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Effectiveness of the Swisswing' Biomechanical Stimulation Device for Recovery After Acute Exercise in Professional Male Soccer Players

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EFFECTIVENESS OF THE SWISSWING$^{®}$ BIOMECHANICAL STIMULATION DEVICE FOR RECOVERY AFTER ACUTE EXERCISE IN PROFESSIONAL MALE SOCCER PLAYERS

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ABSTRACT

The Swisswing® Biomechanical Stimulation Device has been previously used to treat muscle soreness. It is a form of vibration therapy that is beneficial in increasing circulation to treated muscles.

Purpose: To determine the effectiveness of the Swisswing® Biomechanical Stimulation device for decreasing biochemical markers of muscle damage and inflammation and muscle pain after acute exercise in professional male soccer players.

Methods: Seventeen male professional soccer players, aged 20.9 ± 2.4 years participated in a two-week study to determine the effects of receiving treatment with the Swisswing® Biomechanical Stimulation Device. The players were randomly assigned to groups A, B, C, or D to determine the order in which they would receive treatment. During the first week, half of the group received a 4-minute warm-up treatment prior to practice and a 32-minute treatment immediately following soccer practice for five consecutive days. The following week, those who received treatment served as a control and those in the control group received treatment. Creatine kinase (CK) and C-reactive protein (CRP) were measured prior to practice daily, except on day 1 when levels were also measured immediately following practice. Lactic acid (LA) and perceived pain were measured pre- and post-practice as well as post-treatment.

Results: There was no significant difference between treatment and control groups for LA, CK, and CRP. LA increased from pre- to post-workout and then declined post-treatment for both groups. Daily LA accumulation was also greatest on day 1 for both groups. CK levels increased above baseline until day 4 and then spiked again on day 5 for both groups. CRP increased steadily for the control group, while the treatment group experienced a decline on day 4. However, these differences were not significant. Post-treatment perceived pain was significantly lower for the treatment group (1.4) versus control (2.9). This difference was significant across the five days (p=.036) and specifically on day 2 (p = .027).

Conclusions: Swisswing treatment after soccer practice did not produce significant results among the blood markers that identify damage and inflammation. It did, however, help decrease perceived pain, at least on day 2 following the most vigorous practices. Therefore, the Swisswing may be responsible for enhancing the rate of recovery from muscle soreness following intense physical activity.

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CHAPTER I

INTRODUCTION

Athletes who participate in highly intense physical activity often experience a varying degree of muscle soreness and discomfort. Often times, this discomfort is the result of delayed onset muscle soreness (DOMS) and is associated with muscle damage and the subsequent recovery of muscle fibers.[1] DOMS generally occurs 24-72 hours after a bout of exercise involving eccentric muscle contractions. While some athletes participate in sports that include mainly eccentric contractions, soccer players are generally involved in activities that require concentric contractions. Therefore, their muscle soreness may be due to other causes and not direct injury to the muscles.

Acute muscle soreness is often experienced immediately following intense physical activity. There are a number of factors that may contribute to acute muscle soreness including muscular fatigue, ischemia, or direct trauma. In organized soccer practices, for example, drills involving sprints, jumps, and other plyometric activities may lead to muscular discomfort, but not necessarily cause muscle damage. While players may participate in some activities involving eccentric muscle contractions, most of the soreness following practice is acute and not DOMS.

Whether or not the soreness is due to DOMS, the effects of muscle soreness can lead to a decline in muscle function. Often times, the acute muscle soreness in soccer players is accompanied by inflammation and pressure in the muscle that can greatly impair performance. Along with the increased discomfort, players may also be at risk for loss of strength, decreased muscle function, and fatigue, as well as increased chance for further injury.[2] It is important for soccer players to attempt to minimize the extent and duration of muscle soreness experienced after practices so that they can recover quickly to perform maximally during games.

Muscle pain can be identified in athletes following vigorous physical activity. Subjectively, athletes can describe the extent of muscle pain and identify the severity on a scale of 0-10 (Appendix C). The amount of muscle damage can be described by examining specific blood markers that indicate possible muscle damage (CK) and inflammation (CRP). Often times, this discomfort and muscle damage can be due to exercise intensity, which can be measured by lactic acid (LA) levels. An increased level of any of these markers in the blood may be a sign that the body is in a state of inflammation, ischemia or possibly muscular damage with subsequent repair.[1,3,4]

To minimize discomfort caused by intense physical activity, it is in the best interest of athletes to participate in a cool-down and stretching program following activity to facilitate muscle recovery. Vibratory massage is one method athletes can utilize to warm-up, cool-down, and stretch their muscles prior to and following physical activity.

Utilizing vibration as a form of rehabilitation has been a common practice among physicians since the 19th century.[5] Only recently has vibratory massage become popular in sport sciences for aiding in restoration and mobilization of myofascial tissues.[5] While general massage has been a technique used among athletes and coaches to reduce post-exercise discomfort, localized vibratory massage is gaining popularity.

This process is known as biomechanical stimulation (BMS) and is a technique used to reduce muscle soreness in specific muscles by improving circulation through low frequency oscillations of the deep tissues.[5] Improved circulation assists in providing oxygen to the tissues and transporting metabolites quickly through the bloodstream to aid in rapid recovery. The Swisswing® Biomechanical Stimulation device is a new form of vibration therapy that may accelerate recovery after acute exercise and reduce the intensity of muscle soreness.

Vibration therapy with the Swisswing device relies on a different technique than the more widely known whole body vibration (WBV) technique. Whole body vibration is not only a tool for enhancing muscular performance, but can also be used for rehabilitation purposes.[6] For therapeutic means, the individual stands on a platform that oscillates at a selected amplitude and frequency. The Swisswing, however, focuses on localized vibration therapy. Rather than sending vibrations through the entire body via the feet, each muscle group gets specific treatment with the Swisswing.

Purpose of the Study

The purpose of this study was to determine the effectiveness of the Swisswing® Biomechanical Stimulation device for decreasing muscle pain and blood markers of muscle damage and inflammation after acute exercise in professional male soccer players.

Hypothesis

It was hypothesized that immediately following acute exercise, the Swisswing® Biomechanical Stimulation device treatment will aid in lowering levels of blood lactic acid (LA), creatine kinase (CK), C-reactive protein (CRP) and muscle pain compared to the control condition in professional male soccer players.

Definition of Terms

Several terms used in this study are defined as follows:

Swisswing® Biomechanical Stimulation is the manufacturer's name of this form of biomechanical stimulation. For this study it will be abbreviated as Swisswing.

- *Athlete:* The term 'athlete' refers to those individuals who regularly participate in physical activity on a daily, or near daily basis and compete in that activity. For this study in particular, the term refers to the members of the Cleveland City Stars professional soccer team.
- *Biomechanical stimulation (BMS): Mechanical* vibration that transfers oscillations through lengthened muscles. This vibration of the muscle causes a stretch reflex within that specific muscle.

CHAPTER II

LITERATURE REVIEW

During aerobic and anaerobic activity, the human body is under a constant state of stress. Increased heart rate, body temperature, and inflammatory activity are examples of the body's metabolic response to physical activity.[7] Soccer players, specifically, undergo a series of metabolic processes during both organized practices and games that have been known to lead to muscle soreness. This soreness has been attributed to mechanical muscle damage accompanied by an acute inflammatory response to the stress exerted on the body.[8]

Soccer and Physiology

In soccer, athletes rely primarily on their lower body muscle groups. Activities such as running and dribbling require a great amount of skill and agility. Due to the nature of the sport, soccer players experience variations in intensity during games as they alternate between short sprints and jogging or walking. These varying intensities allow the body to utilize the ATP-PC system, anaerobic glycolysis, and even the aerobic system.[9] Quick sprints lasting 3-5 seconds rely on the ATP-PC system, while high intensity running utilizes anaerobic glycolysis, a process that produces lactic acid.

Not only do the athletes participate in highly intense games, they also perform similar activity during regular practices. These include drills that work on foot speed, passing, accuracy, and scrimmages that prepare the players for their next match. During the soccer season, these athletes are engaged in intense physical activity that constantly puts stress on the joints and muscles of the lower body nearly every day. This continual stress may cause some players to experience muscle soreness and injury, including chronic inflammation, tendinosis, and other fascial restrictions.[10] These injuries are often a result of acute trauma, and may lead to inadequate circulation, further immobilizing the athlete. While some athletes do sustain major injuries, including pulled muscles and sprained ligaments, many also endure pain due to tears in and damage to the muscle fibers.[7]

Exercise Induced Muscle Damage and Associated Pain

Muscle damage and its associated decrease in muscle function are fairly commonplace for many athletes. Immediately following intense practice or a competition, the athlete's body experiences a process in which the muscles undergo a state of repair. This process starts with acute muscle damage followed by a release in inflammatory factors leading to full muscular repair.[11] In their study on running and the release of inflammatory factors in skeletal muscle and blood, Malm et al.[11,12] suggested that the result of the inflammatory process was muscular adaptation, and that the muscle would then be capable of performing at a greater functioning level. They also indicated that it was this adaptation that led to muscle soreness, and not simply muscle inflammation.

DOMS occurs among athletes who participate in activities utilizing eccentric contractions. However, muscle soreness can affect any individual participating in intense physical activity. The extent of damage and soreness is generally related to the degree of exercise intensity.[11] Thompson et al.[3] studied the effects of muscle soreness in 16 habitually active male subjects after 90 minutes of high-intensity shuttle running. It was found that during intense physical activity, the muscles endure slight micro-tears, which in turn, lead to an alteration of the muscle itself. This damage can last up to two weeks and lead to decreased range of motion, accompanied by a loss of strength and power.[3,8] While this damage can be detected through muscle biopsies, it is less painful, and often more common, to use blood markers as indicators for muscular stress.[3]

Consecutive bouts of exercise can also lead to muscle fatigue, soreness, and possible damage. Stewart et al.[13] investigated the effects of daily bouts of cycling on muscle alterations. Six male and six female active but untrained subjects with a mean age of 19.2 yr cycled at 60% of their predetermined VO_{2peak} until fatigue. The subjects underwent three days of cycle training followed by three days of recovery. The mechanical properties of the quadriceps muscle were assessed before and after exercise through isometric knee extension and EMG recordings. Immediately following exercise, the subjects underwent a series of tests to measure their neuromuscular function. These assessments measured maximal voluntary contraction, peak power, and muscle compound action potential.[13]

Both maximal voluntary contraction and motor unit activation decreased during the first day of recovery. There was also a decline in peak power immediately following exercise days 1 and 3. Force properties were also lower by nearly 40% after the first day of exercise and continued to stay depressed after day 3 of exercise and all days of recovery. In fact, a persistent weakness in force was noted throughout the recovery process.[13] The research supported the hypothesis that muscle function is impaired following consecutive training sessions due to the excitation and contraction process required for movement.

Stewart et al.[13] believed this impairment to be a direct effect of reduced calcium uptake, release, and storage by the t-tubules in the sarcoplasmic reticulum of the myofibrils. This decreased level of calcium leads to an impairment of the action potential into the muscle fiber, causing an inadequate stimulation of the myofibrillar complex. Ultimately this process is responsible for poor muscle function and muscular fatigue following exercise. However, the study also found that this decline in function could lead to a training effect in which athletes increase mechanical efficiency as an adaptation to the weakness.

Muscle Soreness and the Association of Creatine Kinase (CK) and C-Reactive Protein

CK is an enzyme found specifically in skeletal muscle, which is generally released into the blood as a result of muscle damage.[14,15] Increased levels of CK in the blood usually indicates injury to the sarcomere of the muscle fibers, often in response to prolonged or intense physical activity. In fact, some studies suggest that the amount of

CK released after activity depends on body composition, type of muscle contraction (i.e. eccentric or concentric), intensity of activity, and training background.[14,15]

Totsuka et al.[14] examined the release of CK in subjects with differing physical attributes. The subjects were 15 healthy men, 19-21 years old, who participated in three consecutive days of 90-minute bicycle exercise. Body composition, cross-sectional area and volume of the quadriceps femoris muscle, and anaerobic work capacity were tested on each subject prior to the exercise program. The results not only showed a significant elevation in CK within the first three hours following physical activity, but also that the levels continued to increase over three days.[14] This increase was found to be greater among those subjects with less leg strength and a smaller cross sectional area and volume of the quadriceps femoris muscle. However, there were no differences in CK levels based on body composition. The researchers believed that the differences in CK levels were a result of the strength and fitness history of the subjects.[14]

Like CK, CRP is a marker of systemic inflammation and tissue damage found at increased levels in the bloodstream when the body undergoes skeletal muscle damage.[12] Malm et al.[12] analyzed CRP in skeletal muscle and blood of 13 healthy male subjects with a mean age of 23.9 yrs. The subjects who were randomly selected into the exercise group participated in eccentric cycling exercises at a work rate of 250 or 300 W at 60 RPM. for 30 min. At 24 h following the activity, the exercise group experienced significant DOMS and their CRP had increased by 392%. CK was also elevated 123% above normal levels, which was thought to be affected by the release of other hormones present in the body due to the intensity of the activity. The elevated CRP, however, was believed to be due to exercise intensity and muscle damage.[12]

Lactic Acid

The amount of lactic acid in the blood following exercise indicates the intensity of the activity. A buildup of blood lactate occurs when trained athletes exercise at strenuous intensities relying on the anaerobic energy system. Generally, this system allows for ATP to form during vigorous activity when there is inadequate oxygen available.[4,16] The end product of anaerobic glycolysis is pyruvic acid, which, when accumulated faster than it is cleared, is converted to lactic acid. This accumulation of acid in the bloodstream drops the pH level of the blood, which can lead to impaired muscle function.[17]

Lactic acid accumulates in the muscle fibers during intense activity and diffuses out into the blood.[17] A review on the metabolic response of elite soccer players by Bangsbo et al.[7] revealed that during some soccer games, some players had an accumulation of up to 12 mM of blood lactate. These researchers suggested that high blood lactate levels may have been due to an accumulation of higher intensity activities, as opposed to a single performance. Between practices and games, soccer players often exercise at strenuous levels for many consecutive days.

Massage

There are many treatment options to assist players in recovery from muscle soreness so that they can continue to function at their maximal capacity. Massage, for example, has been found in some studies to be effective in reducing inflammation when performed immediately after physical activity. Hilbert et al.[18] examined the physiological response to massage immediately following physical activity in 18 male and female subjects, mean age 20.4 yrs. The subjects first underwent baseline tests to familiarize themselves with the equipment and establish baseline measurements for hamstring range of motion and peak torque. The group was then divided into a massage intervention (n=9) and control (n=9) groups.

All 18 subjects underwent six sets of eight maximal eccentric muscle contractions of the right hamstring. The subjects in the experimental group received 20 minutes of classical Swedish massage two hours after the activity. Range of motion, peak torque, and intensity of soreness were assessed prior to the activity and following the massage to determine how each were affected by the massage. While no differences were found for range of motion and peak torque, the intensity of soreness was significantly greater in the control group 48 hours post-exercise.

Hemmings et al.[19] also examined the benefits of massage therapy on repairing the body and assisting in recovery following repeated exercise sessions. They reiterated the benefits of massage, including relief from muscle soreness and tension. The concept of massage has many researchers supporting the idea that enhanced blood flow and subsequent oxygen delivery allows for an increased clearance of lactate from the blood. This is thought to be the most effective way of helping athletes physiologically repair the body following a bout of exercise.

Hemmings et al.[19] used 8 male boxing professionals with a mean age of 24.9 yrs as subjects to determine if massage was capable of removing lactate from blood and speeding up the recovery process. Each boxer had their blood lactate level measured first, followed by a 10-minute warm-up of stretching, jogging, and punching hand-held coaching bags. They then completed one round of boxing, which consisted of five, two-minute simulated boxing bouts. Immediately following their session the boxers again had their blood lactate levels measured followed by either 20 minutes of massage, or nothing for the control group. The blood lactate was measured following the massage intervention, and the subjects also completed a scale on perceived recovery. After a 35-minute rest period, the researchers measured blood lactate again and the subjects began their warm-up routine for another 10 min. The boxers then began their second performance of five, two-minute simulated boxing bouts followed by another blood lactate measurement.

The study found that following the second performance, blood lactate levels were higher for those who received massage (mean= 5.31 mM) than the control group (mean= 5.06 mM). This was the only significant difference for blood lactate between the two groups. Perceived recovery was determined by rating how the subjects felt specific adjectives on a scale of 0 (not at all) to 7 (very much so). A higher score signified greater recovery. There was a significant difference in perceived recovery between the control (12.1) and massage (19.0) groups. However, there was no significant difference found in the boxing performance between control and massage groups. The results also showed that the subjects in both groups had a lower punching force during the second bout.

These findings do not support the hypothesis that massage affects performance during repeated sessions of exercise, however, they do support the data found in many other studies regarding massage and recovery. While it is believed to increase blood flow to the muscles causing a greater removal of metabolic bi-product, not much data has been found to support this notion. In fact, many researchers believe that the recovery is more of a psychological factor than a physiological one.

Vibratory massage is another method of recovery that has been studied in the sports sciences to better understand how to restore muscle function and help prepare athletes for their next activity. Along with the ability to rehabilitate athletes, vibration stimulation has also been used as a form of resistance training to achieve an enhanced neuromuscular performance.[10] In a review on vibration in sport by Issurin,[5] it was stated that vibratory massage aims to restore and stimulate the muscles by using low intensity and low frequency oscillations. The effects include enhanced blood circulation, increased blood oxidation, and increased muscle enzyme activation. It seems plausible that the effects of the vibration may help circulate CK, CRP, and LA through the blood at a faster rate and shorten the duration of discomfort after intense activity.

Biomechanical Stimulation

Biomechanical stimulation (BMS), or Nazarov-Stimulation, is a form of therapy discovered in the 1970s by Russian Professor Dr. habil Vladimir T. Nazarov. The process uses longitudinal oscillation to mechanically increase blood flow through the tissues in the body.[20,21] Therapy involves placing any lengthened muscle on a platform that is oscillating between 18 and 50 hertz (Hz). This machine induces a vibration in the muscle causing involuntary muscle contractions. Nazarov believed that these vibrations, or tremors, occur naturally in humans and animals to assist in healing injuries and returning the body to homeostasis.

Shivering is an example of a naturally occurring vibration that helps the body increase core temperature through low frequency muscle contractions. This return to homeostasis can also be seen in toxic tremors where the body attempts to flush toxins out by increasing circulation. This can occur when an individual goes through drug withdrawal or when poisons are introduced in the body. All of these vibrations are beneficial in returning to homeostasis.[21]

Whether it is used as a therapeutic tool to relieve muscular pain or as a reconditioning device to improve neural function, BMS has a wide range of function. According to the Nazarov- Stimulation Institute, the following are possible applications for BMS: muscle and joint discomfort, soreness, muscle atrophy, strains, sprains, paralysis, rehabilitation, poor circulation, edema, decreased metabolism, loss of vision and hearing, decreased concentration, disease, obesity, cellulite, hair loss, aging, and to increase fitness and general health.[20,21] The method by which these disturbances are aided is explained through the physiological effects of vibrations on specific muscles.

While the process of BMS works directly to heal soft tissue in the body, it specifically targets receptors in the neuromuscular system to elicit an effect. The vibration generates a change in muscle length, which triggers a monosynaptic reflex. This stretch reflex occurs when the muscle spindle responds to the change in muscle length. Specifically, it is the Ia afferents that are responsible for reacting to small changes in the length of the muscle fibers. These changes are detected by the intrafusal muscle spindle and can be greatly affected by vibrations.[22]

When there is a change in length of the muscle fibers, motor unit activity occurs, initiating a chain of impulses. These impulses are sent to the spinal cord through the afferent fiber of the sensory neurons to activate motor neurons. The motor neurons return the signal to the muscle through efferent fibers, which activate a response in the muscle fibers.[16,22] This response by the muscle fibers results in continual muscle contractions until the stimulation ceases.

The application of BMS devices to the muscle elicits a muscle stretch reflex based on the extent of the frequency and amplitude. As these contractions occur due to the mechanical vibration, blood flow to the muscle is increased. This not only allows for greater oxygen delivery for contracting muscles to sustain energy, but also for an increased clearance of metabolites in the blood, including pain releasing substances.[21] It is the impact of BMS on the circulatory system that is thought to be the most significant effect of vibration.

As the vibrations stimulate the muscle fibers the blood vessels are also compressed creating a greater pump of blood out of the vessels and prevention of backflow of venous blood.[21] The result is a temporary vacuum in the capillaries, and is responsible for the increase in blood flow. Increased blood circulation throughout the tissues allows for greater mobility and flexibility. The muscles and connective tissue generate a greater contractive force as the vibrations trigger muscle contractions and blood rushes to the tissue. Not only does this allow the muscle to have more tensile capability, but the warming also permits the tissues to tolerate a greater stretch.[5,21]

The effects of BMS on the human body are similar to many of the benefits of physical activity, including the maintenance and increase of bone mass, muscle strength and metabolic rate. All of these benefits are due to the aforementioned effects of vibration on muscle tissue and the associated neurons. Increased bone mineral density occurs through dynamic loading, in which stress is placed on the bone allowing for fluid movement to the bone and an initiation of bone production.[16] A very similar process is responsible for the effects of vibration on muscle strength. The influence of BMS on the neuromuscular system is the same as with exercise. The constant contractions caused by the stretch reflex mimic the muscle movement that occurs during strength training.[21]

Finally, the improved blood circulation that occurs during exercise is also attained through BMS to increase metabolism. Oxygen is pumped into the tissues at a greater extent to allow for an increase in volume of oxygen consumed, and waste products are quickly flushed out. This increase in aerobic capacity can be reached by using BMS without significantly raising heart rate or blood pressure.[21] For this reason, BMS is a great tool for all populations including athletes, sedentary individuals, the elderly, and even those with disabilities. The Swisswing is one of a few biomechanical stimulation devices created for the general population.

A case study performed by Macintyre and Kazemi[10] examined the effects of localized vibration therapy on a 28-year-old soccer player complaining of left elbow pain. The subject had been receiving microcurrent therapy, exercise therapy, and soft tissue treatment for three months prior to the study, yet still experienced weakness and dull aching in the wrist and forearm. After a physical examination to determine a more specific cause of the pain, the subject underwent a grip strength test with a dynamometer. Grip strength was significantly lower in the left hand (60 kg) than the right hand (79 kg). He was then given a treatment of vibration therapy with the Vibromax Therapeutics technique three times per week for three weeks.

Following the three-week therapy, the patient experienced a significant decrease in pain and other symptoms, both during activities of daily living and at rest. He also drastically improved grip strength in the left arm from 60 to 82 kg, an amount similar to the right hand, of which values remained unchanged. The lack of pain and stiffness allowed the athlete to experience greater range of motion and freedom from the immobilization he experienced before treatment.[10] The researchers believe that for acute injury and pain, it is generally the pain that limits performance, and not actual tissue damage. Therefore, relief from this pain is believed to help athletes perform at their peak ability.

Much of the more recent research on localized vibration and motor performance has focused on determining the effects of frequency, amplitude, and time on the motor unit. Intensity of vibrations is determined by frequency and rate. Many studies have shown that the most safe and effective forms of vibration training are at a low amplitude and frequency.[10] While vibration is generally capable of increasing the rate at which motor units react, research has found that after 30 seconds the rate tends to decline.[22]

Bongiovanni et al.[23] tested the effects of 150-Hz vibration on motor units in the tibialis anterior muscle. 25 subjects, aged 9-70 yrs, sat in a reclined position with the ankle resting at 90°. Vibration was applied directly to the tendon of the ankle flexor with a manually held vibration device set to an amplitude of 1.5 mm for 120 seconds. During this time the subjects performed maximal voluntary contractions for four seconds followed by 20-30 second rest intervals. Differences between the control group and the vibration-exposed group were determined by examining peak force at the onset of contraction and reduction of force during contraction.

During this prolonged exposure to vibration, the discharge rate of motor units declined. In fact, maximal voluntary contractions can be reached after about one minute of vibration, but then declines at the end of 20 seconds of vibration. Through EMG, the subjects were found to have an 8% decline in contraction force following muscle vibration. Even when the subjects were allowed visual feedback of their decreased performance, they were still unable to function at their original performance. This was believed to be due to the tonic vibration reflex (TVR), which prevented the subjects from fully relaxing during the rest intervals between maximal voluntary contractions. Tonic vibration reflex is responsible for recruiting low-threshold motor units, thereby causing the motor unit to fire between 30-35 Hz.[23] The significant differences found in this study between the control and vibration-exposed groups speak to the importance of understanding appropriate duration of use for vibratory massage.

Whole-Body Vibration and Whole-Body Vibration Training

Whole-body vibration (WBV) and whole-body vibration training (WBVT) are not interchangeable terms. WBV refers to any form of unintentional exposure to high frequency vibration such as that experienced from tractors, helicopters, or off-road vehicles.[24] These vibrations tend to have negative side effects such as intervertebral disc displacement and other neck and spine injuries. WBVT, however, is a form of neuromuscular training designed as an alternative to traditional exercise.[24,25]

WBVT was not originally created as a form of massage, but rather a technique used to enhance muscle performance. Initially used to improve speed-strength in elite athletes, WBVT is now becoming a more widely used form of resistance training.[25,26] During WBVT, vertical sinusoidal vibrations are generated by the platform on which the individual stands and are transmitted through the body. These vibrations activate alpha-motor neurons in the muscle spindles causing a muscle contraction.[10]

Research continues to examine how varying frequency, amplitude, and duration of WBVT produce specific neuromuscular effects. There is also a significant amount of debate on which type of muscle contraction (dynamic or static) will elicit greater benefit from the vibrations. While there have been many contradicting studies about the effects of WBVT, some reported benefits include increased muscle strength and flexibility.[24] This new method of exercise intervention involves squatting on a vibrating plate that produces sinusoidal oscillations, triggering the muscle's stretch reflex.[26] As the frequency and amplitude of the vibrations increase, the vibrating muscles require a greater amount of oxygen to perform the contractions, thus increasing the oxidative metabolism of the muscles.[26]

Cardinale et al.[26] examined how varying frequencies of WBVT affected gastrocnemius medialis and vastus lateralis oxygenation while performing a squat on a platform. Subjects were 20 male and female volunteers age 24.6 ± 2.9 yrs: 10 sedentary individuals and 10 athletes. Each subject began with a 10-minute warm-up on a cycle ergometer at 50 W, followed by 4 bouts of isometric squats on the vibration platform. Each squat was held for 110 seconds. The first condition was no vibrations, followed by 30, 40, and 50 Hz vibrations, all under the amplitude of 4 mm. Near-infrared spectroscopy was used to determine tissue oxygen saturation. The results showed that WBVT does not affect muscle oxygenation more than a non-vibration training technique.

In a study by Delecluse et al.,[25] it was hypothesized that WBVT would elicit greater gains in strength than resistance training without vibrations. The subjects were 74 young females age 21.5 ± 1.9 yrs who did not participate in regular physical activity or resistance training. The subjects were separated into the WBV group, placebo vibration group, resistance-training group, or control group. Except for the control group, each program lasted 12 weeks and consisted of three training sessions per week.

Both the WBV group and the placebo group underwent the same training. The WBV group used a platform accelerating between 2.28 g and 5.09 g, while the placebo group subjects were on a platform accelerating at only .4 g. The resistance-training group trained in a fitness center and followed the same type of knee extensor training program as the other groups, without vibration. Subjects performed the same protocol for a pretest and posttest to evaluate knee extensor strength.

Isometric strength was tested through two maximal isometric contractions of the knee extensors, each trial lasting 3 seconds. To evaluate dynamic strength the subjects performed isokinetic flexion-extension movements and peak torque was recorded. Finally, the subjects' were asked to extend their lower leg from 90° to 160° at the fastest speed possible under four conditions to determine their ballistic strength, initially under no resistance, followed by increasing resistance. Lastly, the researchers examined power by having the subjects perform a vertical counter-movement jump and recording flight time.

For isometric and dynamic strength, the greatest gains were found in the resistance and the WBV groups. In fact, Delecluse et al.[25] found that dynamic knee extensor strength increased 9% among the group receiving resistance training and WBV. Power was also greater in the WBV group, indicating an improvement in isokinetic and isometric strength after WBV training. These changes are believed to be due to adaptations in the neurons elicited through the vibrations. The interaction between neurons receiving the stimulation and the motor neurons responsible for movement was believed to increase after 12 weeks of training.

Vibrations created by a platform stimulate afferent neurons within the tendons to induce a muscle contraction known as a stretch reflex, or tonic vibration reflex (TVR).[24] Abercromby et al.[24] researched the effects of posture and vibration direction on neuromuscular responses to WBVT. They tested the neuromuscular activation of four leg muscles (vastus lateralis, biceps femoris, gastrocnemius, and tibialis anterior) in nine male age 32.7 ± 7.0 yrs and seven female subjects age 32.7 ± 8.3 yrs on a WBVT platform. Each subject stood on the platform and received two bouts of 30 Hz vibrations; the first vibration direction was vertical and the second was rotational.

The participants were then asked to perform a static squat followed by a dynamic squat on the platform at the same frequency for no more than 30 seconds each. EMG and acceleration values were recorded and calculated at baseline and again during each condition. The researchers found that the neuromuscular activation of the four leg muscles significantly increased during both directions of vibration. They also found that the response was greater during isometric contractions in static squats than the eccentric or concentric phase in dynamic squats. In fact, the response significantly decreased during eccentric contractions.

Rees et al.[27] also examined the effects of WBV on lower extremity muscle strength. Specifically, they tested thirty male and female volunteers age 66-85 yrs. Half the group was assigned to a vibration exercise training program, and the other half to an exercise program without vibration training. Both groups participated in the training programs three nonconsecutive days per week for eight weeks. The vibration protocol consisted of WBV at a frequency of 26 Hz, and an amplitude starting at 5 mm and gradually progressing to 8 mm.

Pre- and post-tests were performed to establish and compare baseline performance. Maximum isokinetic strength and power were measured for the hips, knees, and ankles. Each participant performed two sets of four, uninterrupted, maximal repetitions of the knee, ankle, and hip. The pre-tests showed no significant differences between the two groups. The post-tests for the hip joint revealed that there were no significant differences between or within groups. The knee joint test produced no significant differences between groups, although there was a significant within-group effect for knee flexor and extensor torque and extensor power for both groups.[27] The ankle joint, however, showed no significant changes between or within groups following training.

The study concluded that strength gains following WBV were larger for ankle plantar flexors than knee and hip flexors and extensors. This data agrees with previous research that demonstrates greater gains in the calf musculature through WBV training. Many researchers believe this to be due to the fact that the vibrations are delivered through the feet allowing the calf musculature to dampen the stimuli to the rest of the body.[27] This may be the reason why many researchers believe localized vibration therapy is more effective in targeting specific muscles and generating greater effects than WBV.

CHAPTER III

METHODS

This was an experimental study comparing blood CRP, CK, LA and perceived muscle pain in professional male soccer players after treatment on the Swisswing BMR 2000 (Swiss Therapeutic Training Products, Twinsburg, Ohio) versus no treatment after soccer practice. The independent variable was treatment with the Swisswing versus not receiving treatment after soccer practice, and the dependent variables were CRP, CK, and LA in the blood, as well as subjective level of muscle pain. The study was delimited to the Cleveland City Stars Professional soccer team (United Soccer League).

Subjects

Twenty male soccer players trying out for the United Soccer League's (USL) second division team, the Cleveland City Stars, were recruited as subjects. Each subject was administered the AHA/ACSM pre-participation screening questionnaire (Appendix A) and excluded from the study if they had any history of musculoskeletal problems or any other health problems that would place them at risk for injury. After determining eligibility, all participants provided written informed consent approved by the Institutional Review Board at Cleveland State University (CSU) (Appendix B). At this time, height was measured with a stadiometer and weight was measured on a physician's beam scale in the CSU Human Performance Laboratory.

Experimental Procedures

Subjects were randomly assigned to one of four groups (A, B, C, or D). Each group received treatment for five days on the Swisswing and five days as a control. Group assignment served to control for the order effect of treatment. Therefore, 10 subjects received treatment first and served as a control second, while 10 served as control first and received treatment second (Figure 1).

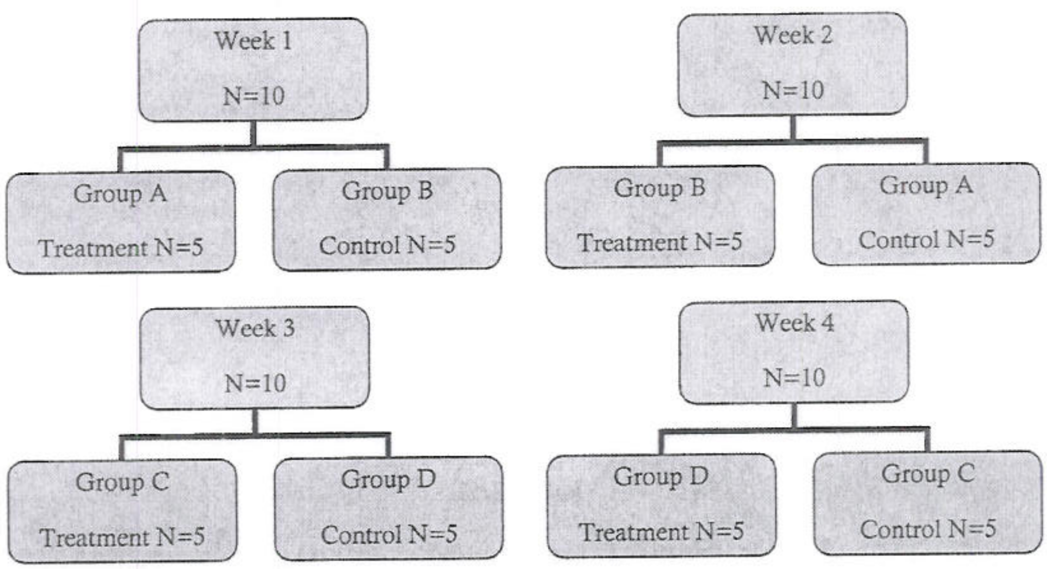

Figure 1. Schematic of experimental design.

All subjects were asked to refrain from any training prior to day 1 to establish baseline levels for all blood markers and muscle pain. After baseline markers were obtained, each group completed regular soccer practice as scheduled. Five subjects received treatment on the Swisswing and five subjects served as controls. Both groups were followed for 5 days with blood markers measured according to Table 1.

Table 1. Sequence for measuring blood markers.

	Pre workout	Post workout	Post treatment
Day 1	LA, CK, CRP	LA, CK, CRP	LA
Day 2	LA, CK, CRP	LA	LA
Day 3	LA, CK, CRP	LA	LA
Day 4	LA, CK, CRP	LA	LA
Day 5	LA, CK, CRP	LA	LA

Venous blood samples were obtained from the antecubital vein and analyzed for CK and CRP at Saint Vincent Charity Hospital's Biochemistry Laboratory (Cleveland, OH). Lactic acid levels were obtained from a finger stick and analyzed using the Lactate Plus analyzer (Sports Resource Group, Inc.) in the CSU Human Performance Laboratory.

Creatine kinase (CK) was measured to determine skeletal muscle damage and C-reactive protein (CRP) was measured to determine inflammation. Lactic acid (LA) was measured to determine the intensity of the practice and was measured daily pre and post practice and post treatment to determine if the treatment aided in LA clearance. CK and CRP were only measured post exercise on day 1 to measure the acute effect of exercise. Thereafter, CK and CRP were measured prior to practice to determine the effect of the Swisswing for recovery.

Muscle pain was assessed pre and post workout as well as post treatment daily using the Management of Cancer Pain Scale (Appendix C). Subjects were asked to indicate their level of muscle pain on a scale of 0-10. A score of 0 represented no pain while a score of 10 signified severe pain.

Subjects were followed for five days to determine the effect of the Swisswing on recovery. All data collection and supervision of treatment was under the auspices of the team physician of the Cleveland City Stars professional soccer team.

Swisswing Treatment Protocol

The Swisswing treatments were performed in the CSU Human Performance Laboratory. Prior to practice, the five treatment subjects underwent a warm-up on the Swisswing according to the manufacturer's protocol (Table II). The warm-up protocol consisted of a short duration (30 sec) vibration per muscle group at a stimulus frequency of 25 Hz. Twenty-five Hz was the manufacturer's recommended warm-up frequency to achieve both enhanced blood flow and neuromuscular activation. The switch responsible for powering the Swisswing was programmed to shut off the machine after exactly 30 seconds for the warm-up. The total warm-up time was four minutes.

Immediately post practice, LA was measured for each subject followed by a treatment using the Swisswing according to the manufacturer's protocol (Table 2). Post practice treatment time was four minutes for each muscle group at a stimulus frequency of 20 Hz as recommended by the manufacturer for stimulation of circulation and muscular relaxation. This frequency had been reported as effective anecdotally with several professional sports teams. Some muscle groups of the right and left legs were treated simultaneously. Total treatment time was 32 minutes. All Swisswing machines were connected through one switch programmed to run each device for exactly four minutes.

Table 2. Treatment protocol.

Muscle Group	Warm-up Time (min)	Stimulus Frequency (Hz)	Treatment Time (min)	Stimulus Frequency (Hz)
Right Calf (Gastrocnemius & Soleus) Left Calf (Gastrocnemius & Soleus)	0.5	25	4	20
Right Hamstring (Semitendinosus, biceps femoris, Semimembranosus)	0.5	25	4	20
Left Hamstring (Semitendinosus, biceps femoris, Semimembranosus)	0.5	25	4	20
Right Adductor muscles (Adductor brevis, longus, magnus, & minimus, Gracilis)	0.5	25	4	20
Left Adductor muscles (Adductor brevis, longus, magnus, & minimus, Gracilis)	0.5	25	4	20
Right Quadricep muscles (Rectus femoris, vastus lateralis, vastus medialis, vastus intermedius)	0.5	25	4	20
Left Quadricep muscles (Rectus femoris, vastus lateralis, vastus medialis, vastus intermedius)	0.5	25	4	20
Gluteus muscles (Gluteus maximus, medius & minimus)	0.5	25	4	20
Total Time (min)	4		32	

The right and left calf muscles were treated simultaneously, with the subjects seated upright in a chair in front of the machine and resting the belly of the gastrocnemius on the drum. The drum was positioned to its lowest setting (Appendix D). The right and left hamstrings were treated individually with the treated leg placed over the drum, bent at the knee. A goniometer was used to ensure the hip was flexed at an 80° angle, according to manufacturer protocol (Appendix D). Right and left adductors were also treated individually with the drum in the same position as it was for the hamstrings. The body, however, is turned to the side, and the subjects hold their foot behind them to avoid touching the non-treated leg on the drum (Appendix D). Left and right quadriceps muscles were treated individually with the drum placed midway between the greater trochanter of the femur and the lateral epicondyle of the femur. The non-treated leg is on a chair behind the subject, flexed at the knee (Appendix D). Finally, the gluteus muscles were tested together with the drum level with the maximal protrusion of the buttocks. The subjects leaned on the drum so as not to apply full pressure (Appendix D).

Control Sessions

Subjects reported to the CSU Human Performance Lab immediately following soccer practice and remained seated while the treatment group was being treated. Blood samples were obtained following the same protocol as the treatment group.

Data Analysis

Descriptive statistics were obtained for all measures. A repeated measures ANOVA was used to assess treatment differences due to the independent variable, Swisswing treatment versus control, on the dependent variables, muscle pain, CK, LA and CRP blood markers. Protected t-tests were used to determine significant differences across serial measures. Correlations were run among the dependent variables to determine if any significant relationships existed. SPSS-PC (version 14.0) was used for all analyses with 0.05 used as the level of significance.

CHAPTER IV

RESULTS & DISCUSSION

Subjects

Seventeen of the original 20 volunteer professional soccer players participated in a two-week study to determine the effects of receiving treatment with the Swisswing Biomechanical Stimulation Device. Three of the original 20 players were not available to participate in the study. Ten individuals completed weeks 1 and 2, while seven participated in weeks 3 and 4. Mean age, height, and body mass were 20.9 ± 2.4 yrs, 181.5 ± 5.5 cm, and 79.0 ± 8.8 kg respectively. All subjects served as their own control, participating in the treatment one week and non-treatment one week.

Lactic Acid (LA)

Acute LA effects were examined to compare pre-workout, post-workout, and post-treatment LA levels over the five days between the control and treatment groups. LA levels were significantly higher at day 1 post-workout for both groups. However, these levels dropped significantly over the next four days at similar rates. Therefore, the differences were not significant between the two groups (p≥ .05) (Figure 2).

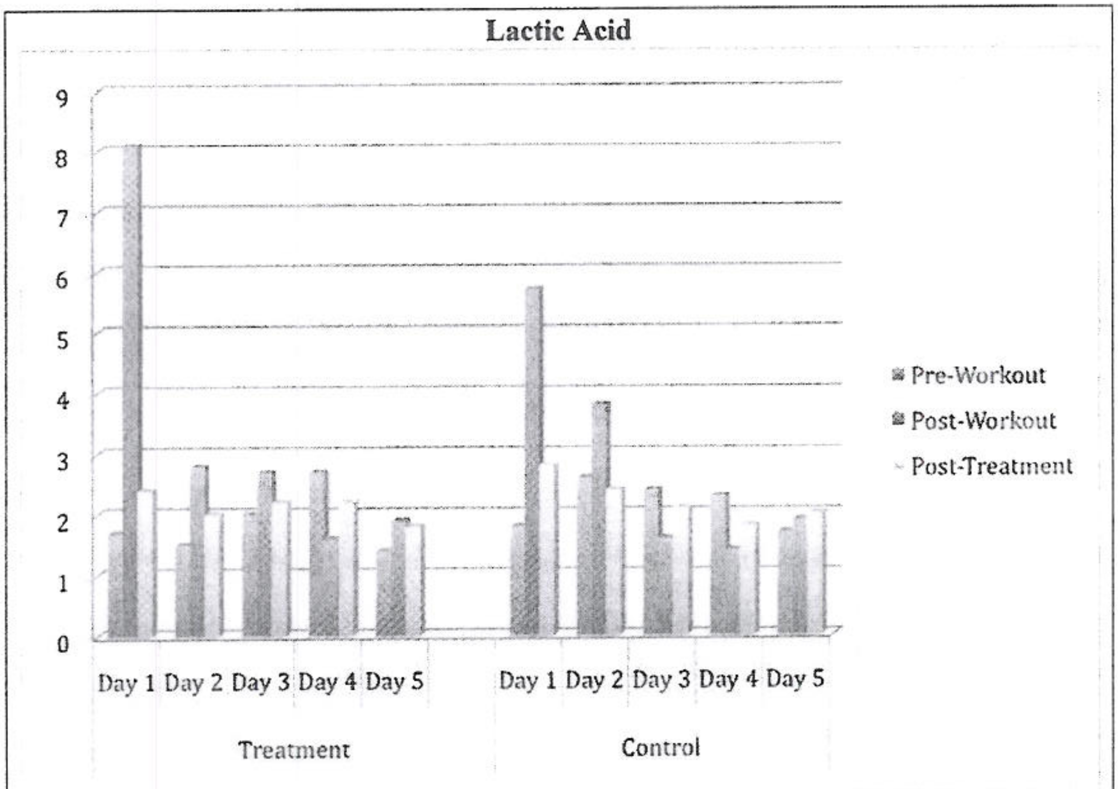

Figure 2. Daily lactic acid levels (mmol/liter) for pre- and post-workout, and post-treatment.
***N=17 for all results.*

Both groups followed similar trends across the five days. Lactic acid levels tended to increase from pre-workout to post-workout, and generally decreased from post-workout to post-treatment. Daily LA levels between pre-workout, post-workout, and post-treatment amongst the two groups were also compared. There were no significant differences in the average LA accumulation within these three measurements between the control and treatment groups (p≥ .05) (Table 3).

Table 3. LA results for treatment (N=13) and control (N=15) groups. Normal resting levels are .5-2.2 mmol/L.

DAY/CONDITION		TREATMENT (Mean ± SD)	CONTROL (Mean ± SD)
1:	Pre-Workout	1.7 ± .8	1.8 ±1.4
	Post-Workout	8.1 ± 4.3	5.7 ± 3.6
	Post-Treatment	2.4 ± 1.3	2.8 ± 1.0
2:	Pre-Workout	1.5 ± .5	2.6 ± 1.2
	Post-Workout	2.8 ± 2.1	3.8 ± 3.0
	Post-Treatment	2.0 ± 1.4	2.4 ± 1.5
3:	Pre-Workout	2.0 ± .9	2.4 ± 1.9
	Post-Workout	2.7 ± 1.7	1.6 ± 1.3
	Post-Treatment	2.2 ± 1.2	2.1 ± 1.1
4:	Pre-Workout	2.7 ± 1.4	2.3 ± 1.4
	Post-Workout	1.6 ± .9	1.4 ± .8
	Post-Treatment	2.2 ± 1.3	1.8 ± .9
5:	Pre-Workout	1.4 ± .3	1.7 ± .4
	Post-Workout	1.9 ± 1.5	1.9 ± 1.6
	Post-Treatment	1.8 ± .7	2.0 ± 1.2

The workout was hardest on day 1 for both groups, and decreased in difficulty through day 4. On day 4, both groups participated in a game, which could be the reason for this decline.

According to Bangsbo et al.,[7] the variation in LA levels between each athlete directly reflects the intensity at which the individual practiced. Those who worked at a greater intensity generally exhibited a higher LA level. In fact, higher LA levels may be an accumulation of high intensity activities during practice, rather than the effect of a single activity. Some individuals had a smaller decline in post-treatment LA levels, possibly due to higher post-workout LA levels, as well as the release of lactate from working muscles.[7]

Perceived Pain

Perceived pain was measured on a pain scale of 0-10, with 0 representing no pain and 10 representing extreme pain. The levels of pain experienced among the players were not high for either group. There was no significant difference found in pre- or post-workout pain across the five days, however the experimental group had a significantly lower level of perceived pain post-treatment (p =.027) (Table 4).

Table 4. Perceived Pain results for treatment (N=13) and control (N=15) groups.

DAY/CONDITION		TREATMENT (Mean ± SD)	CONTROL (Mean ± SD)
1:	Pre-Workout	.7 ± 1.0	.8 ± 1.0
	Post-Workout	1.1 ± .7	1.1 ± .8
	Post-Treatment	.5 ± .7	1.2 ± .8
2:	Pre-Workout	1.4 ± 1.1	1.6 ± 1.0
	Post-Workout	1.9 ± 1.3	2.7 ± 1.6
	Post-Treatment	1.2 ± 1.2	2.9 ± 1.6
3:	Pre-Workout	1.7 ± 1.3	2.0 ± .9
	Post-Workout	1.7 ± .9	2.3 ± 1.0
	Post-Treatment	.9 ± .7	1.7 ± .6
4:	Pre-Workout	.9 ± .6	1.3 ± 1.1
	Post-Workout	1.0 ± .9	1.6 ± 1.4
	Post-Treatment	.3 ± .4	.9 ± .7
5:	Pre-Workout	2.1 ± 1.4	1.8 ± 1.5
	Post-Workout	1.5 ± .6	1.4 ± .9
	Post-Treatment	1.0 ± .9	1.2 ± 1.4

There was also a significant difference between pre-workout, post-workout, and post-treatment levels of perceived pain between the control and treatment group on day 2 (p=.036) (Figure 3), possibly demonstrating that the treatment assisted in reducing the amount of pain experienced.

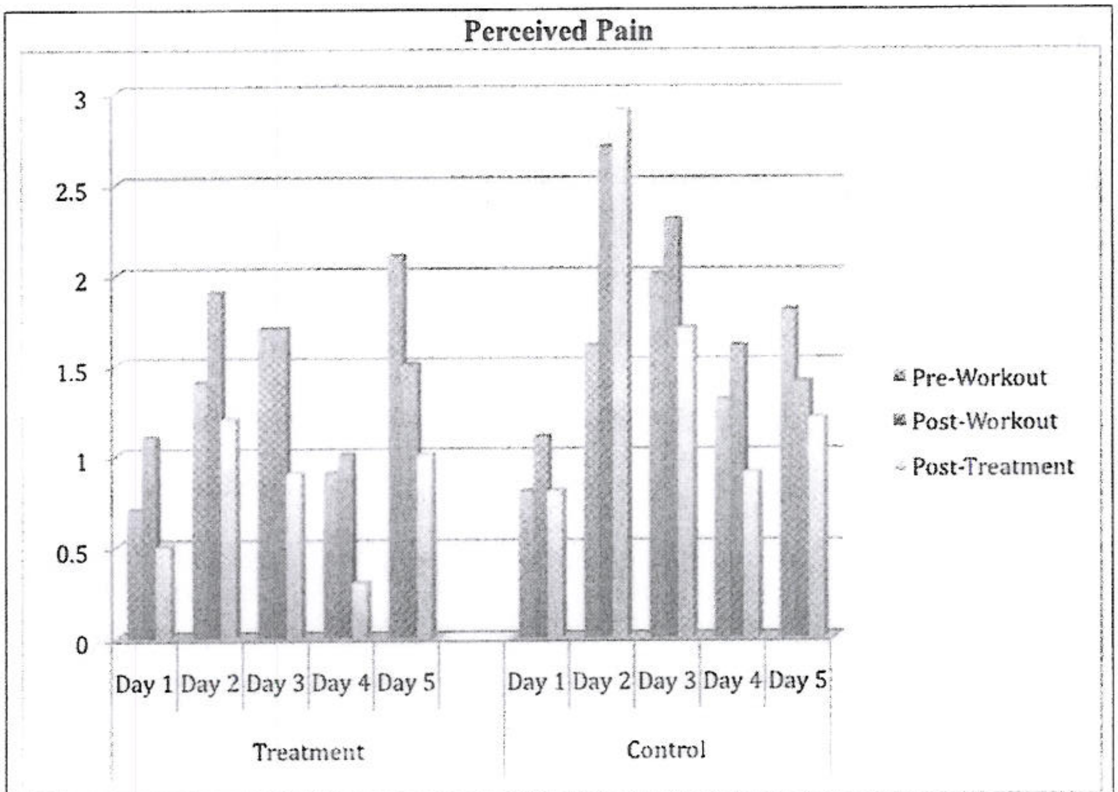

Figure 3. Daily perceived pain levels (scale 0-10) for pre- and post-workout and post-treatment.

Creatine Kinase (CK)

Creatine kinase was measured pre- and post-workout on day 1 to determine acute muscle damage. For days 2-5, CK was measured pre-workout. CK levels increased beyond the normal range, peaking at day 3 for the control group, and day 5 for the treatment group. Pre-workout CK levels for both groups increased from the baseline measurement from day 1 to day 3 (Table 5).

Table 5. CK results for treatment (N=13) and control (N=15) groups. Normal values are 21-232 U/L.

DAY	TREATMENT (Mean ± SD)	CONTROL (Mean ± SD)
1	285.6 ± 197.3	314.8 ± 154.4
2	391.5 ±225.9	360.3 ± 142.5
3	413.7 ± 185.1	412.3 ± 154.9
4	344.6 ± 127.2	349.5 ± 146.7
5	429.7 ± 227.1	375.5 ± 157.9

On day 4, both groups showed a slight decrease in CK followed by a slight increase on day 5, which may be a result of the light practice on day 3 in preperation for the game on day 4. There was no significant difference between control and experimental groups across the five days for pre-workout levels (p=.726) (Figure 4). These results demonstrate that the Swisswing treatment did not assist in faster muscle repair.

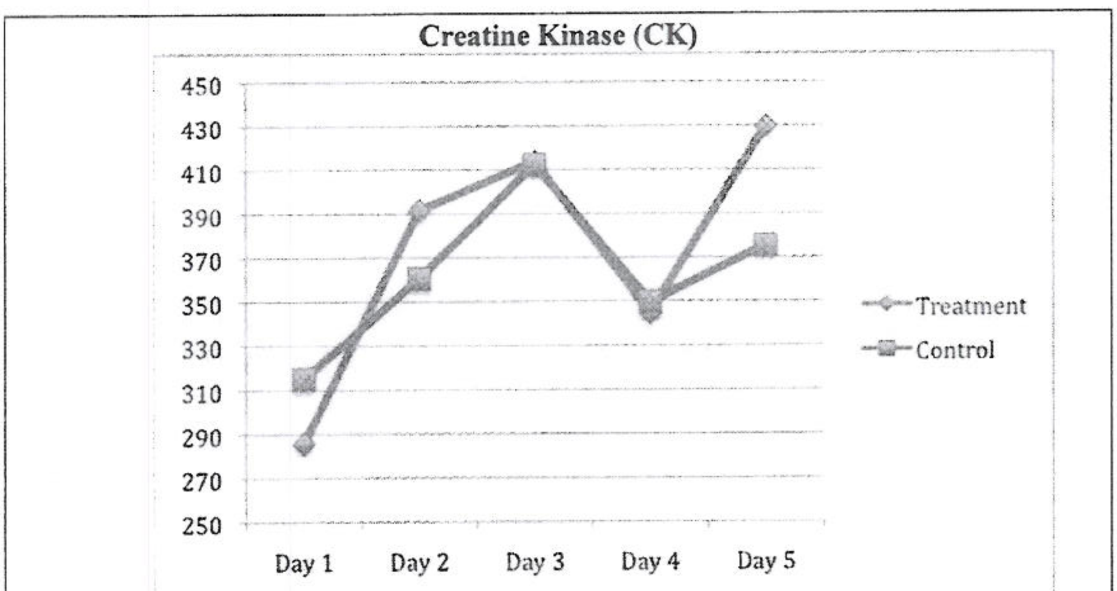

Figure 4. Pre-workout creatine kinase levels.

The decline in CK levels on day 4 agrees with Brancaccio et al.[15] regarding the effects of activity on CK. Brancaccio found that CK levels are significantly higher during day 4 of intense daily training. CK levels remain elevated for 24 hours following intense activity, but decline when athletes rest or exercise at lower intensities.

C-reactive Protein (CRP)

Measurements of CRP were taken on day 1 pre- and post-workout to assess the acute effects of soccer practice. CRP levels between pre- and post-workout on day 1 remained steady for both treatment and control groups (Table 6).

Table 6. CRP results for treatment (N=13) and control (N=15) groups. Normal values are 1.00-3.00 mg/L.

DAY	TREATMENT (Mean ± SD)	CONTROL (Mean ± SD)
1	.95 ± 1.23	.76 ± .79
2	.83 ± .81	.74 ± .69
3	1.01 ± .93	.95 ± .92
4	.73 ± .58	1.04 ± 1.74
5	.93 ± .78	1.13 ± 2.12

The control group showed a small increase in CRP over the 5-day period, while the treatment group's levels fell slightly on days 2 and 4, followed by an increase on day 5 ($p=.625$) (Figure 5).

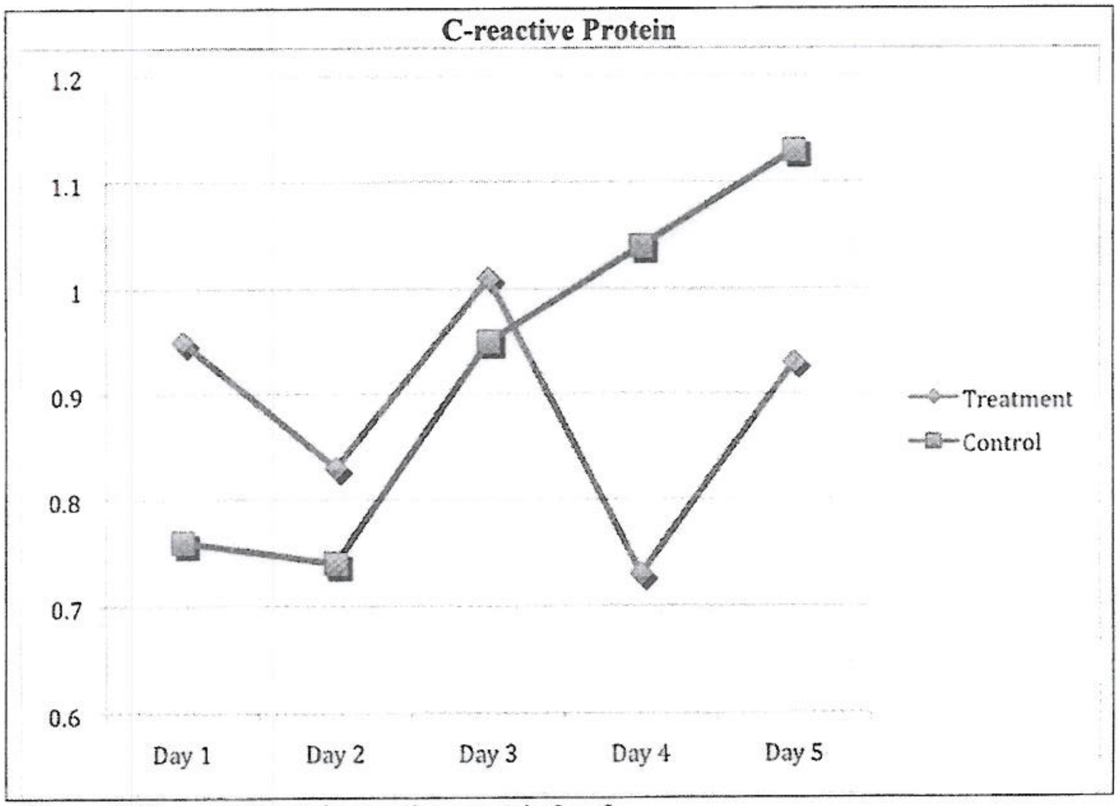

Figure 5. Pre-workout C-reactive protein levels.

Both the control and experimental groups' CRP remained within the normal range of 1.00 and 3.00 mg/L across the 5 days. The treatment group had the highest CRP at day 3, while the control group's CRP peaked at day 5.

This data agrees with Kasapis and Thompson[28] regarding the acute response of CRP following strenuous exercise. Measured to determine the extent of inflammation in the body, CRP tends to increase within the first 24 hours of vigorous physical activity, and then returns to baseline within 2 to 6 days following exercise. Research has shown that this increase is directly proportional to the extent and intensity of the activity. The levels of CRP found among the players suggests that they did not experience significant muscle damage during practices or games. This also correlates with the low levels of pain experienced by the soccer players.

CHAPTER V

SUMMARY & CONCLUSION

Seventeen professional male soccer players took part in this study to determine if the Swisswing® Biomechanical Stimulation device was successful in assisting athletes to recover from muscle soreness more rapidly. Each subject served as his own control. The blood markers creatine kinase and C-reactive protein were measured daily pre-workout to determine the acute effects of the soccer practice. Lactic acid was also measured to determine the intensity of each practice or game. Pain levels were recorded at three points during each day to signify the perceived pain of each player.

No significant differences were found in CRP and CK between the treatment and control groups. The treatment group had a significant lower level of pain when compared to the control group across the five days, suggesting that the Swisswing treatment provided a subjective effect in the athletes' recovery.

For many of the athletes, lactic acid levels increased from pre- to post-workout and then declined from post-workout to post-treatment. However, there was no significant difference in the extent to which the levels declined between the treatment and control groups. This could be explained due to the variation of practice among players. Most players experienced the greatest lactic acid accumulation following practice on day 1 followed by decreasing levels through day 4. These levels then increased slightly on day 5. This could be due to the lighter practices leading up to the games on day 4.

CK displayed similar trends between treatment and control groups. The data showed an increase from baseline until a significant drop on day 4, probably due to the lighter practice on day 3. Following the game on day 4, CK levels spiked on day 5. CRP levels for the control group remained the same as baseline for day 2 and then steadily climbed throughout the week. The treatment group levels were inconsistent demonstrating an increase followed by decreasing levels throughout all five days. The data suggest that the control group maintained slightly higher CRP levels at day 5. It can be concluded that the Swisswing was only effective in reducing perceived pain.

Application

Manufacturers of biomechanical stimulation devices may benefit the most from this study. They could use the data to modify protocols to make their products more effective. While the data shows no significant reduction in blood markers that identify muscle damage and inflammation, the athletes did report a decrease in pain throughout the day. Therefore, sports organizations, coaches and athletes can still make use of this equipment in assisting with reducing discomfort.

Limitations

1. Variation in daily practices; Each practice consisted of different drills and varying intensities. This limitation not only affected consistency among the data, but also the extent of muscle soreness and damage from day to day. This study would probably have produced more consistent data if the activity were controlled and similar in nature over the five-day trials.
2. The type of activity tested; Generally DOMS and muscle damage are experienced during eccentric muscle contractions and long duration activities. While some of the drills may have involved this kind of activity, it is not likely that the majority of the athletes experienced significant, if any, muscle damage. The Swisswing may have been more effective if the athletes tested participated in more activities involving eccentric muscle contractions.
3. Variation in player involvement; Soccer players have varying roles depending on their position on the field. Goalies, for instance, generally underwent different training and did not partake in the same type of sprinting and field running activities. Likewise, some players did not have as much playing time as others, which ultimately affected their levels of LA, CK, CRP, and pain.
4. Participation in other physical activities; Even though the players were asked to refrain from participating in physical activity outside of soccer practice, many of them admitted to involvement in other activities. This may have attributed to higher CK and CRP levels throughout the study.

5. Player injuries; Some of the athletes experienced significant injuries either immediately before the study began or during testing. These athletes may have experienced higher blood marker levels due to the inflammation caused by these injuries. It also made a difference in the amount of time they practiced and the intensity level at which they participated in practice.

Future Research Recommendations

Based on the results of this study, it is suggested that this equipment be used on athletes participating in weight lifting or long distance running. Biomechanical stimulation may be more effective in assisting in recovery for these activities due to the type and extent of the muscle contractions. It may also be important for future research to control the type of activities to ensure that each subject undergoes similar participation.

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APPENDIX A

AHA/ACSM Preparticipation Screening Questionnaire (AHA/ACSM, 1998)
Assess Your Health Needs by Marking All *true* Statements

History
You have had
___A heart attack
___Cardiac cathetization
___Coronary angioplasty (PTCA)
___Pacemaker/implantable cardiac
___Defibrillator/ rhythm disturbance
___Heart valve disease
___Heart failure
___Heart transplantation
___Congenital heart disease
Other health issues:
___You have had musculoskeltetal problems
___You have concerns about the safety of exercise
___You have prescription medication(s)
___You are pregnant
Symptoms
___You experience chest discomfort with exertion
___You experience unreasonable breathlessness
___You experience dizziness, fainting, blackouts
___You take heart medications

Cardiovascular risk factors
___You are a man older than 45 years
___You are a woman older than 55 years or you have had a hysterectomy
or you are postmenopausal
___You smoke
___Your blood pressure is greater than 140/90 mm Hg
___You don't know you blood pressure
___You take blood pressure medication
___Your blood cholesterol level is >240 mg/dl
___You don't know your blood cholesterol level
___You have a blood relative who had a heart attack before age 55
(father/brother) or 65 (mother/sister)
___You are diabetic or take medicine to control your blood sugar
___You are physically inactive (i.e., you get less than 30 minutes of physical
activity on at least 3 days/ week).
___You are more than 20 pounds overweight
___None of the above is true

Please list any medications that you are currently taking and/or any supplements that you are currently taking or have taken within the last 6 months

____
____
____
____
____

Name (please print)____ **Date:** __________________________

Witness: ____ **Date:** __________________________

APPENDIX B

INFORMED CONSENT FOR PARTICIPATION

Effectiveness of the Swisswing® Biomechanical Stimulation device for Recovery after Acute Exercise

Introduction

You have been asked to participate in a research study to be conducted in the Human Performance Laboratory at Cleveland State University. The purpose of the study is to determine the effectiveness of the Swisswing® Biomechanical Stimulation device for recovery after acute exercise. Previous studies have documented changes in skeletal muscle enzymes resulting from the physical demands of acute exercise. Serum markers can be used to assess muscle damage and inflammation resulting from damage; these include creatine kinase (CK) and C-reactive protein. Lactic acid will be measured from a finger stick to measure the intensity of practice. The Swisswing® is a device that uses vibrations to stimulate blood flow and reduce pain. The purpose of the Swisswing® is to improve recovery time and reduce any muscle soreness from the workout.

Procedures

You will be asked to refrain from hard training 24 hours prior to the initial testing. You will also be asked to refrain from using anti-inflammatory drugs such as ibuprofen and Naproxen during both subject and control weeks. Venous blood samples will be taken daily prior to regular soccer practice and measured for CK and C-reactive protein; lactic acid values will be measured using a finger stick for obtaining blood. You will then participate in regular soccer practice. Immediately after practice, you will receive treatment on the swisswing® or be in the control group. Both groups will be followed for five days with blood markers measured according to Table 1. Creatine kinase (CK) will be measured to determine muscle damage and C-reactive protein (CRP) will be measured to determine inflammation. Lactic acid (LA) will be measured to determine the intensity of the practice and will be measured daily pre, post practice and post treatment to determine if the treatment aided in lactic acid clearance. CK and CRP will only be measured post workout on day 1 to measure the acute effect of exercise. Thereafter, CK and CRP will be measured prior to practice to determine the effect of the Swisswing® for recovery from muscle damage.

Table 1. Sequence for measuring blood markers.

	Pre workout	Post workout	Post treatment
Day 1	LA, CK, CRP	LA, CK, CRP	LA, CK, CRP
Day 2	LA, CK, CRP	LA	LA
Day 3	LA, CK, CRP	LA	LA
Day 4	LA, CK, CRP	LA	LA
Day 5	LA, CK, CRP	LA	LA

Risks and Discomforts
Risks associated with this study include mild muscle soreness resulting from soccer practice and discomfort experienced from giving venous blood sample or from the finger stick. A qualified technician will be responsible for obtaining blood samples. Every effort will be made to minimize any risks.

Benefits
The benefits of this study are numerous. If treatment on the Swisswing® improves blood flow, reduces muscle soreness and time for recovery during training, it would be of great importance for you and competitive athletes in other sports.

Confidentiality
To protect your privacy, your name will not be used in any documentation of the project. The information, however, may be used for statistical or scientific purposes with your right of privacy retained.

Participation
I understand that participation in this project is voluntary and that I have the right to withdraw at any time with no consequences. I understand that if I have any questions about my rights as a research participant, I can contact Cleveland State University's Institutional Review Board at (216) 687-3630.

I attest and verify that I have no known health problems that should prevent me from successfully participating in this study.

Patient Acknowledgement
The procedures, purpose, known discomforts and risks, possible benefits to me and to others have been explained to me. I have read the consent form or it has been read to me, and I understand it.

I agree to participate in this program. I have been given a copy of this consent form.

Signature: ______________________________ **Date:** __________

Witness: ______________________________ **Date:** __________

APPENDIX C

Pain should be reassessed at least every 24 hours

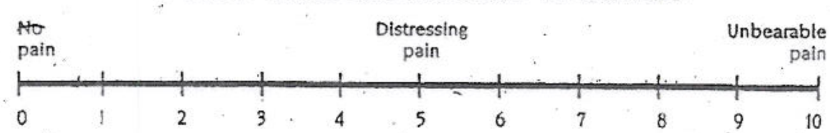
- Key questions to ask patients

PAIN INTENSITY	– Describe the pain (sharp, aching, dull, throbbing, etc)
LOCATION	– Where on your body is the pain?
ONSET	– When did the pain start?
DURATION	– Is the pain always there or does it come and go?
VARIATION	– What makes the pain worse? What makes the pain better?
QUALITY	– Does the pain affect activities like sleeping, eating, walking, etc?

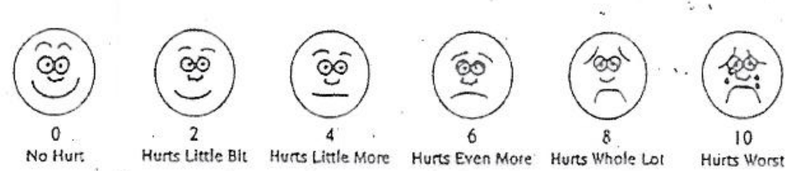
- Watch for behavior, expressions, movements and activities that may indicate pain, eg:

NONVERBAL INDICATORS
- Facial wrinkling, blinking eyes, grimacing
- Guarding an area of the body
- Crying, moaning
- Decrease in social interaction/routines
- Aggression, eg, hitting/biting
- Increase in body movements
- Irritability; increased confusion

Pain Assessment Scales

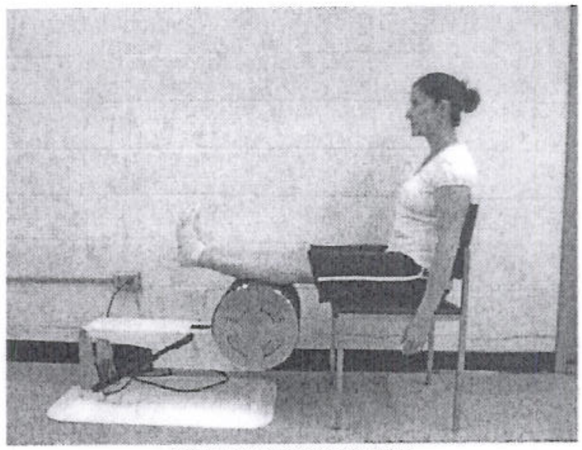


From Jacox A, Carr DB, Payne R, et al. Clinical Practice Guideline Number 9: Management of Cancer Pain. Rockville, Md: US Dept of Health and Human Services, Agency for Health Care Policy and Research; 1994. AHCPR publication 94-0592.



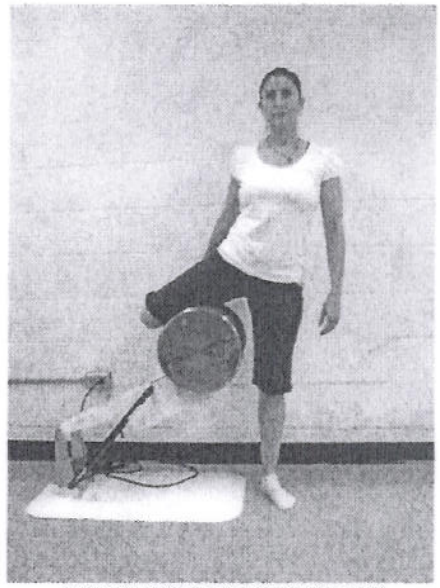
APPENDIX D

SWISSWING DRUM POSITIONING

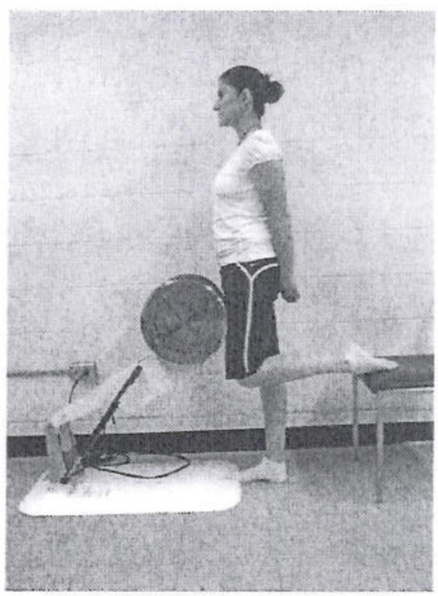


CALF MUSCLES

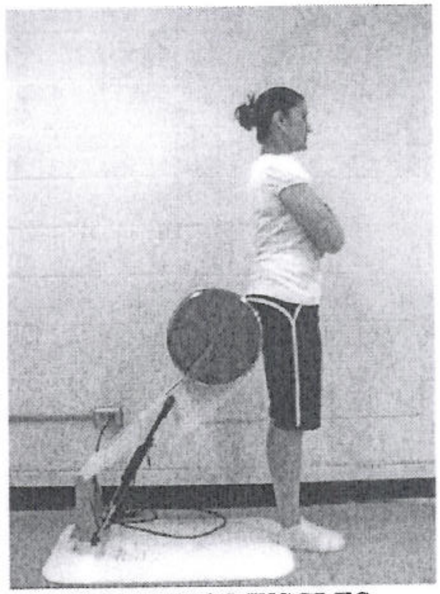
HAMSTRING MUSCLES



ADDUCTOR MUSCLES



QUADRICEPS MUSCLES



GLUTEUS MUSCLES