

Exploring the Front Squat

Stephen P. Bird, PhD, CSCS¹ and Sean Casey, BSKin, BSNutr, CSCS²

¹Exercise and Sports Science Laboratories, School of Human Movement Studies, Charles Sturt University, Bathurst, New South Wales, Australia; and ²CasePerformance, Green Bay, Wisconsin

SUMMARY

THIS ARTICLE EXPLORES THE “FRONT SQUAT” (FSq) AND ITS VARIATIONS AS PART OF THE “BIG THREE” (DEADLIFT, POWER CLEAN, AND SQUAT) EXERCISES PRESCRIBED BY STRENGTH AND CONDITIONING COACHES TO DEVELOP TOTAL BODY STRENGTH, TARGETING THE HIP EXTENSORS (GLUTEUS MAXIMUS), KNEE EXTENSORS (QUADRICEPS), KNEE FLEXORS (HAMSTRINGS), AND CORE MUSCULATURE (ERECTOR SPINAE, QUADRATUS LUMBORUM, OBLIQUES, RECTUS, AND TRANSVERSE ABDOMINIS). MORE SPECIFICALLY, THE PURPOSE OF THIS ARTICLE IS TO INTRODUCE STRENGTH AND CONDITIONING COACHES TO THE FSq TEACHING PROGRESSION, WITH SPECIFIC EMPHASIS ON DEVELOPING THE CORRECT BODY POSITIONING REQUIRED FOR EXECUTION OF THE FSq.

SQUAT TERMINOLOGY

When most individuals hear the word squat, they often think of the back squat (BSq). However, the term squat is an umbrella term that refers to a large collection of exercises, with similar movement patterns, extensively used by strength and conditioning coaches to enhance total body strength and subsequently athletic performance (Table 1). These include the BSq (20,34), jump squat (24,29), overhead/snatch squat (1), Bulgarian/split squat, and single-leg squat (13). Another variation, which will be the focus of this article, is the front squat (FSq) (27,41).

RESEARCH OVERVIEW OF THE FRONT SQUAT

To date, research examining muscle activation patterns and movement mechanics of the squat exercise has focused mostly on individuals completing the BSq (4,16,42). However, a few studies (2,10,22,37) have compared the kinematics and muscle activations patterns of the BSq versus FSq. Recently, Gullett et al. (22) examined the potential differences of BSq versus FSq on the muscle activation and loading patterns of the knee joint in 15 individuals (9 men, 6 women) with squatting experience. In this study, participants completed 2 trials that consisted of 3 repetitions (reps) for each squat variation; the same relative load, 70% one repetition maximum (1RM), was used for each lift. Interestingly, despite lifting ~19 kg more during the BSq, no significant differences in muscle activation of the quadriceps, hamstrings, or erector spinae were noted between exercises. However, unfortunately, activation of the gluteal muscles, specifically the gluteus maximus, was not examined. This is of particular interest because it is the authors' experience that many athletes BSq with a wider stance than when performing the FSq. A wider stance is associated with increased activation of the gluteus maximus (30). Additionally, although no significant differences in knee joint shear stress were reported between FSq and BSq sessions, compressive forces were significantly higher while performing the BSq ($11.0 \pm 2.3 \text{ N} \cdot \text{kg}^{-1}$ versus $9.3 \pm 1.5 \text{ N} \cdot \text{kg}^{-1}$). The authors suggest that the extra load lifted during the BSq is responsible for the increased compressive forces and extensor moments observed during these lifts (22). Although shear stress is resisted in the knee

joint by the anterior and posterior cruciate ligaments, compressive force is opposed within the knee by the meniscus and hyaline cartilage (32). Therefore, in athletes with pre-existing knee injuries, when performed correctly, the FSq may present a safer and potentially more beneficial option than the BSq in terms of maximizing overall muscle recruitment while minimizing compressive forces in the patellofemoral joint. That is to say that a similar training stimulus can be achieved with the FSq while placing less compressive forces on the knee. The same may also hold true for athletes presenting with osteoarthritic concerns. However, caution is warranted in novice lifters because the FSq may cause more knee stress than the BSq with anecdotal reports, suggesting more direct force over the knee joint.

Examining the effects of various exercises on erector spinae and rectus abdominis activity, Comfort et al. (10) had 10 recreational trained men perform a military press, BSq, and FSq at a submaximal load (40 kg). Muscle activity during these dynamic exercises were then compared with that obtained while doing 30-second isometric holds while in the “prone bridge” and “superman” positions. Upon completion of the study, it was found that at this submaximum load, the FSq resulted in significantly greater erector spinae muscle activity versus the BSq, military press, and prone bridge. No difference was found between the superman and FSq exercises. With respect to the rectus abdominis, muscle activity was significantly higher after the prone bridge versus all other exercises. The

KEY WORDS:

front squat; strength training; technique

Table 1
Overview of squat variations and sport-specific applications

Squat variation	Primary muscles used	Comments	Sport-specific applications
Back squat	Quadriceps, gluteus maximus, spinal erectors, abdominals	Total body exercise	Football, powerlifting, basketball
Front squat	Quadriceps, gluteus maximus, spinal erectors, abdominals, deltoids	Essential learning movement for Olympic-style lifts and variants. Decreased compressive stress on knee.	Weightlifting, wrestling, volleyball
Goblet squat (KB/DB options)	Quadriceps, gluteus maximus, spinal erectors, abdominals, deltoids	Essential learning movement for squat pattern	Weightlifting
Bulgarian split squat	Quadriceps, gluteus maximus, hip adductors/abductors	Increased activation of hip stabilizers and lumbopelvic musculature. Allows for heavy loads to be used while developing single leg strength.	Soccer, track events (sprints), baseball, football
Single Leg squat	Hip adductors/abductors, spinal erectors, abdominals	High degree of difficulty. Focus is on maintaining balance while keeping the spine and knee joint in proper alignment during ascent and descent.	Gymnastics, figure skating
Sissy squats	Quadriceps	Heavy loads used for increased strength	Bodybuilding
Snatch/Overhead squat (BB/DB options)	Shoulder musculature, upper back, quadriceps	Essential for mastering power snatch. High level of shoulder mobility required for proper execution.	Weightlifting, basketball
Jump squats	Quadriceps, gluteus maximus, hamstrings, spinal erectors	Enhances explosive power	Basketball, gymnastics, diving, field events (high jump, long jump)
Stability Ball Wall squats	Quadriceps	Beneficial for athletes while rehabilitating from injury or novice squatters learning movement	Postinjury rehabilitation
Hack squats	Quadriceps	Reduced load placed on lower back	Football, rugby, bodybuilding
Isometric squat	Gluteus, quadriceps	Can be used to increase strength at the weakest point in ones squat movement	Wrestling, powerlifting, rugby
Lateral squat	Hip adductors, quadriceps, gluteus maximus	Increases hip mobility and strength in frontal plane	Hockey, speed skating
Drop squat	Quadriceps, gluteus maximus, hamstrings	Used to teach athletes proper landing position while jumping	Basketball, volleyball, football

BB = barbell; DB = dumbbell; KB = kettle bell.

BSq, FSq, and military press elicited similar levels of rectus abdominus activity. It must be noted that all dynamic exercises were performed at a constant absolute load (40 kg). This may limit the application of the results because athletes usually train at a relative load for each particular lift (i.e., 40, 60, 80% 1RM). This is a major consideration before freely applying such a protocol to athletic populations.

Russell and Phillips (37) examined the effects of the BSq versus FSq on both low back injury risk and knee extensor moments. Results indicated that trunk inclination, rather than type of squat, influenced the risk for low back injury. Interestingly, the demands placed on the knee extensors did not differ between either squat variation. However, the study by Russell and Phillips has been criticized for design flaws (19); most notably that participants used the same absolute load, 75% of FSq 1RM, for both lifts. Additionally, the authors did not actually collect electromyographic data and document muscle activity. Rather, data analysis was based on breaking the human body down into a 5-link model that allowed investigators to estimate maximum knee and trunk extensor moments as well as vertebral stresses.

Finally, it is also suggested that FSq may also be a better option than BSq in those individuals who present with anterior shoulder instability issues (17). When performing a BSq, the shoulder is placed in an abducted and externally rotated position to hold the bar. This position is commonly referred to as an “at risk” position for those with glenohumeral ligament laxity (21). In contrast, while completing the FSq, the shoulders remain relatively neutral in the frontal plane and external rotation is kept at a minimum (approximately 15°) (17).

THE FRONT SQUAT AND ITS ROLE IN ATHLETIC DEVELOPMENT

From an acute athletic perspective, there is interest in increasing muscular performance after a resistance exercise, which may be attributed to a postactivation potentiation (PAP) effect (11).

Thus, researchers have examined if one can improve sprint performance, via the PAP effect, after various squat variations. This question was examined by Yetter and Moir (40), who on 3 separate occasions had 10 physically active men complete 40-meter sprint trials preceded by a control condition (4-minute walk), BSq, or FSq protocols that consisted of 5 reps at 30% 1RM, 4 reps at 50% 1RM, and 3 reps at 70% 1RM. In comparison with the control condition, results indicated that the BSq led to faster speeds during both the 10- to 20-meter and the 30- to 40-meter intervals. Improved sprint performance was not observed after the FSq condition. However, the inability of the FSq to elicit a PAP may be load dependent. Determination of FSq 1-RM (113.8 ± 25.7 kg) was a calculated load equivalent to 80% of the directly measured BSq 1-RM (142.2 ± 32.1 kg), and this provided lower loads used during the FSq (30%: 34.1 ± 7.7 ; 50%: 56.9 ± 12.9 ; and 70%: 79.6 ± 18.0 kg, respectively) compared with the BSq (30%: 42.7 ± 9.6 ; 50%: 71.1 ± 16.1 ; and 70%: 99.5 ± 22.5 kg, respectively).

The authors concluded that the lower loads used during the FSq may have limited the activation levels of the hip extensors and therefore the possible PAP effect (40). Thus, more research must be completed in this area to draw firmer conclusions on the PAP effect of the FSq on various performance measurements (38), with loading calculated directly from FSq 1-RM.

Looking at the long-term application of the FSq to an athletic preparation program, Hedrick and Wada (23) highlight that for many athletes, enhanced speed strength capabilities (i.e., power development) is the primary physiological characteristic determining successful athletic performance. Research has indicated that 1RM totals in the weightlifting movements positively correlate with various speed strength skills, such as sprinting (25) and vertical jump power (3). Additionally, hang power clean performance positively correlates ($r=0.39$; $p<0.05$) with FSq 1RM (25). This makes sense

because the mastery of the FSq assists in the development of the necessary strength and body positioning required for receiving the bar at the shoulders in the power clean and for the vertical acceleration that occurs when completing the Olympic-style lifts and related movements (39). Collectively, this indicates that the FSq plays a vital role in the development of speed strength, which is an essential characteristic required for athletic performance. It has been suggested that the FSq is of equal effectiveness as the BSq in developing speed strength skills. Peeni (35) divided 18 Division I collegiate volleyball players into 2 comprehensive 8-week lifting programs that differed only in the method of squatting (FSq versus BSq). Although both groups demonstrated a significant increase in counter-movement vertical jump height (FSq: 6.1 ± 3.9 cm versus BSq: 4.7 ± 5.6 cm) at the conclusion of the study, no significant differences were reported between groups. The authors concluded that the FSq may be a more suitable exercise because it results in similar performance benefits combined with potential safety benefits (ability of the lifter to release the bar during missed lifts) compared with that of the BSq.

The role of the FSq in the enhancement of athletic performance is further supported by Hori et al. (25) who examined the relationship between FSq and physical performance measurements in 29 Australian Rules football players who had incorporated the lift as part of their off-season training program. In comparison with those with lower 1RM in the FSq, athletes with higher FSq 1RM had faster times in both sprint and agility tests, along with higher power outputs during weighted squat jumps. Although this is not a cause and effect relationship, these results suggest that higher 1RM FSq may be associated with greater athletic capabilities. The integral role that the FSq has in developing the hang power clean and athletic performance is supported by additional research (15,26). Optimizing FSq technique and obtaining the subsequent benefits requires correct coaching (8,36).



Figure 1. Set position for the front squat.

TEACHING COMPONENTS

The following brief overview provides explanation for the teaching components of the FSq.

1. *Setup:* The stance is similar to that of a BSq. With a pronated grip, grasp the bar at a width equal to or slightly outside of the shoulders. The upper arm should be approximately parallel to the floor, and the bar should rest above and behind the anterior deltoids and upper clavicle region (Figure 1). If the athlete lacks the wrist or shoulder flexibility to hold the upper arm parallel to the floor, stretching the triceps, posterior deltoids, and the entire shoulder girdle will improve range of motion. Until the athlete develops adequate flexibility in the shoulder, elbow, and wrist joints, lifting straps can be used to assist in emphasizing elbow position. When using lifting straps, the palms will stay in a neutral position throughout the lift (Figure 2). The core should be braced throughout the entire lift to maintain the natural s-shaped curve of the spine (31). Note that during initial coaching of the FSq in novice lifters, the athlete may benefit by performing the lift in front of a mirror, thereby allowing him/her to receive



Figure 2. Front squat performed with lifting straps.

instantaneous visual feedback on squatting mechanics. However, once mastered, it may be preferable to have the lifter FSq without the assistance of a mirror, thus forcing them to rely solely upon kinaesthetic awareness similar to how they would in normal sport competition.

2. *Execution:* The descent of the FSq should be initiated by pushing one's hips behind them while flexing at the knees, which is often termed "sitting back" (6). As the hips descend, the knees should move anteriorly in the same plane as their

feet. The weight should be distributed from the balls of the foot back toward the heel. The entire foot should stay in contact with the ground during the lift. To maintain a neutral spine during the movement, the athlete's upper arm should remain parallel to the floor and their core braced (9). Additionally, the eyes should be focused straight ahead (12) to help prevent rounding of the lower back. Based on the experience of the authors, an athlete should not gaze excessively upward during the movement because this



Figure 3. Bottom position for the front squat. The elbow remains parallel to the floor.

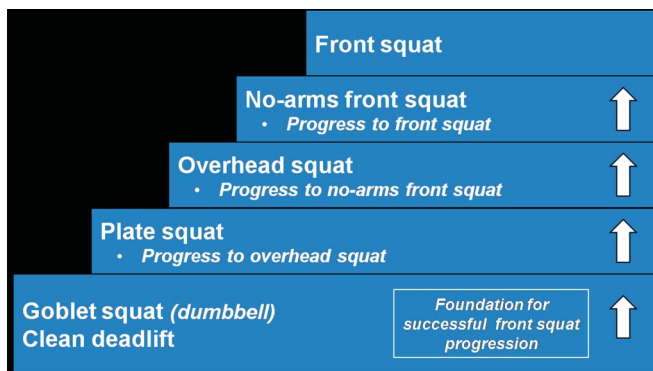


Figure 4. Four-step teaching progression for the front squat. The goblet squat and clean deadlift provide the foundation for successful exercise progression. Adapted from Chiu and Burkhardt (7).

may limit maximum squat depth while lifting heavy loads. The eccentric portion of the lift concludes when an athlete is unable to sink any lower without compromising form (i.e., losing their neutral spine, losing heel contact with the ground) (Figure 3). Upon reaching this “bottom” position, the athlete should consciously accelerate or “fire out of the hole” as fast as possible while still maintaining proper form (33).

3. **Common mistakes:** When first learning the FSq, a common mistake seen in athletes is the lifting of their heels off the ground (8). In doing so, the load shifts from major muscle groups of the lower body onto the

ligaments within the knee joint (40). Also, the inability to keep the knee in the same plane of motion as the foot (i.e., allowing the knees to cave inward) adds increased stress to the knee joints. The athlete should resist rising up onto his/her toes upon finishing the lift because this could lead to a loss of balance, especially while lifting a heavy load. Other common errors include allowing the elbows to rotate toward the ground (i.e., not keeping the upper arm parallel to the floor) and rounding of the back. These technique flaws lead to excessive stress placed on the knee, spine, and wrist joints, increasing the risk of injury.

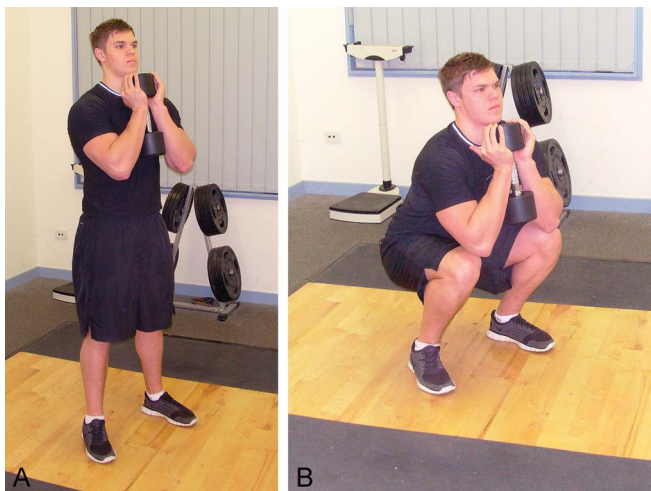


Figure 5. (a) Goblet squat start. (b) Goblet squat finish. Key point: The trunk position throughout the goblet squat creates an upright posture during the downward motion.

4. **Teaching progression:** Interestingly, although the squat exercise is extensively taught by strength and conditioning coaches, there are few published teaching progressions (7,18). Most recently, Chiu and Burkhardt (7) presented the 4-step progression model. Because of the importance of developing correct body positioning required for the FSq, we have adapted the 4-step progression model (Figure 4) to assist athletes who demonstrate an inability to maintain correct body positioning throughout the squat movement. The inclusion of the goblet squat and clean deadlift are considered foundation exercises in the progression because both movements develop correct body positioning. Once athletes have mastered the squat movement pattern of the goblet squat (Figure 5) and developed the correct body positioning in the clean deadlift (Figure 6), they are ready to move onto the next progression in the model, that being the plate squat (7).

VARIATIONS

As with all exercises, there are several variations that can be applied to the squat. Waller and Townsend (41) present 4 variations of the FSq, highlighting the variability of this exercise. Other examples of squat variations include:

1. **Bar position—snatch overhead squat.** In contrast to the FSq, the snatch squat is completed with a wide grip and overhead bar position. Similar to the relationship between the FSq and hang power clean, the snatch squat prepares the lifter for catching the bar during the power snatch.
2. **Equipment—dumbbells/unstable platforms.** The use of dumbbells, rather than a barbell, presents a novel stimulus to the lifter, forcing the upper extremities to work independently while upholding the weight. Such application emphasizes activation of the anterior and posterior oblique slings, which are active components in the pelvic stabilization system linking the hip to the shoulder girdle



Figure 6. (a) Clean deadlift start. (b) Clean deadlift finish. Key point: Establishes strong set position from the floor with the bar close to the shins and shoulders slightly forward.

(oblique abdominal/pectorals; gluteus maximus/latissimus dorsi) (28). The setup for a dumbbell FSq is similar to that of FSq with straps described earlier. However, rather than holding onto the straps, one is holding onto the dumbbell handles.

3. *Stance—single-leg emphasis.* Various squats exist with single-leg emphasis (single-leg squat, Bulgarian squat). The common theme with each single leg squat variation is that it increases activation of the abductor and adductor muscles that stabilize the hip joint. This will allow the strength and conditioning coach to observe for compensatory movement patterns and/or bilateral strength deficits, which are often present due to muscular imbalances throughout the kinetic chain.

CONCLUSION

Due to its ability to develop total body strength and potential for enhancing athletic performance (25), the squat is a fundamental exercise and part of the “big three” exercises prescribed by strength and conditioning coaches. The FSq variations discussed represent advanced functional application that target and engage the posterior chain segment of the hips, buttocks, and hamstrings. Athletes require significant core strength, well-developed squat technique, and sound unilateral balance. For the athlete wanting to develop speed

strength and increase power output, the FSq and variations are essential components of a training program. Upon mastering the FSq, an athlete’s ability to develop the correct body positioning required for the Olympic-style lifts is greatly enhanced (14) because this is often the limiting factor resulting in failure to obtain the correct catch position of the hang power clean. Through mastery of the FSq, the athletes maximize their athletic performance potential (5), transferring their athletic abilities from the training floor to the field.



Stephen P. Bird is a senior lecturer in the School of Human Movement Studies, Charles Sturt University and Coordinator of the Western Region Academy of Sport Strength and Conditioning Internship Program.



Sean Casey is the president of CasePerformance.

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