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Complex regional pain syndrome CRPS in a female soccer player: a cast study

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COMPLEX REGIONAL PAIN SYNDROME (CRPS) IN A FEMALE SOCCER PLAYER: A CASE STUDY

A Thesis Project

Presented to

The Faculty of the Department of Human Performance

San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

Bridget C. Mansell

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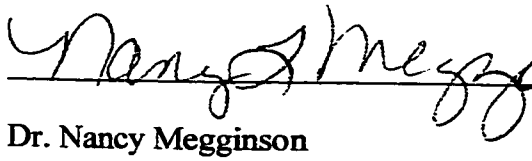

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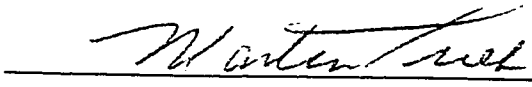

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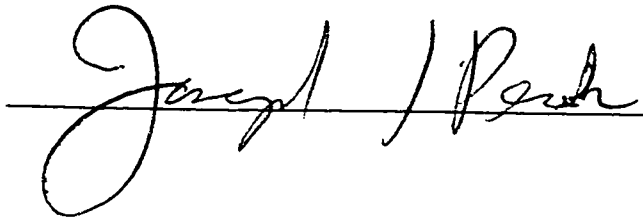

Complex Regional Pain Syndrome (CRPS) in a Female Soccer Player: A Case Study

by

Bridget C. Mansell

Abstract

The objective of this study was to increase certified athletic trainers' knowledge of Complex Regional Pain Syndrome, including examination, mechanism, diagnosis, and treatment through a single case study. Complex Regional Pain Syndrome (CRPS), also known as Reflex Sympathetic Dystrophy (RSD), is a chronic pain syndrome involving the sympathetic nervous system. Because injuries in athletics are fairly common, and the incidence of CRPS in athletic populations is known to be low, the possibility of acquiring CRPS may be overlooked. This study provides a clinical background on CRPS through a literature review; delineation of the patient's history of injury and diagnosis; and review of diagnostic tests, coupled with results, surgical treatments, rehabilitative treatments, medications, and prognosis for this patient. The athletic trainer can help in the early recognition and improved prognosis of CRPS in athletes who present with improportionate pain following an initial athletic injury. The findings of this study were compiled into an article for the Journal of Athletic Training and submitted according to the authors notes.

ACKNOWLEDGEMENTS

In most ceremonies where the conclusion of a huge project or piece is being celebrated I have learned that the author, writer, or artist has very little time and space to thank all the people who so rightfully deserve thanks. I am going to do my best to thank all those who have helped me with this – the largest and most challenging project I have ever taken on.

First and foremost I want to thank my thesis committee: Dr. Leamor Kahanov, Dr. Martin Trieb, and Dr. Nancy Megginson. Even amidst times of frustration, Dr. Kahanov was always a constant source of encouragement; Thank you Dr. Kahanov. I also owe thanks to Dr. Martin Trieb, who always kindly obliged my countless number of questions, and Dr. Nancy Megginson for her helpful and detailed direction throughout each revision of my thesis.

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Finally, I want to thank several of my close friends and my family. Megumi: your organization and energy pushed me to be a better athletic trainer and student. AJ: for your love, compassion, and friendship; for teaching me to seek out and treasure the little joys in life. Kiera: for your sisterly humor, unlike any other. Justin: for housing me from time to time in a skyrocket high rent area, letting me use your lab for research, proof-reading my talks, your rational thought, and for being a truly *wonderful* brother. Melanie: for all the little gifts you have sent me, your attention to details - which I now practice, and for the love and understanding I have always had from you, my older and wiser sister. Dad: for summers in NM, helping me find a way to achieve my goals, and for always reminding me to keep reaching higher.

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Submission Letter

This manuscript 1) contains original unpublished material that has been solely submitted to the *Journal of Athletic Training,* 2) is not under simultaneous review by any other publication, and 3) will not be submitted elsewhere until a decision has been made concerning its suitability for publication by the *Journal of Athletic Training.* In consideration of the NATA's taking action in reviewing and editing my submission, I the undersigned author hereby transfer, assign, or otherwise convey all copyright ownership to the NATA, in the event that such work is published by the NATA. Further, I verify that I have contributed substantially to this manuscript as outlined in item #3 of the current Author's Guide.

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Complex Regional Pain Syndrome (CRPS) in a Female Soccer Player: A Case Report

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Objective: To present the case of a high school athlete with Complex Regional Pain Syndrome.

Background: Complex Regional Pain Syndrome (CRPS), also known as Reflex Sympathetic Dystrophy (RSD), is a chronic pain syndrome involving the sympathetic nervous system. CRPS is characterized as a persistent burning pain in an extremity that follows an initial insult of trauma or injury. CRPS is seen most often in the non-athletic population, and the incidence of CRPS in athletic populations is known to be low, the possibility of acquiring CRPS may be overlooked.

Differential Diagnosis For Lower Extremity: "Shin Splints", stress fracture, compartment syndrome

Treatment: Most successful through a multidisciplinary approach including education, medication, physical, occupational, and behavioral therapies.

Uniqueness: Complex Regional Pain Syndrome is most often found in the non-athletic adult population, with Caucasians, females, and cigarette smokers having the highest incidence. However, this 17 year-old soccer player diagnosed with CRPS does not fit the standard profile of those most often found to have this disorder. This athlete sustained a kick to the medial soleus, a fairly common injury for her sport, but upon recovery from initial injury developed sympathetic pain. X-rays, MRI, and bone scan failed to diagnose the cause of this athlete's pain, and the official clinical diagnosis of CRPS was made based upon key signs and symptoms, and after successful sympathetic blockade confirmed pain relief and improve function.

Conclusions: The athletic trainer can help in the early recognition and improved prognosis of CRPS in athletes who present with improportionate pain following an initial athletic injury.

Key words: Complex Regional Pain Syndrome, lower extremity injury, sympathetically maintained pain, Reflex Sympathetic Dystrophy

Complex Regional Pain Syndrome (CRPS), also known as Reflex Sympathetic Dystrophy (RSD), is a secondary disorder stemming from a primary injury such as muscular strains and ligament sprains. CRPS is a chronic pain syndrome that affects the sympathetic nervous system, and can occur from injuries commonly found in sport. The incidence of CRPS is estimated to be 1 in 5,000 individuals in the general population, and although mostly seen in adults, can occur in children.[1] To date, the incidence of RSD in the athletic population has not been recorded.

CRPS has been documented since 1864, but is still not well understood.[1] As the intensity and frequency of sport activity increases, chances for injury arise, including a possible increased occurrence of CRPS. Heightened knowledge regarding this disorder could prove beneficial to athletes, parents of athletes, physicians, coaches, and allied health care providers in diagnosing CRPS. Research in the area of CRPS and athletics is limited.[2,3,4,5,6] Currently, there are a lack of studies examining CRPS and the role of the certified athletic trainer. The role of the athletic trainer could prove to be vital in early recognition and improved prognosis in the treatment of CRPS among athletes.

Case Report

Seven weeks into the 1999 soccer season, a 17 year-old, Caucasian female, high school soccer player sustained a kick to her right medial soleus during a soccer game. The athlete reported great pain, was ambulatory but had an obvious limp, and presented with a large amount of swelling in her calf, ecchymosis at the base of medial gastrocnemius and posterior tibialis. The athlete was restricted from activity, weight-bearing, and began rest, ice, compression, and elevation protocol, as well as, general

ankle range of motion exercise to tolerance from the injury incidence to one week post occurrence.

One week post-injury calf circumference measurements revealed a 4cm decrease in calf swelling compared to initial injury measurements. The athlete complained of increased pain, rating her pain "7 out of 10", with 10 being the highest on a 1-10 scale. Her pain rating 1 week post injury had increased from an initial rating of "4 out of 10". The athlete described the pain as a "strong ache" that became worse with motion in all planes and drew a picture rendition of her pain pattern (Figure 1). The athlete was found to have normal sensation, strong and regular dorsalis pedis pulse, and good capillary refill. Despite normal skin appearance, the athlete's skin was cool to the touch moving distally from approximately mid-gastrocnemius to the toes. Ankle range of motion was limited due to pain, particularly with plantar flexion and inversion. The athlete was instructed by the athletic trainer to continue Non-Weight Bearing (NWB) ambulation. Electrical stimulation, ice, elevation, compression, lower extremity stretching and ankle Range of Motion (ROM) exercise continued for 1 1/2 weeks with decreased swelling and improved ROM, but a reported marked increase in pain.

The athlete was referred to an orthopedic physician after 10 days and was diagnosed with a calf contusion and saphenous vein rupture. Progressive rehabilitation was prescribed, including ankle ROM, contrast bath, ice, biking, and advancement to partial weight bearing ambulation.

The athlete continued lower leg rehabilitation for 2 weeks post orthopedic evaluation, and progressed to full weight bearing. Rehabilitative exercises included

manual ankle exercises, band exercises, stretching, cycling, stair-climbing, balance exercises with progression to trampoline work, and cardiovascular training. The athlete reported decreased pain and demonstrated improvement in strength and range of motion. The athlete was reevaluated by her physician 4 weeks after initial visit and permitted to begin jogging on a soft surface, progressing to non-contact soccer drills. Some "soreness" in her posterior tibialis was reported, and in the soft tissue of her lateral mallelous, but she had full ROM and good strength. The athlete was cleared to return to soccer one month after initial injury, but required to wear a protective pad over area of injury, and to continue the strengthening and stretching program.

The athlete returned to soccer, practiced as normal, and played in two regular season games. During the second game, the athlete withdrew herself from play, complaining of right side lateral ankle pain and had a noticeable limp. The athlete denied being kicked or falling on the affected ankle, but reported that her pain had increased over the course of the game, particularly after kicking the ball repeatedly.

Pain was reported to be "8 out of 10" with activity. No lower extremity swelling, or ecchymosis was present, but she was highly point tender upon palpation of the lateral aspect of her right ankle and medial soleus. The athlete was restricted from soccer practice by her athletic trainer, continuing rehabilitative exercise, stretching, ice, electric stimulation, pool exercise, and cycling for cardiovascular fitness. After five days of rest and rehabilitation, with no improvement in her ambulation nor change in her level of pain, the athlete was placed on crutches again. One week after restriction from competitive play, the athlete was referred back to the orthopedic physician.

The orthopedist suspected a stress fracture and prescribed Lodine twice daily, instructed the athlete to remain NWB, and continue exercise and modalities. X-rays and bone scan performed were found negative, but MRI findings, per the radiologist, showed ankle joint effusion, representing "a shin-splint".

Two months after initial injury, the athlete complained of constant "aching" pain, was unable to ambulate without pain and a limp, demonstrated a 4 cm of atrophy her right gastrocnemius, had very cold and hypersensitive skin in the area of her tibia and ankle, and all ranges of motion of the ankle joint were painful in active and passive motion. The athlete was diagnosed at this time with Complex Regional Pain Syndrome by her orthopedist and referred to a pain specialist for treatment.

One week after referral the athlete underwent a right sided lumbar sympathetic block and was prescribed Vicoprofen as needed, ibuprofen as needed, and neurontin to be taken three times daily. The athlete was ordered to engage in physical rehabilitation 3 times weekly, focusing on desensitization of affected limb, increasing ROM, strength, progressing to Full Weight Bearing (FWB) normal gait mechanics.

Four weeks after initial evaluation from her pain specialist, the athlete returned for a follow-up appointment, reporting an overall decrease in pain, but still displayed allodynia and vasomotor changes with constant pain. Two days later the athlete underwent a second lumbar sympathetic blockade, which produced lasting pain relief, and increase in limb temperature. At this time, the pain specialist increased her dosage of neurontin taken three times daily.

For four weeks after the second sympathetic block, the athlete continued physical rehabilitation, although the second sympathetic block didn't appear to have as great an affect on relieving pain as the first. Progress was seen in the athlete's range of motion, strength, and desensitization. The athlete was now cycling and had begun some land based walking exercises, despite pain complaints rating at 7-9 out of 10. The pain specialist's prescription called for maintaining rehabilitation despite an increase in pain, with major focus on desensitization.

One week after her fourth follow-up appointment, the athlete underwent a regional sympathetic "Bier" block with guanethidine. "Bier" or regional sympathetic block treatment anesthetizes the limb to provide pain relief. Approximately two hours after the Bier block procedure, the athlete completed physical rehabilitation with her athletic trainer, as requested by the pain specialist. The athlete continued physical therapy for the next two months with major focus of rehabilitation shifting from water therapy to land based training, strengthening, decreasing sensitivity, increasing ROM, and functional activities.

Six months after the initial injury, the athlete returned to competitive soccer, continuing to strengthen her ankle and lower leg, while protecting her medial soleus with a pad during soccer. The athlete returned to activity with full ROM, no allodynia, no edema, resolution of calf atrophy, good and equal strength, and report of minimal calf "soreness" after intense running.

Discussion

Complex Regional Pain Syndrome (CRPS)

CRPS is also referred to as Reflex Sympathetic Dystophy (RSD), Sudeck's Atrophy, and Sympathetically maintained pain. CRPS is challenging not only by its many names but in its mechanism, history, and diagnosis. Several authors identify that sympathetically maintained pain is not fully understood, or easily recognized.[7,8]

Complex Regional Pain Syndrome was first documented in Civil War soldiers who had suffered gunshot wounds with chronic pain long after the wound healed.[9] CRPS is characterized as a persistent burning pain in an extremity following an initial trauma insult or injury. CRPS has multiple definitions, and has been described as a syndrome of pain in an extremity, by hyperactivity of sympathetic nerve fibers, not involving any specific major nerve.[1] CRPS has also been described as regional pain and sensory changes that occur after a noxious event.[7]

The incidence of CRPS mostly occurs in adult, caucasian, cigarette smokers.[1] CRPS is not often found in children and little documentation exists regarding athletes.[2,3,4,10] Nicotine has been linked to CRPS in some cases, since an alteration of plasma concentrations in the body affects the effectiveness of pain medications and anti-depressants.[11] No specific sport has been identified in a higher CRPS incidence. The incidence of smoking, race, or gender is important history information for the health care provider or athletic trainer.

Pathophysiology of CRPS

All bodily sensations are routed and processed through gray matter in the

spinal cord, known as the substantia gelatinosa. The substantia gelatinosa acts as the "gate" between the brain and the body, or between central nervous system and the peripheral nervous system. Two key nerve fiber types transmit pleasure and pain sensations. Large sized sheathed pleasure sensory nerve fibers are known as A-beta & A-gamma nerve fibers, or mechanoreceptors and thermoreceptors. Small unsheathed pain sensory nerve fibers are called C-fibers & A-delta fibers or nociceptors. Steady, normal sensory signal transmission serves to diminish painful signals, thereby suppressing sympathetic overactivity.[7] Over-sensitization of the peripheral mechanoreceptors and nociceptors has been hypothesized to cause sympathetically maintained pain.[7] Increases in afferent or "pain" signals cause the sympathetic nervous system to become active thereby potentially bombards neural pathways to the brain with pain signals.

Theory regarding nerve impulse passage through the gate (substantia gelatinosa) is called the Gate Control Theory (Figure 2). The Gate Control Theory suggests that the cells in the substantia gelatinosa of the spinal cord monitor input from all nerve fiber types. Specifically, in CRPS cases, the substantia gelatinosa monitors input from A and C nerve fibers. Activity in small C fibers opens the gate to the brain allowing for pain impulses to be transmitted. Prolonged stimulation of large A fiber activity is theorized to eventually lead to adaptation, decreasing the effectiveness of gate control and resulting in pain signals passing frequently through an "open gate" without being checked, leading to chronic pain.[9]

Diagnosis

CRPS maybe confusing to medical researchers because syndrome resolution results from varied mechanisms. Mechanisms of CRPS inception include, but are not limited to,: a fall on an extremity, a sprain, a fracture, or site of surgery. In general CRPS has been linked to an initial insult or noxious event.[1,7,8]

General signs and symptoms of Complex Regional Pain Syndrome include burning pain, allodynia, muscle atrophy in affected extremity, edema, and vasomotor changes. Allodynia is the perception of pain caused by nonpainful stimuli, such as touch, or vibration.[4] Vasomotor changes from CRPS are described as extremity skin temperature ranging from warm to cool due to the vasoconstriction of the blood vessels, and/or mottling of the skin.[9] Since many of the vasomotor signs are inconsistent, clinical diagnosis can be difficult.[12]

CRPS usually occurs in three stages. Each stage elicits specific signs and symptoms.[9] Burning or aching pain, swelling, hyperesthesia and warm skin mark stage one, which begins days to months after first injury. Stage two occurs around 3 to 6 months after injury with continued pain, cool or blue colored skin, slowed hair and nail growth (trophic changes), and spotty bone changes on x-raying (Sudeck's atrophy). Stage three is marked by skin and muscular atrophy, continuous pain decreased range of motion, and decreased limb function. Stage three can also mark behavioral changes and psychological conditions such as depression, anxiety, secondary to the pain.

Previous psychological research on CRPS concluded that stressful life events and/or psychological disturbances may play a part in the pathogenesis of CRPS, but

currently there is no clearly linking evidence.[13] Physical pain can also be a symptom of psychological stress and depression.[10] Patients who have CRPS can occasionally appear withdrawn, depressed, angry, and unwilling to cooperate with therapy.[7]

Clinical diagnosis of CRPS is made by signs and symptoms, diagnostic tests such as x-rays, Magnetic Image Resonance (MRI), bone scans, and noted relief through surgical sympathetic nerve blocks. CRPS is often diagnosed after improvement in signs and symptoms following sympathetic nerve block treatment.[1,14] Triple-phase bone scanning has emerged as a helpful tool for diagnosing RSD, yet most research conclude that the most reliable method of RSD diagnosis is pain improvement due to sympathetic blockade.[1,7,12,14]

Treatments

Treatment of Reflex Sympathetic Dystrophy is most successfully achieved utilizing a multidisciplinary approach. Treatment regimens involve education, medication, physical, occupational, and behavioral therapy.[11] Early diagnosis and treatment of RSD directly affects the success of treatment.[7, 14] A greater chance for irreversible changes in soft and bony tissue occurs in patients with CRPS, how pain becomes chronic. The greater the changes in soft and bony tissue the more dysfunction results, reducing the chance for successful treatment.[7] Three treatment areas exist for sympathetically maintained pain: 1) lumbar sympathetic blockade, 2) pharmacological treatment, and 3) physical therapy.[7]

Sympathetic blockades aid in the reduction of CRPS pain intensity by anesthetizing the affected extremity or area. Epidural sympathetic blockades vary according to the area affected and are introduced through a catheter inserted into the spinal column at the level of nerve root involvement. An anesthetic is then injected into the epidural space (Figure 3). Other blockades involve the use of anesthetics paired with corticosteroids to relieve associated swelling and or edema caused by sympathetic pain. Patients treated by a regional intravenous block of methylprednisolone (a corticosteroid) and lidocaine (an anesthetic agent), gained more functional rather than analgesic benefit in the treatment of CRPS.[15] In particular, post-block treatment patients can gain full range of motion and are better able to perform tasks involving a resistive component.[15]

Electro-acupuncture has recently been used as a method to treat CRPS. This treatment involves stimulation of traditional acupuncture trigger points with a low-

frequency transcutaneous electrical stimulation. Although this treatment method is fairly new and more clinical trials are needed, it has been found to elicit satisfactory levels of pain relief in RSD patients, including restoration of normal sensory and pain levels.[16]

Pharmacological treatment of RSD includes a wide range of drug therapy including the use of psychiatric, pain, and neuropathic medications. Corticosteroids and NSAIDS are recommended within the first 2 weeks of injury to decrease the chances of sympathetically maintained pain by stabilizing nerve endings and nociceptors, reducing noxious pain stimuli.[7,15] Neuropathic pain can also be treated with antidepressant or antiepileptic medications like Zoloft, Paxil, or Neurontin. These medications aid in decreasing the burning sensation of pain, seen in patients with CRPS, by inhibiting selective serotonin reuptake.[11] Many patients with CRPS experience depression and anxiety thus anti-depressants may be a key pharmacological treatment.[11]

The use of narcotics and benzodiazepines in the treatment of RSD are not recommended without careful consideration regarding drug dependence, depression, or increased pain in patients.[7] Physicians and athletic trainers must be aware of associated addiction problems with opoid medication treatment.

Physical therapy is an important aspect in CRPS treatment regimens. Patients suffering from CRPS often fall into a pain cycle where the affected area hurts to move, thus motion or touch of that limb is refrained. Inactivity only serves to increase the pain impulses fired from nociceptors. Rehabilitative efforts should focus on "reconditioning" exercises, such as walking and stretching. In addition, therapeutic modalities should be used to reduce pain, edema, and restore function.[11]

Although patients with RSD can be uncooperative at times, sports medicine personnel should act progressively, remembering to empathetically encourage them to progress at a safe and steady pace.[7,11,13,17,18]

Conclusions

Complex Regional Pain Syndrome is a real possibility in athletics. The certified athletic trainer should be aware of the potential for this secondary injury. Education and training sports medicine professionals regarding this disorder could prove to increase the chances for early diagnosis and improved prognosis.

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Figure 1 - Athlete's own rendering of lower leg pain intensity and distribution three months after CRPS diagnosis

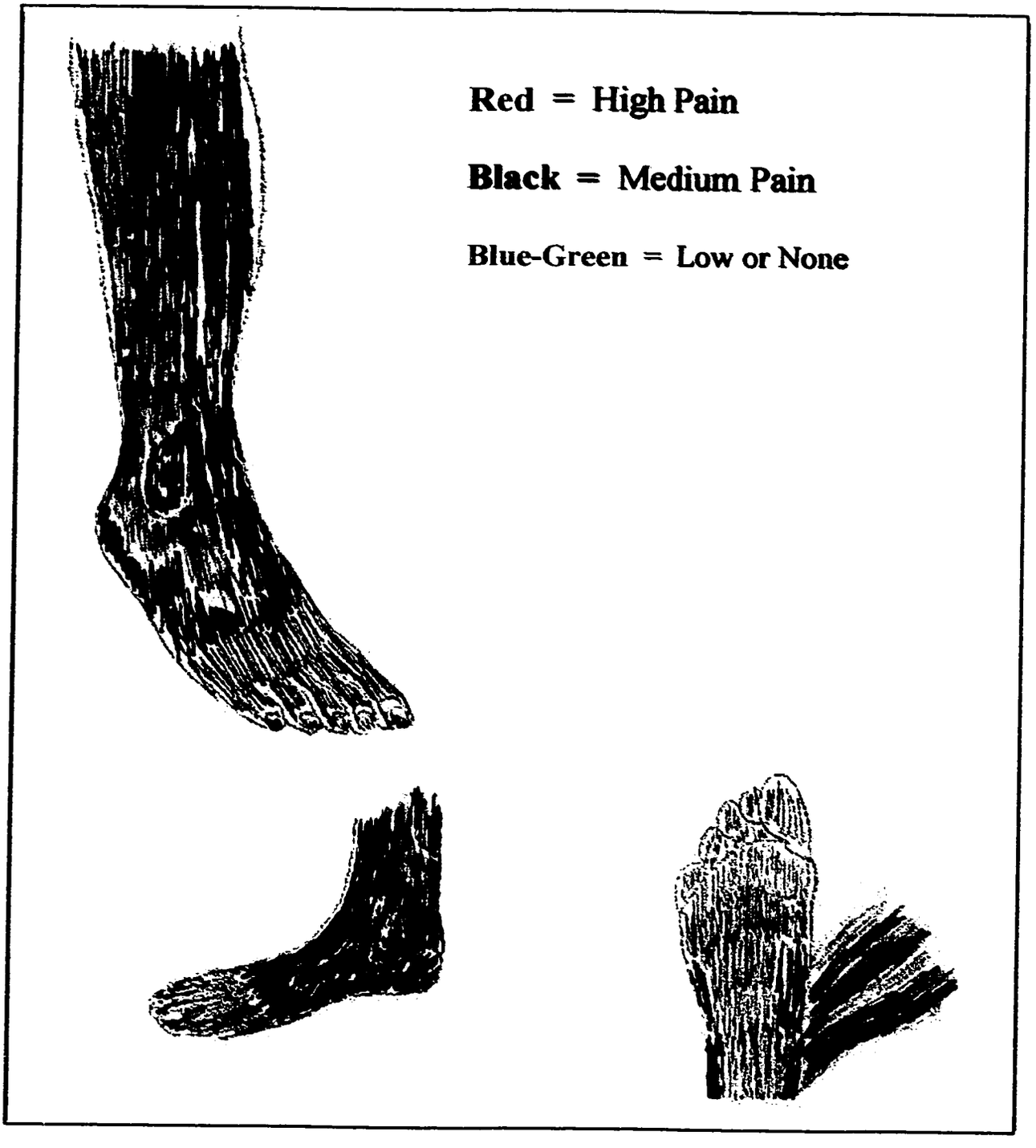


Figure 2 – Gate Control Theory describing how pain and pleasure signals travel from the peripheral nerve fibers to the brain.

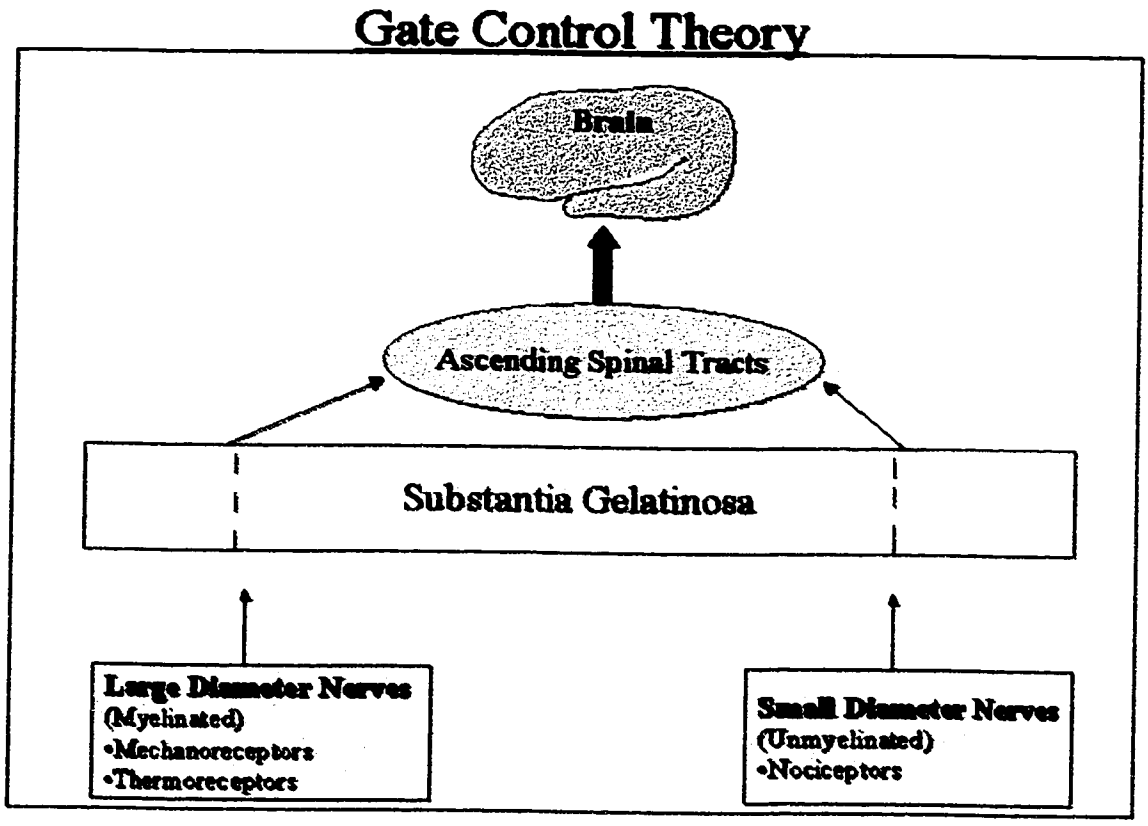
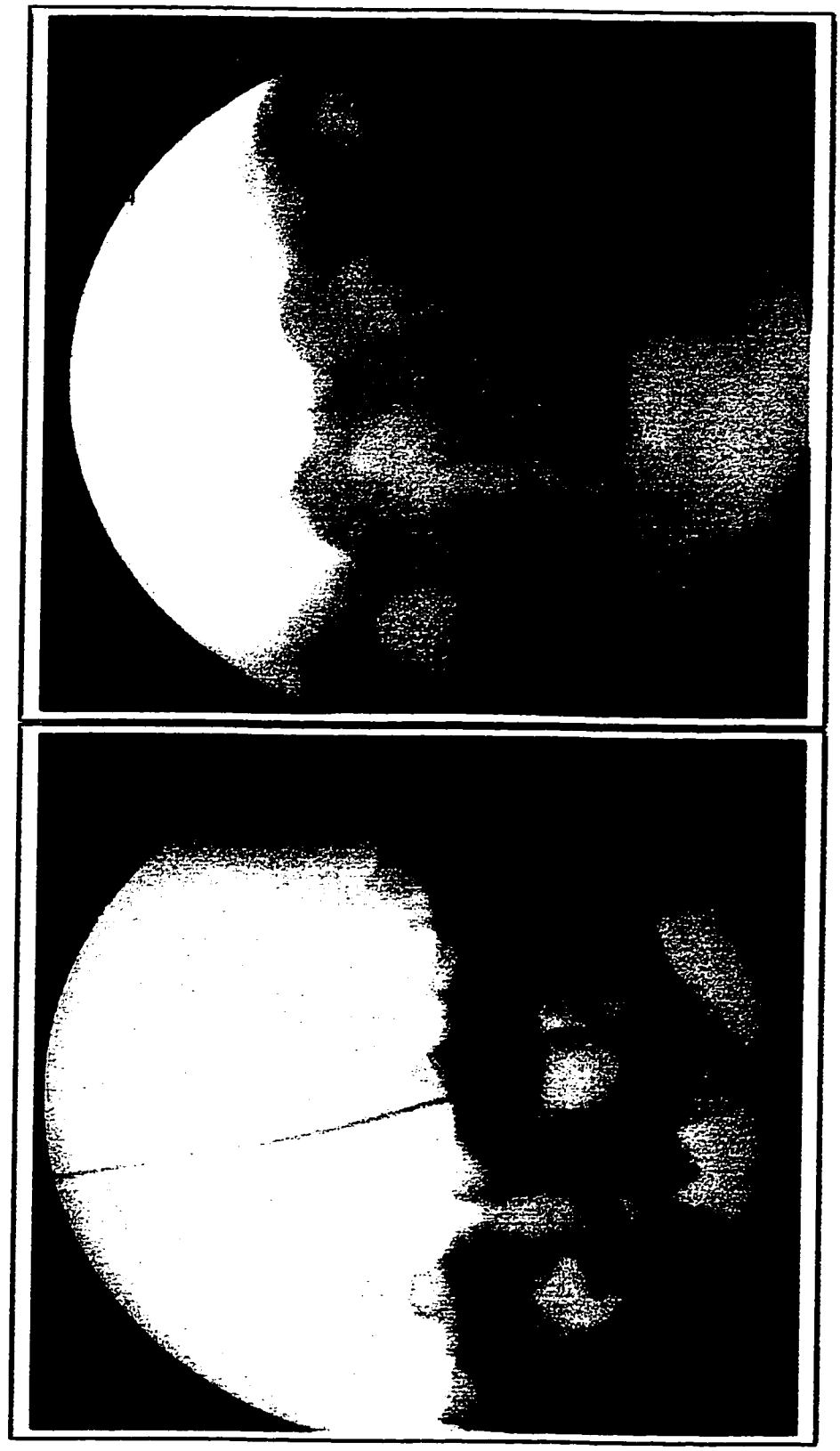


Figure 3 - Lumbar Sympathetic Block



Expanded Support Material

Chapter I

Introduction

In America the emphasis on fitness has proliferated, with more opportunities for female sport, and an increase in intensity of physical activity and sport play (Berger, 1999; Crown & Heatherington, 1989). The potential to increase the amount of sport-related injuries accompanies the higher frequency and opportunities in fitness.

Muscular strains and ligament sprains are ordinary injuries found in sports, Complex Regional Pain Syndrome (CRPS), also known as Reflex Sympathetic Dystrophy (RSD) is a secondary disorder. CRPS affects the sympathetic nervous system, and can occur from an injury like a sprained ankle or fall onto an outstretched arm. CRPS is a chronic pain syndrome that arises after a noxious event affecting the sympathetic nervous system. According to Fishman and Cowin (1997), the incidence of CRPS amongst the general population is estimated to be 1 in 5,000 individuals, and although is mostly seen in adults, can also occur in children. To date, the incidence of CRPS in the athletic population has not been recorded.

Previous examinations of CRPS have been conducted by compiling generalized statistical analysis, radiological case studies, and specific treatment protocols/algorithms (Cully, Folzenlogen, Kentner, & Griffiths, 1998; Denegar, 1997; Fishman et al., 1997; Korpan, Schneider, Leitha, & Fialka-Moser, 1999; Lindenfeld, Bach, & Wojtys, 1996; Marcus, 2000; Schurmann, Gradl, Furst, Schildberg, 1999; Stanton-Hicks, Baron, Boas, Gordh, Harden, Hendler, Koltzenburg, Raj, & Wilder, 1998; Tanelian, 1996; Zyluk, 1998). Most of the research on RSD examines this disorder from a physician perspective

(orthopedic, anesthesiologist, or neurologist), and the majority of the focus is placed on late stages versus prevention and early recognition. Early recognition and prevention is where the role of the certified athletic trainer could prove to be extremely important.

In December 1999, a female soccer player at Cupertino High School, Cupertino, California began to develop improportionate pain associated with a relatively common soccer injury. After multiple evaluative attempts to correctly diagnose the problem, the athlete's orthopedic physician and athletic trainer found tests to be more confusing than definitive. Each diagnostic test was negative, and yet she was still complaining of a great amount of pain. Upon final diagnosis the athlete was determined to have a fairly rare condition for her age and fitness level: Complex Regional Pain Syndrome.

CRPS has been documented since 1864, but is still not fully understood (Fishman & Cowin, 1997). As the intensity and frequency of sport activity increases the chances for injury also rise, including the possibility of an increased occurrence of CRPS. Heightened knowledge regarding this disorder could prove beneficial to athletes, parents of athletes, physicians, coaches, and allied health care providers in diagnosing CRPS. Research in the area of CRPS and athletics is limited. There is a lack of studies examining CRPS and the role of the certified athletic trainer. This case study yields many positive outcomes in hopes of early recognition, diagnosis, and improved prognosis in treatment of RSD, with particular emphasis on the role of the athletic trainer.

Purpose of Study

The purpose of this research is to increase certified athletic trainers' knowledge of RSD, including examination, mechanism, diagnosis, and treatment through a single case

study. This case study will be compiled into a journal article for The Journal of Athletic Training (see Appendix A).

Case Study Need

Many certified athletic trainers (ATC) are not readily educated on diagnosis, treatment, and rehabilitation of CRPS because information on this disorder and athletes is not well documented or taught in Athletic Training curriculum programs (National Athletic Trainer's Association [NATA], 1999) (see Appendix B). Research on this disorder is plentiful (Cully, Folzenlogen, Kentner, & Griffiths, 1998; Denegar, 1997; Fishman et al., 1997; Korpan, Schneider, Leitha, & Fialka-Moser, 1999; Lindenfeld, Bach, & Wojtys, 1996; Marcus, 2000; Schurmann, Gradl, Furst, Schildberg, 1999; Stanton-Hicks, Baron, Boas, Gordh, Harden, Hendler, Koltzenburg, Raj, & Wilder, 1998; Tanelian, 1996; Zyluk, 1998), but few focus specifically to lower extremity injury, athletes, or the role of the ATC in the early recognition and treatment/rehabilitation protocol of CRPS (NATA, 1999). In addition, there is no standard education on CRPS for athletic trainers, and there is a scarcity of articles on CRPS written for or by athletic trainers.

Delimitations

Collection of data on the individual case study subject is retrospective in nature reflecting treatment during: December 1999 through August 2000. Data has been descriptively assessed by presenting the CRPS phenomenon in detail, with no attempt made to test or build theoretical models (Thomas & Nelson, 1996).

Limitations

Results cannot be generalized beyond the case study subject. Physician's notes and tests may not be accurate or complete, which may affect the data gathered.

Definition of Terms

Complex Regional Pain Syndrome (CRPS) : A chronic pain syndrome that is characterized by a continuous intense pain which is made worse by movement (Tanelian, 1996). A syndrome of pain in an extremity that is thought to be linked to sympathetic nervous system over activity, without major nerve implication, also referred to as Reflex Sympathetic Dystrophy (RSD) (Fishman et al, 1997).

Sympathetic Nervous System: Sympathetic Nervous System (SNS) is known as the Fight or Flight physiologic response. Together with the Parasympathetic Nervous System (PNS), this branch of the nervous system makes up the motor portion of the Autonomic Nervous System (ANS). The SNS controls heart rate, contraction and relaxation of skeletal muscle, and constriction and dilation of the vascular system (Tortora & Grabowski, 1996).

Sympathetic Block (Epidural): A block of the sympathetic nervous system with an anesthetic medication that is performed under fluoroscopy to verify an exact diagnosis and/or decrease pain and inflammation in an extremity (Magee, 1997).

Fluroscopy: A method that is used to show movement in joints via x-ray imaging and/or as a tool to help guide injections (Magee, 1997).

MRI (Magnetic Resonance Imaging): A noninvasive, pain-free, imaging method to obtain an image of soft tissue and bone that uses contact to magnetic fields without exposure to ionizing radiation (Magee, 1997).

Bone Scan: Titanium 99 (a radioactive isotope) is injected intravenously to localize specific soft or bony tissue, which cluster that chemical. A scintigraph is then taken which reveals an area of that tissue which indicates an area of healing or of high blood flow. This imaging is used to detect bone disease, fractures, tumors, or infection (Magee, 1997).

A-beta & A-gamma nerve fibers: Large diameter myelinated nerve fibers which transmit nonpain impulses such as sensation/touch, temperature, and proprioceptive information. These nerves are also known as "mechanoreceptors" and "thermoreceptors", due to their large size they transmit information at a faster rate than that of smaller pain fibers (C-fibers and A-delta fibers) (Starkey, 1993).

C-fibers & A-delta fibers: Small diameter unmyelinated nerve fibers which transmit pain impulses. These nerves are also known as "nociceptors" and send information at a slower rate than that of the larger myelin sheathed nerve fibers (A-beta and A-gamma fibers) (Starkey, 1993).

Certified Athletic Trainer (ATC): A health care professional specializing in the prevention, treatment, and rehabilitation of athletic injuries, while acting also as a counselor and liaison between athletes and coaches (Arnheim & Prentice, 1993).

Noxious Event: A harmful accidental injury (Fishman & Cowin, 1997).

Chapter II

Literature Review

Complex Regional Pain Syndrome (CRPS) is a disorder that can affect active athletic populations. CRPS is also referred to as Reflex Sympathetic Dystrophy (RSD), Sudeck's Atrophy, and Sympathetically maintained pain. CRPS is challenging in not only its many names but in its mechanism, history, and diagnosis. Several authors (Lindenfeld et al., 1996; Schurmann et al., 1999) identify that sympathetically maintained pain is not fully understood, nor is it easily recognized. This chapter is presented in 5 sections: 1) CRPS defined, 2) Pathophysiology of CRPS, 3) Diagnosis of CRPS, 4) Treatment, and 5) Summary.

Complex Regional Pain Syndrome

Complex Regional Pain Syndrome was first documented in Civil War soldiers who had suffered a gunshot wound and had chronic pain even after the wound had healed (Barrett, 1995). CRPS is characterized as a persistent burning pain in an extremity that follows an initial insult of trauma or injury. Fishman and Cowin (1997) define CRPS as "a syndrome of pain in an extremity thought to be related to sympathetic overactivity that doesn't involve a major nerve". Lindenfeld et al., (1996) define CRPS as "when regional pain and sensory changes occur after a noxious event". The incidence of CRPS is seen mostly in adults, caucasians, and cigarette smokers. CRPS is not often found in children (Fishman et al., 1997) and little documentation exists regarding athletes (Denegar & Siple, 1996; Gieck & Buxton, 1986; Ladd, DeHaven, Thanik, Patt, & Feuerstein, 1989; Peppard & Denegar, 1994). In some cases, (Marcus, 2000) nicotine alters plasma

concentrations in the body and affects the effectiveness of pain medications and anti-depressants. CRPS has not been found to have a higher incidence in any one specific sport.

Pathophysiology of CRPS

All bodily sensations are routed and processed through the gray matter in the spinal cord, known as the substantia gelatinosa. The substantia gelatinosa acts as the "gate" between the brain and the body, or between central nervous system and the peripheral nervous system. Many fiber nerve types exist, but two key types transmit pleasure and pain sensations. Large sized sheathed pleasure sensory nerve fibers are known as A-beta & A-gamma nerve fibers, or mechanoreceptors and thermoreceptors. Small unsheathed pain sensory nerve fibers are called C-fibers & A-delta fibers or nociceptors. Lindenfeld (1996) hypothesized that sympathetically maintained pain is due to the sensitization of the peripheral mechanoreceptors and nociceptors. Meaning that the mechanical sensing nerve fibers *and* pain nerve fibers are being activated departing from normal nerve conduction and sensation patterns. This increase in afferent or "pain" signals causes the sympathetic nervous system to become active and thereby has the potential to bombard the neural pathway to the brain with pain signals. Steady, normal sensory signal transmission serves to push out painful signals, thereby suppressing sympathetic overactivity (Lindenfeld, 1996).

The theory regarding how nerve impulses actually gain passage through the gate (substantia gelatinosa) is called the Gate Control Theory (see Figure 1). The Gate Control Theory suggests that the cells in the substantia gelatinosa of the spinal cord

monitor input from all nerve fiber types. Specifically, in CRPS cases, the substantia gelatinosa monitors input from A and C nerve fibers. Activity in small C fibers opens the gate to the brain

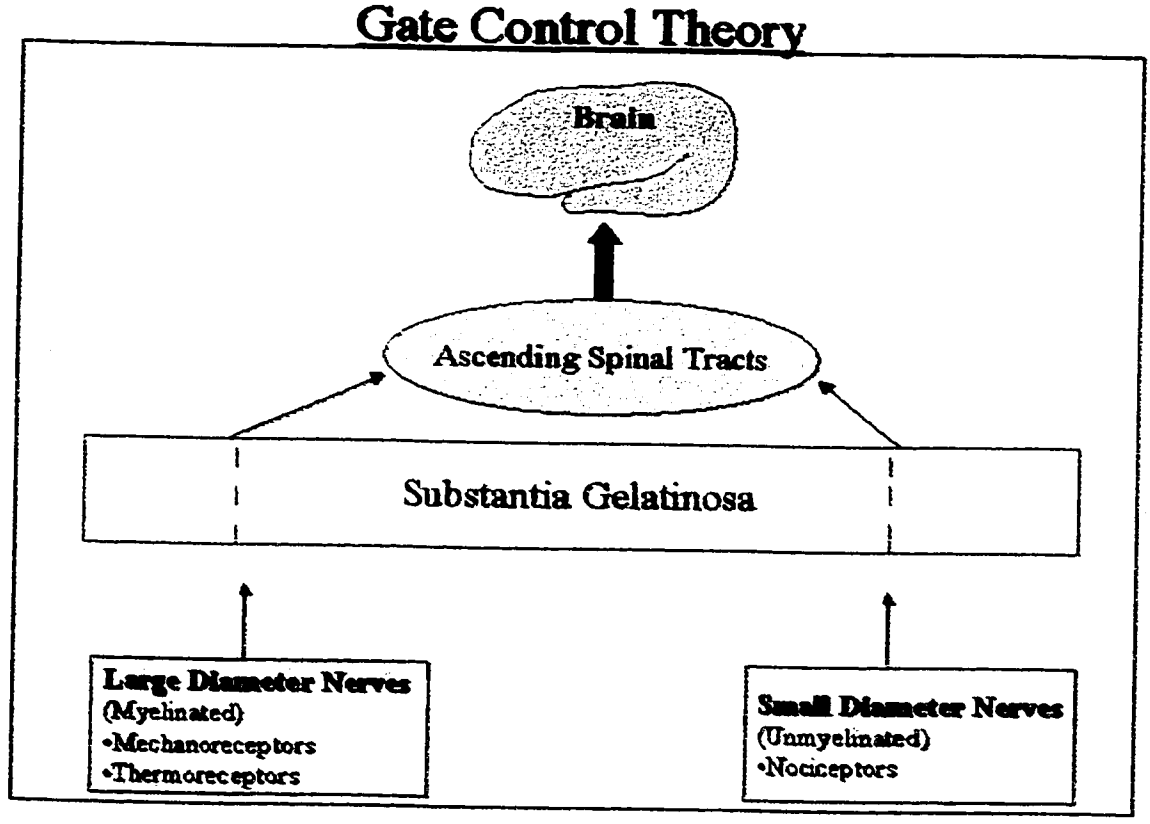


Figure 1. Gate Control Theory describing how pain and pleasure signals travel from the peripheral nerve fibers to the brain. (G.Miller, personal communication, 1997).

allowing for pain impulses to be transmitted. Prolonged stimulation of large A fiber activity is theorized to eventually lead to adaptation, thereby decreasing the effectiveness of gate control and resulting in pain signals passing frequently through an "open gate" without being checked, leading to chronic pain (Barrett, 1995).

Diagnosis of CRPS

One of the reasons that CRPS is so confusing to medical researchers is that it results from varied mechanisms. Mechanisms of CRPS inception include, but are not necessarily limited to, : a fall on an extremity, a sprain, a fracture, or site of surgery. In general CRPS has been linked to an initial insult of some type or noxious event (Lindenfeld et al., 1996; Schurmann et al., 1999; Fishman & Cowin, 1997).

General signs and symptoms of Complex Regional Pain Syndrome include burning pain, allodynia, atrophy of muscles in extremity affected, edema, and vasomotor changes. Allodynia is defined by Marcus (2000) as the perception of pain caused by usually nonpainful stimuli, such as touch, or vibration. Vasomotor changes in CRPS are described as changes in extremity skin temperature ranging from warm to cool due to the vasoconstriction of the blood vessels, and/or mottling of the skin (Barrett, 1995). Since many of the vasomotor signs are inconsistent, clinical diagnosis can be difficult (Cully et al., 1998).

Barrett (1995) has described CRPS in three stages. Burning or aching pain, swelling, hyperesthesia and warm skin mark stage one. This stage begins days to months after first injury. Stage two occurs around 3 to 6 months after injury with continued pain, cool or blue colored skin, slowed hair and nail growth, and spotty bone changes on x-raying. Stage three is marked by skin and muscular atrophy, continuous pain decreased range of motion, and decreased function of the limb. Stage three can also mark behavioral changes and psychological conditions such as depression, anxiety, secondary to the pain.

Research by Geertzen, Bruikn-Kofman, Bruijn, van de Wiel, and Dijkstra (1998) concluded that stressful life events could play a part in the pathogenesis of CRPS, but currently there is no evidence clearly linking stressful life events and/or psychological disturbances with the onset of chronic sympathetically maintained pain. Denegar (1997) examined causes of persistent pain and determined that physical pain can also be a symptom of psychological stress and depression. Patients who have CRPS can occasionally appear withdrawn, depressed, angry, and unwilling to cooperate with therapy (Lindenfeld et al., 1996).

Clinical diagnosis of CRPS is made by signs and symptoms, diagnostic tests such as x-rays, Magnetic Image Resonance (MRI), bone scans, and noted relief through surgical sympathetic nerve blocks. The diagnosis of CRPS is made often if there is an improvement of signs and symptoms following sympathetic nerve block treatment, as clinicians report the procedure targets the sympathetic chain most affected in CRPS (Fishman & Cowin, 1997; Tanelian, 1996). According to Cully et al. (1998), "triple-phase bone scanning has emerged as a sensitive yet nonspecific tool for diagnosing RSD". Several authors (Fishman & Cowin, 1997; Lindenfeld et al., 1996; Tanelian, 1996) have stated that the most reliable method of CRPS diagnosis is made when sympathetic blockade improves signs and symptoms of pain.

Treatment

Treatment of Complex Regional Pain Syndrome is most successfully achieved utilizing a multidisciplinary approach. Treatment regimens involve education, medication, physical, occupational, and behavioral therapy (Marcus, 2000). Early

diagnosis and treatment of CRPS directly affects the success of treatment (Tanelian, 1996; Lindenfeld et al., 1996). In patients with CRPS, according to Lindenfeld et al, as the pain continues it can become chronic, creating a greater chance for irreversible changes in soft and bony tissue. The greater the changes in soft and bony tissue the more dysfunction can result, ultimately reducing the chances for successful treatment. Lindenfeld et al. suggests three treatment areas for sympathetically maintained pain: 1) lumbar sympathetic blockade, 2) pharmacological treatment, and 3) physical therapy.

Sympathetic blockades aid in the reduction of sympathetic pain intensity by anesthetizing the affected extremity or area. Epidural sympathetic blockades vary according to the area affected. Epidural sympathetic blockades are introduced by use of a catheter inserted into the spinal column at the level of nerve root involvement and then an anesthetic is injected into the vertebral space. Other blockades involve the use of anesthetics paired with corticosteroids to relieve some of the associated swelling and or edema caused by sympathetic pain. Research by Zyluk (1998) indicated that patients treated by a regional intravenous block of methylprednisolone (a corticosteroid) and lidocaine (an anesthetic agent), give more functional than analgesic benefit in the treatment of RSD". In particular, this study revealed that post-block treatment patients had full range of motion and were able to perform some tasks involving a resistive component.

Patients with CRPS with less than six months from initial diagnosis can participate in an alternative treatment to sympathetic blockades called electro-acupuncture. In a study of patients with Complex Regional Pain Syndrome (CRPS)

electro-acupuncture was performed by a professional Chinese acupuncture therapist. The therapist stimulated traditional acupuncture trigger points with a low-frequency transcutaneous electrical stimulation. Korpan, Dezu, Schneider, Leitha, and Fialka-Moser (1999) reported a satisfactory level of pain relief in CRPS patients, utilizing acupuncture and sham acupuncture. Specifically, patients had restored normal sensory and pain levels after treatment. This procedure is fairly new and more clinical trials are necessary to validate this treatment.

Pharmacological treatment of CRPS includes a wide range of drug types and classifications, and includes the use of psychiatric, pain, and neuropathic medications. Lindenfeld (1996) and Zyluk (1998) recommend the use of corticosteroids within the first 2 weeks of injury and NSAIDS. Although the exact mechanism for steroid treatment is still debated, the theory suggests that steroids help reverse early sympathetically maintained pain by decreasing capillary permeability, decreasing the discharge of neuroactive peptides which aggravate nerve fibers, and help to stabilize nerve endings and nociceptors, thereby reducing pain and noxious stimuli (Zyluk, 1998).

The use of narcotics and benzodiazepines in the treatment of RSD are not recommended without careful consideration regarding drug dependence, depression, or increased pain in patients (Lindenfeld et al., 1996). According to Marcus (2000), neuropathic pain is best treated with the use of antidepressants or antiepileptics. These medications help decrease the burning sensation of the pain experienced by individuals with CRPS by inhibiting selective serotonin reuptake, allowing for greater sustained pain relief. Examples of indicated anti-depressant medications include Zoloft, and Paxil, and

anti-epileptic drugs like Neurontin. Anti-depressants also have the added benefit of improving sleep, and limiting depression and anxiety that pain can produce. This added benefit can be key in the treatment of CRPS since many patients experience depression and trouble sleeping as a result of their disorder. In addition, pain medications are also often utilized to manage CRPS and range from short-acting to long-acting opioids and NSAIDS. Addiction problems are a concern in opioid medication treatment, and the clinician and athletic trainer must be aware of associated patient risk and potential problems that can arise from the use of opioids.

Physical therapy is a very important part of CRPS treatment regimens. Patients who suffer from CRPS sometimes fall into a pain cycle where the affected area hurts to move, and motion or touch of that limb is refrained. Inactivity only serves to increase the pain impulses fired from the nociceptors. Marcus (2000) recommends that sports medicine personnel focus on "reconditioning" types of exercise such as walking in conjunction with stretching exercises. In addition, therapeutic modalities should be used to help reduce pain, edema, and restore function. One such modality which is often used in the treatment of RSD is the contrast bath which aids in pain management while increasing range of motion in the affected limb and decreasing pain. Contrast baths usually involve alternate soaking of the affected limb between two separate buckets of water, one fairly warm at approximately 100° Fahrenheit for about 3 minutes, then one cold at approximately 55° Fahrenheit for about 3 minutes. Stanton-Hicks et al. (1998) suggest the use of water-therapy as the patient progresses to weight-bearing activities and stress loading.

Sports medicine personnel should be careful and act progressively with patients who have CRPS. Exercise should not cause severe pain. A good guideline to follow in rehab is the patient's ability to complete the exercises day by day with no increase in pain. If the patient is too sore or in too great of pain the day following, the therapist should back down the intensity of exercise (Denegar, 1997). This is important because the patient with CRPS needs to be able to slowly but consistently develop new ways of managing their pain, thus if they are pushed through rehab too quickly the risk depression, and the risk of further physical injury increases.

CRPS patients can be difficult to work with and uncooperative (Lindenfeld et al., 1996; Feldman & Downey, 1999; Geisser, Roth, Theisen, Robinson, and Riley, 2000; Geertzen et al., 1998). The therapist should attempt to work diligently with each CRPS patient through each range of motion and strengthening exercise. Patients with CRPS need to physically restore function and health as well as psychologically maintaining health. Marcus (2000) states: "Psychologic treatment addresses symptoms of depression, anxiety, and teaches stress management. Patients are also instructed in cognitive and behavioral techniques to improve their view of and reactions to their pain complaints". The mental aspect of this disorder can greatly affect the outcome of the patient's physical well being. Research has found that CRPS patients suffer from depression, negative mood, yet have had positive outcomes with the use of coping strategies and mechanisms (Feldman & Downey, 1999). Sports medicine personnel should empathize with CRPS patients while encouraging them to progress at a safe but somewhat steady pace.

Complex Regional Pain Syndrome and Athletics

The rise of participants in sports increases the potential for sport injury. The majority of the literature on Complex Regional Pain Syndrome focuses on the recognition, diagnosis, and treatment of the disorder amongst the general population, with literature addressing CRPS and athletics found to be few (Denegar & Siple, 1996; Gieck & Buxton, 1986; Ladd, et al., 1989; Peppard & Denegar, 1994).

Summary

Complex Regional Pain Syndrome is a chronic pain condition seen in both athletic and non-athletic populations, marked by pain, edema, atrophy, and vasomotor changes following initial injury. Research has been conducted on CRPS since the 1800s and the phathophysiology of the disorder and its successful treatment is still not fully understood. Diagnosis of CRPS is usually based upon signs and symptoms, loss of function, diagnostic results of X-ray films, MRI's, sympathetic blocks, and bone scans. Treatment of CRPS is multidisciplinary with regimens including education, medication, physical, occupational, and behavioral therapies.

CRPS is a challenging disorder in both non-athletic and athletic populations. Specific research on CRPS and athletics is limited, and by examining this disorder in an athletic population, and exploring and delineating the role of the athletic trainer in CRPS there is hope for its early recognition and improved prognosis. The purpose of this research is to increase certified athletic trainers' knowledge of CRPS, examining mechanism, diagnosis, role in prevention, and treatment through a single case study.

This case study has been compiled into a journal article for The Journal of Athletic Training.

Chapter III

Methods

The purpose of this study is to increase athletic trainers' knowledge and role regarding Complex Regional Pain Syndrome (CRPS), through a case study specifically addressing recognition, prevention, treatment, and rehabilitation through the examination of a single case study.

Case study design follows a descriptive typology, where the researcher presents a detailed picture of a problem, but does not attempt to test or build theoretical models. The intended audience for this case study is athletic trainers, sports medicine personnel, or allied health professionals. This study provides a clinical background on CRPS (literature review), delineate the patient's history of injury and diagnosis, review of diagnostic tests, coupled with results, surgical treatments, rehabilitative treatments, medications, and prognosis for this patient.

Research into this specific case study of a female soccer player with RSD can help serve as an educational model for future injury assessment and possible differential diagnoses of athletic injury to the lower extremity. This research can help develop a base for athletic trainers to learn, provide certified athletic trainers with basic orientation to this disorder, and clinical application of athletic training principles. This chapter is presented in four sections: subjects, procedures, analysis of case, and project completion.

Subject

The subject of this research project is a 17 year-old high school female competitive soccer player, who weighs 150 pounds, and is 5 foot 8 inches in height. The

subject plays soccer year-round, in high school during the winter months and with a locally ranked club team the remainder of the year. During the fall and spring, this subject also competes in volleyball and runs track for her high school.

Procedures

Literature review on CRPS was performed utilizing several medical databases, including Galen II, and Medline. Diagnostic and rehabilitative information regarding the research subject specifically was obtained, with full permission from the subject and her parents (see Appendix C), from her orthopedic physician, anesthesiologist/pain specialist, physical therapist, and athletic trainer. Human subjects approval was obtained. X-ray films, an MRI, and a bone scan performed on her affected limb while under the care of her orthopedic physician will be obtained. Under the care of her anesthesiologist/pain specialist record regarding two sympathetic epidural blocks, two Bier blocks, and pharmacological treatment will be obtained. The subject was instructed and assisted by her physical therapist and athletic trainer in physical rehabilitation. Lastly, counseling and discussed coping strategies with her athletic trainer during her rehabilitation has been included.

Analysis of case

Data analysis is retrospective in nature with information from December 1999 to August 2000. The analysis of the case has four sections: timeline of events, analysis by physician, comparison with the literature, and a final analysis.

Project Completion

This case study was compiled into an article for the Journal of Athletic Training and submitted according to authors notes (see Appendix A).

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APPENDIX A. Parental/Subject Permission Letter

San José State
UNIVERSITY

College of Applied Sciences and Arts

Department of Human Performance

One Washington Square
San José, CA 95192-0054
Voice: 408-924-3010
Fax: 408-924-3053

Agreement to Participate in Research

Responsible Investigator: Bridget Mansell
Title of Protocol: Reflex Sympathetic Dystrophy (RSD) in a High School Female Soccer Player: A Case Study.

1. Your child Jennifer Leier has been asked to participate in a research study investigating Reflex Sympathetic Dystrophy (RSD). The purpose of this research is to increase cerified athletic trainers' knowledge about this disorder through the examination of a single case study.

2. Your child or ward will be asked to allow, with your consent, the release of medical information related to any injuries that occurred during her participation in soccer. This information may include (but is not limited to) injuries, rehabilitation, surgeries, prescribed medications, diagnostic tests (x-rays, bone scans, etc.) and her current ability to participate in soccer. In addition to that information, the study will utilize a library database for literature review on RSD and its clinical background. The study will take place during the years of 2000 and 2001.

3. No risks or discomforts to the participant are anticipated as a result of participation in this study.

4. Although there are no direct benefits for the participant, the goal of this research study is to develop and enhance knowledge about Reflex Sympathetic Dystrophy, which may be of benefit to the participant, her parents, and to health professionals in general.

5. Although the results of this study may be published, no information that could identify your child or ward, your family, or you will be included. All materials used in the study will be protected for confidentiality, and all borrowed file materials will be returned.

6. There is no compensation for participation in this study.

7. Questions about this research may be addressed to the researcher, Bridget Mansell, at (408)366-7384. Complaints about the research may be presented to Leamore Kahanov Ed.D., ATC, Chair, Depatrment of graduate Athletic Training, (408) 924-3010. Questions about research subjects' rights, or research-related injury may be presented to Nabil Ibrahim, Ph.D., Associate Vice President, Graduate Studies and Research, at (408)924-2480.

8. No service of any kind, to which a you, your child or ward, and your family are otherwise entitled, will be lost or jeopardized if you choose to "not participate" in the study.

9. Your consent for your child or ward to participate is being given voluntarily. You may refuse to allow his or her participation in the entire study or in any part of the study. If you allow his or her participation, you are free to withdraw your child or ward from the study at any time, without any negative effect on your relations with San Jose State University or with any other participating institutions or agencies. You child or ward has these rights as well.

Parent/Guardian Initial

San José State
UNIVERSITY

College of Applied Sciences and Arts

Department of Human Performance

One Washington Square
San José, CA 95192-0054
Voice: 408-924-3010
Fax: 408-924-3053

10. At the time that you sign this consent form, you will receive a copy of it for your records, signed and dated by the investigator.

- The signature of a parent or legal guardian on this document indicates:
  a) approval for the child or ward to participate in the study,
  b) that the child is freely willing to participate, and
  c) that the child is permitted to decline to participate, in all or part of the study, at any point.

- The signature of a researcher on this document indicates agreement to include the above named subject in the research and attestation that the subject's parent or guardian has been fully informed of the subject's rights.

Jennifer Leier
Name of Child or Ward

Janice Leier 5-22-01
Parent or Guardian Signature Date

Mother
Relationship to Child or Ward

10420 E. Estates DR.
Full Mailing Address
Cupertino, CA 95014

Bridget Mansell, ATC 5/24/01
Investigator's Signature Date

APPENDIX B. IRB APPROVAL LETTER

San José State
UNIVERSITY

Office of the Academic Vice President
Associate Vice President Graduate Studies and Research
One Washington Square
San José, CA 95192-0025
Voice: 408-924-2480
Fax: 408-924-2477
E-mail: gstudies@wahoo.sjsu.edu
http://www.sjsu.edu

To: Bridget Mansell
670 North 18th Street
San Jose, CA 95112

From: Nabil Ibrahim, N
AVP, Graduate Studies & Research

Date: April 26, 2001

The Human Subjects-Institutional Review Board has approved your request for exemption from human subject's review under category "D" in the study entitled:

"Reflex Sympathetic Dystrophy (RSD) in a High School Female Soccer Player: A Case Study."

This approval is contingent upon the subjects participating in your research project or the subject's data collected for the research project being appropriately protected from risk. This includes the protection of the anonymity of the subjects' identity when they participate in your research project, unless they are serving as a primary source, and with regard to any and all data that may be collected from the subjects. The Board's approval includes continued monitoring of your research to assure that the subjects are being adequately and properly protected from such risks. If at any time a subject becomes injured or complains of injury, you must notify Nabil Ibrahim, Ph.D., immediately. Injury includes but is not limited to bodily harm, psychological trauma and release of potentially damaging personal information.

Please also be advised that all subjects need to be fully informed and aware that their participation in your research project is voluntary, and that he or she may withdraw from the project at any time. Further, a subject's participation, refusal to participate, or withdrawal will not affect any services the subject is receiving or will receive at the institution in which the research is being conducted. This approval is granted for a one-year period and data collection beyond April 25, 2002 requires an extension request.

If you have any questions, please contact me at (408) 924-2480.

APPENDIX C. The Journal of Athletic Training Authors Notes

Authors' Guide

(Revised January 2001)

The mission of the *Journal of Athletic Training* is to enhance communication among professionals interested in the quality of health care for the physically active through education and research in prevention, evaluation, management, and rehabilitation of injuries.

SUBMISSION POLICIES

1. Submit 5 copies of the entire manuscript (including tables and figures) to *Journal of Athletic Training* Submissions, Hughston Sports Medicine Foundation, Inc, 6262 Veterans Parkway, PO Box 9517, Columbus, GA 31908–9517. The term "figure" refers to items that are not editable, either halftones (photographs) or line art (charts, graphs, tracings, schematic drawings), or combinations of the two. A table is an editable item that needs to be typeset.
2. All manuscripts must be accompanied by a letter signed by each author and must contain the following statements: "This manuscript 1) contains original unpublished material that has been submitted solely to the *Journal of Athletic Training*, 2) is not under simultaneous review by any other publication, and 3) will not be submitted elsewhere until a decision has been made concerning its suitability for publication by the *Journal of Athletic Training*. In consideration of the NATA's taking action in reviewing and editing my submission, I the undersigned author hereby transfer, assign, or otherwise convey all copyright ownership to the NATA, in the event that such work is published by the NATA. Further, I verify that I have contributed substantially to this manuscript as outlined in item #3 of the current Authors' Guide." By signing the letter, the authors agree to comply with all statements. Manuscripts that are not accompanied by such a letter will not be reviewed. Accepted manuscripts become the property of the NATA. Authors agree to accept any minor corrections of the manuscript made by the editors.
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4. Financial support or provision of supplies used in the study must be acknowledged. Grant or contract numbers should be included whenever possible. The complete name of the funding institution or agency should be given, along with the city and state in which it is located. If individual authors were the recipients of funds, their names should be listed parenthetically.
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6. For experimental investigations of human or animal subjects, state in the Methods section of the manuscript that an appropriate institutional review board approved the project. For those investigators who do not have formal ethics review committees (institutional or regional), the principles outlined in the Declaration of Helsinki should be followed (41st World Medical Assembly, Declaration of Helsinki: recommendations guiding physicians in biomedical research involving human subjects. *Bull Pan Am Health Organ*. 1990;24:606–609). For investigations of human subjects, state in the Methods section the manner in which informed consent was obtained from the subjects. (Reprinted with permission of *JAMA* 1997;278:68, copyright 1997, American Medical Association.)
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8. The *Journal of Athletic Training* uses a double-blind review process. Authors should not be identified in any way except on the title page.
9. Manuscripts are edited to improve the effectiveness of communication between author and readers and to aid the author in presenting a work that is compatible with the style policies found in the *AMA Manual of Style*, 9th ed. (Williams & Wilkins), 1998. Page proofs are sent to the author for proofreading when the article is typeset for publication. It is important that they be returned within 48 hours. Important changes are permitted, but authors will be charged for excessive alterations.
10. Published manuscripts and accompanying work cannot be returned. Unused manuscripts will be returned if submitted with a stamped, self-addressed envelope.

STYLE POLICIES

11. Each page must be printed on 1 side of 8½-by-11-inch paper, double spaced, with 1-inch margins in a font no smaller than 10 points. Each page should include line counts to facilitate the review process. Do not right justify pages.
12. Manuscripts should contain the following, organized in the order listed below, with each section beginning on a separate page:
    a. Title page
    b. Acknowledgments
    c. Abstract and Key Words (first numbered page)
    d. Text (body of manuscript)
    e. References
    f. Tables (each on a separate page)
    g. Legends to figures
    h. Figures
13. Begin numbering the pages of your manuscript with the abstract page as #1; then, consecutively number all successive pages.
14. Units of measurement shall be recorded as SI units, as specified in the *AMA Manual of Style*, except for angular displacement, which should be measured in degrees rather than radians. Examples include mass in kilograms (kg), height in centimeters (cm), velocity in meters per second ($m \cdot s^{-1}$ or m/s), angular velocity in degrees per second ($^\circ \cdot s^{-1}$), force in Newtons (N), and complex rates (mL/kg per minute).
15. Titles should be brief within descriptive limits (a 16-word maximum is recommended). If a disability is the relevant factor in an article, the name of the disability should be included in the title. If a technique is the principal reason for the report, it should be in the title. Often both should appear.
16. The title page should also include the name, title, and affiliation of each author, and the name, address, phone number, fax number, and e-mail address of the author to whom correspondence is to be directed. No more than 3 credentials should be listed for each author.
17. A structured abstract of no more than 250 words must accompany all manuscripts. Type the complete title (but not the authors' names) at the top, skip 2 lines, and begin the abstract. Items that are needed differ by type of article. **Literature Reviews**: Objective, Data Sources, Data Synthesis, Conclusions/Recommendations, and Key Words; **Original Research** articles: Objective, Design and Setting, Subjects, Measurements, Results, Conclusions, and Key Words; **Case Reports**: Objective, Background, Differential Diagnosis, Treatment, Uniqueness, Conclusions, and Key Words; **Clinical Techniques**: Objective, Background, Description, Clinical Advantages, and Key Words. For the Key Words entry, use 3 to 5 words that do not appear in the title.
18. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the article is clearly stated and developed. Tell why the study needed to be done or the article written and end with a statement of the problem (or controversy). Highlights of the most prominent works of others as related to your subject are often appropriate for the introduction, but a detailed review of the literature should be reserved for the discussion section. In a 1- to 2-paragraph review of the literature, identify and develop the magnitude and significance of the controversy, pointing out differences among others' results, conclusions, and/or opinions. The introduction is not the place for great detail; state the facts in *brief*, specific statements and reference them. The detail belongs in the discussion. Also, an overview of the manuscript is part of the abstract, not the introduction. Writing should be in the active voice (for example, instead of "Subjects were selected," use "We selected subjects") and in the first person (for example, instead of "The results of this study showed," use "Our results showed").
19. The body or main part of the manuscript varies

Authors' Guide

according to the type of article (examples follow); however, the body should include a discussion section in which the importance of the material presented is discussed and related to other pertinent literature. When appropriate, a discussion subheading on the clinical relevance of the findings is recommended. Liberal use of headings and subheadings, charts, graphs, and figures is recommended.

a. The body of an **Original Research** article consists of a methods section, a presentation of the results, and a discussion of the results. The methods section should contain sufficient detail concerning the methods, procedures, and apparatus employed so that others can reproduce the results. The results should be summarized using descriptive and inferential statistics and a few well-planned and carefully constructed illustrations.

b. The body of a **Literature Review** article should be organized into subsections in which related thoughts of others are presented, summarized, and referenced. Each subsection should have a heading and brief summary, possibly one sentence. Sections must be arranged so that they progressively focus on the problem or question posed in the introduction.

c. The body of a **Case Report** should include the following components: personal data (age, sex, race, marital status, and occupation when relevant—not name), chief complaint, history of present complaint (including symptoms), results of physical examination (example: "Physical findings relevant to the rehabilitation program were . . . "), medical history (surgery, laboratory results, examination, etc), diagnosis, treatment and clinical course (rehabilitation until and after return to competition), criteria for return to competition, and deviation from expectations (what makes this case unique).

d. The body of a **Clinical Techniques** article should include both the *how* and *why* of the technique: a step-by-step explanation of how to perform the technique, supplemented by photographs or illustrations, and an explanation of why the technique should be used. The discussion concerning the *why* of the technique should review similar techniques, point out how the new technique differs, and explain the advantages and disadvantages of the technique in comparison with other techniques.

20. Percentages should be accompanied by the numbers used to calculate them. When reporting nonsignificant results, a power analysis should be provided.
21. **Communications** articles, including official Position Statements and Policy Statements from the NATA Pronouncements Committee; technical notes on such topics as research design and statistics; and articles on other professional issues of interest to the readership are solicited by the *Journal*. An author who has a suggestion for such a paper is advised to contact the Editorial Office for instructions.
22. The manuscript should not have a separate summary section—the abstract serves as a summary. It is appropriate, however, to tie the article together with a summary paragraph or list of conclusions at the end of the discussion section.
23. References should be numbered consecutively, using superscripted arabic numerals, in the order in which they are cited in the text. References should be used liberally. It is unethical to present others' ideas as your own. Also, use references so that readers who desire further information on the topic can benefit from your scholarship.
24. References to articles or books, published or accepted for publication, or to papers presented at professional meetings are listed in numerical order at the end of the manuscript. Journal title abbreviations conform to *Index Medicus* style. Examples of references are illustrated below. See the *AMA Manual of Style* for other examples.

    Journals:

    1. van Dyke JR III, Von Trapp JT Jr, Smith BC Sr. Arthroscopic management of postoperative arthrofibrosis of the knee joint: indication, technique, and results. *J Bone Joint Surg Br.* 1995;19:517–525.
    2. Council on Scientific Affairs. Scientific issues in drug testing. *JAMA.*1987;257: 3110–3114.

    Books:

    1. Fischer DH, Jones RT. *Growing Old in America.* New York, NY: Oxford University Press Inc; 1977:210–216.
    2. Spencer JT, Brown QC. Immunology of influenza. In: Kilbourne ED, Gray JB, eds. *The Influenza Viruses and Influenza.* 3rd ed. Orlando, FL: Academic Press Inc; 1975:373–393.

    Presentations:

    1. Stone JA. Swiss ball rehabilitation exercises. Presented at: 47th Annual Meeting and Clinical Symposia of the National Athletic Trainers' Association; June 12, 1996; Orlando, FL.

    Internet Sources:

    1. Knight KL, Ingersoll CD. Structure of a scholarly manuscript: 66 tips for what goes where. Available at http://www.journalofathletictraining.org/jat/66tips.html. Accessed January 1, 1999.
    2. National Athletic Trainers' Association. NATA blood borne pathogens guidelines for athletic trainers. Available at http://www.journalofathletictraining.org. Accessed January 1, 1999.
25. Table Style: 1) Title is bold; body and column headings are roman type; 2) units are set above rules in parentheses; 3) numbers are aligned in columns by decimal; 4) footnotes are indicated by symbols (order of symbols: *, †, ‡, §, ‖, ¶); 5) capitalize the first letter of each major word in titles; for each column or row entry, capitalize the first word only. See a current issue of the *Journal* for examples.
26. All black-and-white line art should be submitted in camera-ready form. Line art should be of good quality; should be clearly presented on white paper with black ink, sans serif typeface, and no box; and should be printed on a laser printer—no dot matrix. Figures that require reduction for publication must remain readable at their final size (either 1 column or 2 columns wide). Photographs should be glossy black and white prints. Do not use paper clips, write on photographs, or attach photographs to sheets of paper. On the reverse of each figure attach a write-on label with the figure number, name of the author, and an arrow indicating the top. (Note: Prepare the label before affixing it to the figure.) Authors should submit 1 original of each figure and 4 copies for review.
27. Authors must request color reproduction in a cover letter with the submitted manuscript. Authors will be notified of the additional cost of color reproduction and must confirm acceptance of the charges in writing.
28. Legends to figures are numbered with arabic numerals in order of appearance in the text. Legends should be printed on separate pages at the end of the manuscript.
29. The *Journal of Athletic Training* follows the redundant publication guidelines of the Council of Science Editors, Inc (*CBE Views.* 1996; 19:76–77; also available on the *JAT* web site at http://www.journalofathletictraining.org). Authors found in violation of redundant publication will have sanctions invoked by the Journal Committee of the National Athletic Trainers' Association, Inc.

PUBLICATION POLICIES

30. Original Research manuscripts will be categorized under the following table of contents subheadings: clinical studies, basic science, educational studies, epidemiologic studies, and observational/informational studies.
31. Only Case Reports and Clinical Techniques that define and establish the optimal standard of care or the practice of athletic training will be considered for publication in *JAT*. All other Case Reports and Clinical Techniques will be considered for publication in the *NATA News*.
32. Media Reviews will appear in the *NATA News*.

APPENDIX D. National Athletic Trainers' Association Competencies

National Athletic Trainers' Association Education Task Force

http://www.nata.org/http://www.nata.org/

5/14/01

Competencies In Athletic Training Educational Domains

The Competencies in Athletic Training define the educational domains used in preparing entry-level athletic trainers. Each domain is then further defined by a set of cognitive, psychomotor, and affective competencies. The Competencies Committee has embarked on a major revision of this document.

The first draft of these revisions were posted and the feedback was reviewed by the Competencies in Education Committee, who then forwarded their recommendations to the Education Council's Executive Committee. The EC deliberated on these recommendations, made revisions where appropriate, and passed the recommendations along to the NATA Board of Directors.

In addition to adding or renaming educational content domains, the name of this document has been changed from "Competencies in Athletic Training" to:

Athletic Training Educational Competencies for the Health Care of the Physically Active

Existing Domain	Revised Domain
Prevention of Athletic Injury and Illness	Risk Management
Recognition and Evaluation	Assessment and Evaluation
Management, Treatment, and Disposition	Acute Care
	General Medical Conditions and Disabilities
	Pathology of Injury and Illness
	Pharmacological Aspects of Injury and Illness
	Nutritional Aspects of Injury and Illness
Rehabilitation of Athletic Injuries	Therapeutic Exercise
	Therapeutic Modalities
Organization and Administration	Health Care Administration
	Professional Development and Responsibilities
Education and Counseling	Psychosocial Intervention and Referral