Point/Counterpoint

The purpose of the Point/Counterpoint Column is to provide a respectful and balanced discussion in relation to controversial or current topics in the fields of strength and conditioning, nutrition, and human performance.

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Are Deep Squats a Safe and Viable Exercise?

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SUMMARY

THERE IS A GREAT DEAL OF DEBATE AMONG STRENGTH AND CONDITIONING PROFESSIONALS, REHABILITATION SPECIALISTS, AND RESEARCHERS REGARDING THE SAFETY AND EFFICACY OF PERFORMING THE DEEP SQUAT EXERCISE. IN THIS ARTICLE, THE POTENTIAL BENEFITS AND THE POTENTIAL RISKS OF PERFORMING THIS CLOSED-KINETIC CHAIN LOWER EXTREMITY EXERCISE WILL BE DISCUSSED.

PRO

The squat is widely used as a staple exercise in resistance training programs. It is used by athletic and recreational populations alike to enhance both strength and hypertrophy of the lower-body musculature and improve functional performance (17). However, considerable controversy exists as to optimal squat depth, particularly as to whether deep squatting increases the risk of injury to the knee joint.

The safety concerns about squatting at high knee flexion angles can be traced back to studies performed by Klein in 1961 (7), who used a self-developed measuring device to analyze the knee structures in competitive weightlifters who frequently performed deep squats. Klein reported that these athletes displayed an increased incidence of laxity in the collateral and anterior cruciate ligament (ACL) compared with a control group, potentially compromising their knee joint stability. These findings led Klein to conclude that weighted squats should be limited to a half-knee bend where the thigh descended no lower than parallel to the ground (8). Subsequent to Klein's research, the United States Army banned squat jumping from their conditioning protocol, the New York school system forbid full squats in gym class, and the American Medical Association adopted the stance that deep knee bends posed a risk for severe injury to the soft tissue structures of the knee joint (19).

More recent studies have failed to reveal any association between deep squatting and injury risk in healthy subjects (15,18). Meyers (12), using a copy of Klein's testing instrument, reported no significant differences in knee ligament stability between subjects who performed the full squat versus the half squat. Chandler et al. (2) found that male power lifters and weightlifters who regularly performed deep squats displayed significantly tighter joint capsules on anterior drawer and were significantly tighter on the quadriceps active drawer at 90° of knee flexion than control subjects. Taken as a whole, the body of evidence does not support the assertions that deep squats are detrimental to knee joint stability. In actuality, ACL and posterior cruciate ligament (PCL) forces have been shown to diminish at high knee flexion angles. ACL forces peak between 15 and 30° of flexion, decreasing significantly at 60°, and leveling off thereafter at higher flexion angles (6,9,16). Peak PCL forces are seen at approximately 90° and rapidly decline thereafter (10). Beyond 120°, forces on the PCL are minimal (11). Accordingly, the potential for ligamentous injury would seem to be reduced rather than increased in the deepest portions of the squat.

Squatting at high flexion angles may actually have a protective effect on ligamentous structures, a phenomenon that can be at least partly attributed to compression of posterior soft tissues between the distal femur and proximal

tibia (10). This constrains the knee joint, thereby limiting the amount of tibial translation and thus enhancing tolerance to load.

Theoretically, any increased risk of knee injury from deep squatting would involve damage to the menisci and articular cartilage (4,10). Peak tibiofemoral compressive forces occur at approximately 130° of knee flexion (14), which places these structures under greater amounts of stress. The high amount of patellofemoral stress that arises from contact at the underside of the patella with articulating aspects of the femur during high flexion may also increase susceptibility to patellofemoral degeneration (4). Evidence suggests that deep squatting increases contact force across the tibiofemoral joints (3) to a greater degree than across the patellofemoral joint (5). However, a cause-effect relationship between deep squats and injuries to these structures has not been established in the literature, making any conclusions on the subject speculative at best. Only in those with existing knee pathology (e.g., chondromalacia, osteoarthritis, osteochondritis) and/or those who had postsurgical intervention (e.g., meniscectomy, PCL reconstruction) would squatting at high flexion angles potentially be contraindicated (13).

In conclusion, research does not support the contention that full squats are detrimental to those with healthy knee function. Given that deep squatting confers a number of important benefits, including greater muscle activation and development, improved functional capacity, and better athletic performance (1,20), there is little reason to avoid this exercise provided no medical contraindications exist.

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CON

Most sport stances require some degree of knee flexion; however, few require flexion in which the top of the thigh is below parallel (deep squatting). One of the benefits of using closed kinetic chain (CKC) exercises is specificity of training (1). Therefore, using deep squatting contradicts one of the primary purposes of using a CKC exercise, sports specificity. Although there are some sports that do require deep squatting, such as weightlifting, it is not a routine motion for most.

Another important consideration when choosing squat depth is safety. An extensive review of the literature in this area by Escamilla (4) indicates that low anterior shear forces of the tibiofemoral joint are observed between 0 and 60° of knee flexion; however, compressive force within the patellofemoral joint seem to be a greater concern. High patellofemoral compressive forces can stress the articular cartilage on the undersurface of the patella, which can lead to chondromalacia and eventually osteoarthritic changes (3,5). Beyond the potential risk of the minor to moderate shear and compression forces acting on the cruciate ligaments and the menisci of the knee, the forces placed on the

patellofemoral joint were found to be even greater (2,4). Additionally, Wallace et al. (8) found that the stress through the patellofemoral joint was significantly higher in weighted trials than in nonweighted trials indicating that adding load can increase the injury risk of deep squats. In healthy individuals, the patellofemoral stress associated with deep squatting is the primary risk of injury. Nagura et al (7) suggests that incidence of osteoarthritis may be attributed to repetitive deep squatting seen more often in eastern cultures, where deep knee flexion is common in religious practices compared with Western populations. The combined information in this area regarding patellofemoral stress does point to increased injury risk with repetitive long-term deep squatting activities.

The final consideration is the overall benefit of the deep squat. The quadriceps, hamstrings, and gastrocnemius are all activated while squatting. Specifically, the quadriceps vasti produce significantly more activity compared with the rectus femoris with the parallel squat (3,4,9). Furthermore, a comprehensive literature review by Escamilla (4) noted that quadriceps activity gradually increases as knee flexion increases up to 90°, and little evidence suggests increase activity past parallel. Additionally, hamstring activity peaks within the parallel squat range between 10 and 60°, which is greater during the accent compared with the decent lift phases (6,9). Finally, according to Escamilla et al. (3) and Isear et al. (6), the gastrocnemius activity appears to peak between 60 and 90° of knee flexion.

Overall, the squat exercise provides substantial and well-researched benefits. However, when considering the value of the deep squat, the risks appear to outweigh many of the potential benefits. Most significantly, patellofemoral injury does appear to be associated with deep knee flexion, which can predispose individuals to osteoarthritic changes in the articular cartilage beneath the patella. Also, it is important to note that electromyographic activity across studies have indicated that peak muscle activity in the quadriceps, hamstrings, and gastrocnemius fall within the range of the parallel squat and do not increase beyond parallel of flexion. This suggests that squatting below parallel will not increase muscle activation. Finally, consider what is functional for the individual and the sport, if deep squatting is not part of normal functioning, it may not be contributing to sport performance via specificity.

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