Squats in Detail

Introduction

Squatting comes in many guises:

- Functional, every day life squatting tasks
- High bar back squat
- Low bar back squat
- Front Squat
- Overhead squat
- Goblet squat
- Split squat
- Spanish squat
- Zercher squat
- Pistol squat…

…to name but a few!

Covering technique for every version out there would be a long article! However, there are some common considerations and technique points that as a PT, you will need to be aware of. This article seeks to give you the key pointers. It is not a diagnostic tool, but it will help you understand what is happening in a client's squat movement better.

The physiology

The squat is primarily a knee and hip extensor exercise. However, it also strengthens the trunk. The following is a list of muscles utilised during the movement in both concentric and eccentric phases:

- Quadriceps – knee flexion/extension
- Gluteus Maximus – hip flexion/extension
- Gluteus medius (posterior fibres) – hip flexion/extension and hip internal/external rotation
- Hamstrings – hip flexion/extension
- Erector spinae – spinal extension and pelvic stabilisation
- Latissimus dorsi – spinal extension and pelvic stabilisation
- Adductors (magnus, longus, brevis, minimus) – assist with hip flexion/extension and pelvic stabilisation
- Abdominals and core – spinal and pelvic stabilisation

Squatting is often referred to as a 'triple extension' exercise. Extension at the knee's and hips is obvious. The third type of extension is at the ankle. Extension at the ankle is usually called 'dorsi flexion' in the UK… but we have been americanised!

The squat 'model' movement pattern

There is much debate about what forms correct squat technique. There is a 'model' movement pattern for the squat that is both biomechanically efficient and safer to use than any other. However, it should also be noted that there is not one optimal technique for all clients in all situations – we all have different anatomy and physiology and different objectives for squatting. Squat movement patterns that are a shift away from the 'model' may well be a compromise of either mobility, or the requirement to exert a particular force in a specific way – but that does not always make them 'wrong'!

4 key points for 'model' movement:

1. Squatting should be a 'simultaneous and equal folding of hips and knees'.

   A squat movement pattern is pretty specific. In order to do it correctly, both the hip joints and the knees joints should be flexed virtually simultaneously and at the same rate in the descent, and likewise, extended virtually simultaneously and at the same rate in the ascent. A slight break at the hips prior to the knees is sometimes recommended in order to fully engage the (usually stronger) posterior chain before the descent commences.

2. The bar should rise at the same rate as the hips. Whatever squat technique you use, the bar (or any other load) should rise at the same rate as the hips. Ie, there should be no dissipation of force that is being produced through the legs before it reaches the load.
3. The goal in most squat variations should be to keep the load as close as possible to the client's Centre Of Gravity (COG) in order to maintain balance and the ability to exert maximal force. Keeping the load centred over the COG will also minimise forces at the knees and the lower back.
4. The maximum depth of the squat should usually be a point at which the hip is at or preferably below the knee. The greater depth a squat is performed to, the more active the gluteus maximus muscle becomes. Given the importance of this muscle's function, it therefore makes sense that the goal for most people should be to descend to their greatest safe depth.

3 squat myths:

1. Knees shouldn't go forward of toes.

   Functional movement, whether it is for every day life or for a specific sport, more often than not means that the knee of a client will go forwards of toes during a deep squat. Therefore, it makes sense to train in a similar movement pattern. Pushing knees beyond the toes will however result in an increased shearing force

through the knee joint that we should be aware of – especially for those with a history of knee injury or for those clients with a limited training age.

If forwards motion of knees is inhibited, in order for a client to reach the goal depth of hips below knees, an increased anterior trunk lean must occur as they push their hips backwards. Increasing the trunk lean will increase the torque present in the lumbar spine, potentially increasing injury risk at that point.

It therefore makes sense to allow knees to go somewhat forward of the toes, whilst also allowing a moderate forward lean – dissipating the forces evenly over the joints. A 'rule of thumb' is that shin angle should equal trunk angle when viewed from the side.

2. Don't squat beyond 90 degrees.

   It is often said that squatting deeper than 90 degrees (at knee) will likely cause injury to the knee joint. In fact, if appropriate movement pattern and general conditioning work is undertaken prior to heavy loading, and if biomechanics are considered, then there is no increased injury risk. In fact, squatting beyond 90 degrees is a knee strengthener!

3. There's a perfect width stance.

   Is there a 'one size fits all' when it comes to squat stance width? No, categorically not – it depends what type of 'functionality' you want and what your personal limitations are:

   - The function/purpose of a squat will influence exactly how you perform a squat movement pattern, for example:
     - When picking a baby up off the floor, a wider stance may be appropriate.
     - When coming out of a receiving position in an Olympic lift a narrower stance may be preferred.
     - When powerlifting, it is common to see a wider stance.
   - Your mobility will greatly influence how you move – especially when performing a squat. A lack of mobility will require us to adapt out client's movement around their limitations. That doesn't mean that their prescribed movement pattern will be optimal though – it will still be compromised and we should aim to increase our client's mobility.
   - A person's specific anatomy can also play a role in their squat movement pattern. Particular considerations include:
     - The shape of the hip socket (acetabulum). Some hip sockets are shallow, some deep. Some hip sockets are more open at the front (allowing a more 'knees forward' movement), some more open laterally, (allowing a more 'knees outward' movement). The shape of a hip socket is therefore going to alter the width of a stance that a client is most comfortable in when squatting.
     - The length of a client's femur, relative to their trunk length, will greatly influence squat stance and external rotation requirement of

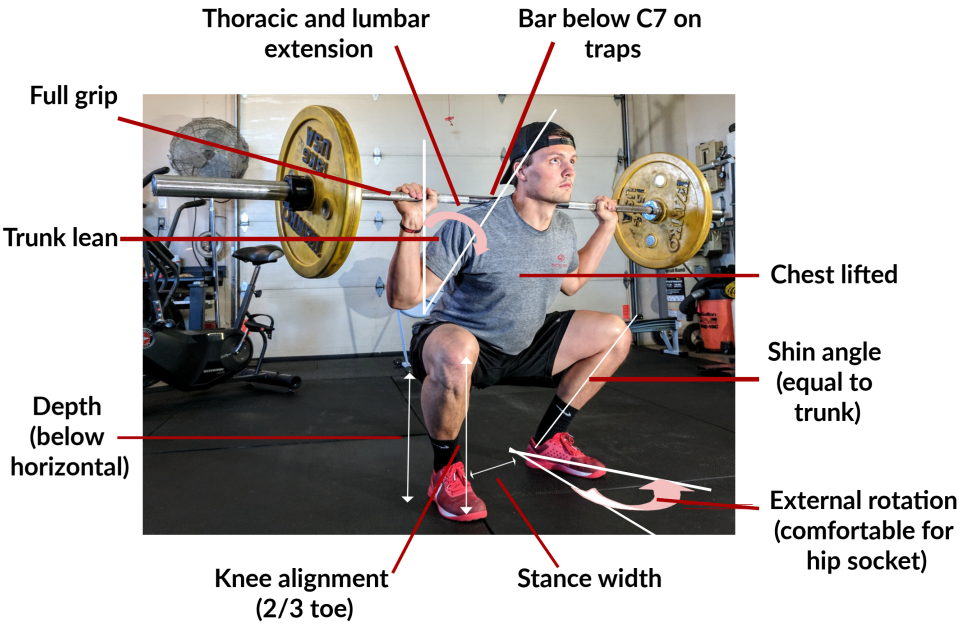
the hip. Longer femurs will usually require more external rotation and a wider stance in order to reduce the acuteness of joint angles at depth.

Usually, more weight can be lifted in a wide stance squat compared to a narrow stance squat. This is because of a combination of reduced acuteness of the joint angles and the accompanying lowered torque requirement. However, a wider squat stance often comes with an increased propensity for knees to fall in (valgus) during the descent.

Squatting in a narrow stance may increase the injury risk at the knee and lower back for three reasons:

- Joint angles at both hips and knees would be more acute in order to reach depth, causing increased torque and shearing forces.
- As depth is increased in a narrow stance squat, there is a risk that the client's lower leg musculature (gastrocnemius and soleus) would cause a 'cantilevering' effect between the tibia/fibula and femur, effectively splaying the knee apart.
- Structural limitations in the skeleton may cause flexion of the spine.

Outline of 'model' squat technique



Phase	Description	Common problems	Variations/solutions
Start position	Hands evenly spaced just wider than shoulder width on the bar.	Unable to grip bar due to poor shoulder external rotation.	Widen grip until comfortable. Work on shoulder external rotation capability.
	Bar positioned just below C7 across upper trapezius and rear deltoids (high bar).	Pain across neck where bar is positioned.	Ensure bar is positioned correctly. Lighten load. The use of a pad is not recommended due to potential movement of the pad during the lift.
	Client in full extension with all supporting muscles contracted for stability prior to descent.	Unable to hold fully extended position.	Ensure that the client has no spinal pathology that limits ability to extend thoracic and lumbar spine. Check that client has correct posture without load.
	Feet are positioned just outside of shoulder width with feet slightly externally rotated	Stance does not allow full depth to be made. Width of stance causes knee valgus.	Allow client to experiment with stance without load in order to find a comfortable width stance that does not cause excessive trunk lean or knee valgus. Appropriate internal/external rotation and abduction ROM tests can be performed to ascertain likely 'ideal' stance.

Descent	Client takes a breath in and braces at start.	Client becomes light-headed.	Do not use this technique if client feels dizziness or has a history of blood pressure issues (hyper/hypo tension)
	Hips are flexed marginally before knees allowing posterior chain to be activated.	Client unlocks knees first.	Client should be coached to push hips backward to initiate the squat movement.
	Hips and knees flexed at a similar rate until hip is lower than knee or femur is parallel with floor.	Hips flex quicker than knees causing a forward lean of the trunk.	Movement pattern should be addressed before heavy loading. This may includes testing for ROM. A wider stance may be used.
	Full foot is in contact with the floor throughout the descent.	Heels come off floor.	Check ankle ROM. Widen stance, externally rotating feet as stance is widened. Raise heel by use of weightlifting shoes or ramps
	Knees go beyond toes in the sagittal plane and maintain alignment of $2^{nd}/3^{rd}$ toe in frontal plain.	1. Knees do not go over beyond toes in sagittal plane. 2. Knees go too far forwards of toes. 3. Knees go valgus.	1. Check ankle mobility. 2. Movement pattern should be addressed. 3. Check for foot eversion and ankle restrictions. 3. Client may have tight adductors, therefore stretch. 3. Client may have

			weak abductors therefore lighten the load.
	Client maintains an appropriate anterior trunk lean throughout the movement maintaining lumbar lordosis and thoracic extension.	1. Excessive trunk lean. 2. Lumbar spine flexion. 3. Thoracic spine flexion.	1. Check for ankle restrictions. 2. Check for hamstring/glute tightness. 2. Check if client can anteriorly and posteriorly tilt pelvis in an unloaded situation. 3. Client may have weak back extensors therefore lighten the load. 3. Encourage client to keep chest up and elbows under the bar.
Ascent	Knees and hips extend simultaneously.	Knees extend first.	Relative imbalance in back/hip extensor strength compared to knee extensor strength. Lighten load.
	Knees maintain alignment over $2^{nd}/3^{rd}$ toes in frontal plane.	Knees go valgus.	Not as big a problem as during the descent, but client should be instructed to maintain alignment by actively pushing knees apart to fully utilise glutes.
	Hips raise at the same tempo as the bar.	Hips rise first.	Client has relative hip extensor weakness. Lighten load.

	Lumbar and thoracic extension is maintained.	Lumbar and thoracic flexion.	Load is too heavy. Lighten load.
	Bracing is maintained throughout the lift. Breath is held until final moments of the movement.	Bracing and or breath released too early.	Coach bracing and breath control.

Outline of other squat techniques

Variation	Additional coaching points to the 'model'	Common problems	Variations/solutions
Front squat 	Bar racked on anterior deltoids	Bar sits on clavicle	Increase mobility through shoulder girdle so that more protraction can take place. Failing that, use 'arms crossed' method.
	Hands grip just wider than shoulder width with a full grip if possible, or open hand if not.	Full grip cannot be taken whilst maintaining arm position.	Increase wrist and shoulder mobility.
	Elbows should be as high as possible with upper arm almost parallel to floor. Upper arms should point forwards.	Elbows are dropped and at an angle	Stretch latissimus dorsi and practice shoulder flexion.
	Maintain an upright trunk throughout lift.	Upper back flexion.	Work on thoracic extension. Strengthen upper back. Reduce load.

Overhead squat 	Grip the bar in snatch grip width (bar should be level with pubis bone when stood at full extension)	1. Bar too high up into abdomen. 2. Bar too low.	1. Narrow grip. 2. Widen grip.
	Bar pressed into overhead position with elbows locked and shoulders internally rotated to engage trapezius fully.	1. Elbows flexed 2. Shoulders not internally rotated	1. Reduce weight. 2. Work on shoulder internal rotation.
	Bar is maintained over mid-foot (COG) during both descent and ascent	1. Bar comes forward of mid-foot during descent. 2. Bar comes back of mid-foot during descent.	1. Work shoulder mobility. 2. Strengthen rotator cuff muscles. 2. Train movement pattern.
Goblet squat 	Weight is held against chest	Weight drops.	Lighten load.
	Hips and load rise at same rate	Hips rise first.	Lighten load.
Split squat 	Rear foot is raised up onto a bench or box.		
	Width of split depends upon intention of exercise – but shorter split causes more stress through patellar tendon due to increased	1. Client's front knee feels uncomfortable /pain. 2. Client's back goes into hyperlordosis/ client's hip	1. Lengthen stance or do not do exercise if pain persists. 2. Shorten stance.

	knee angle. Longer split requires more hip extension on rear leg.	flexors are uncomfortably stretched.	
	Knee alignment and stability should be maintained throughout the movement.	Knee stability is compromised.	Coaching cues given to stabilise foot contact with ground (tripod foot) and to focus on knee tracking.
Spanish squat 	Client's bodyweight is loaded behind the knees and vertical with hips. Some forward trunk lean is ok.	Client cannot maintain trunk position.	Potentially this exercise is too hard for client. Find an alternative or reduce depth.
	Client descends to beyond horizontal femur.	Pain in patellar tendon.	Do not do exercise.
Zercher squat 	Bar is held in the crook of the elbow when elbows are flexed to 90 degrees and supinated.	Pain in elbow where bar sits.	Reduce load.
Pistol squat 	Knee alignment and stability should be maintained throughout the movement.	Knee stability is compromised.	Coaching cues given to stabilise foot contact with ground (tripod foot) and to focus on knee tracking. Use a suspension trainer for added stability.