THE NEWSLETTER FOR WINNERS

STADION news
International Sports Insider
http://www.stadion.com

Volume 6, Number 2, Spring 1999 $3.00

The Role of Aerobic Fitness in High Intensity Efforts, Part I

by Thomas Kurz

"Aerobic training causes harmful changes in skeletal muscle fiber type, hormonal secretions and force output characteristics. The fastest, most powerful muscle fibers become slower and more resistant to fatigue. … Aerobic exercise also produces the catabolic hormone cortisol, which is antagonistic to anabolic hormones such as the human growth hormone and testosterone. … A fighter may have a 20-30 second flurry, rest for 10-15 seconds and so on. … People confuse being out of breath as a need for more aerobic conditioning. … Fighters and forms competitors depend on sharp, crisp techniques. Aerobic training hurts these athletes even more than contact fighters." ("The Problem with Aerobic Training." by Charles I. Staley, B.Sc., MSS [Vice President of Program Development for the International Sports Sciences Association] in *M. A. Training*, Vol. XXV, No. 3, May 1998, p. 24.)

The above statements are full of misconceptions and inaccuracies. The fallacy of some of them is plain to see while others are not as obviously wrong, but state-of-the-art exercise physiology and sports methodology research dispels them all.

How training affects the skeletal muscle fibers and hormonal secretions depends on many factors, not just on whether exercises are aerobic or anaerobic. Consider a sport that requires aerobic and anaerobic energy as well as a great jumping ability—basketball. Basketball is a sport with an energy cost per minute similar to boxing (McArdle, Katch, and Katch 1991), perhaps the most popular form of fighting. Agility and jumping ability are more obviously displayed in basketball than in boxing. All the running and dribbling players do in basketball's 20-minute periods, mostly aerobic activities, does not keep them from jumping high. How come? It is a matter of *how much* of various exercises, including aerobic, they do.

So much for the detrimental effects of aerobic exercise on muscle fibers and force output characteristics....

There is research that shows that endurance athletes (long distance runners, for example) have a greater percentage of slow twitch muscle fibers. But these athletes were studied after many years of doing nearly exclusively exhaustive long-distance endurance training! (Also, they were selected for long-distance running because they likely had predispositions for it, such as a greater percentage of slow twitch fibers.) The effects of long-term, exclusively aerobic endurance training consisting of prolonged workouts on muscle fibers are not the same as the effects of performing aerobic exercises as a part of a mixed training. Fitts and Widrick (1996) show that endurance exercise improves the speed of slow twitch fibers but *prolonged daily endurance workouts* depress peak force and peak power.

The situation is similar with hormonal secretions—a lot depends on the duration of the workout, on the intensity of exercises, on an athlete's gender, and training level, and on the duration in months of the training program. Here's a good rule of thumb: the longer and the more fatiguing the workout, the more it raises the concentration of cortisol in the blood. Another way of putting this rule: The greater the buildup of lactic acid, the greater the concentration of cortisol in the blood (Kraemer et al 1989). Blood lactate concentrations also correlate with an increase of serum growth hormone (Baechle 1994, Hakkinen and Pakrinen 1993). Here are examples.

- One hour of anaerobic exercise at 110% VO_2max done in 2-minute periods elevated levels of cortisol in the blood dur-

Highlights

STADION NEWS is published by Stadion Publishing Co., Inc., P.O. Box 447, Island Pond, VT 05846, U.S.A.

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ing an 8-hour recovery period while one hour of aerobic exercise at 65% of VO_2max did not (Hackney, Premo, and McMurray 1995).

- Eight sets of 10 repetitions maximum (10RM) leg-press with 1-minute rests between sets increased cortisol concentration in plasma while the same workout performed with 3-minute rest breaks did not, because the shorter rest breaks caused a greater lactic acid buildup (Kraemer et al 1996).
- Four sets of 10 repetitions maximum (10RM) squats with 90-second rests between sets significantly raised levels of lactate and cortisol, growth hormone, both total and free testosterone, and adrenocorticotropic hormone (Kraemer et al 1998a). Twenty sets of 1RM squats with 3-minute rests between sets increased slightly the serum concentration of growth hormone but did not significantly increase concentrations of cortisol and testosterone while 10 sets of 10RM did increase the concentration of cortisol as well as growth hormone and testosterone. The 10 sets of 10RM were more fatiguing than 20 sets of 1 repetitions with heavier weight (Hakkinen and Pakrinen 1993).

Knowing all this, you need to note that concentrations of hormones in the blood do not indicate the effects of these hormones on cells (Baechle 1994). Remember that blood lactate concentrations correlate with both cortisol and with growth hormone—the exercise protocols that produce the greatest cortisol responses also produce the greatest growth hormone response (Baechle 1994). Exercises that increase levels of lactate also increase levels of testosterone in blood in males (Kraemer et al 1998a, Kraemer et al 1998b, Baechle 1994). Baechle (1994) writes: "While chronic high levels of cortisol may have adverse effects, acute increases may be a part of a larger remodeling process in muscle tissue." He also points out that using cortisol levels and the testosterone-cortisol ratio "has met with only limited success" in control of strength and power training, probably because of the "multiple roles" of these and other hormones, as well as complex interrelationships among hormones, their receptors in cells, and various exercises (Baechle 1994).

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Self-Defense Tip

In the Fall 1999 issue of *Stadion News* I discussed benefits and gave a warning about the limitations of self-defense instruction from a full-contact sports system, such as boxing, judo, or wrestling. In this issue you will learn about some alternative to these systems from Mr. Ron Beaubien, editor of "The Martial Arts Consumer Protection Site" (http://www2.crosswinds.net/japan/~consumer/). Here is what he says:

"I believe there are also some private self-defense schools in the states and courses offered at community centers teaching self-defense. These would be the best choice in my opinion. 'Model Mugging' is one of these systems for rape prevention, and it has apparently received some recognition. (See: *Defend Yourself!: Every Woman's Guide to Safeguarding Her Life* by Matt Thomas, Larry Strauss, Denise Loveday. New York: Avon Books, 1995.) Many of these private schools and community centers do provide full-contact training. There are problems with these kind of schools and self-defense courses as well, however. Some instructors of these schools may be very good and highly qualified. Others may be teachers of karate or a similar art just looking for a way to make extra money, who don't really have the experience of other systems needed to teach an effective self-defense class. There are also those who always wanted to run a martial arts school but never became proficient enough in any art to be allowed to teach and open up their own school and so had to resort to opening a 'self-defense' school instead. I have met people in all three categories.

"There are some qualities that I thought should be included in self-defense courses (i.e., personal awareness, mental training, physical training, muscle development, full contact experience, techniques geared for modern combat on the streets, weapons training, a concern for what works over any kind of tradition, and legal advice.) When you are looking for a self-defense instructor, [look for] certification that covers these. An instructor who has been trained and certified by many different well-known groups that teach self-defense would be best. (Maybe the Lethal Force Institute for the use of guns, Executive Security International for their bodyguard training to learn awareness and how to escape, maybe Model Mugging for rape prevention.) I am not specifically vouching for any of these organizations, but they are well-known programs."

Here are addresses for Model Mugging, Lethal Force Institute, and Executive Security International:

Model Mugging/BAMM/Impact Self-Defense
629 Bair Island Road, Suite 104
Redwood City, CA 94063
(800) 77-FIGHT
http://www.bamm.org

Lethal Force Institute
PO Box 122
Concord, NH 03302-0122
603-224-6814

Executive Security International
Gun Barrel Square
2128 Railroad Ave.
Rifle, Colorado 81650
800-874-0888
http://www.esi-lifeforce.com/intro.html

There are other reputable organizations in the United States that run self-defense courses. Many of these organizations are listed at: http://www.aware.org/certs.htm

"In general, some schools are better than others in my opinion. I think it is pretty safe to assume that a school that specializes in training people for self-defense would be better than, say, a course taught at a small local martial arts school. By this I mean that a large national nonprofit group has more resources available than Kim's Taekwondo school on the corner."

Sports Skills and Strength Training V

by Thomas Kurz

In the previous articles on strength training you learned about the kinds of strength—from static strength to explosive strength.

Apart from the type of strength that your exercises develop, you need to be concerned also with form and timing of movement. What matters is where (at which angle in the range of movement) and when (at which instant) you get stronger. The common fallacy of strength training is believing that you exercise muscles and not movements. The human mind directs movements. Only after a movement is "ordered" do the brain and the higher levels of the spinal cord specify, without your conscious control, which muscles will do what and when.

Use natural movements for both general and sport-specific strength exercises—do not isolate muscle groups with artificial, bodybuilding-like exercises. There is no isolation in any natural movement, be it lifting, jumping, pushing, or pulling and there is no isolation in any of your techniques. Isolation is a concept of bodybuilding (which is looks-oriented) and has little or no application in strength training for action.

Misconceptions regarding strength training are common. For example, Matt Brzycki, strength coach at Princeton University, said "You won't develop one way with machines and another with barbells, assuming that your levels of intensity are similar with both modalities. And since your muscles don't have a brain, eyeballs, or cognitive ability, *they can't possibly 'know' the source of the workload.*" (Brzycki 1994).

Well, it just isn't so. Exercises of any kind affect the whole body, muscles as well as the nervous system. Muscles do have eyes and a brain—your eyes and your brain. The only muscles that do not have them are those separated from the body and experimented on in a laboratory.

Coach Brzycki's statement applies to increasing muscle mass and raw—not sport-specific—strength but not to sport-specific strength training. Look at Olympic weightlifters' workouts and see if they use any machines. If it did not matter whether weightlifters used machines or free weights, they would develop technique with broomsticks and strength with machines, which are easier and safer to work with.

Another misconception is that "skill training and conditioning are specific to a sport, but strength training is *general . . .* " (Brzycki 1994). There is too much research that contradicts this to list all of it here. Here is one example of a sport-specific strength exercise: Six weeks of practicing volleyball spikes with a 1-lb. weighted glove increased velocity of the players' spike. Tests of triceps and shoulder of their hitting arm on the isokinetic machine, however, did not show any relationship to the velocity of their spike. (Some players did increase strength in the shoulder and elbow extensors, but these improvements were not consistent for all players and probably do not explain increases in spike velocity.) The researchers speculate that improved velocity was the result of some change in technique caused by wearing weighted gloves or *some change in the nervous system rather than in the muscles* (Carlson et al 1998).

Another example: Jumps preceded by a short step or a jump (landing and immediately jumping again) increase the height of a jump from standing in place much more than the other way around. This is because jumps "from a landing" require and perfect reactive strength and starting strength (see definitions in *Stadion News* Summer 1998)—the nervous system's abilities to mobilize one's strength very quickly (Wazny 1981).

To sum it up: Sport-specific strength exercises must take into account the form and timing of movement because of the nervous system's role in strength improvement.

Form of Movement

You should make your sport-specific strength exercises as similar to your technique as possible. The practice of volleyball spikes with a weighted glove is a good example. At the very least do exercises in the same movement pattern as your technique. For example, in hip flexor exercises for sprinters, let your left leg hang below the bench (to put it through the same range of motion [ROM] as when sprinting), and as you raise your left leg simultaneously press your right leg to the back and extend your left arm to the back while moving your bent right arm forward and across your chest. This synchronization of limb movements is the same pattern as that used in running. Thanks to spinal cord reflexes (flexor reflex afferent pathways), these additional movements of the arms and the other leg increase the tension of muscles lifting the left leg. This pattern is similar to that of karate's front, side, and roundhouse kicks.

Right Resistance

The amount of resistance in sport-specific exercises has to ensure duplication of intermuscular and intramuscular coordination. If resistance is too great, the movement may resemble the external form of the technique, but it will require different coordination than the one that is best in the technique. For example, the intermuscular and intramuscular coordination in throwing a 1.5 kg ball using the technique of a javelin throw without a prerun is the same as in throwing a 0.8 kg javelin. In throwing a 4 kg ball in the same fashion, the external form resembles the javelin throw, but the muscular coordination registered by an EMG (Electromyograph) is different. The throw with a 1.5 kg ball can be used as a sport-specific strength exercise, but the throw of a heavier ball may be used only as a directed strength exercise (Wazny 1981). In high jumping, vests with weights amounting to no more than 5% of the body weight are used in training forms of competitive exercises (Matveev 1981). If the time, rhythm, or spatial form of technique changes with a given amount of resistance, then the resistance is too great.

Sometimes an athlete has to use much greater resistance than what he or she is currently able to overcome using full technique. This can be done by starting the movement from an easier position or performing only a part of the technique—for example, in weightlifting, jerking the barbell up from a rack (Matveev 1981).

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Q&A on STRETCHING *(continued from previous issue)*

Study these typical questions on stretching and training carefully. You may find information that relates to questions of yours. Questions are in **boldface.**

■ ***After a hard squash game . . . my shoulder is sore and is becoming chronically sore. Also, my shoulder joints make all kinds of noises as I move my arms . . . creaks, snaps, pops, etc. . . . It feels like ligaments and tendons are catching on things and then suddenly snapping free. This can't be normal, is it? So I am doing the stretching routine for the shoulders.***

I do not believe that stretching your shoulders will help you.

Soreness of your shoulder after games that becomes chronic can be caused by working out too often, by too much anaerobic efforts in relation to your aerobic fitness, by weakness of some muscles of the upper body that causes misalignment of the shoulder joint and thus forces some of its muscles to work inefficiently, by overworking of the biceps brachii, which may cause swelling of its long head's tendon and grind against its groove in the arm bone.

Whenever ligaments or tendons "catch on things," there is a possibility of inflammation and eventual damage to inflamed structures. An inflamed tendon of the long head of the biceps swells, rubs against the bony groove in which it moves, and pops out of it. As a result you get bone spurs in this groove. Also the ligament that holds the tendon in the groove gets overstretched so the tendon pops out of it easier and gets further aggravated. The bone spurs irritate the tendon and may eventually fry it.

Shoulder problems usually start with the impingement syndrome—when the biceps tendon or rotator cuff muscles are impinged upon by the coracoacromial arch. This impingement causes inflammation of the subacromial bursa and the muscles passing under the coracoacromial arch. Eventually you can get rotator cuff tears (partial or complete) and the biceps tendon inflammation possibly ending with its complete tear or avulsion (detachment) from its origin. When your muscles and subacromial bursa are inflamed, the cartilage in your shoulder joint may also be inflamed and badly damaged (ripped and shredded to the point where it does not even resemble joint cartilage). You won't feel the damage to your joint cartilage until the joint mechanics change drastically because joint cartilage has no pain receptors.

Clicking, catching, and popping sensations may be signs of a tear of the glenoid labrum (a fibro-cartilaginous rim attached around the shoulder joint socket).

Partial tears of muscles and bone spurs may require surgery to prevent more serious injuries to the joint and muscles. A surgical repair of a rotator cuff or biceps tear (often both are present) may put you out of your sport for at least six months if not forever. I suggest you read *Management of Common Musculoskeletal Disorders: Physical Therapy Principles and Methods,* 3rd Edition, by Darlene Hertling and Randolph M. Kessler. This excellent book should help you evaluate qualifications of physical therapists or even design your own program of therapy.

Another cause of the swelling of the biceps tendon may be a digestive problem. This happens when the tendon is predisposed to swelling by a presence of bone spurs—result of the impingement syndrome. In some digestive problems the lymphatic system is overwhelmed by toxins and cannot remove metabolic waste from tired muscles. Muscles then recover poorly and stay painful, weak, and sometimes tense. For example, when the ileocecal valve between the small and large intestine does not function properly, the tendon of the long head of biceps brachii, if it is predisposed by previous damage, swells and does not fit in its groove. This digestive cause of your shoulder problems can be accurately diagnosed and removed by a doctor specializing in applied kinesiology. To find such a doctor in your area, visit http://www.icakusa.com.

■ ***You say not to exercise until an injury or problem is totally solved. Does that mean avoiding stretching routines until a joint is healed?***

Unless told by a doctor otherwise, I would avoid all exercise with strong tension of muscles around that joint as well as any movements at the maximum range of motion. This may still leave gentle dynamic and static stretches available to you.