

Acupuncture in Human Performance

THOMAS W. PELHAM,¹ LAURENCE E. HOLT,² AND ROBERT STALKER³

¹Department of Pathology, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada; ²School of Health and Human Performance, Faculty of Health Professions, Dalhousie University, Halifax, Nova Scotia, Canada; ³Sport Medicine Clinic, Dalhousie University, Halifax, Nova Scotia, Canada.

ABSTRACT

To this point in time, acupuncture has been used primarily as an analgesic, a therapeutic intervention that controls pain under pathological conditions. Although some of the mechanisms of acupuncture as it applies to pain relief have been studied, little is known of the positive and/or negative effects of this procedure on the physical performance parameters of healthy people, particularly highly trained athletes. After introducing acupuncture from historical and technique viewpoints, preliminary studies of the effects of acupuncture on strength, aerobic conditioning, flexibility, and sport performance are discussed, as well as concerns regarding the direction of research investigating the potential benefit and/or adverse effects of this practice. Finally, an argument is put forward for the establishment of guidelines for the use of acupuncture in the sports community.

Key Words: ergogenic aids, exercise physiology, sport ethics

Reference Data: Pelham, T.W., L.E. Holt, and R. Stalker. Acupuncture in human performance. *J. Strength Cond. Res.* 15(2):266–271. 2001.

Introduction

Virtually all athletes and coaches are involved in a constant search for ways to improve performance and gain a competitive edge over their rivals. Unfortunately for many, this has led to a win at all costs philosophy that seems to be pervasive, particularly at the “upper” levels of sport. Many athletes are willing to use any substance, technique, or practice, either based on science or exaggerated belief, without a full understanding of either the short-term or long-term ethical, legal and health implications of their actions.

Applications and methods (aside from training itself) that improve the critical physiological and biomechanical variables associated with sport performance or remove factors that limit physiological capacity have been defined as ergogenic aids (1, 2). A large assortment of mechanical, physical, psychologi-

cal, nutritional, and pharmacological commodities have been classified as ergogenic aids.

Advances in training methods (e.g., warm-up, altitude training), strategies (e.g., planned plays), new features in equipment (e.g., aerodynamically designed clothing), nutritional routines (e.g., vitamin supplements, precompetition carbohydrate loading), prescription drugs (e.g., beta-blockers), and nonprescribed drugs (e.g., caffeine) are considered ergogenic aids by many sport health professionals and sport scientists. Also, both prescription (e.g., amphetamines) and illegal drugs (e.g., cocaine) have been used as ergogenic aids. In the past few years, the most publicized banned ergogenic aids have been anabolic-androgenic steroids, steroid precursors such as androstenedione (i.e., Andro), and blood doping. Although steroid use and blood transfusions are important in many medical treatments, their use in sport is considered a serious violation of the rules. Andro, although banned from Olympic events and some professional sports, can be purchased over the counter in the U.S.A. and is the focus of much research and speculation (15).

Although not classified as ergogenic aids, a number of hands-on techniques, such as massage (e.g., superficial/deep), proprioceptive neuromuscular facilitation (PNF) stretching and direct pressure, have been employed extensively and are believed to be useful in preventing injuries and hastening recovery and possibly enhancing performance.

Holistic medicine has gained popularity recently, and a number of alternative medical interventions have emerged with possible performance-enhancing properties. One such candidate currently under investigation is acupuncture, which has been a medical intervention in the Orient for over 2,500 years. Although conventional western medicine has been slow to embrace acupuncture, this ancient form of therapy has been prescribed for a wide variety of medical conditions in the Far East. However, in the west, the role of acupuncture as a treatment option has expanded dramatically since the 1970s to include neurologic (20), respiratory (13), and orthopedic (5) conditions. In all

probability, this trend will continue as health care becomes more holistic in the west.

In the Canadian clinical setting, many certified physical therapists use acupuncture primarily for pain modulation. Controlling pain could be a considerable competitive advantage for athletes in most sports and should be one of the foci of future research.

The side effects of acupuncture have been found to be few and mild. However, in some sports, these side effects (e.g., some individuals may experience dizziness) (28) could place the athlete at risk. During competition, this condition could negatively affect the athlete (e.g., downhill skier) placing him/her in a hazardous situation. Given this possibility and the experimental tendencies of athletes and coaches in their quest for a competitive edge, it seems quite possible that misapplication of this procedure may emerge. In order to prevent a repeat of the many problems encountered with the improper use of other ergogenic aids, it is important for all athletes, coaches, sport scientists, and sport health professionals to have a full understanding of the various practices of alternative medicine, including acupuncture. Stimulation of specific acupoints have been suggested to improve physical performance in sport (12, 21, 33).

With this in mind, the following discussion will center on the influence of acupuncture on athletic performance with special reference to strength, aerobic conditioning, and flexibility.

Historical Aspects of Acupuncture

The ancient Chinese believed that everything in nature was energy, or Qi. Further, Qi was systematically divided into Yin and Yang and symbolized by the sign of TAO (31). The ancient philosophers of China believed that disease was a result of an imbalance between Yin and Yang. According to Taoistic Chinese philosophy, Yin and Yang have an antagonistic relationship, (if one increases, the other must decrease) (31). Another belief of the ancient Chinese was that the basic materials for life were: wood, fire, earth, metal, and water (31). These Five Elements were interrelated and everchanging. The physicians of ancient China applied these beliefs to the health of the body. The 6 solid Zang organs were: heart, spleen, lung, kidney, liver, and the pericardium (31). The 6 hollow Fu organs were: small intestine, stomach, large intestines, urinary bladder, gall bladder, and triple warmer (31). From ancient times, the triple warmer has been referred to as "having a name but no form" (31). The triple warmer consists of 3 parts; the upper warmer, which is the head and chest region, and functions include the heart and lungs. The middle warmer extends from the chest to the umbilicus, and functions of the stomach, liver, and spleen. The lower warmer region is the lower abdomen, and functions of the kidneys and urinary blad-

der. Although the study of anatomy by autopsy was not permitted in ancient China, clinicians used physiological observations to develop the theory of the functions of Zang and Fu organs. The functions of the Fu organs were to receive and digest food (31). Their role was then to transmit the nutrients to the Zang organs, which were to produce and store energy (31).

Central to traditional Chinese medicine (TCM) is the notion that energy flows throughout the body along specific channels, or meridians. The movement of biological energy along these meridians and their collaterals connect and communicate between the viscera and extremities. It is through these channels that the physiological functions of the body are regulated and equilibrium is maintained. There are 12 principle meridians, 6 each from the Zang and Fu organs. Meridians are bilateral and run both a superficial and deep course. Specific acupuncture points are located along each meridian. It is at these points that acupuncture needles are inserted. The purpose of the meridians is to distribute visceral energy to all tissues of the body. The acupuncture meridian system is used to make diagnoses and to develop treatment plans for a wide variety of pathological conditions. As mentioned above, along with the meridians, other internal factors, Yin-Yang, energy, blood, and Zang-Fu organs must remain in balance to maintain health. As well, the body must be in harmony with external (environmental) factors to maintain health. In the event of an imbalance, and based on the diagnosis, specific acupuncture points are stimulated to restore equilibrium.

Acupuncture Techniques

From the oriental perspective, the goal of acupuncture is to re-establish the balance of internal body energies. Internal factors, such as emotion, stress, injury, and external factors, such as cold and heat, can disrupt the harmony within the body.

Over the centuries, treatment plans have been developed for pathological conditions. But little is known of the uses of acupuncture for the enhancement human performance.

The most striking feature of acupuncture is the insertion of needles into specific points on the human body. In the clinical setting, the number of points, duration of the treatment session, and the duration of the treatment program are based on both the identified pathology and training/experience of the practitioner.

Although there are mandatory standards and guidelines with regard to safety, there appears to be no fixed treatment protocol. Selection of points, type of stimulation, amount of stimulation at each treatment session, the number of treatments per week, and the total number of treatment sessions will vary. That is, as mentioned above, the selection of acupuncture points and treatment protocols are based on the spe-

cific diagnosis. However, there would appear to be a degree of variability among authors and practitioners on which points and treatment protocols are used for any particular disease. Needle selection and criteria for usage vary between acupoints and are dependent on a number of factors including treatment method, most notably the desired depth of penetration of the needle. Variable treatment parameters are used by the physical therapist in the Province of Nova Scotia and dictated by the current state of the pathological condition and assessment of results.

Generally, the length of the needle used is determined by the desired depth of insertion and the purpose of the treatment. Commonly used sizes by Nova Scotian physical therapists are 25–40 mm with a diameter of 0.22 mm. In the Nova Scotian physical therapy setting, needles are thin, sterile, and disposable. These needles are encased in plastic tubes.

During acupuncture, the individual is placed in a position of support (usually lying) and comfort, exposing the region to which the needle will be inserted. Before insertion into the skin the area is cleansed with alcohol. The patient may feel a sensation as the needle pierces the skin. A popular adjunct is stimulation of the needle either manually or with electrical current.

Acupuncture, Pain, and Physical Performance

A noxious event, such as an insult to tissue can activate nociceptors (pain receptors) (19). Stimulation of nociceptors generate impulses that are transmitted to the central nervous system (CNS) where the incoming signals are processed in the diencephalon and pain is perceived. However, these transmissions can be inhibited (24). Acupuncture has been suggested to be associated with the release of β -endorphins (26). These opiates have been identified with pain modulation and nociceptive transmission inhibition at all levels of the nervous system. Both exercise and acupuncture stimulate afferent nerve fibers. The A-delta and C fibers are possible targets (3) and have been shown to be pathways for pain sensation. The hypothalamus and other brainstem nuclei have been suggested as possible sites affected by acupuncture (3).

Increased concentrations of β -endorphins have been found following both exercise and application of acupuncture. β -Endorphins have been associated with long-lasting pain control. As well, acupuncture has been hypothesized to attenuate the sympathetic system at the level of the CNS.

As mentioned earlier, the philosophy underlying TCM is based on the notion that the healthy human body is in a balance of energy. Further, energy flows through the body in well-marked pathways, or meridians. Illness and pain can disrupt this balance. As well, Jaung-Geng et al. (12) have hypothesized that fatigue

caused by vigorous exercise can disrupt these meridians, interfering with energy flow and circulation. They state that ear point-specific acupuncture can “unblock the meridians” and thereby attenuate fatigue. The goal of TCM acupuncture is to insert needles into specific acupuncture points along these meridians attempting to re-establish the flow of energy and return to homeostasis.

In western medicine, both the classical approach and a neurophysiological/neurochemical approach are used, and in the latter approach, needles are inserted into specific points that are associated with nervous tissue that activate specific muscles. By stimulating these points with needles, β -endorphins are released for pain control.

Along with altering pain sensation, exercise and acupuncture can be beneficial by having a positive effect on mood states (3). Optimal performance has been associated with mood (i.e., arousal level) (23).

Acupuncture and Strength

Acupuncture, particularly electroacupuncture, is felt to be able to produce the same excitatory characteristics within the motor nerve and muscle as does exercise (3). Electrical stimulation is a common procedure used by physical therapists to increase strength in atrophied muscle. The question then arises as to whether acupuncture can increase strength and to what extent?

In the popular literature, acupuncture has been advocated as an adjunct to hypertrophy training (i.e., bodybuilding); a means to develop specific muscle groups; a way to accelerate recovery from both workouts and injuries; and as a stimulant for growth hormone and testosterone production (25). In regards to aesthetics, it has been suggested that “acupuncture stimulates facial muscles to contract and strengthen almost immediately” (16). This application seems to be without foundation, as a review of the literature failed to reveal any controlled studies investigating the use of acupuncture for body hypertrophy or any of the aforementioned factors.

Muscle activity and potential changes in strength following acupuncture have been examined in one study. Concentric and isokinetic strength and endurance were tested using a hand dynamometer and a leg extension isokinetic dynamometer in 17 young healthy men postacupuncture (34). A single needle was inserted for 15 minutes into either a flexor muscle of the wrist or the semitendinosus muscle. Although muscle endurance or muscle strength test scores did not change, electromyography recordings were different following acupuncture for the stimulated semitendinosus muscle during the strength test and the non-stimulated semitendinosus muscle during the endurance test. The investigators suggested that acupuncture is able to influence neuromuscular activity (34).

However, a serious confounding variable in this study was the fact that the needle was inserted into the belly of the muscle and not into specific acupuncture points. Therefore by definition, this treatment in fact was not acupuncture.

Exercise and acupuncture have been reported to have several common physiological effects on the human body. Physical exercise and acupuncture have been suggested to attenuate the nervous system and to produce similar effects (described below) on the cardiovascular and pulmonary systems, along with producing similar neuroendocrine responses (3).

Acupuncture and Aerobic Conditioning

In endurance sports, such as long distance swimming, cross-country skiing, and the marathon, superior aerobic capacity has been identified as a critical factor to high level performance (22). Oxidative capacity is determined by how efficiently oxygen is delivered and utilized by the active tissue. A common method used by sport scientists to investigate oxygen delivery and utilization is direct or indirect submaximal, or maximal oxygen consumption (VO_{2max}) testing. During testing, a variety of metabolic, cardiovascular, and pulmonary factors are measured. This approach has been used in a number of studies where acupuncture was administered before testing (7, 14).

Karvelas et al. (14) measured heart rate, ventilation, ventilatory equivalent for oxygen, respiratory exchange ratio, and oxygen uptake during continuous submaximal or maximal cycle ergometer exercise in healthy individuals after a single bout of acupuncture. Karvelas et al. (14) used bilateral acupoints Li 13, P 6, S 36, Sp 6, and unilateral acupoints Cv 20 and Co 15. Needles were sterile, disposable stainless steel. Diameter and length of the needles were either 0.25×50 mm or 0.20×30 mm. They found no significant changes in any of the physiological parameters.

Measurements of blood lactate during submaximal and maximal exercise can provide some insight into the aerobic potential of the athlete. Two specific points on the lactate accumulation versus workload curve used by sport scientists are the lactate threshold and onset of blood lactate (Lt) accumulation (OBLA). Reaching OBLA at a lower percentage of aerobic uptake is a favorable outcome for the athlete. Ehrlich and Haber (7) investigated the influence of acupuncture administered once per week over a 5-week period on anaerobic threshold and work capacity during exercise in healthy young, untrained males. These investigators (7) found that individuals in the acupuncture treatment group had higher maximal exercise capacity and were able to perform higher workloads at OBLA than individuals in the placebo group. As well, individuals who received acupuncture demonstrated lower heart rates at various submaximal and maximal levels than

controls. Overtraining in distance runners as interpreted through a TCM approach would indicate that exhaustive training with inadequate recovery results in an energy imbalance, inducing obstructions of the meridians, leading to illness and disease (deficiency syndromes) (27). Point-specific acupuncture can be used to re-establish the energy flow through the meridians, thus relieving the symptoms of overtraining.

The use of acupuncture to treat exercise-induced musculature pain has been studied (6, 32). A highly trained young runner was forced to restrict training as a result of experiencing pain in the lower anterior abdominal region during workout sessions. Standard treatment had failed to correct this problem. For the first 3 weeks, the runner was treated once per 3-day cycle followed by 1 treatment per week for 4 weeks. Acupoints used in various combinations over the treatment period were: Pc 3, Lv 14, St 36, Sp 9, Lv 2, and Sp 3. Through TCM the runner was able to resume training without further incident.

Neural involvement in hemodynamics is an important factor that must be taken into consideration while preparing for sport competition. The demands placed on the autonomic system during intense sporting activities can limit physical performance. Acupuncture has been shown to have autonomic effects (both sympathetic and parasympathetic) on central cardiac function (17) and peripheral circulation (35). Research has reported that properly prescribed acupuncture can decrease heart rate and increase stroke volume leading to a more efficient cardiac output (17). Athletes who have lower heart rates and higher stroke volumes at various workloads have a clean advantage over competitors in sporting activities where cardiorespiratory endurance is an important factor.

Acupuncture has been shown to be associated with vasodilatation of the peripheral system leading to peripheral resistance and blood pressure reductions and blood flow increases (17). Explanations range from activation of efferent vasodilator fibers to point-specific acupuncture stimulation of reflexive autonomic vasodilatation responses.

Acupuncture and Flexibility

Flexibility is important in sport performance. Physical therapists, sport scientists, and sport medicine physicians and coaches share a commonly held notion that achieving adequate degrees of flexibility may prevent or reduce injuries (9, 10). Maintaining sufficient flexibility is related to efficient musculoskeletal function. Decreases in relative flexibility can lead to tissue dysfunction and a wide range of problems (11).

Physiologic and morphologic factors influence flexibility (8). The level of motor unit activity will influence muscle tension, as will the viscoelastic properties of the surrounding fascia (8). Both will affect the de-

gree of flexibility surrounding a particular joint. A variety of active and passive stretching techniques are used to elongate taut tissue. Unlike static and ballistic stretching, PNF stretching relies heavily on neural input to relax and elongate soft tissue (29, 30). Acupuncture, because of its influence on the nervous system can be used as an attenuating agent in combination with PNF stretching to increase joint-specific flexibility. This is a common treatment combination used by the senior author to increase range of motion around a joint. As mentioned earlier, acupuncture has been shown to alter electromyographic activity of a stimulated muscle; therefore it has the potential to change the tension within the muscle, allowing the muscle to relax and elongate (9, 10). The additional analgesic effects of acupuncture to combat myofascial pain usually associated with taut myofascia, as well as exercise-induced muscle soreness (6), lend support for the use of this treatment protocol.

Fifteen subjects with acute Torticollis were treated with electroacupuncture (4). All subjects reported pain with cervical spine movement and demonstrated reduced range of motion of the cervical spine. On average, after 4.5 treatment sessions, subjects reported a marked reduction in pain with a decrease in muscle spasm. One postulated mechanism by the authors was that the electrical current dilated the postcapillary sphincters of the muscles in spasm, increasing local circulation and thereby, decreasing the muscle spasm (4).

Sixteen subjects with a variety of rotator cuff tendinitis and inflammatory capsular conditions received acupuncture to the shoulder region (18). The acupoints used were determined based on the pathological condition. Most noticeable symptoms were pain with shoulder movement and decreased shoulder movement. Along with acupuncture, manual physical therapy techniques were used. Patients reported less pain with shoulder movement and an improvement in the activity of the shoulder following treatment (18).

Some Concerns to Consider

The significance of acupuncture in enhancing performance remains controversial. One reason is that there are few controlled studies in this area. We simply do not know the positive and/or negative aspects of acupuncture applied to highly trained athletes. However, it would seem prudent to avoid the situation that developed in the mid-1980s, where blood transfusions were banned by the International Olympic Committee after the 1984 Olympic Games, even though there was no method of unambiguous detection. To avoid such a problem further research with regard to the use of acupuncture in sport performance is essential. Defining what, if any, improved physiological parameters are associated with acupuncture and the treatment de-

sign surrounding these improvements would add information that sport governing bodies could use to decide whether or not acupuncture should be considered an acceptable adjunct to training. Research may also determine the effectiveness of acupuncture as a prophylactic in high performance sport.

Athletic performance is determined by a number of factors, with their specific contribution varying from sport to sport. For example, long distance running is a simple, repetitive skill with high aerobic power demands, whereas baseball consists of a set of complex skills requiring a high level of neuromuscular coordination and relatively low to moderate levels of muscular endurance and cardiovascular conditioning. The ergogenic effects of acupuncture on different sports must be evaluated on an individual basis.

On the other hand, identifying the potential health risks associated with acupuncture while participating in vigorous physical activities or training is required. Scientific information regarding the dangers and contraindications for the use of acupuncture on highly trained athletes is a prerequisite before accepting acupuncture for performance enhancement. Furthermore, governing bodies can design acceptable procedures and conditions for acupuncture use. Designing appropriate standards of conduct and practice for the use of acupuncture and developing ethical and legal guidelines for each sport should be a priority for sport health professionals, sport scientists, coaches, and athletes.

Practical Applications

The impact of acupuncture on specific strength and conditioning training methods—modes, training intensities, frequencies, volumes, and rest intervals—needs further investigation. Of special interest would be the effects of acupuncture on the neuromuscular components of speed-endurance and plyometric training.

More information is required concerning the effects of acupuncture on muscle physiology and bioenergetics. As well, research is needed to investigate the cardiovascular, respiratory, neuroendocrine, and neuromuscular responses to acupuncture in association with resistance, aerobic, and flexibility training and sport-specific performance.

The combination of acupuncture and various dietary and nutritional programs with regard to weight gain or loss and exercise metabolism would be of interest to many athletes and strength and conditioning coaches in weight control sports such as rowing, boxing, and gymnastics. The effects of acupuncture on emotion would be helpful to athletes desiring more control of anxiety, arousal, and selective attention.

If acupuncture has sport-enhancement properties, the proper and safe match of acupuncture points and

treatment regime with sporting event or skill can only be obtained with further study. This information would allow the athlete, strength and conditioning coach, sports scientist, and health care provider knowledge required for informed decisions as to the moral, ethical, and legal boundaries of acupuncture as an enhancement aid in designing strength and conditioning programs for performance enhancement.

References

- American College of Sports Medicine. Position statement on the use of anabolic-androgenic steroids in sports. *Med. Sci. Sports Exerc.* 19(5):534–539 1987.
- American College of Sports Medicine. Position statement on blood doping as an ergogenic aid. *Med. Sci. Sports Exerc.* 19(5):540–543 1987.
- ANDERSON, S. Physiological mechanisms in acupuncture. In: *Acupuncture and Related Techniques in Physical Therapy*. V. Hopwood, M. Lovesey, S. Mokone, and G. Lewith, eds. New York: Churchill Livingstone, 1997. pp. 19–39.
- BATRA, Y.K. Electroacupuncture in the treatment of acute painful Torticollis. *Am. J. Acupuncture* 15(1):257–259 1987.
- CHRISTENSEN, B.V. Acupuncture treatment of severe knee osteoarthritis: A long-term study. *Acta Anaesthesiol. Scand.* 39:519–525 1992.
- CRAIG, B.W., M.-K. SHIN, J. KIM, J.-S. KIM, R. BLAUDOW, L. ARTALE, AND G. GEHLEN. The analgesic effects of acupuncture on exercise-induced muscle soreness [Abstract]. *J. Strength Cond. Res.* 13(4):423. 1999.
- EHRLIC, D., AND P. HABER. Influence of acupuncture on physical performance capacity and haemodynamic parameters [Abstract]. *Am. J. Acupuncture* 21(1):85. 1993.
- HOLT, L.E., J.B. HOLT, AND T.W. PELHAM. Flexibility redefined. *Biomechanics in Sports XIII*:170–174 1996.
- HOLT, L.E., J.B. HOLT, AND T.W. PELHAM. What research tells us about flexibility I. *Biomechanics in Sports XIII*:175–179 1996.
- HOLT, L.E., J.B. HOLT, AND T.W. PELHAM. What research tells us about flexibility II. *Biomechanics in Sports XIII*:180–183 1996.
- HOLT, L.E., J.B. HOLT, AND T.W. PELHAM. Flexibility: The future. *Biomechanics in Sports XIII*:184–188 1996.
- JAUNG-GENG, L., H.S. SALAHIN, AND L. JUNG-CHARNG. Investigation on the effects of ear acupressure on exercise-induced lactic acid levels and the implications for athletic training. *Am. J. Acupuncture* 23(4):309–313 1995.
- JOBST, K., K. MCPHERSON, V. BROWN, H.J. FLETCHER, P. MALE, J.H. CHEN, J. ARROWSMITH, J.E. FTHIMIOU, G. MACIOCIA, K. SHIFRIN, AND D.J. LANE. Controlled trial of acupuncture for disabling breathlessness. *Lancet* 2:1416–1419 1986.
- KARVELAS, B.R., M.D. HOFFMAN, AND A.I. ZENI. Acute effects of acupuncture on physiological and psychological responses to cycle ergometry. *Arch. Phys. Med. Rehabil.* 77(12):1256–1259 1996.
- KING, D.S., R.L. SHARP, M.D. VUKOVICH, G.A. BROWN, T.A. REIFENRATH, N.L. UHL, AND K.A. PARSON. Effects of oral androstenedione on serum and adaptations to resistance training: A randomized controlled trial. *JAMA* 281(21):2043–2044 1999.
- LATONA, V. About face. *Vegetarian Times* November:92–96 1998.
- LEE, D.C., M.O. LEE, D.H. CLIFFORD, AND L.E. MORRIS. The autonomic effects of acupuncture and analgesic drugs on the cardiovascular system. *Am. J. Acupuncture* 10(1):5–30 1982.
- MARCUS, A., AND R.I. GRACER. A modern approach to shoulder pain using the combined methods of acupuncture and Cyriax-based “orthopaedic medicine.” *Am. J. Acupuncture* 22(1):5–14 1994.
- MELZACK, R., AND P.D. WALL. Pain mechanism: A new theory. *Science* 150:971–979 1965.
- NAESER, M.A. Real versus sham acupuncture in the treatment of paralysis in acute stroke patients: A CT scan lesions site study. *J. Neurolog. Rehabil.* 6:163–173 1992.
- NICKEL, D.J. *Acupressure for Athletes*. New York: Holt & Co., 1987.
- PELHAM, T.W., AND L.E. HOLT. Competitive anxiety in elite and non-elite young male ice hockey players. *Clin. Kinesiol.* 53(2):37–40 1999.
- PELHAM, T.W., AND L.E. HOLT. Testing for aerobic power in paddlers using sport-specific simulators. *J. Strength Cond. Res.* 9(1):52–54 1995.
- PERL, E.R. Afferent bases of nociception and pain: Evidence from the characteristics of sensory receptors and their projection to the spinal dorsal horn. In: *Pain*. J.J. Bonica, ed. New York: Raven, 1980. pp. 19–46.
- POLIQVIN, C. Question of strength. *Muscle Media* April:39–40 1998.
- PROMERANZ, B., AND D. CHIU. Naloxone blocks acupuncture analgesia. Endorphin is implicated. *Life Sci.* 19:1757–1762 1976.
- REAVES, W. Traditional Chinese medicine and the distance runner. *Am. J. Acupuncture* 16(1):5–10 1988.
- ROSTED, P. Literature survey of reported adverse effects associated with acupuncture treatment. *Am. J. Acupuncture* 24(1):27–34 1996.
- SCHMITT, G.D., T.W. PELHAM, AND L.E. HOLT. Changes in flexibility of elite female soccer players resulting from a flexibility program or combined flexibility and strength program: A pilot study. *Clin. Kinesiol.* 52(3):64–67 1998.
- SCHMITT, G.D., T.W. PELHAM, AND L.E. HOLT. A comparison of selected protocols during proprioceptive neuromuscular facilitation stretching. *Clin. Kinesiol.* 53(1):16–21 1999.
- SOLINOS, H., L. MAINVILLE, AND B. AUTERACHE. *Atlas of Chinese Acupuncture. Meridians and Collaterals*. Sillery, QC: 3-8-3 publishing Canada Inc. 1998.
- STERNFELD, M., Y. FINELSTEIN, A. ELIRAZ, AND I. HOD. Runner’s stitch syndrome successfully treated by acupuncture. *Am. J. Acupuncture* 16(1):5–10 1992.
- TEKEOGLU, I., B. ADAK, AND M. ERCAN. Investigation into the possibilities of using ear acupuncture for increasing the pain threshold during athletic training. *Am. J. Acupuncture* 26(1):49–52 1998.
- TOMA, K., R.R. CONATSER, R.M. GILDERS, AND F.C. HAGERMAN. The effects of acupuncture needle stimulation on skeletal muscle activity and performance. *J. Strength Cond. Res.* 12(4):253–257 1998.
- WONG, W.H., AND D. BRAYTON. The physiology of acupuncture: Effects of acupuncture on peripheral circulation. *Am. J. Acupuncture* 10(1):59–63 1982.