

THE KNEES:

Keeping them strong and stable

By

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How do we correctly strengthen the knees to avoid injury and chronic pains? Are some of us just destined to have knee problems or is this something we can prevent? Well, when one looks at the knees from a kinetic chain perspective, many times we can see there is a greater potential for injury due to faulty alignment, improper movement mechanics, unbalanced length tension ratios, dehydration of soft tissue, or just plain weakness in the surrounding musculature and soft tissue. Understanding these and the proper mechanics of the knee structure, one can create a training program designed to prevent future knee injuries or rehab current problems. Understanding the load bearing mechanisms of this joint and the proximal (hip) and distal (ankle) joints of the leg, an athlete can minimize the risk of injury while maximizing the training effect.

Just by looking at an athlete in normal standing posture, one can gauge the potential for injury in the lower extremities. For example, if an athlete closes their eyes and marches in place for five seconds, then stops without opening their eyes, this will provide the coach with some insight on the athlete's structure. If there is a load bearing discrepancy (ie; athlete feels more weight on one foot vs the other), the athlete may be de-loading one leg, while overloading the other. From this, an athlete may then have a hip shift, with one hip elevated vs the other. This hip elevation may then change the dynamics of the spine, as it is no longer resting on a completely balanced pelvis, spinal musculature compensations need to be made to keep the athlete upright. For instance, this type of compensatory cycle can carry all the way to the shoulder for a baseball pitcher, putting excessive strain on the shoulder or elbow during throwing mechanics.

Looking at this same athlete, there may also be a shift in the structure of the knees or ankles. For instance, due to improper alignment of the pelvis, the knees may have excessive valgus stress (knock kneed) and the feet may evert (feet pointing outward). When an athlete with excessive valgus stress and eversion of the feet needs to stop and change direction, the knee capsule is at high risk of damage because the proper deceleratory mechanics do not exist due to the altered structure of the knee. Certain quadriceps muscles such as the vastus medialis obliques (VMO) which are responsible for stabilization of the knee, may be weak, which then opens the knee to risk of injury. These are just some of the factors to take into account during an initial evaluation with a personal trainer, strength coach, or performance specialist. IF YOUR INITIAL EVALUATION WITH YOUR PERSONAL TRAINER DOES NOT CONSIST OF STRUCTURAL OR MOVEMENT EVALUATIONS, GO SOMEWHERE ELSE, as the risk of injury will only increase if you are lifting heavy weights or performing “pattern overload” movements on restricted range of motion machines.

Movement screening can also provide the coach with valuable information regarding potential for injury. For instance, an athlete scoring low in a movement evaluation may be at greater risk of injury, therefore not worth the risk of signing to a long term contract. Gray Cook has excellent DVDs and books on this topic, and has clearly outlined how to score and rate each movement. Quite possibly the best method is that of Structural Balance testing by world renowned strength coach Charles Poliquin. Over his 25+ years as the best strength coach in the world, coach Poliquin has come up with normative data for agonist/antagonist muscle strength ratios. For example, an athlete should be able to perform X% of their 1 rep max bench press in the seated dumbbell external rotator exercise. If the athlete cannot perform this, then the limiting factor of their bench press may be the health of their shoulder capsule, particularly their external rotators. Look around the gym at the guys who only bench press, and see if their shoulders are rounded forward. That is a sure sign of weakness in the external rotators due to lack of training, while the pectoral musculature is too tight due to excessive training. For more info, go to his website www.charlespoliquin.com.

Unilateral Training

So, now that we know the knees may have some structural problems, how do we train them to avoid future knee problems. It seems most regular gym goers rely on leg extensions, leg presses, and

hamstring curls, while most athletes are given a prescription of squats, deadlifts, and cleans. Well these are all great exercises (with exception of the leg extension machine), but are these actually correcting structural imbalances? For instance, if the previously mentioned athlete decides to do a 6 sets of squats for 5-7 repetitions each set, will this correct the load bearing imbalance or shift in the hips. In actuality, this may magnify the imbalance as the athlete is forced to load the stronger leg with greater resistance, while the weaker leg is trying to alleviate the stress by shifting the body/pelvis over the stronger leg. This only reiterates the imbalance, leading to greater potential for injury, never mind the chronic low back and knee pains felt during squatting, and eventually every day movements. A more viable solution may be the use of unilateral exercises until the athlete is ready to perform bilateral movements.

With unilateral training, the athlete can ensure proper load bearing mechanics for each leg, while putting stress on the proper musculature required to perform the exercise correctly. An athlete should begin with static base unilateral exercises first, then proceed to more dynamic movements, to avoid the risk of injury. Too many times have athletes jumped to dynamic movements, never allowing the body to recruit or strengthen the proper musculature, leading to cumulative injuries all over again. Proper exercise progression is the key, so make sure you are training with somebody who knows how to do this, as the risk of reinjuring may be too great to leave in the hands of somebody who does not know what they are doing.

Specificity Of Training

Ah, all we seem to hear nowadays is sport specific training. Standing on a BOSU trainer while holding a body blade and curling a dumbbell in the other hand seems to be the latest craze. Well, I hate to burst the bubble, but the only sport that this training prepares an athlete for is one that consists of standing on a BOSU trainer while holding a body blade and curling a dumbbell. The list of sports in which this exists is pretty short. To become a better athlete, one needs to become structurally balanced, which then leads to greater neuromuscular efficiency, which then leads to greater strength/muscle fiber hypertrophy, which then leads to the potential to increase rate of force development (power), which then leads to increases in acceleration, agility, and speed. So you see, with a stronger athlete, when trained correctly, the potential for increased power, acceleration, agility and speed is increased exponentially. So in essence, proper strength training which recruits the active musculature of a particular sport, at specific movement velocities is perhaps the greatest form of sport specific training.

Training the VMO and Hamstrings

In sport, does an athlete activate the VMO in a supine (lying on the back) position or are most athletes activating the VMO from a standing position in which they are decelerating or cutting. I would venture to guess the latter. But it seems in many rehabilitation settings, the VMO is only trained in the seated or supine position, which may not adequately prepare the athlete for the on-field exposures. Training the VMO in a standing position is of critical importance to prevention of injury, rehabilitation from injury, or maintenance of knee structure health. A quality therapist, personal trainer or strength and conditioning coach will be able to guide an athlete through proper standing VMO exercises which train the muscle at both ends of its activation spectrum.

The hamstrings are of critical importance as well. Walk into any gym today and you can see many gym goers performing bilateral hamstring curls or trainers advising their clients to perform hip extensor only hamstring exercises. With these exercise prescriptions many things can happen, including strength imbalances from one leg to the other, individual hamstring musculature imbalances on the same leg, or weakness in the lower attachment of the hamstring because of lack of leg curls when only performing hip extensor exercises. A proper training protocol will include both hamstring as flexor of the knee and extensor of the hip, as well as variations in foot position, and unilateral leg training to ensure proper structural balance.

Half squats are better than deep squats, right?????????

A study performed by Caterisano et al 2002 provides valuable insight into squat depth and muscle activation. In this groundbreaking study, the researchers found glute activation during full squats to be greater than twice that of partial squats (35.4% compared to 16.9%), hamstring activation to be similar, while quadriceps activation dominated during the partial squats only. Understanding the importance of this information can completely change the way an athlete prepares for and performs on the field. The following paragraphs illustrate the importance of full squatting vs half squatting, and the effects on knee health and stability.

The best way to approach this is to quote an excerpt from Dr. Mark Rippetoe's book Strong Enough. Rippetoe states "the fundamental misunderstanding here is about what we're trying to accomplish when we squat. The quadriceps are not the only muscles that are supposed to be involved in

the exercise. The hamstring muscles on the back of the thigh attach at the front of the tibia, at the bottom of the knee, wrap around it on both sides and pull back on the knee from below it as they get tight. The adductors connect the groin area of the pelvis to the medial (inside) aspect of the femur, and these muscles also pull back on the knee when they tighten, but from above the knee and toward the inside. Both of these muscle groups tighten from behind the knee as the torso leans forward, the knees travel out to stay parallel to the feet, and the hips reach back of correct depth, balancing the forward pulling stress from the quadriceps and the patellar tendon around the front of the knee. But they only exert this balancing pull **when they are stretched**, in the full squat position. At the bottom of the squat, where the hamstrings and adductors are fully stretched, there is as much pull on the knee from the posterior as from the anterior. In this position, the quadriceps' knee extension force is balanced by the hamstrings' knee flexion force. At the same time, the adductors have stretched too, and if the knees stay parallel to the feet, as they should, the adductors will get tight and pull on the femurs. This knee out position anchors the femur so that adductor contractions and hamstring contractions produce hip extension, which is apparent when sore adductors show up the day after a heavy squat workout (5)."

"Because the hamstrings attach to the pelvis at the ischial tuberosity, any forward tilting of the top of the pelvis will stretch the hamstrings away from their insertion points at the knees. When the pelvis and the back are properly locked in a flat rigid unit by the back muscles, the forward angle of the torso and pelvis tightens up the hamstrings. At the same time, if the knees are shoved out to the sides at the bottom of the squat, the adductors are tightened. If this is done correctly, there is a slight "bounce" or muscular rebound off the hamstrings and adductors at the bottom of the squat, which initiates the upward drive out of the hole. This hip extension is accomplished much more efficiently and much, much more safely for the knee when it occurs from this correct position- **the position that cannot be achieved unless the squat is deep (5).**"

With regard to half squats, Rippetoe goes on to state "the only muscles under any stress are the quads, since the hamstrings, glutes, and adductors are not involved due to the limited range of motion. The spine is invariably loaded too heavily, since it is incredibly easy to "squat" big weights if you only have to move them a few inches. The knees are disproportionately subjected to anterior stress, since the lack of depth does not engage the hamstrings and activate their posterior balancing effect. The lower back muscles, used in the full squat to maintain spinal alignment and the back and pelvis angle,

get little work in the half squat because it is not deep enough to ever put the low back at much of an angle (5).”

So where did the myths about half squats being better for the knees come from. The following excerpts from Bill Starr’s excellent book *The Strongest Shall Survive* will provide valuable insight into this controversy. Starr states “In the early sixties, Dr. Karl Klein of the University of Texas, published a piece of research which concluded that full squats loosened the knee joint and, therefore, the exercise was harmful to the knees, especially to those engaged in contact sports such as football. As a result, coaches across the nation forbid their players from doing full squats. Some states, such as New Jersey, even outlawed full squats in secondary schools. If coaches allowed their athletes to squat at all, they only gave the OK to half or quarter squat (7).”

“Dr. Klein tested a group of 128 competitive weightlifters who had done full squats against 360 college students who had no such experience. He concluded that the weightlifting group had unstable collateral and anterior cruciate ligaments as a result of the squatting and advised against performing the full range movement (7).”

“Dr. Klein used an aluminum gadget for his test which covered the upper and lower leg much like a leg cast. He exerted pressure from each side of the knee and took a reading on a dial similar to a blood pressure gauge. Dr. Klein always inquired whether the subject did full squats before he conducted the test (7).”

Starr had disputes on two main objections. “One, the applying of the pressure was far too subjective. The tester could push harder and harder on the knee joint and secure a pre-determined reading. Many athletes complained that the tester actually hurt their knees because he pushed so hard. Did he push equally hard on each subject? Two, the tester always had the subject classified as a squatter or non-squatter before he tested him, rather than after. This certainly gave the tester the opportunity to have a built in prejudice and eliminate the testing procedure from the pure, controlled category (7).”

“By applying the same testing procedure, another researcher, with an eye to reversing the findings, could quite easily do so. A pure piece of research should not have this wide margin of testing subjectivity unless it is specifically spelled out in the conclusion, which it definitely was not in this case (7).”

With regard to this controversial study, Rippetoe goes on to state “Dr. Karl Klein’s study at the University of Texas in 1961, a poorly designed and badly conducted mess that has never been replicated and has been successfully rebutted many times. Klein concluded that below parallel squats produced “loose” knees, although no other training protocol was evaluated for comparison, no other tester administered the measurements, and all the data was biased by pre-test questioning of the subjects (5).” A quick google search on the subject will provide you with further information. Also, check if Dr. Klein is still recognized as a reputable PHD, or if he had been barred from research.

In closing, Starr points out the immense benefits of deep squatting by stating “it is equally recognized that full range movements build more strength in the muscles and tendons simply because more fibers become involved. It logically follows that full squats work more muscles than do half squats, just as a full range curling motion brings into play more muscles of the upper arm than does a partial curling movement (7).”

“The culprit is not the full range movements but the stretching of the tendons and ligaments that results when the trainee literally bounces at the bottom most position. Full squats involve more muscles than half squats. Should you doubt this assertion, merely try a few sets of high repetition full squats after a period of only performing half squats. The insides of your thighs, your glutes, and your lower back will all experience a new soreness, after doing full squats (7).”

Knee health, function, and stability can be greatly influenced by one’s movement mechanics, structural balance, and strength levels. As has been shown, proper training with regards to muscle activation, full range of motion movements, specificity of training, and progression can have tremendous benefits in knee rehabilitation, injury prevention, and performance enhancement. With strong knees, one can place more emphasis on their performance and less energy on worrying about the possibility of knee injury.

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