

2007

# Light Therapy: The Effectiveness of Light Therapy on Pain and Swelling of Acute Lower Extremity Sprains and Strains of Collegiate Athletes

Elisabeth A. Martin  
*Cedarville University*

Follow this and additional works at: [http://digitalcommons.cedarville.edu/education\\_theses](http://digitalcommons.cedarville.edu/education_theses)

 Part of the [Sports Sciences Commons](#)

---

## Recommended Citation

Martin, Elisabeth A., "Light Therapy: The Effectiveness of Light Therapy on Pain and Swelling of Acute Lower Extremity Sprains and Strains of Collegiate Athletes" (2007). *Master of Education Research Theses*. 14.  
[http://digitalcommons.cedarville.edu/education\\_theses/14](http://digitalcommons.cedarville.edu/education_theses/14)

This Thesis is brought to you for free and open access by DigitalCommons@Cedarville, a service of the Centennial Library. It has been accepted for inclusion in Master of Education Research Theses by an authorized administrator of DigitalCommons@Cedarville. For more information, please contact [digitalcommons@cedarville.edu](mailto:digitalcommons@cedarville.edu).

LIGHT THERAPY:  
THE EFFECTIVENESS OF LIGHT THERAPY ON PAIN AND  
SWELLING OF ACUTE LOWER EXTREMITY SPRAINS AND STRAINS OF  
COLLEGIATE ATHLETES

A thesis submitted in partial fulfillment  
of the requirements for the degree of  
Masters of Education

By


ELISABETH ANN MARTIN  
B.A. Physical Education, Cedarville University, 1996


2007  
Cedarville University

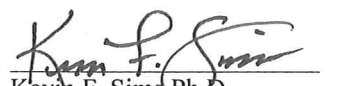
CEDARVILLE UNIVERSITY  
SCHOOL OF GRADUATE STUDIES

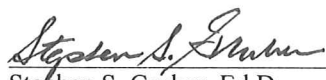
January 9, 2007

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Elisabeth Ann Martin ENTITLED Light Therapy: The Effectiveness of Light Therapy in Acute Lower Extremity Sprains and Strains of Collegiate Athletes BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF Master of Education.

  
\_\_\_\_\_  
William E. Brown Ph.D.  
President

  
\_\_\_\_\_  
Robert W. Milliman, Ph.D.  
Academic Vice President

  
\_\_\_\_\_  
Kevin F. Sims Ph.D.  
Dean, School of Social Sciences  
and Professional Studies

  
\_\_\_\_\_  
Stephen S. Gruber, Ed.D.  
Education Department Chair  
Thesis Advisor

## ABSTRACT

Martin, Elisabeth A. M.Ed., Education Department, Cedarville University, 2007. Light Therapy: The Effectiveness of Light Therapy on Pain and Swelling of Acute Lower Extremity Sprains and Strains of Collegiate Athletes.

This thesis investigated light therapy to discover if this therapeutic modality had any effect on pain and swelling in acute lower extremity sprains and strains of collegiate athletes. The subjects were 18-22 year old male and female collegiate athletes from Cedarville University. The study was a blind study using experimental and sham treatment groups. The researcher used the Dynatron 709 Solaris unit with a superluminescent diode cluster probe with wavelengths from 660 nm to 880 nm. The dosage was 10 J/cm<sup>2</sup> of continuous strength for 1 minute and 40 seconds at each injury site. The conclusion of this study was that light therapy decreased pain in the experimental group although it was not found to be significant. There was no significance in the decrease of swelling. My research found that light therapy is an effective modality for use with acute pain of acute lower extremity sprains and strains.

## TABLE OF CONTENTS

	Page
I. INTRODUCTION OF THE STUDY.....	1
Introduction to the Investigation.....	1
Definition of Terms.....	3
Statement of the Problem or Issue.....	4
Scope of the Study and Delimitations.....	4
Significance of the Study.....	4
Methods of Procedure.....	5
II. LITERATURE REVIEW.....	7
III. METHODOLOGY.....	17
Introduction to the Method.....	17
Rational for the Method.....	17
Population of the Study.....	17
Sample.....	17
Method of Sampling.....	18
Procedure.....	18
Instruments.....	20
Pilot Study.....	21
Inter-rater Reliability.....	21

IV. RESULTS AND ANALYSIS.....	22
Introduction.....	22
Description of the Data.....	22
Data Analysis and Conclusions.....	26
V. DISCUSSION AND IMPLICATIONS.....	27
Introduction.....	27
Interpretation of the Results.....	27
Potential Applications of the Findings.....	27
Biblical Integration.....	28
Relation of the Results to Theory and Other Literature.....	28
Strengths of the Study.....	28
Limitations of the Study.....	29
Suggestions for Future Research.....	30
REFERENCES.....	31
APPENDIX A.....	36
Data Collection Form.....	36
Medical Research Consent Form.....	38
APPENDIX B.....	41
VITAE.....	42

## LIST OF FIGURES

Figure	Page
1. Pain Reduction between days.....	24
2. Swelling Reduction between days.....	26

## LIST OF TABLES

Table	Page
1. Mean amount of pain reduction from day one to day 7.....	23
2. Means of pain reduction between days using day one as baseline.....	24
3. Means of swelling reduction between days using day one as baseline.....	25



## ACKNOWLEDGEMENTS

I would like to acknowledge the following individuals for their support during my thesis process. I first wish to thank my Lord, without Him I would have not had the strength or perseverance to continue through this season of my professional development. I would also like to thank the athletes and coaches at Cedarville University for their patience and cooperation throughout the research process. Your help is greatly appreciated. I would like to thank Dr. Chi-En Hweng for her guidance and help with my statistics. I would also like to thank Dr. Delyte Morris as well as Elliot Moore and Kurt Fraser for their help with my statistics and literature review. I would like to thank my thesis advisor Dr. Stephen Gruber for his direction and guidance during the thesis process. I also wish to thank my program director Dr. Evan Hellwig for his direction and leading as well as the many questions that I had for him. Thank you to my fellow Certified Athletic Trainers and the School of Health and Human Performance at Cedarville University who constantly lifted me up in prayer and gave me so much support. I want to thank my mother, Patty Martin, for her willingness to read through this thesis and check for grammar and spelling errors on many different occasions. Finally I want to thank my family for their unfailing love and devotion to my professional development. Without your help I would have never made it this far. I love you all.

## DEDICATION

I want to dedicate this thesis and research to my grandfather, Isaac Ratliff. He showed so much love and support toward my professional development and was a constant driving force in the completion of my M.Ed. He passed away on November 6, 2005 and is greatly missed. This is for you Papa.

Your Favorite Granddaughter

## I. INTRODUCTION

### *Introduction to the Investigation*

The purpose of this thesis was to study the effectiveness of light therapy in swelling and pain of acute lower extremity sprains and strains of collegiate athletes. Light Therapy, Low Level Laser Therapy, or Cold Laser has been around for many years. In fact the Europeans and Russians pioneered the use of lasers in the early 1960's (Fitz-Ritson, 2001). The United States has been using light therapy as a therapeutic modality since the early 1970's. In 2002 the Food and Drug Administration made light therapy available to Allied Health Professionals all over the United States by stating that light therapy was allowed to be used for the relief of carpal tunnel syndrome and in relieving chronic neck and shoulder pain. (McLeod, 2004). The term laser is actually just an acronym. Laser stands for "Light Amplification by Stimulated Emission of Radiation." In 1917 Albert Einstein published a paper which outlined the key concepts and principles for the stimulated emission of photons. The birth of a piece of equipment termed the MASER (Microwave Amplification by Stimulated Emission of Radiation) was made about forty years later (Cartwright, 2002).

Much research has been done using light therapy for therapeutic modalities. Light therapy has been found to decrease inflammation in patients by 20-30% after being treated daily for 10 minutes (Fitz-Ritson, 2001). Inflammation, researchers have found, is a significant source of pain. Research is beginning to show that light therapy may lessen muscle spasm and pain by working at the circulatory level (Fitz-Ritson, 2001).

Light therapy also seems to have a biostimulating and analgesic effect through direct irradiation without causing a thermal response (Kulekcioglu, 2003).

Most of the research today uses the term Low Level Laser Therapy, but there has been much confusion as to what type of laser the researcher is using. Lasers are classified by the type of material that is placed in between the two reflecting surfaces. This is called a medium. Of the many different types of lasers on the market, each has its own wavelength and characteristics based on the medium that is used. The most common mediums are the following: crystal and glass, gas and excimer, semiconductor, liquid dye, and chemical.

Lasers are either high powered or low powered. High powered lasers tend to be hot or thermal and very expensive. Low powered lasers are used for wound healing and pain management (Prentice, 2003). Many clinics use low powered light therapy due to its cost effectiveness. Low powered laser is the type of laser that I focused on in this thesis. The light therapy unit that is used in the Cedarville University Athletic Training Program is a Dynatron Solaris 709 and the wavelength is 660 nm-880 nm. It has 32 infrared super luminous diodes that put out a wavelength of 880nm and 4 visible diodes that put out a wavelength of 660nm.

The purpose of this thesis was to use light therapy to treat a randomly assigned group of injured athletes. The athletes that I used in this study came from the collegiate sports teams at Cedarville University. I was hoping to see swelling and pain decrease while using the light therapy as the primary therapeutic modality.

### *Definition of Terms*

For the purposes of this study:

Irradiation or irradiate means that an athlete is being treated with light therapy or radiation.

Joule is an international system unit of electrical, mechanical and thermal energy. The total amount of energy is equal to the output wattage and the treatment duration (Joules = power × duration) (Starkey, 2004).

Light Therapy (LT) represented a therapeutic modality that used light from the red end of the electromagnetic spectrum to promote healing at the cellular level in order to have wound and/or tissue healing. LT is low level laser therapy that takes place at irradiation intensities so low that any biological effects are due to the direct effects of the radiation and not as a result of heating (Fitz-Ritson, 2001). Wavelength from 660nm – 950nm will be considered Low Level Laser.

Nanometer (nm) stands for a metric unit of length equal to one billionth of a meter.

Pain was measured by using a visual analog scale using the numbers 0 (representing no pain) through 10 (representing the worst pain possible). The treatment and control groups reported this daily when the study participants were measured for swelling.

Sham Light Therapy refers to the head of the LT wand not being held perpendicular with the skin so as to not give a treatment dose to the athlete.

Swelling was measured using a circumferential (girth) measurement of the thigh, knee, calf, and ankle. I used centimeters as the standard for measurement.

Wavelength is light in the form of electromagnetic energy that has wavelengths between 100 and 10,000 nanometers (nm) inside the electromagnetic spectrum. Visible light

ranges from 400 nm (violet) to 700 nm (red). Beyond the red portion of the visual range is the infrared and microwave region, and below that is ultraviolet, x-ray, etc. (Prentice, 2003). During this study I focused on the visible light end of the electromagnetic spectrum. Wavelength is important to this study because it determines two things: depth of penetration and light absorption.

#### *Statement of Problem or Issue*

I studied the effect that light therapy has on pain and swelling in collegiate athletes. I specifically wanted to know if light therapy had any effect on the decrease of pain and swelling.

#### *Scope of the Study and the Delimitations*

The study began on August 14, 2006. I conducted a pilot study from August 14, 2006 until September 15, 2006. I began the actual study on September 16, 2006 and ended the study on November 1, 2006. I then began to put the data together in order to write and defend the thesis. The sample of the study was male and female collegiate athletes from Cedarville University that were 18-22 years of age. All participants were healthy and passed a pre-participation physical with our campus physician.

#### *Significance of the Study*

This study was significant because most of the research that exists on light therapy uses a higher wavelength than what is used in the Cedarville University Athletic Training Room. Finding out if this lower level of light therapy has any therapeutic value was the focus of this study. This was important because the research that I found discussed open wounds in rats or tissues that had been taken out of the body of rats in order to be treated. Other research focused on other issues only to find that pain and

swelling were ultimately affected as well. I was interested in seeing what light therapy would do for my athletes in a normal injury that they may incur over the course of a collegiate athletic season. This was research that was very relevant to athletic training and will benefit all Allied Health Professionals.

### *Methods of Procedure*

This study was a blind study involving male and female athletes from Cedarville University. It was blind because the athletes did not know if they were receiving the experimental treatment or the sham treatment. The athletes gave their written consent to be in the study.

The injuries used in the study were sprains and strains of the lower extremity. I evaluated each of the athletes and then randomly assigned them to a group, either control or treatment. I conducted a pilot study of this experiment from August 14, 2006 to September 15, 2006. This allowed a proper amount of time to work out any problems that arose in the study. I began the actual study on September 16, 2006 and ended the study on November 1, 2006. I used a visual analog scale, specifically the Numeric Rating Scale (NRS), with ranges from 0-10 for pain levels and circumferential measurements for swelling. The measurements for the swelling were done once the athlete incurred an acute musculoskeletal sprain or strain of the lower extremity. Measurements at the ankle were taken at the figure 8 position of the foot and ankle. Measurements of the calf were taken one-quarter, one-half, and three-quarters of the distance between the medial malleolus and the tibial tuberosity. Knee measurements were at the superior and inferior poles of the patella and the middle of the patella. Thigh measurements were one-quarter, one-half, and three-quarter distance between the anterior

superior iliac spine of the pelvis and the superior pole of the patella. These measurements were taken seven out of ten days at the area in which they were injured. The athlete was questioned and measured at the same time everyday, specifically before they began athletic activity.

I used the Dynatron Solaris 709 system, with the 660 nm-880 nm cluster probe as the modality instrument. All sprains of the lower extremity received 10 J/cm<sup>2</sup> for one minute and forty seconds at the four most tender points. I measured swelling and pain in participants seven out of ten days. This allowed for injured athletes' absences due to teams traveling over the weekends or during the week.



## II. REVIEW OF THE LITERATURE

Lasers have been used in the medical field for many years. It was not until a few years ago that light therapy (LT) was approved as a therapeutic modality in hospitals, physical therapy clinics, and sports medicine facilities. LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. In 1917 Albert Einstein published a paper 'Zur Quantum Theori der Strahlung' that outlined the key concepts and principles for the stimulated emission of photons (Cartwright, 2002). The MASER (Microwave Amplification by Stimulated Emissions of Radiation) was created about forty years later.

In 1960 Maiman produced the first working laser consisting of a synthetic ruby crystal surrounded by a helical flashlamp which produced pulsed dye laser at a visible wavelength of 694 nanometers (nm). This led to the use of the ruby laser on human skin in the early 60's by Goldman et al, and led to the extensive use of high powered lasers in Dermatology (Cartwright, 2002).

Light therapy emerged about forty years later. Initially, however, the benefits were unrealized. LT was thought to have no biological effects until Mester et al initiated a series of experiments which unearthed what is now termed photobiostimulation (Cartwright, 2002).

Photobiostimulation is much like photosynthesis in plants. All human cells contain mitochondria that produce energy to allow for cell function, and many chemical reactions take place inside the mitochondria. The Krebs cycle of metabolism occurs on the inner membrane of the mitochondria, releasing energy from the chemical bonds

present in ATP molecules. This inner membrane is very sensitive to light, and stimulating it with certain wavelengths of light causes it to accelerate its activity making more energy available to the cell (Johnson, 2003). One theory that attempts to explain effects of LT is that when an injury occurs, the energy state of a cell is changed which alters the electromagnetic communication between cells. LT is thought to influence this communication favorably (de Bie, 1998).

Light in the electromagnetic spectrum has a well- established role in medicine. Sunlight was used by the ancient Greeks to heal and strengthen (Basford, 1999). The use of laser irradiation to speed wound healing in the human first appeared in literature in 1971 (Moore, 2005). In present day ultraviolet and visible light are used as bactericidal agents as well as for treatment of psoriasis and mood disorders. Short wave diathermy, which uses a longer wavelength portion of the electromagnetic spectrum, is a common physical therapy modality (Basford, 1999).

LT is based on the belief that laser irradiation is able to alter cellular and tissue function in a manner dependent on the characteristics of light itself. Initial work began in Europe some thirty years ago, but with poor results. However, this did not stop the attention that LT received. Europe and the Soviet Union have continued to work with this concept and interest has spread, research has continued, and clinical use has grown (Basford, 1999). As a result of the interest in LT, the US Food and Drug Administration gave its approval for LT to be used in the clinical setting in 2002 for use on many types of injuries and conditions.

There are many different types of lasers that the medical community uses. I focused my research on lasers that used low energy or energy that had no heating effect

on the tissue. In the 1970s and 1980s this type of laser was considered “cold” or “soft” due to the fact that it had no thermal effect on the skin and was considered safe compared to its high-powered counterpart (Enwemeka, 2005). Technological advancements now permit the use of non-laser based monochromatic light sources, such as light-emitting diodes (LEDs), superluminescent diodes (SLDs), and polarized polychromatic light, to achieve the same therapeutic goals that were previously accomplished with low fluence lasers (Enwemeka, 2005).

Lasers are classified by the type of material that is placed in between the two reflecting surfaces; this is called a medium. There are many different types of lasers on the market. Each has its own wavelength and characteristics based on the medium that is used. The most common mediums include the following: crystal and glass, gas and excimer, semiconductor, liquid dye, and chemical. Lasers are either high powered or low powered. High powered lasers tend to be hot or thermal and very expensive. Low powered lasers are used for wound healing and pain management (Prentice, 2003). The newer LED and SLD devices are often configured as clusters of diodes emitting two or more wavelengths of light from a single applicator, making them dual or multiple wavelength sources rather than coherent single wavelength light sources. Accumulating evidence indicates that the therapeutic effects of these newer light sources are similar to those of lasers, when factors, such as wavelength, fluence, and other treatment parameters are taken into consideration (Enwemeka, 2005).

Light therapy’s effectiveness is affected by four important factors: Wavelength, treatment duration, and dosage (Gur, 2003). Wavelength is light in the form of electromagnetic energy that has wavelengths between 100 and 10,000 nanometers (nm)

inside the electromagnetic spectrum. Visible light ranges from 400 nm (violet) to 700 nm (red). Beyond the red portion of the visual range is the infrared and microwave region, and below that is ultraviolet, x-ray, etc. (Prentice, 2003). The wavelength is the most important determinant of tissue penetration (Wertz, 2004). It is known that lasers with different wavelengths produce different effects on fibroblasts. The literature has begun to show that the effects of laser using visible and near-infrared wavelengths showed differences. Most of them indicated that the best results were obtained when visible wavelength was used (Almeida-Lopez, 2001). Optimal light wavelengths, which were proven in prior studies of laser and LED light to speed wound healing, include 680 nm, 730 nm, and 880 nm. Spectra analysis taken from wrist flexor muscles in the forearm and muscles in the calf of the leg demonstrate that most of the photons at wavelengths of 630 nm and 800 nm travel approximately 23 cm through the skin surface (Whelen, 2003). One of the main problems that practitioners need to be cautious of is the fact that tissue absorption and scattering of the energy affects the wavelengths and dosages that are used. Tissue absorbing properties are dependent on their concentration of light accepting molecules such as amino acids, cytochromes, chromophores and water. Each of these interacts with light at specific wavelength ranges or bandwidths. Scattering is considered to be a change in light propagation direction and thought to occur due to the varying shapes of biomolecules. Depth of penetration is determined by tissue type and wavelength emitted by a laser system. As with many forms of energy there is loss of the amount of energy that reaches the area to be treated due to the absorption and scattering issues (Marovino, 2004). According to the law of Grothus-Draper, when photons emitted from a laser encounter a change in density – in the case of therapeutic applications this is

most often the different layers of tissue (skin, fat, muscle, ligament, and bone) the photons will be reflected, refracted, absorbed, or transmitted. In addition, if the treatment head is not held perpendicular to the skin, the energy is refracted and scattered (McLeod, 2004).

Dosage refers to the amount of energy the patient is receiving during his treatment time. In LT the dosage is given in joules. A joule is an international system unit of electrical, mechanical and thermal energy. The total amount of energy is equal to the output wattage and the treatment duration (Joules = power  $\times$  duration) (Starkey, 2004). Power is the laser's output power in watts and time is the treatment duration in seconds (McLeod, 2004). Depending on the duration or time that you are administering your dosage you can achieve a number of outcomes. The most important measurement in laser dosage is the energy density, which is calculated by dividing the total energy delivered to an area by the area of irradiation and expressed as joules per centimeter squared ( $J/cm^2$ ) (Marovino, 2004). Dosages reported by other researchers include ranges from 2-10 joules of energy per point of treatment (Marovino, 2004). I focused on pain and swelling in my active research. Marovino, (2004) reported that even at what is recognized today as being a very low dosage, it was still effective in reducing pain and tenderness in their small sample group. An additional finding according to Marovino, (2004) was that the more acute or immediate the injury, the less energy was needed to irradiate the area.

The frustrating problem with the parameters of wavelength and dosage is that most of the research reports how important wavelength and dosage are, but the authors are quick to say that they did not really know what the right parameters were, and if they

did not find anything of significance, the researchers will say that this could have been because they did not know what parameters should be used. It seemed to me that none of the research was 100% sure what the parameters should be. This made it really hard to figure out what my parameters should be in my own research. In fact Fung, (2002) reports that to the best of the researcher's knowledge, there is no reported study that examined the best dosage to use. The controversy among the previous studies may be due to the difference in treatment dosages, and there is no consensus on what should be the "optimal" dosage for therapeutic laser. As a result of this I used the parameters set forth by Whelan and NASA (2003).

When looking at the best ways to carry out LT as a therapeutic modality, I wanted to make certain what other modality I should use in conjunction with the LT in order to give the most effective treatment. Through my research I found that when used in conjunction with cryotherapy (ice), it is best to perform LT after cryotherapy. The rationale is that with cryotherapy there will be a vasoconstriction of local blood vessels and a reduction in the amount of tissue perfusion, which will allow for an increased depth of penetration secondary to the decreased superficial absorption. Conversely, it is better to use LT before using any heating modalities due to the fact that the heating modalities will increase blood flow to the area, and in turn increase tissue perfusion and then decrease the depth of LT penetration as a result of increased superficial absorption by hemoglobin (McLeod, 2004).

When researching light therapy I found that much study had been done on LT; however, in most of the research the researchers were just trying to see what kind of effect the LT would have on a condition. What most researchers found was that LT

resulted in having a significant effect on pain and swelling, and the effect was usually a decrease in both of those. I wanted to do specific research that focused on those two aspects of acute lower extremity sprains and strains in collegiate athletes. Several researchers have used superficial wounds to assess the supposed effects of LT on healing. Some have used clinical wounds or ulcers of various sizes and depths, and others have developed superficial wound models in animals. When analyzing healing among wounds, it would be beneficial if the wounds were as alike as possible; therefore, the differences in healing could be attributed to the treatment and not to other factors (Hopkins, 2004). This is the main reason why I focused my study on sprains and strains. They are similar injuries and have similar healing that must occur.

There are three phases to the healing process: inflammatory response, fibroblastic repair phase, and maturation-remodeling phase. The inflammatory response phase begins immediately following an injury and is considered the most important phase in injury healing. During the inflammatory phase many physiological effects happen. Without those effects further healing cannot occur. When the injury occurs cells are damaged and leave a large clean up behind. Phagocytic cells come in and clean up the mess that was created by the injury. Cells that are injured release chemicals that aid the healing process. Symptomatically this phase can be characterized by redness, swelling, tenderness, fever (increased temperature), and loss of function. This phase typically lasts for two to four days after the initial injury (Prentice, 2005). The fibroblastic repair phase is the second phase of injury healing. During this phase of healing the cells are rapidly rebuilding and are regenerating which leads to scar formation and repair of the injured tissue. The period of scar formation, or fibroplasia, starts within the first couple hours

after injury and may continue up to four or six weeks. Pain and tenderness to touch usually diminish or go away completely during this phase. This is due to scar formation over the injury site (Prentice, 2005). The final phase, maturation-remodeling phase, is a long term process. In total it can take several years to complete. This phase requires the scar tissue to realign and remodel according to the tensile forces that are applied to it. With increased forces and stress, the collagen fibers that make up the scar realign so that they run parallel to the lines of tension. The tissue will then gradually take on normal appearance and function, although it will never be as strong as the original tissue. This process usually begins after about three weeks (Prentice, 2005).

Light therapy is suggested to have biostimulating and analgesic effects through direct irradiation without causing thermal response (Kulekcioglu, 2003). In a study done by Kulekcioglu, (2003) it was found that there was a significant reduction in pain in the treatment group and the effects lasted for one full month. The researchers used a GaAs laser with a wavelength of 904 nm for treatment on patients with temporomandibular joint pain. At the end of the study they found that significantly more improvement was noted in the active treatment group in all parameters (Pain intensity, number of tender points, number of joint sounds, active mouth opening, passive mouth opening, right lateral motion, and left lateral motion).

A study was done on cancer patients who when put through their chemotherapy regime ended up with painful sores in their mouths. While this is a common occurrence in cancer patients, the study was done to see if LT would be helpful for pain management. The results of the study were as follows: The pain measurement results verify significantly lower pain after daily laser treatment compared with the pain before



the treatment started. The average pain reduction was 67% with a  $\pm$  95% confidence interval the average pain reduction was 47%-88%. Another significant finding was that there was pain reduction during the five days of consecutive treatment (Nes, 2005).

A study was done by Giuliani et al (2004) in which the researchers were interested in whether or not LT had an effect on edema (swelling) and pain. They conducted their study on rats and had some interesting outcomes. A single laser application at the selected point resulted in a prompt reduction of edema so that it did not differ from the uninjured paw. It was also shown to reduce the overall severity of the edema. Rats that were treated with LT displayed a slight but significant reduction in the overall neuropathic pain behavior. Something else that the researchers found that was not expected was that the treatment resulted in resolving asymmetry in soft tissue depth between painful and non-painful sides (Giuliani, 2004).

Therapeutic laser inhibits inflammation although problems in standardizing the dosage of laser delivered make any interpretation of this literature very difficult. In patients with tennis elbow, a double-blind randomized controlled trial of LT produced a small improvement in pain and improved grip strength after eight treatments, but the authors concluded that laser alone was not a recommended treatment (Scott, 2004).

The neuropharmacological analgesic effects of lasers are most likely due to the release of serotonin and acetylcholine at the site. LT is also able to ease the effects of experimentally induced inflammation. Daily laser irradiation of less than ten minutes was sufficient to inhibit the inflammation by 20-30% (Fitz-Ritson, 2001).

While not all researchers agree that LT is the best treatment option for every injury or condition there is significant research that shows that LT has a profound effect

on those conditions, and it should be used more widely. It would behoove the medical community to do more research on what is the optimal wavelength and dosage that should be used, in order that we may more effectively treat our patients and athletes.

### III. METHODOLOGY

#### *Introduction to Method*

In athletic training rooms and clinics all over the world therapeutic modalities are used in order to prepare the tissue for exercise and to promote healing. A majority of the modalities are used before the athlete begins exercise.

#### *Rationale for the Method*

Using the therapeutic modality of light therapy, I conducted this research during the fall season of the 2006-2007 school year. Research was done at that time because most of the lower extremity sprains and strains happen during the sports that occur during the fall months.

#### *Population of the Study*

The population studied was 18-22 year old male and female collegiate athletes at Cedarville University. The athletes had the potential to come from any of the sports offered at Cedarville University. The sports that were used were soccer, basketball, and cross country. I decided to use the different sports in order to make the sample size larger.

#### *Sample*

The sample was chosen on the basis of the injury sustained by the athlete. Many different injuries occur in sports, but I chose to specifically focus on acute sprains and strains of the lower extremity.

### *Method of Sampling*

When an athlete came in with an acute lower extremity sprain or strain, the athletic trainer from that team would send the injured athlete to me. I assessed the injury to make sure that it fit into the scope of the research that was being done. The assessment involved using the method of injury evaluation known as HOPS; history, observation, palpation, and special tests. I performed special tests that were common to the area injured in order to decide if the athlete had incurred the injury I wanted to conduct research on. I did not accept any injuries that were over two days old. If the athlete had been hurt during practice on the same day that they were evaluated, the first day of their treatment began on the following day.

Once it was decided that the athlete fit the research, I reviewed the research methodology with the athlete and asked if they would be willing to be a part of the research for seven out of ten days. Once the athlete agreed to be in the study I asked them to sign and date a consent form (Appendix A) which was then signed by me.

### *Procedure*

Eligible athletes were randomly assigned to either the experimental group or the control (sham) group by having them pull a letter (either A or B) out of a colored canvas bag. The A's stood for the control group and the B's stood for the experimental group. The athlete was not made aware of what group they were put into. Each athlete had his own data collection form (Appendix A) where all information was kept on his daily measurements. I finished the study with 12 athletes, six in each group. There were three athletes who were disqualified due to not being able to come in the required amount of times for treatment. The athlete was to be "cold" meaning that he was to not have been

practicing or warming up for athletic activity in any way. If he was “warm” then I would start the research the next day before his athletic activity began. The athlete was then asked to ice the injured area for 15 minutes with an ice bag.

Girth measurements were taken once the athlete had finished icing. The ankle measurement was a figure 8 measurement going around the following points: tibialis anterior tendon, navicular, base of the fifth metatarsal, medial malleolus, and the lateral malleolus. A permanent black marker was used to place marks at each of these locations and those to follow. The girth measurements for the calf were taken by first measuring the distance between the middle of the medial malleolus to the tibial tuberosity. Once that distance was found, I drew marks on the tibia at one-quarter, one-half, and three-quarters distance on the tibia. The girth measurements for the knee were taken by first getting a measurement from the distal pole of the patella to the proximal pole of the patella. A mark was made at the distal pole, middle of the patella and the proximal pole of the patella. The girth measurements for the thigh were taken by first measuring the athlete from the superior pole of the patella to the anterior superior iliac spine of the pelvis. Once this measurement was taken a mark was made at the one-quarter, one-half, and three-quarters lengths. The same measuring tape was used on every athlete every day for the measurements taken at all of these locations and each athlete was instructed to wash the area, but not scrub. Each mark was refreshed daily. All measurements were made in centimeters. The athlete was then asked to rate his pain on a Visual Analog Scale (VAS) 0-10, 0 representing absolutely no pain and 10 representing the worst pain possible.

Once all measurements were taken, the athlete was treated with the light therapy (LT) treatment (Appendix B, Figure 1). The instrument used was the Dynatron Solaris 709 with a cluster probe having wavelengths from 660 nm-880 nm. The probe had 32 infrared super luminous diodes that put out a wavelength of 880 nm and four visible diodes that put out a wavelength of 660 nm. This machine was calibrated in July of 2006. I specifically used 10 joules of power with 500 w/cm<sup>2</sup> of continuous intensity for one minute and forty seconds on the four spots that were the most tender. All control group members received sham light therapy. Sham light therapy refers to the head of the LT wand not being held perpendicular with the skin so as to not give a treatment dose to the athlete (Appendix B, Figure 2). Each control group athlete received this “dosage” on the four spots that were the most tender. All athletes in both the treatment and control groups were covered with a bright yellow towel which was triple folded so that they could not see if they were getting experimental treatment or sham treatment (Appendix B, Figure 3). The machine made a beeping sound at the end of the treatment time so I was not able to set the machine on a setting in which the subject would receive no treatment. All experimental group members received 10 joules of power with 500 w/cm<sup>2</sup> of continuous intensity for one minute and forty seconds at each of the four spots.

Once the treatment was over the athlete was instructed to lightly stretch or go through a basic range of motion which was pain free for five minutes following his treatment. This included tracing the alphabet in the air with the big toe for the ankle, and stretching the major muscle groups of the lower body using five repetitions and holding the stretch for 30 sec. I did not use elastic wraps to control swelling as this was one of

the variables that was being studied. Most of the athletes were still able to continue playing and this was allowed.

A pilot study was done from August 14, 2006 to September 15, 2006. During this time I evaluated and treated five athletes to test this protocol. It was decided at this time that the minimum number of athletes needed to complete this study would be 10 with the maximum being 20. The actual study began on September 16, 2006 and ended on November 1, 2006. The study ended with 12 study participants. I was the only one involved with the actual data collection. This was done so that there would be no confusion as to what spots were to be measured and the procedures to be followed on a day to day basis. The VAS was used due to the fact that it has been found to be a reliable instrument for evaluating pain (Puett, 1994).

This study showed that LT had a positive effect on pain and swelling in acute lower extremity strains and sprains. Potential threats to the validity of this study were that some athletes were able to continue playing and others were not, thus increasing pain and swelling. No wrapping of injuries occurred due to the fact that this can help swelling to decrease. I wanted to see if the swelling went down as a result of LT, and not from wrapping or other treatment. Athletes also swell differently. For instance, some athletes will swell up very quickly and stay swollen for days, others will not swell immediately and then swell slightly only to be back to their normal baseline the next day. I also did not take into account that the athletes did not incur the same type of sprain or strain. Some athletes may have received a minor sprain (grade I). Other athletes may have incurred a severe sprain (grade III). Each of these grades present issues in regards to pain and swelling. I put all of the grades in together rather than splitting them up.

#### IV. RESULTS AND ANALYSIS

##### *Introduction*

The null hypothesis or Ho of the study was that pain and swelling would not be affected as a result of using light therapy on acute lower extremity sprains and strains.

All data analysis was done by SPSS software for Windows.

##### *Description of the Data*

When looking at the means for the control and experimental groups I found that the pain levels went down continually in the experimental group and went down gradually yet slowly in the control group (Table 1).

***Table 1***

Mean amount of pain reduction from Day One to Day Seven

Day of Treatment	Control		Experimental	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
1	3.83	1.72	5.00	2.00
2	3.17	1.60	3.67	2.42
3	2.67	1.21	3.50	2.57
4	2.50	1.52	2.83	2.32
5	2.83	1.72	2.33	2.88
6	2.33	1.97	2.33	2.66
7	2.67	2.88	1.50	1.38



The repeated measures ANOVA reveals that the day-to-day change in pain is statistically significant, but the group differences are not. [F(6,60)= 5.156, and p <.05]

For all remaining tables the baseline is the first day measurement. In Table 2 there is a reduction in pain between days starting with day 2 (Table 2, Figure 1).

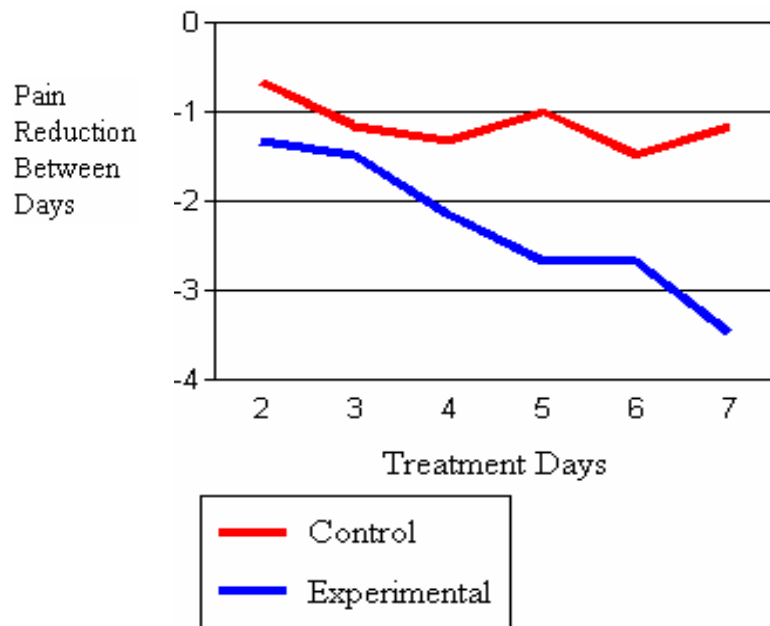
**Table 2**

Means of pain reduction between the days using day one as the baseline measurement.

Pain Reduction Between Days	Control		Experimental	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
2	-0.67†	.82	-1.33†	1.51
3	-1.17†	1.17	-1.50†	1.97
4	-1.33†	1.37	-2.17†	1.33
5	-1.00†	2.28	-2.67†	1.75
6	-1.50†	1.98	-2.67†	1.51
7	-1.17†	3.31	-3.50†	1.22

† Negative Values indicates reduction

*Figure 1*



I conducted an independent samples t-test which found that the experimental groups constantly experienced more pain reduction than the control group. The difference between the two groups is not significant due to the small sample size.

In regards to swelling the means showed that the experimental group followed a steady pattern of decline, but the control group was up and down (Table 3, Figure 2).

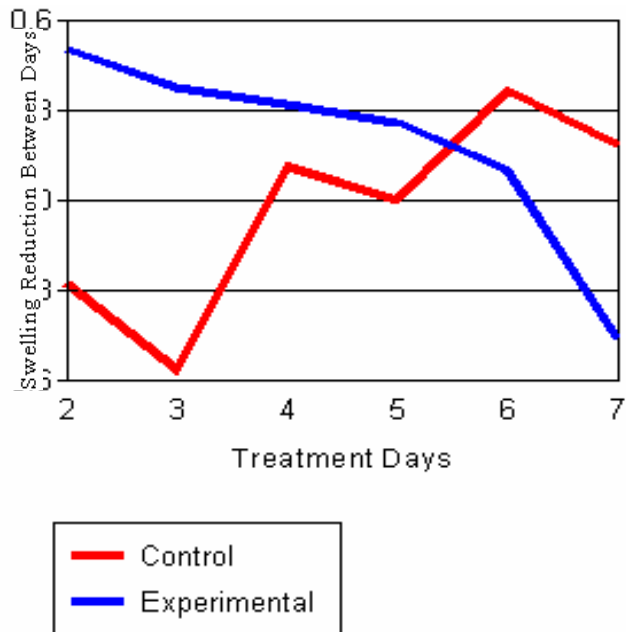
**Table 3**

Means of Swelling reduction between the days with day one being the baseline measurement.

Swelling Reduction Between Days	Control		Experimental	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
2	-.28†	.27	.50	.55
3	-.57†	.64	.38	.39
4	.11	.51	.32	1.14
5	.00	.56	.26	.80
6	.36	.59	.10	1.25
7	.18	.63	-.46†	.94

† Negative values means reduction

**Figure 2**



An independent samples t-test was run on the reduction in swelling between the days and it was found that the amount of swelling was significantly different between the two groups in Day 2 ( $t = -3.13, p < .05$ ) and Day 3 ( $t = -3.08, p < .05$ ).

#### *Data Analysis & Conclusions*

The data has shown that I can reject the  $H_0$ , because there was decrease of pain in the experimental group. There were also significant results in swelling on day two and day three for the experimental group although not a decrease.

## V. DISCUSSION AND IMPLICATIONS

### *Introduction*

Light therapy, in this study, showed to be an effective modality for use with pain in acute lower extremity sprains and strains. Swelling did not have the same effect.

### *Interpretation of the Results*

While both conditions were affected, pain seemed to be affected more than swelling. Table 3 showed the decrease in pain from day to day and showed that the experimental group had a definite decrease over the control group although not significant because of low sample size. Swelling was only significantly affected on the second and third days and that difference was an increase in swelling rather than a decrease.

### *Potential Applications of the Findings*

It appears from this study that the more beneficial reason to use light therapy would be for pain control rather than swelling control. It begs the reader and researcher to delve more deeply into what is happening at the nervous system level rather than the cellular or tissue level. What is physiologically happening in order to control the pain threshold over cell metabolism? This needs to be examined further in future studies.

### *Biblical Integration*

The human body was created in such a way, that even the smallest cell and parts of the cell are working immediately to begin the healing process. It is an Almighty God that would have put this being together. God even created this being to use the knowledge given him so that he might use technology to further the healing process.

The human body has pain receptors for a reason. Most humans are just annoyed by pain, but pain actually tells us many things about what is going on in the healing process. God allowed humans to discover technology that would help to control pain and in some instances swelling so that the healing process might be shortened. Swelling was not affected as much as pain in this study, but they were both affected at some point, whether negatively or positively. Through this study I found myself praising God for the uniqueness of each of the athletes that agreed to be in my research. They allowed me a deeper look into the creation of God. How humbling to think that we are created in His image!

### *Relation of the Results to Theory and Other Literature*

After reviewing the literature and conducting this study, it is possible to see that there is a relationship between the use of LT and the reduction of pain. Swelling was negatively affected, but that may have changed with more treatments.

### *Strengths of the Study*

One of the strengths of this study would be that there were no inter-rater reliability issues. This was due in large part because I was the only one who took the measurements and administered the treatments. It was also a controlled environment. The athlete came to the same room at the same time everyday and did the same procedure

for seven days. They sat at the same treatment table and had the same equipment used everyday. The athlete did not have to worry about someone else treating him, and I didn't have to worry about another athletic trainer taking the wrong measurements or giving a treatment in the wrong sequence.

### *Limitations of the Study*

There were many limitations of this study, the main one being the small sample size. In any given athletic season there are many injuries that can occur, and generally sprains and strains are the major injuries that occur. This fall, however, that was not the case. Should I decide to do a study of this nature again, I would lengthen the study time to a full year so that I would have a better chance of getting some significant results.

Another limitation would be that we did not withhold anyone from athletic activity while they were in the study. This could have been a reason why the swelling measurements were not affected as much as the pain measurements. The question that begs to be asked is why is swelling affected negatively and pain positively? Pain is a direct response to the amount of swelling that is in the area. If the swelling is increased, then why would pain not be increased as well? This is a question that needs further research to be answered. It was not in the scope of this study to find.

Another limitation was that I did not take into account was the fact that not all of the athletes incurred the same severity of injury. This, I feel, played a part in the larger decrease in pain in the experimental group. This may have been due to the fact that a more severe injury was in the experimental group and therefore a higher pain number was noted on day one.

One of the other limitations would be that every human is unique and athletes more so than the general population. Because every human is unique the athlete may swell differently than another athlete. This can prove to be a problem in research where swelling is measured, especially considering that in some athletes minor injuries may swell worse than some athletes' major injuries. It may have been more beneficial to get a pre-season baseline girth measurement before the athlete had incurred an injury.

The last limitation is that I may not have treated the athletes enough times or I did not give the right dosage. I did not find research to help this fact and so I went on what other researchers had done previously. This needs to be researched further.

#### *Suggestions for Future Research*

The main suggestion that I have for future research would be to split up the two conditions and just measure swelling or pain. The other suggestion that I would have would be to focus on the nervous system rather than the cellular level for the research. I would also change the criteria so that the athlete could not participate in athletic competition during that seven- day period in which he was in the study. While this would not be an agreeable situation for the athlete or his coach it may make the results more significant and valuable. In future research it would be beneficial to split up the groups based upon the severity of the injury sustained. This would insure that the pain number given was a true representation of the injury incurred.



## REFERENCES

- Almeida-Lopes, L., Rigan, J., Zângaro, R.A., Guidugli-Neto, J., & Jaeger, M.M.M. (2001). Comparison of the low level laser therapy effects on cultured human gingival fibroblasts proliferation using different irradiance and same fluence. *Lasers in Surgery and Medicine*, 29, 179-184.
- Basford, J.R., Sheffield, C.G., Harmsen, W.S. (1999). Laser therapy: A randomized, controlled trial of the effects of low-intensity Nd: YAG laser irradiation on musculoskeletal back pain. *Archives of Physical Medicine and Rehabilitation*, 80, 647-652.
- Cartwright, R. (2002). *A comparison study involving the use of low level laser therapy with or without the application of tea tree oil in the treatment of plantar warts*. Unpublished doctoral dissertation, University College, Northampton.
- De Bie, R.A., de Vet, H.C.W., Lenssen, T.F., van den Wildenberg, F.A.J.M., Kootstra, G., Knipschild, P.G. (1998). Low-level laser therapy in ankle sprains: A randomized clinical trial. *Archives of Physical Medicine and Rehabilitation*, 79, 1415-1420.
- Enwemeka, C.S. (2005). Low level laser therapy is not low. *Photomedicine and Laser Surgery*, 23, 529-530.
- Fitz-Ritson, D.(2001). Lasers and their therapeutic applications in chiropractic. *Journal of Canadian Chiropractic Association*, 45, 26-34.

- Fung, D.T.C., Ng, G.Y.F., Leung, M.C.P., & Tay, D.K.C. (2002). Therapeutic low energy laser improves the mechanical strength of repairing medial collateral ligament. *Lasers in Surgery and Medicine*, 31, 91-96.
- Fung, D.T.C., Ng, G.Y.F., Leung, M.C.P., & Tay, D.K.C. (2003). Effects of a therapeutic laser on the ultrastructural morphology of repairing medial collateral ligament in a rat model. *Lasers in Surgery and Medicine*, 32, 286-293.
- Guiliani, A., Fernandez, M., Farinelli, M., Baratto, L., Capra, R., Rovetta, G., et al. Very low level laser therapy attenuates edema and pain in experimental models. *International Journal of Tissue Reaction*, (26). 29-37.
- Gur, A., Cosut, A., Sarac, A., Cevik, R., Nas, K., & Uyar, A.(2003). Efficacy of different therapy regimes of low-power laser in painful osteoarthritis of the knee: A double-blind and randomized-controlled trial. *Lasers in Surgery and Medicine*, 33, 330-338.
- Gur, A., Sarac, A.J., Cevik, R., Altindag, O., Sarac, S. (2004). Efficacy of 904nm gallium arsenide low level laser therapy in the management of chronic myofascial pain in the neck: A double-blind and randomize-controlled trial. *Lasers in Surgery and Medicine*, 35, 229-235.
- Hakgüder, A., Birtane, M., Gürcan, S., Kokino, S., & Turan, F.N. (2003). Efficacy of low level laser therapy in myofascial pain syndrome: An algometric and thermographic evaluation. *Lasers in Surgery and Medicine*, 33, 339-343.
- Hopkins, J.T., McLoda, T.A., Seegmiller, J.G., & Baxter, G.D. (2004). Low-level laser therapy facilitates superficial wound healing in humans: A triple-blind, sham-controlled study. *Journal of Athletic Training*, 39, 223-229.

- Johnson, D.S. (2003). Low-level laser therapy in the treatment of carpal tunnel syndrome. *Athletic Therapy Today*, 8, 30-31.
- Kim, Y.H., Ko, M.H., Seo, J.H., ou, C. Kim, N.K. (2002). Effects of visible light therapy in patients with pain. *American Journal of Physical Medicine and Rehabilitation*, 81, 552.
- Kulekcioglu, S., Sivrioglu, K., Ozcan, O., & Parlak, M. (2003). Effectiveness of low-level laser therapy in temporomandibular disorder. *Scandinavian Journal of Rheumatology*, 32, 114-118.
- McLeod, I.A. (2004). Low-level laser therapy in athletic training. *Athletic Therapy Today*, 9, 17-21.
- Marovino, T. (2004). Cold lasers in pain management. *Practical Pain Management*, 1-5.
- Moore, P., Rdgway, T.D., Higbee, R.G., Howard., E.W., Lucroy, M.D. (2005). Effect of wavelength on low-intensity laser irradiation-stimulated cell proliferation in vitro. *Lasers in Surgery and Medicine*, 36, 8-12.
- Nes, A.G., & Posso, M.B.S. (2005). Patients with moderate chemotherapy-induced mucositis: Pain therapy using low intensity lasers. *International Nursing Review*, 52, 68-72.
- Nicola, J.H., & Nicola, E.M.D. (2002). Wavelength, frequency, and color: Absolute or relative concepts? *Journal of Clinical Laser Medicine and Surgery*, (20). 307-311.

- Prentice, W.E, Arnheim, D.D. (2005). Recognizing different sports injuries. In W. Prentice, *Essentials of Athletic Injury Management* (298-315). New York, NY: McGraw-Hill.
- Prentice, W.E. (2003). Low-power lasers. In W. Prentice, *Therapeutic Modalities for Sports Medicine and Athletic Training* (342-360). New York, NY: McGraw-Hill.
- Puett, D.W., & Griffin, M.R. (1994). Published trials of nonmedical and noninvasive therapies for hip and knee osteoarthritis. *Annals of Internal Medicine*, *121*, 133-140.
- Scott, A., Khan, K.M., Roberts, C. R., Cook, J.L., & Duranio, V. (2004). What do we mean by the term “inflammation?” A contemporary basic science update for sports medicine. *British Journal of Sports Medicine*, *38*. 372-380.
- Starkey, C. (2004). Light Modalities. In C. Starkey, *Therapeutic Modalities 3<sup>rd</sup> edition*, (334-351). Philadelphia: F.A. Davis Company.
- Stergioulas, A. (2004). Low-level laser treatment can reduce edema in second degree ankle sprains. *Journal of Clinical Laser Medicine and Surgery*, (22). 125-128.
- Vecchio, P., Cave, M., King, V., Adebajo, A.O., Smith, M., & Hazleman, B.L. (1993). A double-blind study of the effectiveness of low level laser treatment of rotator cuff tendonitis. *British Journal of Rheumatology*, *32*, 740-742.
- Wertz, R.L. (2004). Caution-therapeutic lasers in use...don't get burned. *Avicenna Class IV Laser Therapy*, 1-7.

Whelan, H.T., Buchmann, E., Dhokalia, A., Kane, M.P., Whelan, N.T., Wong-Riley, M.T.T., et.al. Effect of NASA light-emitting diode irradiation on molecular changes for wound healing in diabetic mice. *Journal of Clinical laser Medicine and Surgery*, 21, 67-74.

APPENDIX A

**Data Collection Form**

Name \_\_\_\_\_ Sport \_\_\_\_\_

Control \_\_\_\_\_ Experimental \_\_\_\_\_

Date Begin \_\_\_\_\_ Date End \_\_\_\_\_

Injury \_\_\_\_\_

Day	NRS	Swelling Measurement			Treatment	
<b>1</b>	<b>Numeric Rating Scale</b>	Site	¼	½	¾	<ul style="list-style-type: none"> <li>- Ice</li> <li>- Light Therapy</li> <li>- Sham-Light Therapy</li> <li>- Stretching</li> <li>- Therapeutic Exercise</li> </ul>
	0 1 2 3 4 5 6 7 8 9 10	Ankle				
	No Pain      Moderate Pain      Worst Pain Possible	Calf				
		Knee				
		Thigh				
<b>2</b>	<b>Numeric Rating Scale</b>	Site	¼	½	¾	<ul style="list-style-type: none"> <li>- Ice</li> <li>- Light Therapy</li> <li>- Sham-Light Therapy</li> <li>- Stretching</li> <li>- Therapeutic Exercise</li> </ul>
	0 1 2 3 4 5 6 7 8 9 10	Ankle				
	No Pain      Moderate Pain      Worst Pain Possible	Calf				
		Knee				
		Thigh				
<b>3</b>	<b>Numeric Rating Scale</b>	Site	¼	½	¾	<ul style="list-style-type: none"> <li>- Ice</li> <li>- Light Therapy</li> <li>- Sham-Light Therapy</li> <li>- Stretching</li> <li>- Therapeutic Exercise</li> </ul>
	0 1 2 3 4 5 6 7 8 9 10	Ankle				
	No Pain      Moderate Pain      Worst Pain Possible	Calf				
		Knee				
		Thigh				

<b>4</b>	<b>Numeric Rating Scale</b>	<b>Site</b>	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	<ul style="list-style-type: none"> <li>- Ice</li> <li>- Light Therapy</li> <li>- Sham-Light Therapy</li> <li>- Stretching</li> <li>- Therapeutic Exercise</li> </ul>
	0 1 2 3 4 5 6 7 8 9 10	<b>Ankle</b>				
	No Pain      Moderate Pain      Worst Pain Possible	<b>Calf</b>				
		<b>Knee</b>				
		<b>Thigh</b>				
<b>5</b>	<b>Numeric Rating Scale</b>	<b>Site</b>	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	<ul style="list-style-type: none"> <li>- Ice</li> <li>- Light Therapy</li> <li>- Sham-Light Therapy</li> <li>- Stretching</li> <li>- Therapeutic Exercise</li> </ul>
	0 1 2 3 4 5 6 7 8 9 10	<b>Ankle</b>				
	No Pain      Moderate Pain      Worst Pain Possible	<b>Calf</b>				
		<b>Knee</b>				
		<b>Thigh</b>				
<b>6</b>	<b>Numeric Rating Scale</b>	<b>Site</b>	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	<ul style="list-style-type: none"> <li>- Ice</li> <li>- Light Therapy</li> <li>- Sham-Light Therapy</li> <li>- Stretching</li> <li>- Therapeutic Exercise</li> </ul>
	0 1 2 3 4 5 6 7 8 9 10	<b>Ankle</b>				
	No Pain      Moderate Pain      Worst Pain Possible	<b>Calf</b>				
		<b>Knee</b>				
		<b>Thigh</b>				
<b>7</b>	<b>Numeric Rating Scale</b>	<b>Site</b>	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	<ul style="list-style-type: none"> <li>- Ice</li> <li>- Light Therapy</li> <li>- Sham-Light Therapy</li> <li>- Stretching</li> <li>- Therapeutic Exercise</li> </ul>
	0 1 2 3 4 5 6 7 8 9 10	<b>Ankle</b>				
	No Pain      Moderate Pain      Worst Pain Possible	<b>Calf</b>				
		<b>Knee</b>				
		<b>Thigh</b>				

**Researcher Signature** \_\_\_\_\_

**Researcher Print** \_\_\_\_\_

**Date** \_\_\_\_\_

## APPENDIX A

### **Medical Research Consent Form**

#### **What is Informed Consent?**

I am asking you to take part in a clinical research study. Before you can participate you must have all of the information concerning the study so that you can make an informed decision whether or not to participate. You should understand the possible risks and benefits of this research study. This consent form will provide you with the information about the study so that you can make an informed decision. No guarantees or assurances can be made about the results of this study.

It is essential that you are completely truthful regarding your health history and any symptoms or reactions you may experience during the study. If you are not truthful, you may harm yourself by participating.

#### **Invitation to Participate**

I invite you to participate in a study of Light Therapy and its therapeutic effects. The purpose of this study is to see if Light Therapy is of therapeutic value in regards to collegiate athletic injuries. A total of 20 participants will take part in this study. You are being asked to participate in this study because you are between the ages of 18-22, and you are a healthy and active collegiate athlete.

#### **Investigational Procedures**

If you choose to participate in this study you can expect the following:

1. After you incur a certain injury you will be evaluated and measured by me at the following sites for swelling:
  - A. Quad
  - B. Knee
  - C. Calf
  - D. Ankle
2. You will then be placed in an experimental or control group for seven consecutive days. You will have a 50% chance of going into either group.



3. I will measure you everyday for seven consecutive days once you begin “treatment.” The treatment will be determined by what group you are placed in. Everyone in the study will receive: ice, stretching, and therapeutic exercises, and light therapy or sham-light therapy
4. Your part of the study is finished when the seven days have come to an end.

The treatment you receive as part of this study will not be used if you would not benefit from this treatment. Your health is of the utmost concern and you will not be jeopardized in anyway in regards to your return to your sport.

### **Exclusions**

You should not participate in this study if you have the following:

Cancer

Idiopathic photophobia or abnormally high sensitivity to light

If you have been pre-treated with one or more photosensitizers

If you have a pacemaker

If you have numbness in the area that is being treated.

### **Risks**

There are no known risks in using Light Therapy

### **Benefits**

The benefits of this study are possible optimal return to sport activities without pain or loss of range of motion

### **Alternatives**

The alternative to participating in this study would be to decide that you are not going to participate. You could also decide during the treatment that you would like to try something different and we will allow that.

### **Privacy of Records**

Your privacy is important during the research process. In addition to the members of the athletic training staff who usually have access to your medical records, your medical records and the consent form you sign may be inspected by the research staff, and the institutional review board of Cedarville University. The results of this study may be presented at meetings or in publications; however, your identity will never be disclosed. If you sign this form, you have given us permission to release information to these other people.

A copy of this form will be placed in your student athlete file. Everyone who has access to this file will be able to see that you were willing to participate in this study.



APPENDIX B

**Figure 1**



**Figure 2**



**Figure 3**



## VITAE

Elisabeth Ann Martin  
January 2007

### Professional Address

251 N. Main St  
Cedarville, OH 45314  
(937)766-4135

### Home Address

559 Marshall Dr.  
Xenia, OH 45385  
(937)206-8590

### 1. Education

In Process: Masters of Education from Cedarville University Spring of 2007

Bachelor of Arts in Athletic Training  
Cedarville College, June 1996

### Continuing Education Experiences:

National Athletic Trainers Symposium, Indianapolis, Indiana, June 2005.

Sports Medicine Symposium; Greene Memorial Hospital. Herman N. Menapace Center for Health Education. Xenia, OH. March 1, 2003.

Disordered Eating Among Athletes. Human Kinetics. September 26, 2002.

Great Lakes Athletic Training Association Symposium. Columbus, OH. March 9, 2002.

Assessment and Rehabilitation of Shoulder Instability. Human Kinetics. December 3, 2001.

Sacroiliac Joint : Evaluation and Functional Rehabilitation. National Athletic Trainers Association. Naperville, IL. August 11, 2001.

Diet, Exercise and Fitness. Home Study. November 11, 1999.

Patellofemoral Dysfunction Exam and Treatment. Ortho Ed. Fort Lauderdale, FL. September 18, 1999.

## 2. Professional Experience

### Professional Positions:

Associate Athletic Trainer: Department of Athletic Training. Cedarville University, August 2001 - Present

Head Athletic Trainer: Dade Christian School. Miami, Florida August, 1996 to June 2001.

Facilities Manager: Super Bowl Half-time show. The super bowl was in Miami in 1999 and the halftime show practice at Dade Christian for the month of January. I was the Facilities Manager for eight of the twelve practices. Miami, Florida. January 1999.

Facilities Manager: Consular Cup. Many nationalities are represented in the Miami, Florida area. In 1999 and 2000 I was the facilities manager for the soccer tournament known as the Consular Cup. Teams from all over the world competed on our soccer fields. February 1999 and 2000. Miami, Florida

### Teaching Experience:

#### Cedarville University

Upper SEAT (Supervised Experience in Athletic Training) 2001-2002

Essentials of Athletic Training Fall 2006 and Spring 2007

#### Dade Christian School

Anatomy and Physiology

Physical Science

Earth Science

1<sup>st</sup> through 5th grade Physical Education

### Clinical Experience:

Associate Athletic Trainer, Cedarville University, August 2001 - present. Assist with the delivery of athletic training services for Men's Soccer, and Women's Softball. I also help with the other sports as needed.

Head Athletic Trainer, Dade Christian School. I was responsible for the care of 14 Varsity Sports as well as their Junior High and Junior Varsity counterparts. The sports included: Football, Volleyball, Cross Country, Cheerleading, Men's and Women's Soccer, Wrestling, Men's and Women's Basketball, Track and Field, Baseball, Softball, Tennis, and Golf. August 1996 - June 2001.

3. Research and Publications

Research on Light Therapy and its effectiveness on pain and swelling of acute lower extremity strains and sprains in collegiate athletes. Fall 2006

4. Presentations

Health and Wellness Seminar: How to begin a workout program, Cedarville University March 15, 2003

Health and Wellness Seminar: How to begin a workout program, Cedarville University May 18, 2002

5. Professional Affiliations and Certifications

Certified Athletic Trainer, National Athletic Trainers Association Inc. June 7, 1998. Membership #952531, Certification #069802549, Ohio License # AT-001875.

6. Institutional Service (Cedarville University)

N/A

7. Honors and Awards

5 year award, Cedarville University, August 8, 2006  
Crusader Service Award, Dade Christian School May 17, 2001

8. Community Service

Member, Dayton Avenue Baptist Church 2005-Present

Choir member - Dayton Avenue Baptist Church

Special Music - Dayton Avenue Baptist Church

Member, Grace Baptist Church, October 2002 - 2005

9tLive Bible Study, Grace Baptist Church

Choir Member, Grace Baptist Church

9. Personal Information

Marital Status: Single  
Children: None

10. References

Dr. Evan Hellwig  
Director of Athletic Training Education Program  
Cedarville University  
Cedarville, Ohio 45314  
(937) 766-7691

Christopher Cross  
Head Athletic Trainer  
Cedarville University  
Cedarville, OH 45314  
9937) 766-4493

Robert Duchardt  
Assistant Athletic Trainer  
Cedarville University  
Cedarville, Ohio 45314  
(937) 766-3205

Pastor Jon Young  
Dayton Avenue Baptist Church  
1121 Dayton Avenue  
Xenia, OH 45385  
(937) 376-8223

