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The Effect of Horseback Riding Activity on the Tibialis Anterior, Vastus Lateralis, and Rectus Abdominis of a Paraplegic

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The Effect of Horseback Riding Activity on the Tibialis Anterior, Vastus Lateralis, and Rectus Abdominis of a Paraplegic

(TITLE)

BY

Laurie A. Price

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
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THE EFFECT OF HORSEBACK RIDING ACTIVITY ON THE TIBIALIS ANTERIOR, VASTUS LATERALIS, AND RECTUS ABDOMINIS OF A PARAPLEGIC

by
Laurie A. Price

A thesis submitted in fullfillment
of the requirements for
a Masters Degree in Physical Education

Department of HPER
in the Graduate School
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And finally, I am deeply indebted to my parents, Don and Katie Blackford. They built my apparatus, traveled hundreds of miles to spot Gary, assisted in the pre-test and post-test, and suffered many setbacks along with me. Their love and support, financial and otherwise, kept me going.

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ABSTRACT

Horses are now being used in various programs under various conditions. The use of horses for therapy and recreation for the physically and mentally disabled first began in Germany and Switzerland. The United States now has many schools and different riding programs as well.

Riding seems to be especially beneficial to those with neurological impairments. Treatment of paraplegia is very limited but recreational activities are advancing. The use of the horse is beneficial for paraplegics emotionally as well as physically. Measurements and evaluations of these benefits are lacking. This project analyzes and measures the physical benefits of horseback riding on a classification T8 paraplegic.

The subject underwent a pre-test and post-test electromyographic analysis (EMG) of the tibialis anterior, vastus lateralis, and rectus abdominis before and after eight weeks of horseback riding. The riding was conducted three times a week, for thirty minute sessions. The purpose of the study was to see if there was an increase in muscle amplitude and duration in the muscles tested. A secondary purpose was to see if there was an increase in cardiovascular activity caused by horseback riding. The subject's heart rate was monitored by a Vantage Performance Monitor and was recorded during each session.

The pre-test and post-test EMG was conducted in the human physiology lab at Eastern Illinois University. One page of EMG recordings was run on each muscle. Only the muscles of the right

side of the body were tested. The subject mounted a special apparatus which was built by the experimenter for the purpose of these tests. The apparatus was manually manipulated in the rhythmic stepping action of a horse. Each sheet of results on each muscle was measured and recorded in two separate ways. First the duration of the muscle was measured and then the amplitude. Each spike was measured and recorded by the experimenter. These scores were then compared using an unpaired, two-tailed, T-test.

By design, the heart rate was 73 beats per minute at the beginning of each session. The heart rates were recorded at fifteen minutes and again at thirty minutes by using a Vantage Performance Monitor. The changes in heart rate at fifteen and thirty minutes were compared using a paired T-test.

The muscle activity in the tibialis anterior, vastus lateralis, and rectus abdominis increased after the subject completed the horseback riding activity. There were statistically significant increases in both amplitude and duration of the EMG on each muscle. The subject's heart rate increased according to recorded scores taken during the riding sessions compared to that of the subject's resting rate and there was no significant difference between fifteen and thirty minutes.

DEDICATION

I would like to dedicate this project to my best friend and partner in research. Her cooperation and dedication to this study aided in its success. Without her willingness to achieve and her vast amount of knowledge in horsemanship, this project would not have had such positive results.

I dedicate this thesis to Babe, my horse of 21 years, who died September 5, 1989 at the age of 26, approximately one year after the completion of the practical part of this study.

Babe

She roams the higher plain today
With wind blown tail and mane;
Her eyes are bright--her step is light
She shows no hint of pain.

No fences there to hem her in--
She wanders to and fro;
In pastures lush and green with grass
Where crystal waters flow.

We loved to ride the wooded paths
Our lives were so entwined--
And then one day she slipped away
And left me here behind.

Now in my dream I saddle her--
We ride the midnight sky;
The night wind fresh against my face
Once more--just Babe and I.

(Written by my Mother, Kathryn Blackford)

Chapter I

INTRODUCTION

"I Saw A Child"

I saw a child who could not walk
sit on a horse, and laugh and talk.
Then ride it through a field of daisies
and yet he could not walk unaided.

I saw a child no legs below,
Sit on a horse and make it go
through wood of green and places he had
never been
to sit and stare, except from a chair.

I saw a child who could only crawl,
Mount a horse and sit up tall;
Then put it through degrees of paces
and laugh at the wonder in our faces

I saw a child born in strife,
take up and hold the reins of life
and that same child was heard to say,
Thank God for showing me the way.
John Anthony Davies

The first study of the value of horseback riding was undertaken by Chassigne in Paris in 1875. As a result of his experiments, Chassigne concluded that riding was beneficial in the treatment of paraplegia and other neurological disorders. Specifically, Chassigne noted an improvement in posture, balance, joint movement, and muscle control, brought about by the active and passive movements provided by the horse. (Rosin, 1980)

Since the time of Chassigne, horseback riding has taken on new forms. One form horseback riding has taken is Equestrian Therapy. Equestrian Therapy requires the involvement of a registered Physical Therapist in the horseback riding program for physically, mentally, or emotionally disabled individuals to create, monitor and/or carry out a program which will decrease the individual's present level of disability or prevent an increase of the disability. The physical therapist works in conjunction with a horseback riding instructor who specializes in working with handicapped riders. Personnel needed in the program will vary according to the type of disability and the degree of disability. (Stanford, 1982)

The second form of riding therapy, uses the horse's back as a surface to conduct a number of physical therapy exercises, including relaxation, stretching, strengthening, equilibrium, and coordination techniques. (Progress Report, 1983)

International attention was focused on horseback riding as a means of therapeutic recreation during the 1952 Olympic games, when Liz Hartel of Copenhagen, who had used riding to help her recover from poliomyelitis, won the silver medal for dressage. Since then, riding programs have been initiated for persons who are mentally retarded, emotionally disturbed, deaf, blind, autistic, and physically disabled. Many programs are geared toward the orthopedically and neurologically impaired. (Freeman, 1983)

Riding is dynamic rather than static and the benefits of the normal activity are enhanced by the position of the rider on the horse and the constant need for weight-shifting. Horseback riding enhances the neurologically handicapped person's ability to respond to a variety of sensory stimuli, because of sensory information from the tactile, auditory, visual, skeletal and vestibular systems. (Freeman, 1983)

Riding can be a relaxing and wonderful form of active recreation. Along with goals of strengthening specific muscles and improvement of balance, riding has some other purposes. It serves as a method of low-level cardiovascular conditioning, especially for persons in a wheelchair who have only a minimum of physical activity. This is accomplished through different gaits, for example the trot is excellent for improving circulation and respiration, as it requires more physical exertion on the part of the rider. On a horse, a disabled rider achieves success in an activity that many able-bodied persons find difficult. The psychological benefits are tremendous since the disabled person becomes mobile while on a horse. (Rosin, 1980)

Purpose

The purpose of this study was to examine the amount of muscle amplitude and duration in the tibialis anterior, vastus lateralis and rectus abdominis before and after eight weeks of horseback riding. A secondary purpose of the study was to measure and document the heart rate of the subject before, during and after each session of riding to show an increase in the use of the cardiovascular system.

Hypothesis

As a result of the subject participating in regular horseback riding activity, the muscle amplitude and duration of the tibialis anterior, vastus lateralis and the rectus abdominis will increase according to electromyographic analysis. The dynamic activity of riding will also promote some increase in cardiovascular activity.

Delimitations

This study was a case study and was limited to a particular subject who volunteered for the study. The subject was a classification T8 paraplegic. The test was limited to muscles on the right side of the subject since the test caused some fatigue to the subject and it would not be necessary to measure both sides of the body.

An electromyography of the muscle amplitude and duration were taken while the apparatus was manually manipulated to simulate the walking action of a horse. Measurement occurred in the human physiology lab in order to gain a more accurate response from the muscles tested. All measurements and recordings were done by the researcher. This was done in order to decrease any variability in the findings. The muscles measured were the anterior tibialis, vastus lateralis and the rectus abdominis on the right side of the subject. A secondary procedure was the measurement of the subject's heart rate. This became a concern after realizing the effect on the subject's pulse rate during the pre-test.

Measurements of the pulse were taken with a Vantage Performance Monitor while the subject was on the horse. These were, however, taken outdoors under various climate conditions.

Limitations

A generalization to a populace would not be applicable since this investigation was a case study of one person with a particular disability.

Definitions

Active Cushion-the cushion used by the subject. It is a specially made cushion for paraplegics who are active. It has a special gel in the seat to sit on and save the paraplegic from possible pressure sores. It also has straps that fasten around the legs in order to keep it under the person's seat so that it goes where the paraplegic goes.

Apparatus-a specially made device for this study. It was constructed for testing purposes. The device had a saddle on a barrel which rested on springs and was manually manipulated in the walking action of a horse. (See Diagram I)

Canter-this is a three beat, slow, collected, running gait of a horse similar to a gallop.

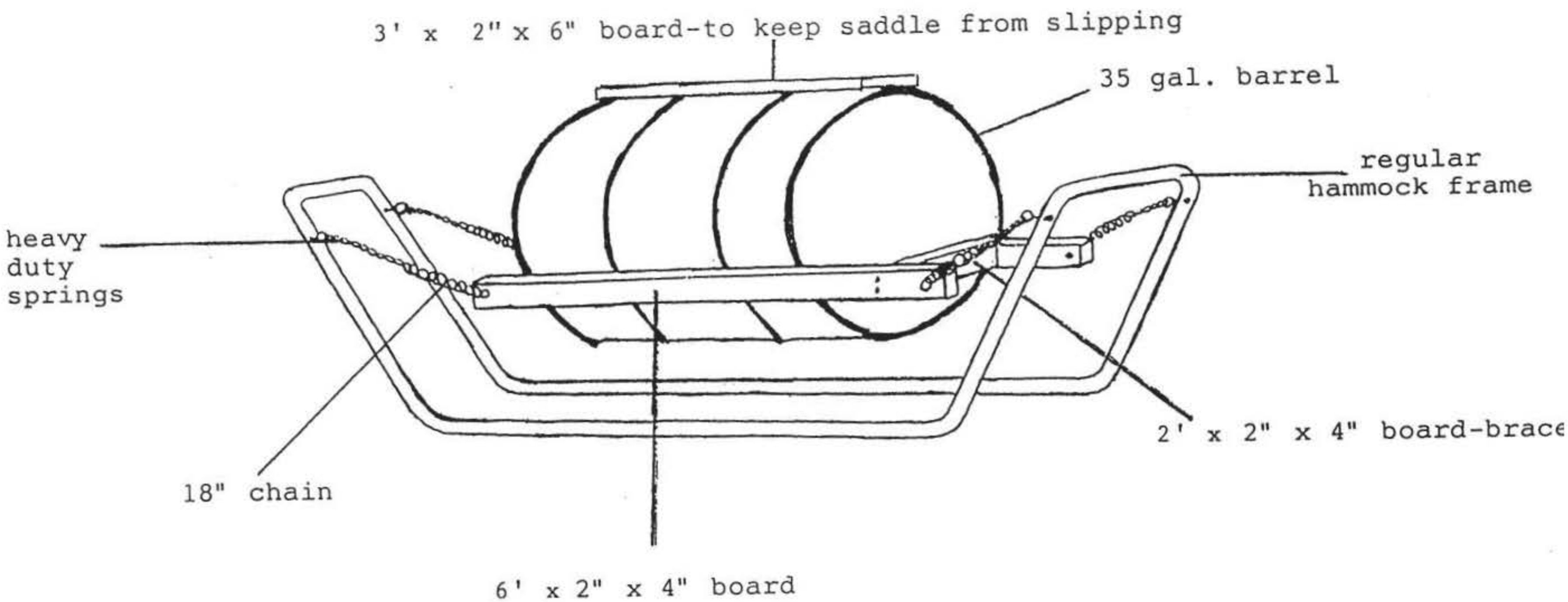
Classification T8-classification is determined at the lowest normally functioning nerve root segment. In the subjects case it is the eighth vertebra of the thoracic level.

EMG-is an abbreviation for electromyography. Electromyography measures muscle duration and amplitude during contraction of the muscle.

English Riding Bat-a small hand held whip used most often for show jumping and also used in making the horse move faster into different gaits.

DIAGRAM I

Apparatus Designed for Simulated Horseback Riding



Hippotherapy-a horseback riding program designed to be specifically therapeutic. Hippo is the Greek word for horse and therefore has been established as a term for horseback therapy. Hippotherapy is an extension of traditional therapeutic programs for persons who are mentally retarded, emotionally disturbed, deaf, blind, autistic, and physically disabled.

Horseback Activity-mentally learning and physically applying the act of riding a horse.

Paraplegia-is paralysis of the lower body including the lower extremities caused by trauma, disease, infection or tumor of the spinal cord. Following complete transection of the spinal cord there is immediate onset of motor paralysis and loss of sensation below the level of the lesion, including loss of bowel and bladder control.

Vantage Performance Monitor-is a microprocessor-based instrument which can record cardiovascular exertion levels during exercise.

Chapter II

REVIEW OF RELATED LITERATURE

Introduction

Research dealing specifically with paraplegic horseback riding is limited, therefore a review of literature will be presented under the following topics: 1) the paraplegic, 2) fitness of the spinal cord injured, 3) activities for the paraplegic, 4) horseback therapy, 5) recreational riding, 6) physical benefits of riding.

The Paraplegic

During the past four decades the understanding of spinal cord injury has developed and improved. But because of its multisystem involvement, it still remains one of the most catastrophic injuries--socially, economically and physically--to occur. (Krusen, 1982)

Two decades after the end of World War I, Hinman wrote that most fatalities among patients with spinal cord injuries were due to urinary tract infections and bedsores and the failure to prevent or control these. Improved understanding of the management of the bladder dysfunction and improved nursing care for the prevention of bedsores accounted for changes in survival rates prior to and during World War II. (Krusen, 1982)

In 1943, Manro reported a mortality rate of 0.575 per year in 40 patients during the previous nine-and-one-half-year period. In 1958, a Veterans Administration study of 5743 patients with spinal cord injuries who survived the immediate handling and the potential early complications in service hospitals and who were subsequently treated, between 1946 and 1955, for their traumatic paraplegia or quadraplegia disclosed an overall mortality rate of 0.139 of those studied. As the incidence of urinary tract complications declined with progressively better management, the longevity of the spinal cord-injured individual has increased. Spinal cord injury occurs most frequently in younger age groups: 80 per cent are under age 40; the median age is 23; the mean 29; and the most common age is 20 years. Fifty per cent of the spinal cord injured have an impairment of quadraplegia, and 82 per cent are male. (Krusen, 1982)

In 1957, Michaelis estimated, there were approximately 10 new cases per year of spinal injury per million of the population of a country. In a study during the years 1960 to 1967 in Switzerland, Gehrig and Michaelis concluded that the annual incidence was 15 per million population, with an annual increase of 1.7 per cent. The National Spinal Cord Injury Data Research Center in a 1979 report describes an annual incidence of 30 to 35 based on individuals who do not succumb prior to hospital admission.

The 1982 edition of the World Almanac of Facts reported 9.4 million cases of spinal injury in that year. These cases were males and females of all ages and there is a reported 10,000 new cases every year in this country.

Fitness of the Spinal Cord Injured

In previous years, the patient with a spinal cord injury was not considered a special problem. It was taken for granted that the patient was a hopeless invalid with a very brief life expectancy. Now, with the application of intensive rehabilitation methods plus perseverance on the part of the patient, these people can live useful and independent lives. (Krusen, 1982)

It is well documented that skeletal muscle paralysis results in disuse atrophy as well as decreased strength and endurance. Preliminary studies performed on paralyzed muscles of humans have indicated that exercise training consisting of electrically-induced pulsatile isometric contractions could improve muscle performance and increase muscle strength and endurance. It should be understood that exercise needs to become a permanent part of one's lifestyle if beneficial effects are to be maintained. (Faghri, et al., 1989)

Corrective therapy is initiated early in the schedule to prevent deconditioning and to hasten ambulation as much as possible. Exercise is given to maintain muscle tone and develop power. (Kessler, 1950)

Activities for Paraplegics

Activities for paraplegics have been very limited in the past. With medical advancement and a better understanding of the problem on the part of the patient, activities are increasing and improving. (Krusen, 1982)

Sports such as wheelchair basketball, tennis, racquetball and even flag football are being developed. Participation is growing. Swimming is also a popular activity for the wheelchair bound. Activities such as these provide psychological, social and physical benefits. Most are performed indoors and most are performed from the wheelchair. (Wolf, 1986) The opportunity to reach beyond the wheelchair and into the outdoors doesn't happen often. With horseback activities this can be accomplished. Riding stimulates the disabled person's interest in an outside activity. Exercises that are dull and repetitious become enjoyable and game-like when executed on horseback. (Rosin, 1980)

Horseback Therapy

Using horses as therapeutic instruments began approximately in 1974 in Germany and Switzerland where it is widely accepted. In America, however, acceptance has been somewhat slower. There are a few riding therapy centers with therapists trained in hippotherapy and riding skills in the United States. (Progress Report, 1983)

Hippotherapy (hippo meaning horse in Greek), and riding therapy aims at improving neuromuscular control of the head and trunk; maintaining posture of the trunk; improving the muscular control of the hip joints; and helping with spatial orientation, concentration, motivation for physical and mental activity, and communication. According to Jan Jockich, a rehabilitation specialist and program director of the Old Dominion School of Therapeutic Horsemanship in Great Falls, Virginia, "The horse seems to be able to accomplish the therapy with a lot more joy, attention and cooperation than the conventional types of therapy." (Progress Report, 1983)

The key aspect of hippotherapy is the movement of the horse--a three dimensional swinging motion (up and down, forward and backward, and side to side) which, if the animal is properly trained, corresponds with the human gait for its rhythm and course. "These movement patterns can stimulate areas of the body the patient is not able to normally stimulate." (Progress Report, 1983)

Recreational Riding

According to Gordon, and Stewart, (1975) "All horseback riding is therapy, and all horseback riding is recreational. Any riding program, if properly organized will provide physical improvement and emotional satisfaction. That is the ultimate goal."

Scientific studies and research supporting the benefits of horseback riding as recreation or as a form of therapy are virtually non-existent. Dr. S. R. Rosenthal, Medical Director of the Research Foundation in Chicago conducted a study of the post-riding physical and mental reactions of 102 physically handicapped children in Canada, the United States and Great Britain. His study was based on the observations of therapists and riders which showed that the feelings that occurred ranged from elation to euphoria. The study also showed an increase in mobility, motivation and courage. According to Dr. Rosenthal, "Riding is a risk exercise and fills a primal need of man to engage in controlled risk activity." Dr. Rosenthal believes that because of the life of modern man the need to take physical or mental risks has been virtually eliminated. "This desire to be physical and to take risks likely remains in man's genetic structure." (Fourteenth World Congress of Rehabilitation International, 1980)

Dr. Rosenthal goes on to suggest that because of a lack of risk taking activity, there is likely a hormone or body chemical deficiency which leads to diminished vigor, motivation and courage. This theory would help to explain the improved mobility, motivation and courage as well as the feelings of euphoria. Therefore, horseback riding programs may in fact serve some of man's deep primal physiological and psychological needs. (Fourteenth World Congress of Rehabilitation International, 1980)

Since riding is a risk sport, there is a challenge for the rider to learn the sport well. This is also accompanied by feelings of achievement and mastery of the rider over the horse. According to Joseph Baur, "motivation of disabled persons to overcome their handicap through increased physical efforts is often unconsciously triggered by their ambition to master their mount or perform on its back in a certain, in their eyes more or less daring manner."

Handicapped persons gain confidence as well as self-esteem in proving that they can participate in a sport that is normally performed by able-bodied persons. Patricia Lynn Rosin, B.PT., explains that the most important psychological benefit is that once mounted, the disabled rider does not appear handicapped. Most importantly, people must "look up" to a handicapped rider on a horse, rather than "looking down" on the rider as occurs when in a wheelchair. (Rosin, 1980)

Physical Benefits of Riding

Sport is the most natural form of exercise. It can help put the handicapped person back in the mainstream of life, it will also help him/her develop his/her remaining capabilities. (Fourteenth World Congress of Rehabilitation International, 1980)

Very limited research has been done on the physiological benefits of riding. Some of the suggested benefits of riding are:

1) Improved relaxation of spastic muscles, i.e. decreased spasticity.
2) Increased strength.
3) Improved coordination and reflexes.
4) Improved balance.
5) Improved mobility.
6) Improved cardio-respiratory function.
7) An improved sense of well-being. (Rosin, 1980)

The following list of benefits of exercise have been documented and categorized by Dr. Lorentz, a German specialist in sports medicine. He claims that exercise positively effects the body in the following areas.

1) The central nervous system and organs of equilibrium.
2) The heart and its vessels.
3) The respiratory system.
4) The blood and the blood vessels.
5) The digestive system and metabolism.
6) The constitution.
7) The body movement.

In comparing the two lists, it is obvious that riding benefits the handicapped in most of Lorentz's categories. This supports riding for overall well-being for the handicapped person. (Rosin, 1980)

Improved Balance Through Horseback Riding

Balance is improved by eliminating the need to concentrate on standing on one's feet. For someone unable to stand, maintaining an erect posture astride a moving horse develops reflex action, improved muscle strength and an awareness of body position. All of which cannot be reproduced by exercises. (Rosin, 1980)

Because of the need for sensory input, the use of stirrups is essential. Sensations such as temperature, position and texture are transmitted from the feet to the brain. If injury prevents walking, a lot of this sensory input is lost-but with repeated pressure on the pads of the feet, the stirrups can assist in restoring the sensory pathways. Stirrups help maintain the rider's balance by relieving the weight of the legs and taking strain from the lower back. (Rosin, 1980)

As the horse moves, balance is unconsciously adjusted by the rider to maintain a steady erect position in the saddle. It is this unconscious use of muscles that makes them function again. This process is the best way to recall the normal function of a muscle. (Rosin, 1980)

The horse provides instant feedback to the rider in a most direct manner and is especially appropriate in developing or retraining balance, coordination and cognitive powers. (Fourteenth World Congress of Rehabilitation International, 1980)

Improved Strength Through Horseback Riding

Since riding is a sport, the rider will enjoy it more than a prescribed set of exercises and will likely try harder and persevere longer. Any form of exercise will increase muscle strength (whether or not it is a conscious total body involvement exercise) and will increase overall body strength. (Rosin, 1980) Often, this increase is measured with electromyography. Experiments have shown that the intensity of a muscular contraction is reflected in the total quantity of EMG response. A linear or near linear relationship exists between integrated EMG activity and force of isometric muscular contraction. Investigators have used EMG techniques to evaluate relationships between states of the nervous system and human neuromuscular functioning. (Morris, Beaudet, 1980)

Increasing the use of a muscle will aid in strengthening the muscle. While riding, the unconscious use of the abdomen, quadriceps and tibialis anterior to maintain balance will also increase their strength. (Freeman, 1983)

Improved Flexibility Through Horseback Riding

Decreased range of motion often results from a lack of movement. Riding promotes movement and prevents the decreased range of motion which would likely occur if the person remained inactive. (Freeman, 1983)

Increased range of motion is also brought about by the stretching of tight structures. A person permanently bound to a wheelchair is likely to have tight knees, ankles and hip structures. Riding is an excellent way to stretch and loosen these structures. (Freeman, 1983)

Improved Cardiovascular Fitness Through Horseback Riding

As an exercise, riding develops a certain amount of cardiovascular and cardiorespiratory fitness. Riding is not an easy sport since the rider doesn't merely sit on the animal. Instead, it demands a certain amount of participation from the rider. The large muscle groups are extremely active during riding, thereby increasing the oxygen uptake and improving the level of fitness. (Rosin, 1980)

For most handicapped persons, riding is the most strenuous activity they will be involved in. Therefore, it is bound to increase their cardiorespiratory status. Because of increased demands of the muscles for oxygen, the circulation to the muscles, brain and spinal cord is also increased. Plus, physical exertion forces the rider to take deeper breaths and fully ventilate the lungs. This increased depth of respiration should improve gas exchange and prevent secretions from building up in the airways. (Rosin, 1980)

The increase in circulation added to the general sense of health and well being attained from exercise and fresh air is very beneficial to a disabled person. Exercise will also stimulate body metabolism and overall bodily functions causing the person to sleep better, eat better, and be more relaxed than without exercise. (Rosin, 1980)

Robert Mayberry sums up riding most effectively: "What happens and why when a child or adult who is disabled, learns to ride, when he becomes one with the horse, are not yet clearly understood. Is it the unique movement of the horse, the psychodynamics involved, or a primal atavistic need for experiencing controlled risks? Perhaps, it is all or none of these; suffice to say, the mystique of the horse is strong medicine."

<u>Summary</u>

The review of related literature encouraged the use of the horse for therapeutic and recreational exercise for the physically disabled. The psychological, emotional and physical benefits seem to be very strong for these riders. Riding adds to the list of different activities which are becoming available for paraplegics. The added physical benefits for the paraplegic only add validity to the use of promotion of riding activity for paraplegics The literature suggests improved balance, strength, mobility, coordination and reflexes as well as elevated cardiovascular function which all add to the feasibility of horseback riding for paraplegics.

Chapter III

METHODOLOGY

Procedures

This study was designed to examine the effect of horseback riding on the tibialis anterior, vastus lateralis, and the rectus abdominis. A secondary concern was the effect of the horseback riding on the heart rate during this activity.

The Subject

The subject was a 27 year old male who volunteered to participate in the study. He is a paraplegic with a complete spinal injury and is classified as a T8. The subject resides in Kansas, Illinois. The subject was previously a college athlete who played basketball at Bemidji State University in Minnesota. The subject is 6'1" tall and weighs 185 pounds. While deer hunting, he fell 9 ft. from a tree stand shattering the eighth vertebra of the thoracic area.

Methods

This study consisted of a pre-test and a post-test EMG reading of the tibialis anterior, vastus lateralis, and rectus abdominis. The first test was a pre-test for the purpose of determining the amount of muscle duration and amplitude. Also, at these times the heart rate was monitored to determine the amount of fatigue involved in the testing. The meetings were conducted at 3:30 p.m. in the Physiology lab of the Life Science building at Eastern Illinois University.

Heart Rate

The heart rate was taken by using a Vantage Performance Monitor which the subject wore while on the horse. The subject's resting heart rate was 73. The rate of 73 was reached before the riding began, to start with a consistent baseline. Before the subject mounted, the chest band of the monitor was placed on the subject's chest-then the watch was placed on the subject's wrist. At this time, the heart rate was measured to make sure that the subject reached his resting heart rate before the activity began. The heart rate was recorded after fifteen minutes and again at the end of the thirty minute session. (See Appendix A)

The Horse

The horse used was a twenty-five year old Quarter horse mare. She had been trained as a western pleasure show horse and was easy to handle and extremely gentle and patient. The horse was relatively small at 14 hands or 56 inches tall. This aided the subject in mounting and dismounting.

The Tack and Other Adaptations

The use of a Western saddle can be beneficial for a paraplegic. The seat is slightly deeper than an English saddle and the back of the seat comes up higher giving the rider a more stable position. Also, a horse trained for Western riding can be directed with one hand allowing the rider to hold on to the saddle horn with the other hand. This may be imperative for those with a spinal injury on a vertebra high on the spinal cord.

The saddle used was a Simco western show saddle with a 15" seat. The saddle has metal rings attached to the skirt in the rear. This was necessary for holding up the D rings that held the subject in place. The D rings were screwed onto the metal rings of the saddle and firmly tightened. Two nylon luggage straps, 2" by 6', were run through the D rings. One strap went forward around the subject's legs and in front of the saddle horn where it was fastened. The other one went slightly upward and tightened around his waist. The first strap was used to keep his legs from bouncing up and down. The second one was used to keep his seat firmly against the saddle.

The bridle used was a regular Western bridle with a slight adaptation. The reins were split leather and were tied in a slip knot at the very end and hung over the horn and pommels of the saddle. A cotton lead rope was then attached and adjusted so the subject could pull the horse to a stop without choking up on the rope. This was done to help the subject control the horse by himself. The leather reins tied around the horn worked as a safety catch in case the horse jerked the rope from the subject's hands. This way he could pick up the reins and still control the horse. The single lead rope was used so the subject could control the horse with one hand. He needed the other hand to hold onto the horn to keep his balance since he does not have the use of his lower back and lower abdominal muscles.

Other adaptations included placing 24" by 15" pieces of fleece under his legs. These pieces of fleece went from his midupper thigh down to his ankle bone to insure against saddle sores. The subject also carried an English riding bat which he could slip over his wrist. Since he could not kick the horse, he tapped her with the bat on the shoulder to make her go forward.

Pre-Test Procedure

During the pre-test, the subject was tested to determine the amount of muscle activity in the tibialis anterior, vastus lateralis, and rectus abdominis. The tibialis anterior was tested first, then the vastus lateralis and the rectus abdominis was done last. Only one sheet was run on each muscle since there was some fatigue on the subject from transferring his weight to the apparatus. The muscles of the right leg were the only ones tested; this allowed the subject less time in the testing procedure. Once the subject was on the apparatus and it was in place, the apparatus was manually manipulated in the rhythmic stepping action of a horse. The entire testing procedure took approximately one hour.

During the first meeting, the balance and posture of the subject was noted on the apparatus. This was done by watching the position of the subject on the apparatus and also by verbal feedback of the subject on how he felt once he was on the apparatus and when the apparatus was placed in motion.

For the purpose of testing, the subject wore shorts to allow for easy access to the muscles of the leg. The subject also wore an active cushion to protect him from possible pressure sores.

The subject transferred his own weight from the wheelchair to a lab table top. A cushion was placed under him after he was on the table to prevent bruising and to help stabilize him. The apparatus was then moved in front of the table for easier mounting. The subject slid his left leg over the top of the saddle and pressed up with his arms while two spotters moved him over onto the saddle. The spotters were on each side of him and a third person stabilized the apparatus. After the subject was in place, his feet were placed in the stirrups. The apparatus was then slid into place directly in front of the electromyograph recorder by the spotters.

Placement of the Electrodes

The electrodes used in the study were Narco-Biosystems 710-0010 surface electrodes which were 11 millimeters in diameter.

Double adhesive washers were placed on the electrodes. The adhesive washers were used to keep the electrodes in place over the muscle belly during testing.

Electrode paste, Redux Creme, number 651-1021 from Hewlett Packard Medical Electronics was placed on the skin surface between the muscle and the electrode.

The negative electrode was placed on the belly of the muscle being tested, approximately 3 cm from the origin. The positive electrode was placed proximal to the muscle belly 1 cm from the negative electrode. The ground electrode was placed anterior to the positive electrode at 1.5 cm. This same procedure was conducted on all three of the muscles that were being tested.

Regular Riding Sessions

The riding was conducted three times a week for thirty minutes. Sessions occurred every other day in the morning or evening to avoid the heat of the summer days.

The riding was done at a stable in Charleston, Illinois. The subject signed release of injury and informed consent forms which were kept on file by Eastern Illinois University, the stable and myself. (See Appendix B)

The riding took place in a 45′ by 60′ outdoor arena. However, on two separate occasions the riding took place in a 25′ by 50′ indoor arena because of rain.

Mounting

Mounting was done outside next to the outdoor arena in which the activity took place. The subject pulled his handicapped equipped van parallel to the fence of the arena with the passenger side facing the fence (this was the side his wheelchair lift was on). The van was parked approximately 10 feet from the fence. A ditch of approximately 12′ by 8′ was dug with a front end loader tractor, between the van and the fence. This was done so that the horse would stand down in the ditch making her slightly lower than the subject in his wheelchair.

Once the van was parked and the wheelchair lift was in place, the subject put on the Vantage Performance Monitor since mounting would raise the heart rate. The subject when wheeled out to the edge of his wheelchair lift to mount.

Three people assisted the subject in mounting. Once person led the horse into the ditch between the van and the fence. The fence helped keep the horse from moving sideways away from the van. Once the horse was in place and close enough to the subject, two spotters moved in to assist the subject. One person was at the left shoulder of the horse and the other was at the left hip. After two weeks of mounting, the person at the shoulder was no longer needed. It was imperative that the person holding the horse stood directly in front of her and kept her completely still.

To mount, the subject manipulated his right leg up from under his knee and extended it out across the saddle. Then he scooted forward to the front edge of his wheelchair. At this point, a spotter placed his left foot into the left stirrup of the saddle. This was done so that the subject's leg could be used as a lever when he pressed up into the saddle. After his right leg was across the saddle and his left foot was in the stirrup, the subject grabbed the saddle horn with his left hand and the back of the seat with his right. On the count of three, the subject did a body press upward and over with the spotters moving with him. His active cushion was attached around the legs and waist so it went with him giving him support as well as a cushion to land on.

As soon as the subject was mounted, the horse was led a few steps forward. The spotters moved with her. This was done to prevent her from bumping the subject's legs on the fence or the wheelchair lift. After she was clear of these obstacles, two pieces of fleece were placed by the spotters under the subject's legs to prevent saddle sores. The subject was then strapped onto the saddle. Two nylon luggage straps were used to support the subject's legs. The lower strap went forward over the subject's legs and around the saddle horn while the second strap went slightly upward around his waist like a seatbelt.

Riding

Once the subject was secure in the saddle, he was led into the arena. For the first two weeks, three people were needed. One led the horse while the other two spotted on each side of the subject. These spotters stayed very close to the subject - each with a hand on the back of the saddle. During the second week, however, the two spotters did not keep their hands on the saddle.

Each session lasted thirty minutes. This was timed from the moment the subject entered the arena and actually started riding. After ten minutes of riding, the horse was stopped and the subject was unstrapped. While he was unstrapped, he would press up off of the saddle and shift his weight slightly. The spotters would push his cushion under him again since it had a tendency to work its way backward. The fleece pads under his legs were checked as well and moved if needed. After everything was checked and the subject felt secure, he was strapped back into the saddle and another ten minute ride would begin. This was done twice during the thirty minute session; however, after four weeks the subject wanted to push himself and stop only once after fifteen minutes. The amount of time he was stopped was not timed; only the time he spent riding. The estimated average rest time was three to five minutes. The subject's pulse rate was checked at the halfway point, which was after fifteen minutes of riding. During riding, the subject checked his own pulse by reading the heart monitor and reported it to the investigator to be recorded. The pulse was taken again after thirty minutes of riding and recorded. This was done before the subject dismounted, since dismounting raised his pulse rate.

After the third week of riding, only one spotter was used. The horse was still led and made to walk quickly. After the fourth week, the person leading the horse was no longer used and two spotters walked next to the subject as he learned to control the horse on his own. During the fifth week, the subject started riding completely on his own; however, one person stayed in the center of the arena in case he needed assistance. By the end of the sixth week this person was no longer used and the subject was in complete control.

Gait

The gait used was a walk for the first two weeks. The horse was led and made to walk quickly. During the third week the subject wanted to try a trot and the horse was led at this pace. The subject learned to ride at a trot with a spotter beside him.

During the fifth week, however, all spotters were completely removed and he continued to ride at a trot. At the end of this week, he tried a canter by himself. At first he simply cantered from one end of the arena to the other just to get an idea of what it was like. The subject felt comfortable with this; and his balance was good so be began riding at a canter the sixth week. At this time he started practicing different maneuvers with the horse. He worked on stopping and starting, turning from side to side, riding in circles and figure eights, and also backing. The purpose of this was to make the horse listen to the subject as the rider and for him to know what could and could not be done with the horse. He also learned how he would have to command the horse so he could eventually ride on trails or roads outside of the arena.

Dismounting

The first dismounting session proved to be a hazard for the subject. The idea at the beginning was to take him off of the horse the same way he went mounted. This was done by leading the horse back into the ditch between the van and the fence. One person led her and moved her as close to the wheelchair lift as possible. Then that person stood in front of her to keep her completely still. The two spotters moved in at the shoulder and the hip of the horse on the left side. The spotter at the hip went around the horse and took the subject's right foot out of the stirrup. The spotter at the shoulder took his left foot out of the stirrup and unstrapped him. The subject again pressed his body up, using the horn and the seat of the saddle. At this point the spotters moved in closer, lightly holding his legs. The subject then had to turn and slightly fall into his wheelchair which was locked in place on the lift.

This type of dismounting proved to be a difficult maneuver for the subject to accomplish. There was also the danger of hurting the subject's leg when the horse was led back into the ditch. This was more difficult than when he mounted because the horse needed to be closer to the van since the subject had to reach across the seat of the chair to gain his balance for the dismount. Also, there was a problem with the fact that he had to twist his body to come back to his chair. On one occasion he twisted his ankle as he was doing this maneuver.

Therefore, a second method was adopted. The subject decided that we were actually "over adapting" for his disability and that the safest way for him to dismount would be as an able bodied person would. The second method of dismounting was much easier and went quicker with less complications. The subject rode the horse out of the arena and stopped in a level clearing. At this time, a final heart rate was recorded. While this was took place, one of the spotters pulled the subject's van away from the ditch and turned it around on a level spot close to the subject. His wheelchair was lowered to the ground and then wheeled over to the horse. A spotter moved in to hold the horse and the chair was moved to the left side of the horse with the foot braces slightly under her. The other spotter moved to the right side of the horse and dropped the subject's right foot from the stirrup and unstrapped both of the safety straps. The spotter at the head of the horse dropped his left foot from the stirrup and stood in front of the horse to keep her completely still. At this point, the spotter on the right manually moved the subject's right leg in a backward lifting motion just as an able bodied person would do when dismounting. As the spotter moved the subject's leg, the subject would lean forward over the saddle horn. The leg was brought back over the horse's rump turning the subject sideways over the saddle. This left the subject with his upper body across the saddle and his legs hanging free in front of his wheelchair. Once the subject was in this position the spotter on the right moved away and the subject held the saddle horn with his left hand and the back of the saddle seat with his right. Then he lowered himself without assistance into the seat of his wheelchair. The person holding the horse stepped toward the subject and made sure his legs folded properly while the spotter at the rear of the horse watched where the wheelchair was and adjusted it to him if necessary. Once the subject was safely into his wheelchair, he placed his feet on the foot braces and then rolled himself backward in the chair away from the horse. Following this, the horse was led away.

In dismounting it was imperative that the saddle be fastened as tightly as possible, since the subject lowered himself to his chair by holding onto the saddle. It was also important that the horse stand completely still since the subject's legs ended up practically beneath her. Before the subject dismounted, the horse was sprayed with fly-spray to prevent her from stomping and accidentally kicking the subject's legs.

Post-Test Procedure

The post-test occurred eight weeks after the pre-test. During the post-test, the subject was tested to determine the amount of gain in muscle activity from the horseback riding in the tibialis anterior, vastus lateralis and rectus abdominis. The procedures of the post-test were followed as closely as possible to the pre-test.

As in the pre-test, the muscles tested were in this order; tibialis anterior, vastus lateralis, and rectus abdominis. Again, because of some fatigue on the subject, only one sheet was recorded on each muscle. The muscles of the right leg were the only muscles tested. The test was conducted in the Human Physiology lab at Eastern Illinois University at approximately 3:30 p.m.

As in the first meeting, the balance and posture was noted. This was done by verbal feedback from the subject and observation.

Placement of Electrodes

The electrodes and the electrode paste used were exactly the same as in the pre-test. Also, all procedures were followed in precisely the same manner as the pre-test.

Measurement of EMG

The measurement of the amplitude and the duration of the spikes from the EMG on each muscle tested was taken by the researcher. Each page of recordings by the EMG machine was measured by following each spike in height and width. The individual spikes were measured with callipers and the callipers were then laid on a metric ruler and the scores were recorded in millimeters. Each individual spike was measured in two ways; the width or the duration which was the x axis and the height or the amplitude which was the y axis. This was done on the pre-test and the post-test with Tenormin 50 measuring callipers. The scores were then compared in a computerized unpaired, two-tailed T-test which compared the mean and standard deviation of the pre-test and post-test.

Heart Rate Recordings

The heart rate recordings were taken at fifteen minutes and thirty minutes. These recordings were subtracted from the resting rate of 73 to obtain two sets of 24 scores. These scores were then entered into a paired, T-test. An analysis of variance (ANOVA) comparing all three heart rates could not be performed since there was no variability in the resting rate.

Chapter IV

ANALYSIS OF DATA

This study employed electromyography to measure the muscle amplitude and duration of the tibialis anterior, vastus lateralis and the rectus abdominis. The study was designed to determine whether exercising by horseback would cause these muscles to respond to the activity and increase the action of the muscles tested. A secondary purpose was to measure the heart rate of the subject to see if the activity caused any increase in the cardiovascular system.

Participating in the study was a 27 year old male paraplegic who volunteered for the study. He is a classification T8 with a complete spinal injury.

Pre-test vs. Post-test

One page of EMG recording based on a sixty second interval was used from each muscle. For each page, the spikes were measured from beginning to end. The measurements were taken in two different ways. The amplitude of each spike was measured as well as the duration. This was done exactly the same in both the pre-test and post-test.

The spikes were measured on the tibialis anterior, vastus lateralis and rectus abdominis. The measurements from each muscle were recorded in separate groups of duration, which is the x axis, and amplitude which is the y axis. These scores were than entered into a computerized unpaired, two-tailed T-test. Data from each muscle was entered separately and each axis was compared separately. The pre-test for duration was compared to the post-test for duration and likewise with the amplitude. The same procedure was then followed for all three muscles.

Table I presents a summary of the muscle amplitude findings. Presented in this table are a comparison of the means, standard deviations and T-scores. Also presented are the N value, standard error of the mean, range and level of significance of muscle amplitude.

Table II presents a summary of the muscle duration. The same comparisons of means, standard deviations and T-scores are represented as in Table I. Also presented again are the N values, standard error of the mean, range and level of significance of muscle duration.

Tibialis Anterior/Amplitude

The pre-test of the tibialis anterior for amplitude scored a mean of 5.28, a standard deviation of 4.43 and a standard error of the mean of .33. The N value was 178. The post-test for amplitude scored a mean of 6.60, a standard deviation of 4.54 and a standard error of the mean of .35 and N was equal to 161. This produced a T score of 2.91. The post-test was significantly greater than the pre-test and was significant at the .01 level. (See Table I and Appendix C)

TABLE I

Muscle Amplitude Results from Pre-Test/Post-Test

	T. Anterior Amplitude		V. Lateralis Amplitude		R. Abdominis Amplitude	
	Pre	Post	Pre	Post	Pre	Post
N	178	161	171	163	154	124
Mean	5.28	6.7	3.11	4.81	8.59	17.14
SD	4.43	4.55	2.64	3.04	10.08	14.32
SEM	.33	.35	.2	.24	.81	1.29
Range	1-28	1-31	1-20	1-18	1-87.5	2-53
T-Score	2.91		5.45		5.83	
Significance Level	(P<0.01)		(P<0.01)		(P<0.01)	

TABLE II

Muscle Duration Results from Pre-Test/Post-Test

	T. Anterior Duration		V. Lateralis Duration		R. Abdominis Duration	
	Pre	Post	Pre	Post	Pre	Post
N	178	161	171	163	154	124
Mean	1.11	1.6	1.32	1.72	1.37	1.92
SD	.61	.76	.72	.85	.78	1.28
SEM	.05	.06	.05	.06	.06	.12
Range	.5-3	.5-4	.5-4	.5-5.5	.5-5	.5-10
T-Score	6.49		4.69		4.37	
Significance Level	(p<0.01)		(p<0.01)		(p<0.01)	

Tibialis Anterior/Duration

The pre-test of the tibialis anterior for duration produced a mean of 1.11 and a standard deviation of .61. The standard error of the mean was .04 and N was 178. The post-test produced a mean of 1.59 and a standard deviation of .76. The standard error of the mean was .06 and N equaled 161. A final T score of 6.49 was reached. This proved that the post-test was significantly greater than the pre-test at the .01 level of significance.
(See Table II and Appendix C)

Vastus Lateralis/Amplitude

The pre-test mean score on the vastus lateralis was 3.11, the standard deviation was 2.64, the standard error of the mean was .20 and N equaled 171. The post-test mean was 4.81, the standard deviation was 3.04, the standard error of the mean was .24 and N was equal to 163. The final T score was 5.45. This meant that the post-test was significantly greater. The level of significance was at the .01 level.
(See Table I and Appendix D)

Vastus Lateralis/Duration

The pre-test for vastus lateralis produced a mean score of 1.32, a standard deviation score of .72, and a standard error of the mean of .05. The N value was 171. The post-test mean score was 1.72, the standard deviation was .85, and the standard error of the mean was .06. The N value was 163. The T score was 4.69

and the level of significance was at the .01 level. Therefore, the post-test was significantly greater than the pre-test. (See Table II and Appendix D)

Rectus Abdominis/Amplitude

The pre-test on the amplitude of rectus abdominis produced a mean score of 8.60, a standard deviation of 10.08, and a standard error of the mean of .81. The N value was 154. The post-test mean was 17.14, the standard deviation was 14.32, and the standard error of the mean was 1.29. The N value for this group was 124. The final T score was 5.82. the post-test group was significantly greater than the pre-test group at the .01 level of significance. (See Table I and Appendix E)

Rectus Abdominis/Duration

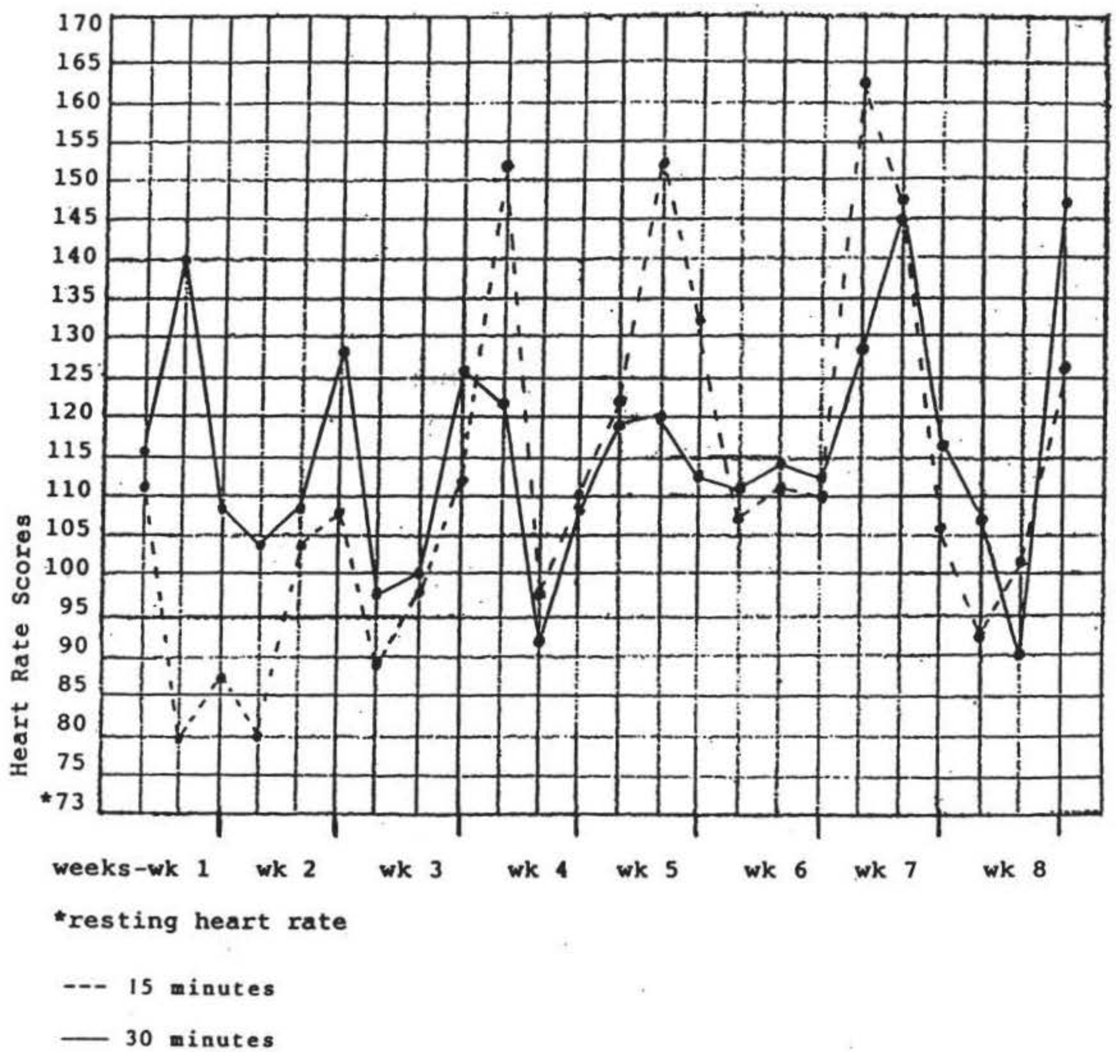
The mean for the pre-test on rectus abdominis was 1.37, the standard deviation was.78, the standard error of the mean was .06, and N was equal to 154. The post-test score for the mean was 1.92; standard deviation was 1.28, the standard error of the mean was .11, and N was 124. The T score was 4.37. The post-test was significantly greater than the pre-test at the .01 level of significance. (See Table II and Appendix E)

Heart Rate

The heart rate was measured with a Vantage Performance Monitor. This was placed on the subject and scores were taken at fifteen and thirty minutes during each session. (See Figure I)

FIGURE I

Heart Rate Scores for each Session



The pulse rate was recorded while the subject rode the horse. At the end of the study, scores were compared between the differences in the pulse during the activity and the subject's resting heart rate. The N value for the heart rate after fifteen minutes and thirty minutes was 24 each. The range for fifteen minutes was 80-163. The range for thirty minutes was 90-147. A paired two-tailed T-test was done on the difference between the fifteen minute scores (Group #1) and resting, and the thirty minute scores (Group #2) and resting. Group #1 had a mean of 112.5, a standard deviation of 22.9 and a standard error of the mean of 4.7. Group #2 had a mean of 115.1, a standard deviation of 14.6 and a standard error of the mean of 3.0. Mean #2 was not significantly different from mean #1. Therefore, once the heart rate had risen after fifteen minutes, it did not rise significantly more after thirty minutes.

Discussion

In discussing the benefits, scientific data has been collected to help verify the improvements of this study's subject. The results from this study provide validity to the physiological benefits of horseback activity for the handicapped. (See Figures II and III)

Various effects were experienced by the subject in regard to his own observation of his body resulting from the horseback riding. Prior to the riding, he walked with leg braces through a set of hand rails approximately ten feet long. This was done as part of his rehabilitation therapy. He continued this practice on

FIGURE II

Average Amplitude During Pre-Test/Post-Test

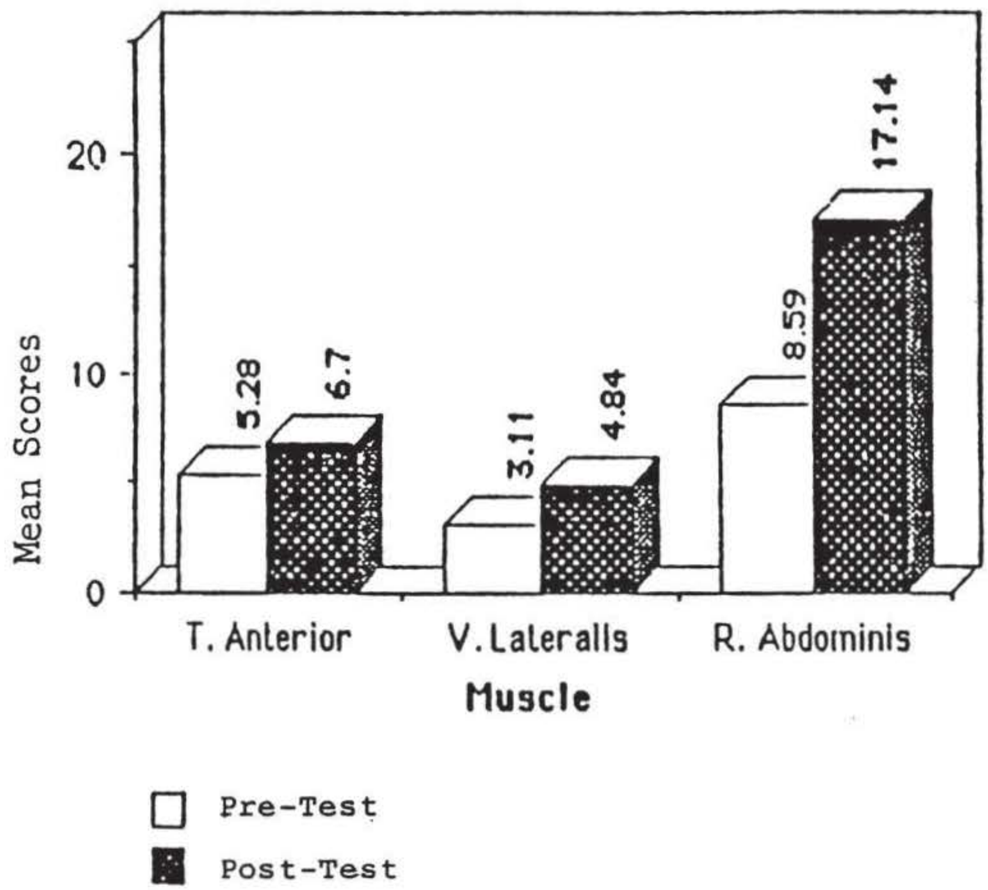
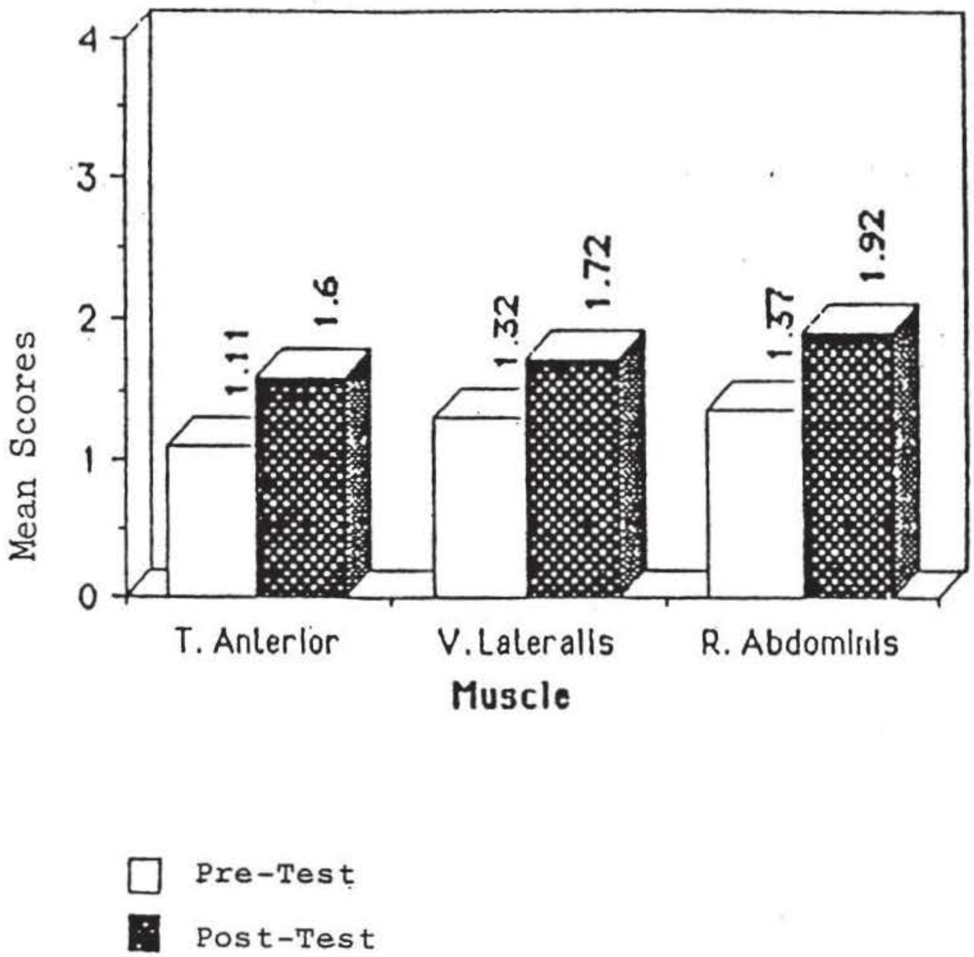


FIGURE III

Average Duration During Pre-Test/Post-Test



his own at home with his own set of hand rails. The subject refrained from this activity for the purpose of the study since this may have caused an effect on the leg muscles. Although, approximately halfway through the study he did get into the leg braces and stood using the hand rails. At this time he noticed it was much easier to stand and his abdomen looked as flat as before his accident. This was important to him since it had not been flat since that time. The reason for the relaxed abdomen was because of his inability to use those muscles. Therefore, he believed that the riding actually tightened those unused muscles in the abdominal area and helped him gain his balance more sufficiently. What the subject experienced, agreed with Rosin (1980) that improvement of balance is one of the most dramatic consequences of riding for the handicapped. Rosin claims that balance is a dynamic function that requires the constant adjustment of muscle tone and joint position in order to retain the weight over the base. Therefore, an increase in muscle tone in the abdomen would tighten those muscles as well as improve balance.

After the completion of the first week on the horse, the subject experienced lower back pain. This was exciting to him since the phantom pain was below the level of injury. It is not known exactly what caused the pain and in most cases of complete injuries phantom pain is unheard of. However, phantom pain is rather common in patients with partial injuries. The subject in this study had been diagnosed with a complete spinal cord injury.

According to a local neurologist, this may have been from a condition in which the spinal cord is pressed from the vertebra when the vertebra was injured instead of actually being severed.

Other positive signs noted by the subject were decreased spasticity and increased loosening of the muscles. This was especially noticeable when the subject first dismounted. His legs when mounting would be very rigid; after the riding session they would be extremely loose and relaxed.

The subject also felt that the activity aided in his digestion and helped the urinary tract. Activity is good for the system, especially in the area of the intestines where he has no muscle control. The same holds true for the bladder. Anytime a paraplegic can help the bodily functions is very positive, since paraplegics and quadraplegics have a high incidence of urinary tract infections.

The results of this study agreed with the conclusions of Rosin (1980) that any form of exercise will increase muscle strength whether it is a conscious total body involvement or not. The results of the improvement in amplitude and duration from this study support this position. This study showed a particular increase in overall muscle activity of the tibialis anterior, vastus lateralis, and rectus abdominis of a paraplegic as a result of horseback activity.

The study also agreed with Freeman (1983) that increasing the use of a muscle will also aid in the activeness of the muscle. According to Freeman the unconscious use of the abdomen, quadriceps and tibialis anterior to maintain balance will increase the strength of these muscles. In this study, there was significant improvement in these muscles in amplitude and duration, as a result of horseback activity.

In the area of cardiovascular activity, this study agrees with the study done by Rosin (1980) in the area of physical benefits. Rosin states that through riding, the large muscle groups are extremely active, thereby increasing the oxygen uptake and bringing about improved fitness levels. Rosin goes on to say that for most handicapped persons, riding is the most strenuous activity they will perform, so it is bound to improve their cardiovascular status. Because of the activity found in the large muscle groups in this study and the measurement of cardiovascular function, this study agrees with Rosin that cardiovascular activity will increase as a result of horseback activity.

Monaco '89, the Vth International Convention on the Relationship between Humans and Animals showed the extensive use of the horse for the handicapped and the amount of world wide interest. Guidelines and standards are being established by the North American Riding for the Handicapped Association, Inc., in order to gain credibility as a recognized form of therapy in the United States. The conference covered different types of therapy using the horse such as psychotherapeutic treatment. This form of therapy covers socialization skills and emotions that are verbalized while the subject is on the horse. The subject in this study found these factors crucial to his social and emotional development as well. Some of the other topics covered by the conference were: The horse as a facilitator for the human sensory-motor process; Training the horse and its application for therapeutic riding programs; and A plan for assuring quality in therapeutic riding programs. The amount of interest in the use of the horse for the handicapped provided by this conference verifies the need for scientific findings such as those provided by this study.

Chapter V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

This chapter will present a summary of the study, conclusions from the results of the study and recommendations based on those conclusions.

SUMMARY

Horses are now being used in various programs under various conditions. The use of horses for therapy and recreation for the physically and mentally disabled first began in Germany and Switzerland. The United States now has many schools and different riding programs as well.

Riding seems to be especially beneficial to those with neurological impairments. Treatment of paraplegia is very limited but recreational activities are advancing. The use of the horse is beneficial for paraplegics emotionally as well as physically. Measurements and evaluations of these benefits are lacking. This project analyzes and measures the physical benefits of a single classification T8 paraplegic.

The subject underwent a pre-test and post-test electromyographic analysis of the tibialis anterior, vastus lateralis, and rectus abdominis before and after eight weeks of horseback riding. The riding was conducted three times a week, every other day for thirty minute sessions. The purpose of the study was to see if there was an increase in muscle amplitude and duration in the muscles tested. A secondary purpose was to see if there was an increase in cardiovascular activity caused by horseback riding. The subject's heart rate was monitored by a Vantage Performance Monitor and was recorded during each session.

The pre-test and post-test electromyographic analysis was conducted in the human physiology lab at Eastern Illinois University. One page of EMG recordings was run on each muscle. Only the muscles of the right side of the body were tested. The subject mounted a special apparatus which was built by the experimenter for the purpose of these tests. The apparatus was manually manipulated in the rhythmic stepping action of a horse. Each sheet of results on each muscle was measured and recorded in two separate ways. First, the duration of the muscle was measured; then the amplitude. Each spike was measured and recorded by the experimenter. These scores were then entered into a computerized, unpaired, two-tailed T-test.

The heart rate was recorded at fifteen minutes and again at thirty minutes. The resting rate of 73 was subtracted from these scores. These two sets of scores were entered into a paired, two-tailed T-test to see if there was a difference between the risen heart rate of fifteen minutes and that of thirty minutes.

The hypothesis stated: "As a result of the subject participating in regular horseback riding activity, the muscle amplitude and duration of the tibialis anterior, vastus lateralis, and rectus abdominis will increase according to electromyographic analysis. The dynamic activity of riding will also promote some increase in cardiovascular activity." This was proven significant on each muscle in amplitude and duration at the .01 level of significance.

CONCLUSIONS

A major conclusion of the study was that there was an increase in amplitude and duration in the tibialis anterior, vastus lateralis, and rectus abdominis of a paraplegic as a result of horseback riding. A secondary conclusion was that cardiovascular activity increased during horseback riding. However, there was no significant difference in the amount of cardiovascular activity after fifteen minutes and thirty minutes.

RECOMMENDATIONS

It is recommended that this study be repeated using similar subjects, conditions and variables in order to validate the findings of the present study. This would help to verify the conclusions of this particular study.

It is recommended that this study be repeated with different types of spinal injury. Different levels of injury may be affected differently. Also various ages of subjects and the amount of time since the injury could have an effect on the results.

It is recommended that different types of muscle diseases be studied to see if the results would be as positive. Subjects suffering from multiple sclerosis, muscular dystrophy or polio could be measured as well.

This study was a case study. Therefore, two sets of EMG recordings from a single subject were all that were available. It would be suggested that a study be done on a group of individuals with different backgrounds. Studying males and females with different abilities would substantiate the conclusions greatly. Also, this particular subject was a former college athlete. Therefore, it would be interesting to see if the results would be similar from a nonathlete.

The cardiovascular activity needs to be examined more scientifically. A great concern among paraplegics is trying to elevate the heart rate by doing some form of physical activity. Therefore, it is recommended that this be repeated with less variables such as outdoor temperatures. More scientific statistics needs to be used in order to see how much the heart rate actually rose from resting. Also, the level of anxiety on the part of the subject needs to be considered and if possible measured in some way.

The level of sensitivity in the electromyography machine used for this study was not as precise as other machines. If the study were to be repeated, a more sensitive machine would be suggested in order to establish a less wavy baseline.

The value of horses in therapy is becoming more and more understood but the collection of data is lacking. The need for more documentation is great for the simple reason of adding validity to a growing form of therapy and recreation.

If there is to be any hope of surgically repairing the spinal cord injured, then atrophy must be decreased through exercise or there will be far less of a chance of using the muscles of the legs. This study provided data supporting that the action potential of muscles can be increased through the use of a horse. Therefore, the need to continue this research is as great as the need for finally repairing the injured spinal cord. Research and scientific studies to support the benefits of riding are virtually non-existent. Until now, the benefits on the reasons for the success of riding are usually hypothesized since no scientific data has been collected-only subjective comments based on observation by therapists, instructors, teachers, parents and the riders themselves. Scientific data will provide validity to the value of horseback activity. The replication of this study can play an instrumental role in developing a rationale for horseback riding for the handicapped.

BIBLIOGRAPHY

Annual Report and Journal (1976). North American Riding for the Handicapped Association, Inc. (N.A.R.H.A.) Leesburg, Va: Potomac Press.

Bertoti, Dolores B. (October 1988). Effect of Therapeutic Horseback Riding on Posture in Children with Cerebral Palsy. Physical Therapy, Vol. 68, No. 10.

Davies, John A. (1967). The Reins of Life: An Instructional and Informative Manual on Riding for the Disabled. London, Eng. J.A. Allen.

DeLacerda, Fred G.; Claypool, L. P.(May-June 1984). Determination of a Fatigue Curve as a Function of Electromyography and Mechanical Work. The Journal of Orthopedic and Sports Physical Therapy. Vol. 5, No. 6.

Depaw, K.P. (1986). Horseback Riding for Individuals with Disabilities: Philosophy and Research. Adapted Physical Quarterly, Vol. 3, pp.217-226.

Faghri, Pouran D.; Glaser, Roger M.; Figoni, Stephen F.; Miles, Daniel S.; Gupta, Satyendra C.; (July-August-September 1989) Feasibility of Using Two FNS Modes for Spinal Cord Injured Patients. Clinical Kinesiology Vol. 43, No. 3.

Freeman, Gertrude. (1983). Hippotherapy/Therapeutic Horseback Riding. Clinical Management, Vol. 4, No.3.

Gordon, Eleanora C. and Stewart, Bannie M. (June, 1975). Riding Programs and Mental Retardation. N.A.R.H.A. News.

Hedrick, Bradley. (1984). The Effect of Wheelchair Tennis Participation and Mainstreaming Upon the Perceptions of Competence of Physically Disabled Adolescents, University of Illinois, Thesis for Doctorate.

Kessler, Henry H. M.D. (1950). The Principles and Practices of Rehabilitation, Philadelphia: Len and Febiger.

Kottke, Frederick, J., M.D.; Stillwell, Keith, G., M.D.; Lehman, Justus, F., M.D.; (1982). Krussen's Handbook of Physical Medicine and Rehabilitation, W. B. Saunders Co.

Mayberry, Robert P. (June-July, 1978). The Mystic of the Horse is Strong Medicine: Riding as Therapeutic Recreation. Rehabilitation Literature, pp. 192-196.

McAdam, Terry. (1955). Very Much Alive: The Story of a Paraplegic, Boston: Mifflin Co.

McDonnell, Samuel. (1976). Leisure and Its Role in the Adjustment of Spinal Cord Injured Persons.

Morris, Alfred F.; Beaudet, Suzanne M. (July-August 1980). Electromyographic Latencies Associated with Rapid Maximal Force Production in Five Different Muscle Groups in College Adults. American Corrective Therapy Journal. Vol. 34, No. 4.

Popp, Martha. (June, 1989). Therapeutic Riding; Handicapped Program Becomes Confidence Builder. Illinois Agri-News.

Progress Report, (December 1983). The Modality That Neighs.

Randolph, Elizabeth. (June, 1989). Riding High; From Victim to Champion-A Woman and Her Horse. Family Circle. pg. 129.

Rosenthal, Sol Roy. (May, 1975). Risk Exercise and the Physically Handicapped. Rehabilitation Literature, pp. 144-149.

Rosin, Patricia Lynn, B.PT. (1980). Horseback Riding for the Handicapped: A Discussion of the Benefits. Fourteenth World Congress of Rehabilitation International.

Stanford, Elizabeth; Hawn, Patricia, (1982). Equestrian Therapy in the Treatment Head Injury Patients. 4th International Congress on Therapeutic Riding-Transcript.

Walsh, J.J., M.D. (1964). Understanding Paraplegia, Tavistock Publications.

White, Carolyn, (May, 1988). Handicap Won't Slow Horseman. USA Today.

APPENDIX A

LOG

Heart Rate Recordings

	15 minute rate	30 minute rate
	112	116
wk 1	80	140
	87	108
	80	104
wk 2	104	108
	108	128
	89	97
wk 3	97	100
	112	126
	152	122
wk 4	97	92
	110	108
	123	119
wk 5	152	120
	133	113
	107	111
wk 6	111	114
	110	113
	163	128
wk 7	147	140
	106	112
	93	107
wk 8	102	90
	126	147

*Resting Rate-73

APPENDIX B

EASTERN ILLINOIS UNIVERSITY - DEPT OF PHYSICAL EDUCATION
STATEMENT OF INFORMED CONSENT FOR RESEARCH PROJECT
THERAPUETIC HORSEMANSHIP: JUNE 1988

Physical therapy for paraplegic individuals has taken many forms. Recently hippotherapy has been suggested as a possible positive therapy for this condition. In an attempt to provide a better understanding concerning the contribution of hippotherapy the present research project is being undertaken.

Involvement in this project will require the use of hippotherapy as the sole therapy during the course of this study (approximately eight weeks). The subject will be required to attend 3 therapy sessions per week for the duration of the study. Each session will consist of 30 minutes of horseback riding. In addition to program adherence the subject will be required to participate in pre and post testing that will consist of surface electromyographic (EMG) analysis. EMG testing will take place at Sarah Bush Lincoln Hospital.

Possible benefits of this project to the subject include; training effect on skeletal muscles, as well as the opportunity to obtain a leisure skill. Possible risks associated with the project include; injury due to handling or falling from the horse, and the development of pressure sores from the saddle.

At any time the participant is free to withdraw from the study without questioning. Any data as a result of participation in this study will remain confidential and if presented in a research report will be in an annoymous manner.

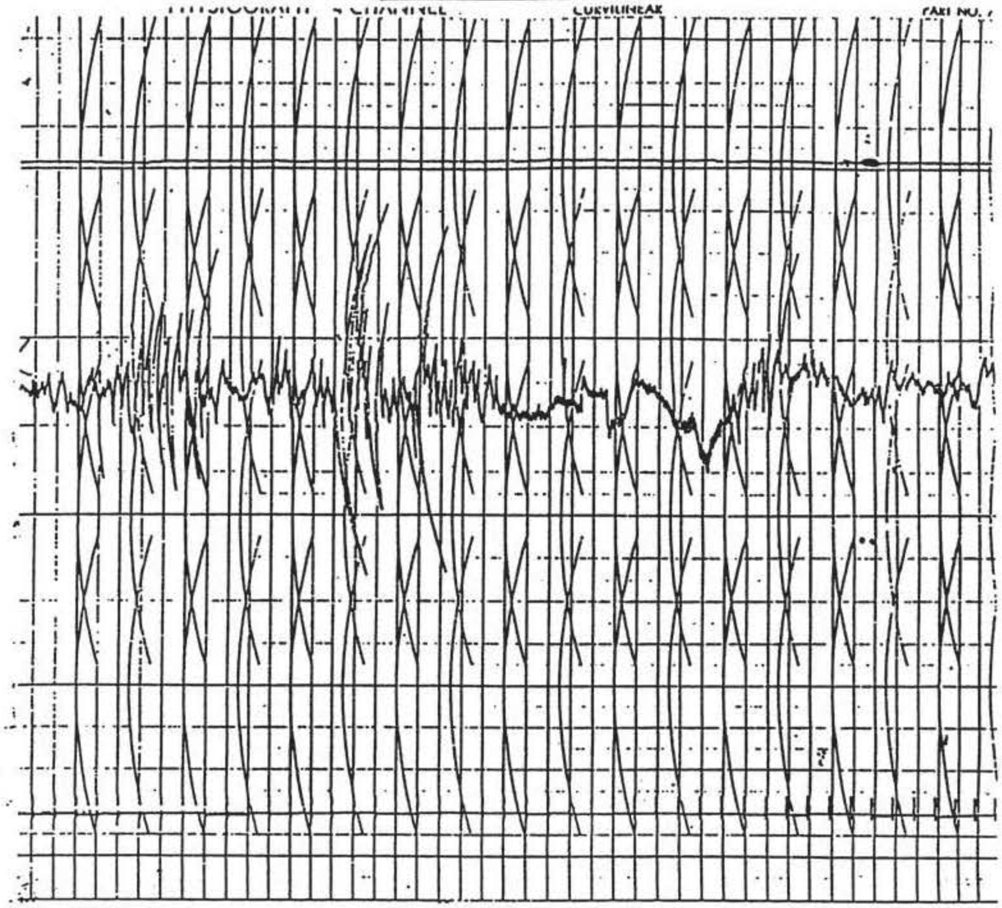
I have carefully read the above statement and have had the opportunity to ask questions pertaining to the parameters of this study. By signing this document I do hereby freely and voluntarily consent to participate in this research study.

[redacted] 7-7-88

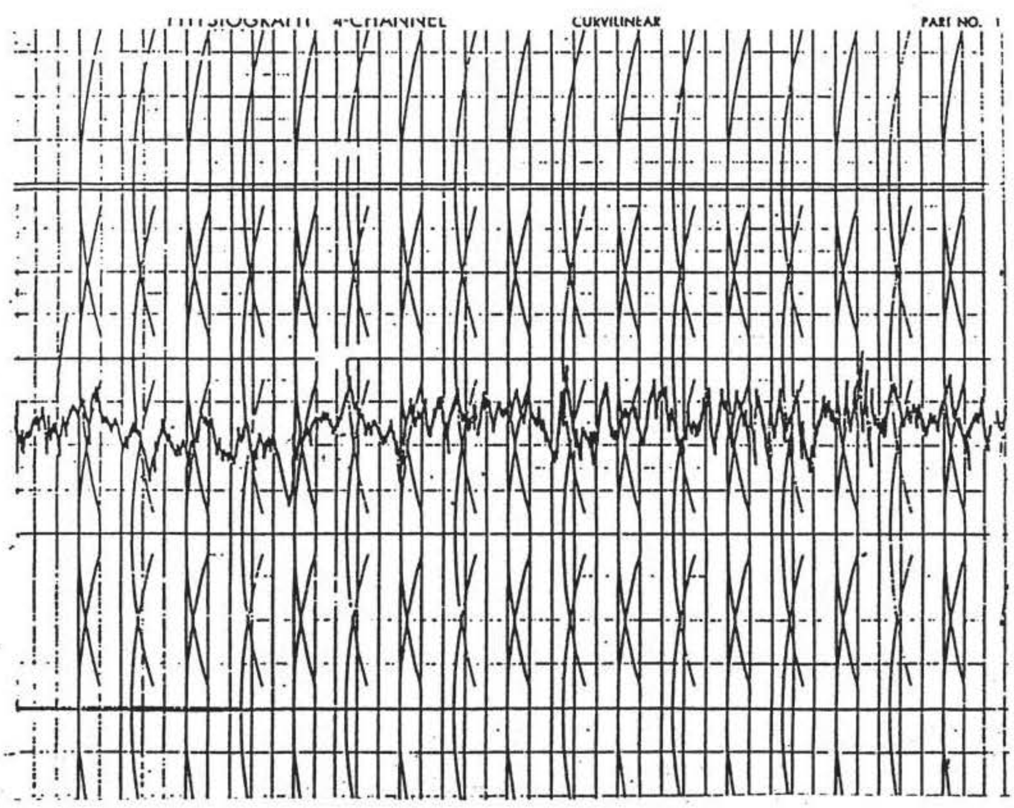
Signature Date

APPENDIX C

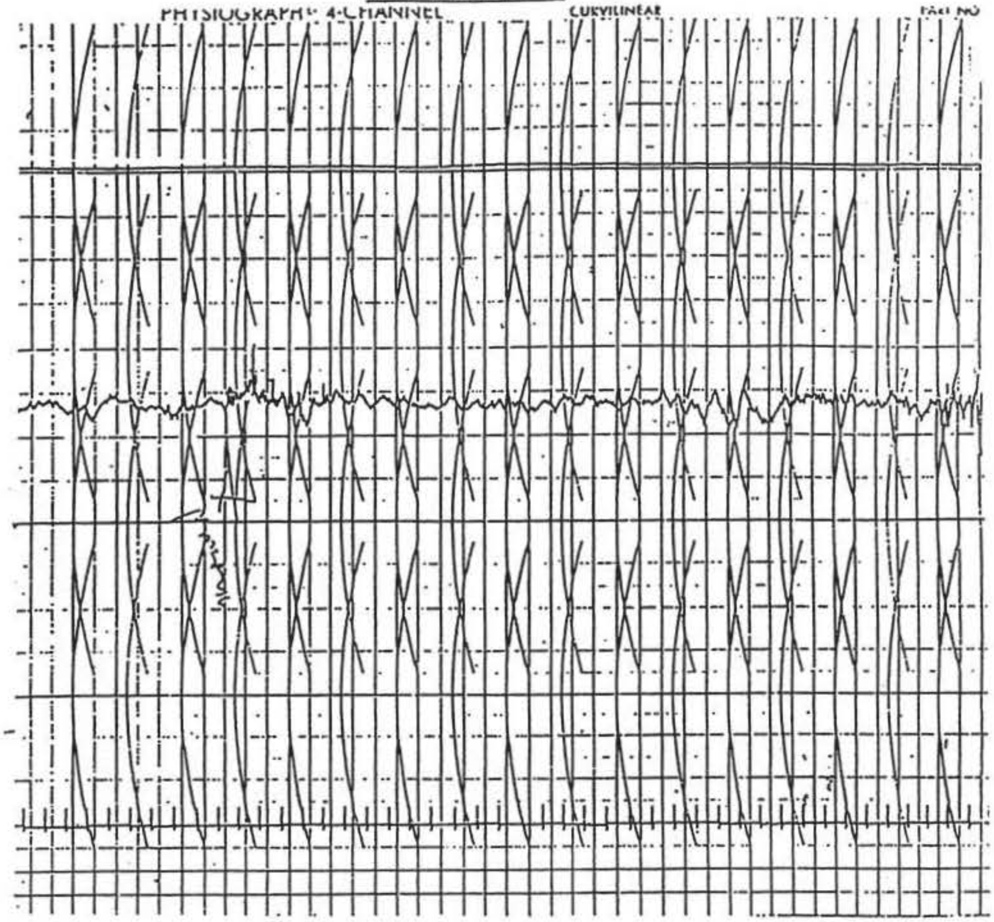
Tibialis Anterior Pre-Test



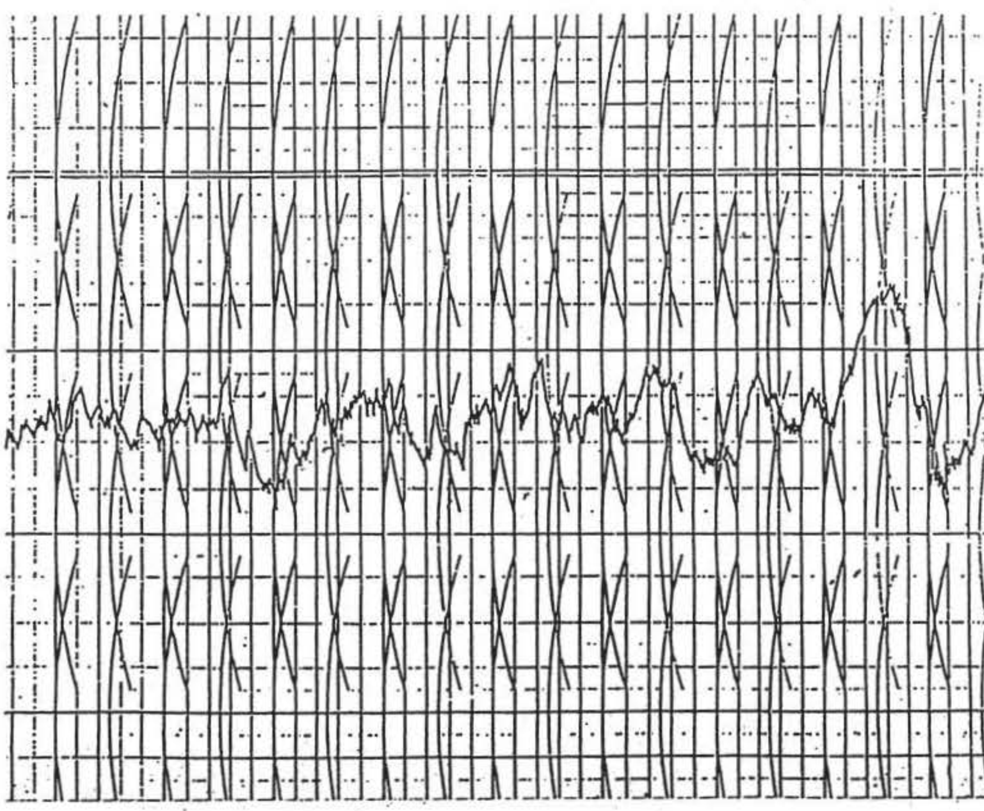
Tibialis Anterior Post-Test



APPENDIX D

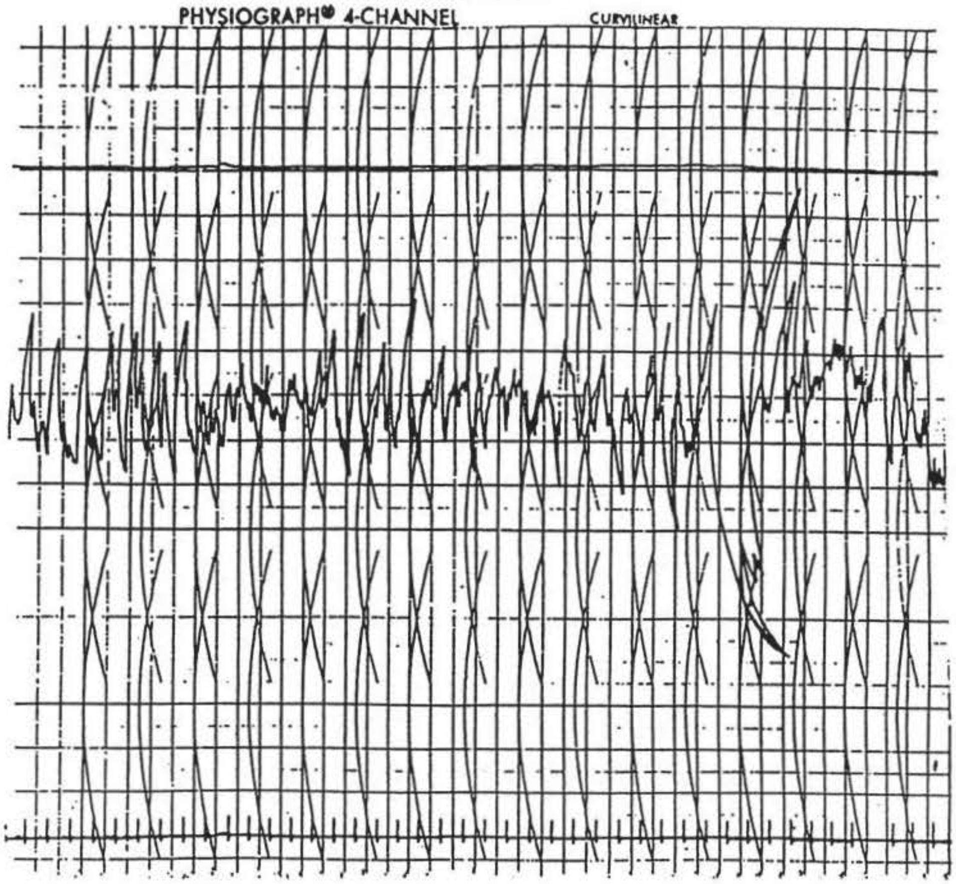


Vastus Lateralis Pre-Test

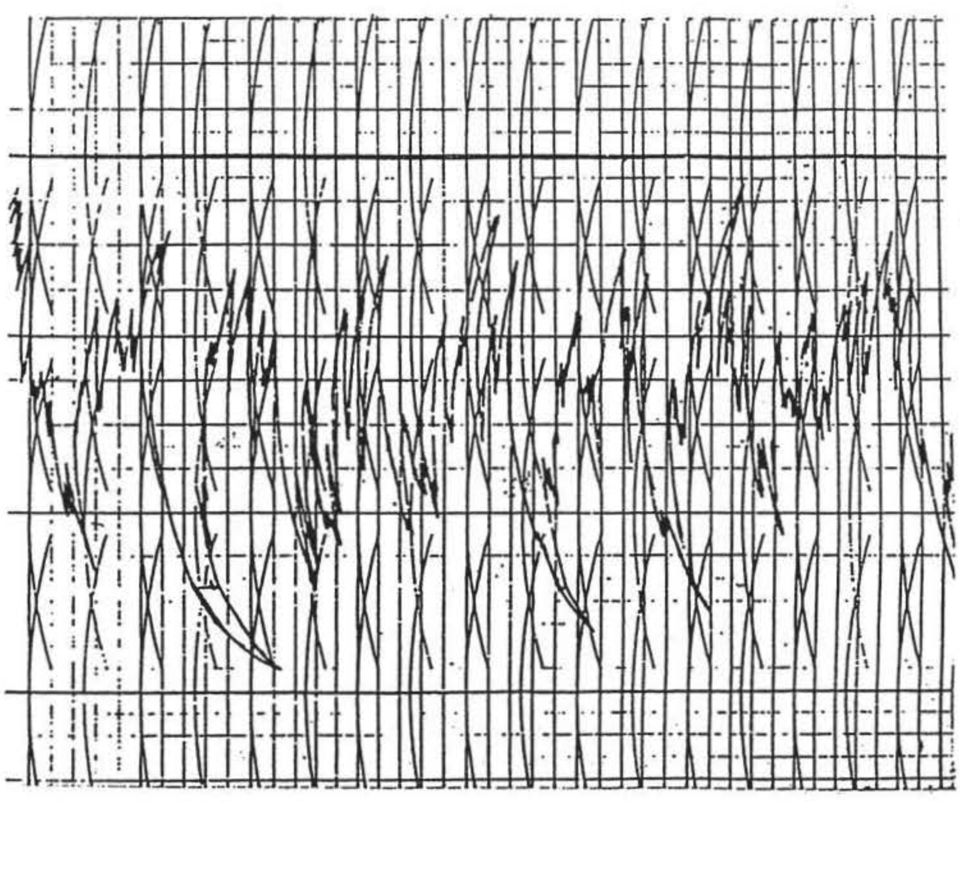


Vastus Lateralis Post-Test

APPENDIX E



Rectus Abdominis Pre-Test



Rectus Abdominis Post-Test