5-2021

The Effectiveness of Physical Therapy Intervention Modeled After the Scroth Method and Fits Concept for Treatment of Radicular Symptoms Secondary to Mild Scoliosis in a 16-year old Female.

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THE EFFECTIVENESS OF PHYSICAL THERAPY INTERVENTION MODELDED AFTER THE SCROTH METHOD AND FITS CONCEPT FOR TREAMTENT OF RADICULAR SYMPTOMS SECONDARY TO MILD SCOLIOSIS IN A 16-YEAR -OLD FEMALE

by

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Bachelor of General Studies
University of North Dakota, 2019

A Scholarly Project Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota
May, 2021

This Scholarly Project, submitted by Mary Therese L. Gray in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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Department Physical Therapy

Degree Doctor of Physical Therapy

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Signature Mary Therese L. Gray

Date 10/1/2020

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ABSTRACT

Background and Purpose. Physical therapy as an intervention for scoliosis typically involves a method-based scoliosis specific approach to treatment that requires extensive training such as the Schroth method or FITS concept. The purpose of this study is to determine if physical therapy treatment alone, when modeled after the Scroth method and FITS concept can be an effective treatment method for lumbar radiculopathy and pain secondary to mild scoliosis.

Case Description. The patient featured in this case report is a 16-year-old female with a medical diagnosis of scoliosis and fibro-lipoma on her filum terminal. The patient had a Cobb angle of 17 degrees and experienced lower extremity radicular symptoms.

Intervention. Intervention included therapeutic exercise to strengthen abdominal and gluteal musculature, stretching of trunk musculature, neuromuscular reeducation to promote postural alignment and education on scoliosis, vertebral anatomy, postural positioning, and safe lifting techniques.

Outcomes. Outcomes were assessed using the Lower Extremity Functional Scale (LEFS), side bend range of motion of the trunk and strength of trunk flexion, trunk rotation, hip abduction and hip flexion. At discharge, the LEFS score improved from 67/80 to 80/80. Side bend range of motion was within 0.5cm bilaterally. Trunk flexion, trunk rotation, hip flexion and hip abduction all measured 5/5 strength.

Discussion. The results of this study suggest that physical therapy treatment when modeled after concepts from the Schroth method, FITS concept are an effective intervention for the 16-year-old female featured in this case study.

CHAPTER I

BACKGROUND AND PURPOSE

Scoliosis can be defined as 3-dimensional abnormal curvature of the spine observed in the frontal, transverse, and sagittal plane. [1] It may take the shape of a C, with one convexity, or S with two convexities. The etiology of scoliosis can be divided into four categories of neuromuscular, mesenchymal, congenital and idiopathic.[1] Neuromuscular scoliosis is caused by neuromuscular health conditions such as cerebral palsy or muscular dystrophy.[2] Impairments from the neuromuscular condition, such as muscle weakness secondary to decreased innervation, lead to structural impairments of the spine.[1] Mesenchymal scoliosis is caused by health conditions that affect passive stabilizers of the spine such as osteogenesis imperfecta or Marfan's syndrome.[1] Examples of passive stabilizers of the spine include ligaments, vertebrae and vertebral discs.[3] Congenital scoliosis is a type of scoliosis that is present at birth due to incorrect development of the spine or rib cage in the womb. Idiopathic scoliosis is of unknown cause and can be divided into three additional categories based upon age group, infantile scoliosis (ages 0-3), juvenile scoliosis (ages 2-10) and adolescent scoliosis (ages 11-21.)[1,4]

Adolescent Idiopathic scoliosis (AIS) is the most common form of scoliosis, comprising 85% of all cases.[4] Evidence describing the prevalence amongst adolescents varies across studies, ranging from 0.59 to 5.2%.[1,4] Adolescent girls are more likely to

have progressed or severe idiopathic scoliosis than adolescent boys. The girl to boy ratio increases from 1.4:1 in mild scoliosis to 7.2:1 in severe scoliosis.[1,4] The ratio of girls with AIS compared to boys also increases as adolescents age. [1]

Severity of scoliosis is categorized based upon age of onset, etiology, shape of curve, and cobb angle.[1,4] Cobb angle is the primary form of measurement for angular deviation from normal spinal alignment for scoliosis. It is usually measured radiographically.[5] If the Cobb angle is less than 10 degrees, a diagnosis of scoliosis cannot be made.[6] Those with a larger cobb angle at a younger age have a worse prognosis and are more likely to require surgical treatment. This is because when one's Cobb angle is already severe before he or she has finished growing, the Cobb angle will likely progress through growth. Those with a smaller Cobb angle have a better prognosis and are more likely to benefit from conservative treatment.[1,4]

As previously described, treatment for scoliosis is determined by the degree of the Cobb angle and symptoms present. Those with an angle of 25 degrees or less and no symptoms may be under observation, not treated at all or may benefit from physical therapy alone.[7] Those with a cobb angle in between 25 and 45 degrees may benefit from physical therapy, bracing or a combination of the two.[7] For those with a cobb angle of 40-50 degrees or greater, surgical treatment may be recommended. Severity of symptoms and a conversation with one's physician and physical therapist are all taken into consideration when determining the best treatment option.[7,8]

The purpose of surgical treatment is to stop and correct the 3D malformation of scoliosis. In 2016, a systematic review was done to compare the outcomes of those with a Cobb angle of 40 degrees or greater who underwent surgery to those who only used

conservative treatment. The researchers did not find evidence that surgical treatment was a superior method of treatment for individuals with a Cobb angle greater than 40 degrees.[8] In addition, a retrospective analysis was done to determine the cost of surgical treatment for scoliosis in adults as of 2009. The analysis found that an average of 10 vertebrae were fused; the mean cost for treatment was $47,127.[9] Current rates for inpatient stays for vertebral procedures are reported by the Minnesota Hospital Association. These pricings do not consider insurance coverage and are not specific to a vertebral fusion, however, they do include expected cost per day. As of October 2020, the cost for an inpatient stay for a vertebral procedure ranges from $12,530 to $17,458. The average length of stay ranges from 2.7 to 14.5 days, depending on the hospital.[10]

A conservative method of treatment for AIS is bracing. Bracing may be used alone or in combination with physical therapy treatment. Bracing is commonly used for treatment of moderate Cobb angles.[7] While literature demonstrates that bracing may prevent up to 50% of curve progression in skeletally immature individuals, there are negative psychological components to bracing as well. This is due in part, to the adolescent patient's concern with how she is perceived by her peers. Braces must be worn for 18 to 23 hours daily and are often uncomfortable.[11] This leads to decreased compliance with treatment on the patient's end.

The efficacy of physical therapy treatment for idiopathic scoliosis is controversial among health care professionals and organizations internationally, although there is some evidence to support it.[7, 11] One article describes how bracing is the only form of conservative treatment that can alter the progression of scoliosis curvature.[11] This article also states that a combination of inpatient intensive physical therapy, outpatient physical

therapy and bracing has shown reduce curve progression.[11] Typically, the purpose of conservative treatment has been to decrease pain, increase vital capacity which may be affected by scoliosis curvature on the lungs and reduce or stop curve progression. [7]

Successful treatment of physical therapy has historically been defined by a decrease in Cobb angle of 5 degrees or greater. However, a 2019 study described how an improvement in scoliosis may be better determined by outcome measures such as the Global Rating of Change scale (-7 a great deal worse to +7 a great deal better). [13] This study compared the Schroth method of physical therapy treatment to the "standard of care" which was defined as observation or bracing.[13] The researchers found a correlation between largest Cobb angle and Global Rating of Change (GRC). Participants in the Schroth group reported an average change in GRC by +4.4 compared to – 0.1 in the control group.[12] This suggests that physical therapy can be an effective treatment method for scoliosis symptoms.

Researched physical therapy interventions for scoliosis that have evidence to support their practice are known as scoliosis specific intervention methods. These methods require additional education and extensive training not provided in physical therapy school.[7] The Schroth, Doboweicwiz, side shift Methode Leyonaise and FITS concept are examples.[12] Principles from the Schroth and Functional Independent Treatment for Scoliosis (FITS) were applied to the patient featured in this case study.

Schroth exercises focus on the patient's balance, postural awareness, and trunk musculature.[12] The method focuses on treating muscle imbalances through strengthening, lengthening and neuromuscular coordination.[13] Mirrors are used for

postural correction and rotational breathing. Exercise repetition and trunk muscle endurance are key components to this method.[13]

The Functional Individual Treatment for Scoliosis (FITS) concept endorses 10 principles for treatment of spinal curvature. They are as follows:[14 p. 2]

I. To make the child aware of existing deformation of the spine and trunk as well as indicate the direction of scoliosis.
II. To release myofascial structures which limit three plane corrective movement.
III. To increase thoracic kyphosis through myofascial release and joint mobilization.
IV. To teach correct foot loading to improve position of pelvis and to realign scoliosis.
V. To strengthen pelvic floor muscles and short rotator muscles of the spine in order to improve stability of the lower trunk.
VI. To teach the correct shift of the spine in frontal plane in order to correct the primary curve while stabilizing (or maintaining in correction) the secondary curve.
VII. To facilitate of three plane corrective breathing in functional positions (breathing with concavities).
VIII. To indicate correct patterns of scoliosis correction and any secondary trunk deformation related to curvature (asymmetry of head position, asymmetry of shoulders, asymmetry of shoulders' lines, waist triangles and pelvis).
IX. To teach balance exercises and improvement of neuromuscular coordination with scoliosis correction.
X. To teach correct pelvis weight bearing in sitting and correction of other spine segments in gait and ADL.

The FITS concept was used to treat individuals with Cobb angles of 10-25 degrees (Group A) and Cobb angles of 26 degrees or greater (Group B). Groups were further divided into subgroups of single and double convexities. Outcomes were measured through plumb line imbalance, scapulae alignment and angle of trunk rotation. Improvement was defined as a decreased Cobb angle of 5 degrees or greater. Fifty percent of participants in group A1 and A2 improved, compared to 20% and 28% in group B, suggesting that the FITS concept is the most effective when treating mild Cobb angles.[14]

The principles of both the Schroth method and FITS concept are similar to principles for treatment of low back pain with sciatica in individuals 16 years of age or older. The clinical practice guidelines for treatment of low back pain with or without sciatica supports the use of biomechanical therapeutic exercise and encouragement for self-management strategies provided through education.[15] The clinical practice guidelines allow the use of manual therapy such as mobilizations or soft tissue massage for treatment of low back pain with or without sciatica. It is clarified that the term sciatica includes leg pain caused by lumbar nerve root pathology. While the authors acknowledge “radiculopathy” as a more specific term, “sciatica” is universally understood by patients and health care providers.[15] Princeton created a recommended exercise program for prevention or treatment of lumbar spine pathology. [16] The program included strengthening of deep abdominal musculature including glutes and transverse abdominus, frequent stretching of hamstrings, hip flexors and trunk musculature, core stabilization and proprioceptive exercises.[16]

A randomized control trial was done to compare physical therapy to steroid injections for treatment of radiculopathy. The physical therapy intervention began with end range directional exercises and mechanical traction. Treatment progressed to therapeutic exercise including trunk stabilization and strengthening.[17] Outcomes were measured through the Global Rating of Change, a pain scale and the Low Back Disability Questionnaire at baseline, 8 weeks post treatment and 6 months post treatment. The researchers found a significant decrease in pain and disability in both groups, but not a significant decrease in pain between the two groups at any time during follow up.[17]

The patient in this case report represents a unique situation. The patient's Cobb angle was minimal, but she presented with occasional severe radicular symptoms. Had her symptoms not been disrupting to her activities of daily living, she may not have required treatment for scoliosis at all. If her Cobb angle was larger, she may have required a different form of treatment. However, her symptoms were disrupting her activities of daily living, and per her report, caused significant pain and discomfort, thus requiring physical therapy treatment. Currently, evidence towards non-method based conservative treatment of physical therapy for scoliosis with a mild Cobb angle and radicular symptoms is lacking. Methods of scoliosis treatment require extensive education and primarily target Cobb angle for means of improvement. In this case report, the patient's goal of treatment was not to decrease her Cobb angle but was to decrease her lumbar radicular symptoms. The purpose of this case study was to describe the outcomes of non-method based physical therapy treatment for radicular symptoms caused by lumbar and thoracic scoliosis.

CHAPTER II

CASE DESCRIPTION

Examination, Evaluation and Diagnosis

This case report features a Caucasian16-year-old female whose medical diagnosis included scoliosis and fibro-lipoma on her filum terminal. Filum terminal lipoma is congenital and assumed to be prevalent in 4-6% of the population. It often goes unnoticed and has gained recent awareness due to cadaver studies. Fibro-lipoma on the filum terminal is generally asymptomatic but can be associated with tethered cord syndrome.[18] Assessing the conus medularis radiographically is essential in determining if the condition should be of concern.[19] The patient in this case study was radiographically assessed and the fibro-lipoma on her filum terminal was not of concern.

The 16-year-old female first noticed symptoms three years prior to examination and evaluation with pain in her low back. The symptoms progressed noticeably the third year. Four months prior to exam and evaluation, the patient lost sensation in both of her legs after participating in a tennis meet and collapsed. It is not known if the patient sought medical attention immediately after the event. The patient had an X-ray done to determine her Cobb angle 9-12 months prior to the date of exam and evaluation. The X-ray showed a Cobb angle of 17 degrees which falls under the mild category. She had not previously sought treatment for her scoliosis symptoms.

The patient lived in a rural area with her mother, father and four younger siblings in a one-story home. There were a few steps to get into her home. She was very active, involved in tennis and softball. She lifted weights with her team members on a regular basis. The patient worked at a gas station where she was on her feet and occasionally required to lift large, heavy objects.

The day prior to examination and evaluation the patient saw a neurologist who referred to physical therapy with orders to evaluate and treat. According to the patient and her mother, the neurologist was concerned that if conservative treatment did not work to manage the patient's symptoms, spine surgery would be necessary. The patient's chief complaint was that she could not participate in tennis practice because of her symptoms. The patient and family's goals were for the patient to fully participate in tennis and softball and to avoid spine surgery.

At the time of exam and evaluation, the patient rated her pain using the numerical pain scale as a 1/10 (0 being no pain at all and 10 being the worst possible pain).[20] Activity such as bending, twisting, lifting, prolonged stairs and walking increased the patient's pain. The patient rated her pain 9/10 at worst. She did not define the magnitude of stairs or walking that exacerbated her radicular symptoms. The patient reported experiencing an occasional sharp pain anterior of her sternum and on her medial left thigh simultaneously.

The 16-year-old female ambulated without an assistive device. There was no known family history of scoliosis or fibro-lipoma. No psychological issues were reported or found in medical records. She drove to physical therapy appointments independently

or was accompanied by her mother and younger sibling. The patient was not taking medications for pain or other health conditions during the time of treatment.

Systems review included integumentary, cardiovascular, neuromuscular, musculoskeletal and cognition/communication. Through observation during examination, it was determined that the patient had no impairments of her integumentary system or cognition. The patient had no new cardiovascular symptoms, did not smoke, use drugs or alcohol and was in a healthy BMI category, therefore there was no concern of cardiovascular disease. Her musculoskeletal and neurological systems were impaired. Musculoskeletal findings were demonstrated through the examination measurements described below. Neurological impairments were demonstrated through lack of proprioceptive awareness of the spine and pelvis.[21] Blood pressure and heart rate were not recorded. The patient did not have red flag symptoms that required immediate referral such as loss of bowel/bladder control. She was screened for spina bifida occulta through palpation and observation of her spinal cord and paraspinal area for café au lait spots and hairy patches.[21]

Examination techniques were based off Magee's *Orthopedic Physical Examination.*[22] Range of motion measurements included side bend range of motion bilaterally, lumbar and thoracic spine extension and lumbar and thoracic spine flexion. Side bend range of motion was taken in standing and measured from tip of the patient's middle finger to the floor. Spine flexion and extension were measured in standing. The change in distance from C7 to L5 was recorded with each movement. Strength was recorded for trunk flexion, trunk rotation, hip flexion and hip abduction. Trunk strength was tested using the sit-up technique digressing in order of hands behind head, arms

across chest, arms in front of body, partial range, muscle twitch and no muscle activity. Hip flexion was tested with the patient's feet supported on the floor, sitting on the mat table. Hip abduction was tested in sidelying on the mat table. Results are listed in table 1 and 2 below.

Table 1. Initial Active Trunk Range of Motion

Right Side Bend	47 cm
Left Side Bend	50 cm
Trunk Flexion	9 cm
Trunk Extension	7 cm

Table 2. Initial Trunk and Hip Strength

Trunk Flexion	4-/5
Trunk R Rotation	4/5
Trunk L Rotation	4/5
R Hip Flexion	4/5
L Hip Flexion	4/5
R Hip Abduction	4/5
L Hip Abduction	4/5

Special tests were used to identify underlying causes of pain. Straight leg raise and Thomas test were measured in supine on the mat table and both were negative

bilaterally. The straight leg raise has a sensitivity of 0.80 -0.97 and specificity of 0.40. It was chosen to determine contributing pathology from dysfunction in the SI joint, lumbar spine, neurological irritation or tight hamstrings.[23] The Thomas test has a sensitivity of 0.32 and specificity of 0.57 for testing hip flexors. It is not accurate unless the pelvis is actively stabilized to the mat table while testing.[24] It was chosen to rule out the possibility of tight hip flexors contributing to the patient's symptoms by pulling anteriorly on her lumbar vertebrae due to their origin on the lumbar spine. Pelvic stabilization was monitored during the patient's performance of the Thomas Test.

Leg length was measured in supine from ASIS to medial malleoli and umbilicus to medial malleoli. Discrepancy bilaterally can determine the presence of functional scoliosis caused by malalignment of the pelvis.[25] Leg length was even bilaterally. Knee valgus was noted during the patient's squat, indicating incorrect neuromuscular facilitation of her gluteal muscles and/or weak gluteal hip abductors.

Vertebral alignment was also assessed in sitting on the mat table with feet supported on the floor. The patient was found to be flexed rotated and side bent to the right (FRSR) from T3-T6 and flexed rotated side bent to the left (FRSL) L1-L4. To assess non-neutral vertebral dysfunction, thumbs are placed on the posterior transverse process of the vertebral column. In sitting, the patient is instructed to anterior tilt and extend her vertebral column, then posterior pelvic tilt and flex her vertebral column. A diagnosis of FRSR indicates that the patient's right transverse process is posterior compared to the left and the same level of vertebrae is limited in extension.[26,27] In FRSL the left transverse process is posterior and limited into extension.[26,27] Paraspinal muscle spasms were noted in the patient's lumbar and thoracic spine. The patient reported an

increase in pain with palpation at vertebral levels T9-11. The patient had two convexities in her vertebral column in her thoracic and lumbar spine. Her gait was normal.

The Lower Extremity Functional Scale (LEFS) was used to measure outcomes because of the 16-year old female's lower extremity radicular symptoms. While there are other functional scales that are more specific to scoliosis, the LEFS has excellent test retest reliability (0.86) and an internal consistency of 0.94 for radiating leg pain secondary to low back pathology.[28] Additionally, the LEFS does not demonstrate floor or ceiling effects when used on this patient population.[28,29] There is moderate correlation between LEFS and the visual analogue scale.[28]

The examination findings demonstrated minimal impairments in several categories. Her side bend range of motion was more limited on the right side compared left. Hip flexor and abductor strength was less than normal. Although the patient had adequate trunk strength for functional activities, she did not appear to fully engage her trunk musculature when needed, as indicated by trunk flexion and rotation of 4/5 and an increase in symptoms with trunk flexion and rotation activities. Additionally, the patient's symptoms were exacerbated from twisting and bending activities. Because her symptoms radiated to her extremities, it was suspected that the combination of vertebral rotation from scoliosis with two convexities and the activities she participated in daily (hitting a tennis ball, lifting garbage bags) were causing impingement. Restoring trunk muscle balance, muscle facilitation and increasing postural awareness became a focus of her physical therapy plan of care. The patient's problem list included pain in her low back that radiated to her extremities, decreased hip abductor strength bilaterally, asymmetrical side bend range of motion and muscle imbalance.

The physical therapy diagnoses for this patient included decreased right side bend range of motion, impaired neuromuscular coordination, decreased hip abductor strength, impaired strength of trunk flexion, impaired strength of trunk rotation and trunk muscle imbalances. The ICD 10 code for scoliosis is M41.9

Prognosis and Plan of Care

The 16 year-old -female's plan of care included manual therapy of soft tissue mobilization to relax protective muscle spasms in the patient's thoracic and lumbar vertebrae and muscle energy techniques to correct vertebral dysfunction in her thoracic and lumbar spine, stretching to lengthen trunk muscles and restore muscle balance, therapeutic exercise to the strengthen trunk musculature including abdominals, hip extensors and abductors, and neuromuscular proprioceptive activities to promote body awareness and restore posture. Patient education was provided on safe lifting techniques, Cobb angle, vertebral anatomy, postural alignment, home exercise program and life-long maintenance of scoliosis radicular symptoms.

Although the plan of care was not a method-based treatment for scoliosis such as FITS or the Schroth method, principles of treatment for both methods as well as treatment for radicular symptoms secondary to lumbar spine pathology were incorporated into the patient's plan of care. These principles include strengthening trunk

musculature and lengthening to promote muscle balances, neuromuscular reeducation through postural alignment and body awareness, vertebral mobilizations, and soft tissue mobilization to release paraspinal muscle spasms. [12-14]

Long term goals were expected to be met within 10 weeks. Goals addressed pain, range of motion, the Lower Extremity Functional Scale (LEFS) and the patient's performance of her home exercise program. By the end of treatment, the patient was to rate her worst pain as 4/10, decreasing from 9/10. She was to have equal side bend range of motion bilaterally and score 80/80 on the LEFS. The patient would be independent with her home exercise program by discharge. Short term goals addressed the same limitations but were to be met at 5 weeks with less improvement noted. The expected greatest level of improvement was participation in tennis, softball, weightlifting and work with minor pain or discomfort after increased activity rather than severe pain and discomfort.

One article describes risk factors for progression of scoliosis. It identifies sex, magnitude of curve prior to treatment and potential for growth as the most important contributions to progression of spine curvature.[4] If one is a female, is in early adolescence and begins treatment with a Cobb angle larger than 25 degrees, the prognosis decreases, and the curve is more likely to progress.[4]

The 16- year old female in this case study was past the point of early adolescence, and to the best of the authors knowledge, had a 17- degree Cobb angle that was measured 9-12 months prior to treatment. Additionally, the patient was very motivated to relieve her symptoms and participate in activities that were limited due to her symptoms. Her support system was strong which indicated good compliance with her home exercise program. These factors led to a good prognosis for the patient.

CHAPTER III

INTERVENTION

Physical therapy appointments were scheduled twice a week for thirty minutes for 10 weeks. The patient was provided with a home exercise program that included exercises given throughout treatment. Every physical therapy appointment took place in the morning before the patient started school. No other health care professionals were involved in the care of this patient during the time of treatment and after physician referral. Equipment included a cushioned massage chair, yellow TheraBand, green TheraBand, an exercise ball, an adjustable mat table and a wooden box. Treatment was provided in a closed environment within a treatment room.

Treatment began on the date of evaluation in a sitting position with feet supported to perform muscle energy techniques to correct vertebral rotation in the direction of flexed rotated, side bend towards the right (FRSR) at levels T3-T6 and flexed rotated side bend left (FRSL) at levels L1-L4. Effleurage and petrissage massage techniques to the patients lumbar and thoracic spine were administered while the patient was sitting in a cushioned massage chair with her front side supported and posterior side facing the student physical therapist for 13 minutes. Mobilizations and soft tissue mobilizations are reported to be acceptable means of treatment according to the clinical practice guidelines for low back pain with or without sciatica.[14] In hooklying, the

patient completed one set of 10 bridges with her feet shoulder width apart, then two sets of 10 repetitions of pelvic tilts. One anterior and one posterior pelvic tilt combined counted as one repetition. The patient had difficulty coordinating movements to originate from her pelvis. The patient transitioned from pelvic tilts in hooklying to pelvic tilts sitting on a therapeutic ball. She had more success with the motion and completed one set of 10 repetitions in this position. Right side bend stretching was held for two sets of thirty seconds. The patient was educated on the meaning of Cobb angle and how it determines the severity of scoliosis. She was also educated on vertebral anatomy, cause of radicular symptoms and purpose of physical therapy treatment for her conditions. This treatment session included principles of neuromuscular coordination and awareness of posture to tilt the patient's pelvis in an anterior and posterior direction, as supported by the FITS and Scroth methods of scoliosis treatment.[13,14] It began strengthening of abdominal and gluteal musculature and stretching of left side bend muscles of the trunk. Bridging coordinates muscle facilitation of abdominals, gluteals and hamstrings. Education and therapeutic exercise are supported in the clinical practice guidelines for low back pain with or without Sciatica.[15]

Vertebral dysfunction was assessed and found not to be rotated during the second treatment. This appointment included 10 minutes of effleurage and petrissage in sitting to the patients thoracic and lumbar spine using the same technique as previously described. In hooklying, a yellow theraband was added around the patient's mid-thigh during bridging to incorporate hip abductors (glute medius and minimus). The patient progressed to two sets of 10 repetitions. She was cued to contract abdominal muscles after reporting discomfort in her low back. Abdominal contraction corrected her low back

discomfort. Treatment concluded with a right side bend stretch with the patient's right arm at her side and left arm overhead. This was held for two sets of 30 seconds. The progression of strengthening and lengthening of trunk musculature is a key component to the Scroth method.[13]

The patient's third visit to physical therapy included education on safe lifting techniques. The patient practiced lifting with her legs, engaging her core and keeping the load close to her body. A wooden box was used to simulate required lifting activities at work. The patient transitioned to hooklying exercises on the mat table, beginning with two sets of 10 reps of bridges with a yellow theraband around her knees. In hooklying on the mat table, the patient completed one set of ten pelvic tilts. She required cues to flatten her back to the mat and contract her core. Education on postural alignment and neutral spine position was reiterated, improving the patient's awareness to existing spinal deformities and how to correct them as encouraged by the FITS concept.[14] In a standing lunge position wither her left foot forward, the patient held a warrior stretch for 30 seconds. The warrior stretch coordinates trunk stretching, lower extremity and abdominal strengthening and proprioceptive abilities to maintain symmetrical trunk alignment in the frontal and sagittal plane, as endorsed by the FITS concept. [13]

On the following appointment, vertebral alignment was found to be FRSR at levels L2-L4 and was corrected using muscle energy techniques in a sitting position on the mat table with feet supported on the floor. After two sets of ten reps of bridging in hooklying using the yellow TheraBand, an additional bridging exercise was added. Butterfly bridging was completed in hooklying on the mat table, starting with feet together. Hips are then raised to neutral and knees are abducted with a yellow

TheraBand around her mid-thigh. The patient did two sets of 10 repetitions of this exercise before transitioning to standing stretches. In standing, the patient completed warrior stretch for two sets of thirty seconds bilaterally. The patient had trouble maintaining alignment in the frontal plane and was cued accordingly. Reinforcing correct frontal plane alignment of the patient's spine during the warrior stretch correlates with principle vi of the FITS concept.[14] Additionally bridging exercises progressed hip abductor and abdominal strength.

The 16-year-old female progressed in strengthening exercises on her fifth appointment. Three sets of 10 repetitions were completed for bridges and butterfly bridges using a green TheraBand instead of yellow. The patient required cues maintain even pelvic alignment during the exercise. In quadruped, the patient completed 12 sets of the cat/cow stretch. This exercise increased pelvic and trunk proprioception and length of anterior and posterior trunk muscles, treating muscle imbalances as supported by the Scroth method.[12] Stabilization activities continued in hooklying with a march while maintaining a posterior pelvic tilt. Cues were required to maintain a posterior pelvic tilt during this exercise.

Vertebral rotation was assessed on the sixth visit, but vertebrae were not found to be rotated. The crescent pose was added to the patient's home exercise program. This stretch was completed in standing with arms abducted to end range above the patient's head, without over activation of upper traps, and a side bend to either side. The patient bent in the frontal plane to end range while contracting her abdominals and maintaining neutral spine alignment. This stretch was held for three sets of 30 seconds bilaterally. The warrior stretch was held for three sets of 30 seconds bilaterally. First

position bridges were added to the patient's exercise program. These are performed in hooklying with heels together and lower extremities externally rotated. Two sets of 15 were completed with a green TheraBand. Treatment concluded in hooklying with three sets of 10 posterior pelvic tilts and march. Occasional cues required to maintain posterior pelvic tilt. The repetition of strengthening and lengthening exercises in order to build trunk muscle endurance is a vital component of the Scorth method.[12]

On the last physical therapy appointment, the patient was reassessed for strength and range of motion. The LEFS was used to track improvement of radicular symptoms. The patient was educated in lifelong maintenance of scoliosis and progression of her home exercise program. Education on postural alignment and vertebral anatomy was reiterated. Education is a key component to the FITS concept and clinical practice guidelines for low back pain with or without sciatica.[13,14] Exercise during treatment included first position bridges with a green TheraBand two sets of 15. Progress towards goals and outcomes are recorded in the outcomes section.

CHAPTER IV

OUTCOMES

Discharge of care was predicted to be 10 weeks post examination. The 16-year-old female's symptoms from scoliosis and fibrolipoma improved rapidly. She was compliant to the home exercise program and had a great support system. For this reason, an earlier discharge was discussed with the patient and her mother. The patient was discharged from care after four weeks of treatment and seven appointments. The patient was educated on how to progress her home exercise program and given a black and blue TheraBand to do so independently. She was provided with the physical therapist's contact information if questions arose. The patient's chart remained open for four weeks post reassessment in case symptoms presented again. To the best of the authors knowledge, the patient did not seek additional treatment during those four weeks.

Overall, the patient responded well to intervention. Because of her age and baseline level of strength, technique was a focal point of treatment. The patient required many cues for technique in the beginning treatment. As treatment progressed, she required less cues and was able to perform exercises with correct form. Cues were needed to contract her abdominal muscles during bridging and the warrior stretch, and to not let her trunk leave the frontal plane during the warrior stretch. Cues were also given to flatten her back the mat table during a posterior pelvic tilt. When the patient did

not use the correct form, discomfort was noted during exercise. When she progressed in technique and applied it to her home exercise program, the patient did not experience discomfort.

Table 3. Discharge Active Trunk Range of Motion

	Initial	Discharge
Right Side Bend	47 cm	49.5 cm
Left Side Bend	50 cm	50 cm
Trunk Flexion	9 cm	NA
Trunk Extension	7 cm	NA

Table 4. Discharge Trunk and Hip Strength

	Initial	Discharge
Trunk Flexion	4/5	5/5
Trunk Rotation	4/5	5/5
R Hip Flexion	4/5	5/5
L Hip Flexion	4/5	5/5
R Hip Abduction	4/5	5/5
L Hip Abduction	4/5	5/5

Through comparison of objective and subjective data collected on the date of initial evaluation and discharge, the outcomes of physical therapy treatment were satisfactory. Strength measurements were reassessed for trunk flexion, trunk rotation, hip flexion and hip abduction. Side bend range of motion was measured. Strength and range of motion measurements were taken using the same technique as described in the examination. The 16-year-old female improved in every measurement of strength. Side bend range of motion improved to a difference of 0.5 cm bilaterally. Initial and discharge measurements are compared in tables 3 and 4. Improvement was noted in the Lower Extremity Functional Scale (LEFS) at discharge. The patient's score increased from 67/80 to 79/80.

Physical therapy goals consisted of reducing pain from 9/10 at worst to 4/10 at worst, increasing right side bend range of motion to be equal to left, improving the LEFS to 80/80 and being independent with home exercise program technique. These goals addressed functional activities of lifting objects and rotating her trunk. The patient's goal was to return to full participation of tennis and softball and avoid surgery on her spine. Some of the patient's goals were met after treatment while others were nearly met. The patient was independent with technique of her home exercise program following discharge. Right side bend range of motion was 0.5 cm shorter than left and the patient rated her worst pain as 1/10. The LEFS score shied from a perfect 80/80 by one point. Regardless, the patient was able to participate in work, tennis practice and tennis meets without any restrictions. She no longer felt a need for spine surgery.

The 16-year-old female reported satisfactory outcomes from physical therapy treatment. On the date of discharge, the patient reported she was able to participate in

numerous tennis matches the weekend prior without noticing an increase in symptoms. She was able to participate in tennis practice and weight-lifting with her teammates. Even after an eight-hour shift of being on her feet and lifting heavy objects at the gas station, she did not notice symptoms. Overall, the patient was pleased with the care she received and excited to fully participate in tennis.

CHAPTER V

DISCUSSION

As previously described, interventions used to treat the 16-year-old female with scoliosis and fibrolipoma were modeled after the Schroth method and FITS concept of treatment. Because the patient had mild scoliosis determined by her Cobb angle of less than 25 degrees, but her symptoms were severe, treatment was primarily intended to reduce her radicular symptoms. It is suspected that impingement from her activities of daily living (bending, twisting) contributed to her symptoms. Methods of treatment for lumbar radicular symptoms are comparable to the concepts of Schroth and FITS. The focus of treatment is postural alignment, core strengthening, core stretching, manual therapy, neuromuscular reeduction and patient education on posture. Both Schroth and FITS use manual therapy techniques such as soft tissue mobilization along with strengthening, stretching and neuromuscular coordination.[13-15] The clinical practice guidelines for lumbar pain with or without sciatica (radiculopathy) state that education, core stabilization exercise programs and manual therapy are acceptable methods of treatment.[15]

The patient in the case study was incredibly motivated to improve, which contribute to her success. She had support from her family, coaches, physician, and physical therapy staff to complete her home exercise program. The patient stated that her coach would make time during practice for the patient to complete her exercises. The patient's baseline level of function and strength did not suggest severe disability, but rather a sum of minor limitations that contributed to a larger problem. Addressing these minor

problems such as 4/5 trunk and hip abductor strength and increasing her postural awareness decreased her symptoms and participation limitations. Aside from fibro-lipoma on her filum terminal, the patient did not have comorbidities, which improved her prognosis

The results of this study imply that extensive scoliosis specific education may not be necessary when treating the 16-year-old female featured in this case study. It is not known if symptoms decreased due to an improvement of posture and muscle balance alone, or if interventions affected the patient's Cobb angle which secondarily improved symptoms. Furthermore, the results of this study must be received with caution due to the small patient population and lack of comparable outcomes amongst participants. It is recommended that future studies include a larger participant pool and assess Cobb angle prior to treatment and at discharge.

Reflective Practice

Reflecting on this case and the care I provided has been a great learning experience. Although this patient had great outcomes with the treatment provided, there are still things I would do differently if given the opportunity. At the time I accepted this patient for care, I did not have extensive education on scoliosis. This led to missing components of examination that would have improved my evaluation and allowed a thorough comparison of before treatment and after treatment. One special test I would have done is the Adam's forward bend test. The patient bends forward at the waist and if scoliosis is present in the thoracic spine, a rib hump will be noticed on the convex side

of the vertebral curve. One can also measure the degree of inclination of the rib hump with a scoliometer or inclinometer. Although the purpose of treating this patient was to address possible disc herniation and impingement on the spinal cord caused by scoliosis rather than decreasing Cobb angle, It would have been interesting to know if this patient's rib hump decreased with treatment. If the thoracic angle decreased after treatment, it could have been assumed the patient's Cobb angle also decreased with treatment. Research that discusses non-method-based physical therapy treatment of Cobb angles below 20 degrees with the intention of decreasing Cobb angle are not currently available to the best of my knowledge.

During the initial evaluation, there are questions that if answered, would have given me a better understanding of the patient's daily life and would have made documentation more specific. When the patient reported pain. I assumed she meant in her low back, but I didn't explicitly ask her every time, so I could not include this in documentation. Additionally, the patient stated there were a few steps to get into her home, but I did not ask how many. I would have also asked the patient to return with the imaging of her spine, if possible, and asked specifically what dates she saw other medical professionals for management of her scoliosis, their recommendations and asked for more specific details about how her symptoms developed. I asked many of these questions to the patient, but I didn't dig deep into them, for fear the patient would think I am not paying attention. Therefore, the answers given were vague and left room for interpretation. I realize part of this problem was my inexperience and lack of confidence asking patients questions at the time of treatment. Now I have a solidified the importance of digging deep into the patient's history and asking for specific details.

Reflecting on this aspect of care will increase the quality of future subjective information I will collect.

The outcomes assessment used to record progress could have been more specific to the patient's conditions of scoliosis. The clinic I was at distributed outcome assessments based upon the location of the patient's symptoms. Because the patient had lower extremity symptoms, she was given the Lower Extremity Functional Scale. This would have been a great opportunity for me to research an assessment that was more sensitive and specific to the patient's conditions and educate my clinical instructor on the assessment. I have since learned of assessments that would be reliable for scoliosis management and will use them in the future.

The plan of care was focused primarily on postural education, restoring muscle imbalances and increasing trunk strength. Education pertaining to these topics was included. Neuromuscular reeducation was incorporated by increasing the patient's proprioception. These treatment methods have evidence to back up their effectiveness for treating back pain, but not necessarily reducing Cobb angle. Treatment for reducing Cobb angle is method based and requires additional education, which I was not able to obtain. That being said, after the patient progressed in her exercise program, I would have introduced functional activities that related to her goal of participating in tennis. The patient was able to return to tennis regardless, but it would have made her plan of care more specific to her activities of daily life.

One piece of this case report that would benefit from further evidence is the use of vertebral muscle energy techniques to correct vertebral rotation in scoliosis. My clinical instructor had additional education on this treatment method and recommended

it for our patient. There is evidence to support its use for lumbar pathology in non-scoliotic vertebral columns, but more evidence is needed to support this treatment method for scoliosis.

Despite the components of patient care I would improve if given the opportunity, I am satisfied with the results the 16-year-old female had post physical therapy intervention. The interventions led to her pain free participation in tennis meets and work and eliminated the possibility of spine surgery. These were the patient's goals and she reported satisfaction with her outcomes. There is always room for improvement, however, and reflecting on this episode of care will improve the quality of objective and subjective information I collect the next time I treat a patient with mild scoliosis with severe radicular symptoms. This opportunity to treat and reflect will improve how I incorporate collected information into a plan of care that is specific and functional to the patient's daily life.

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