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Sleep and Sports Training by Thomas Kurz

Apart from good nutrition, restful sleep is the most important means of recovery. Lack of sleep causes irritability and an increased feeling of fatigue. It impairs memory, learning of sports skills, reaction time, attention, creative thinking, and the ability to deal with unfamiliar situations. If sleep deprivation is frequent, the efficiency of physical work is also impaired. Some authorities on sleep research state that sleep deficit accumulates—getting less sleep than needed over several nights can affect performance as badly as not sleeping at all for two or more nights, depending on how many hours added up for the sleep deficit. Sleep disturbance, even partial sleep deprivation, reduces immunity.

Sleep is divided into five stages, which are repeated in several cycles during sleep.

The first stage is entered after 5–20 minutes of relaxation. This stage itself lasts from several seconds to a few minutes. During this stage breathing becomes shallow and muscles relax suddenly. People can be easily woken up during the first stage of sleep as they are still aware of their environment.

The second stage lasts 10–20 minutes. People in this stage of sleep are unaware of their environment. Dreams occur but are rarely remembered.

The third and fourth stages of sleep are called slow-wave sleep and differ in the type of slow brain-waves that dominate at each of these stages. They last 30–40 minutes. Heart rate and blood pressure fall and breathing slows down to reach the lowest values in the fourth stage—the deepest sleep. Slow-wave sleep is very important for physical recovery as during it the growth hormone secretion peaks.

The fifth stage is Rapid Eye Movement (REM) sleep. During this stage vital signs rise and eyes move under closed eyelids but the body is immobile. People awakened during REM sleep usually remember their dreams.

People who regularly do intensive physical activity need more total sleep and more slow-wave sleep than people who are not so active.

For more information on sleep and what to do to sleep well see *Science of Sports Training*.

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Growth Hormone by Thomas Kurz

Your hormonal responses to exercises, to food, and to rest determine the effectiveness of your training. One of the key hormones is the growth hormone. Growth hormone promotes fat loss and muscle gain; it strengthens ligaments, bone, and joint cartilage and even thickens the skin.

Growth hormone stimulates protein synthesis and cell growth and multiplication and thus muscle hypertrophy, bone growth, and cartilage formation—all essential for growth and rebuilding of the

body after exercise. (In grown-ups, high [but not pathological] natural levels of growth hormone will not increase height, of course, but do help rebuild the body.) It stimulates the use of lipids (fat, popularly speaking) for energy while inhibiting the use of glucose by the cells, which helps keep blood glucose (blood sugar) levels high. This glucose-sparing action, which lets you exercise for a long time, occurs after 30 minutes of exercise (Kozlowski and Nazar 1995).

Growth hormone secretions are triggered by exercise, stress, fasting, low blood glucose concentration, and sleep. Not all these triggers are suitable for frequent use in sports training. Without these triggers very little or no growth hormone is secreted during most of the day but large bursts of secretion occur 1 to 2 hours after falling asleep.

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Growth Hormone

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Growth hormone and other hormones

Whatever affects secretions of growth hormone affects secretions of other hormones. Some of them have functions similar to growth hormone and some have opposite functions. The hormonal mix depends on what triggered the hormonal response and on a person's hormonal status.

Exercise and growth hormone

Exercise stimulates growth hormone secretions, most probably through neural factors and not such factors as raised levels of by-products of anaerobic metabolism (such as lactate, pyruvate, alanine), blood glucose levels, or body temperature (McArdle, Katch, and Katch 1996). During exercise growth hormone concentrations may reach levels 10–20 times higher than its concentration at rest (Kozlowski and Nazar 1995).

Growth hormone in addition to directly stimulating protein synthesis in various tissues, especially in the muscle tissue, causes production of insulin-like growth factor in the liver (hepatic IGF-I) and other organs (local IGF-I). One of the forms of the local IGF-I is activated only by mechanical stimuli in the affected cells—for example, muscle and bone cells (Goldspink 1999; Goldspink and Yang 2001). This form is called mechano-growth factor.

Some resistance exercises—deadlifts and squats—cause all skeletal muscles to grow, probably because they are strenuous enough to trigger large growth hormone releases and also put enough tension on all your muscles and bones to activate the mechano-growth factor in them.

In strength training, the more total tonnage you lift the more growth hormone is secreted (Gotshalk et al. 1997; Hakkinen and Pakrinen 1993). This fits with the observation of coaches that an athlete's strength depends on the total tonnage lifted in a given period of training—provided, of course, it is a rational training program (Wachowski and Strzelczyk 1994). Also, the more intensive the workout, the more growth hormone is secreted (Wathen 1994). Lifting the same total tonnage but with drastically less resistance per repeti-

tion may result in no significant increases of growth hormone levels as compared to lifting heavier weights. For example, a 20-minute workout consisting of seven sets of seven reps at 85% of one's 7RM (repetition maximum) significantly raised growth hormone levels, but a workout of the same duration consisting of seven sets of 21 reps at 28% of one's 7RM did not (Vanhelder et al. 1984).

Endurance training also causes high secretions of growth hormone, and the more intensive the training, the greater the secretions (McArdle, Katch, and Katch 1996). But excessive intensity (in relation to your condition) may lead to overtraining very quickly, as readers of *Science of Sports Training* know.

All exercises cause many hormonal responses. How secretions of various hormones change depends on the gender, age, health, and training status of the athlete and on the duration of the workout and character of exercises. So, the effect of exercises is determined by the different ratios of several hormones and by such local factors as the amount of mechanical stress on particular muscle, cartilage, and bone cells.

Normally, the same exercise that increases growth hormone secretions also increases secretions of cortisol, and in men, of testosterone.

Breathing and growth hormone

Altering your breathing pattern alone, without any additional exercise, may affect secretions of growth hormone. Either hyperventilation or breath holding by themselves cause a 1.5- to 5.5-fold increase of growth hormone secretions (Djarova et al. 1986).

While frequent breath holding during exercise is not advisable even if possible, deep and frequent breathing—in rhythm with exercise—is possible and it helps in ways other than just influencing hormones. For example, it delays fatigue, helps with force application, and even with stabilizing the body.

Meals and growth hormone

What you eat and when you eat influences growth hormone secretions. A high

carbohydrate diet reduces the release of growth hormone during an exercise (Kozlowski and Nazar 1995).

Eating a protein-carbohydrate meal 2 hours before a strength workout and immediately after the workout raises blood levels of growth hormone, IGF-I, and insulin immediately after the workout but lowers testosterone to below resting values (Kraemer et al. 1998).

Strength training workouts should begin when blood sugar and blood lipids are at normal resting values because raised blood glucose or free fatty acids, such as after a meal, inhibit the release of growth hormone (Cappon et al. 1993; Valcavi et al. 1994).

Research shows that three hours after a high-glycemic carbohydrate meal, which initially depressed growth hormone secretions, the secretions may reach levels higher than without such a meal (Valcavi et al. 1992; Valcavi et al. 1994). There are downsides to eating high-glycemic meals, however. (These downsides are described in the *Science of Sports Training*.) It is better to eat healthily and refrain from such manipulations.

Drinking water during a workout lowers growth hormone secretions because it reduces the physiological stress—and stress is one of the triggers for growth hormone secretion (Saini et al. 1990). Not drinking water when one is dehydrated reduces heat tolerance and may cause injuries due to lowered strength and endurance. Well-trained athletes in an optimal environment may easily withstand two hours of intensive exercise without drinking, but the decision whether to drink water should be made by the athlete depending on how he or she feels.

Sleep and growth hormone

While both day and night sleep increase secretion of growth hormone, only night sleep simultaneously inhibits secretion of cortisol (Pietrowsky et al. 1994). (Cortisol is a hormone secreted by the adrenal glands. It promotes conversion of protein and fat into glucose. Its levels in blood are raised normally during and after exercise but chronically raised levels lead to excessive protein breakdown.)

Lack of night sleep or awakening during

Growth Hormone

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night sleep inhibits secretion of growth hormone (Spath-Schwalbe et al. 1995; Van Cauter et al. 1992).

Interfering with nightly growth hormone secretion leads to insufficient rebuilding and eventually a breakdown of muscles, bones, and joint cartilage.

There may be a connection between overtraining associated with chronically elevated levels of cortisol, lack of sleep, and the mental symptoms of overtraining. Gronfier et al. (1999) shows that REM sleep is associated with a decrease in cortisol secretion. Not sleeping for two nights causes a stress response with an increase of plasma cortisol and suppression of the nightly release of growth hormone (Radomski et al. 1992).

In *Science of Sports Training* you will find more information on effects of lack of sleep, such as on the mood and on the immune system, as well as on methods of obtaining restful sleep.

Doping with growth hormone

Supplementation of growth hormone by athletes is prohibited by the International Olympic Committee.

Increasing growth hormone levels through unnatural means and without exercise gives poor results. For example, injecting growth hormone causes muscles to grow bigger but mushy and weak and joints to become painful (Friedl 1994; Kraemer 1994).

Even combining growth hormone injections with a program of resistance exercise is not very effective. Studies done on both young and elderly men showed that injecting growth hormone did not increase strength any more than resistance training alone (McArdle, Katch, and Katch 1996; Zachwieja et al. 1996). Fat-free body mass increased more in subjects (both young and old) who received growth hormone in addition to performing the exercises but that increase was most likely in lean tissues other than skeletal muscle. In older men who did strength training, injecting growth hormone nullified some of the benefits of strength training, such as improvements in insulin sensitivity.

The downsides of injecting growth hormone are: hypertension, muscle disorders,

nerve inflammation, insulin resistance and even diabetes, water retention, carpal tunnel compression, coarsening of skin, thickening of bones, and overgrowth of soft tissue (Chrostowski 1995; McArdle, Katch, and Katch 1996).

Synthetic growth hormone is very expensive. Growth hormone harvested from cadavers, available on the black market, is cheaper but can carry HIV, Creutzfeldt-Jakob disease, and hepatitis.

Methods of increasing secretions of growth hormone by injecting "growth hormone releasers," such as the amino acid arginine, are not as effective as high-intensity or high-volume exercise with short rest breaks (Friedl 1994). Ingesting various amino acid supplements for this purpose is even less effective.

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Q and A on STRETCHING and TRAINING

(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 *italic boldface*.

■ *You advocate doing strength training exercises with free weights rather than on machines, regardless of the athlete's skill level. I recommend persons who have never lifted before start with machines before progressing to free weights. For beginners the most significant advantage of machines over free weights is that machines eliminate the factor of balance. Machines allow the trainee to concentrate on the intensity, without having to worry about either balance or the skill involved in the lift. Don't you agree?*

Instead of wasting their time on machines the beginners should start with no weights (calisthenics) or minimal weights (broomstick, then an empty light bar) and thus develop correct form, balance, and timing for the lifts—skills that transfer to other movements.

■ *You advise doing squats and deadlifts for strengthening the whole body. In my experience, the deadlift has always been primarily to strengthen the lower back, hamstrings, and buttocks, and the squat for quads and buttocks. I do not see how you can claim any great training effect on the abdomen, upper back, arms, or forearms, as they are largely kept immobile during the exercise.*

You are wrong. Just because a body part is kept immobile during an effort does not mean that it is not affected by it. For example, in a correctly performed deadlift the lower back is kept relatively immobile in relation to the pelvis and yet it is strengthened by the deadlift. To see why, read the article on growth hormone in this issue of *Stadion News*.

■ *As a result of an injury to the disk of the C7 vertebra, I had been experiencing pain in my right shoulder, arm, and neck. I had been unable to do basically anything so I stopped all activity: Tae Kwon Do, weights, and yoga (and vacuuming, cooking, etc.). After 6 weeks I was finally able to start doing lunges and squats be-*

cause I could hold my head up without pain. My muscles are finally okay and I have full mobility of my neck, shoulder, and arm. However, I know that I am limited on my right side as any extra movement results in pain—I am probably looking at surgery to correct the problem. My question is: I know that had I hurt only my arm I could continue to work out my left arm while my right healed. Can I do that with my back and chest muscles? That is, can I safely exercise only the left side of my back and chest without compromising myself later? Would it harm the spine to maintain the strength on only one side of the back?

I think that muscles of the back cannot be as well isolated as those of arms or legs. If you can achieve such isolation you have an amazing degree of control over your muscles. Regardless of whether you manage to truly isolate the sides of your trunk or back or not, I think that prolonged working on one side of the trunk is not going to be good for you.

Before deciding on the operation I would investigate all other, less intrusive and less irreversible treatments. In my opinion injuries, both chronic and sudden, are most effectively treated by physicians specializing in Applied Kinesiology. These physicians know how to find out what prevents an injury from healing and how to restore the function of all systems involved in an injury (nerves, muscles, and joints). To find such a physician in your area, visit the referral Web page of the International College of Applied Kinesiology (<http://www.icak.com>).

Keep in mind that correctness of a diagnosis is confirmed by effectiveness of the treatment. Further, a good physician can tell you in advance how your symptoms will change over time as you heal, when you will feel improvement, and how long it will take for full recovery.

To find out more about this method of diagnosis and treatment get report #10.

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