



**The Role of Acupuncture in the
Enhancement of Athletic Performance**

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Abstract

With the high economic and social pressures towards athletes to perform at their peak performance, competitors are increasingly turning towards ergogenic aids such as steroids or nutritional supplements to help maintain their competitive edge. These aids, however, only address some of the factors that can affect athletic performance. Factors that can influence performance include cardiovascular fatigue, muscular fatigue, delayed-onset-muscle-soreness, injury, and anxiety. Both theory and recent clinical evidence suggests that acupuncture can successfully address the physical and as well as the psychological factors that can prevent an athlete performing at his or her peak potential.

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The Role of Acupuncture in the Enhancement of Athletic Performance

Introduction

Traditional Chinese Medicine (TCM) is has been used as an acknowledged method of healing in China for over 2,500 years. Historically, a combination of herbs and appropriately placed acupuncture needles was used to treat virtually all diseases or injuries that people encountered ranging from emotional problems to skin diseases to back-pain. Within the Western medical community however, TCM has been gaining acceptance as a valid healing methodology only in the last thirty years. The most dramatic benefits “re-discovered” by Western doctors are the analgesic effects of acupuncture to treat joint pain and increased joint mobility (Riley, 2003). An increasing number of studies are beginning to appear in medical journals documenting the success and failures of TCM towards a much wider range of modern medical pathologies (Chuang, 2000). Modern practitioners of TCM have begun to expand their vision even further by looking beyond the treatment of injury and disease towards enhancement or improvement of physical and mental performance. Specifically, TCM is being investigated as a means to improve performance of both professional and amateur athletes.

It is difficult to read or watch sports news today without being exposed to the latest scandal regarding illegal use of “performance enhancement” drugs by professional athletes. Accusations and confessions of athletes using steroids or steroid-like substances are almost commonplace among competitors ranging from Olympic track athletes, to Tour de France bicyclists and professional baseball players. This prevalence of drug-use

in sports reflects the overwhelming pressure that today's athletes face to perform their best at virtually any cost.

Western Athletic Enhancement Solutions

With the modern athlete's constant quest to maintain a competitive edge and the ever-increasing restrictions against the use of chemical enhancements, alternative modalities to increase athletic performance and decrease recovery time are being investigated. Substances that are purported to increase athletic performance are called ergogenic aides. Examples of currently legal ergogenic aides being investigated include nutritional supplements and herbs. Clinical studies have been conducted in substances such as creatine, colostrom, and dihydroxyacetone pyruvate (DHAP). All of these occur naturally in the body as either a precursor or result of metabolic processes. Creatine has been shown to improve performance in exercises requiring bursts of high intensity activity such as sprinting and swimming (Healthgate CAM Medical Review Board, 2003). Other studies suggest that it can increase lean muscle and bone mass. Colostrom, normally found in human breast milk, contains growth factors such as IGF-1 that have also been shown to increase sprinting ability and improve lean muscle mass (Healthgate CAM Medical Review Board, 2003). DHAP (pyruvic acid) is a substance that is essential in the production of ATP within the body. Current studies to determine the effectiveness of using this as a supplement to improve performance have not been successful (Healthgate CAM Medical Review Board, 2003). Ginseng is an herb commonly used in TCM prescriptions to tonify original Qi, tonify spleen and stomach,

and calm the mind (Healthgate CAM Medical Review Board, 2003). Specifically, three types of ginseng are available; Asian Ginseng (*Panax ginseng*), American Ginseng (*Panax quinquefollius*), and Siberian “Ginseng”. Siberian ginseng is actually a misnomer to describe an herb originally promoted by Russian scientists to function identical to Asian Ginseng. Of these three variations, only Asian Ginseng has demonstrated an ability to improve aerobic capacity in a clinical study (Healthgate CAM Medical Review Board, 2003).

Alternative Athletic Enhancement Solutions

Using herbs or supplements to enhance athletic performance is becoming and increasingly risky alternative due to the growing list of “banned” substances as dictated by the professional sports community. As a result, other modalities have also been investigated including massage-therapy, magnet therapy, meditation, and acupuncture. These less conventional approaches towards enhancement address human performance in a more holistic manner by acknowledging the integral link between mind and body. They assume that optimal health and maximum athletic performance can be attained by tuning the mind and the body to their greatest potential. This concept reaches beyond common practices of simply trying to increase strength or “fuel” for the muscles. Recent studies regarding the use of TCM, specifically acupuncture, suggest that it can be successfully used for enhancing human performance from several different angles including improving concentration, modifying metabolic processes typically involved in extreme

exercise, and improving recovery time for athletic-based injuries (Holt, L., Pelham, T., Stalker, R., 2001).

Traditional Chinese Medicine: An Introduction

Traditional Chinese Medicine (TCM) is a 2,500 years old healing system whose foundations lie in the belief that health and nature exist in terms of Yin and Yang and can be represented by the Tao symbol. The concepts of Yin and Yang represent the cyclic patterns of change both in nature and the human body. Yin typically represents dark, dense, cold, wet, and earth. In contrast, Yang usually represents light, warmth, and activity. Optimal health can be achieved by maintaining the proper Yin/Yang balance within the human body. From a TCM perspective, the body contains vital substances including Qi, Blood, Yin, Yang, and Jing (essence). An imbalance or blockage of these substances can lead to disease or injury to the internal organs known as the Zang-Fu. Access to these substances and their relation to the organs is attained through specific points along the surface of the skin. The points lie along specific meridians that correspond to each of the internal Yin and Yang (Zang and Fu) organs. Of the several types of Qi or energy within the body, “true” Qi or Zhen Qi (Maciocia, G. 1989) refers to the Qi that flow along the meridians. Acupuncture points are considered local areas where Zhen-Qi tends to collect and are vulnerable to stimulation by inserting needles to those areas. Choosing which acupuncture points to needle depends on the individual diagnosis. One of the more common schools of diagnosis is called the School of 8 Principals. By classifying all symptoms within 4 specific categories, a full diagnosis and

treatment protocol can be established. The first category is to determine whether a disease (disharmony) originates internally (from the organs themselves) or from an external sources. External sources include virus, bacteria, and parasites, injury-based and chronic-use trauma, severe weather, and poor-quality lifestyles. The second category differentiates between excess and deficiency. Excess conditions include all external sources as described in the first category along with conditions of Qi stagnation. Deficiency conditions include one or more of the vital substances; Yin, Yang, Qi, Blood, or Essence. The third category can identify the symptoms in terms of Yin or Yang. The vital substances, for example, can be loosely identified in terms of being more Yin or Yang-like in nature. For example, Qi is usually, but not always, identified with Yang while blood is usually identified with Yin. The last category classifies symptoms in terms of hot or cold. A person will usually describe their injury or problem in terms of being hot or cold and whether they feel better with application of warmth or cold. These four categories comprise the 8 Principals method for diagnosis where all afflictions can be described in terms at least one or more of these categories.

Effects of Exercise on Human Health: A Western Perspective

Before acupuncture can be demonstrated to improve athletic performance, the physiology of exercise must be examined and a comparison drawn between the etiology of athletic fatigue according to Western medicine and its TCM-based equivalent. Exercise has been long known to improve the over-all health and well-being of people. The physiological benefits of exercise have been thoroughly investigated and are

discussed in-depth in a number of texts on exercise physiology (Plowman, S., Smith, D. 2003). Three specific factors of physiological response to exercise that will be examined are cardiovascular effects of endurance training, the effect of exercise on immune response, and the proposed models to explain fatigue and muscle soreness due to exercise. All of these factors can play a role in athletic performance.

Aerobic exercise, specifically endurance training, has been proven to cause several changes to the cardio-vascular system (Plowman, S., Smith, D. 2003). One of the these changes is the increase in mass and size of the heart, including an increase in the size of the myocardium (heart muscle) as well as its surrounding coronary vascular bed (coronary arteries and veins). This is the result of endurance training exposing the heart to conditions of increased ventricular filling. Chronic exposure to conditions of high-level ventricular filling, also known as volume overload (Plowman, S., Smith, D. 2003), results in an increase in size of the left ventricle and the surrounding arteries.

Blood volume has also been shown to increase up to 25% in endurance athletes compared to untrained subjects (Plowman, S., Smith, D. 2003). Further investigation has shown that this increase is initially due to an increase in plasma volume. After around 30 days however, it is attributed to both an increase in plasma and red-blood cells (Plowman, S., Smith, D., 2003). The higher volume of plasma and subsequent increase in red-blood cells facilitates a higher supply of oxygen to the muscles. The higher volume delays the transition from aerobic respiration to less efficient anaerobic respiration.

The larger ventricular diastolic volume and the increase in blood volume will result in higher cardiac output, specifically in terms of stroke volume. Cardiac output is defined as the amount of blood that can be pumped per unit time. Elite endurance athletes, for example, can have cardiac output levels greater than 35 liters per minute (Plowman, S., Smith, D., 2003). All of these changes in cardiac function during athletic training have a direct benefit in athletic performance by controlling the efficiency at which an athlete will utilize oxygen and burn energy. Since the heart can work more efficiently to distribute blood and oxygen, valuable stores of energy can be more easily be utilized by the skeletal muscles.

The immune system also undergoes radical changes during exercise. The immune system is made up of several types of white blood cells that are collectively labeled leukocytes. Within this grouping, however, there are several different types of cells that play different roles in destroying pathogens or consuming cellular debris. Several studies have been conducted to measure these leukocytes levels under a variety of exercise conditions (Plowman, S., Smith, D., 2003). Changes in cell-count have been measured in athletes after both mild and intense bouts of prolonged exercise lasting from 1-3 hours. During both mild and intense levels of exercise, total leukocytosis (act of making new leukocytes) increases dramatically up to 300 %. This includes an increase in formation of neutrophils, monocytes, natural killer cells, and T-cells. During the recovery period from intense prolonged exercise, however, both natural-killer cells and T-cell activity show a significant decrease to below normal levels as much as 60% (Plowman, S., Smith, D., 2003). Natural killer cells aid the immune system by directly attacking virus-infected

cells and cancerous body cells while T-cells can either directly attack virus and cancer-infected cells or control the activity of the other leukocytes during the immune response. This suppression of the immune system may explain the high incidence of upper respiratory tract infections among endurance athletes (Plowman, S., Smith, D., 2003) .

Along with the possible suppression of the immune system, two other consequences of over-exertion that can ultimately effect overall athletic performance are muscular fatigue and muscle soreness. Fatigue is generally defined as the progressive loss of work capacity. Two hypotheses are currently used to help explain muscular fatigue. The depletion theory suggests that fatigue results from the exhaustion of required metabolites used in muscle contraction such as ATP, phosphocreatine, and creatine. The accumulation theory, however, suggests that fatigue is caused by the excessive buildup of metabolites that impair muscular contraction including lactate, hydrogen ions, ammonia, and phosphate (Plowman, S., Smith, D., 2003). The most modern research for causes of fatigue suggest that it is a much more complex mechanism largely depending on the muscle type and the activity involved (See Table 1) (Plowman, S., Smith, D. 2003).

Muscle soreness is a very common consequence of training and can be divided into two categories: (1) Immediate-onset-soreness (IOS) is pain experienced during and immediately after exercise that can persist up to several hours. IOS is thought to be the result of by-products of cellular respiration including hydrogen ions associated with high levels of lactic acid (Plowman, S., Smith, D., 2003). These by-products can trigger pain-receptors in the peripheral nervous system. This type of pain will usually subside

immediately or a few hours after exercise. (2) Delayed-onset-muscle-soreness (DOMS), in contrast, increases 24 to 48 hours after exercise and can persist up to 5 to 7 days (Plowman, S., Smith, D., 2003). Although DOMS is not yet fully understood, two theories exist to may help explain it. The mechanical trauma model suggests that damage to the muscle fibers occurs during muscle contraction. The resultant damage to the sarcolemma of the cell leads to disruption of calcium homeostasis and ultimately leads to cell and tissue death. The immune response is activated, bringing increased levels of macrophages to consume cellular debris, resulting in swelling and inflammation (Plowman, S., Smith, D., 2003). An alternate theory is called the ischemic model. This model suggests that all exercise, whether it is moderate or intense, causes swelling in the muscle tissue, resulting in increased tissue pressure. This tissue pressure leads to local ischemia or reduced blood flow, causing pain and tonic muscle constriction or spasms. These spasms cause additional swelling, resulting in additional constriction and further ischemia (Plowman, S., Smith, D., 2003). Muscle fatigue and soreness can both play a large role in affecting physical performance. Excessive amounts of either will markedly decrease athletic ability. Aside from rest, increasing evidence suggests that acupuncture can positively influence these factors, leading to shorter recovery times, less pain, and ultimately improved athletic performance.

Effects of Exercise on Human Health: A TCM Perspective

From a TCM perspective, symptoms of fatigue, over-training, pain, and injury are not only localized to the muscles, but can affect the function of the internal organs as

well. Treatment by TCM–based acupuncture involves addressing the whole body including the musculo-skeletal system, the internal organs, and the psychological stressors involved with prolonged competitive environments.

Traditional Chinese Medicine can first address optimization of athletic performance by examining the psychological components that can negatively impact the athlete. Fear is a very common emotion that athletes at all levels experience to various degrees before competition. Whether it is anxiety over performing in front of large audiences, fear of not meeting expectations, or simply competing in an unfamiliar environment, fear can prevent the athlete from achieving that competitive and intuitive state. This state, often referred to as “the zone” or “tunnel vision”, allows the mind and body to act in complete unison in which the athlete can bypass the higher functions of cognitive thought and react in a faster, more instinctive state. According to TCM, excessive fear is attributed to damaging the kidneys and causing the spleen to over-act on the kidneys (Ni, M., 1995). Several acupuncture points can be used to help lower anxiety and calm the spirit such as Ren 15, Ht 7, Pc6, Liv3, D20, and GB15 (Ni, Y. 1996). Additional points such as Yin Tang (on the forehead) or Shen Men (in the ear) can also be employed. Additional points such as Ky3, Ky 6, or UB23 , and UB52 can also be added to directly strengthen the kidneys if the anxiety is a chronic condition. These particular points directly address deficiency of the kidney and are very effective in tonifying all aspects the kidneys including kidney yin, kidney yang, and kidney essence (Ni, Y. 1996). Point prescriptions for each competitor may vary depending on what symptoms they manifest.

Fear and other emotions such as over-thinking or over-worrying will manifest differently depending on their specific causes. Excess conditions that may lead to fire are the result of hectic lifestyles and suppressed emotions. Organs that are usually affected include the heart, stomach, and liver. In this circumstance, needles would be used to sedate the Qi and may include Ren 14, Ht 8, P6, and Ren 24 (Wimmer, R., 2005). Ren 14 is the front Mu point of the heart is often used to calm rebellion, or in conditions where the patient shows excess signs of anger, ranting, or agitation. Ht 8 is a common point to clear excesses of the heart that can manifest as palpitations or excessive worry. P6 is also considered an effective point to calm the heart, clear nausea, and reduce insomnia. Ren 24 is included in cases where the heat has ascended to the head and leads to strong emotional outbursts (Deadman, P., 2001)

Conditions such as overwork, stress, improper diet, and lack of sleep tend to affect the heart, kidney, and spleen. In these circumstances, the deficiency applies to vital substances including heart or kidney qi, heart or kidney yin, and spleen blood. These deficiencies can be tonified by stimulating acupuncture points Ky6, Sp6, Du20, CV4, and CV6 (Wimmer, R., 2005). Specifically, Ky6 can be used to tonify both kidney yin and kidney yang. Sp 6 is used to tonify the liver, kidney, and spleen, and helps build spleen blood. Du20 is a powerful point to help raise yang of the whole body. Both CV4 and CV6 are used to nourish original essence, qi, and blood (Deadman, P., 2001). Qi stagnation is a third condition that can result from excessive emotional stress. The qi that normally flows smoothly along the channels and the internal organs will become inhibited or “stuck” usually at the heart or liver resulting in a disharmony known as heart

or liver qi stagnation (Wimmer, R., 2005). In TCM, this qi stagnation can manifest as physical pain, heat, or phlegm. Acupuncture points that could be applied to ensure movement of qi include Liv3, CV17, CV14, LI4, and LI10. Liv3 is used to promote the free flow of qi throughout the entire body. CV17 can unbind qi of the chest and helps dispel phlegm. LI4 is often used to reduce pain. LI10 is attributed to promoting qi flow in the upper body and for reducing pain. Additional points may be added if qi stagnation has transformed to heat and/or phlegm, such as LI11 or St40 (Deadman, P., 2001). Again, the specific points are largely determined by what specific symptoms are present.

Fear and anxiety disorders that result from chronically stressed and competitive environments are the result of prolonged release of excessive neurotransmitters including epinephrine, norepinephrine, dopamine, and corticosteroids (Grout, M., 2002). Western medicine often prescribes the short-term use of benzodiazepenes such as valium and ativan to combat these syndromes. Unfortunately, these substances have several negative side-effects including possible addiction, decreased appetite, dry mouth, constipation, fatigue, and possible sexual side-effects. These risks are clearly not symptoms desired by professional athletes. Acupuncture, however, can provide a safe and effective path for minimizing these psychological obstacles without introducing additional stress to the subject.

Aside from emotional factors, acupuncture can also address performance impairment factors such as a decrease in the immune system resulting from over-training. As previously discussed, over-exertion can lead to a suppression of parts of the immune system. Both natural-killer cells and T-cells have been shown to markedly drop in both

concentration and activity level after prolonged intense activity (Plowman, S., Smith, D., 2003). From a TCM perspective, over-training and a hectic life-style typically associated with athletes can overly tax the kidneys. Among several other functions, kidneys are closely related to the lungs by providing the energy to the lungs for inhalation.

Resistance to external pathogens is provided by a protective energy called wei qi that is produced by the lungs. A weakening of the lungs will commonly result in lowering the immune system (Maciocia, G. 1989). To correct for suppressed immune functions caused by the kidney/lung disharmony, acupuncture points such as Ky3 and Ky4 can be used. These points directly tonify both kidney and lung qi (Ni, Y. 1996). Further tonification of the immune system could be provided by needling points Lu7, Lu9, LI4, St36 (Ni, Y. 1996). Lu7 is used specifically to expel pathogens. Lu9 is needed to tonify the lungs and to maintain a healthy immune system. LI4 and St36 used together also help to enhance the immune system (Deadman, P., 2001).

Aside from possible immune deficiency symptoms, the kidney qi deficiency can result in several other problems. The kidneys are considered the root of both yin and yang as well as the store-house for both pre-heaven and post-heaven essence within the body. These substances are strongly linked to sexual development the overall vitality of the athlete. They also play a role in supporting other organs and their associated functions as well. Strengthening kidney qi, kidney yin, and kidney yang can be achieved through various combinations of acupuncture points CV4, CV6, St 36, K3, K2, and K7 (Wimmer, R., 2004). CV4 is a powerful used to strengthen original kidney qi, essence, and blood. CV6 acts similar to CV4, but is more appropriate for tonifying kidney qi and

kidney yang. St36 is also known for tonifying qi, yin, and blood of the entire body. Ky3 is well known for nourishing kidney yin while Ky7 is more appropriate for tonifying kidney yang. Ky2 is used to regulate kidney qi and clear kidney heat (Deadman, P., 2001). Muscular fatigue can also be effectively treated by acupuncture. Western medicine acknowledges that muscle fatigue is thought to be a combination of depletion of essential nutrients needed for muscle contraction as well as an accumulation of metabolites that impair muscle function. The TCM perspective also treats muscle fatigue as a combination of deficiency (depletion) and stagnation (accumulation). Both qi and blood are responsible to provide energy to the muscles during exertion. The primary organ responsible to provide qi and blood to the four limbs is the spleen (Ni, Y. 1996). The spleen is also largely associated with the stomach and its responsibility to properly adsorb and digest food and drink for energy conversion. From an athletic perspective, The spleen is vulnerable to muscular over-exertion, consumption of greasy or damp foods, and excessive over-thinking or worrying; all of which are common in the lifestyle of the typical high-school or college athlete. Strengthening the spleen and its function to provide energy to the four limbs can be achieved by needling St36, CV12, and Sp3 (Wimmer, R., 2004). St36 is appropriate here for both tonifying qi, blood, and yin as well as regulating digestion. CV12 is effective to help resolve damp accumulated from eating greasy foods. Sp3 is used to strengthen the qi of both the spleen and stomach (Deadman, P., 2001). If spleen qi deficiency persists for a long time, it can manifest as Wei Syndrome or Flaccid-Attack Syndrome characterized by extreme weakness, atrophy, or flaccidity of the muscles. Western medicine would likely characterize this condition as

chronic fatigue syndrome. From an athletic perspective, this condition can be related to extreme training “burnout” where the athlete experiences feelings of lassitude and loses all motivation to train or compete. Along with an extended rest-period, the acupuncture points Sp21, St36, CV4, CV6, UB17, and UB23 can be needled (Ni, Y. 1996). In this circumstance, Sp21 is used to treat overall body weakness, St36 is used to nourish qi, yin, and blood. CV4 and CV6 are effective in nourishing kidney essence, kidney qi, yin, yang and blood. UB17 is known to nourish th blood, and UB23 is restore kidney essence (Deadman, P., 2001).

Aside from the spleen, the liver may also undergo depletion or deficiency symptoms. Constant training with insufficient rest can lead to liver blood and/or liver yin deficiency. Two functions of the liver are to promote the free-flow of Qi throughout the entire body and to provide blood to nourish the sinews (Ni, Y. 1996). Emotions including anger and frustration as well as over-taxing the muscles can impair the liver’s function to provide blood to the muscles and to ensure the proper flow of nutritive qi along the meridians. In TCM, impairment of proper liver function can both be caused by or result in emotional factors of anger, resentment, or chronic irritability. Liver qi stagnation is usually linked to these emotions and can typically manifest as moodiness, sighing, and a sore neck and shoulders. Liver qi stagnation will often lead to liver blood and/or liver yin deficiency. Without the liver blood’s ability to nourish the tendons, the muscles can become tight resulting in possible tearing or muscle spasms. Liver qi stagnation can first be minimized by applying needles to acupuncture points Lv2, Lv 3,

and CV17 (Ni, Y. 1996). To then nourish or tonify liver blood, the acupuncture points St36, Sp6, LI4, Lv3, Liv8, and GV20 can be needled (Wimmer, R., 2004).

As can be demonstrated above, TCM attributes muscular fatigue to a variety of factors that affect both the individual muscles along with a number of internal organs including the kidneys, spleen, and liver. Acupuncture can be used to treat both the muscle and the supporting organs; all of which can help athletes to perform their optimal level.

Regardless of an athlete's physical condition, a change in their training routine, or simply training harder than normal can result in muscle soreness. As previously stated on page 10, muscle soreness can be separated into immediate onset soreness (IOS) and delayed onset muscle soreness (DOMS). In the perspective of athletic performance, treatment of DOMS is of the greatest concern because the characteristic pain and swelling persist up to 5 to 7 days after its inception. While western medicine attributes DOMS to local inflammation due to either mechanical damage or swelling leading to ischemia and muscle spasms, TCM views DOMS as localized qi and blood stagnation that manifests as pain and soreness of the joints, muscles or tendons. Collectively, this is known as muscle Bi-syndrome (Xinnong, C., 1987). Acupuncture can be used to dispel the discomfort by needling points for overall body pain such as SI3, UB62, Sp21, UB17, LI15, LI4, GB34, GB39, and St41 (Xinnong, C., 1987). SI3 and UB62 are the master/couple points to free the qi along the du channel if the qi stagnation runs along the spine. Sp21 is known to treat general body pain. LI15 and LI4 are helpful to relieve pain along the arms, while GB34 GB39, and St41 are appropriate for freeing qi flow and relieving

pain in the lower body (Deadman, P., 2001). Moving the local qi and blood stagnation can be accomplished by needling localized tender points called ahshi points along the meridian of the sore muscle.

While DOMS can be quite painful and temporarily debilitating to athletic performance, there is no evidence linking it to permanent structural damage to the muscle itself. Muscle, tendon, or ligament sprains or tearing, however can result either long-term or permanent damage to the athlete. As previously mentioned, TCM attributes the root cause of muscle sprains or tendon tears on liver qi stagnation leading to liver yin or liver blood deficiency. Once the tear or sprain occurs, TCM views this as a type of Bi-syndrome otherwise known as painful obstruction (Chuang, 2000). Bi-syndrome exists in many forms depending on what symptoms are present. It is usually caused by external factors including wind, hot, cold, or damp. It can also be caused by traumatic injury. Within Western medicine, most sports injuries are categorized into three phases defined as acute, sub-acute, and chronic (Chuang, 2000). The acute phase refers to the first 72 hours after the onset of the injury and is usually characterized by swelling, discoloration, severe localized pain, and decreased range of motion. The sub-acute stage ranges from 72 hours to 90 days after the injury and is the stage most receptive to treatment by acupuncture or most vulnerable to improper care. The chronic phase is defined the injury state after 90 days. TCM acknowledges these phases by differentiating them into different types of bi-syndrome. For example, during the acute or even the sub-acute stage, the injury could be classified as muscle bi-syndrome but later transform into painful, fixed, or heat bi-syndrome depending its specific symptoms (Chuang, 2000). In

all circumstances, however, moving the stagnated qi and blood is of primary importance. Additional treatment designed to clear heat, tonify yin, or tonify yang may be necessary depending the symptoms that manifest.

The common obstacles that plague competitors and can adversely affect athletic performance include anxiety, fatigue, delayed-onset-muscle-soreness, and muscle sprains. Theoretically, TCM-based acupuncture can offer several solutions to these problems. Only in the last few years have clinical studies been conducted to verify these claims. The following case studies not only suggest that acupuncture can successfully address these factors, but also emphasize how little research has actually been conducted in this field.

The Effects of Acupuncture on Human Performance: Clinical Studies

Although testimonials exist in almost every acupuncture clinic claiming that acupuncture can improve the overall well-being of patients, few published studies exist demonstrating the effectiveness of acupuncture in lowering the stress of athletes in a competitive environment. In 2003, an investigation was conducted on a team of female soccer players to determine if acupuncture can improve the overall well-being. The parameters used to determine the effectiveness of acupuncture included measuring levels of both immunoglobulin A (SIgA) and cortisol levels in the saliva. As previously mentioned, intense exercise for prolonged periods can negatively impact the immune system. Corticosteroids (cortisol) are neurotransmitters that increase in concentration resulting from a chronically stressed environment. Chronically high levels of cortisol are

linked with several negative side-effects including a decrease in protein synthesis within the muscles and suppression of the immune system (Huether, 2000). Additional parameters used in the test included a subjective rating of well-being and profile of mood states (POMS) test that each competitor had to fill out. The team was divided into two groups; the acupuncture group and the control group. The acupuncture group was treated to 15 to 20 minutes of acupuncture at LI4, St36, St6, and Lu6 4 hours after competition every night during the competition period. The control group received no acupuncture. The results stated that the acupuncture group did not exhibit the expected decrease in SigA or increase in cortisol levels experienced by the control group. The scores on the POMS test were also considerably higher with the acupuncture group when compared to the control group (Akimoto, 2003). Although the results of this study are encouraging, it was only a preliminary test. Possible improvements to this test include incorporating a placebo group to rule out the possibility that the acupuncture group simply convinced themselves that the treatments were going to work.

Studies to address exercise-induced muscular fatigue have been studied only briefly and have yielded mixed results. In one test, strength and endurance were tested on a group of 17 young healthy men using a hand dynamometer and a leg extension isokinetic dynamometer. Electromyography was also conducted during the test to measure the electrical activity of the individual muscle. A single needle was inserted into the flexor muscle of either the leg or forearm for 15 minutes prior to the exercise. Although strength and endurance results did not change, the electromyography recordings were markedly different on the muscles that received the treatment compared

to the muscles that received no treatment (Pelham, 2001) This suggested that acupuncture can influence neuromuscular activity. This test was flawed in that only a single needle was used directly into the belly of the muscle and not into any traditional acupuncture points dictated by TCM.

Acupuncture effects on fatigue from aerobic exercise have also been only briefly investigated. One factor that is commonly measured to determine the level of athletic conditioning is VO₂max. This is defined as maximum oxygen consumption and is calculated as product of cardiac output and arteriovenous oxygen difference (Plowman, S., Smith, D. 2003). In simple terms, it measures how efficiently the body can successfully utilize oxygen. Higher conditioned athletes will have higher VO₂max values. Another factor used to determine athletic conditioning is the amount of lactate in the blood. As previously mentioned, lactate is a byproduct of both anaerobic and aerobic muscular activity that can impede the cross-linking function of the muscle fibers. In simple terms, a more conditioned athlete will have lower lactate levels for a given amount of exercise. In the test to investigate the effect of acupuncture on endurance training, factors including heart rate, respiratory exchange, VO₂max were measured following a single acupuncture treatment. Measurements were taken on healthy subjects during sub-maximal and maximal exercise on a cycle ergometer. The acupuncture points used included Li13, P6, St36, Sp6, and CV30. According to the researchers, the acupuncture treatment had no effect on these parameters (Pelham, 2001). This test could have been improved by providing a control, placebo, and a test group. Like the flawed strength test, TCM theory was not generally used for these subjects. The acupuncture

was viewed as a possible “magic bullet” where the one treatment could have been sufficient to provoke marked changes in cardio-vascular efficiency. From a traditional perspective, however, treatment protocols are largely determined specific symptoms where significant changes are not usually expected for at least 5 to 10 treatments (Pelham, 2001).

A similar test that more closely followed TCM acupuncture protocol involved treating two separate groups of healthy men with acupuncture. Both a placebo group and a target group were treated with acupuncture once per week over a five-week period. In this test, subjects treated with the valid acupuncture treatments exhibited lower concentration of blood lactate and showed lower heart rates at both sub-maximal and maximal exercise (Pelham, 2001). Although the results of this test are encouraging, greater details of the experiment are needed to determine its validity.

The effectiveness of acupuncture on delayed-onset-muscle-soreness (DOMS) was investigated by subjecting 20 male athletes to intense exercise that induced DOMS. The group was separated into both a control group that received no acupuncture and the treatment group that received acupuncture. Both a subjective rating of muscle soreness as well as serum kinase activity was taken from both groups at 24, 48, and 72 hours after exercise. Although creatine kinase levels were the same for both the control and the test group, subjects treated to acupuncture claimed to have significantly less pain and increased range of motion (Pelham, 2001) Whether the acupuncture treatment simply increased levels of beta-endorphins to block pain receptors or had a direct influence on DOMS could not be determined from this report.

The application of acupuncture to treat muscle sprains or tears is increasingly common. Individual cases claiming success can be found where acupuncture was used to successfully treat sports-related injuries including knee, shoulder and ankle pain that inhibited proper joint function (Chernish, 1994). Unlike measuring metabolites that are associated with fatigue or factors that reflect cardiovascular function, however, quantifying the influence of acupuncture on injury recovery is difficult.

The use of ergogenic aides is increasingly common among top athletes to gain an extra “edge” over their competitors. Although it is not yet generally accepted as a viable alternative to legal or illegal medical supplements, acupuncture has been successfully demonstrated to aid in increasing athletic performance by addressing several factors that can prevent an athlete from performing at his or her peak potential. According to both classic TCM theory as well by an increasing collection of supporting evidence, factors such as anxiety, muscular and cardiovascular fatigue, delayed-onset-muscle-soreness, and minor injuries can be addressed with acupuncture. While current evidence is suggesting that acupuncture is successful at treating athletes, the lack of formal trials suggests that this field is still very new and has tremendous opportunity for further research.

Table 1. Most Probable Causes of Muscle Fatigue

Type of Activity	Probable Causes for Fatigue
Anaerobic Activity (Sprinting)	Depletion of Phosphocreatine (PC) Accumulation of H ⁺ Inhibits glycolysis Decreases Ca ²⁺ from SR Interferes with Ca ²⁺ - troponin binding Accumulation of Lactate interferes with cross-bridging
Long-term, Moderate to Heavy Submaximal aerobic	Depletion of glycogen Accumulation of H ⁺ Accumulation of H ⁺ Inhibits glycolysis Decreases Ca ²⁺ from SR Interferes with Ca ²⁺ - troponin binding Accumulation of Lactate interferes with cross-bridging
Incremental Aerobic Exercise to Maximum	Depletion of glycogen Accumulation of H ⁺ Accumulation of H ⁺ Inhibits glycolysis Decreases Ca ²⁺ from SR Interferes with Ca ²⁺ - troponin binding Depletion of PC Accumulation of Lactate interferes with cross-bridging
Static Resistance	Depletion of PC Accumulation of H ⁺ Inhibits glycolysis Decreases Ca ²⁺ from SR Interferes with Ca ²⁺ - troponin binding Depletion of PC Accumulation of Lactate interferes with cross-bridging Occlusion of blood flow Inhibition of motor cortex via sensory fibers in muscle Accumulation of Lactate interferes with cross-bridging
Dynamic Repetitions Low Repetitions High Repetitions	Depletion of PC Depletion of glycogen Accumulation of H ⁺ Inhibits glycolysis Decreases Ca ²⁺ from SR Interferes with Ca ²⁺ - troponin binding Accumulation of Lactate interferes with cross-bridging

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