Pilates* exercises are based on what the body needs, which is attention to the whole body, especially the spine and core, which determines overall health and sense of youth. Having a strong core and flexible spine are essential principles to make our entire bodies work optimally. Pilates spent time observing babies as well as animals to understand some of the natural laws of movement. He was particularly fascinated with the way animals kept themselves in shape, and how they instinctively stretched, tensed and bent their bodies.[152] Most of the exercises in the classic repertory focus on the strength and flexibility of the spine as well as the oxygenation of the entire body. The Roll-Up exercise for example strengthens the core, which its main role is to protect the spine, acts as a "spinal massage" by articulating every vertebra, and in combination with proper breathing, the rolling motion helps pushing all of the air out of the body to help with oxygenation and circulation (see Chapter 6 for details).

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[151] Isacowitz and Clippinger, *Pilates Anatomy*, 11.

[152] Pont and Romero, *Pilates: The Bibliography*, 62.

Similarly, string-playing methods aim to find natural laws to establish efficient technique. String technique evolved to best accommodate the human body and find ways to play in the most natural way. Regarding the cello, the adoption of the endpin beginning in the seventeenth century, improved both posture and technique.[153] The endpin allowed a more relaxed position for the legs and low back, allowing the player to stabilize the instrument with the knees as opposed to with the legs, especially the left calf.[154] It also freed the left hand, because it no longer had to help support the instrument, and therefore it could achieve a more natural position, more perpendicular to the fingerboard rather than tilted, and also enabled freer vibrato.

The Underlying Thread Linking *Pilates* and Music: Proprioception and its Effects on Motor Learning

Proprioception is an essential aspect of both *Pilates* and string playing, and the practice of *Pilates* can be helpful for musicians to improve their instrumental proprioception. In general terms, proprioception is body awareness and body control; proprioception is knowing what the body is doing and where it is placed in space. Proprioception is the sense that allows body position, posture, balance, movement, and the action of parts of the body relative to each other, and is specifically addressed in both

[153] Tilden A. Russell, "Endpin," vol. 8 of *The New Grove Dictionary of Music and Musicians,* 2nd ed., ed. Stanley Sadie (London: Macmillan Publishers Limited, 2001), 198.

[154] Ibid., 198.

Pilates training and string technique.[155]

Correct posture or body alignment, is the utmost prerequisite before doing any exercise in *Pilates*, and it should also be the prerequisite for any musician before playing to assure efficient body mechanics. Optimal alignment allows for correct and safe limb movements, targeting the right muscles and keeping the muscles working in harmony. On the other hand, exercising with incorrect posture emphasizes certain muscles to overwork, creating even more imbalances in the body and potentially leading to injury.

Several studies support the importance of posture and proprioception in *Pilates*. In a study by Gladwell and others it was found that proprioception improved in patients with chronic non-specific low back pain after a *Pilates* program that specifically focused on core stability and functional movements.[156] Regarding their *Pilates*-based core strengthening program for adults, Smith and Smith explain that core muscle strengthening and the resulting torso stability help rehabilitate the upper and lower extremities and reduce the number of muscle and joint injuries.[157] They also state that core muscle strength and stability helps with "improving functional movement and other neuromuscular facets such as proprioception, coordination, and balance."[158]

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[155] J.L. Taylor, "Proprioception," in *Encyclopedia of Neuroscience*, ed. Larry R. Squire (Oxford: Academic Press, 2009), 1149.

[156] Velerie Gladwell, Samantha Head, Martin Haggar, and Ralph Beneke, "Does a Program of Pilates Improve Chronic Non-Specific Low Back Pain," *Journal of Sport Rehabilitation* 15, no. 4 (November 2006): 338.

[157] Kristin Smith and Elizabeth Smith, "Integrating Pilates-based Core Strengthening into Older Adult Fitness Programs: Implications for Practice," *Topics in Geriatric Rehabilitation* 21, no. 1 (January 2005): 59.

[158] Ibid.

In a review of recent methods to measure proprioception in musicians and dancers, Smitt and Bird reported that proprioception is impaired in certain musculoskeletal conditions such as shoulder instability, joint disease and hypermobility syndrome.[159] They also reported that there is evidence of post-*Pilates* proprioception improvement in the joint capsule after joint replacement surgery in degenerative arthritis patients.[160] This information is key to understanding why *Pilates* is a great asset for musicians. Every *Pilates* exercise involving movements of the limbs specifically targets joint stability and mobility by focusing on the secondary powerhouse. Each movement of the arms, is done by stabilizing the scapula and pectoral girdle, which supports the functionality of the arm joints and improves proprioception.

In contrast to other types of exercise such as weightlifting, through its focus on proper alignment, joint stabilization and correct range of motion, *Pilates* is a safer and better-suited alternative for helping musicians to avoid musculoskeletal diseases in the arm joints and to improve proprioception. Weight lifting tends to emphasize the bigger muscles and neglect the smaller muscles that provide stabilization, thus being a potential hazard for musicians. There is also a tendency to work hard and push one's limits, which has the potential to cross the line of safe range of motion, emphasized by *Pilates.* On the opposite end of the spectrum, emphasizing too much flexibility over stability, as some do in yoga, can also present a hazard for musicians. Smitt and Bird explain that

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[159] Myrim Sillevis Smitt and H. A. Bird, "Measuring and Enhancing Proprioception in Musicians and Dancers," *Clinical Rheumatology* 32, no. 4 (April 2013): 469.

[160] Ibid.

> [Extreme flexibility] compromises the level of stability and could increase the occurrence of injury as the joint laxity in hypermobile individuals can impair proprioception. Hypermobile joints demonstrate a lower level of tendon reflex forces and muscle spindle and mechanoreceptor output, resulting in decreased proprioceptive acuity.[161]

It is certainly possible to benefit from activities such as weightlifting and yoga, or other physical activities, but problems tend to arise when exercise is done mindlessly or without adequate proprioception. Therefore, the practice of *Pilates* is recommended to enhance proprioception and body awareness, which allows one to safely play an instrument or to participate in any other kind of physical activity.

The regulation of posture in string playing has an effect on body balance, sound and free movement of the limbs. Correct posture is necessary for efficient technique in both the left hand and right hand. The regulation of body position in string playing also has an effect on consistency and accuracy. If one is constantly changing the position of the body in relation to the instrument, the arm length and freedom of the fingers changes; consequently, shifting may feel significantly different in one body position or another. Body position has also an impact on sound. In a video recording, Lynn Harrell demonstrates the importance of posture in cello playing and the different sound projections of the cello that result from leaning the upper torso forwards or backwards. When leaning the upper torso backwards the sound is reduced, while when leaning the upper torso forwards the sound increases considerably, without intentionally changing the pressure of the bow.[162] Incorrect posture in string playing not only negatively affects

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[161] Ibid., 472.

[162] Lynn Harrell, Cello Workshop Volume 1 Part 1, https://www.youtube.com/watch?v=EN-g4XFpTaM.

technique and sound, but also leads to muscle imbalances, pain and musculoskeletal disorders.

Proprioception is the sensory information that allows us to sense our bodies' position and movement in space. In this process, stimuli are transduced by proprioceptors in joints, tendons, muscles, the inner ear, and eyes, into neural impulses that are transmitted to the central nervous system and produce sensory information. Proprioception is important to maintaining kinesthesia and postural balance.[163] Blanchard et al. explain that proprioception and motor control can be enhanced if more than one stimulus and sensory response are present; "The combination of two sensory modalities such as vision plus muscle proprioception, vestibular system plus muscle proprioception, vestibular system plus vision, or touch plus muscle proprioception, has generally been shown to improve the resulting perceptual or motor responses."[164]

In string playing, more than one sensory modality is combined, such as tactile, muscular, visual and auditory. In a shift for example, tactile information of the finger shifting in contact with the string is used, together with the feel of the other fingers, left hand and arm in contact with a specific position. As the shift progresses, the fingers and hand adjust their position according to the gradual change in size of the fingerboard. Muscular sensory information is also involved, as changing the angle of the arm between

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[163] National Library of Medicine, accessed November 3, 2016, https://www.nlm.nih.gov/cgi/mesh/2016/MB_cgi; Caroline Blanchard et al., "Differential Contributions of Vision, Touch and Muscle Proprioception to the Coding of Hand Movements," Ed. by Nicholas P. Holmes, *PLoS ONE* 8 no. 4 (April 2013): 1-11.

[164] Blanchard et al., "Differential Contributions of Vision," 1.

one position with a more acute angle to another position with a larger angle, or vice versa, involves different muscle activation of the forearm and elbow proprioception. Sometimes the eyes are also involved in accuracy of finding a specific note in a shift, by using a visual cue such as a physical landmark on the instrument or an overall visual parameter of the size of a particular shift. Ultimately, the ear is, or should be, the sensory information judge of a shift, as it helps the player know where the hand and fingers should stop when sliding into a specific note, sending feedback on the pitch accuracy.

Every aspect of playing a string instrument involves some degree of proprioception. New technologies on sensory feedback allow us to get a sense of the different proprioceptive levels involved in string playing. Grosshouser and others describe the use of sensor-based technologies to measure tactile sensory information in order to understand finger pressure on the bow. The sensory technology they used is called "adaptive and reactive technology integrated sensing system" or "ARTIS."[165] By placing sensors between the contact point between the bow and thumb, first finger, little finger, and the position of the ring finger and middle finger together, Grosshouser and others were able to measure the pressure exerted by each individual finger.[166] Their measurements indicate that "each bow position and bowing type results in a unique

[165] Tobias Grosshouser, Ulf Grossekathöfer, and Thomas Hermann, "Adaptive and Reactive Sensor Technology for Musical Instruments: Teaching, Exercising and Pedagogy," in *Art in Motion II: Motor Skills, Motivation, and Musical Practice*, ed. Adina Mornell (Frankfurt, DE: Peter Lang GmbH, Internationaler Verlag der Wissenschaften, 2012), 195.

[166] Ibid., 204-205.

pressure and position combination, a 'unique pressure fingerprint.'"[167] The researchers further explain that variations in pressure exist according to different technique schools. Carl Flesch's school for example, emphasizes rotation of the hand, which results in more pressure between the first finger and thumb. Other schools have a flatter hand posture with a more even distribution of pressure between the fingers.[168]

Incorrect pressure or bow angle corresponds to an incorrect or undesired sound, and the string player has to learn how to regulate pressure and bow direction both consciously and unconsciously in order to obtain a specific sound. Grosshouser and others were also able to measure arm angles for different kinds of bowings such as *martelé, détaché*, and *spiccato* in different tempi. They placed a goniometer (an instrument for the precise measure of angles) in the elbow to measure the joint between the forearm and the upper arm. This tool allowed the recognizing of 3000 different types of bowing.[169] Through proprioception, the body is capable of learning complicated patterns involving different positions of the elbow and different muscle combinations of the shoulder, forearm and fingers.

Another aspect investigated by Grosshouser and others was legato bows, using a sensory board to measure the smoothness and accuracy of keeping a straight line on a particular angle. Playing a legato bow is a simple concept, yet a rather difficult process for the body. Maintaining a straight line on a particular angle and contact point on a

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[167] Ibid., 205.

[168] Ibid., 205.

[169] Ibid., 206.

string instrument is challenging because it requires complex compensating motions, beginning in the shoulder up to the fingers.[170] The researchers used the "line drawing task for legato bowing," based on the ideas of Goltz on teaching legato by drawing a straight line.[171] The test consisted on measuring a straight line drawn by the right hand, with or without a real bow, with a sensory board and free in space. The sensory board produces auditory feedback indicating if there are any deviations of movement from the virtual straight line. Grosshouser and others claimed that "executing the movement without the instrument allows to better concentrate on the basic motion and coordination problems."[172] This study demonstrates that practicing muscular and spatial proprioception away from the instrument is helpful to improve that aspect when playing with the instrument, by allowing more concentrated attention on a particular motion of the body and a healthy detachment from the instrument.

Just as balance and acute muscle control is needed in order to keep a bow straight and even, many *Pilates* exercises involve balance and acute muscle control, especially from smaller muscles. Several *Pilates* exercises are executed in a slow and controlled motion, involving a similar proprioception process as the example of legato bowing. In order to maintain a slow and controlled movement, the body has to learn how to feel the gradual change in muscle activation as the exercise progresses, and to make appropriate adjustments or compensations in order to maintain balance and control. An example is focusing on drawing perfectly smooth circles with the legs in slow motion, as in the Leg

[170] Ibid., 210.

[171] Ibid., 209.

[172] Ibid., 210.

Circles exercise (see Chapter 6 for details). This exercise is performed while lying down on the back, lifting one leg straight up and drawing controlled circles with the leg by rotating the femur in the hip socket. The slow and controlled movement activates the smaller and deeper stabilizing muscles of the hip. The movement also produces a gradual change in weight perception of the leg as the leg moves farther away from the body, and closer to the body. As the leg moves away from the axis of the body, the challenge is increased and in order to compensate and maintain stability, the core muscles must activate. In the same manner, when string players draw the bow away from the center of the body in a down bow, the natural weight of the bow is gradually decreased and the player must make adjustments to compensate and keep the sound stable. This compensation is achieved by a slight forearm pronation in order to add more weight into the bow to keep the sound. *Pilates* exercises that focus on controlled movement of the limbs while working on stabilization systems, are extremely valuable for musicians because they can help enhance proprioceptive muscle control when playing an instrument.

Finally, enhanced proprioception can result in improved motor learning, because the two are connected. According to Massey, "motor learning is an adaptive response to sensory integration, using the senses of touch, vision, movement and positional sense [proprioception]."[173] An established model of motor development theory involves three phases: cognitive, associative and automatic.[174] These phases are clearly present in both

[173] Massey, *The Anatomy of Pilates,* 48.

[174] Ibid.

Pilates and music learning, which suggest that practicing *Pilates* can improve and accelerate the process of motor learning.

The cognitive phase involves understanding a movement, visual input that demonstrates the correct movement, ideas on how to achieve it, and repetitions of that movement.[175] In *Pilates* the cognitive phase would involve achieving correct posture, developing a breath pattern, understanding the correct movement of an exercise and being able to identify specific muscles through isolation.[176] In string technique it would involve establishing correct posture with the instrument, understanding positions of the left hand and being able to find notes or play in tune, achieving correct bow hold, and understanding movement of the left hand and right hand.

The associative phase involves a higher coordination of movement, enhanced awareness, ability to focus on movement performance, and ability to incorporate more challenging exercises.[177] In *Pilates* this phase would involve maintaining proper core activation while being challenged, improving movement patterns, and achieving more control in isolating or coordinating certain muscles.[178] In string technique it would involve enhanced coordination and dissociation of the left and right hand, the ability to perform advanced bow strokes in coordination with the left hand, the ability to continue vibrato while changing notes, and improved movement patterns resulting in better sound,

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[175] Ibid.

[176] Ibid., 49.

[177] Ibid., 48.

[178] Ibid., 49.

such as legato bows and shifting.

The automatic phase involves higher quality of movement and coordination and automatic movement.[179] In *Pilates* this phase would involve the performance of the complete and correct exercises with minimal attention.[180] In string technique, it would involve technique proficiency with minimal attention that allows focusing more exclusively on the music. Examples include the sense of an "automatic" vibrato, which is a vibrato that happens naturally after considerable practice. The natural vibrato does not need to be measured or micromanaged, and works in harmony with changing fingers or shifting. Another example is quality and accuracy of shifts, allowing the player to avoid tensions caused by the lack of proficiency in shifting.

This chapter has explored the numerous similarities between *Pilates* and string technique/performance, demonstrating why *Pilates* is so appropriate for musicians and has the potential to help musicians by improving proprioception and motor learning. Chapter 4 explores the postural faults and tendencies of lower string players, in order to identify areas of concern that can be addressed with *Pilates*.

[179] Ibid., 48.

[180] Ibid., 49.

CHAPTER 4: POSTURE AND POSTURAL TENDENCIES OF LOWER STRING PLAYERS

This chapter defines and explains the importance of proper posture and alignment. Common postural faults and tendencies associated with playing the cello and double bass are explored, and specific muscles associated with those postures are identified. Based on this information and supporting research, I provide a summary of the compromised muscles as well as key muscles to be targeted in order to counteract problems. *Pilates* exercises to help those specific muscles identified for all string players are presented in Chapter 6.

The Importance of Postural Alignment in String Instrument Playing

String instrument playing requires asymmetrical body positions, but postural alignment for string players is essential for free movement of the limbs, efficient technique and correct breathing.[181] When the body is aligned properly, all of the muscles are in optimal balance, which promotes efficient movement and reduces muscle overuse.[182] According to Tubiana, Chamagne, and Brockman, an ideal position, whether

[181] Sang-Hie Lee, Stephanie Carey, Rajiv Dubey, and Rachel Matz, "Intervention Program in College Instrumental Musicians, with Kinematics Analysis of Cello and Flute Playing," *Medical Problems of Performing Artists* 27, no. 2 (June 2012): 86.

[182] Paul Rolland and Marla Mutschler, *The Teaching of Action in String Playing: Developmental and Remedial Techniques* (Urbana, IL: Illinois String Research Associates, 1974), 32.

standing or sitting, requires the least muscular effort to maintain.[183] Tubiana and others state that playing an instrument requires some deviation from neutral position, but these deviations should only be momentary, since constant deviation from neutral presents a risk for the body.

Gerhard Mantel explains that when the body is aligned "gravity pulls at all points evenly and equilibrium is maintained."[184] On the other hand, when someone's body is out of alignment, the person makes adjustments to protect the unstable frame--that is, the spine; consequently, some muscles work harder than others to compensate.[185] Higher risk for injuries occurs as a result of muscle imbalances.

In correct spinal alignment the head, shoulders, hips, knees and ankles stack one above another, along with a level pelvis.[186] The spine is divided into regions: the cervical, thoracic, lumbar and sacrum, and when aligned correctly the spine presents several natural curves. The sacrum is convex towards the spine, the lumbar region is concave (lordosis), the thoracic region is convex (kyphosis), and the cervical region is concave.[187]

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[183] Raoul Tubiana, Philippe Chamagne, and Roberta Brockman, "Fundamental Positions for Instrumental Musicians: Third of Three Articles," *Medical Problems of Performing Artists* 20, no. 4 (December 2005): 192.

[184] Mantel, *Cello Technique*, 19.

[185] Victor Sazer, *New Directions in Cello Playing: How to Make Cello Playing Easier and Play without Pain* (Los Angeles: Ofnote, 1995), 15.

[186] Massey, *The Anatomy of Pilates*, 39.

[187] Blandine Calais-Germain, *Anatomy of Movement*, rev. ed. (Seattle, WA: Eastland Press, Inc., 2014), 35.

Correct alignment can be assessed through the concept of a plumb line, which has been used in the medical, orthopedic and physiotherapy fields, as well as by *Pilates* practitioners, to assess posture.[188] The plumb line consists of a line (or chord) with a weight attached to its end, which pulls the line straight down in order to determine a vertical position. An actual plumb line, or a vertical line drawn in the wall, can be traced either in the sagittal plane or coronal plane in order to determine alignment and relative symmetry of string players. The plumb line in the sagittal vertical axis, or side view of the body, should fall through the center of the earlobe and the upper cervical vertebrae, through the center of the thorax and the lumbar vertebrae, at or just behind the hip joint, just in front of the knee joint, and just in front of the ankle joint.[189] If this ideal alignment is achieved, gravity should be centered in the body (see figure 4.1).[190]

Additionally, in ideal alignment the feet would face forward in parallel position, slightly apart and directly below the hip joints. The knees would be straight but relaxed, and the arms would hang freely with the hands just in front of the hips. The shoulders and ribs would be directly above the hips, and the head balanced over the shoulders, with the eyes looking straight ahead.[191]

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[188] Jamal McClendon et al., "Cranial Center of Mass Compared to C7 Plumb Line Alignment in Adult Spinal Deformity," *World Neurosurgery* 91 (July 2016): 199-204; Steven D. Glassman et al., "The Impact of Positive Sagittal Balance in Adult Spinal Deformity." *Spine*, 30, no.18 (2005): 2024-2029; Florence Peterson Kendall, Elizabeth Kendall McCreary, and Patricia Geise Provance, *Muscles, Testing and Function: with Posture and Pain.* Baltimore, MD: Williams & Wilkins, 4th edition, 1993.

[189] Paterson, *Teaching Pilates for Postural Faults,* 13-14.

[190] Ibid.*,* 13.

[191] Ibid.*,*14.

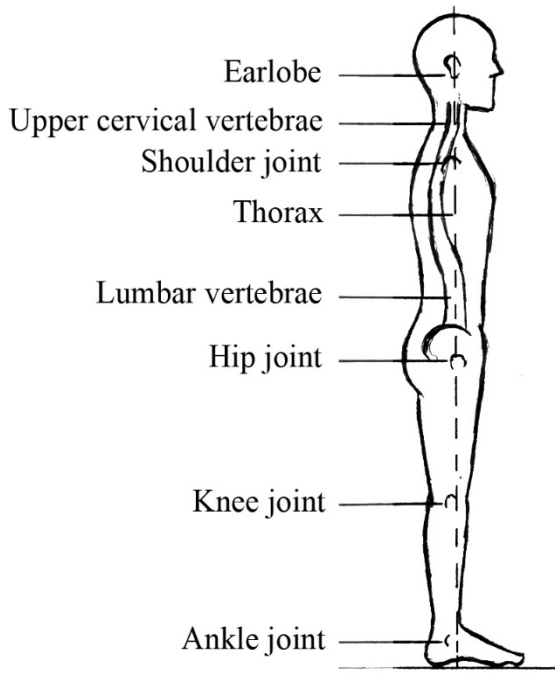

Figure 4.1. Plumb line on sagittal plane. Adapted from Paterson, *Teaching Pilates for Postural Faults, Illness and Injury,* 14.

A plumb line in the coronal plane, or back view of the body, is also advantageous for string players, as asymmetries in this plane will often be more evident. The plumb line follows the line of the spine and divides the body into left and right symmetrical halves.[192] Assuming the same stance as described above, in this position the head should be balanced on top of the spine. The tops of the shoulders and the shoulder blades should be leveled with each other, as should the pelvic rims and the hands. The ankles, knees and hip joints should be stacked one above another, and the Achilles tendons should be equally developed, with the same length and thickness (see figure 4.2).[193] The plumb line test could be used in a *Pilates* class for string players to address alignment and

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[192] Ibid.,15.

[193] Ibid.,15.

asymmetries of each individual student, as well as to help students become more aware of their posture. It could also be used as a way to evaluate progress by testing the posture of students at the beginning of the course, and again at the end.

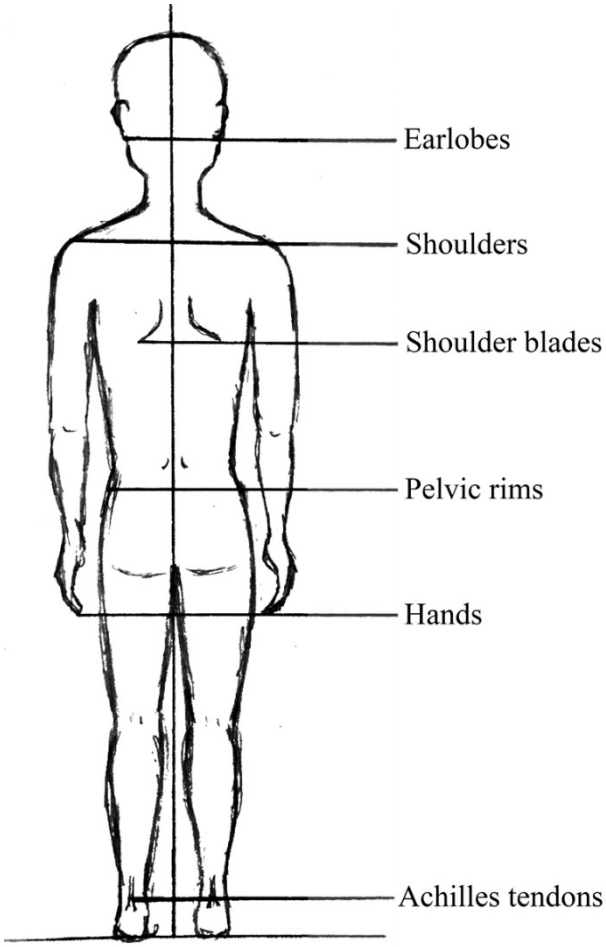

Figure 4.2. Plumb line in the coronal plane. Adapted from Paterson, *Teaching Pilates for Postural Faults, Illness and Injury,* 15.

The diaphragm is a muscle that aids in respiration. It adapts to the movements of the trunk and is affected by thoracic misalignments. Proper alignment allows for proper breathing, which is necessary to release physical tension and have efficient muscular

coordination.[194] Several parts of the body are involved in optimal alignment. The foundation of the feet is key in assuring alignment and correct breathing. Recognized string players pedagogues such as Paul Rolland, Michael Wolf, Yehudi Menuhin and Victor Sazer have recognized in their work the importance correct alignment and breathing.

Paul Rolland, acclaimed violin and viola pedagogue, explains that the body and arms need to be in a balanced relationship and that "good body balance is based on a correct stance."[195] When the body is misaligned, breathing is compromised, which creates even more tension in the body.[196] Regarding double bass technique, Michael Wolf emphasizes the importance of an effective stance and distributing one's weight evenly between the two feet.[197] He also explains that tensions derived from poor posture tend to be manifested in breathing.[198] In *Principles of Double Bass Technique*, Wolf provides breathing exercises to be used while playing to encourage "freeing the rhythm of the breath from the motion of the arms as well as to promote relaxation in the larger muscles of the back, rib cage and stomach."[199] Acclaimed violinist Yehudi Menuhin also recognized the importance of correct breathing for string players and he also provides

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[194] Lee et al., "Intervention Program in College Instrumental Musicians," 86.

[195] Rolland, *Teaching in String Playing,* 33.

[196] Ibid., 25.

[197] Wolf, *Principles of Doublebass,* 20.

[198] Ibid., 23.

[199] Ibid., 23.

breathing exercises in *Violin and Viola*.[200]

In *New Directions in Cello Playing*, cellist and pedagogue Victor Sazer recommends using a breath test to demonstrate how breathing is affected by slight modifications of positions of the body while standing or sitting. The breathing test while standing is helpful to all string players but especially to upper strings and double bass players. It helps players identify positions that inhibit optimal breathing. The directions of the standing breath test are the following:

> Breath deeply as you perform each of the following steps.
> Step 1. Assume a balanced stance.
> Step 2. Lean your head forward.
> Step 3. Lean your head to one side.
> Step 4. Turn your torso a degree or two to one side.
> Step 5. Rotate your torso gently from side to side with even, continuous motion.
> Step 6. Lean your torso slightly forward.
> Step 7. Hold your elbow a bit behind your back.
> Step 8. Lift one or both of your shoulders.
> Step 9. Pull one or both of your shoulders forward.
> Step 10. Bend your wrists downward.
> Step 11. Experiment with other body positions.

Sazer's breathing test while sitting is especially helpful for cellists; it starts by assuming a playing position and explores different foot placements to understand their effects on breathing. The directions for this test are the following:

> This demonstration explores different foot placements without the cello. Perform the breath test with each step.
> Step 1. Sit tall on the front edge of your chair and place your feet:
> Behind your knees;
> Straight down from your knees; and
> various distances in front of your knees.
> Step 2. Test each position by moving your trunk forward and backward. Find the position which feels the most comfortable and stable.

[200] Yehudi Menuhin and William Primrose, *Violin and Viola* (New York: Schirmer Books, 1976), 20.

Step 3. Sit tall with your feet in front of your knees. Experiment with the distance between your feet. Place your feet as if each leg is touching the side of your cello. Move your feet apart a little at a time.
Step 4. Test each position by circling your trunk in all directions. Readjust the distance between your feet to find the most comfortable and stable position.
Step 5. Repeat Step Three as you move your right arm to simulate full bow strokes.[201]

The sitting test can also be used for upper string and double bass players. In the case of upper strings, it could also include exploring leg positions by placing one foot underneath the knee and the other foot behind the knee, and then alternating. This could go along with opening the legs to varying distances in addition to simulating arm movements. For double bass players it could include experimenting with the stool's height, by having both feet on the ground and parallel, by placing both feet on the footrest of the stool, and by alternating one foot on the stool footrest and the other on the ground. Simulating arm movements while playing should be explored in all different positions.

These breathing tests provide ways to understand the importance of correct postural alignment from the inside out, how alignment allows for better movement and how it affects one's breathing. Therefore, these exercises would be appropriate to use in the introductory portion of a *Pilates* class for string players.

Posture and Alignment in Cello, and the Anatomy of Sitting

Cellists play while seated, so the anatomy of sitting is a good starting point to help players understand a neutral spine and identify tendencies that challenge a healthy posture. In an ideal sitting position for cello, the head, torso and pelvis should be aligned

[201] Sazer, *New Directions in Cello Playing,* 64.

above one another following the plumb line, so that the head and vertebrae of the spinal column can balance with the least muscle activity. The cellist should sit towards the front of the chair, with the body weight distributed between the ischium, or sitting bones, (about 75%) and the feet (about 25%). The feet should be placed right underneath the knees. Failure to distribute part of the weight on the feet creates extra weight on the spine. According to Tomás Martín López, the weight on the vertebral discs is three times greater when sitting than when standing.[202] Additionally, the feet help sustain an erect position of the torso and provide the necessary leverage for steering the body's movements while playing.[203]

In an ideal sitting position, the hips should also be positioned slightly higher than the knees in order to keep the curve of the lumbar spine (lower back) closer to ideal.[204] A.C. Mandal explains that the body was not designed to sit with the hips flexed at ninety degrees.[205] Research by Mandal and others explain that the hip moves freely in the hip socket only up to about sixty degrees. Passing beyond this point causes the pelvis to rotate posteriorly (backwards) and disrupts the natural curve of the lumbar spine (natural

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[202] Tomás Martín López, *Como Tocar sin Dolor, Tu Cuerpo, Tu Primer Instrumento* (Valencia, España: Piles, 2015), 113.

[203] Sazer, *New Directions in Cello,* 43.

[204] Sazer, *New Directions in Cello,* 58-59; Jaume Rosset i Llobet and George Odam, *The Musician's Body: A Maintenance Manual for Peak Performance* (Aldershot, England: Ashgate, 2007), 38.

[205] Sazer, *New Directions in Cello*, 54; A.C. Mandal, "Investigation of the Lumbar Flexion of the Seated Man," *International Journal of Industrial Ergonomics* 8, no. 1 (August 1991): 77.

lordosis), causing it to bulge (see figures 4.3 and 4.4).[206]

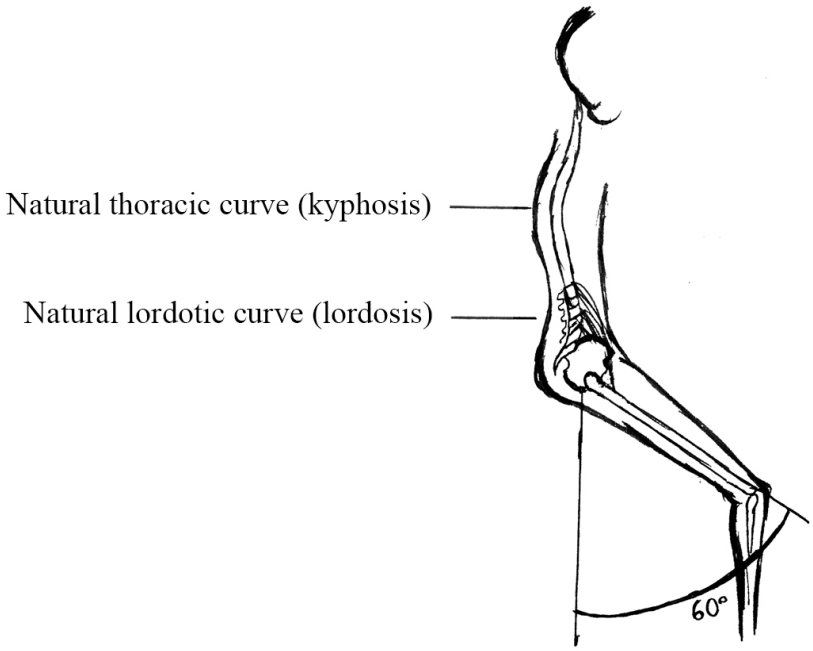

Figure 4.3. Optimal sitting position, side view, adapted from Mandal, "Investigation of the Lumbar Flexion of the Seated Man," 78.

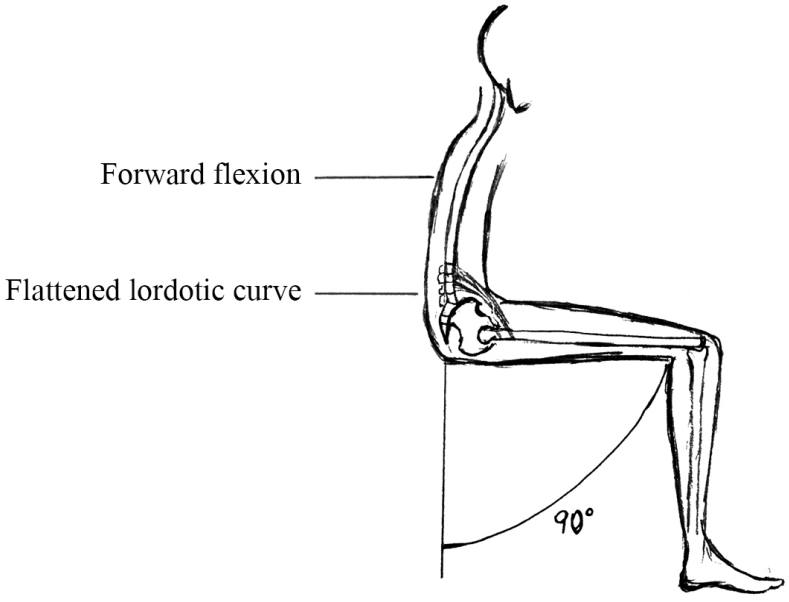

Figure 4.4. Poor sitting position with unnatural or flattened lordotic curve, side view, adapted from Mandal, "Investigation of the Lumbar Flexion of the Seated Man," 78.

[206] Sazer, *New Directions in Cello*, 54.

Orthopedic surgeon Hanns Schoberth studied the relationship between the pelvis and the spine while standing and sitting through x-rays. He observed that while standing, the pelvis and thighs were aligned almost vertically and a normal lordosis (or concavity) in the lumbar region was present. However, when sitting, there was an average flexion of sixty degrees in the hip joint and thirty degrees in the lumbar region, showing convexity.[207] This posture forces the body to bend forwards and consequently there is a greater weight loading in the lumbar region, especially on the fourth and fifth discs.[208] This compression of the lumbar discs is often a major contributor to chronic low back pain. Additionally, the thoracic spine (upper back) is constrained from movement, because in that position, the ribs are recruited as stabilizers.[209]

Maintaining a neutral spine during extended hours of playing requires significant trunk support from the deep postural muscles and abdominal muscles. The deep postural muscles include the erector spinae group and transversospinalis group, both located along the posterior aspect of the vertebral column. The erector spinae group runs between the sacrum and the occiput and its fibers are long and vertical (see figure 4.5).[210]

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[207] A.C. Mandal, "Investigation of the Lumbar Flexion of the Seated Man," *International Journal of Industrial Ergonomics* 8, no. 1 (August 1991): 77.

[208] Ibid., 78.

[209] Ibid., 78.

[210] Biel, *Guide to the Body*, 196.

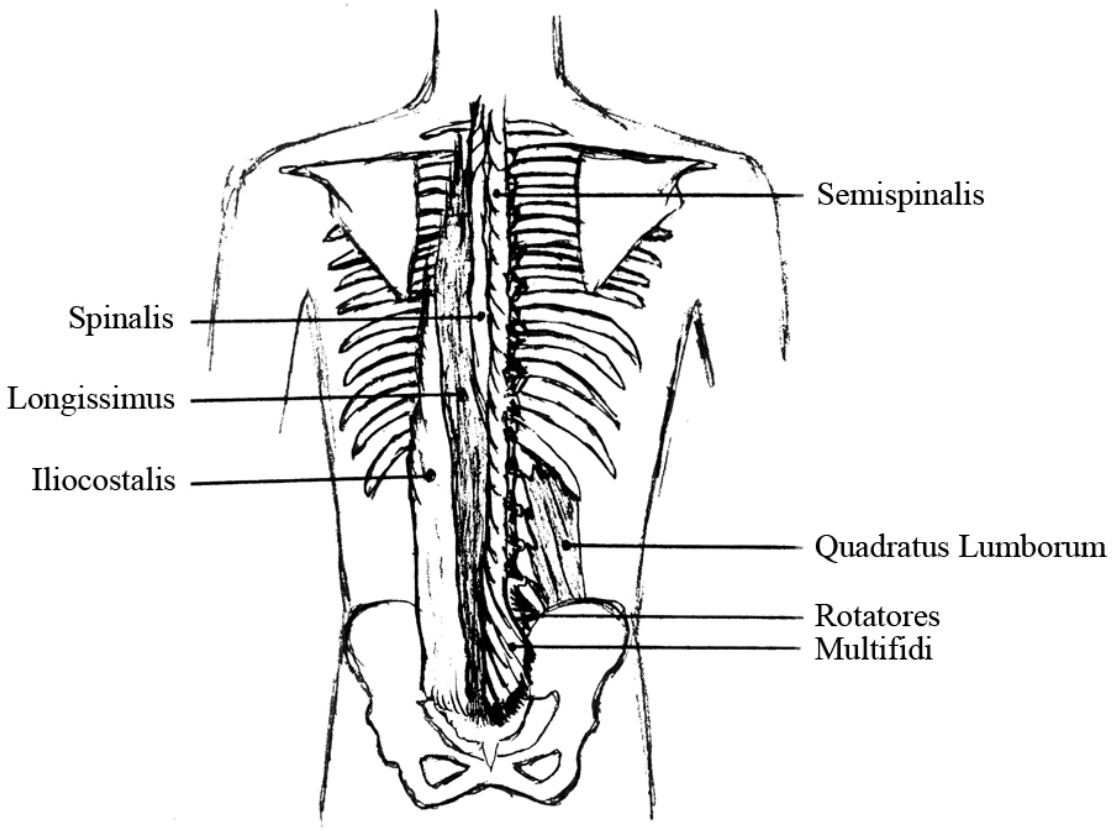

Figure 4.5. At left, the erector spinae group: Spinalis, longissimus and iliocostalis. On the right the tranversospinalis group: Semispinalis, rotatores and multifidi. Adapted from Isacowitz and Clippinger, *Pilates Anatomy*, 15, and from Biel, Trail Guide to the Body, 200.

Muscles of the erector spinae powerfully extend and support the erect position of the spine.[211] In a seated position, the quadriceps and hip flexors become shortened and tightened, which cause the gluteus maximus and hamstrings to become inactive. As a consequence, the erector spinae takes over in order to keep the spine from collapsing, which overuses the muscles leading to low back pain.

The multifidus and semispinalis are part of the transversospinalis group and comprise short and diagonal fibers. The semispinalis is located along the thoracic and

[211] Isacowitz and Clippinger, *Pilates Anatomy,* 15.

cervical vertebrae and reaches the cranium. The multifidus covers the lumbar vertebrae and its direct attachment to the vertebrae makes this muscle very powerful.[212] The lumbar multifidus has been shown to be particularly crucial in the stabilization and rehabilitation of the spine.[213]

Different postural habits have different effects on trunk muscle activity. The study by Waongenngarm and others found greater core muscle activation in an upright sitting posture, with the hips at a ninety-degree angle, as opposed to a slumped sitting posture. They observed an over-activation of the internal oblique, transversus abdominis, and iliocostalis lumborum.[214] Other studies have also shown that it is possible to reduce the strain of the postural muscles by sitting on a slope. O'Sullivan and others found a reduction in the activation of the lumbar multifidus muscle when using a forward-tilted chair.[215]

The study by Gladwell and others supports that the dysfunction and weakness of core muscles (transversus abdominis, multifidus, pelvic floor muscles and diaphragm muscle) is associated with chronic low back pain. In this study, *Pilates* was used to help improve the tone and strength of these muscles, and it was found that low back pain was

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[212] Biel, *Guide to the Body*, 200..

[213] Isacowitz and Clippinger, *Pilates Anatomy*, 15.

[214] Pooriput Waongenngarm, Bala S. Rajaratnam, and Prawit Janwantanakul, "Perceived Body Discomfort and Trunk Muscle Activity in Three Prolonged Sitting Postures," *Journal of Physical Therapy Science* 27, no. 7 (July 2015): 2183.

[215] Kieran O'Sullivan et al., "Can We Reduce the Effort of Maintaining a Neutral Sitting Posture? A Pilot Study," *Manual Therapy* 17, no. 6 (December 2012): 569.

reduced after the intervention.[216] They also found an increase in flexibility, proprioception and sports functioning, changes that would reduce pain and improve cellists' playing.[217] The researchers additionally noted that *Pilates* was successful in reducing low back pain because its principles encompass "biological, educational and psychological aspects."[218]

The use of ergonomically-improved chairs or "cello chairs" has already been adopted by many professional orchestras. These chairs are tilted by fifteen to twenty degrees and help maintain the natural curve of the lumbar spine. The slope prevents posterior tilt of the pelvis, which causes a compression of the sacroiliac joint and spine, and allows the player to properly maintain weight distribution between the sitting bones (ischium). Furthermore, the slight forward tilt of the spine automatically activates the co-contraction relationship of the deep hip flexors (iliopsoas) and multifidi, which properly stabilizes the torso. Unfortunately, these chairs are not standard equipment in schools or, especially, practice rooms. A simple solution for students is to carry wedge-shaped cushions or small wood blocks of about one to two inches that can be installed underneath the back legs of a chair in order to tilt it forward.[219] This measure, together with *Pilates* exercises to strengthen the deep postural muscles (deep abdominals, spinal

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[216] Valerie Gladwell, Samantha Head, Martin Haggar, and Ralph Beneke, "Does a Program of Pilates Improve Chronic Non-Specific Low Back Pain?" *Journal of Sport Rehabilitation* 15, no. 4 (November 2006): 339.

[217] Ibid., 346.

[218] Ibid., 339.

[219] Rosset i Llobet, *The Musician's Body,* 39.

extensors and transversospinalis group), should have a positive effect in reducing the chronic low back pain common for cellists.

Besides affecting muscle tension in the trunk, the sitting posture during extended periods of time negatively affects muscle balance of the lower posterior chain and compromises the flexibility and mobility of the joints. The lower posterior chain is the most influential muscle group of the body and includes the lower back, gluteals, hamstrings and calves. In a seated position, the gluteus maximus is inactive while the hip flexors are particularly tightened. The main role of the gluteus maximus is to stabilize the hip, and when activated it provides hip extension. When there is a dysfunction of the gluteus maximus, it produces further dysfunction on the muscles of the chain. The hamstrings and calves are additionally shortened and tightened.[220] Therefore, for cellists and other string players who spend many hours in a sitting position, exercises that improve the performance and flexibility of the lower posterior chain muscles (gluteals, hamstrings and calves) should be emphasized, as well as exercises that improve the performance and flexibility of the quadriceps. *Pilates* exercises that encourage a co-activation of the gluteals together with the hamstrings quadriceps and abdominals, are also recommended. The fixed position of the feet while sitting leads to ankle joint stiffness, mainly as a result of being in a constant position. Therefore, cellists should also include exercises that mobilize the ankle joint, especially by including plantar flexion (points the foot) and dorsiflexion (flexes the foot), which additionally work important lower leg muscles.

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[220] Biel, *Trail Guide to the Body,* 306-311.

The deep hip flexors or iliopsoas are responsible from keeping the body erect when sitting with the knees bent, and preventing it from falling backwards.[221] Sitting during long periods of time creates an excessive tightness of this muscle as well as stiffness of the hip joints due to lack of the movement that lubricates the joints.[222] Exercises that extend the hip by strengthening the gluteals at the same time can counteract this tendency. Also beneficial are exercises that encourage hip mobility and activate the core at the same time.

Another muscle that can be particularly affected by the sitting posture of cellists is the piriformis, a small muscle located deep behind the gluteus maximus, which connects the greater trochanter to the area between the coccyx and posterior superior iliac spine.[223] This muscle is responsible for stabilizing the pelvis and it is involved in abducting (opening) the hip when the hip is flexed. It can be especially tight in cellists, because of the constant abducted leg and hip position while seated which is required to secure the instrument. The piriformis muscle runs diagonally, and the sciatic nerve runs vertically just beneath it. Therefore, tightness in this muscle should be avoided because it can cause problems with the sciatic nerve, such as piriformis syndrome (see figure 4.6). Exercises that lengthen the gluteals are also used to lengthen and relax the piriformis, and are especially recommended for cellists.

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[221] Ibid., 44.

[222] Raquel Castanharo, Marcos Duarte, Stuart McGill, "Corrective Sitting Strategies: An Examination of Muscle Activity and Spine Loading," *Journal of Electromyography and Kinesiology* 24, no. 1 (February 2014): 114-119.

[223] Biel, *Trail Guide to the Body,* 330.

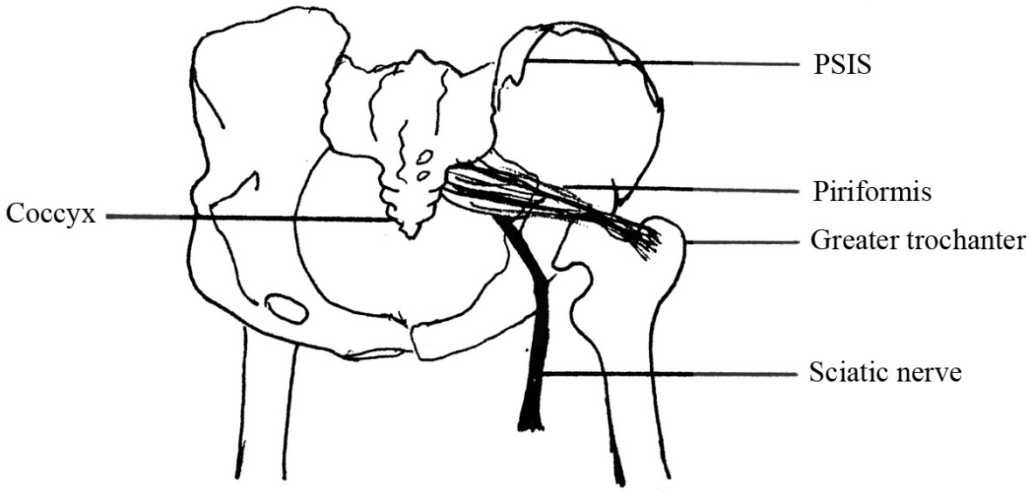

Figure 4.6. Pelvic girdle from front, adapted from Biel, *Trail Guide to the Body,* 330.

Postural Faults of Cellists: Forward Head Posture, Rounded Upper Back, and Rounded Shoulders

A common faulty postural tendency in cellists is the forward head posture (FHP), which is associated with an exaggerated posterior thoracic curve or kyphosis and rounded shoulders.[224] FHP has been defined as an excessive anterior positioning of the head and cervical spine, which causes muscle imbalances and pain, and restricts range of motion.[225] The risks associated with FHP include slipped disks in the cervical spine,

[224] Jane Paterson, *Teaching Pilates for Postural Faults, Illness and Injury: A Practical Guide* (Oxford, UK: Elsevier, 2009), 18; Katherine Harman, Cheryl L. Hubley-Kozey, and Heather Butler, "Effectiveness of an Exercise Program to Improve Forward Head Posture in Normal Adults: A Randomized, Controlled 10-Week Trial," *Journal of Manual and Manipulative Therapy* 13, no. 3 (2005): 163.

[225] Sun-Myung Lee et al., "Clinical Effectiveness of a Pilates Treatment for Forward Head Posture," *Journal of Physical Therapy Science* 28, no. 7 (July 2016): 2009; Harman et al., "Effectiveness of an Exercise Program to Improve Forward Head Posture," 163.

temporomandibular disorders (disorders of the jaw) and chronic low back pain (CLBP).[226] In cello playing, FHP often results from looking down at the fingers while playing, moving the head forward and away from the tuning pegs of the instrument, or moving the head forward to better read the music.

Some players have trouble aligning the head perfectly over the torso because the tuning pegs of the instrument are in the way. In this case, the player should consider using posture pegs (also known as "key pegs"), which remove the protruding portion of the peg and allow extra space for the head. Pegs can be replaced for the C string only, or both the C and G strings for additional room.[227] However, even with the use of posture pegs, many cellists have some degree of forward head posture due to playing in the high register and gestures that support playing with intensity, which involve pulling the head forward and down.

By positioning the head forward and away from the center of the body, the posterior neck extensor muscles (located at the back of the neck) and the pectoralis (chest muscles) are overworked or strained while the deep neck flexors (in the front of the neck) are weakened. In the study by Lee and others they were able to improve FHP by using *Pilates* exercises as a treatment. The exercises chosen in the study to improve FHP aimed at stretching the neck extensors and pectoral muscles and strengthening the deep neck flexors, shoulder retractors (the muscles that pull the shoulders down and backwards),

[226] Lee et al., "Pilates Treatment for Forward Head Posture," 2009.

[227] Rosset i Llobet, *The Musician's Body,* 46.

back, and abdominal muscles.[228]

Harman and others were also able to improve FHP by using exercises that focused on stretching the neck extensors and pectoralis major and strengthening the deep neck flexor and shoulder retractor.[229] The exercise to strengthen the deep cervical flexors consisted of tucking the chin while lying in supine position, then lifting the head in tucked position. The exercise used to stretch the cervical extensors consisted of a chin drop, first by the head alone and then with weight added by the hands. To strengthen the shoulder retractors they used a shoulder pull back with an elastic band while standing, and to stretch the pectoralis they used unilateral (single arm) and bilateral (both arms) pectoralis stretches.[230]

A study by Kim and others indicates that exercises that strengthen the deep cervical flexors while stretching the upper cervical extensors are effective in treating FHP.[231] The deep cervical flexors lie along the anterior cervical spine (front of the neck). The longus colli and longus capitis are considered the core muscles of the neck or main stabilizers, responsible for supporting the head against gravity and stabilizing the neck

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[228] Lee et al., "Pilates Treatment for Forward Head Posture," 2010.

[229] Harman et al., "Effectiveness of an Exercise Program to Improve Forward Head Posture," 163.

[230] Ibid., 168.

[231] Bo-Been Kim et al., "Effects of Suboccipital Release with Craniocervical Flexion Exercise on Craniocervical Alignment and Extrinsic Cervical Muscle Activity in Subjects with Forward Head Posture," *Journal of Electromyography and Kinesiology* 30 (October 2016): 32.

during movement.[232] Pain in the head and neck is often associated with the dysfunction of these muscles. In their study, Kim and others significantly improved FHP by using low-load craniocervical flexion exercise (CCFE) and suboccipital release (SR). CCFE is utilized to activate the deep cervical flexors of the upper cervical spine without recruiting the superficial flexors, the sternocleidomastoid muscle (SCM) and the anterior scalene (AS).[233] The exercise features subtle movements of the head in order to generate changes in the curve of the neck, activated by deep neck muscles. SR is a manual technique applied to the craniocervical region aimed at releasing the superficial neck muscles before exercising and ensuring their relaxation through the exercise.[234]

The exaggerated posterior thoracic curve (exaggerated upper back curvature) and rounded shoulders often seen in cellists is additionally exacerbated by the position of the arms in front of the body while playing, which contributes to spinal flexion. In this position, the pectoralis muscles are hypertonic (overly toned) or tightened, while the muscles that stabilize the scapula are weakened and possibly lengthened. Tightness of the pectoralis minor is associated with scapular misalignment, causing an anterior tilt of the scapula in relation to the humerus, which can lead to shoulder impingement. It is essential for cellists to counteract this tendency by improving stabilization of the scapula and stretching the pectoralis. Strengthening the spinal extensors would also help counteract

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[232] William J. Hanney and Morey J. Kolber, "Improving Muscle Performance of the Deep Neck Flexors," *Strength and Conditioning Journal* 29, no. 3 (June 2007): 79.

[233] Bo-Been Kim et al., "Suboccipital Release with Craniocervical Flexion Exercise," 34.

[234] Ibid.

the excessive upper thoracic curvature or "slumped upper back posture."[235] Emphasis should also be placed on lateral breathing with even expansion of the lower ribs together with proper activation of the core muscles and diaphragm. This will help restore alignment of the thoracic area and improve lung capacity.

The position of the arms in front of the body and slightly internally rotated when reaching down the fingerboard, abducts (separates) the scapula and rotates them upwardly. It is common to see an excessive scapular elevation associated with the elevation of the arms, due to lack of training of the scapula stabilizers. The scapular depressor muscles consist of the lower trapezius and serratus anterior (see figure 4.7). Isacowitz and Clippinger explain that the contraction of the lower trapezius adducts or retracts the scapula, and allows the head of the upper humerus to keep its proper alignment within the shoulder socket (joint centration), which reduces the risk for shoulder impingement.[236] Strengthening the lower trapezius and serratus anterior is necessary for cellists in order to facilitate the transfer of weight from the back of the body into the arms, which can only happen effectively through proper scapular alignment.

[235] Isacowitz and Clippinger, *Pilates Anato*my, 15.

[236] Ibid., 140.

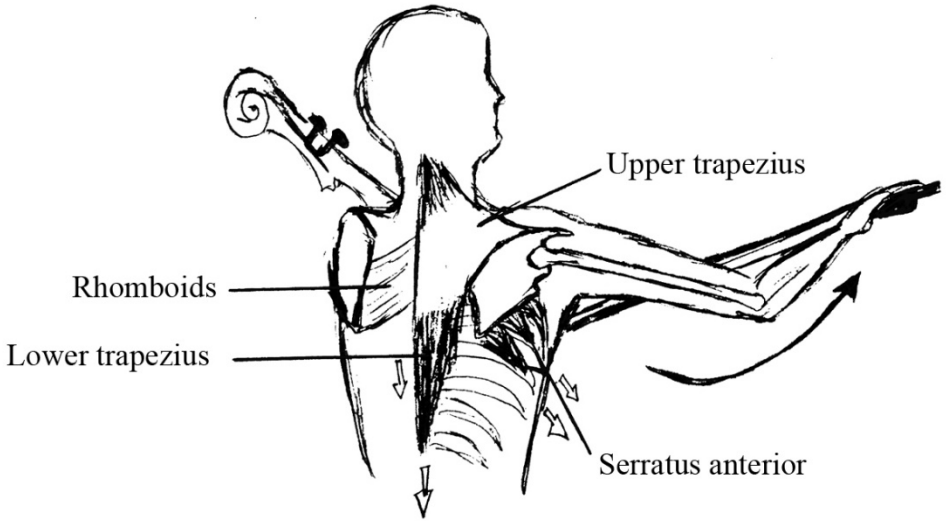

Figure 4.7. Muscles associated with proper support of arms, by author.

Misalignment of the scapula not only has been associated with kyphosis (rounded upper back), but also compromises shoulder joint function and can lead to shoulder injuries.[237] A study by Rickert and others confirms the high prevalence of right shoulder injuries in cellists, and suggests that the causes are poor scapula stabilization and weak rotator cuff muscles.[238] The study also shows that injuries are more common in professional cellists (42%) than college-level cellists (20%). This finding stresses the importance of laying a *Pilates* exercise foundation early in college that can be maintained well afterward, in order to avoid shoulder injuries and other disorders.

Richard Norris, a leading figure in the performing arts medicine field, explains

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[237] Paterson, *Teaching Pilates for Postural Faults,* 18.

[238] Dale Rickert et al., "A Study of Right Shoulder Injury in Collegiate and Professional Orchestral Cellists: An Investigation Using Questionnaires and Physical Assessment," *Medical Problems of Performing Artists* 27, no. 2 (June 2012): 65.

that cellists are often affected in the right shoulder, mostly by the extreme arm position while playing on the A string. This position involves significant abduction (opening and lifting) of the arm and forearm pronation (inward rotation). Norris explains that, in this position, the rotator cuff and bursa can be pinched between the head of the humerus and the acromion of the clavicle (collar bone), which can lead to problems such as tendinitis, bursitis, and disabling pain (see figures 4.8 and 4.9).[239]

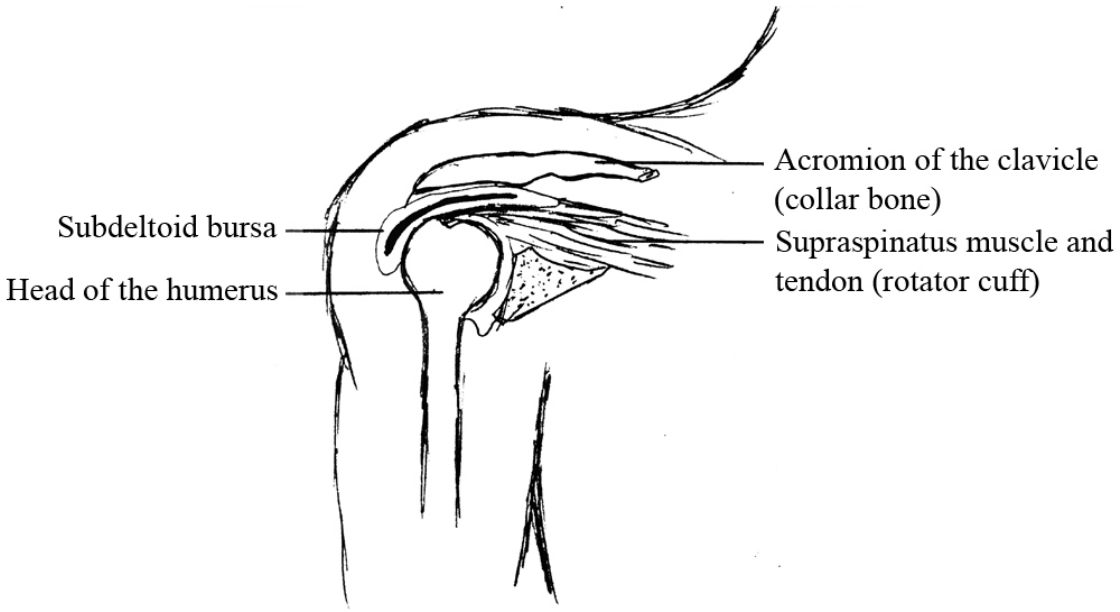

Figure 4.8. Components of the shoulder in natural posture, adapted from Norris, *Musician's Survival Manual,* 47.

[239] Norris, *The Musician's Survival Manual,* 45.

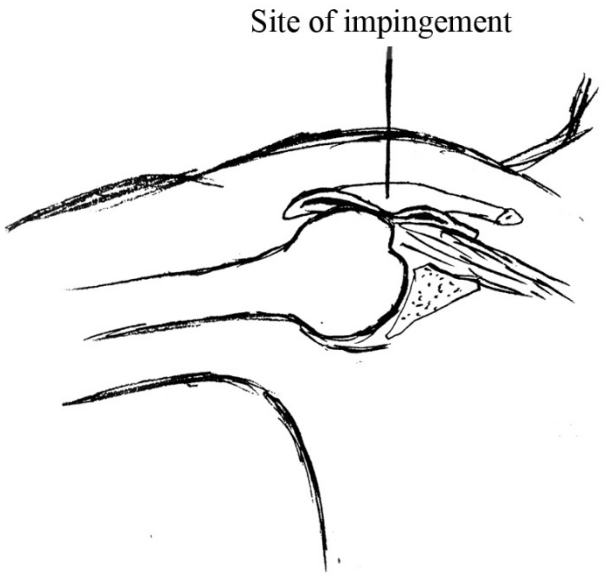

Figure 4.9. Potential impingement between head of the humerus and the collar bone, adapted from Norris, *Musician's Survival Manual,* 48.

The superficial muscle of the shoulder, the deltoid, is responsible for abduction and forward flexion movements of the arm.[240] Beneath the deltoid are the rotator cuff muscles, which are responsible for the stabilization of the humerus head in the joint socket as the deltoid moves the arm.[241] The rotator cuff muscles include: the supraspinatus, the infraspinatus, teres minor and subscapularis (see images 4.10, 4.11, and 4.12).[242]

[240] Norris, *The Musician's Survival Manual,* 45.

[241] Ibid., 45.

[242] Biel, *Trail Guide to the Body,* 74.

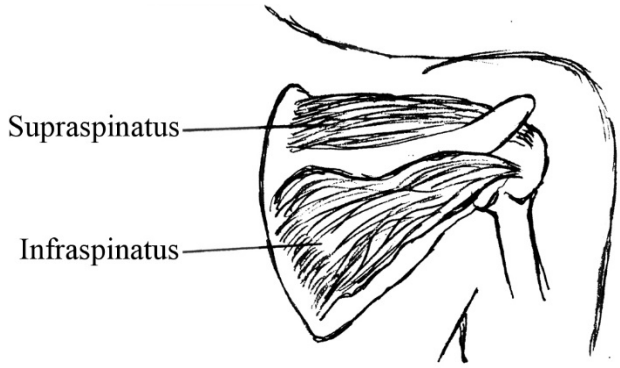

Figure 4.10. Posterior view of the right shoulder, adapted from *Trail Guide to the Body,* 74.

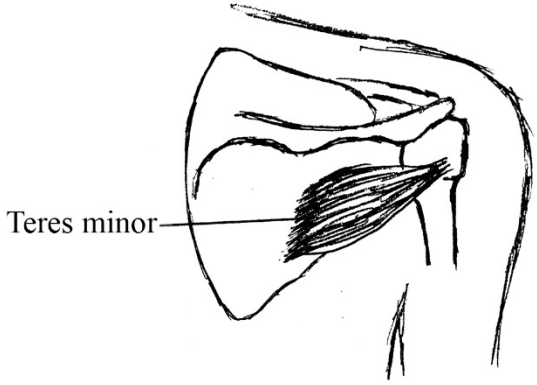

Figure 4.11. Posterior view of the right shoulder, adapted from *Trail Guide to the Body,* 74.

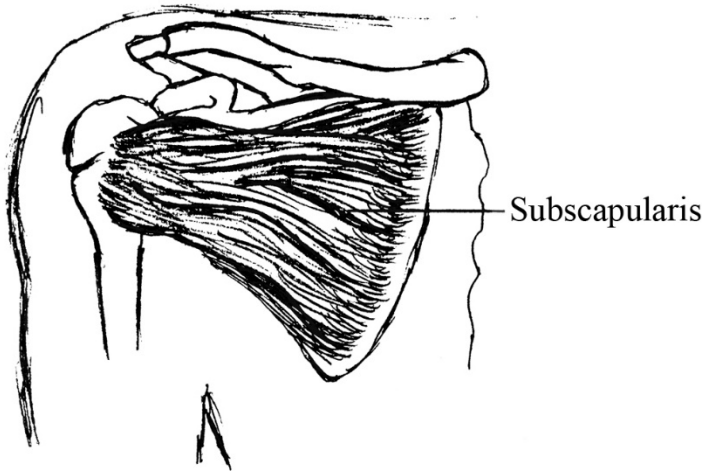

Figure 4.12. Anterior view of the right shoulder, adapted from *Trail Guide to the Body,* 74.

The supraspinatus assists the deltoid in abduction of the shoulder. The infraspinatus and

teres minor work together to assist lateral rotation of the shoulder.[243] Teres minor and major work in opposition in rotating the humerus, and the subscapularis rotates the shoulder medially (internally).[244] Norris suggests therapeutic exercises aimed at increasing the strength and endurance of the rotator cuff muscles, in order to protect against overuse and impingement.[245] The exercises need to include gentle but progressive resistance to rotational shoulder movements, and he suggests a TheraBand™ could be used.[246]

Because the A string on the cello is the farthest string from the right arm, some players, especially those with shorter arms, tend to rotate their torso towards the left in order to put the bow in a position closer to the higher strings. This is helpful to reduce the internal rotation at the shoulder needed to play towards the tip of the bow on the A string and may prevent pain.[247] However, this position is not recommended because it presents asymmetries in the body and may lead to strain in the back muscles.[248] Ideally, the player needs to find the most natural efficient way of playing by adapting the cello to his or her body, not the other way around. Slight movements of the cello may help in finding the optimal position for the arms, as well as freedom of movement in the torso and arms. The tendency to rotate the torso towards the left should be balanced with rotational work of

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[243] Ibid., 74.

[244] Ibid., 74.

[245] Norris, *The Musician's Survival Manual,* 49.

[246] Ibid.

[247] Norris, *The Musician's Survival Manual,* 45.

[248] Ibid., 46.

the spine emphasizing rotation to the right side. This will help prevent asymmetry-related injuries.

Figure 4.13. Summary of identified muscles involved in possible postural tendencies of cellists.

Problem/muscles involved	**Solution/muscular focus**
Forward head posture: overworked or strained posterior neck extensors, weakened deep neck flexors/stabilizers, overworked and shortened superficial neck flexors, weak shoulder retractors.	Strengthen the deep cervical flexors. Lengthen the cervical spine. Strengthen shoulder retractors. Stretch the neck extensors, pectoralis major and pectoralis minor. Subtle exercises activating deep neck flexors while maintaining superficial neck flexors relaxed.
Exaggerated thoracic curve and round shoulders: scapular elevation/upward rotation and hypertonic or tight pectoralis. Right shoulder problems: lack of rotator cuff stabilization.	Extension of the thoracic spine. Strengthen semispinalis, and all spinal extensors. Scapula stabilization. Stretch pectoralis. Strengthen scapula depressors: trapezius and serratus anterior. Improve stabilization and performance of the rotator cuff muscles to maintain joint centration (optimal joint position) of the humerus head. Lateral breathing.
Compromised sitting posture. Weak core/postural muscles: Erector spinae muscle group, transversospinalis group, transversus abdominis, pelvic floor, internal obliques and diaphragm muscles.	Trunk support. Strengthen: Erector spinae muscle group, transversospinalis group, transversus abdominis, pelvic floor, internal obliques and diaphragm muscle.
Prolonged sitting posture affecting the lower posterior chain: Shortened/weakened inferior gluteus maximus fibers, tightened hip flexors (illiopsoas), tightened/shortened hamstrings, calves, and quadriceps. Tightened piriformis. Joint stiffness.	Hip extension with gluteals strengthening. Improve performance and flexibility of lower posterior chain (gluteals, hamstrings and calves), and improve performance and flexibility of quadriceps. Exercises with co-activation of gluteals, hamstrings, quadriceps and abdominals. Lenghten and relax piriformis (and gluteals). Plantar flexion and dorsiflexion. Hip mobility with core stabilization.

Posture and Alignment in Double Bass Playing

Double bass playing presents many challenges to the body due to its size and absence of standardization. Additionally, different ways of playing, sitting or standing as well as different bow holds, result in a lack of consistency in technique and playing-related issues. An absence of literature on the subject, as compared to that on upper strings, limits the evidence available to identify specific postural problems associated with the particular positions of the double bass player. For the purpose of this paper, only general tendencies can be identified; they may not be as standardized as those mentioned for cello or upper strings, due to the various ways of holding the instrument and bow.

The two main ways of playing the double bass are sitting or standing, with further variations that change the way the player aligns his or her body and instrument. In sitting, the body should be balanced as much as possible between the two sitting bones or ischium so that the natural curves of the spine can be maintained. However, the size of the instrument makes it challenging to acquire an ideal sitting posture; the instrument cannot be played from a standard-sized chair. A taller stool is required, which changes the support of the legs and the alignment of the spine.

Sitting Position in Double Bass Playing

The most common stool for bass found in orchestras and schools is around eighty centimeters, or about thirty-two inches, tall. The height of this stool puts the hips significantly higher than the knees and the width of the instrument does not allow both feet to be placed evenly on the ground. Most players address this problem by having only the right foot on the floor and the right the leg extended at about 140 degrees, while the

left leg is flexed with the foot on an elevated footrest. This position is problematic as it places more weight on the right leg, which compromises the alignment of the pelvis, and therefore of the entire spine. Andrews explains that playing a one-sided instrument, especially the double bass, together with a poor seated position, causes weakness of the erector spinae muscle, resulting in compromised spinal curvature (reflecting a "C" or "S" curve).[249]

The erector spinae is responsible for bending backwards and assisting in side bending. True dysfunction of this muscle can lead to shoulder and elbow problems due to compensation, sciatica, and tingling or pain in the legs and feet, among other issues.[250] Strengthening this muscle in order to avoid rounding the spine and to help prevent scoliosis should be emphasized through *Pilates* exercises for this population. Additionally, when a "C" or "S" curve exists, the lung on the concave or compressed side of the body does not function properly. Therefore, directed breathing exercises are extremely valuable to restore lung capacity in the affected area and to help elongate and align the spine. They consist of intentionally directing air specifically into the concave or compressed side of the thorax.

Another adaptation to the sitting posture is the one promoted by Catalin Rotaru (and others), double bass professor at Arizona State University.[251] He uses a shorter than standard stool of about sixty centimeters, or about twenty-four inches. It allows both feet

[249] Andrews, *Muscle Management,* 183.

[250] Ibid.

[251] Catalin Rotaru, conversation with author, November 28, 2016.

to contact the ground, in a manner closer to that of cello playing. The feet on the ground provide more stability and allow for distributing some weight of the body onto the legs, which reduces the weight overload on the inter-vertebral discs. It also allows the player to better distribute the body weight between the ischium, which helps to better align the spine. In comparison to the cello position, the knees are slightly lower in relation to the hips, and the legs are flexed at about 110-120 degrees. This approaches a more anatomically correct position, much like the one described by Mandal and others.[252]

Yet another variation on the sitting posture involves keeping both feet on the footrest of a standard stool.[253] This position is helpful to maintain symmetry, in a manner similar to cello technique. However, playing with both feet off the floor can be problematic for people with balance issues, and the result is still not as stable as the cello position, with both feet on the ground.

The heavy weight of the instrument pushes on the body and often leads to a rounded back. Instead, the instrument should be supported by the body, which requires significant core and back strength in order to maintain correct posture during extended hours of playing. A potentially helpful measure is experimenting with bent endpins, which alter the center of gravity of the double bass in a way that reduces the weight transmitted to the player.[254] The flat surface of the standard double bass stool is another contributor to round back and flattened lumbar spine. Although some stools for double bass are designed or modified to tilt forward, they are not widely available in schools.

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[252] Mandal, "Investigation of the Lumbar Flexion," 79.

[253] James Karrer, conversation with author, February 12, 2017.

[254] Ibid.

Another contributor to round back and shoulders is the size of the bass. Playing in the higher registers requires an even farther reach forward and down of the arms than in cello playing, which increases the tendency for round shoulders and back, misalignment of the scapula, and leads to FHP, caused by looking downward at the hands. The same exercises for cellists are recommended for bassists in order to strengthen the musculature of the trunk, counteract round back/shoulders, enforce scapula stabilization and counteract FHP.

Standing Position in Double Bass Playing

The standing position for double bass should follow as closely as possible the concept of the plumb line. To distribute the player's weight evenly, the feet should be aligned under the hipbones and shoulders, without locking the knees. In his book *Principles of Double Bass Technique,* Wolf explains that the body needs to be balanced between the two legs and that one should be able to switch the weight from one leg to another.[255] However, because of the dimensions of the instrument, having the bass completely centered in relation to one's body is simply not possible, and the ability to balance between the two legs is challenged. Therefore, the instrument is usually placed slightly towards the left of the body, affecting the angle of the right arm and contributing to asymmetries.

One postural habit that contributes to asymmetry is the tendency to load more weight onto the right leg to support the weight of the right arm as it reaches to play the

[255] Michael Wolf, *Principles of Doublebass Technique* (Essen, Germany: Verl. Die Blaue Eule, 1991), 20.

strings. By loading more weight onto the right leg, the pelvis and hip stabilizers on the right side of the leg are often overworked.[256] The gluteus medius and minimus can go into a spasm if they are overloaded due to uneven weight distribution between the legs.[257] This, in turn, causes the pelvis to twist, takes the hips and shoulders out of alignment, and produces shoulder problems and back and buttocks pain.[258] The gluteus medius and minumus are involved in abduction (opening) of the leg. Which means, that the adductors or inner thighs on the same leg may be weakened. Strengthening and lengthening the adductors of the right leg encourages that this muscle group co-contracts properly when the gluteus medius and minumus activate. Ultimately, the abductors and adductors of both legs need to be properly strengthened and stretched to maintain balance.

Another tendency that creates asymmetry is the lateral rotation of the upper torso and head towards the left in order to look at the left hand and bring the bow closer to the strings. Some rotation of the torso when playing on the higher strings may be unavoidable, but when returning to the lower strings the shoulders should be brought back into alignment with each other.[259] Failure to do so not only creates imbalances in the trunk, upper extremities and head, but also reduces efficiency when transmitting weight into the bow from the muscles of the back. This situation presents risks for the arm and

[256] Andrews, *Muscle Management*, 196.

[257] Ibid.

[258] Ibid.

[259] López, *Cómo Tocar sin Dolor,* 126.

shoulder.[260] Rotational exercises of the torso and head should make it apparent if one side is more tense than the other. *Pilates* exercises that increase the range of motion towards the less developed side, in this case towards the right, should be helpful to promote balance and emphasize correct posture while playing. Muscles that rotate the body to the right would possibly need strengthening, including the right internal obliques and left external obliques (which assist in rotation to the right), and the deeper multifidi and rotatores.[261]

One problem that arises in trying to reach the higher registers is locking or hyper extending the knees while bending the upper torso, which can lead to flat back posture. Extended knees, together with the pelvis in neutral position or posteriorly rotated, produce a flattened lumbar curve or flat back.[262] This reduced lordosis shifts the line of gravity forward, by placing the weight of the body towards the front of the feet, which adversely affects correct alignment and function of the entire spine, hips, knees, ankles and feet.[263] According to Paterson, possible problems associated with flat back posture include: neck tension and cervical spine problems associated with the forward head position, impaired spine function associated with weakness of the thoracic back extensors and erector spinae, shoulder problems associated with impaired pectoral girdle alignment and scapular stabilization, lower back problems associated with weak lumbar paraspinalis

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[260] Ibid., 127.

[261] Biel, *Trail Guide to the Body*, 212.

[262] Paterson, *Pilates for Postural Faults,* 16.

[263] Ibid.

and poorly developed and tight gluteals, hip problems associated with weakened deep hip flexors (illiopsoas), hamstring problems associated with shortened and tight hamstrings, and knee and ankle problems associated with impaired pelvis, lower limb, and feet alignment.[264]

López recommends reaching the high register of the double bass by slightly bending the hips and knees, letting the gluteals move backwards and the knees slightly forward while keeping the spine from bending.[265] He explains that keeping the knees extended not only makes it harder to go up to the higher register, but also increases the tension in the feet, back and neck.[266] Besides corrective FHP exercises, exercises to support correct posture and counteract tendencies toward flat back posture should include: strengthening the thoracic extensors and erector spinae, improving scapula stabilization, strengthening the lumbar paraspinalis, strengthening the deep hip flexors (illiopsoas), strengthening and stretching the gluteals, elongating and improving the performance of hamstrings, and improving the alignment of the pelvis, lower limb, and feet.

Arm Position and Bow Hold in Double Bass Playing

Because the neck of the instrument is in a higher position than that of the cello, the left hand is also at a higher elevation. This tends to lift the left shoulder in the case of

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[264] Ibid.

[265] López, *Cómo Tocar sin Dolor,* 126.

[266] Ibid., 127.

poor scapular stabilization, which contributes to uneven height of the shoulders and possible scoliosis. The posture of the torso tilted towards the right produces further imbalances in the muscles that assist lateral flexion to the right, including the erector spinae and quadratus lumborum (refer to image 4.5). The quadratus lumborum is the deepest muscle of the abdomen, which is attached to the lumbar vertebrae and runs from the lowest rib to the posterior iliac crest.[267] If a lateral contraction of the body toward the right is apparent, *Pilates* exercises should focus balancing the torso by strengthening the same muscles on the opposite side, while stretching those on the right.

The two main bow grips in bass playing are the French bow hold and the German bow hold. The German school embraces additional variations of the grip of the hand, but their discussion lies outside the scope of this paper. In the French bow hold or "over hand grip", the four fingers are on top of the bow with the thumb inside the frog. In the German bow hold or "under hand grip," the thumb is on top of the bow, the pinky is on the bottom of the frog and the other fingers connect to the frog between thumb and pinky. The under hand grip, with the palm facing upwards, is achieved by a supination of the forearm and elbow. This arm position encourages a better scapular alignment than the French bow hold. In the French bow hold, when the arm lifts up or abducts to reach the higher strings, the scapula can rotate upwardly or "wing out". Therefore, as in cellists, for double bass players that use a French bow hold, exercises that encourage activation of the scapular depressors while lifting the arms should help avoid shoulder issues.

On the other hand, in the German bow hold, as the arm lifts, the supinated

[267] Biel, *Trail Guide to the Body*, 207.

position of the arm encourages the scapula to stay down. However, one problem that may arise with this position is applying excessive weight or force, or playing during extended hours without breaks. Excessive use of the supinator muscles has been associated with nerve entrapment syndrome in the area of the elbow, causing pain in the area between the elbow and the hand on the thumb side.[268] Because the supinator muscles are generally much stronger than the pronator muscles, playing with a supination position of the arm produces an even higher imbalance of the rotational muscles of the right arm.[269] Therefore, awareness together with balancing work of the rotational muscles of the right forearm may be needed. This could include *Pilates* exercises with the TheraBand™ that add some pronation to the right forearm, to encourage the co-activation of the pronators when the supinators are used.

[268] Andrews, *Muscle Management,* 147.

[269] Biel, *Trail Guide to the Body,* 145.

Figure 4.14. Summary of identified muscles involved in possible postural tendencies of double bassists.

Problem/muscles involved	**Solution/muscular focus**
Forward head posture: overworked or strained posterior neck extensors, weakened deep neck flexors/stabilizers, overworked and shortened superficial neck flexors, weak shoulder retractors.	Strengthen the deep cervical flexors. Lengthen the cervical spine. Strengthen shoulder retractors. Stretch the neck extensors, pectoralis major and pectoralis minor. Subtle exercises activating deep neck flexors while maintaining superficial neck flexors relaxed.
Uneven shoulders, "C" or "S" curve: erector spinae weakness, compromised breathing. Right lateral flexion of the torso: right emphasis of erector spinae and quadratus lumborum. Left shoulder elevation: lack of scapula stabilization.	Strengthen erector spinae and incorporate directed breathing exercises. Emphasise lateral flexion towards the left: left-side contraction of erector spinae and quadratus lumborum. Improve scapula stabilization.
Exaggerated thoracic curve and round shoulders: scapular elevation/upward rotation and hypertonic or tight pectoralis. Right shoulder problems: lack of rotator cuff stabilization.	Extension of the thoracic spine. Strengthen semispinalis, and all spinal extensors. Scapula stabilization. Stretch pectoralis. Strengthen scapula depressors: trapezius and serratus anterior. Improve stabilization and performance of the rotator cuff muscles to maintain joint centration (optimal joint position) of the humerus head. Lateral breathing.
Compromised sitting posture, round back. Weak core/postural muscles: Erector spinae muscle group, transversospinalis group, transversus abdominis, pelvic floor, internal obliques and diaphragm muscles.	Trunk support. Strengthen: Erector spinae muscle group, transversospinalis group, transversus abdominis, pelvic floor, internal obliques and diaphragm muscle.
Head and torso lateral rotation towards the left. Tighter left internal obliques and right external obliques. Balance rotation of the multifidis and rotators.	Emphasize rotation and increase range of motion towards the right. Strengthen right internal obliques and left external obliques. Rotation to the right, multifidi and rotators.

Extended knees, posterior rotation of the pelvis, flat back posture (FHP, weak thoracic back extensors and erector spinae, impaired pectoral girdle alignment and scapular stabilization, weak lumbar paraspinalis and poorly developed and tight gluteals, weakened deep hip flexors (illiopsoas), shortened and tight hamstrings, impaired pelvis, lower limb, and feet alignment).	Counteract FHP. Counteract flat back posture: strengthen thoracic extensors and erector spinae, improve scapula stabilization, strengthen lumbar paraspinalis and gluteals (also stretch gluteals), strengthen deep hip flexors (illiopsoas), elongate and improve performance of hamstrings, improve pelvis, lower limb, and feet alignment.
Uneven leg weight distribution, right leg dominance: overworked right gluteus medius and minimus.	Balance right leg with inner thigh strengthening and lengthening. Improve strength, flexibility and balance of both legs.

This chapter has explored optimal alignment when playing the cello and double bass and has identified specific muscles associated with potential misalignments and their causes. It has also identified what muscles may need conditioning, in order to provide *Pilates* exercises that will be helpful for this population. Chapter five identifies potential misalignments of upper string players.

CHAPTER 5: POSTURE AND POSTURAL TENDENCIES OF UPPER STRING PLAYERS

This chapter explores the common postural faults and tendencies associated with playing the violin and viola and identifies specific muscles associated with those postures. Based on the information and supporting research, this chapter provides a summary of the identified compromised muscles as well as key muscles to be targeted in order to counteract the problem. *Pilates* exercises to address those specific muscles are provided in chapter 6.

Standing Posture and Alignment

The violin and viola are different instruments with different playing demands, but since they share more postural traits and tendencies than either does with the lower strings, they will be discussed together in this chapter.[270] Upper strings can alternate their playing position between standing and sitting. The standing position allows more freedom of the upper torso but sometimes challenges the stability of the base, while a sitting position provides a more stable base but limits the freedom of the upper torso. Usually a standing position is used for practice as well as solo performances, while a sitting position is adopted for most chamber ensembles and orchestral settings.

As explained in Chapter 4, an ideal posture while standing should follow the plumb line as closely as possible. However, perfect alignment in upper strings is

[270] Alice G. Brandfonbrener, "Epidemiology of the Medical Problems of Performing Artists," in *Textbook of Performing Arts Medicine,* ed. Robert Thayer Sataloff, Alice Brandfonbrener, and Richard J. Lederman (New York: Raven Press, 1991), 42.

challenged by the weight of the instrument on the upper left extremity. The body must counterbalance this asymmetry with the base of support, the legs. As a result, different methods offer different opinions on ways to place the feet to provide balance and support. Some choose a forward position of the left foot, others choose to keep the feet in a more even plane from left to right. The spectrum of foot placement options can be noted in some of the writings of renowned upper string pedagogues and technique schools.

According to Rolland, the correct standing position places the feet underneath the hip joints with the left foot very slightly in front of the right.[271] The slightly forward position of the left foot is meant to align the foot with the scroll of the instrument for more adequate support. The Suzuki method promotes a similar stance, in which the feet are in a "v-shaped" position with the heels slightly apart and the left foot forward.[272] In *The Viola*, Barret describes the best stance as one in which the feet form an angle of about forty-five degrees, the heels are placed between five and ten inches width apart and the left foot is slightly forward.[273] Barret further explains that some violists lean forward onto the legs while standing, which requires a great activation of the leg muscles for stabilization, while others lean backwards to counterbalance the heavy weight of the instrument.[274] In all three stances involving a forward position of the left foot, it is

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[271] Rolland, *Teaching in String Playing,* 68.

[272] Marianne Murray Perkins, "A Comparative Study of the Violin Playing Techniques Developed by Kato Havas, Paul Rolland, and Shinichi Suzuki," (DMA diss., Catholic University of America, 1993), 131.

[273] Henry Barret, *The Viola: Complete Guide for Teachers and Students* (University, AL: The University of Alabama Press, 1978), 48.

[274] Ibid.

emphasized that the stance should be well balanced, allowing changes in weight distribution for relaxation and free movement of the upper body and limbs.[275]

The v-position of the feet departs from ideal alignment because it challenges the ability to stabilize the femur in the hip socket, compromising stability, creating muscle imbalance and potentially leading to injuries. Furthermore, the playing position may contribute to a faulty postural pattern that favors a turned-out position of the feet or hips (when not playing), which can cause further problems in the feet and toes, knees, and the pelvic girdle. Muscles used in this position are sometimes overactive or overly tightened and include those involved in lateral or external rotation of the hip and leg: superior fibers of gluteus maximus, gluteus medius (posterior fibers), small and deep lateral hip rotators, iliopsoas, rectus femoris, sartorius and lateral side of the hamstrings (biceps femoris) (see figures 5.1. and 5.2). [276] In cases where this position is used, it is crucial to incorporate exercises with the feet in a v-position to encourage better alignment and efficiency when playing in upright position. These exercises should aim to strengthen the arches of the feet (tibialis posterior muscle) for better ankle stability, and recruit the hip and leg adductors (inferior fibers of gluteus maximus, deep hip rotators and adductor magnus) together with the deep abdominals (TA). Activating these muscles, which form part of the concept of Deep Front Line as described my Thomas W. Myers, will

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[275] Rolland, *Teaching in String Playing,* 68; Marianne Murray Perkins, "A Comparative Study of the Violin Playing Techniques Developed by Kato Havas, Paul Rolland, and Shinichi Suzuki," (DMA diss., Catholic University of America, 1993), 131; Barret, *The Viola,* 48.

[276] Paterson, *Pilates for Postural Faults*, 25; Biel, *Trail Guide to the Body,* 303.

contribute to better alignment even when using a turned out or v- position of the feet (see figure 5.3).[277] When the Deep Front Line is recruited, it allows the body to use the deep lateral rotators of the hip instead of the superficial external rotators, thus keeping the hip joint and pelvis in proper alignment and stabilizing the femur in the hip socket. Additionally, strengthening exercises with the hip joints in a neutral position and parallel feet are recommended to encourage alignment when not playing and avoid a permanent turned out position and further muscles imbalances.[278]

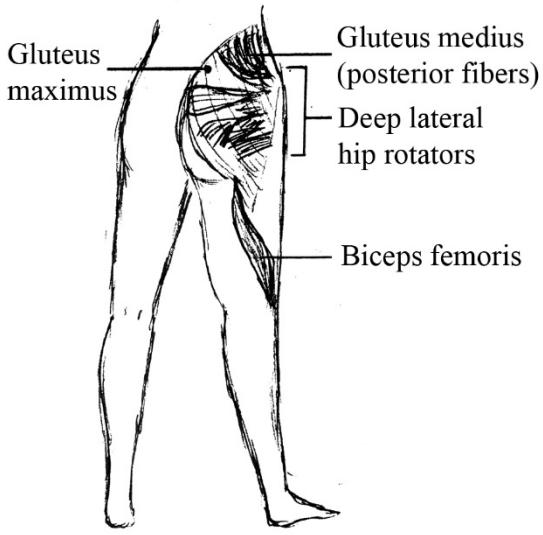

Figure 5.1. Posterior/lateral view of the legs. Muscles involved in external rotation. Adapted from Biel, *Trail Guide to the Body,* 303.

[277] Thomas W. Myers, *Anatomy Trains: Myofascial Meridians for Manual and Movement Therapists,* 3rd ed. (Endinburgh: Churchhill Livingstone/Elsevier, 2014) 185.

[278] Paterson, *Pilates for Postural Faults*, 25.

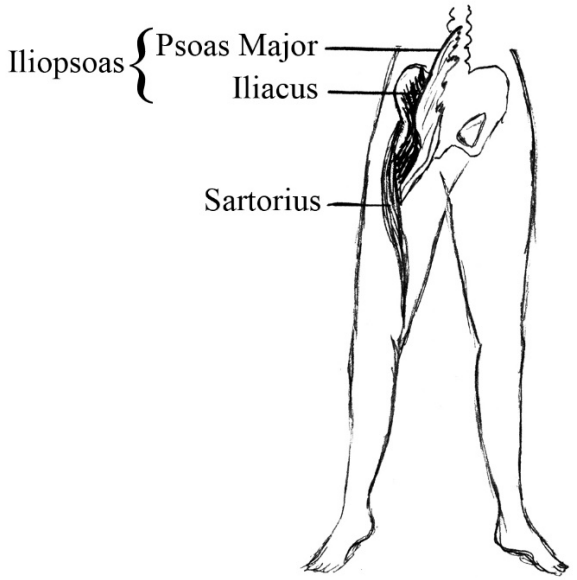

Figure 5.2. Anterior/medial view of the legs. Muscles involved in external rotation. Adapted from Biel, *Trail Guide to the Body,* 303.

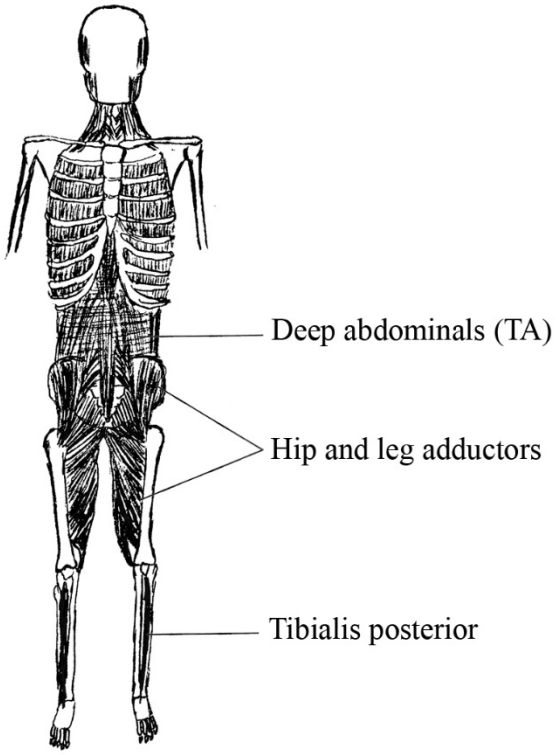

Figure 5.3. The Deep Front Line. Adapted from Myers, *Anatomy Trains,* 184.

Pilates exercises for the feet are highly recommended for upper string players to facilitate better contact with the floor, improving proprioception, balance and stability.

Especially for stances that involve a forward position of the left foot, the work on the foot muscles can improve the distribution weight evenly between the left and the right foot.

Other ways to counterbalance the weight of the instrument consist of a foot placement on an even plane such as the foot stances supported by Carl Flesch and Kató Havas. According to Flesch, the best playing position is the "spread" or "straddling leg position," consisting of a slight turn out of the feet, with the heels approximately underneath the hips.[279] Flesch claimed that the spread of the feet, as opposed to the feet closer together, provides a broad foundation and freedom of movement.[280] The ideal stance, according to Havas, consists of a broad stance, where the feet are placed somewhat wider than the hip joints and the weight of the body is on the heels. Instead of having the weight centered, the weight is directed more toward the back of the body, back of the spine and shoulder blades, and the hips are offset in a slightly forward position.[281] Havas stated that throwing the weight backwards counteracts the "jutting-forward position of the violin" and that the position reduces the fatigue of standing.[282]

The position explained by Havas, with the weight of the body on the heels and the forward position of the hips, is especially problematic because it presents potential for hyperextension of the knees and sway-back posture. According to Paterson, hyperextension of the knees is associated with pelvic instability, weakened hamstrings,

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[279] Carl Flesch, *The Art of Violin Playing*, 2nd rev. ed., trans. Frederick H. Martens, bk. 1 (New York: Carl Fischer, Inc., 1939), 14.

[280] Ibid.

[281] Kató Havas, *A New Approach to Violin Playing* (London: Bosworth & Co.:1961), 15.

[282] Ibid.

quadriceps, and other muscles that are either located at or cross the back of the knee.[283] When the knees are hyperextended, the muscles in the legs are not being used properly, and instead the ligaments stabilize the body. Furthermore, excessive tension occurs in the lower back, the sacroiliac area (area between the sacrum and ilium bones), the upper fibers of gluteus maximus, the hip abductors, the calf muscles, and the sole of the foot.[284]

In sway-back posture, the head is forward, the upper thoracic spine sways backwards and presents an exaggerated kyphosis, the natural curve of the lumbar spine is flattened, the pelvis sways forward and creates a posterior pelvic tilt that compromises the proper function of the posterior hip muscles, the knee joints are hyperextended, and the center of gravity is shifted backwards.[285] Associated with sway back posture is a forward head posture (FHP), which involves weakened deep neck flexors, lengthened and weakened thoracic back extensors, shortened and tight serratus anterior and pectoralis. Other features include weakened gluteus maximus, which compromises the control of the femoral head within the hip socket. Furthermore, if one leg is favored over the other, which is common in upper string instrumentalists, the posterior fibers of gluteus medius may be hypertonic (overly toned) or tighter on the side that carries more weight and weaker on the other side.[286] The rectus abdominis and internal and external obliques may be shortened but not necessarily strengthened in this position, and the iliopsoas and rectus

[283] Paterson, *Pilates for Postural Faults*, 26.

[284] Ibid., 27.

[285] Ibid., 16.

[286] Ibid., 17.

femoris may be lengthened and weakened.[287]

Violinists and violists who adopt a stance on an even plane with a slight turn-out of the feet, similar to the ones described by Flesch or Havas, should beware of shifting the weight of the body toward the back, and rather find a centered weight that is also flexible, allowing the body to swing freely, front to back and sideways. *Pilates* exercises to counteract sway back posture are strongly recommended for upper string players, to create awareness and support the musculature needed to avoid this postural fault. Exercises that counteract sway back posture include: strengthening the deep neck flexors, strengthening the thoracic back extensors while stretching the pectoralis, and stretching the serratus anterior; strengthening the gluteus maximus and balancing the gluteus medium on the weaker leg; strengthening and stretching the rectus abdominis and obliques; strengthening the iliopsoas and rectus femoris.

Sitting Posture and Alignment

In general, the considerations for sitting posture for upper strings are the same as those discussed for cello. The player should sit towards the front of the chair and find balance between the ischium or sitting bones in order to maintain proper spinal alignment.[288] The hips should be positioned slightly higher than the knees, to keep the natural lordotic curve of the low back and correct alignment of the entire spine and head. Unfortunately, in most orchestras and schools the cello chairs, as the name suggests, are

[287] Ibid., 17.

[288] Barret, *The Viola,* 50.

reserved almost exclusively for cellists and as a result, violinists and violists have faulty postural tendencies such as adopting a slouching position or leaning the back on the back of the chair for support.[289] The slope of the cello chair is also beneficial for free movement of the bow, because it places the right knee in a lower plane and allows more space for the right arm.

When using a standard chair, or in the case of wearing high heels that elevate the knees above the hips, upper string players often bend the right knee more than the left. This places the right foot under the chair rather than directly below the knee joint, in order to avoid the right arm hitting the knee. The left leg is bent at about ninety degrees with the entire sole of the foot on the ground, while the right foot has only the front or ball of the foot in contact with the ground, and the heel off the ground. A study by Spahn and others compared the posture of violinists while standing and sitting, and found that while standing, the body weight distribution was fifty percent on each side, while in the sitting position the majority of the weight, 62.1%, was on the left sitting bone.[290] They also found that the location of the music stand with respect to the player had an effect on the sitting weight distribution. When the stand was located to the left of the player, it emphasized the tendency to place more weight on the left sitting bone. When the stand

[289] Alice G. Brandfonbrener, "Epidemiology of the Medical Problems of Performing Artists," 42.

[290] Claudia Spahn, Céline Wasmer, Franziska Eickhoff, and Manfred Nusseck, "Comparing Violinists' Body Movements While Standing, Sitting, and in Sitting Orientations to the Right or Left of a Music Stand," *Medical Problems of Performing Artists* 29, no. 2 (June 2014): 88.

was located to the right of the player, it evened out the weight distribution.[291] This is likely to affect the players sitting towards the right of the stand in orchestral situations, when players are seated in pairs.

When the weight of the body shifts towards the left side of the pelvis, it disrupts the entire alignment of the spine, presenting a risk for functional scoliosis. This condition develops as the result of postural habits, in which an initial deviation of the lumbar spine creates another deviation in the thoracic spine.[292] Over time, functional scoliosis can lead to: rib cage deformity that compromises breathing, upper back problems associated with the change in thoracic kyphosis, shoulder problems associated with shoulder and scapula misalignment, lower back problems associated with the change in normal lordosis (which can lead to slipped discs, sciatica, or chronic low back pain), and loss of hip mobility associated with misalignment of the hips.[293] When the alignment of the shoulders is disrupted, there is a higher risk for right shoulder impingement since the right arm is in a lower plane and may have to increase the range of motion in order to reach the lower strings. When the arm and shoulder are raised beyond ninety degrees (in relation to the front of the body), a higher risk for shoulder impingement is present because the head of the humerus compresses the rotator cuff into the acromion (collar bone).[294]

A study by Barczyk-Pawelec and others corroborates the tendency for functional

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[291] Ibid.

[292] Paterson, *Pilates for Postural Faults*, 23.

[293] Ibid.

[294] Norris, *Survival Manual*, 48.

scoliosis in upper string instrumentalists. They found an exaggerated, lengthened kyphosis and a flattened, shortened lordotic curve associated with playing the violin, which contributed to asymmetries in the shoulder girdle.[295] Recommended *Pilates* exercises are those that help balance the asymmetric tendencies that can lead to scoliosis and should focus on: balancing the posterior hip muscles and mobility of the hips, correction of kyphotic and lordotic curves, balance of the whole body weight over the lower limbs and feet, improvement of rib cage mobility and breathing (especially if one side is compressed), and improvement of the pectoral girdle alignment and erector spinae.[296]

Another consideration when distributing weight unevenly on the pelvis, is that the piriformis may be tighter on one side. According to Andrews, this is common in upper string instrumentalists, and often leads to deep pelvic pain, a turned-in foot, and possible ankle pain.[297] Therefore, like cellists, this population should aim for optimal balance between the piriformis of the two sides, and elongate both, especially on the tighter side.

Renowned upper string performers and pedagogues have recognized and emphasized the importance of abdominal work in maintaining erect posture in the upper body while playing, whether sitting or standing. Barret supports the need for abdominal strength in violists and instructs students and teachers to "stretch upwards instead of

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[295] Katarzyna Barczyk-Pawelec et al., "Anterioposterior Spinal Curvatures and Magnitude of Asymmetry in the Trunk in Musicians Playing the Violin Compared With Nonmusicians," *Journal of Manipulative and Physiological Therapeutics* 36, no. 4 (May 2012): 319-326.

[296] Paterson, *Pilates for Postural Faults*, 24.

[297] Andrews, Muscle Management, 195.

dumping the upper body weight onto the pelvis."[298] He continues: "Keep the long abdominal muscle firm and taut. This will take great strain off the back muscles. Do not permit the back to curve."[299] In *Violin and Viola,* Menuhin also supports the need for core strength in upper string players, and recommends physical exercises to strengthen the stomach muscles and promote circulation, as well as exercises to strengthen the back and gluteal muscles, which are necessary to support correct standing posture.[300]

Instrument Considerations: Sizing and Asymmetry

One major cause of musculoskeletal disorders in upper strings is an improperly sized instrument.[301] For violists this is especially problematic, since instrument size is not standardized. Players with different body types need to carefully select an instrument that allows correct biomechanics. The main factor in determining size has to do with the string length and how easily the player can reach the strings with the left arm.[302] A study by Blum and Ahlers analyzed musculoskeletal problems in 311 violists within an experimental group of 1,432 string players, comparing players with smaller instruments

[298] Barret, *The Viola*, 50.

[299] Ibid.

[300] Menuhin, *Violin and Viola*, 15.

[301] Alice G. Brandfonbrener, "Epidemiology of the Medical Problems of Performing Artists," 43.

[302] Ibid.

to those with larger ones.[303] The researchers found that violists were the most affected group among string players, and that violists with larger instruments suffered from even more injuries than those with smaller instruments. Playing a larger viola presents a greater risk for the left rotator cuff.[304] The larger instrument requires an increased reach of the arm, which results in an increased extension of the elbow, hyperextension of the wrist, and greater external rotation of the left arm.[305]

The weight of the instrument itself has an effect on muscle activation, and can create asymmetries in the body that need to be balanced through. This tendency is especially relevant with a heavier instrument, like the viola.[306] The rhomboid muscles are responsible for pulling the shoulder blades towards the spine, and they help counterbalance the weight of a violin or viola in front of the body.[307] Since the instrument is held on the left side, it is possible that the rhomboids on the left side will be hypertonic (increased muscle tone), overused, or tighter than the rhomboids on the right. Andrews explains that problems with rhomboids occur mostly in one-sided instruments like upper strings. These issues are caused by constantly pulling the spine towards one side, a

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[303] Jochen Blum and Jurgen Ahlers, "Ergonomic Considerations in Violists' Left Shoulder Pain," *Medical Problems of Performing Artists* 9, no. 1 (March 1994): 25.

[304] Ibid., 26.

[305] Ibid., 26.

[306] Moraes, Geraldo Fabiano de Souza and Adriana Papini Antunes. "Musculoskeletal Disorders in Professional Violinists and Violists: Systematic Review." *Acta Ortopédica Brasileira* 20, no. 1 (2012): 46.

[307] Andrews, *Muscle Management,* 125.

position that causes one rhomboid to be tight or strained and the other one weakened.[308] *Pilates* exercises can help balance the rhomboids if apparent differences exist, strengthening the weaker rhomboid (right side) and stretching both.

Accessories such as the chin rest and shoulder rest are meant to provide a more appropriate fit of the instrument according to the player's neck length. The chinrest is attached on top of the instrument for placement on the left side of the jaw, and can be adjusted either more centrally or laterally.[309] The shoulder rest is attached underneath the instrument and rests on the left clavicle. These accessories reduce the distance between the head and the shoulder, thus reducing the degree of neck flexion or shoulder elevation required to secure the instrument. These adaptations potentially reduce tension.[310] Studies such as those by Okner and others and Lee and others, have shown that the use of chinrests and shoulder rests reduces significantly the recruitment of the muscles that support the instrument--the trapezius and sternocleidomastoid muscles--thus reducing the risk for musculoskeletal issues.[311]

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[308] Ibid.

[309] Raoul Tubiana, Philippe Chamagne, and Roberta Brockman, "Fundamental Positions for Instrumental Musicians: Third of Three Articles," *Medical Problems of Performing Artists* 20, no. 4 (December 2005): 193; Alice G. Brandfonbrener, "Epidemiology of the Medical Problems of Performing Artists," 42.

[310] Tubiana, Chamagne, and Brockman, "Fundamental Positions for Instrumental Musicians," 193.

[311] Marla A. O. Okner, Thomas Kernozek, and Michael G. Wade, "Chin Rest Pressure in Violin Players: Musical Repertoire, Chin Rests, and Shoulder Pads as Possible Mediators," *Medical Problems of Performing Artists* 12, no. 4 (December 1997): 112-121; Charles E. Levy et al., "Electromyographic Analysis of Muscular Activity in the Upper Extremity Generated by Supporting a Violin with and without a Shoulder Rest," *Medical Problems of Performing Artists* 7, no. 4 (December 1992): 103-109.

Despite using chinrests and shoulder rests, specific technique challenges can produce unnecessary tension in upper string players. According to Rolland, the instrument should be supported by the chin, shoulder and left hand, instead of by the chin and shoulder only, because it allows for better balance and relaxation.[312] However, technical difficulty in musical performance disrupts the ideal balance, since the left hand needs to be free to move, and almost complete support by the chin and shoulder is therefore sometimes necessary.[313] Okner and others were able to corroborate the increase of pressure associated with challenging repertory, by placing a sensor mat under the contact point of the chinrest. They found an increased pressure and force during the performance of excerpts from Max Bruch's concerto, in comparison to excerpts from a G. F. Handel sonata.[314]

The design of and execution on upper string instruments require significant awareness and muscle control to be able to balance the instrument with the help of the left hand whenever possible, and keep the neck muscles from tensing during challenging musical passages. The prolonged activation of the neck and shoulder muscles in combination with unnecessary tension has been associated with musculoskeletal disorders in the neck, shoulder and temporomandibular joints.[315]

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[312] Rolland, *Teaching in String Playing,* 71.

[313] Ibid.

[314] Okner, Kernozek, and Wade, "Chin Rest Pressure in Violin Players," 112-121.

[315] Geraldo Fabiano de Souza Moraes and Adriana Papini Antunes, "Musculoskeletal Disorders in Professional Violinists and Violists: Systematic Review," *Acta Ortopédica Brasileira* 20, no. 1 (2012): 43.

A study by Kruta de Araújo and others analyzed the unnecessary tension patterns of violin students from the Paraíba (Brazil) Young Symphony Orchestra, who were also enrolled in a four- or five-year program at a conservatory or university.[316] Researchers took photographs to measure specific angles of the arm, wrist, and head, to determine the frequency with which postural faults occurred. The study showed that students had a tendency to lift the left shoulder especially when playing on the lower strings, D and G. Out of sixty-five captures while playing on the D string, only thirteen showed a correct position of the shoulder, and out of thirty-three captures while playing on the G string, only three showed a correct position of the shoulder. The study also showed that all of the students had left lateral deviation of the neck, and in 76 % of the captures the angles of deviation were between ten and twenty degrees.[317] Instances of right lateral deviation of the head were infrequent. Out of 222 captures, sixteen showed some lateral deviation; in 75% of these the deviation was smaller than ten degrees and in 25%, the deviation was between ten and twenty degrees.[318]

A study by Park and others compared the electromyographic (EMG) activity in superficial neck muscles and neck range of motion (ROM) while playing and not playing

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[316] Nívia Cecília Kruta de Araújo, Maria Cláudia Gatto Cárdia, Francisco Soares Másculo, and Neide Maria Gomes Lucena, "Analysis of the Frequency of Postural Flaws During Violin Performance," *Medical Problems of Performing Artists* 24, no. 3 (September 2009): 111.

[317] Ibid.

[318] Ibid.

the violin, both in students with and without neck pain.[319] The researchers found that neck pain was associated with a greater leftward rotation and lateral bending of the cervical spine as well as greater activation of the superficial neck muscles: the left upper trapezius, both cervical extensors, and both sternocleidomastoid muscles.[320]

A study by Stechman Neto and others, which was reported in a systematic review by Moraes and Antunes, found joint clicking in the jaw in 54.54% of the observed violinists and violists.[321] It was suggested that the main causes for temporomandibular dysfunction were due to "neck and jaw positioning while playing, excessive pressure applied to hold the instrument and occlusion with excessive force."[322] Additionally, more problems were found in violists.[323] According to Moraes and Antunes, the first recommendation to reduce temporomandibular symptoms is to alter the technique in order to reduce excessive tension while holding the instrument, changes made easier through enhanced awareness and acute muscle control or muscle differentiation.

Specific *Pilates* exercises that help mobilize the neck by reducing the excessive recruitment of neck muscles such as the sternocleidomastoid, left upper trapezius, and cervical extensors, are recommended to encourage using the weight of the head more

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[319] Kyue-nam Park et al., "Comparison of Electromyographic Activity and Range of Neck Motion in Violin Students with and without Neck Pain During Playing," *Medical Problems of Performing Artists* 27, no. 4 (December 2012): 188.

[320] Ibid.

[321] Geraldo Fabiano de Souza Moraes and Adriana Papini Antunes, "Musculoskeletal Disorders in Professional Violinists and Violists: Systematic Review," *Acta Ortopédica Brasileira* 20, no. 1 (2012): 46.

[322] Ibid.

[323] Ibid.

effectively to secure the instrument. Because of the fixed position of the neck towards the left side, neck movement towards the right side may be compromised. Therefore, *Pilates* exercises that mobilize the neck and increase the range of motion towards the right side are also recommended to balance any differences. Finally, strengthening the back extensors, especially the thoracic extensors (longissimus, iliocostalis, spinalis and semispinalis), should help in maintaining proper spine and head alignment, when playing and when not playing (refer to figure 4.5).

Rotator Cuff, Scapula, and Shoulder

Shoulder and scapula alignment in upper string instrumentalists is crucial for efficient support of the instrument and right arm movement. Tubiana and others explain the importance of correct scapula alignment in violin playing, which also applies to viola: "Scapulothoracic positioning is extremely important here, as the position of the inferior angle of the scapula against the rib cage at the end of its physiologic sliding seems to be an essential element to the resistance of the weight of the arm and of the instrument."[324] *Pilates* exercises that focus on the stabilization of the scapula are essential for this population.

When playing upper strings, the left arm is practically in complete external rotation and supination. Bringing the left arm closer to the body in order to reach the higher positions on the neck of the instrument increases flexion and strain.[325] With the

[324] Raoul Tubiana et al., "Fundamental Positions for Instrumental Musicians," 193-194.

[325] Ibid., 194.

increased flexion there is a tendency to pull the elbow forward and out of alignment, due to lack of scapula stabilization, causing a larger muscle, the upper trapezius, to take over. Andrews sustains that the upper trapezius is often more developed on the left side than the right side in violinists and violists.[326] The upper trapezius runs from the cervical vertebrae to the tip of the shoulder, and is attached to the shoulder blades and collar bone. It is responsible for lifting the shoulder girdle and bending the neck to one side. The levator scapulae muscle connects the top four cervical vertebrae to the inner corner of the shoulder blade.[327] This muscle lifts the shoulder blade and turns the head to one side. Both the upper trapezius and levator scapulae are likely to be recruited to hold the violin or viola when there is a lack of scapula/shoulder stabilization due to weakened subscapularis, lower trapezius and rhomboids (see figure 5.4).

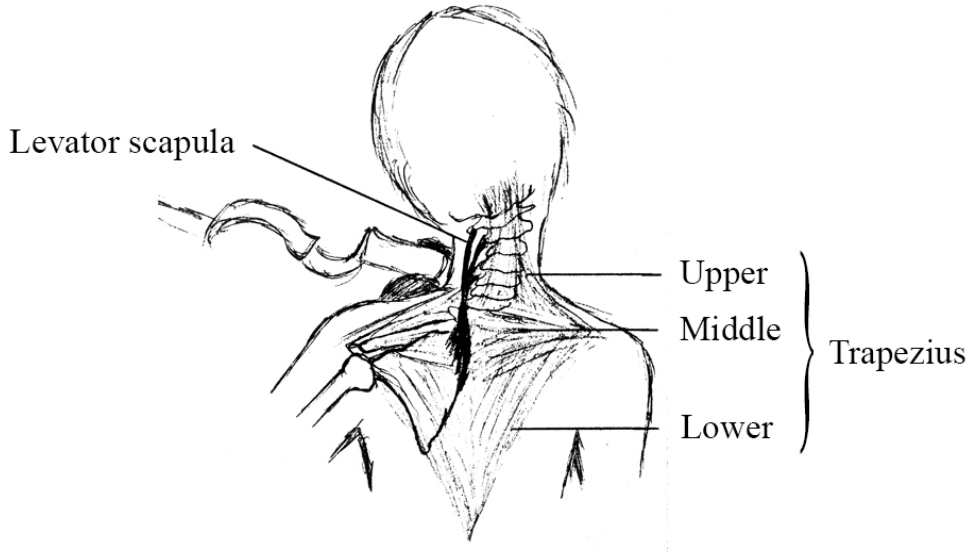

Figure 5.4. Posterior view of upper trapezius and levator scapulae muscles. Image by author, based on Biel, *Trail Guide to the Body,* 83-84.

[326] Andrews, *Muscle Management,* 111.

[327] Ibid.

The study by Wilkinson and Grimmer confirms the recruitment of the upper trapezius on the left side of elite violinists and violists.[328] They used ultrasound technology to explore the activation of the muscles of the left pectoral girdle and found a significant difference in the activation of the left upper trapezius, mid-trapezius and the tendon of the long head of the biceps.[329] *Pilates* exercises that focus on scapula stabilization should be used to prevent the shoulder blade from "winging out" and to keep the trapezius muscle from taking over.[330] These should be performed for both shoulders.

A common faulty posture of the right arm is an excessive bending of the wrist, due to technical reasons. Studies have shown more discrepancy in the wrist position of the right hand of upper string players than in their left hand.[331] The excessive flexion of the wrists often leads to problems. The study by Kruta de Araújo and others showed that all the students had faulty posture of the right wrist when playing on the middle and at the frog of the bow.[332] It was also noted that the excessive bend of the wrist was accompanied by lifting or abducting the right shoulder, especially when trying to reach

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[328] Maureen Wilkinson and Karen Grimmer, "Ultrasound of the Left Shoulder Girdle in Professional Violists and Violinists: A Pilot Study," *Medical Problems of Performing Artists* 16, no. 2 (June 2001): 58-65.

[329] Ibid.

[330] Andrews, *Muscle Management,* 113.

[331] Claudia Spahn et al., "Comparing Violinists' Body Movements While Standing, Sitting, and in Sitting Orientations to the Right or Left of a Music Stand," *Medical Problems of Performing Artists* 29, no. 2 (June 2014): 86-93.

[332] Kruta de Araújo, "Frequency of Postural Flaws During Violin Performance," 112.

the lower strings, D and G.[333] This, again, suggests a lack of scapula stabilization, which was noted when lifting the arm higher. By strengthening the scapular muscles, the shoulder can be held properly in its socket as the arm lifts higher to reach the lower strings. Consequently, the wrist can stay aligned and maintain a more neutral position, which could help reduce wrist problems.

Figure 5.5. Summary of identified muscles involved in possible postural tendencies of upper string players.

Problem/muscles involved	**Solution/muscular focus**
V-position of the feet: stronger external rotators.	Emphasize the recruitment of the Deep Front Line: strengthening of the feet arches (tibialis posterior), and recruitment of hip and leg adductors (inferior fibers of gluteus max, deep hip rotators and adductor magnus) together with the deep abdominals (TA). Exercises in neutral and parallel position of the feet.
FHP. Sway back posture: lengthened and weakened thoracic back extensors, shortened and tight serratus anterior and pectoralis, weakened gluteus maximus, gluteus medium imbalance (possibly tighter on one side and weaker on the other side), shortened and likely weakened rectus abdominis and internal and external obliques, lengthened and weakened iliopsoas and rectus femoris.	Counteract FHP. Strengthen thoracic back extensors, stretch serratus anterior and pectoralis, strengthen gluteus maximus and balance gluteus medium on the weaker leg, strengthen and stretch rectus abdominis and internal and external obliques, strengthen iliopsoas and rectus femoris.
Lack of abdominal strength.	Strengthen core.

[333] Ibid.

Scoliosis.	Balancing the posterior hip muscles and mobility of the hips, correction of kyphotic and lordotic curves, correction of balance of the whole body over the lower limbs and feet, improvement of rib cage mobility and breathing, improvement of the pectoral girdle alignment and erector spinae.
Shoulder problems: lack of scapula stabilization and rotator cuff muscles strength. Left rhomboids more developed.	Strengthen and stabilize the rotator cuff muscles and scapula. Balance the right rhomboids if weaker.
Levator scapulae and upper trapezius may be tense on the left side.	Improve scapula stabilization and strengthen lower trapezius, subscapularis and rhomboids on both sides.
Right shoulder abduction.	Improve scapula stabilization.
Leftward rotation and lateral bending of the cervical spine, tense superficial neck muscles (SCM, left upper trapezius, cervical extensors).	Increase range of motion to the right; improve mobility of the head and neck by relaxing superficial neck muscles. Strengthen erector spinae group and transversospinalis group.

This chapter has explored different postural habits of upper string players and has identified specific muscles associated with potential misalignments and their causes. It has also identified muscles that may need conditioning, in order to provide *Pilates* exercises that will be helpful for this population. Chapter 6 presents the *Pilates* exercises that could be used in a class for string players, showing exactly how they can address the identified muscular imbalances and help improve faulty postures.

CHAPTER 6: PILATES EXERCISES FOR STRING PLAYERS

A selection from classical mat exercises and contemporary *Pilates* is provided in this chapter to demonstrate how the exercises can address the identified problems of string players. Some modifications have been chosen as examples of how the exercises can be adapted to better fit the needs of string players and to help protect their necks, hands and wrists. However, this is not meant to be a comprehensive list, nor provide all the possible modifications. The exercises must be properly selected by a qualified instructor, and the instructor should adapt them to fit the individual needs of each student. Some individuals may not be able to perform certain exercises, and it is up to the instructor to provide different exercises that are appropriate to help them gain skills and strength. There may be different levels within one group; therefore, a certain amount of flexibility will be needed. The order in which the exercises are described here does not represent a sequence to follow, instead the purpose is to show how they work and what their benefits are. An additional list of a suggested order for learning the exercises is included at the end of this chapter. The *Pilates* class for string players would start with a few of the simplest exercises, appropriate for beginners, and gradually progress, incorporating more exercises from the list and advancing in difficulty only when adequate strength has been achieved. Further adaptations or modifications other than the ones presented here may be needed. Despite being a group class, accommodating individual needs is essential, which means some people will be assigned different exercises in the class if necessary.

The selected exercises require a minimum of equipment so that they can be easily incorporated into the lives of the musicians. The OverBall and TheraBand™ have been

chosen as examples of props that can facilitate some of the exercises, though they are not absolutely necessary. Only a *Pilates* mat is necessary for all the exercises performed on the floor, to protect the spine. Because the majority string players are seated during most of their playing time, exercises from standing *Pilates* have been chosen to help improve alignment in a vertical position. According to Breibart, "standing *Pilates* was developed to teach correct alignment in functional positions."[334] Furthermore, working on alignment in the vertical position can help string players maintain better alignment while playing, whether standing or sitting. Another benefit of the standing exercises is that they do not require any equipment, which makes the exercises invaluable tools for musicians. Some of them are particularly helpful to do between practice sessions or before performances, to avoid tension and enhance mobility.

A description of the exercises is provided to demonstrate how they specifically address the main points or concerns for string players. The description is not meant to be a guide on how to perform the exercises. For that, a qualified instructor would need to provide detailed steps for the exercises as well as appropriate cueing. The cueing and feedback from the instructor are key elements to the effectiveness of the exercises. To simplify matters, a detailed description of when and how breathing and muscle activation works for each exercise has been excluded. Therefore, the reader should bear in mind that for each exercise there is a precise and intentional activation of the core, together with the breath, that enhances the benefits of the exercise as well as protects and stabilizes the spine during movement. In an actual *Pilates* class, the instructor indicates specific breath patterns before each movement begins. This helps create a deep awareness of the breath

[334] Breibart, *Standing Pilates,* 43.

and enhances concentration.

The *Pilates* Exercises for String Players

Exercise for Whole Body Warm Up

The Hundred is a signature exercise from the classic mat repertory and is usually the first exercise in a traditional *Pilates* class because it warms up and strengthens the entire body and stimulates circulation. The exercise basically consists of pumping the arms a hundred times while lifting the head, neck, shoulders and legs off the mat, as illustrated (see figure 6.1). The position of the head in this exercise activates the deep neck flexors, which is beneficial to improve posture and counteract FHP tendencies. The main focus of the exercise is the abdominal muscle group. The center of gravity is in the core while the arms and back of the legs stretch away. The legs and arms must be kept long but relaxed, reaching through the fingertips and toes and using the back of the armpits (serratus anterior) and triceps to pump up the arms. The legs press together while the arms move with some intentional resistance, as though they were moving through water. Neither the head nor the trunk should move as the arms pump, remaining as still as possible.

The Hundred improves control of thoracic breathing and supports optimal breathing patterns, useful for string players to manage stress levels during performances.[335] The breath is coordinated with the movements of the arms, usually an inhale for a count of five arm pumps and an exhale for a count of five arm pumps. The breath pattern can also be varied to challenge breath and coordination, such as an inhale

[335] Eisen, *Anatomy of Fitness: Pilates*, 31.

for a count of six and an exhale for a count of for four, or an inhale for a count of seven and an exhale for a count of three, or an inhale for a count of three and an exhale for a count of seven.

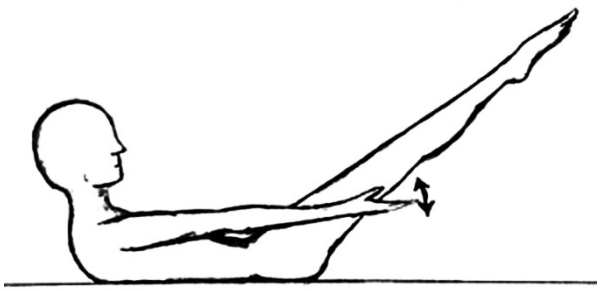

Figure 6.1. The Hundred.

The extended position of the legs in the Hundred produces the effect of a lever. The closer the legs are to the mat or floor, the more challenging and potentially dangerous the exercise is for people without adequate strength.[336] The weight of the legs challenges the strength of the hip flexors and abdominals, which must work together to stabilize the body and prevent the lower back from arching.[337] The spine should remain in contact with the mat by pulling in the abdominals.

For string players it is recommended to start with modifications of the Hundred to develop the required strength and skills, and to avoid problems. A recommended way to learn the Hundred is to perform it in a vertical position with the back aligned with the wall, standing one foot's distance away from the wall. The spine stays aligned with the wall as one leg extends in front of the body and the arms lift slightly in front. If the neck

[336] Ibid., 80.

[337] Ibid., 80.

is not too tight, the head, neck and shoulders round forward and the arms begin to pump up and down in the same manner as in the original Hundred, in coordination with the breath.

After enough practice of the vertical Hundred, modifications of the supine version would be adequate. Bending the knees with the feet on the ground, assuming a tabletop position with the legs, or extending the legs closer to ninety degrees, are ways to reduce tension in the hip flexors and abdominals. Keeping the head and chest down avoids excessive neck tension. Placing a pillow or a towel underneath the head for support helps relax the muscles of the neck. In order to build up strength gradually, the head can also alternate between being up and down, lowering the head as soon as tension is felt on the neck. In *Return To Life through Contrology*, Pilates advises starting with a count of twenty and gradually building up to one hundred.[338] Although traditionally it is performed with the palms facing down, for string players it is recommended to keep the palms up in order to encourage supination of the arms and promote better scapular alignment.

Exercises to Strengthen the Core, Strengthen and Stretch the Legs and Hips

Exercises such as the Leg Circles, the Single Leg Stretch, the Double Leg Stretch, and the Single Straight-Leg Stretch are useful for string players because they focus on strengthening the core as well as strengthening and stretching the legs and hips. The Single Leg Circles or One Leg Circle consists of lifting one straight leg towards the ceiling, while the rest of the body stays in contact with the floor for stabilization. The

[338] Pilates, *Return To Life through Contrology,* 39.

arms can be kept along the sides of the body or opened in a "T" position (at shoulder height) for extra support, while the lifted leg moves in a circular motion (see figure 6.2). The arms slightly press into the mat activating the scapula and arm extensors. The circles can be large or small, and both versions are beneficial for string players. The large circles involve bringing the leg across the midline of the body. They encourage mobility and flexibility of the hip joint, and require a fine coordination of the hip muscles in order to keep the circles as smooth as possible. The small, more controlled circles require keeping the pelvis in contact with the mat throughout the exercise. They develop stability of the pelvis and core, by focusing on trunk stabilization as the leg moves. For each leg, five circles are usually performed in one direction followed by five in the opposite direction.

The Leg Circles is an invaluable exercise for all string players, especially those who sit for long periods of time, because it works important hip and leg muscles, including: the hip flexors, the hamstrings, the knee extensors, the hip rotators, and hip/leg adductors and abductors, including the deep piriformis muscle. Additionally, the circling leg uses ankle-foot plantar flexion while the stabilizing leg uses ankle-foot dorsiflexion, which is beneficial to add mobility to the ankle joint.

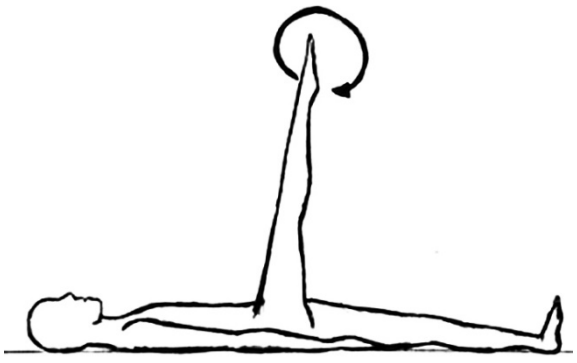

Figure 6.2. The One Leg Circle (small circles).

It is recommended to first learn this exercise using small circles, keeping the hips from moving as one leg moves, and progress gradually into larger circles. One modification for individuals with low back pain or tight hamstrings is to bend the knee of the stabilizing leg. The lifted leg can be also slightly bent or kept at a lower angle. As in The Hundred, performing the Leg Circles in a vertical position is a recommended variation for string players, especially to counteract the effects of sitting postures. The vertical version provides a stretch for the hip flexors and is easier for people with tight hamstrings. At the same time, it challenges balance and stability. A modification for the supine version to reduce strain on the hip muscles and core is to wrap a TheraBand™ around the ball of the foot and hold it with a hand on each end for support. The Single Leg Circles can also be modified to become the Double Leg Circles, and an OverBall can be placed underneath the pelvis. The elevation of the pelvis reduces the strain on the hip flexors and allows greater mobility for the hips.

The Single Leg Stretch and the Double Leg Stretch not only strengthen the core, deep neck flexors, and legs, but also provides a stretch for the hips and increases coordination. Both exercises are performed in a supine position with the head and scapula lifted off the mat. In the case of cellists with lower back pain and weak abdominal muscles, a useful modification is to use pillows to support the area between the head and the bottom of the shoulder blades.[339] If using pillows, the head and neck should be in a comfortable position, keeping the space of a golf ball between the chin and the chest as well as maintaining contact with the back of the head and neck on the pillows during the

[339] Menezes, *Complete Guide to Pilates,* 80.

exercises.[340]

In the Single Leg Stretch one knee is pulled towards the chest with the opposite hand on the knee and the same side hand on the shin, while the other leg extends at a forty-five degree angle. The legs alternate positions as smoothly as possible, without changing the height of the chest or changing the angle of the legs (see figure 6.3). The exercise challenges core stability and scapular alignment. As the shoulder flexors hold the arms in front of the body, the scapula must stay in neutral alignment, avoiding a lift or upward rotation. This can enhance scapular stability in string playing, which is needed to avoid the upward rotation of the scapula due to the forward position of the arms while pressing down on the strings and bow. The exercise also strengthens the legs and provides a dynamic stretch for the hips (by activating the gluteus maximus), needed to counteract sitting postures.

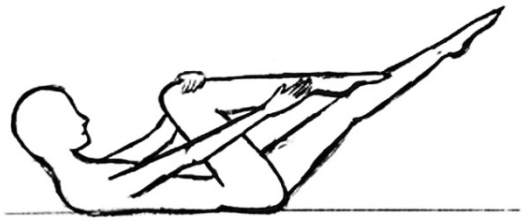

Figure 6.3. The Single-Leg Stretch.

The Double Leg Stretch is a more advanced version of the Single Leg Stretch, and is recommended only after adequate core strength has been achieved through the practice of the Single Leg Stretch. In the Double Leg Stretch both legs bend together while the

[340] Ibid.

arms hold on to the shins at the same time. Then both legs extend together while simultaneously the arms circle around the body to reach straight over the head, alongside the ears (see figure 6.4). The arms and legs reach in opposition and away from the axis of motion, which challenges the strength of the core. The motion of the arms challenges the stability of the scapula and mobilizes the shoulder joints.[341] The exercise helps increase body awareness through the control and precision required by the movements in coordination with the breath and core activation.

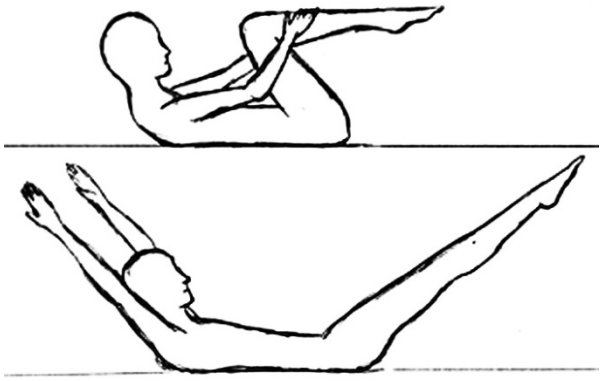

Figure 6.4. The Double-Leg Stretch.

Single Straight-Leg Stretch does not belong to the classical mat repertory, but it is similar to Scissors, an advanced exercise that appears in *Return to Life through Contrology*.[342] The Single Straight-Leg Stretch version is safer and better suited to string players, because the hands are not involved in supporting the weight of the hips (as in the original exercise), and because the weight load on the neck is avoided. The first leg is

[341] Ibid., 88.

[342] Pilates, *Return to Life*, 69.

straightened and lifted towards the forehead and grasped with both hands near its ankle, while the second leg reaches straight out, hovering as close as possible to the mat, but only to a point in which the lower back can still maintain contact with the mat.[343] The first (lifted) leg is stretched through two pulses in coordination with two inhales. Then the legs trade positions and the second leg is lifted and pulsed twice accompanied by two exhales (see figure 6.5). The breath pattern is then reversed. The head, neck and chest must remain still and lifted off the mat. If this produces any strain of the neck, pillows can be used as described in Single and Double Leg Stretches. The exercise challenges core, pelvic and scapular stability. It additionally provides a dynamic stretch for the hips and hamstrings. A modification for this exercise, involves placing the OverBall under the pelvis and keeping the arms on the floor. The elevation of the pelvis and the surface of the ball make the exercise feel easier by reducing the strain on the hip flexors and providing a cushion for the pelvis and sacrum.

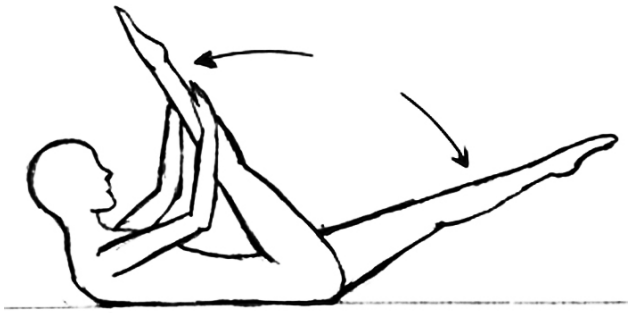

Figure 6.5. The Single Straight-Leg Stretch.

[343] Ibid., 84.

Exercises for Leg, Hip, and Foot Strength, Flexibility, Alignment and Balance

Exercises that focus on alignment of the hips, legs and feet are essential for string players to counteract faulty stances and muscle imbalances and to improve dynamic balance. They include, the Side Kick, Side Lying Exercises, and footwork. Side Kick works the lateral flexors (mainly as stabilizers) through the movement of a leg that swings forward and backward. The exercise is performed lying down on one side with the lower arm extended on the floor, or bent for additional head support. The top arm is bent in front of the body, with the palm of the hand on the floor for balance (see figure 6.6). A towel or pillow can be used to support the head and help relax the neck muscles. The exercise develops core stability, because the muscles in the front, side and back of the trunk must work together to maintain equilibrium and keep a neutral spine and pelvis while the leg swings front and back.[344] The exercise also provides a dynamic stretch for the hamstrings and hips, which is needed in most string players to counteract problems from sitting postures. Flexing the foot as the leg moves forward emphasizes the hamstring stretch, and pointing the foot as the leg moves backward adds mobility to the ankle joint, works the potentially underdeveloped leg muscles of string musicians and provides a stretch for the shin muscles. Focusing on alignment of the legs and maintaining a neutral position of the feet (neither turned out nor turned in), helps enhance alignment while standing in upper string players and bassists, and helps counteract the tendency to externally rotate the feet in violin and viola players.

[344] Ibid., 151.

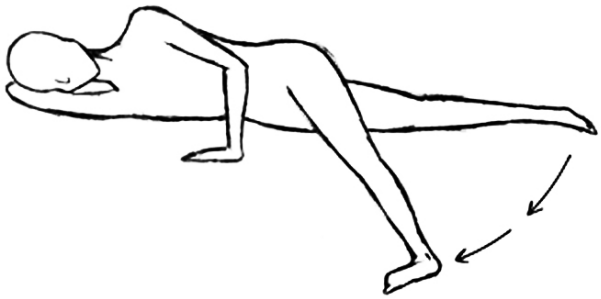

Figure 6.6. The Side Kick.

Side Lying exercises do not belong specifically to the classical mat repertory; however, they are variations of the Side Kick and are frequently used in contemporary *Pilates* classes. They provide different ways to work on alignment of the lower limbs, which is particularly helpful for upper string players and bass players who favor one side over the other while playing. For all of the Side Lying exercises (including the Side Kick), the legs can be together and aligned with the upper body at the edge of the mat, they can be together but slightly forward from the upper body, or in some cases the bottom leg can be bent for more support.

The Hot Potatoes variation consists of internally rotating the foot of the top leg and tapping the toes on the floor in front, center, and back of the other leg, and then reversing directions. This can also be done with the foot in neutral position. Working with the legs in neutral or internal rotation is especially helpful to counteract the turn-out of the legs and feet of upper string players. Furthermore, the internal rotation of the leg enhances the activation of the internal rotator muscles and hip stabilizer muscles (gluteus medius and minimus). If imbalances between the two legs exist, slightly more repetitions can be done on the weaker side, to improve the stabilization of the pelvis on the

compromised side.

Another variation in side lying position is Side Lying Leg Circles. This exercise consists of extending the top leg and drawing circles, which can either be small or large. The small circles have a similar muscular focus as in the Hot Potatoes, targeting stabilization, and they can be performed in line with the body, in front of the body, or behind the body. The large circles provide more mobility for the hips and further challenge the stability of the core. The upper leg is kept as straight as possible, and the motion is centered directly above the lower leg. The movement must originate by rotating the femur head in the hip socket, while keeping the leg straight.

A beneficial exercise for the feet is the Towel exercise. The exercise is performed while seated on a chair, with parallel feet directly beneath the knees, and a towel placed under the feet. It can also be performed without the towel, simply imagining that there is one. The exercise consists of curling the toes, pulling the towel in toward the heels. The toes are then lifted and spread apart, then lowered to repeat the exercise. The exercise is also reversed by lifting and curling the toes, then lowering the toes and spreading them apart. The towel is pushed away as the toes straighten. The legs should not move during the exercise. This exercise works important muscles of the feet and lower leg, including the tibialis posterior muscle, and can help improve proprioception and balance.

The Flamingo (from contemporary *Pilates*) consists of standing with the feet in parallel position, hip width apart, and lifting the arms above shoulder level, shoulder width apart. One knee is lifted and then extended, and the leg steps forward onto ball of the foot, followed by the heel. The movement is repeated with the other leg (see figure 6.7). The exercise is recommended for all string players because it helps improve postural

alignment and balance while standing, which is particularly useful for string players who perform while standing. It also helps stretch the hip flexors without compromising the back for individuals with back problems, which may be the case for cellists.

Figure 6.7. The Flamingo.

Exercises for Spine Flexibility

Exercises that focus on flexibility of the spine can help reduce stiffness or tension in the back and improve mobility and performance. They also strengthen the core, contributing to better postural alignment and reducing the risk for back injuries. Such exercises include the Roll Up, the Wall, Rolling Like a Ball, the Standing Mermaid, Spine Twist, the Pelvic Curl, the Cat Stretch, and the Spine Stretch. The Roll Up in supine position focuses on fine spinal articulation by rolling forward toward sitting, one vertebra at a time, starting with the head, neck, and continuing to roll up until the upper

body hovers over the lower body as far as possible (see figure 6.8). The articulated flexion of the neck on the way up also provides a stretch for the neck extensors, which is helpful to counteract FHP. The action of the back rolling against the mat helps push air out of the lungs, facilitating breathing, which in turn improves circulation and oxygenation for the entire body.

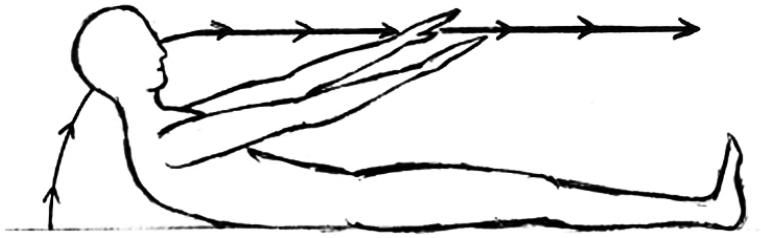

Figure 6.8. The Roll Up in supine position.

The Roll Up requires significant core strength; if the core is not strong enough at the beginning, excessive tension in the neck may be the result. It may be impossible to lift the upper body without the help of the arms. It is therefore recommended to first build up strength by starting the exercise with the upper body in a lifted position while holding the back of the knees in a flexed position with the soles of the feet on the mat. The upper back then rolls back towards the mat until the arms stretch completely. Then the body returns to the original position.

The Roll-Up also works as a spinal massage, stretches muscles of the back and provides a hamstring stretch, beneficial for players that sit for long periods of time. It also requires straightening the arms by using the elbow extensors while keeping the shoulders down by activating the scapular depressors. Using the elbow extensors (the triceps) helps

counteract the predominant flexion of the arms while playing, especially in the left arm of upper string players, which is in constant flexion (mostly using the biceps). The use of the scapular depressors in this exercise is beneficial to all string players for the improvement of shoulder alignment through arm movement. The additional flexion and extension of the feet and ankles in the exercise helps enhance foot alignment and ankle joint mobility.

The Wall exercise (from contemporary *Pilates*) is similar to the Roll-Up, except it is performed in a vertical position. An additional segment of the exercise provides work for the legs and helps translate vertical alignment to sitting postures. In this exercise, the back is aligned against a wall and the feet are placed one foot's distance away from the wall. The first part of the exercise consists of rolling down by first tucking the chin in and peeling one vertebra at a time off the wall, until the upper body hangs close to the floor and the legs. Next, the upper body reverses the movement, stacking one vertebra at a time, one above another. For string players, it is recommended to first build up strength and flexibility through this part of the Wall exercise before trying the Roll Up in supine position.

The second part of the Wall makes this exercise quite complete and a great asset for string players because it can be practiced virtually anywhere and provides various benefits. Part two consists of bringing the feet farther away from the wall, hip width apart, so that the knees can bend to about ninety degrees, with knees above the ankles. The arms hang by the sides of the body. Keeping the spine on the wall, the knees bend while the arms lift straight in front of the body. The arms are lowered as the knees extend and the body slides up. Following, the feet are brought closer to the wall, to the original

position, and the hands press backwards, pushing the body away from the wall while keeping the pelvis in alignment. Bending the knees provides leg strengthening, and keeping the back against the wall as the knees bend helps integrate vertical alignment to sitting positions. The additional movement of the arms challenges coordination as well as improves scapular alignment. By pressing the arms backwards into the wall, the triceps are activated while the chest is stretched. Together with the spinal articulation and core strengthening from the roll down, the Wall is a whole body exercise that can be incorporated before or between practice sessions, or even before or after performances, to warm up the entire body, improve coordination and control, and encourage correct alignment for standing and sitting positions.

Rolling Like a Ball is a classical *Pilates* exercise that can be incorporated after adequate strength of the core and back muscles has been achieved. A more advanced exercise, it presents numerous advantages for string players. Rolling Like a Ball calls attention to scoliosis if present; if so, the body will shift towards one side rather than staying centered. The exercise brings awareness to tighter muscle groups on one side of the body, which create the imbalances and the effect of "pulling" the body towards one side. By strengthening or intentionally contracting the weaker muscles during the exercise, one can improve body symmetry, and the quality of the roll can be improved. The exercise requires significant control and it does not work without properly activating the core and coordinating the breath. Exhaling on the way up is key to efficiently rolling up without compromising the space between the legs and the arms, as is keeping the navel inward towards the spine the entire time. The exercise challenges balance and concentration, especially each time the body rolls back up to the original position,

balancing on the pelvis while keeping the feet off the floor. The feet do not touch the mat through successive rolls. The position of the neck, tucked in, provides a stretch of the neck extensors, which is needed in the case of FHP. The exercise helps reduce tension in the spine. For string players it is recommended to roll back only as far as the shoulder blades and not further (onto the neck), to protect the neck and avoid injuries. The first step in learning this exercise is to simply balance on the pelvis, by holding the round position of the body with the feet hovering off the floor. After adequate core and balance control has been gained, rolling back can be incorporated.

Figure 6.9. Rolling Like a Ball.

The standing version of the Mermaid (contemporary *Pilates*) works the oblique muscles while providing a deep muscle stretch in the lateral trunk flexors, which enhances mobility of the spine.[345] String players should stand with parallel feet, hip width apart. As one arm extends toward the ceiling while pressing towards the ear, the other

[345] Massey, *The Anatomy of Pilates*, 139.

arm reaches down by the side of the body. Keeping the arm against the ear, the arm reaches up and sideways into a diagonal (see figure 6.10).

Figure 6.10. Standing Mermaid.

In Standing Mermaid the hips must be stabilized in order to keep them from moving towards the opposite side as the arm and upper torso flex. The exercise requires an activation of the muscles on the side of the trunk (the obliques) as well as a balanced activation between the anterior and posterior trunk muscles in order to keep the body from tilting forwards or backwards.[346] Asymmetries of the spine can again be noticed and addressed in this exercise. It may be especially important for upper string players and double bass players. If a weaker side is evident, strengthening of the muscles on that side of the body may be slightly emphasized in order to achieve balance and encourage alignment. The exercise is also valuable for string players because it emphasizes scapular alignment, by activating the scapular depressors of the arm that reaches up.

[346] Isacowitz and Clippinger, *Pilates Anatomy*, 149.

The Spine Twist provides lateral rotation for the spine, which enhances the mobility of the trunk and helps counteract trunk alignment asymmetries. It also enhances postural control when sitting. It consists of twisting the upper body towards one side, with the arms extended at shoulder height, while sitting on the mat with the legs extended and together, or separated for more support (see figure 6.11). At first there may be a tendency to lead the rotation from the arms rather than from the torso due to a lack of scapular stabilization. The torso must initiate the movement by activating the rotators and multifidus, deep muscles that help rotate the body from the lower back to the base of the head.[347] A helpful image when performing this exercise is to imagine wringing a towel to emphasize the elongation the body upwards while rotating, instead of collapsing or flexing. The scapular adductors must be activated to maintain proper scapular alignment and to keep the relationship of the arms with the trunk consistent as the body rotates.[348] As the upper body rotates towards one side, the pelvis must also remain in place. The seated position with the legs extended can be difficult for people with tight hamstrings. Also the extended position of the arms can be challenging for people with compromised scapular stabilization. Therefore, it is recommended to first learn the exercise by sitting on a chair, crossing the arms in front of the body. The exercise will also point out if one side of the body is tighter than the other, because there will be a limited range of motion towards the compromised side. This can be the case for all string players, but especially upper string players and double bass players. It is recommended to slightly emphasize the

[347] Ibid., 159.

[348] Ibid., 159.

compromised side in order to gradually improve the range of motion and strengthen the weaker oblique muscles that help rotate towards that side.

Figure 6.11. The Spine Twist.

Although the Pelvic Curl and the Cat Stretch do not belong to the classical mat repertory, they are widely used in numerous contemporary mat *Pilates* classes because they benefit spinal flexibility and alignment. The Pelvic Curl starts the spinal articulation from the pelvis, lifting one vertebra at a time from the mat and continuing through the low and middle back until reaching the shoulder blades (see figure 6.12). This exercise requires a co-activation of the hamstrings and the abdominal muscles. These muscle groups are attached to opposite sides of the pelvis, the abdominals on the upper anterior and hamstrings on the lower posterior. These act together as "force couples," to create the same movement: a posterior rotation of the pelvis (the abdominals lift up the pelvis while the hamstrings pull it down).[349] The co-activation of these muscles is essential to improve postural alignment and encourage a neutral pelvis. Violinists and violists who have an exaggerated lumbar curve with tendencies for sway back posture can benefit from awareness and strengthening of these muscles. Additionally, the Pelvic Curl provides a

[349] Isacowitz and Clippinger, *Pilates Anatomy*, 41.

stretch for the hips, essential for cellists and instrumentalists who sit during extended hours. It also improves the function of the hamstrings, which are often compromised from sitting.

Figure 6.12. The Pelvic Curl.

The Cat Stretch articulates the spine in both directions providing flexion and extension, and enhances mobility and flexibility of the spine. This is particularly beneficial after playing for long hours in a single position (see figure 6.13). It can be especially useful for upper string players to increase the mobility of the neck and release tension in this area. Because the exercise is performed in a quadruped position, it can easily be done on the floor of a practice room or by placing the hands on a chair with the legs extended but relaxed. This exercise can easily be done during practice breaks.

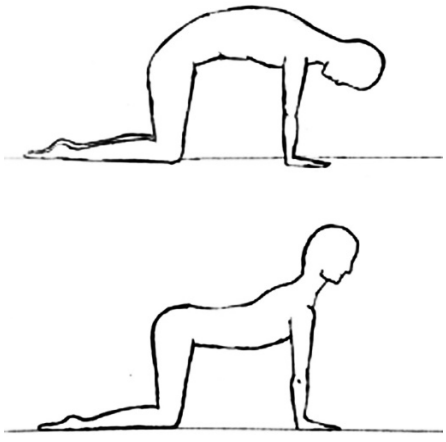

Figure 6.13. The Cat Stretch (flexion and extension).

The Spine Stretch is particularly useful to improve the flexibility of the thoracic vertebrae and to strengthen the thoracic extensors, which is needed to improve the mobility and alignment of the head and thorax in people with FHP, SBP and FBP. The Spine Stretch with added extension is beneficial for all string players, but particularly for cellists. The exercise consists of sitting upright with the legs extended and stretching forward by articulating the upper back exclusively. The pelvis should remain upright, as should the area between the ribs and pelvis. The head and upper thoracic spine reach forward, creating an effective stretch for the upper back. An addition to this exercise is to extend the rest of the back and hamstrings. The pelvis must rotate anteriorly to allow the trunk and arms to reach into a diagonal, which activates the spinal extensors (see figure 6.14). For cellists with an exaggerated kyphosis (rounded upper back), movement in the thoracic area can be limited, and the Spine Stretch can help restore freedom in this area. The optional, diagonal stretch makes returning to a sitting position feel significantly easier, also an invaluable tool for cellists. Adding a small pumping movement of the arms backwards by keeping the shoulders down is another beneficial variation to the exercise, because it provides more conditioning for the back muscles and scapula depressors. People with tight hamstrings who have trouble sitting with the legs extended may adapt the exercise to a sitting position on a chair, or standing with the back aligned to the wall.

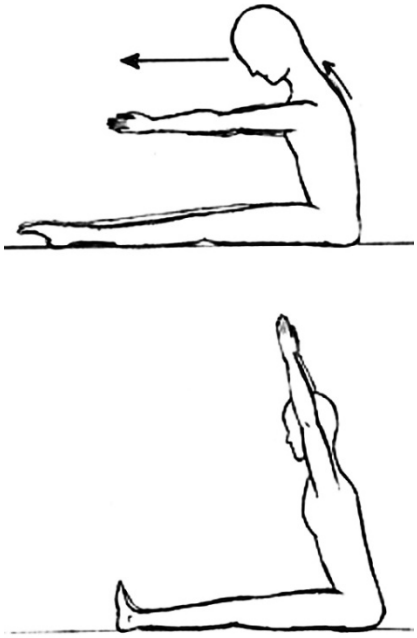

Figure 6.14. Spine Stretch and upper back extension.

Exercises to Open the Chest and Strengthen the Back

Exercises such as the Swan preparation, Single Leg Kick, Double Leg Kick, and the Pelvic Lift can help string players open the muscle groups of the chest while strengthening the back, which is necessary to avoid rounding the shoulders and to counteract flexion. The Swan preparation or upper thoracic extension is particularly helpful for cellists and other string players who have an exaggerated kyphosis, and limited movement of the upper back. The exercise consists of lying down in a prone position (on the stomach) with the palms of the hands on the floor near the shoulders. The movement starts with a scapula depression; the shoulder blades and elbows are pulled downward towards the feet. This movement creates a subtle lift of the head, continues through the articulation of the upper thoracic vertebrae, and peels the upper torso

gradually off the mat (see figure 6.15). When an exaggerated kyphosis already exists, it is beneficial to place an OverBall under the chest cavity. This helps release the body into the ball, and creates a feeling of gradually pushing or rolling the ball forward, which improves the articulation of the thoracic vertebrae. The activation of the gluteus and the legs while extending long provides hip extension, useful to counteract prolonged hours of sitting. Pointing the feet by plantar flexion is also beneficial for all string players, whether they mainly sit or stand.

Figure 6.15. Swan preparation.

A Back Extension in prone position is a variation of the Swan, with the arms reaching long by the sides of the body and the legs extended with pointed feet (see figure 6.16). The position of the legs activates the gluteus maximus and hamstrings and provides a stretch for the hip extensors, especially valuable for cellists. The pointed feet provide ankle-foot plantar flexion, which provides an effective stretch for the ankle-foot dorsiflexors after standing or sitting for long periods of time. Adding a small pumping action of the arms upward, with the palms up, activates the triceps and provides a stretch for the shoulders and pectoralis. The extension of the elbows, by the triceps, is beneficial to all string players to counteract the predominant flexion position of the arms and

shortening of the biceps. Back extension can significantly improve the posture of string players by strengthening the spinal extensors and simultaneously activating the abdominals to protect the spine.

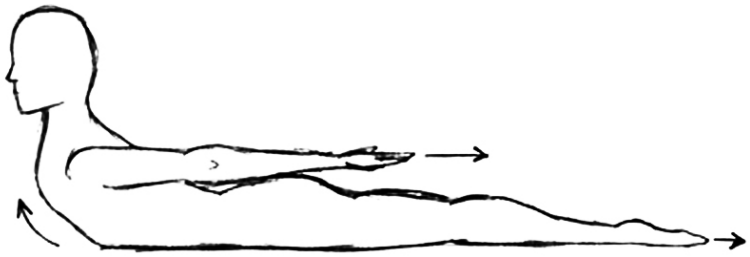

Figure 6.16. Back Extension.

The Single Leg Kick and the Double Leg Kick are also valuable in counteracting the predominant flexion of string players, because they strengthen the back of the body and provide extension. Both exercises are performed in prone position. The Single Leg Kick involves bending one knee at a time with the foot pointed and the heel towards the buttocks, through three quick pulses, alternating legs in coordination with the breath. The upper body is propped up on the elbows (see image 6.17). Traditionally, the exercise is performed with the hands grasped together in a fist in front of the body; however, for string players it is recommended to keep the hands separated and aligned with the shoulders. This position provides better alignment for the scapula and helps counteract the flexion of the thoracic area. The forearms must press down in this position to activate the shoulder extensors, scapula depressors and upper spinal extensors. The abdominals must be strongly activated to prevent an anterior tilt of the pelvis.

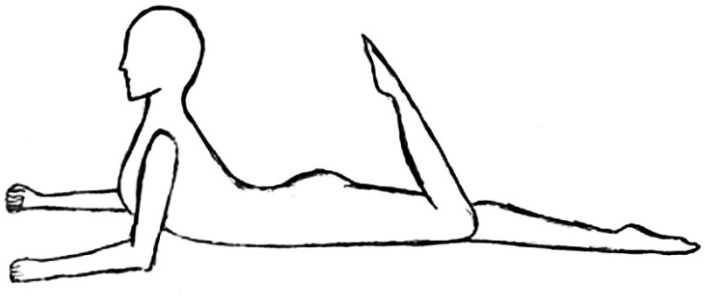

Figure 6.17. The Single-Leg Kick.

The Double Leg Kick begins in prone position, with fingers interlaced behind the body. While the head is laid on one side on the mat, the legs bend together through three quick pulses as the heels are moved towards the buttocks. Then the chest lifts off the mat, while the elbows straighten and the hands reach towards the legs. The legs are straightened, either pressing on the mat or with the heels lifted off the floor if strength and hip flexibility allows (see figure 6.18). The straightening of the arms behind the body provides a wonderful shoulder and chest stretch, and enhances movement of the thoracic spine. When the body returns to the initial position, the head turns in the opposite direction. The rotation of the head to the sides, together with the action of keeping the shoulders down, increases the flexibility and mobility of the neck, which is especially helpful for upper string players. Because both the arms and legs are raised simultaneously off the mat, the Double Leg Kick provides a stronger activation of the spinal extensors than the Single Leg Kick, and helps build endurance in these muscles. Lifting both legs at the same time also challenges the abdominals in maintaining trunk stability, and enhances

control of the hamstrings.[350] String players with tight shoulders may not be able to grasp the hands behind the body, in which case they can hold on to a TheraBand™ or towel.

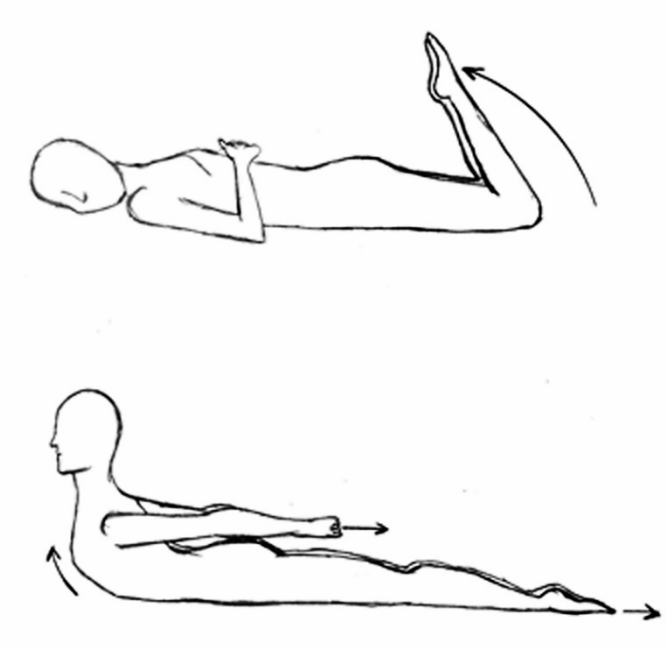

Figure 6.18. The Double Leg Kick.

The Pelvic Lift (also known by other names) is very similar to the Pelvic Curl, with the only difference being that the pelvis and trunk lift together in one piece, while a neutral position of the spine is maintained, as opposed to articulating the vertebrae. This emphasizes spine and pelvis stability over flexibility. The abdominals, gluteals and hamstrings must activate together to maintain a neutral spine. The exercise strengthens the hip extensors and provides a stretch for the hip flexors. Engaging the arms by reaching long and pressing down on the mat activates the triceps, opens the chest and provides scapular alignment. A second part of the exercise, included in *Return to Life*,

[350] Isacowitz and Clippinger, *Pilates Anatomy*, 183; Massey, *The Anatomy of Pilates*, 95.

consists of lifting one straight leg at a time towards the ceiling by contracting the hip flexors.[351] This challenges hip stability and requires significant strength of the supporting leg. In the original exercise, the hands also support the waist, but the ninety-degree angle of the wrist in the original is potentially dangerous for string players. The exercise in its original form is considered advanced and therefore would not be appropriate for a semester-long class for string players. Only the first part of the exercise is recommended.

Exercise for Back Extensors and Trunk Stability

Swimming is an advanced exercise that not only works the extensors of the body but also helps develop trunk rotational stability. It also helps improve movement coordination.[352] The exercise is performed in prone position with the arms and legs extended, palms facing down and feet pointed. The chest, arms and legs are raised slightly off the mat, while one leg and the opposite arm, then the other opposing limbs lift higher. A swimming motion is approximated by alternating the limb movements rapidly (see figure 6.19). The spinal extensors are activated by keeping the chest off the mat during the entire exercise, while the multifidus and semispinalis are activated in order to stabilize the trunk and prevent it from rotating to the sides as the limbs move.[353] This type of limb movement is essential for motor development, which can enhance body

[351] Pilates, *Return to Life,* 73.

[352] Massey, *The Anatomy of Pilates*, 119.

[353] Isacowitz and Clippinger, *Pilates Anatomy*, 185-186.

awareness and refine control of movement while playing a string instrument.[354] A modification for Swimming is to perform the exercise in quadruped position. One leg and the opposite arm are raised simultaneously until they are aligned with the head and trunk, and then sides are alternated. This modification would be appropriate to use in a class for string players. Progressing to the advanced version would be recommended only after adequate strength of the back extensors has been achieved.

Figure 6.19. Swimming.

Exercises for Scapular Alignment

Some of the exercises that have been already discussed, such as the Standing Hundred, Standing Mermaid, Spine Twist, Swan preparation, the Single Leg Kick and Double Leg Kick, help improve scapular alignment. In addition to those, exercises that focus on shoulder girdle stability and biomechanics of the shoulder are highly recommended for string players because they can help prevent shoulder and arm injuries and increase stamina. Such exercises include Arm Circles, Open Tray, Arm Swings and Arm Weights.

Arm Circles exercise is performed while standing with the back aligned against

[354] Ibid., 185.

the wall, as in The Wall exercise. The arms lift to shoulder height in front of the body, open to the sides, lower to the sides of the body, and finally return to the starting position, completing a circle. The direction of the circle is then reversed (see figure 6.20). The exercise can also be done while lying down on the mat. The wall (or floor) provides alignment feedback to the back muscles, which is helpful for maintaining correct scapular alignment. The exercise works the rotators of the arm (rotator cuff muscles) and helps improve scapular stabilization during arm movement, which is essential to all string players.

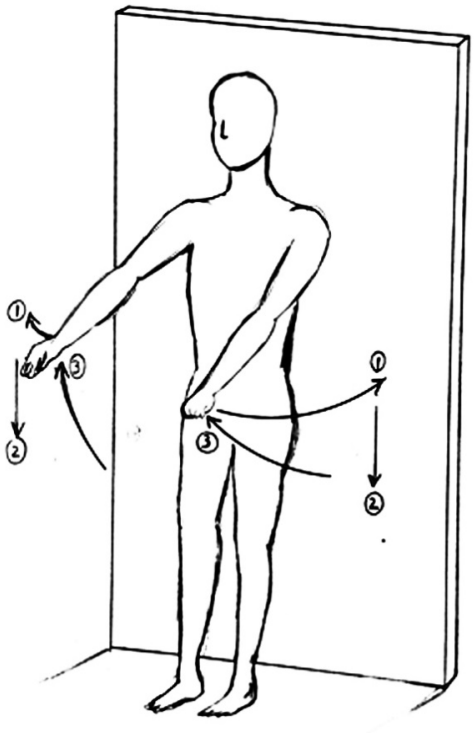

Figure 6.20. Arm Circles on the wall.

Open Tray (name may vary) is not an exercise from classical *Pilates*; however, it is often included in various *Pilates* classes. It consists of bending the arms to ninety

degrees at the elbows, with the palms facing up and the elbows slightly pressing into the sides of the body, as if holding a tray. Then the hands rotate moving slightly towards the back, working the rotator cuff muscles. Stretching a TheraBand™ around the forearms outwards with each hand can be used for enhanced activation of the rotator cuff muscles and to build muscle endurance, necessary to protect against overuse and shoulder impingement (see figure 6.21). A variation of the exercise is often called Serve a Tray. Assuming the same position, the TheraBand™ is wrapped around the back and its ends are wrapped around each hand, secured with the thumbs. With the fingertips extended, the arms reach forward and upward towards shoulder height, without letting the elbows rise higher than the shoulders. As the arms lift, the scapula must be drawn down. Serve a Tray is a beneficial exercise for upper string players, to encourage correct shoulder alignment while holding the instrument up and to build endurance of the shoulder, back and arm muscles to support the weight of the instrument.

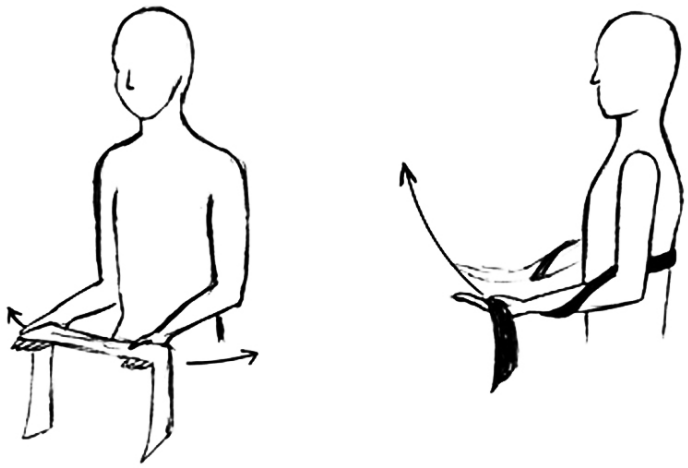

Figure 6.21. Open Tray and Serve a Tray.

The Arm Swings are exercises from contemporary *Pilates* and are explained by

Menezes in *The Complete Guide to Joseph H. Pilates' Techniques of Physical Conditioning.*[355] One variation is Alternating, performed in a standing position with parallel feet hip width apart, and involves stretching the arms in front of the body, at shoulder height. The palm of one hand faces up while the other faces downward. The arm with the palm facing down moves upwards towards the ceiling while the other arm moves downward towards the floor. Then the arms return to center position, the palms are rotated to alternate the starting position, and the exercise is repeated (see figure 6.22). As the arm reaches up, the shoulder girdle must be stabilized in order to prevent the shoulder from lifting. The movement of the arms helps mobilize the shoulder joints in a safe way, by focusing on alignment and stability. The exercise additionally opens the chest and improves the thoracic and cervical alignment.[356]

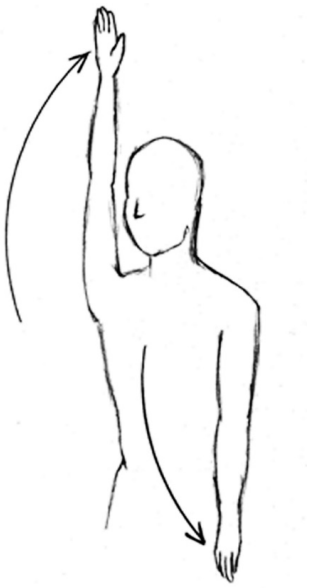

Figure 6.22. Arm Swings: Alternating.

[355] Menezes, *The Complete Guide to Pilates,*105.

[356] Menezes, *The Complete Guide to Pilates,* 105.

Another variation of Arm Swings is called Chest Expansion by Menezes.[357] Assuming a similar position to the one described in the previous exercise, the arms are extended slightly lower, with the hands at navel height with both palms facing up. The arms proceed to open to the sides of the body in a forty-five-degree angle, while kept in peripheral view (slightly in front of the shoulders) (see image 6.23). This exercise has similar benefits to Alternating.

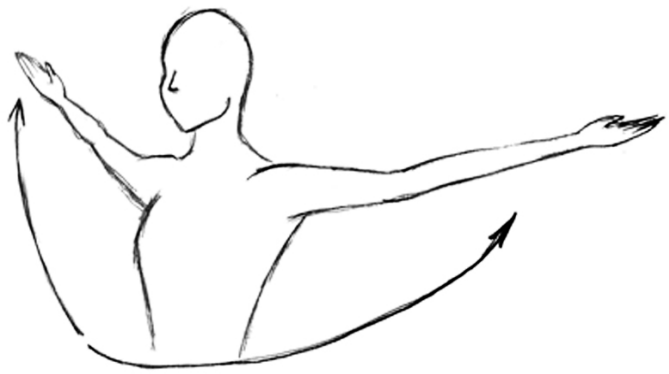

Figure 6.23. Arm Swings: Chest Expansion.

The Arm Weights variations, from contemporary *Pilates*, strengthen the muscles of the back that support the arms. This can help increase stamina and reduce fatigue when playing, especially the fatigue associated with holding the arms up while playing and supporting a violin or viola, as well as holding the bow. The exercises also help with opening the shoulders. All variations are performed while standing, with parallel feet that are hip width apart. The exercises are completed as if using real weights, with intentional resistance in all directions of movement. They can also be performed with weights; however, for string players it is recommended to start without weights to focus on the

[357] Ibid., 106.

alignment and stability of the shoulder girdle, and to avoid the larger muscles taking over. An essential element in achieving correct position of the shoulders consists of "plugging in" or retracting the shoulder blades toward the shoulder sockets, or consciously pulling the shoulders towards the center of the back. This position must be maintained throughout the exercise.

One variation begins with the arms in front of the body, at shoulder height and bent at ninety degrees at the elbow. The arms then extend (down to shoulder height only, not lower) as if pushing a great weight away from the body, and then they return to their original position as if pulling in a great weight. The upper arm must stay parallel to the floor throughout the exercise. A similar variation of this exercise is the low-curls, in which the arms are extended by the sides of the body with the palms facing forward, and the elbows are bent as if pulling a great weight, and then are extended back to the original position. Yet another variation, similar to the first, begins with the arms bent at ninety degrees, but with the upper arms extended from the sides of the body at shoulder height, and then extending and bending the arms in the same manner as the first exercise (see figure 6.24).

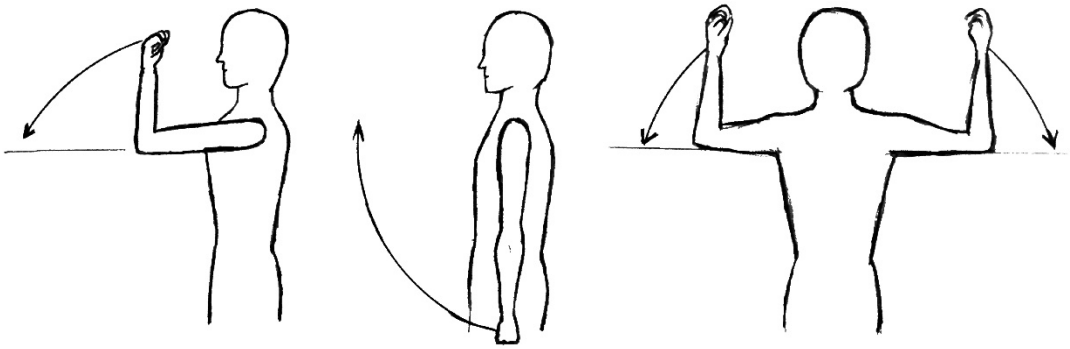

Figure 6.24. Arm Weights.

The Zip-Up variation starts with the arms lowered in front of the body by the legs, as if holding two weights touching together. With the activation of the "powerhouse," the arms begin to bend bringing the elbows out to the sides and keeping the imaginary weights together, as if "zipping up" a jacket. The elbows do not lift higher than the shoulders. The arms then lower, reversing the movement (see figure 6.25).

The Shave-Stand also begins with the imaginary weights held together in front of the body. The arms lift in front of the body and continue all the way over the head. Then the elbows bend on the sides, while the hands reach behind the head, as if shaving the back of the head, and then return to the original position (see figure 6.26). If the neck and shoulders are tight, the hands may also stay in front of the forehead in a gesture resembling a "salute". Both the Zip-Up and Shave-Stand exercises require a considerable downward pressing of the shoulders to avoid hunching.

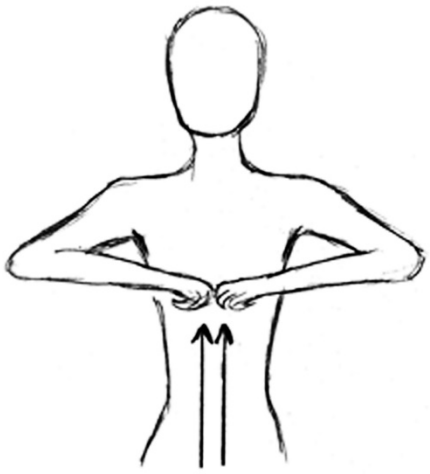

Figure 6.25. The Zip-Up.

Figure 6.26. The Shave-Stand.

Chest-Expansion begins with the arms extended in front of the body at shoulder height, shoulder width apart. The arms lower and continue to move behind the back. The arms stay in the back while the head turns first towards one side and then the other. After the head alternates sides, it returns to center and the arms lift back to the start position (see figure 6.27). The exercise requires significant control in order to avoid moving the head forward or moving the shoulders as the head moves. Chest Expansion considerably opens the chest and stretches the neck muscles, and can help individuals with one sided-neck tension balance their necks and regain range of motion.

Figure 6.27. Chest Expansion.

Exercises for Head and Neck Stabilization and Mobilization

Finally, specific exercises to improve the mobility and alignment of the head and neck are of interest to string players, in particular upper string players and double bass players. They include the Oy Vey, Head Nodding, and Head Turning. Although these exercises do not belong to the classical mat repertory, they are used by *Pilates* practitioners to help improve cervical spine stability and mobility in patients with impaired necks.

The Oy Vey exercise is particularly beneficial to strengthen the muscles of the neck and improve head alignment. Standing with the feet in parallel position, hip width apart, the hands stack together in front of the forehead. The hands press into the forehead, producing an isometric contraction of the neck stabilizer muscles, while the back of the neck lengthens. The exercise helps counteract FHP. The Oy Vey can also be done by pressing the heel of one hand directly on the same side of the head, which activates the side muscles of the neck. For upper string players that have neck imbalances, with shortened and tighter neck muscles on the left side, it may be helpful to strengthen the right side of the neck, while lengthening and relaxing the left side. It is important that the head does not move as the hand presses, emphasizing alignment. Another variation of the Oy Vey uses the OverBall. This exercise is performed by standing with the back next to a wall, placing the ball between the back of the head and the wall. The head presses gently into the ball, subtly lengthening the back of the neck. A helpful cue is to imagine opening the "eye balls" on the back of the head. This encourages proper alignment of the head and stretches the muscles on the back of the neck (see figure 6.28).

Figure 6.28. Oy Vey with variations.

Head Nodding, or craniovertebral joint mobilization, is another subtle exercise that improves the function of the deep cervical spine stabilizing muscles, which may be especially impaired in upper string players. It is performed in quadruped position (or four-point kneeling) with the hips and knees flexed at ninety degrees. The little fingers of the hands must press slightly into the floor in order to engage scapular stabilization, while the scapula are kept wide and in neutral position. The back of the neck lengthens while keeping the neck relaxed and the chin is drawn toward the base of the neck for one or two inches, as if drawing a line on the floor with the chin.[358] After the head returns to neutral it lifts slightly upwards into an extension, while keeping the superficial neck muscles relaxed (see figure 6.29). During the movements of the head the orientation of the neck relative to the floor should not change.[359] This exercise is also valuable for string players because it improves scapular stability and lumbar stability, through correct activation of the scapular abductors and abdominal muscles.

[358] Paterson, Pilates for Postural Faults, 136.

[359] Ibid.

A similar exercise is Head Turning or atlantoaxial joint mobilization.[360] Assuming the same quadruped position described in the previous exercise, this exercise consists of rotating the head very slightly towards one side and then towards the other, moving through the first and second cervical vertebrae only (see figure 6.29).[361] As in the previous Head Nodding, it is important to keep the superficial neck muscles as relaxed as possible in order to improve atlanto-axial rotation and mobility of the cervical spine, which may be compromised in upper string players and double bass players. The exercise aims to improve the performance of the deep cervical spine stabilizing muscles, improve scapular alignment, and muscle control over lumbar spine stability.[362]

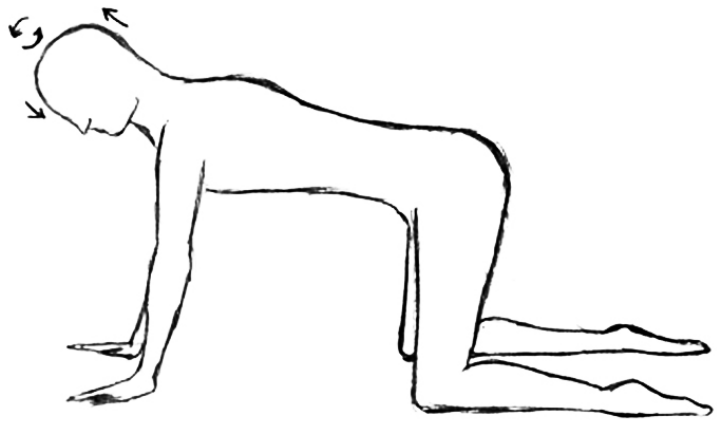

Figure 6.29. The Head Nodding and The Head Turning exercises.

[360] Ibid.

[361] Ibid., 138.

[362] Ibid., 138.

Figure 6.30. Summary of the *Pilates* Exercises including general focus and targeted muscles. See Appendix B for a detail description of muscle groups. *Indicates exercises already addressed, to avoid repetition of muscular focus.

WHOLE BODY WARM UP	
The Hundred	Main Muscular Focus: Spinal flexors (abdominals), deep neck flexors, serratus anterior, hip flexors. Secondary Muscular Focus: Anterior spinal stabilizers, hip adductors, knee extensors, ankle-foot plantar flexors, shoulder extensors, shoulder flexors, elbow extensors.
STRENGHTEN CORE, STRENGHTEN AND STRETCH LEGS AND HIPS	
The Single Leg Circles	Main Muscular Focus: Anterior spinal rotators and stabilizers, posterior spinal rotators and stabilizers, hip flexors, hip extensors, hip abductors, hip adductors, hip rotators, hamstrings, knee extensors. Secondary Muscular Focus: Scapula, arm extensors, ankle-foot plantar flexors, ankle-foot dorsiflexors.
Single Leg Stretch	Main Muscular Focus: Spinal flexors (abdominals), deep neck flexors, scapular stabilizers, hip flexors, hip extensors, hamstrings. Secondary Muscular Focus: Anterior spinal stabilizer, knee extensors, ankle-foot plantar flexors, shoulder flexors, shoulder extensors, elbow flexors, elbow extensors.
Double Leg Stretch	Main Muscular Focus: Spinal flexors, deep neck flexors, scapular stabilizers, arm rotators (rotator cuff muscles), pectorals, hip flexors, hip extensors. Secondary Muscular Focus: Anterior spinal stabilizer, hip adductors, knee extensors, ankle-foot plantar flexors, knee flexors, shoulder flexors, elbow flexors, elbow extensors.
The Single Straight-Leg Stretch	Main Muscular Focus: Spinal flexors, deep neck flexors, hip flexors, hamstrings. Secondary Muscular Focus: Anterior spinal stabilizer, hip extensors, knee extensors, ankle-foot plantar flexors, shoulder flexors.

LEG, HIP AND FOOT STRENGTH, FLEXIBILITY, ALIGNMENT AND BALANCE	
The Side Kick	Main Muscular Focus: Spinal lateral flexors and stabilizers (external oblique, internal oblique, quadratus lumborum, erector spinae, semispinalis, deep posterior spinal group, rectus abdominis, transversus abdominis), hip abductors. Secondary Muscular Focus: Hip flexors, hip extensors, knee extensors, ankle-foot plantar flexors.
Side Lying Exercises: Hot Potatoes and Leg Circles	Hot Potatoes Muscular Focus: Anterior and posterior spinal stabilizers. Internal rotator muscles of the hip, gluteus medius and minimus. Leg Circles Muscular Focus: Anterior and posterior spinal stabilizers. Hip flexors, hip rotators, hip abductors, hip adductors, ankle stabilizers, knee stabilizers, hip stabilizers.
Footwork: The Towel Exercise	Muscular Focus: Tibialis posterior muscle, flexors of the foot and toes, extensors of the foot and toes.
The Flamingo	Postural alignment and balance. Stretches hip flexors.
SPINE FLEXIBILITY	
The Roll Up	Main muscular focus: spinal flexors, spinal extensors, hip flexors, hip extensors, hamstrings. Secondary muscular focus: Spinal stabilizers, ankle-foot dorsiflexors, shoulder flexors, shoulder extensors, scapula depressors, and elbow extensors.
The Wall	Part 1. Muscular focus: Similar to the Roll-Up. Part 2. Muscular focus: Quadriceps, hamstrings, hip flexors, hip extensors, transversus abdominis, scapula, triceps. Pectoralis stretch.
Rolling Like a Ball	Main Muscular Focus: Spinal flexors, anterior stabilizers, hip flexors. Secondary Muscular Focus: Hip adductors, shoulder extensors, elbow flexors.

Standing Mermaid	Muscular focus: Spinal lateral flexors and stabilizers, quadratus lumborum, shoulder abductors, latissimus dorsi, scapula depressors.
Spine Twist	Main Muscular Focus: Spinal rotators, anterior spinal stabilizers, back extensors. Secondary Muscular Focus: Ankle-foot dorsiflexors, shoulder abductors, elbow extensors, scapula adductors.
Pelvic Curl	Main muscular focus: Spinal flexors, spinal stabilizer, pelvic floor muscles, hip extensors, latissimus dorsi, hamstrings. Secondary Muscular Focus: Spinal extensors, knee extensors, shoulder extensors.
Cat Stretch	Main muscular focus: spinal extensors, latissimus dorsi, rectus abdominis, iliopsoas, sartorius, spinal stabilizer, deltoideus anterior. Secondary Muscular Focus: Trapezius, deltoideus posterior, biceps branchii, triceps branchii, serratus anterior, multifidus, biceps femoris (from hamstrings) and vastus intermedius, vastus lateralis, and rectus femoris (from quadriceps).
Spine Stretch	Main Muscular Focus: Spinal extensors, spinal flexors, hamstrings, psoas, hip flexors. Secondary Muscular Focus: Anterior spinal stabilizers, hip extensors, ankle-foot dorsiflexors, shoulder flexors, elbow estensors.
OPEN CHEST AND STRENGTHEN BACK, SPINE EXTENSION	
The Swan preparation or upper thoracic extension and Back Extension	The Swan preparation. Main Muscular Focus: Spinal extensors, scapula depressors, hip extensors. Secondary Muscular Focus: Anterior spinal stabilizers, ankle-foot plantar flexors Back Extension. Main Muscular Focus: Spinal extensors, elbow extensors. Secondary Muscular Focus: anterior spinal stabilizers, hip extensors, shoulder adductors.

The Single Leg Kick	Main Muscular Focus: Spinal extensors, hip extensors, hamstrings, quadriceps, pectorals, scapula depressors. Secondary Muscular Focus: Anterior spinal stabilizers, knee flexors, knee extensors, ankle-foot plantar flexors, shoulder extensors.
The Double Leg Kick	Main Muscular Focus: Spinal extensors, lumbar extensors, hip extensors, hamstrings, rhomboids, middle trapezius, infraspinatus, teres minor. Secondary Muscular Focus: Anterior spinal stabilizers, hip adductors, knee flexors, knee extensors, ankle-foot plantar flexors, shoulder extensors, pectorals, scapular depressors, elbow flexors, elbow extensors.
Pelvic Lift	Main Muscular Focus: Posterior spinal stabilizers, anterior spinal stabilizers, hip extensors, psoas, hamstrings, latissimus dorsi. Secondary Muscular Focus: Shoulder extensors, scapula adductors.
BACK EXTENSORS AND TRUNK STABILITY	
Swimming	Main Muscular Focus: spinal extensors, rotators, hip extensors. Secondary Muscular Focus: anterior spinal stabilizers, hip flexors, knee extensors, ankle-foot plantar flexors, shoulder flexors, shoulder extensors, scapula depressors, elbow extensors.
SCAPULAR ALIGNMENT	
*Standing Hundred, *Standing Mermaid, *Spine Twist, *The Swan preparation, *The Single-Leg Kick and *Double-Leg Kick	
SHOULDER GIRDLE STABILITY	
Arm Circles	Muscular focus: Mobilization and stabilization of rotator cuff muscles, scapular stabilization.

Open Tray and Serve a Tray	Muscular focus Open Tray: Rotator cuff muscles. Stretches pectoralis. Muscular focus Serve a Tray: Serratus anterior, lower trapezius, deltoid, biceps.
Arm Swings: Alternating and Chest Expansion	Muscular focus: Mobilization and stabilization of rotator cuff muscles. Thoracic and cervical alignment. Stretches pectoralis.
Arm Weights: Arm curl, low curl, side curl. The Zip-Up, the Shave-Stand, Chest-Expansion.	Muscular focus: Serratus anterior, latissimus dorsi, Teres minor. Shoulder girdle. Scapular depressors. Elbow flexors and extensors.
HEAD AND NECK STABILIZATION AND MOBILIZATION	
Oy Vey and variation	Deep cervical spine stabilizing muscles. Stretches neck extensors.
Head Nodding (craniovertebral joint mobilization)	Muscular Focus: atlanto-occipital flexion, atlanto-occipital extension, lumbar spine stability, scapular stabilization.
Head Turning (atlantoaxial joint mobilization)	Muscular Focus: atlantoaxial rotation, lumbar spine stability, scapular stability.

Suggested Order of *Pilates* Exercises:

1. Standing Hundred and supine Hundred
2. The Wall (with Arm Circles)
3. The Flamingo
4. Roll-Up
5. Standing Leg Circles and supine Leg Circles
6. Pelvic Curl
7. Rolling Like a Ball
8. Single Leg Stretch
9. Double Leg Stretch
10. Single Straight Leg
11. Towel
12. Spine Stretch Forward with extension
13. Cat Stretch
14. Swan Preparation
15. Back Extension
16. Single Leg Kick
17. Double Leg Kick
18. Pelvic Lift
19. Spine Twist
20. Side lying Exercises (Side Kicks, Leg Circles, Hot Potatoes)
21. Swimming
22. Mermaid
23. Arm Weights
24. Open Tray
25. Serve Tray
26. Oy Vey
27. Head Nodding
28. Head Turning

CHAPTER 7: CONCLUSION

Current literature on musculoskeletal disorders of musicians shows that the most affected group of instrumentalists is string players, and that posture is one of the major contributors of problems. Current studies suggest the necessity of a more specialized intervention on the part of higher education music institutions, so that problems may be addressed as soon as possible. Additionally, more long-term, sustainable, mind-body conditioning programs are needed, so musicians can easily maintain their practice through daily life and into their careers. This dissertation has proposed the incorporation of *Pilates* into the university music curriculum as an effective tool to help string players improve posture and reduce musculoskeletal disorders associated with asymmetric postures and faulty postural tendencies. The literature review of *Pilates* studies shows that the method can improve several areas that are of interest to musicians, such as problems with the musculoskeletal system (including chronic low back pain, chronic neck pain, and shoulder issues), posture, alignment, stability, dynamic balance, the respiratory system, flexibility, intelligence, mindfulness, and relaxation.

The most significant contribution of this paper is Chapter 6, which presents my adaptations of *Pilates* exercises that can help condition specific issues involving musculature of string players which have been compromised due to asymmetric postures and other common postural tendencies--something that has not been done before. The provided selection of exercises from classical and contemporary *Pilates* includes discussion of the musculature involved, dynamic illustrations showing the direction of movement and range of motion, and considerations and modifications for string players. Most of the chosen exercises target posture, and they are adaptable and transportable to

fit the lives of musicians. The information can be helpful to both string players and to *Pilates* instructors or other health practitioners who work with string players, in efforts to ensure safe practice and avoid further problems.

After this extensive chapter, a syllabus of a *Pilates* class for string players was provided as an example of how the method can be incorporated into the university music curriculum. The goal of this class is to provide students with a regular practice of *Pilates* that would help address issues as they occur, and provide the tools for continuing the work after the class ends. After taking this class, students would have a better understanding of the ways their bodies and the exercises work, and they would have the options to practice the exercises individually, join a *Pilates* group class or on-line class, or apply the *Pilates* principles to other activities and exercises to improve their performance.

Chapters 4 and 5 explored common tendencies and possible postural faults of lower string players and upper string players, respectively, and identified specific muscles associated with potential misalignments and their causes. The information is invaluable to string players because these musicians often experience discomfort in specific areas of their bodies, yet their anatomical knowledge is often limited, which prevents them from understanding how to balance their compromised musculature or communicating with health practitioners. The information is also insightful for *Pilates* instructors and other health practitioners who may not be familiar with the challenges of playing a string instrument or the particularities of a string player's body.

Chapters 1 through 3 provided background information necessary for a full understanding of the value of *Pilates* for string players. I consider the information

necessary for understanding why *Pilates* should be inserted into the music curriculum. Chapter 1 provided a literature review of the state of the current health norms in schools as well as studies on musculoskeletal disorders of string players and on the effectiveness of *Pilates*. Chapter 2 provided the motivations and philosophies of *Pilates*' founder, and a background of the *Pilates* method. The chapter provided evidence of how the method has been previously used among performing artists, to help understand how the method is appropriate for string players. This chapter also provided important considerations for a *Pilates* class for string players, and clarified some of the misleading concepts around the method to explain the potential of *Pilates* when exercised correctly.

Chapter 3 detailed the connection between *Pilates* principles and instrumental technique, specifically the performance of string players. The striking similarities between the two have not been previously explored, and they help explain the value of *Pilates* for string players. The principles of concentration, control, precision, centering, breathing, and flow are present both in *Pilates* and music playing. To my knowledge, no other type of mind and body conditioning program is more appropriate and sound for string players than *Pilates*. This chapter also explored and identified the deeper connective thread between *Pilates* and music, proprioception and its effect on motor control.

The numerous parallels between *Pilates* and musical performance suggest various benefits from practicing *Pilates* that have yet not been studied. Studies on *Pilates*' effects on string players are needed to help explore the different areas in which *Pilates* can be beneficial for this population, including areas of posture, musculoskeletal disorders, proprioception, motor learning, awareness, concentration, relaxation, and stamina.

Studies will also help support the insertion of Pilates into the music curriculum as an effective tool to condition the mind and body, balance asymmetries and provide long-term effects.

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APPENDIX A

SAMPLE COURSE SYLLABUS

CONDITIONING FOR MUSICIANS
PILATES FOR STRING PLAYERS, MUP 436

COURSE DESCRIPTION

This class introduces beginners to the *Pilates* method as adapted by the instructor to optimize benefits for players of bowed string instruments. Students will study *Pilates* Principles and perform basic mat exercises to help counteract asymmetrical postures associated with playing their instrument. Students will learn how to center and improve concentration for music performances. Students will also learn basic and relevant anatomical concepts to understand how the body works and how to use it efficiently. This class helps improve alignment, coordination, proprioception, dynamic balance and motor control, which are necessary for playing an instrument with precision and ease. This class also helps reduce back pain, neck pain, shoulder, elbow and wrist problems.

LEARNING OBJECTIVES

1. Improve postural alignment and biomechanics.
2. Increase mind-body awareness.
3. Increase strength, flexibility, stamina and concentration.
4. Reduce stress and enhance self-esteem.
5. Perform *Pilates* exercises and demonstrate good form and movement through the performance of the exercises.
6. Learn basic concepts of anatomy related to playing string instruments.
7. Develop a personal routine of *Pilates* exercises to be maintained after the course is over.
8. Learn the *Pilates* principles to apply them to playing an instrument and other activities, including sports, to assure safety and to improve efficiency of movement.

LEARNING OUTCOMES

1. After completion of this course students will have a better understanding of beneficial posture and how to maintain it.
2. Students will learn basic *Pilates* exercises and develop a personal routine that can safely be practiced after the class ends.
3. Students will learn a foundation of *Pilates* exercises and design a personalized routine that incorporates regular exercise into daily activity. Students will also learn the *Pilates* principles and will be able to apply them to other forms of exercise and movement.
4. Students will learn important information regarding their bodies and how to modify exercises, so they can better communicate their concerns to other *Pilates* instructors or health practitioners, and be able to safely adapt exercises given in a regular *Pilates* class or online class.
5. Students will improve their knowledge of anatomy related to playing their

instrument to avoid injuries.

REQUIRED MATERIALS AND TEXT

Pilates or yoga mat: Around ½ inch in thickness. Dimensions: 70" to 72" X 20" to 22".
Blank notebook for journaling.
OverBall or soft inflatable ball, between 9 and 10 inches in diameter.
TheraBand™ or resistance band
Blandine Calais-Germain. *Anatomy of Movement*. Revised Ed. Seattle, WA: Eastland Press, Inc., 2014.

SUGGESTED READING

Isacowitz and Clippinger, *Pilates Anatomy*
Pilates, *Return to Life through Contrology*
Pilates, *Your Health*

COURSE REQUIREMENTS

- Attendance and punctuality are mandatory.
- Student must sign a consent form before the course starts and provide health background on the attached form by the 2nd class meeting.
- Students will keep a journal of exercises including important cues and steps for each exercise.
- Students are expected to practice specific exercises as instructed, and keep track of practice sessions, observations and personal goals in the journal.
- The student must be prepared to show the journal to the instructor at anytime as requested, but instructor will check journals weekly.
- Readings are assigned for each major topic and discussed in class.
- Section quizzes on performed exercises will demonstrate correct form and application of *Pilates* principles.
- There will be a final project consisting of a personal routine designed by the student, through consultation and approval of the instructor. Journal entries will be due at the end of the course.

DRESS

Reasonably form-fitting attire is necessary to observe postural alignment and asymmetries. Flexible clothes or workout attire, such as fitted shirts, flexible sweatpants, footless tights, or leggings are good choices. Shoes will not be work and socks are optional. Crop tops, hats, skirts and shorts shorter than mid-thigh are inappropriate for class. Jewelry should be removed before class. Hair should be secured away from the face and neck in a way that is comfortable on the mat. Bring water, which is mandatory

to stay properly hydrated in class.

GRADING

50% Attendance and participation
10% Journal
20% Quizzes
20% Final Project

COURSE SCHEDULE

Week 1

Pilates Background, Principles and Philosophy

The six principles: Concentration, control, precision, centering, breathing, and flow.
Controlling performance anxiety through breathing and centering.
The Powerhouse.

The Importance of Postural Alignment

Plumb line test. Alignment in every position: standing, sitting, prone, supine, sideways.
The importance of breathing. The breath test, by Victor Sazer.
Lateral breathing and core engagement.
Exploring alignment and breathing with the instrument: Looking at different stances and sitting postures with the instruments.

DUE: Health form.

Week 2 and 3

The Powerhouse

Readings:
The Trunk. Movements of the trunk, p. 29-33
Abdominal muscles, p. 94-99
How the diaphragm and abdominal muscles are involved in breathing, p. 100

Exercises that focus on the powerhouse: Hundred, The Wall, the Roll-Up, Leg Circles, Pelvic Curl, Rolling Like a Ball, Single Leg Stretch, Double Leg Stretch, Single Straight Leg...

Continued practice.

QUIZ 1

Week 4 and 5

Spinal and Pelvic Alignment

Readings:
The vertebral column, p. 34-42
Pelvis, p. 43-49, 56-57
Movements of the hip, p. 198-199

(New) Exercises that focus on alignment and flexibility of the spine and pelvis: The Wall, the Roll-Up, Pelvic Curl, Rolling Like a Ball, the Flamingo, Cat Stretch

Continued practice.

QUIZ 2

Week 6 and 7

Hip, Leg and Foot Alignment

Readings:
Leg alignment, p. 215
Muscles of the hip, p. 228-23
Leg muscles, p. 231-24, 243-244-250, 252-255
The ankle and foot, p. 257-261, 29

(New) Exercises that focus on hip, leg and foot strength and alignment, and hip mobility: Single Leg Stretch, Double Leg Stretch, Single Straight Leg, the Wall, Standing Leg Circles, Standing Hundred, The Flamingo, the Towel

Continued practice.

QUIZ 3

Week 8, 9 and 10

Thoracic and Cervical Alignment and Function

Readings:
Thoracic spine, p. 58-64
Cervical spine, p. 65-71
Posterior muscles of the trunk and neck, p. 73-77
Intermediate muscles of the trunk and neck, p. 78-83
Anterior and lateral neck muscles, p. 84-88

(New) Exercises that focus on fine articulation and of the thoracic spine and back extension, and exercises for neck and head alignment: Spine Stretch Forward, Swan Preparation, Back Extension, Single Leg Kick, Double Leg Kick, Swimming, Pelvic Lift, Oy Vey

Continued practice.

QUIZ 4

Week 11, 12 and 13

Shoulder Alignment and Function

Readings:
The shoulder, p. 102-109
The shoulder girdle, p. 110-118
Shoulder muscles, p. 119-127
Rotator cuff muscles, p 128
Scapohumeral muscles of the shoulder, p. 129-132
Muscle actions in specific movements of the shoulder, p. 133-135

(New) Exercises that focus on the spine rotation, lateral flexion and core stability when moving a limb: Mermaid, Spine Twist, Side lying Exercises (Side Kicks, Leg Circles, Hot Potatoes), Arm Weights, Open Tray, Serve Tray

Continued practice.

QUIZ 4

Week 14

Arm, Wrist and Hand Anatomy

Readings:

Muscles for flexion and extension of the elbow, p. 145-148
Pronation and supination of the forearm, p. 149-155
The wrist and hand, 157-161
Muscles of the wrist and hand, p. 171-189.

(New) Exercises for head, neck and thoracic alignment that also strengthen the wrists: Head Nodding, Head Turning.

Continued practice.

QUIZ 5

Week 15

Practice, review and discussion/closure.

DUE: Final Project and Journal.

APPENDIX B

MUSCLE GROUPS

Adductors: Adductor magnus, adductor brevis, adductor longus.

Ankle-foot dorsiflexors: Tibialis anterior, extensor digitorium longus.

Ankle-foot plantar flexors: Gastrocnemius, soleus.

Anterior spinal stabilizers (and rotators): Rectus abdominis, external oblique, internal oblique, transversus abdominis.

Atlantoaxial rotators: The short muscles between the atlas and occiput (suboccipital muscles), together with the left and right sternocleidomastoid and trapezius muscles.

Atlanto-occipital extensors: The postvertebral muscles.

Atlanto-occipital flexors: Short muscles between the atlas and occiput, together with the left and right anterior neck muscles (sternocleidomastoid and longus capitis).

Deep lateral hip rotators: Obturator internus, gemellus superior, gemellus inferior, quadratus femoris.

Deep neck flexors: Longus capitis, longus colli.

Elbow extensors: Triceps branchii

Elbow flexors: Biceps branchii, branchialis

Erector spinae: Iliocostalis cervicis, thoracis, lumburum. Longissimus capitis, cervicis, thoracis. Spinalis cervicis, thoracis.

Extensors of the foot and toes: extensor digitorum brevis, extensor hallucis brevis, abductor hallucis, abductor digiti minimi

Flexors of the foot and toes: flexor digitorium brevis, flexor hallucis brevis, abductor hallucis, abductor digiti minimi, flexor digiti minimi brevis.

Gluteals: Gluteus Maximus, gluteus minimus, gluteus medius.

Hamstrings: Biceps femoris, semitendinosus, semimembranosus.

Hip abductors: Gluteus medius, gluteus minimus, tensor fasciae latae, sartorius.

Hip adductors: Adductor longus, adductor brevis, adductor magnus, gracilis.

Hip extensors: Gluteus maximus, hamstrings (semitendinosus, semimembranosus).

Hip flexors: Iliopsoas, rectus femoris.

Knee extensors: Quadriceps femoris.

Lumbar spine stability: Erector spinae, the pelvic floor and transversus abdominis.

Medial hip rotators: Gluteus medius, gluteus minimus, tensor fasciae latae, adductor magnus (part), pectineus (when leg abducted).

Pelvic floor muscles: Coccygeus, levator ani (pubococcygeus, puborectalis, iliococcygeus).

Posterior spinal stabilizers (and rotators): Erector spinae, semispinalis, deep posterior spinal group.

Quadriceps: Rectus femoris, vastus lateralis, vastus medialis, vastus intermedius.

Rotator cuff muscles: Supraspinatus, infraspinatus, teres minor, subscapularis.

Scapula abductors: Serratus anterior.

Scapula depressors: Lower trapezius, serratus anterior, pectoralis minor (sometimes).

Shoulder abductors: Middle deltoid, supraspinatus, anterior deltoid, pectoralis major (clavicular).

Scapular stabilizers: Lower trapezius, serratus anterior, latissimus dorsi.

Shoulder adductors: Pectoralis major with latissimus dorsi.

Shoulder extensors: Latissimus dorsi, teres major, pectoralis major (sternal), posterior deltoid.

Shoulder flexors: Anterior deltoid, pectoralis major (clavicular).

Spinal extensors: Erector spinae, semispinalis, deep posterior spinal group.

Spinal flexors: Rectus abdominis, external oblique, internal oblique.

Spinal rotators: External oblique, internal oblique, erector spinae, semispinalis, deep posterior spinal group (especially multifidus).

Spinal stabilizer: Transversus abdominis.

BIOGRAPHICAL SKETCH

María Luciana Gallo is a member of the Tucson Symphony Orchestra and has also played with the Phoenix Symphony, Arizona Opera, West Bay Opera (Palo Alto), the Reno Philharmonic, and Dubuque Symphony Orchestra, among others. She completed the Doctoral of Musical Arts degree in Cello Performance at Arizona State University in 2017, where she was a teaching assistant to Thomas Landschoot from 2014 to 2016. She studied research methodologies with Kay Norton. Gallo holds a Master of Music degree in Cello Performance and Orchestral Career Studies from the University of Nevada Reno, where she was a teaching assistant to Dmitri Atapine from 2011 to 2013 and a member of the Nightingale String Quartet.

Gallo's expertise in cello is complemented by her certification from the Pilates Sports Center in Scottsdale, AZ; she teaches Pilates for musicians at Remedy Pilates and Barre Center, in Scottsdale, and also privately. Gallo's interest in body movement and somatic practices began in 2008 when studying with cellist and Felndenkrais practitioner Uri Vardi at the University of Wisconsin-Madison. She also participated in the National Cello Institute and the Feldenkrais for Musicians Workshop taught by Uri Vardi, Hagit Vardi, Steven Doane, and Hans Jørgen Jensen. In 2016, she participated in the Pilates Method Alliance conference in Phoenix, and was subsequently invited to teach a Pilates class for cellists at the Tucson Cello Congress, at the University of Arizona. Gallo taught a Pilates class for the cello studio of Arizona State University in 2017, and was invited to teach a Pilates class for string players at the Paul Rolland String Pedagogy Conference at Arizona State University in June 2017 (www.paulrollandevents.com). In addition, Gallo has taught at the Cellobration festival at Arizona State University from 2014 to 2016, and was the lead string teacher and coordinator for the Phoenix chapter of the Harmony Project of America, a music for social change program (www.harmonyprojectphx.org).

Gallo was born in Argentina and began music lessons with her mother, Ana Gabriela Bazán, who taught at the Conservatorio Superior de Música Félix T Garzón, in Córdoba. She began cello lessons at age seven at the Suzuki Method School and later, at the Conservatory. Luciana came to the United States in 2007, funded by a generous scholarship from the Liberace Arts Foundation.