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Strength and Conditioning for Peak Performance

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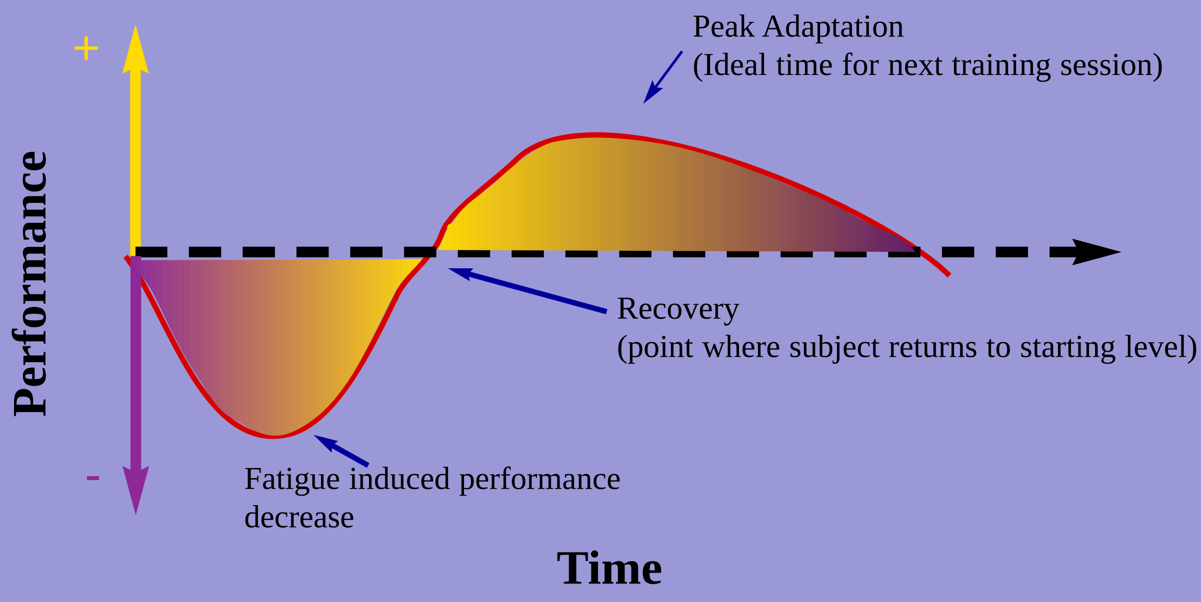
Preventing Overtraining

Ed McNeely, M.S.

The purpose of training is to create a stress and subsequent adaptation, which results in an improved performance. Selye (1956) was the first to popularize the concept of adaptations to stress in his book the Stress of Life. Selye proposes a three-part response to stress called the General Adaptation Syndrome (GAS). The first stage, the alarm stage, is characterized by increases in stress hormones (particularly those of the adrenal cortex) and activation of body defenses. The second stage, the stage of resistance, is a period where the body attempts to adapt so that homeostasis is restored. The third stage, the stage of exhaustion, occurs if the amount of stress is too great for the body to adapt. There is an increase in stress hormones and a reactivation of body defenses as in the alarm stage. In extreme cases the stage of exhaustion can lead to death. Garhammer (1979) has developed a model of the GAS as it applies to exercise and training. Figure1 summarizes his model. Figure 1 describes a typical exercise response and adaptation. A training session imposes a stress on the body, following the session there is a decrease in performance as a result of decreased energy stores and or structural damage. At some point in time the body will replenish energy stores and repair damage. If enough time is left before the next training session a training adaptation can occur and performance will be improved.

It has been proposed that the more frequent the application of the training stimulus the greater the long-term adaptation (Bompa, 1983). This is a logical hypothesis provided there is adequate time for the body to adapt to the previous session. When frequent training is continued for an extended period of time there is both a gradual improvement in performance and a gradual accumulation of fatigue (Figure 2). If this process continues for an extended time overtraining can occur.

Figure 1. Adaptation to Training (modified from Garhammer, 1979).



Overtraining is a period of prolonged fatigue where the athlete experiences plateaus or decreases in performance despite continued training (Mackinnon and Hooper, 1991; Stone et al. 1991; Fry, Morton and Keast, 1991).

There are many degrees of 'overtraining'. The following definitions will help clarify some of the terminology commonly associated with discussions and research into overtraining.

Overtraining

Overtraining is a general term that indicates that the athlete has been stressed through training or other stressors to the point that they can no longer perform at an optimum level (Fry, Morton and Keast, 1991).

Overreaching

Overreaching is a short term overtraining in which performance decreases. Generally there are no health problems associated with overreaching if it is recognized early. Overreaching can be reversed if a slightly longer than normal regeneration period is followed. Overreaching is sometimes used to try to stimulate a peak just prior to a major competition (Stone et al. 1991; Fry, Morton and Keast, 1991).

Overtraining Syndrome

Overtraining syndrome is a chronic situation that results from long periods of high intensity or high volume work without rest periods. This type of overtraining is characterized by prolonged periods of decreased performance. Health problems may develop out of this type of overtraining (Stone et al. 1991; Fry, Morton and Keast, 1991).

Overstrain

Overstrain is the result of acute muscle tissue damage that results from exercise which exceeds the stress tolerance of the muscle. This normally occurs after exercise that induces muscle damage and delayed onset muscle soreness (Fry, Morton and Keast, 1991).
Symptoms of Overtraining
Overtraining is characterized by chronic fatigue and decrements in performance of 5-15%. The fact that decreases in performance is one of the best indicators of overtraining presents a problem to both the coach and athlete. Once performance is negatively affected by overtraining it is often not possible to correct the situation in time for an important competition (Mackinnon and Hooper, 1991). There are other symptoms that the coach and athlete should be aware of which are useful in the

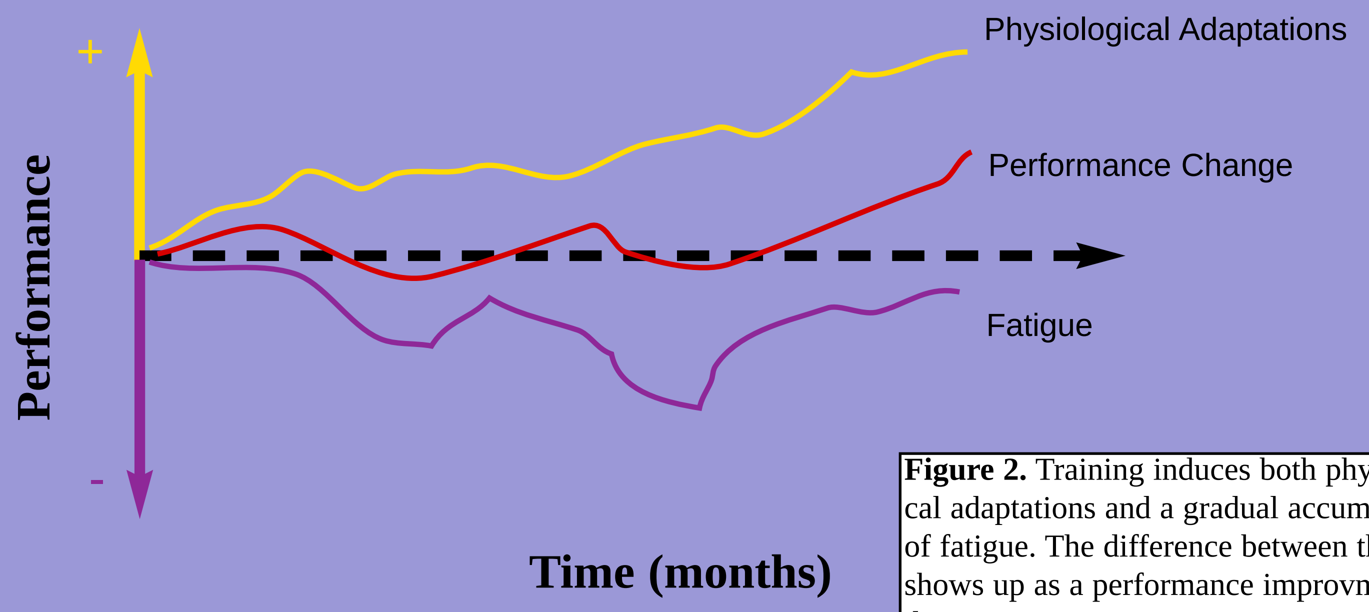


Figure 2. Training induces both physiological adaptations and a gradual accumulation of fatigue. The difference between the two shows up as a performance improvment or decrease.

early detection of overtraining these can be seen in table 1.

Unfortunately, some of the symptoms of overtraining are similar to signs of fitness improvements. Decreased body fat, lower exercising heart rate, and a shift in lactate curves can all be interpreted as training improvements. For this reason overtraining cannot be evaluated on the basis of one symptom. Only when multiple symptoms start to occur should overtraining be suspected.

The type of overtraining experienced by speed and power athletes is slightly different than that experienced by endurance athletes. Israel (1976) has broken overtraining into sympathetic overtraining, in which the sympathetic nervous system is most affected, and parasympathetic overtraining, where the parasympathetic nervous system is most affected. Parasympathetic overtraining is associated with the exhaustion of the neuroendocrine system, and affects endurance athletes while sympathetic overtraining is the result of a gradual accumulation of stress and affects speed and power athletes (Bompa, 1983).

Causes of Overtraining

There are a variety of factors that can contribute to the development of the overtraining syndrome.

Training Program Design

Training program design is ultimately the cause of overtraining. Since overtraining is an imbalance between training and recovery excessive periods of training with inadequate recovery are the root of the overtraining syndrome. Alterations in the program, decreases in training volume and intensity, are necessary for any athlete who displays symptoms of overtraining. The most common program flaws that lead to overtraining are:

- Inadequate recovery between training sessions
- Excessive amounts of high intensity training
- Increases in training volumes of greater than 10% per week
- Sudden increases in training intensity
- Monotonous unvarying training programs
- No break in training between seasons
- Frequent competition and travel
- External stressors (family, job, school etc.)

Often, more than one of these factors contribute to the devel-

Symptoms of Overtraining

Physiological

- Abnormal ECG readings
- Heart discomfort on exertion
- Changes in blood pressure
- Changes in resting heart rate
- Changes in exercising heart rate
- Increased respiratory frequency
- Decreased body fat
- Increased O_2 at submax loads
- Elevated BMR
- Loss of apetite
- Muscle soreness/tenderness
- Increased aches and pains
- Tendon pains
- Muscle damage
- Headaches
- Chronic fatigue
- Shift in lactate curve towards the x axis

Performance

- Decreased performance
- Decreased strength
- Loss of coordination
- Technical errors increase
- Prolonged recovery
- Reduced tolerance of training load

Psychological

- Depression
- Apathy
- Emotional instability
- Fear of competition
- Personality changes
- Difficulty in concentrating
- Increased distractability

Immune Function

- Increased susceptibility to illness
- Swelling of lymph glands
- One day colds
- Minor scratches heal slowly
- Increased blood eosoniphil count
- Flu like illnesses
- Decreased total lymphocyte count

Biochemical

- Negative nitrogen balance
- Decreased bone mineral content
- Low free testosterone
- Delayed menarche
- Decreased hemoglobin
- Depressed muscle glycogen
- Elevated cortisol
- Increased urea concentrtaion
- Decreased serum ferritin

opment of overtraining. Fortunately, it is relatively easy to prevent overtraining. Following the principals of periodization and having a good understanding of physiology can help prevent most cases of overtraining.

Nutritional

Undereating and weight loss are primary factors in the development of overtraining (Eichner, 1991, 1992; Yates et al, 1994).

Carbohydrates (CHO) undernourishment is particularly problematic. Daily or multiple training sessions in a day place deplete the body's carbohydrates stores. Since full repletion of CHO can take as much as 36-48 hours most athletes work in a partially CHO depleted state. If the levels of available CHO decrease too much protein becomes a greater contributor of energy. Protein normally plays a minimal role as a fuel source during exercise. Only 5 to 10% of the total energy turnover can be attributed to protein (Hultman, Harris, and Spriet, 1999). This may rise to as high as 25% of total during prolonged training sessions or periods of carbohydrate depletion.

The reliance on protein as an energy source can have several negative side effects for the competitive athlete. Glutamine and alanine are two of the amino acids readily converted to energy (Hultman, Harris, and Spriet, 1999). Glutamine is also an important fuel for white blood cells, so reductions in blood glutamine concentration following intense exercise may contribute to immune suppression in overtrained athletes (Parry-Billings et al., 1990a; Parry-Billings et al., 1990b; Parry-Billings et al., 1992; Kargotich et al., 1996; Newsholme and Calder, 1997).

Another group of amino acids that are used for energy are the Branched chain amino acids (BCAA). The availability of BCAA during exercise has been theorized to contribute to fatigue (Newsholme et al., 1991). During endurance exercise, BCAAs are taken up by the muscles rather than the liver in order to contribute to energy production. The source of BCAAs for energy metabolism during exercise is the plasma BCAA pool, which is replenished through the catabolism of whole body proteins during endurance exercise (Davis, 1995; Kreider, 1998; Newsholme et al., 1991). However, the oxidation of BCAAs in the muscle during prolonged exercise may be greater than capacity to provide BCAAs. This means that the plasma BCAA concentration may decline during prolonged endurance exercise (Blomstrand et al., 1988; Blomstrand et al., 1991). The decline in plasma BCAAs during endurance exercise can result in an increase in the ratio of free tryptophan to BCAAs.

Free tryptophan and BCAAs compete for entry into the brain via the same amino-acid carrier (Newsholme et al., 1991). Therefore, a decrease in BCAAs in the blood allows entry of tryptophan into the brain. The decrease in plasma BCAAs and increase in free tryptophan during prolonged endurance exercise alters the ratio of free tryptophan to BCAAs and increases the entry of tryptophan into the brain (Newsholme et al., 1991). An increased concentration of tryptophan in the brain promotes the formation of the neurotransmitter 5-hydroxytryptamine (5-HT). 5-HT has been shown to induce sleep, depress motor neuron excitability, influence endocrine function, and suppress appetite. An exercise-induced imbalance in the ratio of free tryptophan to BCAAs has been implicated as a possible cause of acute fatigue (central fatigue). It has also been hypothesized that chronic elevations in 5-HT concentration, which may occur in athletes maintaining high-volume training, explains some of the reported signs and symptoms of the overtraining syndrome: postural hypotension, anemia, amenorrhea, immunosuppression, appetite suppression, weight loss, depression, and decreased performance (Newsholme et al., 1991; Gastmann and Lehmann, 1998; Kreider, 1998).

The use of whole body proteins to supply energy will tend to decrease muscle mass. Decreases in muscle mass will ultimately lead to decreased strength and power production thereby decreasing athletic performance. This explains the decreases in performance and body weight associated with overtraining.

Endurance athletes are most susceptible to CHO depletion because of the energy used to fuel the large volumes of exercise that is the norm with these athletes. Strength and power athletes are less susceptible to CHO problems unless they follow the high protein/low CHO diets that are popular in the muscle magazines and tabloids, or continually try to train for

Fun Nutrition Facts

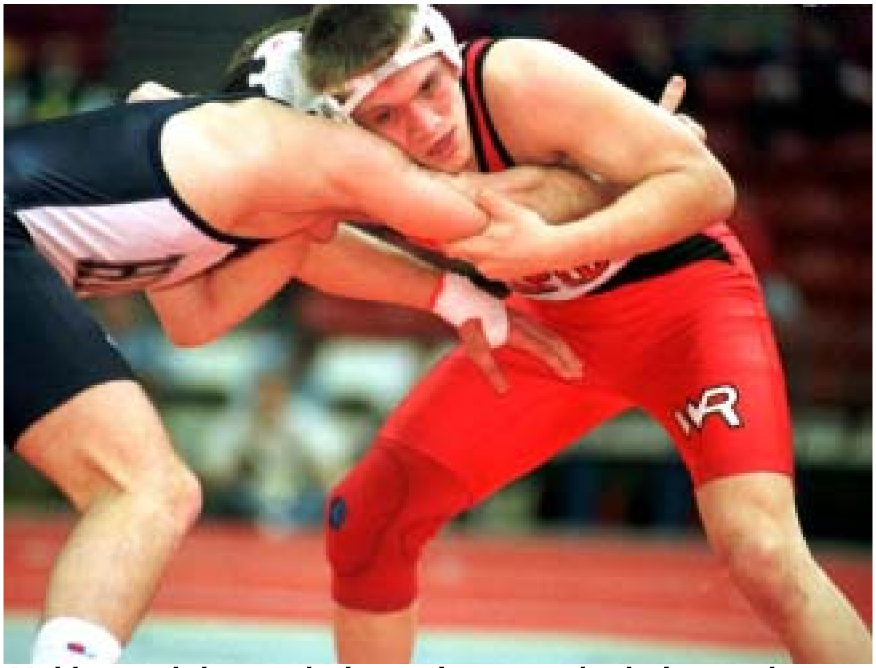
In a recent study of 50 ginseng supplements 44 of them contained less than 9% ginseng.

In North America over 100 billion dollars is spent every year on weight loss and weight loss products

It takes more than 20 strips of bacon to equal the amount of fat in one serving of Fettucini Alfredo

Chocolate can be lethal to dogs. Theobromine, an ingredient that stimulates the cardiac muscle and the central nervous system, causes chocolate's toxicity. As little as two ounces of milk chocolate can be poisonous for a 10-pound puppy.

Red or pink grapefruit is higher in vitamin C than white grapefruit.



Making weight can induce glycogen depletion and increase the likelihood of overtraining

muscle soreness.

Muscle soreness is the result of damage to the muscle fibers. While popular magazines promote muscle soreness and damage as a means of increasing muscle size there is no scientific support for this theory. Following muscle damage glycogen storage can be impaired for as much as 10 days (Eichner, 1995). This may cause chronically low levels of CHO and contribute to overtraining.

Psychological

Stress is a non-specific response to an external stimulus. As such, not only does physical training play a role in the development of the overtraining syndrome other stressors are involved. Emotional stress from job, family, friends, finances, or school can all contribute to the development of overtraining (Costill, 1986). During periods of high psychological stress the training load should be reduced.
Prevention of Overtraining
Highly motivated people are at the greatest risk of overtraining. These people are capable of pushing themselves for long periods of time. Elite athletes tend to spend much of there time on the verge of overtraining. These athletes are normally able to recover from training following a couple of days of rest. Recovery from the overtraining syndrome may take several weeks or months. Early recognition of overtraining and prevention can keep an athlete from losing a large part of their season to overtraining (Mackinnon and Hooper, 1991).

PREVENTING OVERTRAINING

Prevention of overtraining is accomplished through the use of a periodized training program and periodic fitness testing. Some of the key factors in program design that help prevent overtraining are listed below.

Recovery Weeks

A recovery week is a period of reduced training volume and intensity. They will normally occur every three to six weeks and constitute a decrease on training volume of about 50%. Recovery weeks allow the nervous system, endocrine system, muscular system, and connective tissue to full recover and adapt following training. Following a recovery week athletes are mentally refreshed and physically capable of doing more work.

Sequence of Workouts

With endurance athletes, hard workouts occur only once per day and training sessions which place a high demand on the body's CHO stores are not done consecutively. For strength and power athletes shorter more frequent training sessions may cause less muscle soreness and damage.

Testing

Periodic performance or physiological tests provide a basis for measuring the effectiveness of the training program and training improvement. If the athlete consistently fails to improve on planned testing sessions a degree of overtraining may be present.

Gradual Volume Increases

Sudden increases in volume seem to trigger both overtraining and increase the likely hood of injury. Maximum increase in training volume from week to week should not be more than 10% of the previous week's volume.

Plan for External Stress

External stressors are a part of life. Many of them are unexpected but there are those that can be predicted and built into the training plan. Exam periods for student athletes are set far enough in advance that they can be built into the training plan. Busy period at work often can be predicted and planned. Holidays occur at the same time every year. Recovery weeks and decreased periods of training volume should be planned to coincide with these external stressors.

Plan Meal Times

When athletes try to balance training with work or school commitments meal times are often sacrificed. One of the main causes of overtraining is inadequate food or CHO intake. Building meals into the training schedule can help ensure that the athlete is getting enough to eat and eating properly.

Monitoring Overtraining

Even when the training program is well planned overtraining can occur. Coaches and athletes need to watch for signs that overtraining is occurring. Overtraining can be monitored through physiological measures, psychological measures, and training logbooks.

Physiological Measures

Most physiological measures are not practical for a coach or athlete to use on a daily basis, but they are very valuable for medical personnel and can help with the prevention of some medical problems associated with overtraining. Depressed testosterone, chronic cortisol elevation, elevated urea or uric acid, and immune function measures are all proposed overtraining indicators (Fry, Morton, and Keast, 1991).

Lactate tests, which are used by many athletes to determine training intensities, can also provide evidence of overtraining. Decreases in lactate at VO2 max may indicate a degree of carbohydrate depletion, which if sustained for a prolonged period of time may cause overtraining.

Psychological Measures

Rapid changes in training volume are a main cause of overtraining

Mood states like tension, anger, depression, and fatigue can all be indicators of overtraining (Hooper and Mackinnon, 1995). A psychological test called Profile of Mood States has been used to measure overtraining in elite athletes (Raglin and Morgan, 1994).

Training Logs

Training logbooks are the most readily available tool for monitoring overtraining. Test results, time trial results, competition results, training sessions should all be recorded. A weekly analysis of the logbook can help head off overtraining before it occurs. Failure to show improvement in tests or training session should be a clue that the training plan needs an adjustment.

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Research Reviews:
the Science of Training

Neuromuscular adaptations during concurrent strength and endurance training versus strength training

Hakkinen, K., M. Alen, W. J. Kraemer, E. Gorostiaga, M. Izquierdo, H. Rusko, J. Mikkola, A. Hakkinen, H. Valkeinen, E. Kaarakainen, S. Romu, V. Erola, J. Ahtiainen and L. Paavolainen.
European Journal of Applied Physiology. 89: 42-52, 2003.

The controversy over the impact that concurrent strength and endurance training has on strength, power, and muscle hypertrophy is a longstanding one. While many studies show detrimental effects on measures of muscle strength and hypertrophy when endurance training is performed in conjunction with strength training, there is still much debate over the mechanism involved. Some have hypothesized that the performance decrement is due to overtraining from too frequent endurance training sessions. The following study addresses that issue, but still finds reason for many athletes to curb their endurance training.

In The Lab:

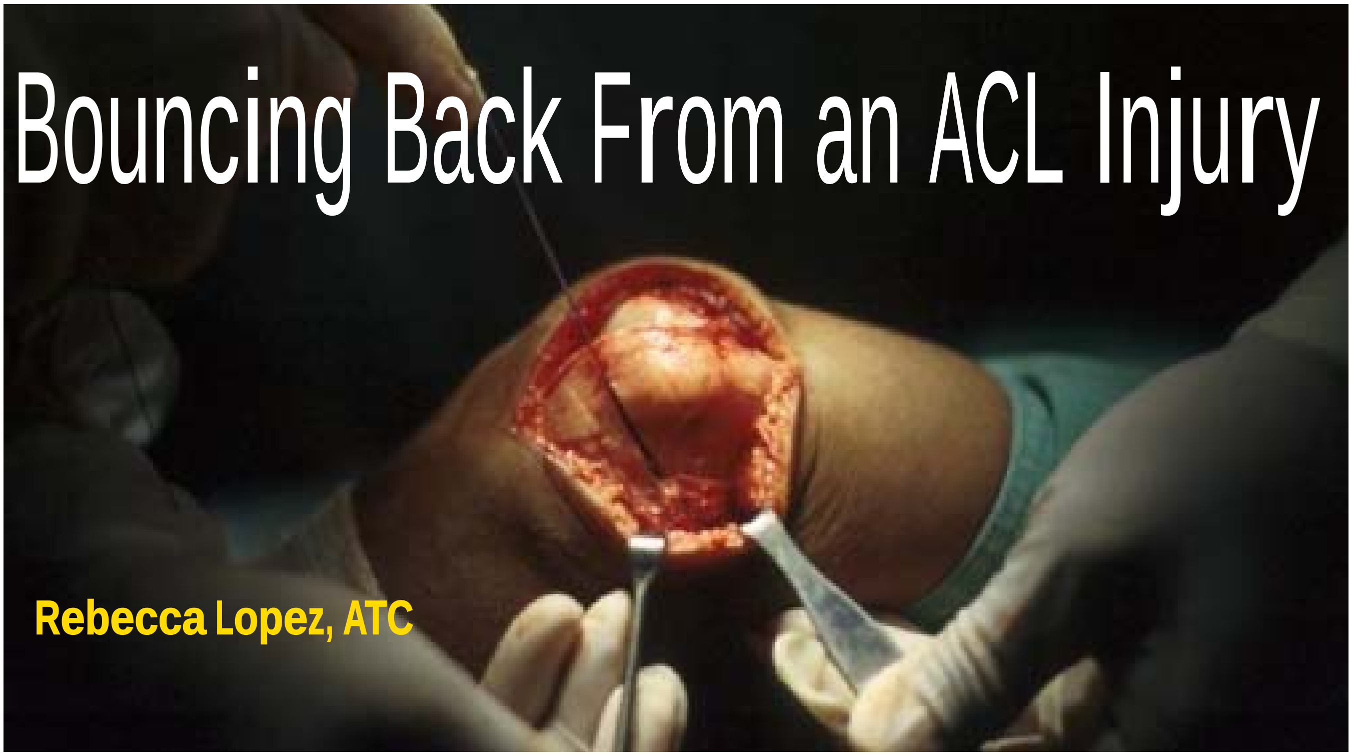
Scientists from the University of Jyvaskyla (Finland) had 27 male subjects who were recreationally active, train twice a week in the weight room with 11 (due to dropouts) also training twice a week on a cycle ergometer for 21 weeks. Weight training consisted of the leg press, leg extension, leg curls, leg adduction/abduction, bench press, triceps pushdown, lat pulldown, situp, and biceps curl. The loads varied to include typical strength training at 60-80% 1 RM, and power training at 50-60% 1 RM.
The first seven weeks of endurance training consisted of 30 minute sessions under the aerobic threshold level. During weeks 8-14 the duration of the first training session was 45 minutes (15 min below the aerobic threshold level, 10 min between the aerobic-anaerobic thresholds, 5 min above the anaerobic threshold and 15 min again under the aerobic threshold). The second session lasted 60 min and was under the aerobic threshold level. The last 7 weeks of training they cycled for 60 minutes on t he first session (15 min under the aerobic threshold, 2*10 minutes between the aerobic-anaerobic thresholds, 2*5 minutes above the anaerobic threshold and the final 15 minutes under the aerobic threshold). The other training session lasted about 60-90

minutes and was under theaerobic threshold.
Following 21 weeks of training the results were fairly similar for both groups. The 1 RM on leg extensions increased by 21% for those who strength trained only (S), and 22% for those who strength and endurance trained (SE). Maximal isometric force on the leg extension also increased similarly with an 18% enhancement in S and 21% in SE. Maximum iEMG of the vastus lateralis muscle increased by 26% in S and 29% in SE. The cross-sectional area of the quadriceps femoris (measured with MRI) increased by 6% in S and 9% in SE, although it was not statistically different between groups. The mean fibre areas of types I, IIa and Iib muscle fibers also increased similarly after training in both S and SE.
There were two major differences that were discovered between S and SE after 21 weeks of training. The first difference was an 8% decrease in the coactivation of the biceps femoris muscle during the leg extension. This may be the reason that the SE group showed a slightly better (although not statistically different) enhancement of strength. The second difference between the groups involved power. There was about a 60% increase in the rate of force development on the leg extension in S, while SE showed no increase after training.

On the Field:

For the athlete, this study suggests that if their major goal is strength and hypertrophy, a couple of 60 minute endurance bouts will not interfere with their strength training adaptations, and may in fact help them with developing strength, gaining muscle and losing body fat (as the SE group did lose a significant amount of body fat that did not occur in S). But if their sport requires explosive power (and which sports don't?), then their endurance training should be limited (specifically during the competitive season)- as it can inhibit increases in power even when power training is performed. This study also underscores the importance of periodized training regimens for developing overall physical fitness.

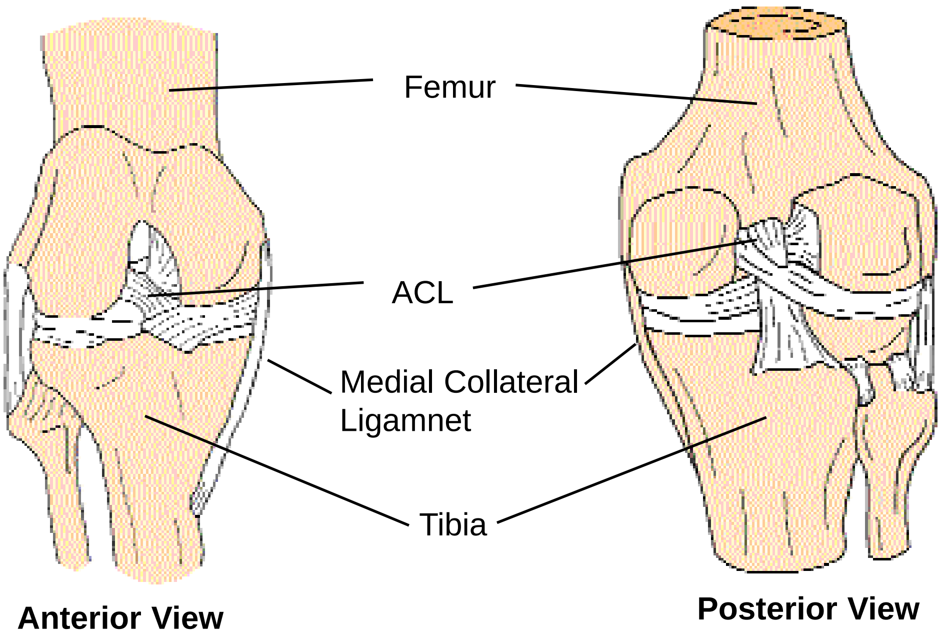
Jim Stoppani Ph.D
Science Editor Muscle & Fitness and Flex



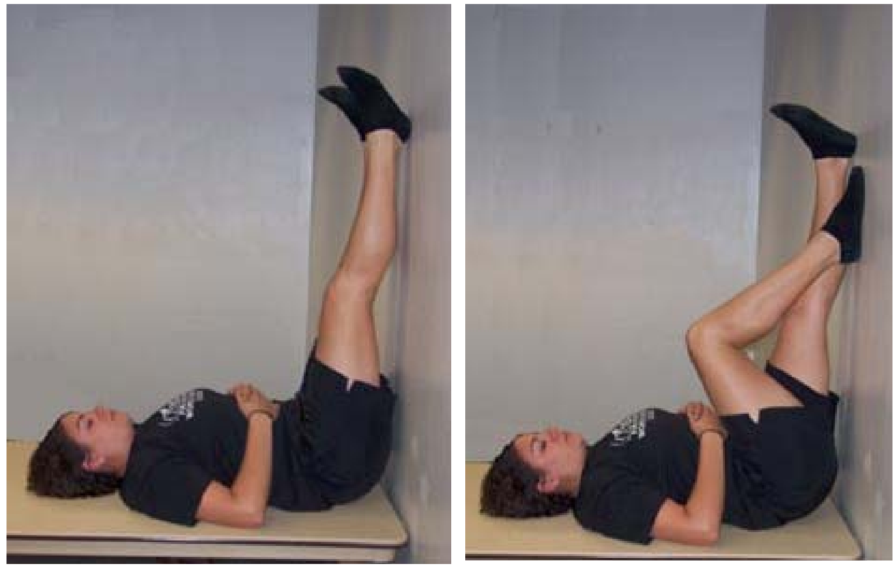
The ACL Injury

One of the last things an athlete wants to hear from their doctor is, "You tore the anterior cruciate ligament in your knee, and you're going to need surgery." To most competitive athletes, tearing your anterior cruciate ligament, or ACL, can seem devastating. What they don't realize, however, is that although it requires an intensive rehabilitation process to return from this injury, many athletes can return from a knee injury just as strong as they were before the injury.

The ACL and the posterior cruciate ligament (PCL) form an "X" shape in the very center of your knee. The ACL provides most of the stability in the knee by preventing anterior translation of the tibia. In other words, the ACL prevents your lower leg from continuing to move forward



when you plant your foot. The ACL can be torn by a hyperextension of the knee as well as a twisting motion of your body while the foot remains planted. Most athletes will have significant pain and swelling with an ACL tear and they will report having heard a "pop" when they were injured. Although older, non-competitive individuals who tear their ACL can manage with a non-operative rehabilitation program, athletes who plan on continuing to engage in high intensity and/or competitive exercise would benefit from an ACL surgical reconstruction.



Wall slides start and finish positions.

Most individuals undergoing ACL reconstruction are given the option of using an autograft (using a tendon of your own as the new ACL) or an allograft (using a donor's tissue). The most common technique is the use of an autograft, where the center of the patellar tendon is used as the ACL. The rehabilitation from this surgery can take anywhere from 6 weeks to 9 months, although athletes who are less conservative and return sooner usually have more problems in the long run. Progressing too quickly or performing exercises that are too vigorous during the rehabilitation can lead to damaging the repaired knee.

Goals of the Rehabilitation Program

As with most rehabilitation programs, there are certain goals a physical therapist or athletic trainer will have in the return of an athlete from an ACL injury. The main goal of the rehab process is to return the knee to normal function. Normal knee function can be defined as having a full range of motion, normal strength and stability, the absence of swelling, a relative pain-free state with activity, and the ability to perform sport-specific movements and activities.1 However, every athlete is different and may take more or less time in the rehab process. Two very important things the athlete must have during the rehabilitation process are patience and discipline in following the rehabilitation program.

Post-Operative Management (0 - 6 days)

After surgery, the knee is immobilized using a controlled-motion brace or knee immobilizer. This type of brace allows the physician or therapist to alter the setting so that the knee is only allowed to move within a certain range or it can be locked at 0º of extension (leg completely straight). The length of immobilization varies, but the degrees of knee flexion allowed by the brace should increase as range of motion improves. The athlete may also begin partial weight bearing almost immediately while using the brace and with the help of crutches. The use of a continuous passive motion device, or CPM, is now used immediately after surgery. The CPM is a device that moves the knee passively within a certain range. It is applied on the knee during recovery and helps regain range of motion.

Passive knee extension

Maximum Protection Phase (0 to 6 weeks)

During this phase of the rehab process, the main goals that need to be accomplished are:

1. Reduction of pain and edema (swelling) through the use of ice, compression, and massage.

2. Increased range of motion (ROM)

Brace: At this stage, the brace can be locked at 10^o.

Passive ROM: The CPM or assisted ROM exercises should go from full knee extension to 90^o of flexion for the first 1 to 2 weeks post-surgery.

Wall slides can be incorporated to increase knee flexion. These are performed by having the athlete lie supine with hip flexed and legs against a wall. The athlete then flexes the knee to the limit and holds it there for a sustained stretch to the quadriceps muscle.

Passive knee extension: Sit on a chair and place your heel on another chair of equal height. Relax your leg and let your knee straighten. Hold this position for a couple of minutes a day to improve your extension.

3. Prevention of atrophy (loss of muscle) and improvement of neuromuscular control: Aside from simply preventing atrophy of the quadriceps muscles, it is important to re-educate the neuromuscular functioning of the entire lower extremity during the later part of this phase. This is accomplished with a variety of exercises that increase the strength of the quadriceps and hamstrings without putting too much stress on the ACL.

Electrical stimulation can be used to re-educate the quadriceps muscle.

Quadriceps setting: Quad sets are performed by having the athlete sitting down with legs straight

Straight Leg raises help prevent atrophy of the quads

and the injured knee extended or slightly flexed. The athlete then contracts the quadriceps isometrically and holds this contraction for 10 seconds.

Straight leg raising (SLR): While sitting down with legs straight, you first contract the quadriceps, as in the exercise above, and then lift the leg to about 45º of hip flexion while keeping the knee straight. Hold the leg in that position for 10 seconds then slowly lower it. SLR should also be done in the prone and side-lying positions with the brace locked in full extension.

Ankle pumps: At the beginning of the rehab process, you may begin by performing ankle pumps while sitting on a table with only your foot hanging off the edge.

Half squats and terminal knee extensions (TKE): Begin by standing next to a sturdy table or chair that you can support yourself with. Make sure your feet are shoulder width apart, and bend your knees and hips until about 45º of knee flexion. Hold this position for 10 seconds and return to the starting position. To add resistance, while facing the table, loop one end of a theraband around the table leg and place the other end around the the injured leg. Bend your leg against the resistance of the band, as if doing a squat, until you're at about 45º of knee flexion. Return to the starting position.

Prone knee flexion: Lie on a table prone (on your stomach) with your legs straight. Bend your knee and bring your heel toward your buttocks. Hold this position for 5 seconds and return to starting position.

4. Progression to full weight bearing: Crutches can be discontinued and full weight bearing (FWB) with the knee immobilizer can be achieved as early as 2 to 3 weeks post-surgery. Again, these progressions may differ depending on the athlete and the physician directing the rehab program.

Half Squats

With a resistance band

5. Cardiovascular fitness: It is extremely important for athletes (especially endurance athletes) to maintain their cardiovascular fitness throughout the rehabilitation process. An upper body ergometer (UBE), which is best described as a stationary bike-like machine for the arms can be used at any point during the rehab in order to maintain cardiovascular fitness. A stationary bicycle can also be used once range of motion is gained as long as the injured leg can move throughout a pain-free range of motion. The athlete can also use the bike to move within the limited allowable range of motion while progressively increasing the ROM of the injured leg.

Moderate Protection Phase (6 to 12 weeks)

If full weight bearing can be accomplished at this stage of the program, crutches should be discontinued. However, the knee immobilizer should still be worn, especially when walking or performing weight bearing activities.[2] At this point of the rehabilitation, a check up with the orthopedic surgeon is recommended to ensure proper healing of the knee and adequate progression in the rehab process. The focus of the Moderate Protection Phase should be on re-establishing full ROM and regaining strength of the injured leg. By week 9, the graft should be healing adequately and exercises can be more vigorous.[2] Toward the end of this stage, balance exercises to help restore lost proprioception can be incorporated into the rehab program.

Proprioception is a joint's ability to maintain stability or orientation during static or dynamic abilities; it has also been defined as spatial awareness. The following exercises can be integrated in order to increase the strength, endurance, and stability of the quadriceps, hamstrings, and hip musculature:

1. ROM: Range of motion should be at 120^{o} of flexion and full extension (0^{o}).

· Wall slides, passive knee extensions: Continue these ROM exercises from the previous phase.
· Prone hangs: In order to accomplish full extension of the knee, lie on your stomach and allow the injured leg to hang off the end of the table for a couple minutes. Light ankle weights can be wrapped around the ankle to allow the weight to assist in straightening the leg.

2. Muscular strength and endurance: During this stage, emphasis is placed on increasing the muscular strength and endurance of the knee extensors and knee flexors, the quadriceps and hamstrings, respectively. The quadriceps usually atrophy quickly with this injury. Strengthening the hamstrings group is also important because these muscles aid in the stability of the posterior aspect of the knee.

Closed chain exercises are those in which the feet are in a fixed position. Examples include bilateral (both legs) leg press, stepping exercises, mini squats, and terminal knee extensions (TKEs). During this stage, these exercises can be continued but the exercises should be maintained between 60 and 0 degrees. After week 8, bilateral closed chain exercises can be performed safely from 90 to 45 degrees.[1]

Opened chain exercises are those in which the feet are not in a fixed position, such as the typical knee extension and the straight leg raise (SLR). At the beginning of this stage, bilateral open chain exercises should be performed within from 90 to 60 degrees.[2] They can then be progressed to 90 to 45 degrees by week 8.[1]

3. Proprioception: Once full weight bearing is pain-free, exercises such as balancing on the injured leg can begin to restore lost proprioception of the injured leg. Proprioception should progress from static to dynamic techniques, such as balancing on wobble boards, balance discs, or mini trampolines as long as the injured leg is strong enough. Proprioception exercises should begin with using a table or wall for support and then progressing to full balancing.

4. Cardiovascular fitness: Continue stationary cycling and/or UBE. Swimming can also be incorporated as a cardiovascular exercise.

5. Bracing: The knee brace can be removed several times a day during this stage for straight-line walking.2

Minimal Protection Phase (12 to 24 weeks)

During this phase, the rehabilitation program focuses on restoring light, functional activities such as walking and jogging, and some agility drills. This is dependent of the achievement of 75 to 80 % of the knee's muscular strength.2 The unlocked knee brace should be worn during these activities.

Range of motion should be continued to maintain full range of motion. Weight room activities should be increased. At this stage, begin unilateral closed-chain exercises (leg press 0 - 60o, step-ups). Proprioception exercises should also be progressed to exercises such as double and single leg hops and other exercises which may resemble sport-specific activities.

Return to Activity Phase (6 to 9 months)

At this point in the rehabilitation process, the athlete should have no trouble with functional activities, such as jogging, and should continue to progress into more sport-specific activities. Muscular strengthening and endurance activities should continue to progress by incorporating advanced weight room exercises such as squats, the leg press, and dead lifts. A full range of motion should be maintained as it is imperative to a successful return to activity. Plyometric activities can also be incorporated into the program. Isokinetic testing can be performed to determine if the athlete has achieved sufficient gains in strength, endurance, and balance. The orthopedic surgeon should be the one who ultimately decides when the athlete is ready to return to their competitive sport or activity. Although an ACL rehabilitation program can be lengthy and complex, athletes with this injury who are patient and disciplined with the rehab process will be able to return to competition at pre-injury fitness levels or better.

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Exercise of the Month:

Med Ball Chest Pass:

Stand or knee, holding a med ball at chest level, facing a partner, wall or the Med Ball rebounder. Throw the med ball at the rebounder so that the ball rebounds back to the starting position. As soon as the ball touches your hands throw it back into the rebounder using a chest pass motion. Try to get a rhythm going with this drill, completing as many throws as possible in 15 seconds.

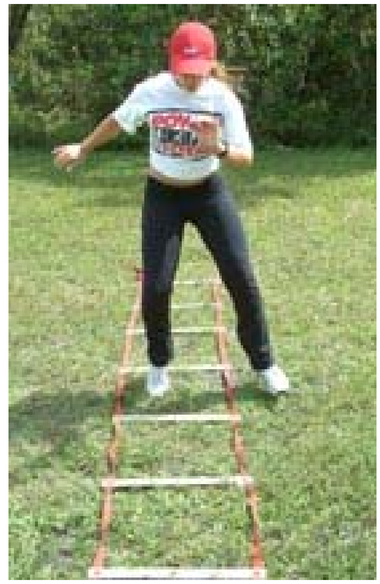
STRENGTHPRO

SPEED AND POWER CERTIFICATION

The quickness to break through the line and accelerate past tacklers, grabbing a rebound out of the hands of your opponent, ripping off a 130 mph tennis serve or driving a golf ball 300 yards all have one thing in common. They all require incredible power.

Power, the optimal combination of speed and strength is essential for sport performance and is the difference between good and great athletesNot every sport has the same power requirement, being able to determine the ideal relationship between speed and strength for a sport, test an individual athlete for their strength and weaknesses and teach proper exercise progressions will allow you to develop more effective training programs and separate yourself from other trainers in the filed of athlete development.

With this in mind StrengthPro has created a certification that covers every aspect of power and speed development, from the science, to the exercises, to the development programs to maximize you clients results.



This four session lecture-workshop will provide each participant the skills and knowledge needed to develop explosive power programs. Examining both historical perspectives and the newest, scientific approaches for developing power the workshop will consist of approximately 50% of the time being devoted to lecture and 50% to practical application hands on applications, allowing participants to bridge the gap between science and practice.

Session 1: The Strength-Speed-Power Continuum

This lecture session will introduce participants to the physiological basis of power development and the Strength-Speed Power continuum. To develop optimal power one must first know whether that power is strength based or speed based. The continuum allows the participant to analyze the power demands of a sport or activity and determine the proportions of strength and speed needed to excel. Other topics covered include:

- Muscle and Nervous system physiology
- Force-velocity curve

- The length-tension curve
- Acceleration, Torque and Impulse
- Elastic energy, the stretch reflex and momentum
- Dynamic Power Expression
- The trade – off between strength and speed
- Where does optimal sport specific power lie?
- Sport and position specific power analysis

Session 2: Developing a Power Profile

During this practical workshop participants will be lead through a series of specific and general strength, speed, and power tests. They will learn to administer the test protocols, interpret the results and set training priorities and goals based on the testing and how the results match the strength-speed-power continuum analysis.

Session 3: The 5 Step Power Program

This lecture session provides the program variables and theoretical framework for designing specific power programs. The 5 step model provides participants with a simple, effective means of ensuring that they are covering ever aspect of power development. Topics covered include:

- Training muscles vs. training movements
- Replication and skill transfer
- The weight training paradox
- Power periodization cycling
- Antagonistic power combinations
- Volume-intensity relationships
- Overload
- Acceleration and deceleration

Session 4: Power Techniques

Building on the previous session, this hands on session features the drills, exercises and training methods discussed in the previous lecture. The group will be broken into smaller groups and cycle through four different stations where participants will learn and learn to teach ten different exercises and drills for a total of 40 new exercises ranging from releases and throws to plyometrics and Olympic lifts.

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Strength Training Technique: Beginners Squat Progression

Narda Williams

Tighter buns and thighs are every woman's dream. One way of achieving that dream is to do the traditional squats. Squats are great for working the gluteus maximus, hamstrings and quadriceps. This exercise has been around for a while and is used by many professionals in the sports arena for strengthening those muscles. It is one of the basic ingredients in a lower body workout.

Free Hand Squat

The free hand squat is used to learn the basic body position and balance for the squat. Maintaining a good base is a necessary ingredient to this exercise. To keep the body properly balanced place the feet about shoulder-width apart. If the feet are too far apart, it could add strain to the Iliotibial band, which runs along the lateral border of your leg. If they are too narrow balance can become an issue when weight is added. Turn the feet out at about a 30 degree angle, this further increases your base of supports and allows your knees to track normally over your feet. Place your hands on your hips or across your shoulders.

As you descend into the squat, imagine that there is a chair behind you that you are going to sit on; this ensures that both the hips and knees bend at the same time. One of the most common errors when someone starts to squat is breaking the knees first and trying to descend without bending from the hips. Think about moving your knees out as you descend, lowering your body until the tops of your thighs are parallel to the floor. Knees should be over the toes and your weight should be back on the heels. The whole foot should remain in contact with the floor at all times. Keep your chest up and out and tilt the head slightly up. If you have difficulty keeping your feet flat on the floor try a slightly wider stance, if that does not work place a small weight plate or block of wood under your heels until you improve calf and ankle flexibility. The ascent is the opposite movement. Drive upwards, initiating the movement with the legs, keeping the trunk upright. Your weight should be evenly distributed across your foot for the whole squat.

Free Weight Squat

In strength rooms, a bar with weights is used doing the same movement. Progression should not occur until you can perform the skill correctly without having to put too much thought into the different key points. This could take a few weeks or more, depending on your ability and comfort level. Don't be in a rush to add weights.

The movement is exactly the same as in the free hand squat. The difference now is in the positioning of the hands and the bar. You can either place the bar across the posterior deltoids at the middle of the trapezius placing the hands wider than shoulder-width length, or above the posterior deltoids at the base of the neck placing the hands only slightly wider than shoulder-width length. The palms of the hands should be facing forward when gripping the bar. Grip the bar with the thumb wrapping the bar opposite to the fingers. Gripping the bar firmly and evenly helps to maintain control while performing the movement. If the bar is too low, it will throw the balance off and cause injury. If it is too high in the neck, it will cause discomfort and force you to shift your position, thus causing injury. The posterior deltoids at the middle of the trapezius also act as a cushion for the bar. The added weight onto the body tends to shift the center of gravity and compromise balance;

descend slowly into the squat so that you can maintain balance.

Balance Disc Squats

Once you have established a base level of strength, squatting with 50% of your body weight added to the bar and mastered the technique for the basic squat you can move onto a more challenging version of the exercise using a balance disc. Standing on a Balance Disc causes the activation of muscles that you didn't even realize existed in order to prevent you from falling over. Besides the quadriceps and hamstrings, the legs contain muscles that help to provide balance, which include the six lateral rotator muscles and the five adductor muscles - all of which helps to control movement between the pelvis and femur. There is also the gluteal muscles, especially the Gluteus Medius, which stabilizes the pelvis.

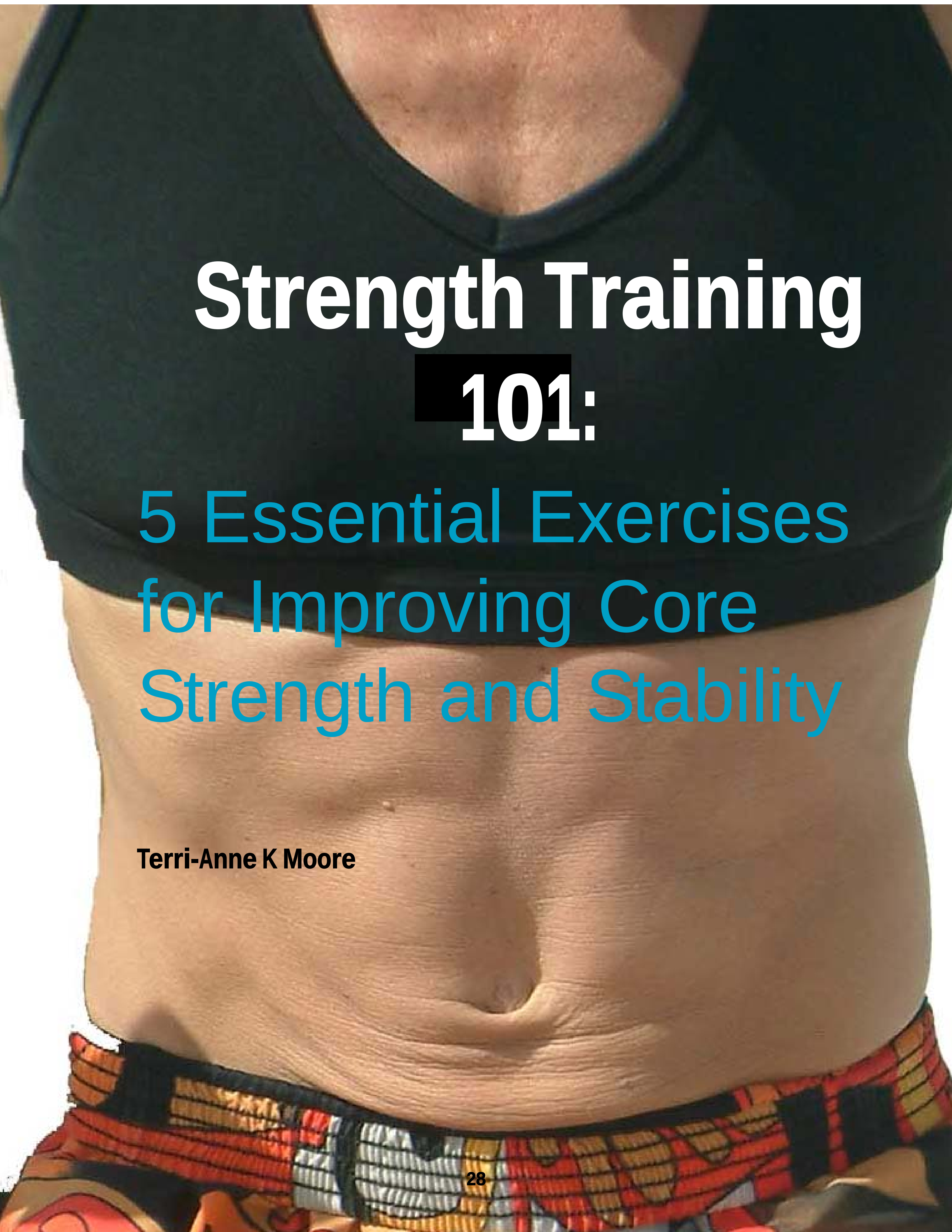
Place two air filled Balancing Discs on the ground shoulder-width apart or slightly wider and stand up on them and first try to maintain your balance while just standing there. Once you are in position with hands either on your hips or shoulders, slowly perform the squat. Maintain all of the proper body mechanics as if you were flat on the ground. This adds a real challenge to the regular squat. Not only are you activating the working muscles, but you are also using stabilizer muscles so that you can maintain good posture. Concentrate on keeping the chest up and hips back as well as keeping the weight through the heels. Control the movement and take your time. Don't forget to breathe.

Balance Disc squats should not be though of as a replacement for regular squats but as a compliment to free weight squats. The instability of Balance Disc squats prevents you from using the same weight as you would in a free weight squat. The lighter weight won't be enough to stimulate increases in strength of the prime mover muscles, the quadriceps, hamstrings and gluteus maximus. Using Balance Disc squats as you warm up for your free weight squats will give you strength in both the prime movers and stabilizing muscles.

Bosu Squats

Another daring feat is to do the squat on a Bosu Disc. If you're not familiar with the Bosu Disc, it is a device with a flat bottom and a domed balloon top. Usually, you would have the flat surface on the ground and you would be exercising on the domed top. However, for this exercise, we place the domed surface on the ground and stand on the flat surface. The first trick is to get on top of it. The quickest way is to just jump right on top of it. The easiest and safest would be to have someone act as a support while you try to maneuver your way on. Once you get on the Bosu you will try to maintain your balance just standing there; once you can do this you are ready to try the free hand squat. It sounds easy, but once you get on the Bosu, you will realize how much effort is needed just to maintain your balance and not end up flat on the ground. It is always a good idea to have someone close by to spot you in the event that you lose your balance. If that is not possible, place the disc close to a wall or something stable that you can hold on to. Don't attempt this exercise until you have gone through all of the other progressions confidently and safely.

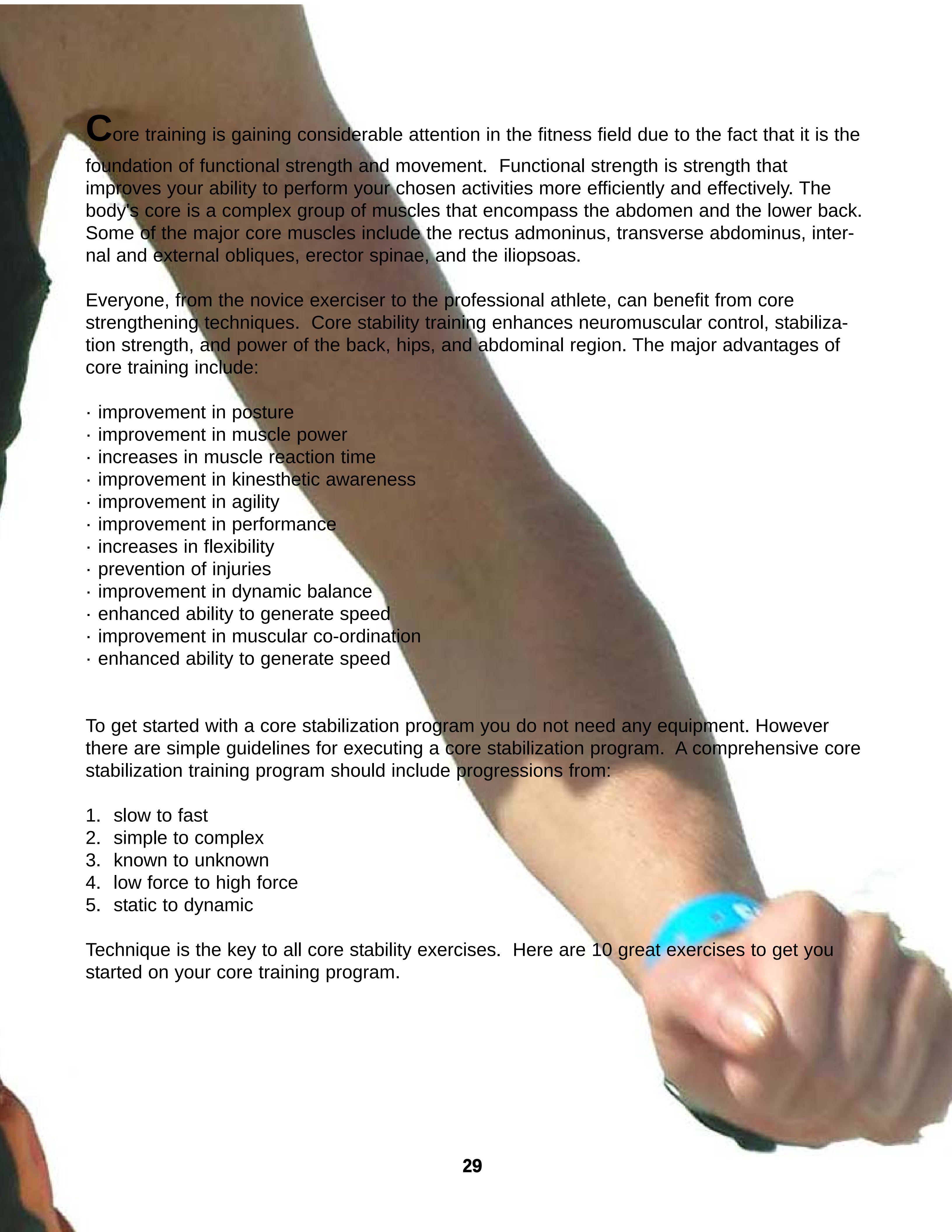
The squat is the king of the lower body exercises because it works all the muscles of the legs, hips and core. It takes some time to do the exercise properly and safely but including it in a training program will pay off in the long run.



Strength Training 101:

5 Essential Exercises for Improving Core Strength and Stability

Terri-Anne K Moore



Core training is gaining considerable attention in the fitness field due to the fact that it is the foundation of functional strength and movement. Functional strength is strength that improves your ability to perform your chosen activities more efficiently and effectively. The body's core is a complex group of muscles that encompass the abdomen and the lower back. Some of the major core muscles include the rectus admoninus, transverse abdominus, internal and external obliques, erector spinae, and the iliopsoas.

Everyone, from the novice exerciser to the professional athlete, can benefit from core strengthening techniques. Core stability training enhances neuromuscular control, stabilization strength, and power of the back, hips, and abdominal region. The major advantages of core training include:

· improvement in posture
· improvement in muscle power
· increases in muscle reaction time
· improvement in kinesthetic awareness
· improvement in agility
· improvement in performance
· increases in flexibility
· prevention of injuries
· improvement in dynamic balance
· enhanced ability to generate speed
· improvement in muscular co-ordination
· enhanced ability to generate speed

To get started with a core stabilization program you do not need any equipment. However there are simple guidelines for executing a core stabilization program. A comprehensive core stabilization training program should include progressions from:

1. slow to fast
2. simple to complex
3. known to unknown
4. low force to high force
5. static to dynamic

Technique is the key to all core stability exercises. Here are 10 great exercises to get you started on your core training program.

Power Crunch: Lie on your back with knees bent and feet against a wall. Arms should be placed either across the chest or by the head. Keeping the upper back as straight as possible; lift the head, neck and chest about two inches off the ground. The exercise should be repeated as many times as possible.

4 Point Balance: This is performed on all fours. There are three progressions to this exercise (a) lift one arm (b) lift one leg and (c) lift the opposite arm and leg off the floor and holds it for about 2-3 seconds. For all three exercises it is important to keep your navel pulled towards your spine. This exercise is designed to strengthen the abdominals, lower back, hamstrings, and glutes.

Bridge: This exercise works many of your core muscles in combination. Lie on your back with your knees bent. Keep your back in a neutral position, not overly arched and not pressed into the floor. Avoid tilting your hips up. Cough to activate your transversus abdominis. Holding the contraction in your abdominal muscles, raise your hips off the floor. Align your hips with your knees and shoulders. Hold this position for as long as it takes to complete three deep breaths - about five to eight seconds. Return to your starting position and repeat. For a challenge, try alternately extending one knee while maintaining the bridge position. With each of these exercises, coordinate your breathing with the activation of your transversus abdominis. If you don't, you won't benefit from these exercises.

Segmental rotation: Lie on your back on the floor with your knees bent and your back in a neutral position. Cough to activate your transversus abdominis, and keep it contracted throughout the exercise. Keeping your shoulders on the floor let your knees fall slowly to the left. Go only as far as your body will comfortably allow you to go - you should feel no pain, only a stretch. Use your trunk muscles to pull your legs back up to the starting position. Repeat the same movement, letting your knees falls to the right. Remember to breathe freely and deeply during these exercises, don't hold your breath.

Superman: Lie facedown on the floor. Place a rolled towel or a small pillow under your hips to support your back. You might also use a folded towel to support your head. Tighten your trunk muscles. Raise your arms and legs a few inches off the floor. Be careful not to raise your arms or your legs more than a few inches off the ground. That's all you need for this exercise to be effective in strengthening your lower back.