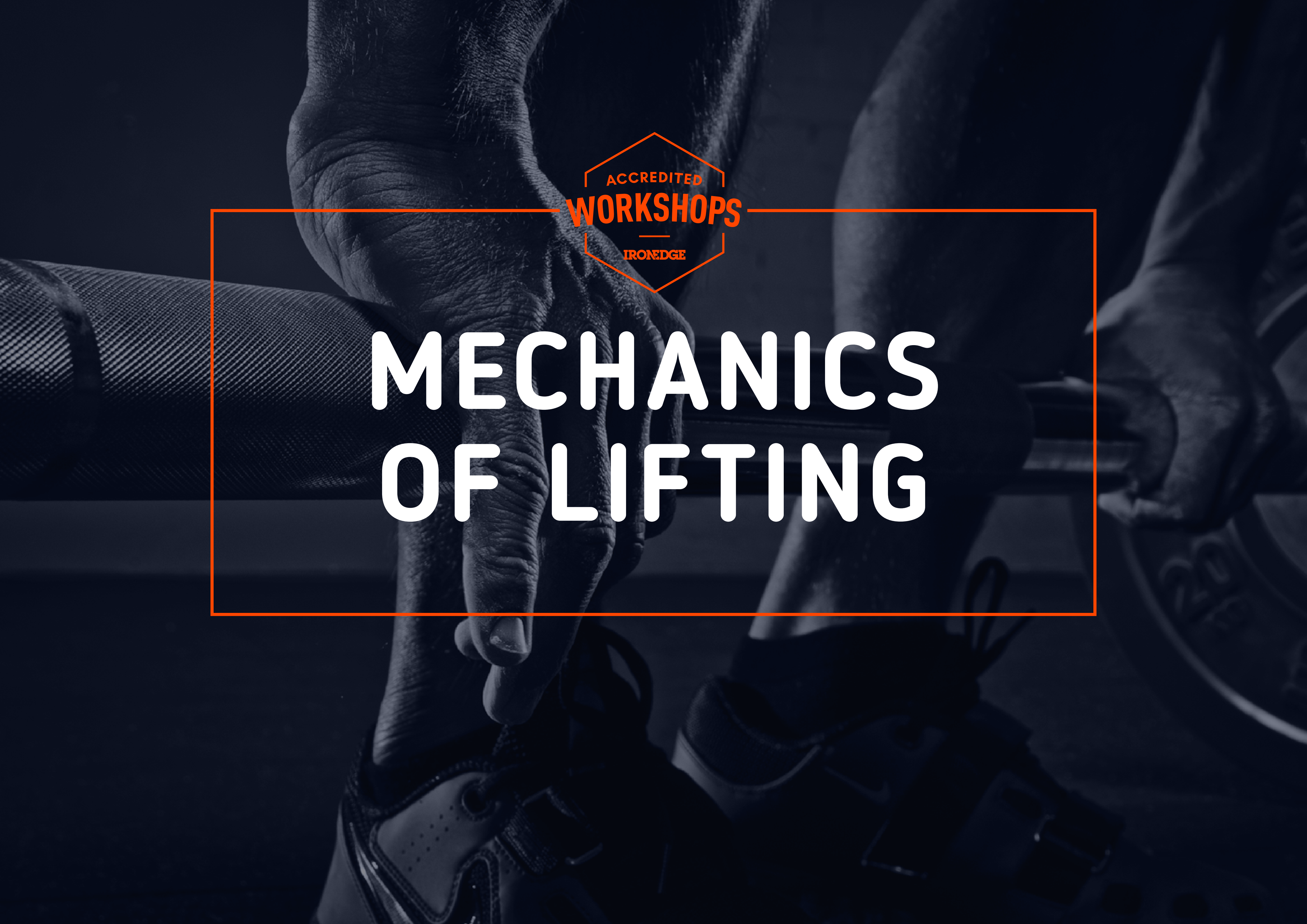


ACCREDITED WORKSHOPS

IRONEDGE

MECHANICS OF LIFTING

This manual will supplement and build further upon concepts that arise from the Iron Edge Mechanics of Lifting Workshop. It is designed to be used as an ongoing reference point and will delve into detail surrounding the theory and concepts learnt within the workshop.

AIMS OF THE MECHANICS OF LIFTING WORKSHOP AND MANUAL:

- Provide a basic introduction to mechanical principles and its relationship to human movement
- Relating daily activities to training methods and recognising how mechanics can assist with movement and reduce injury risk
- Teach participants how to recognise and relate biomechanical principles to their training of the human body
- Provide guidelines for obtaining proper lifting mechanics
- Teaching how faulty mechanics can lead to detrimental consequences, and how to correct positional faults that limit efficient training
- Teaching participants how mechanics can change with various movements, and how to maintain proper mechanics at all times throughout a lift
- Teaching proper mechanics, technique and coaching cues across a variety of lifts

SAFETY PRECAUTIONS

Safety should always be the first priority when teaching lifting techniques. To enhance safety and reduce risk of injury, ensure the following points are met:

1. Always ensure you have sufficient room for performing various lifts, away from any hazards or obstacles
2. Always ensure close supervision of all lifts, especially for beginners. When technique breaks down in any exercise, stop the exercise to reduce injury risk.
3. Always begin with a bodyweight (or use a dowel) to teach movement patterns and screen clients for appropriate range of motion, and ensure technique is sound before adding external load.
4. If pain occurs at any time - STOP the exercise and seek treatment
5. Ensure breathing technique is learnt and executed before heavy lifting

WHAT YOU WILL GAIN FROM THIS COURSE

After completing the Iron Edge Mechanics of Lifting course, you will have a introduction level understanding of the mechanical aspects of lifting and how to relate these to training your clients.

It is your responsibility as a trainer to instruct safe exercise routines, and to put methods in place that will provide the best chance of performance gains for those who you train. This workshop will teach you how to analyse movement, with the aim of reducing injury risk and outlining how to modify movements in particular ways to maximise desired results.

The relationship between various segments of the body, and the effect of movement at one joint has on movement at another, will be discussed and you will learn how to correct common flaws in certain exercises. Overall, the workshop aims to provide the basis for you to extend your learning and maximise your potential as a trainer.

This is your first step in the process of making yourself a more efficient and skilled trainer. With the education gained from this course you will be perfectly placed for all future Iron Edge workshops, and become one of the most knowledgeable, sought-after trainers in the gym.

CONTENTS

INTRO TO BIOMECHANICS

The human body is designed to move. The combination of soft tissue structures, the skeletal arrangement and joint configuration form a functional basis for challenging the physical abilities of what humans can achieve. The ability to move fluidly in an efficient, coordinated pattern can limit injury risk and enhance one's physical capabilities. To do so requires an understanding of how the movement is occurring. Whether it be in a sporting context, in a training environment or in daily activities, knowledge and recognition of proper movement patterns will aid and assist an individual's ability to successfully perform a variety of tasks.

Techniques used in training will ultimately define the resultant adaptations, therefore the mechanics of various lifts are imperative to learn and understand. The mechanics that we lift with will dictate muscle activation, as different joint angles and movement patterns stimulate contraction of muscles in particular ways. Optimal mechanics and movement patterns will have many beneficial outcomes in terms of muscle development and functionality, whereas faulty mechanics can increase injury risk[2].

WHAT ARE BIOMECHANICS?

Biomechanics involve combining mechanical concepts of motion to biological scenarios, and is often used to explain human movement[3]. Biomechanics have long been studied and developed in an effort to improve sports and physical performance, with successful results.

For the purpose of this manual, lifting mechanics will be defined as relating the mechanical aspects of movement to a resistance training setting. You should be thinking about treating your body as a machine, and therefore apply mechanical thoughts to the movement of your body and those of whom you train for performance gains and safety.

WHY IS IT IMPORTANT FOR TRAINERS TO UNDERSTAND?

Biomechanical considerations do not just relate to lifting movements, but should be respected and adhered to in all activities. It is extremely important for coaches, personal trainers and lifters to understand and appreciate lifting mechanics and their effect on lifting performance. If one does not understand how a movement occurs, or how a simple positional modification at one point can affect force at another point in the kinetic chain, such as ankle flexion on knee angle, then one cannot prescribe training effectively as the training adaptations are not being controlled.

Furthermore, the safety implications of poor lifting mechanics can be substantial. Where proper technique and optimal mechanics will enhance an individual's ability to perform tasks, incorrect movements and poor posture whilst lifting can be extremely detrimental and dangerous to an individual[2,4]. Injury risk increases greatly with improper mechanics due to increased loads on the body and high stress at joint locations[5].

FUNDAMENTAL BIOMECHANICAL PRINCIPLES

This section will introduce various biomechanical principles and relate them to human movement. As noted, this manual is simply a beginner's guide to biomechanics and aims to encompass the most critical aspects of biomechanics that may concern you in your time working with clients.

Biomechanical principles relate to all types of movement, whether it be in the gym or in daily life, therefore it is important to have an understanding of a number of concepts. You will often find you are aware of and implementing certain biomechanical ideas in your training and life already.

1. Lever Systems
2. Moment Arms
3. Work, Power and Energy
4. Force/Velocity Curve
5. Types Of Force
6. Stability
7. Kinetic Chain

LEVER SYSTEMS

A lever is simple mechanical machine, made up of a rigid structure that can be made to rotate around a pivot point[6]. The class of lever is determined by the position of the pivot point in relation to a resistance and an applied force. Humans display all three classes of levers within the body with different movements, with the muscles applying force that creates movement of a bone (rigid structure) around a joint (fulcrum).

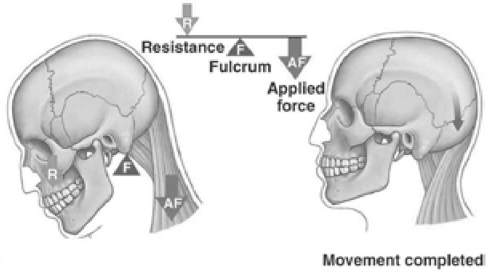
First-class levers involve the fulcrum positioned in between the applied force and the resistance, as it is in a pair of scissors. Relating this to the human body, maintaining head position requires the posterior trapezius muscles to produce a force to lift the resistance (the anterior skull), using the atlantaoccipital joint as the fulcrum[7].

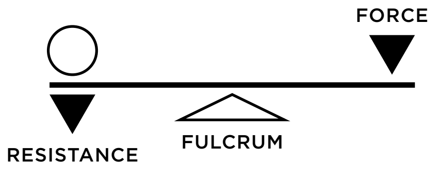
Second class levers involve having both the resistance and the applied force on the same side of the fixed pivot point, with the resistance closer to the axis point than the applied force. For example, in plantarflexion the toes act as the fulcrum, the weight of the foot the resistance whilst the gastrocnemius applies force to lift the heel off the ground.

Third class levers are the most common occurring lever in the biological system and again involve the resistance and applied force on the same side compared to the fulcrum, but in this case the applied force is closer to the pivot point than the resistance. A clear movement example of this occurring in the body is the bicep curl, as the elbow joint provides the pivot point, the biceps attaching on the forearm create the force and the load held in the hand acts as the resistance.

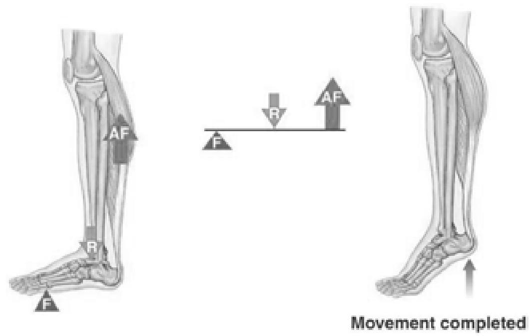
Recognising the various types of levers are important in human movement as it will lead to a greater understanding of how the body moves, and what forces are being applied in relation to the resistance.

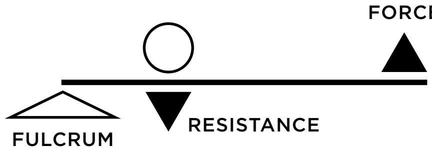
FIRST CLASS LEVER



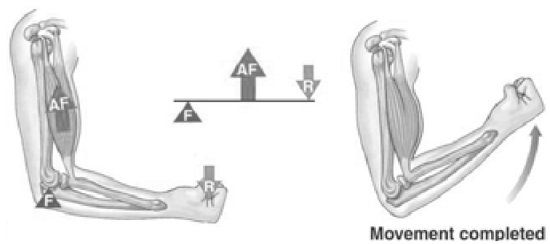


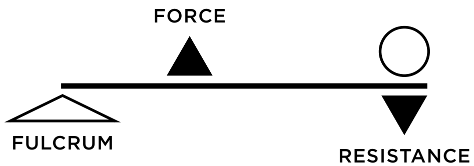
SECOND CLASS LEVER





THIRD CLASS LEVER

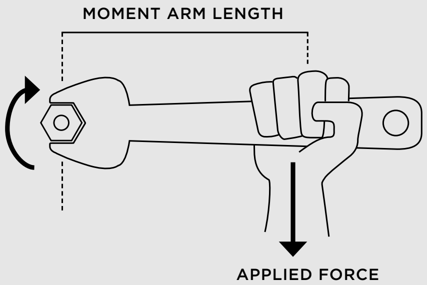




IRONEDGE

MOMENT ARMS & LINE OF FORCE

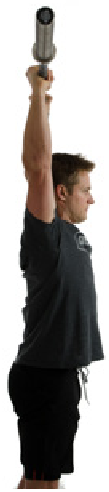
TORQUE = Force x Moment Arm Length



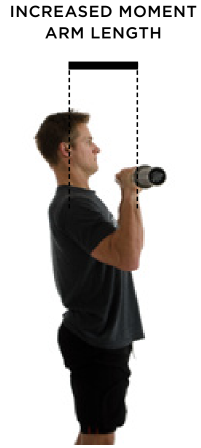
Moment arms are another important biomechanical aspect to consider, especially when discussing levers and force. The moment arm is defined as the perpendicular distance between the axis of rotation and the line of action[6]. In the human body, moment arms could be described as the distance between the muscle and the centre of the joint[3]. In some cases it is beneficial to keep the moment arm short, however in other scenarios a longer moment arm can create greater force production. An increased moment arm length means greater load is applied through the joint axis. This can be observed through the equation for torque, which describes the rotary effect of a force about an axis of rotation[6].

A relatively short moment arm is effective for heavy weights in the overhead press. With a heavy bar, it is more desirable to minimise the length of the moment arm as this makes the movement more efficient[8]. This can be done by starting the bar close to the axis of rotation (shoulder girdle) and pressing directly vertical. If the moment arm was increased, via starting the bar away from the shoulder and pressing the bar out away from the body in a curved bar path, there must be a reaction from the body to counteract this force and the back would move backwards as a reaction to maintain the centre of mass over the base of support[8]. This leads to an inefficient movement, increasing stress on the shoulders, back and wrists.

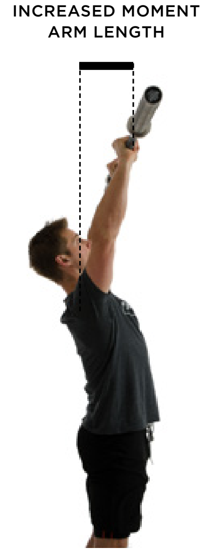
1A: CORRECT START POSITION FOR OVERHEAD PRESS



1B: CORRECT FINISHING POSITION



2A: STARTING THE BAR OUT FROM SHOULDER



2B: FINISHING THE BAR OUT FROM SHOULDER LEANING BACK

As you can see, the efficient overhead press minimises the length of the moment arm, through a vertical bar path. Starting the barbell close the body (1A) allows for this vertical path and creates a more biomechanically efficient position as the bar is closer to the centre of mass.

The inefficient bar path results from lengthening the moment arm at the starting position (2A), which forces the bar away from the body when pressed overhead. As you can see (2B), the back of the lifter has too lean posterior to counteract the weight of the barbell in front of the body.

Generally in the weight room, increasing the moment arm length would be a hindrance to performance. However there are cases in movement where maximising moment arm length may be advantageous for clients or athletes. In sports-specific movements it is often valuable to increase the moment arm as this will generate greater lever length and in turn generate greater force production. An example of this would be in golf, where the club forms an extension of the physical lever and therefore the perpendicular distance between the line of action and the joint axis (shoulder) is greater, to allow for more torque.

WORK, POWER & ENERGY

From a mechanical standpoint, these are three important terms to be aware of which will assist in understanding the mechanical properties of movement.

WORK

In mechanical terms, work refers to the amount of force applied against a resistance multiplied by the change in distance travelled. It is important to distinguish between 'mechanical work' (being described here) and a workout, or the feeling of hard 'work'[6]. In most cases, a lifter will perform 'mechanical work' on a barbell, moving it from point A to point B. Mechanical work only occurs when an object is moved from its original position. Therefore when an isometric contraction occurs, where there is muscle activation and co-contraction of agonist and antagonist muscle groups but no change in muscle length occurs, mechanically there is zero work being performed due to zero change in distance of the segment lengths.

POWER

The extension of mechanical work is power, which describes the average magnitude of mechanical work over a period of time[3,6]. This allows for a better understanding of the actual movement, not just the force produced. Work is equal to force multiplied by distance, therefore power can be increased by improving force output (training at high resistance) or decreasing the time taken to perform the movement (increasing velocity). When looking to develop explosive capabilities in clients, the equation demonstrates that the training focus can either concentrate on developing the force or velocity component, with best results stemming from an increase in both variables[9].

ENERGY

Mechanical Energy describes one's capacity to complete mechanical work. The two types of mechanical energy are kinetic energy (KE) and potential energy (PE).

Kinetic energy involves the energy of a body in motion, and is determined by velocity and mass6. For example a kettlebell has a particular kinetic energy throughout a figure-of-eight exercise as it is in constant motion around the body. If the lifter performed the same exercise with the same weighted kettlebell but at a quicker velocity, the kettlebell's KE would increase as magnitude of KE relates to the mass of the object and the velocity of movement. In a contact sports setting, it is beneficial for an individual to elicit a greater than their opponent. In a rugby example, if two individuals of the same weight collide, the player with greater velocity at the time of the collision will be better able to maintain their direction of travel as velocity has greater influence in calculating KE due its value being squared in the KE equation. Therefore from a trainers standpoint, increasing velocity of movement would be a more pertinent goal of the training program than increasing mass in order to enhance kinetic energy. Having a greater kinetic energy will often relate to increased force production and work[6].

Potential energy differs from kinetic energy as it takes into account the force of gravity and more specifically the position of a body in space. If a barbell is racked at a height of 1.6metres, it has a greater potential energy than a barbell sitting on the platform due to the distance away from a reference surface (the ground). Taking the mass of a body/object into account, we can predict the amount of PE or 'stored energy' an object has. The specific equations are above the required knowledge for this workshop, but gaining an understanding and appreciating the behaviour of an object in space, and how the same object at a greater height will have different energetic properties is important.

WORK

=

FORCE X DISTANCE

POWER = WORK / TIME

(Force x Distance) / Time

Force x Distance / Time

Force x Velocity

KENETIC ENERGY

=

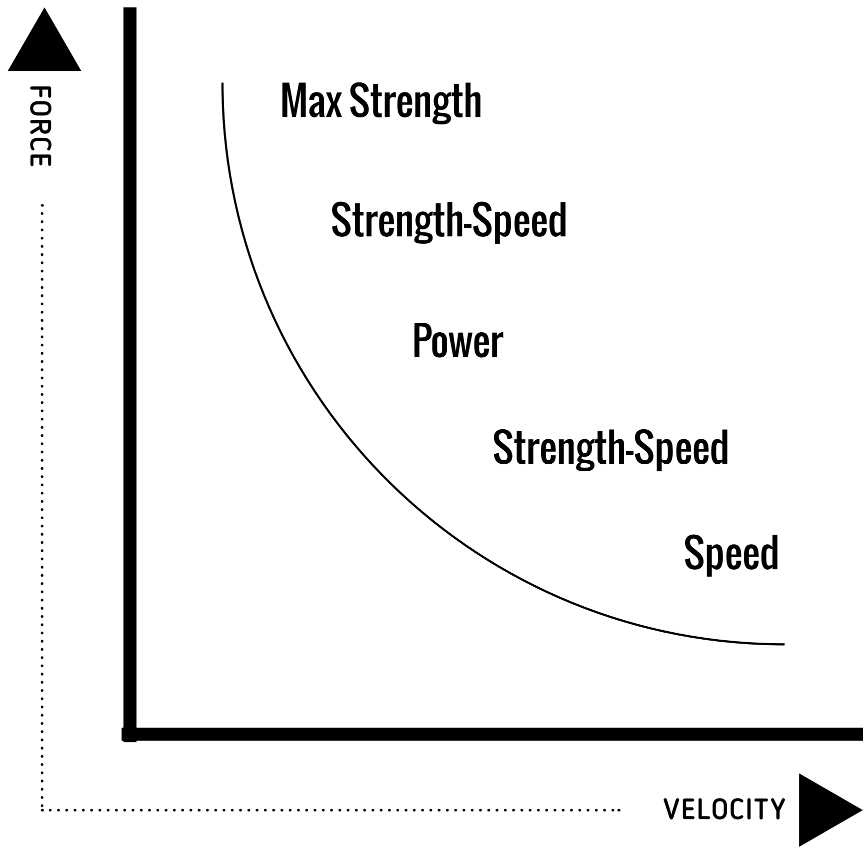
½ X MASS X VELOCITY

FORCE-VELOCITY CURVE

The force-velocity curve should be a concept that resonates closely with the majority of trainers. In its most basic form, the force-velocity curve explains that the heavier a resistance, the greater force required to produce movement. The trade-off for this increased force production is a reduction in velocity, as such a high amount of force cannot be produced with high velocity. Alternatively, when velocity of movement is high, the force required to shift a resistance will be low.

Relating this to lifting mechanics, when a lifter is performing a back squat of 60% 1RM, they will be more likely to produce a higher velocity movement than when the same lifter is performing a maximal 1RM effort. The 1RM effort will generate higher force output, but the velocity of movement and hence the power will be less. Greater resistance equals greater force required, therefore less velocity in the movement[6].

Extending on this knowledge, the force-velocity curve can be used to direct training prescription and guide periodisation. Training all aspects of the force velocity curve (high resistance/low velocity, medium resistance/medium velocity, low resistance/high velocity) encourages wider adaptation and limits the chance of overtraining as the stimulus and intensity is varied. Of course, this type of programming is dependent on the athlete or client's training goals, but should be considered. For someone trying to improve muscle power, they should focus on training both ends of the force-velocity curve[9].



FORCE-VELOCITY CURVE

As force increases, the training focus moves closer towards training for strength, with lower velocity and greater force. With velocity increments, force drops and the focus shifts to more of a speed perspective with quicker movements.

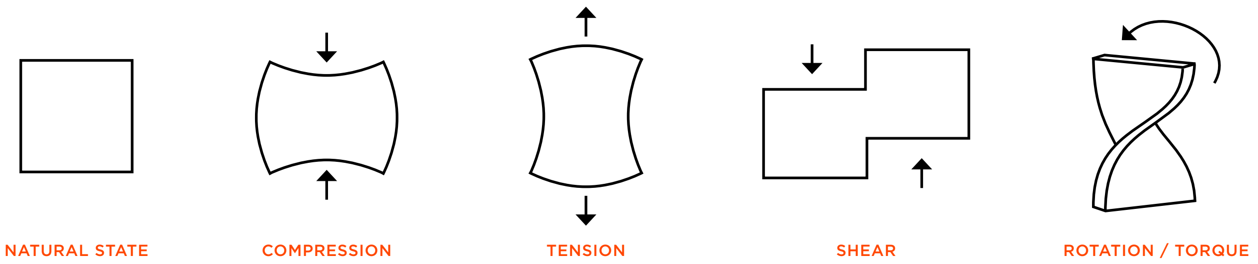
IRONEDGE

TYPES OF FORCE

All movement places different forces on the body, whether it be simply walking down the street, climbing stairs or completing a heavy lift. When we do lift, we put the body under a variety of forces specific to the movement pattern and the position of external load. Understanding the types of force is important for a coach to grasp as limiting particular types of force at certain joints can reduce injury risk, both in the weight room and in a sporting context.[2,10,11] Before describing the types of forces, it is important to differentiate between force and stress. Force causes stress in a particular area, and stress is ultimately the cause of injury or dysfunction. Therefore forces should be monitored to ensure stress does not exceed limitations of human mechanical structure.

> "Shear forces are far more of a concern than compressive forces; our spines actually handle compressive forces really well. You can't buttress shear effectively in flexion, so it's important to avoid it – especially at the most commonly injured lumbar spine segments – at all costs. The spine doesn't buckle until 12,000-15,000N of pressure are applied in compression, but as little as 1,800-2,8000N in shear will get the job done[33]."

Eric Cressy talking about Stuart McGill's research.



COMPRESSION

Compressive force is defined as any force which acts to reduce the length of the body it is acting upon.[6,8] When a lifter is standing in the squat rack, with a loaded barbell across their shoulders in preparation for a back squat, compressive forces from the barbell and the ground reaction force are acting to compact the vertebrae. Therefore compressive forces are important to monitor and reduce where possible, as high levels of force compacting the spine can lead to serious injury.

TENSION

Tensile force is the opposite of compression force, and defined by any force which acts in a pulling or stretching fashion [6,8]. It can be thought of as the force acting when a body or segment is being lengthened, as occurs when hanging from a chin-up bar or in the arms in the initial stages of an upright row, where the bar is 'pulling' the arms towards the ground due to gravitational force to create tension throughout the arms.

SHEAR

Shearing forces differ from compression and tension forces in terms of the line of force, which occurs parallel to the surface, in a sliding manner, instead of in line with the body. Think about the knee at the bottom of the squat position. With the knee at a high angle of flexion, the force of the femur creates a shearing force on the knee and increases the stress on the joint structures and associated soft-tissue components (ligaments, tendons, muscles) that hold the body in position. Whilst the body is able to cope with compressive stress in a reasonable fashion, shear forces are arguably more dangerous to joint structure and function of the body at particular segments, and in most cases should be limited. It is important for coaches and trainers to recognise particular movements that will increase shear force and the stress this places on the body.

ROTATIONAL

Rotational force (also known as torque) explains the forces that occur in any twisting or swivelling movement[6]. Determined by the amount of force multiplied by the length of the moment arm at where the force is applied, it is very common in sporting movements. In the gym, an example could be using the torsonator to perform side-to-side twists.

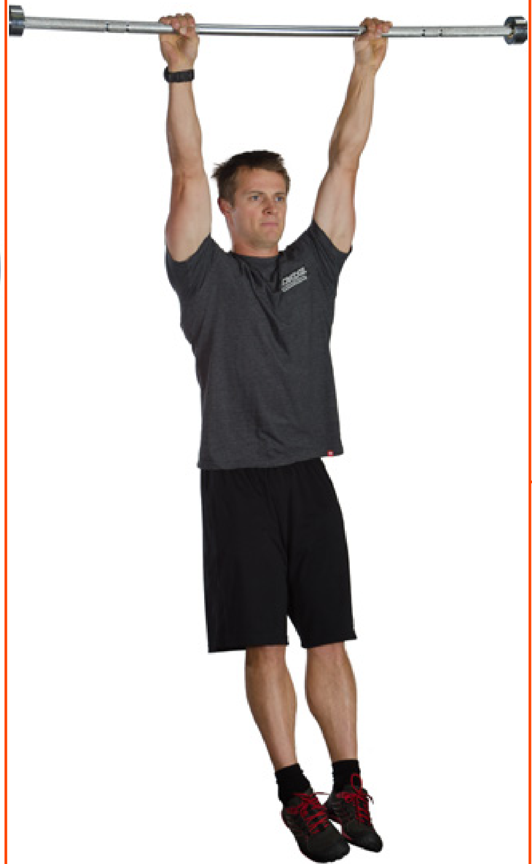
Limiting rotational force in particular areas is important for joint integrity, such as the lumbar spine and the knee, as these structures are not designed to cope with large amounts of rotational force. Compare this to the hip and shoulder ball-and-socket joints, which are mechanically proficient in rotation and therefore allow much greater levels of rotational force. It is for this reason that rotational movements should not involve a fixed hip or pelvic position. Fixing the pelvis does not allow for the hips to contribute to rotation, therefore the force is increased through the lumbar region, where it should be limited due to a small range of motion[12].

IRONEDGE

TYPES OF FORCE

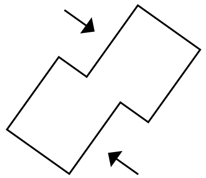
COMPRESSION

OVERHEAD PRESS / BACK SQUAT



TENSION

PULL-UP



SHEAR

MID FRONT SQUAT POSITION

ROTATION

TORSONATOR FULL CONTACT TWIST

STABILITY

CENTRE OF GRAVITY/CENTRE OF MASS

Centre of gravity, or centre of mass, is one of the most important aspects to consider when discussing lifting mechanics. The centre of gravity is the specific point at which a static or dynamic body's weight is equally balanced, regardless of body position[6]. Importantly, the CoG is 3-Dimensional, and can therefore be positioned in space outside of the physical body.

The ability to have an external load, for example a barbell, as close as possible to the line of centre of mass of the body is beneficial as this reduces the moment arm length between the load and the joint. Again, think about the overhead press diagram (page 8). The efficient position involves the barbell in close proximity to the shoulder girdle, compared to the inefficient movement where the shoulder girdle and barbell are separated to a larger degree. Smaller moment arms means less leverage to overcome and a more efficient movement as the joint forces are limited[8]. This all reverts back to understanding and appreciating the position of the centre of mass and its affect on mechanics.

Being in the exact position of the balance point is often hard to perfectly replicate and maintain due to the constant dynamic nature of human movement, so we aim to achieve a position as close as possible to the balance point when we are lifting in movements such as the squat, deadlift and overhead press.

The centre of mass will change with different barbell loads and limb position in space. Lengthening the body (as occurs in an overhead press with arms and hands extended vertically) will force the centre of gravity further away from the ground and requires greater dynamic stability than a deadlift, where the barbell is closer to the ground and hence the centre of gravity is lower to the ground.

BASE OF SUPPORT

Whilst the centre of gravity is important to recognise, arguably more important to stability and balance is the base of support when lifting. A wider base of support, defined by Hall as the area bordered by the points of contact between a body and a surface[6], ultimately allows for greater deviation away from the centre of gravity without losing balance.

Once the centre of gravity moves outside the base of support, the horizontal force becomes too great for the body to maintain stability and lateral movement will occur. For example, a sprinter shifts their CoG outside their base of support to initiate movement off the starters blocks. In a squatting example, if the CoG shifts outside the base of support it will not necessarily mean that the lifter will overbalance and fall, but the movement does become less biomechanically efficient. Therefore greater reactive forces must be produced to overcome this momentum, meaning less force can be directed into lifting the barbell. The heavier the load becomes, it is essential that the base of support contains the centre of gravity from both a performance and a safety standpoint.

LINE OF FORCE/ACTION

Almost every biomechanical concept relates back to Newton's laws of physics in some way. Newton's third law of motion states that "For every reaction there is an equal and opposite reaction". Simply put, when an individual creates and applies a force to produce movement, the surface or object into which they are applying the force must provide an equal force in the opposite direction, to maintain static and dynamic equilibrium.

STABILITY

CORRECT SQUAT MECHANICS

The line of force should pass through the base of support in most movements, otherwise the lifter may not be able to maintain a balanced state. Still, there are certain scenarios when the line of force does not pass through the base of support by design, such as a 'Good Morning' exercise.

However it is important to ensure when teaching various core lifts (squat/deadlift/OH press) that the lifter has a wide enough base of support to accommodate slight variations in reaction forces that may occur due to higher loads slightly altering technique factors.

INCORRECT SQUAT

GOOD MORNING STYLE

LINE OF ACTION FROM THE BOTTOM OF THE SQUAT

The lift on the left has an efficient line of action, as evidenced by the red line. This vertical line of action will maintain the balance point within the base of support and should allow for a successful lift. There are no energy leakages present and the force from the bottom is directed vertically.

The lift on the right is an inefficient lift, as there are horizontal forces present as well as vertical forces. The horizontal forces, caused by the barbell moving in an anterior-to-posterior path as well as vertical, will force the body to produce reactive forces in order for the individual to remain standing. This movement will likely increase injury risk also, as the back is forced under greater stress levels and made to lift the weight more so than the lower limb extensors.

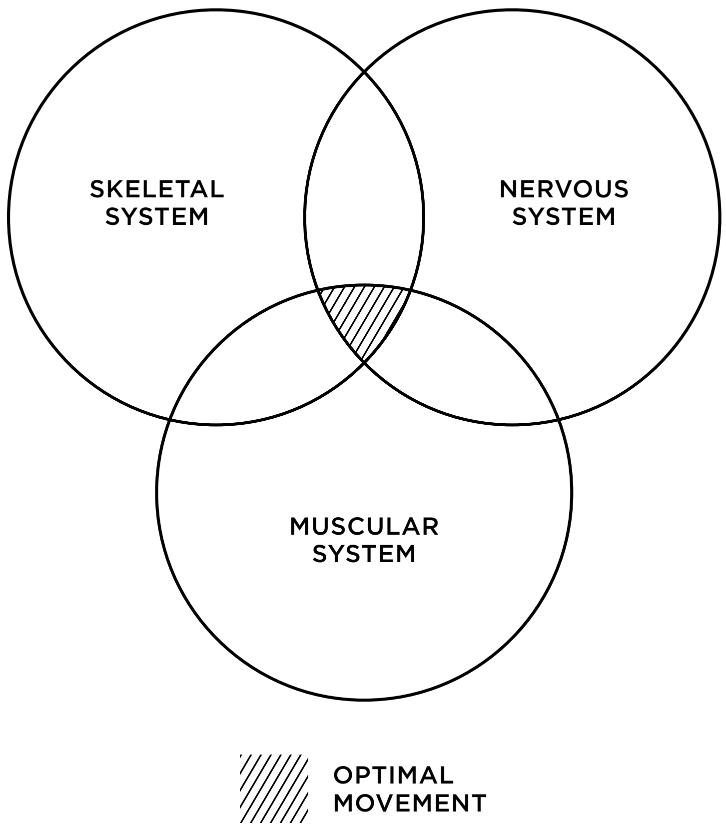
IRONEDGE

KINETIC CHAIN

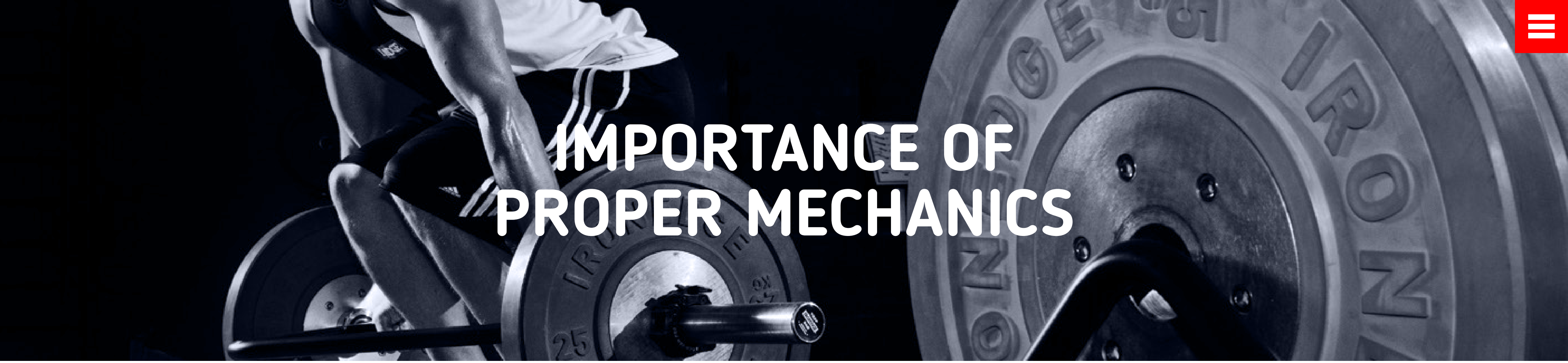
The kinetic chain is critical to understand in reference to lifting mechanics. Put simply, the kinetic chain is the linkage of body segments to produce movement. In a lifting example, the squat requires energy transfer and linkage from the ground up, with muscle recruitment from ankle, knee and hip extensors all contributing in a coordinated and sequential manner to finish in a standing position. The bracing of the trunk in a lift provides a strong base for the kinetic chain to work off and links the upper and lower extremities.

Relating this concept to sport, and throwing activities especially, the proper utilisation of the kinetic chain is critical to maximise distance. Linking all body segments in a fluent nature, where energy is transferred from the feet, up the legs, into the hips and through the trunk, shoulder, down the arm and ending with the hand and wrist will maximise distance due to energy transfer from one segment to the next. Nothing changes in our squat example. If the muscles do not transfer their kinetic energy to the next segment in the chain, the movement will be inefficient due to energy leakage.

Ideally, the body will be trained in such a manner that promotes kinetic chain linkage. A smooth, succinct kinetic chain will allow for energy to 'travel down the chain' and minimise energy leakages, resulting in an efficient movement that improves performance, trains the movement and has functional results in daily living.



IRONEDGE



IMPORTANCE OF PROPER MECHANICS

As is evident throughout the manual, having proper lifting mechanics is imperative for reducing injury risk and maximising performance. However there are many other benefits that can result from lifting in a fluent, sequential and coordinated manner.

MOBILITY

Lifting and moving with correct body position enables increased mobility and flexibility[13] and has proposed to be greater in improving flexibility than static stretching[14], as opposed to poor mechanics which conversely may limit range of motion and in turn increase injury risk due to poor mobility. Increased range of motion and mobility allows for enhanced muscle recruitment which also may lead to greater muscle development and improvements in force and power output[8].

JOINT STABILITY & MOBILITY

Maintaining joint stability throughout movement is critical. Having stability through the knees and mobility around the ankles and hip will allow for a strong movement base. With various forces having to be adjusted to and overcome throughout movement, joints must be stable and strong to maintain correct alignment and positioning. Joint stability also prevents energy leakages, as force is able to be transferred into and through the joint, linking the segments.

CLOSE RELATIONSHIP TO DAILY ACTIVITIES

All of the movements discussed in this workshop and accompanying reference manual relate closely to daily activities. Training with correct technique will allow for an increased ability to move more efficiently when performing daily tasks, from picking up heavy objects or getting out of the car. Switching on and utilising our trunk musculature and constantly thinking about the way we move can improve functionality and reduce injury risk away from training.

CLOSE RELATIONSHIP TO SPORTING MOVEMENTS

Being aware of mechanics and how they can improve lifting and movement can transfer to a variety of sporting movements. Knowing what to look for in a squat can trigger similar cues in running and agility movements, where posture, body position and alignment is likewise critical for increased performance. As mentioned throughout the workshop and this manual, movement and lifting mechanics are vital to understand and be aware of in all types of movement.

ABILITY TO INTERCHANGE BETWEEN IMPLEMENTS AND OBJECTS

Learning a strong set of skilled movement patterns allows an individual to easily interchange between training implements. For example, once proper lifting mechanics are realised for a barbell deadlift, that individual will be able to translate the movement from a barbell to a variety of other implements simply and effectively, as the basis of movement is also ingrained. Examples of other implements include kettlebells, aqua bags, dead balls, the torsonator or power bags. Having the ability to transfer seamlessly between implements can add variety to a training program and can increase the ability to relate training movements to real life scenarios.

NEGATIVES ASSOCIATED WITH INCORRECT MECHANICS

Whilst injury risk is a cause for great concern with poor movement patterns, it is only the beginning of a cascade of negative consequences. From the personal trainer point of view, an injury to a client can lead to legal complications and if they cannot train due to their injury, a direct loss of income. For everyone, an injury can lead to discomfort and time away from work, loss of fitness, reduced functionality and a decreased self-esteem. The best form of injury prevention is proper technique, therefore it is imperative that efficient mechanics are taught and encouraged throughout training.

BRACING TO ASSIST POSTURE IN LIFTING

Before any actual lifts are discussed, it is vital to review the procedure of bracing the vertebral column and how to effectively prepare the body for movement. Skilled lifters will be able to brace immediately and without conscious effort, a skill developed over years of training. For beginners and those looking to further improve their lifting capacity, correct bracing techniques can provide a boost to performance.

Without getting to technical, bracing basically allows the body to lift in the safest possible manner and can be easily achieved and trained. Bracing (known as a high-tension technique) involves co-contraction of transverse abdominis, erector spinae, internal and external obliques, and rectus abdominis, the muscles that surround the spine[15]. Together, these muscles act as the human bodies in-built weight belt, wrapping around the spine to protect and stabilise.

BREATHING

Increasing the capacity of the thoracic cavity (lung volume) will contract the diaphragm and 'switch on' these core muscles5. This process will co-ordinate trunk musculature throughout the anterior and posterior regions to isometrically contract and provide strong foundation support for all lifts[16].

Taking a big deep breath in (not maximal) before a heavy lift will raise the intra-abdominal pressure, stabilise the spine for movement and allow it to safely protect from the compressive forces it will be subjected to throughout most lifts. To increase stabilisation, the Valsalva manoeuvre should be implemented, involving forcefully exhaling with a closed throat after the deep initial breath. In effect, the thoracic cavity will remain large and intra-abdominal pressure increases. Holding this breath throughout a lift will maintain this pressure throughout the trunk. Exhaling fully before a lift is complete diminishes the pressure and acts as an 'off' switch for spinal stabilisers, increasing the risk of an injury due to insufficient support. This is a process that should be trained, as clients come to understand that maintaining a held breath throughout a movement will aid in their stabilisation.

GLUTE SUPPORT

The bracing procedure can be aided by including the lower body in the process. By creating tension through the glutes at the same time as the trunk, the kinetic chain is further supported. The glutes make up one of the most powerful muscle groups in the human body, capable of producing high levels of force and power as well as stabilising the hip complex[5]. Activation of the glutes will in turn activate the adductors, abductors and surrounding hip flexors to support the lift and brace also. Being situated at the hip complex, the glutes also link the upper body and lower body chains of movement and hence are critical in kinetic chain progression and linkage.

HOLLOW BODY

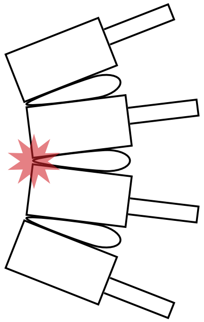
Another technique to improve trunk stability is training the hollow-body position. Often used in gymnastics settings, the hollow body position helps to integrate the upper and lower body segments and remain stable throughout particular movements, as well as maintaining a neutral, straight spine.

The Hollow Body position is often taught lying down on the floor. There is no lumbar flexion in the hollow body position, and the position ends when the back 'breaks' off the floor. Improvement in the hollow-body position can be gauged by the position at which an individual 'breaks' and loses stability in their midsection as their legs track towards the ground. The lower the legs to the ground in a controlled movement, the greater trunk stability. Improved trunk stability will transfer to the movements discussed in the manual, and improving bracing techniques as the spine is protected. Another advantage is a strong, stable base for initiating limb movement.

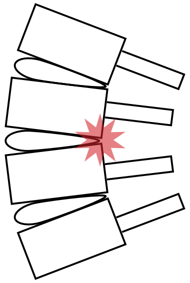
TRANSFERABILITY

Once proper bracing and high-tension techniques are learnt, they will be easily transferable to activities away from the lifts discussed in this manual. Whether it be lifting a baby out of the car, carrying shopping bags or completing home renovations, the ability to brace and utilise the core muscles to not only assist in the movement, but protect the spine from injury is invaluable. Likewise, transferring the bracing skill to other training activities to maintain correct posture will occur more readily once learnt and practised. Such activities may involve kettlebell swings, sled push/pulls, hill sprints or power rope workouts, all of which require strong posture and trunk stabilisation.

BENEFITS OF A NEUTRAL SPINE



FLEXED
SPINE DIRECTION



EXTENDED
SPINE DIRECTION

A neutral spine position involves the back being in a strong, safe position. The spinal cord is vulnerable when in either extension or flexion, especially with heavy loads either on the back or in the hands. Between each vertebrae are fluid-based discs, which aid in facilitating movement and absorbing compressive force. As evident in the below diagram, a neutral spine will decrease the likelihood of a slipped or popped disc, which can be incredibly painful and also have disastrous consequences not only in terms of training but also daily life[4,8].

In a flexed spine, the position of the vertebrae can put pressure on the discs and when a movement is loaded, with the addition of external compression force from a heavy bar, the risk of this occurring is increased. The excruciating pain derived from a slip disc occurs due to the disc putting pressure on the spinal cord, which is an intricate system of nerves and neural connections. A slipped disc can also limit range of motion in limbs, and can have long recovery periods. In this case prevention is the best cure, therefore neutral spine position is critical to teach and learn when completing lifts such as the squat, deadlift and an array of other lifts[11]. Maintaining a neutral spine throughout various lifts and functional movements should be a focus for trainers and lifters.

NEUTRAL STANDING POSITION WITH DOWEL ROD

NEUTRAL HIP HINGE WITH A DOWEL ROD

NEUTRAL PLANK WITH A DOWEL ON THE BACK

IRONEDGE

SPECIFIC MECHANICS FOR VARIOUS MOVEMENTS IN THE TRAINING PROGRAM

As discussed, biomechanics are critical to consider when performing any lift in the program. The major principles can be related to any movement, and coaches should be aware of how a change in one lifting aspect can affect another.

The following pages will explore four of the most common primal movements, and how the information in the previous pages relate to the performance of each movement. A solid understanding of the following points will stand a coach or trainer in good stead for not only safe lifting practices, but efficient and effective programming to specifically target the training goal.

Squat
Overhead Press
Deadlift
Pull-Up

SQUAT

KEY TECHNIQUE POINTS

- Feet ideally shoulder width apart and pointing between 10 to 30 degrees outward. This will need to be adjusted according to the individual nature of the client.
- Breathe in and brace, perform the squat then breath out at the top.
- Maintain barbell over the midfoot throughout the position.
- Knees travel in the direction of where the toes are pointing.
- Coordinated flexion of hips, knees and ankles during the descent, and coordinated extension in the assent.
- Even pressure through the foot during the squat.
- Maintain neutral alignment always.
- Aim to reach a depth that allows the knee to line up parallel with the hip, or lower if you have the range whilst holding a neutral spine.
- Minimise tail tuck or butt wink as much as possible. This is the point when the angle of the pelvis changes, appearing to posteriorly rotate or tuck under, changing and effecting the natural level of lordosis at the lumbar spine.
- Grip the bar with a narrow grip, pulling down and creating strong tension through the lats and thoracic spine.
- Keep your elbows behind the barbel when positioned on the back, and keep your wrists locked and straight throughout the movement.

It's relationship to daily life is also infinite, and is a much more functional and safer movement than other leg exercises. How many times per day do you get in and out a chair, squat down to pick something up or jump up to reach something above your head? The squatting movement is hugely popular movement pattern within daily life, therefore being mechanically sound in performing a squat makes sense for everyone.

The major aim of the squat is to develop lower-body strength, however the type of squat can shift the focus on particular aspects of leg strength and force application. Further, it is not just an exercise that engages the legs. Inner core strength, shoulder mobility and posterior chain maturity are all required to perform a successful squat, as the body needs to maintain itself in correct alignment and trunk position throughout the range of movement in order to balance and stabilise body position[17,18].

Prior to any external load being added to the squat, it is essential that technique is assessed under bodyweight conditions. This is known as an 'air squat', and can demonstrate any technique faults present before extra load is added. One of the best aspects of the squat is that once proper technique is learnt, its application to different implements and scenarios is easy to transfer.
For that reason, this manual will focus on barbell squat variations, but after efficient barbell squat mechanics are understood you will be easily able to apply the technique to squatting with kettlebells, power bags, aqua bags, slosh balls, dead balls or the torsonator.

IRONEDGE

SQUAT

FRONT SQUAT

The front squat involves the lifter gripping the barbell with a clean grip (little wider than shoulder width[19]) and squatting with the barbell resting across the front of the shoulders. This grip, with elbows pointed straight ahead, does require a certain amount of shoulder mobility. If shoulder mobility is lacking, straps can be used to reduce the required flexibility whilst still allowing for a stable barbell position. A cross-arms squat position is sometimes implemented, however should be avoided as it is unsafe and there is little transfer to other weight-room activities[8].

Having the bar in this position requires a much more upright back and trunk, as having a forward inclination with the barbell anterior to the body will cause the lifter to fall forward. Having the back in such a vertical position also allows for a deeper squat to occur, and a deeper squat means greater lengthening of the quadriceps and therefore increased muscle activation[8]. Lumbar stress is also reduced as the spine is not in a flexed position and the hip angle is more open, which appeals to clients who may want to develop leg strength but who experience back pain. Having an open hip angle also diminishes the load through the hip flexors, placing greater loads on the quadriceps and glutes to perform hip extension.

The trade-off with being able to squat deeper and having a more vertical back angle is that the knee extensors undergo greater loads, due to increased knee flexion and forward inclination[20].

Therefore clients with injured knees and who are undergoing rehabilitation may be better suited by a different squatting variation other than the front squat.

The front squat with clean grip also relates very closely to Olympic Lifting and sport-specific movements, as it is fundamentally the same bar position as the bottom position of a clean or power clean. Whilst the potential load lifted is less than the back squat variations (due to less recruitment of the hamstrings and glutes - see following sections), it should not be ignored for this reason. In fact it should be encouraged, especially for beginners, as it is a great starting point for teaching the squat due to the fact it is easier to learn the basic movement pattern. If the bar does not travel vertically over the midfoot, the lifter will likely overbalance and be unable to rise up after descent.

HIGH BAR BACK SQUAT

The second variation of the barbell squat is the high-bar back squat, where the bar is placed slightly above the acromion (across the upper trapezius muscles of the back). As you can see, a relatively upright position is required to maintain the barbell over the midfoot, however not as vertical as the front squat.

Again, the almost-vertical nature of the spine and the moderately open hip angle minimise compressive forces on the spinal column and translates to a forward knee inclination.

The historical theory that 'The knees shouldn't travel in front of the toes in a squat'[21] has been suggested to be too limiting in it's prescription, and has been countered by recent research[22]. Whilst over-inclination should still be avoided due to shearing forces at the knee[5, 22], it is important to appreciate that the knees are required to travel over the toes to optimise hip and lower back mechanics, and therefore to not try and avoid such angle in lifters with healthy knees.

Clients with shoulder mobility issues will be better served by the high-bar back squat also, however other flexibility and mobility exercises should be included in the program to improve movement throughout the shoulder. A high-bar back squat also encourages a 'chest up' position to maintain a vertical spine, decreasing load through the lumbar regions.

Slightly greater hamstring and posterior chain activation occurs in the high-bar back squat than the front squat, however it is still less than the low-bar variation as the acute knee angle increases the 'slackness' in the hamstrings. As they are already contracted due to hip extension and knee flexion, they struggle to contract any further. Therefore the high-bar back squat is still a quadriceps dominant exercise that relates closely to Olympic lifting, and is a good exercise for developing leg strength and minimising lumbar stress levels whilst still engaging some hip torque.

LOW BAR BACK SQUAT

The low-bar back squat involves the barbell resting across a shelf formed by the rear deltoids, slightly below the acromion. Having the bar in a lower position across the back immediately forces the lifter to flex to a greater magnitude at the hip to maintain the necessary barbell position vertically over the midfoot. As such, the compressive forces are of a greater magnitude in a low-bar back squat[20]. This increased hip angle and forward trunk predisposition engages the posterior chain to a massive degree, as the hamstrings are now constantly under tension throughout the entire movement[20]. Forces through the hip flexors are also increased, with more vertical shin position and greater angle at the hip/trunk complex. It does take away from some of the compressive and shear forces at the knee joint however, therefore with ACL rehab clients it may be more appropriate than the front squat.

The engagement and recruitment of the hamstrings and glutes to such a large degree does allow for greater loads to be lifted when low-bar squatting compared to high-bar and front squats. For this reason it is the preferred lift of powerlifters, whose aim is to lift as much weight as possible. Heavy loads and the increased compressive load on the spine increase the importance of bracing intra-abdominal musculature to create a rigid back and stabilised spine.

IRONEDGE

SQUAT

FRONT SQUAT

HIGH BAR BACK SQUAT

LOW BAR BACK SQUAT

BAR POSITION

There are 3 distinctly different barbell positions to consider when discussing the squat. The mechanics and body position are inherently different across the three variations, and it is important for trainers to understand the biomechanics when prescribing and instructing the various methods. Particular sports, body types, client goals and individual mobility will benefit from one particular bar position over another, therefore knowledge of the specific mechanics of each are critical.

SQUAT

STANCE

The position of the feet when squatting is vital, and may influence the muscle engagement and forces experienced throughout the ankle, knee and hip.

A wider stance is likely to increase compressive forces at the knee and hip[8,23]. This may not be ideal in many scenarios, including a history of knee injuries in the lifter. The knees should be 'pushed out' during squat descent to prevent from knees caving in and losing force production capacity, and with a wide stance this becomes more difficult due to anthropometry. A wider stance increases glute activation slightly, but going too wide limits range of motion and can therefore limit overall muscle development.

A moderate stance is the recommended stance for most lifters, with feet pointing out at about 30 degrees[8]. Having the feet in this position will lead to external rotation of the hips and in turn recruitment of both the groin muscles (adductors) and the external rotators which ultimately provides a larger quantity of muscle fibres activated and being called upon to perform the movement. This stance opens up the hips and also allows for greater depth to be achieved. There will always be compressive and shearing forces throughout a squatting movement, however in the moderate stance the forces are not particularly large and less than a wide or narrow stance.

A narrow stance will increase shear forces at the knee joint due to the direction of force being applied from the upper leg[23]. Standing narrow also reduces the base of support and may therefore lead to balance issues.

In terms of muscle activation, a narrow stance limits groin activation and increases calf muscle engagement, as well as decreasing range of motion and therefore reducing hamstring activation[8]. To better condition the groins and maintain strength through such an important muscle group, narrows stances are not recommended.

Overall, foot position should be dictated by individual client goals and the total amount of musculature they are attempting to target and activate, as well as comfort. For those athletes or clients who require lateral movement in their sport or job, it may be beneficial to include a moderate or slightly wider stance with feet pointed out as that would recruit more adductor and synergistic muscles related to their functional movement.

MOVEMENT SPEED AND TEMPO

The barbell squat is a complex exercise that requires control. If rushed, the squat can be unsafe and lead to injury. Any movement that involves large compression forces through the body should be monitored with safety as the main priority. Squatting with a high cadence, which will often involve 'bouncing' rapidly out of the bottom of the squat to increase momentum, leads to increased joint forces and therefore joint integrity may be compromised. Having a slight bounce may be beneficial as it utilises stored elastic energy to rise up from the bottom, but the risk increases with the speed of the bounce as stress on the joints increase with increased momentum. For beginners however, bouncing should be limited.

BREATHING

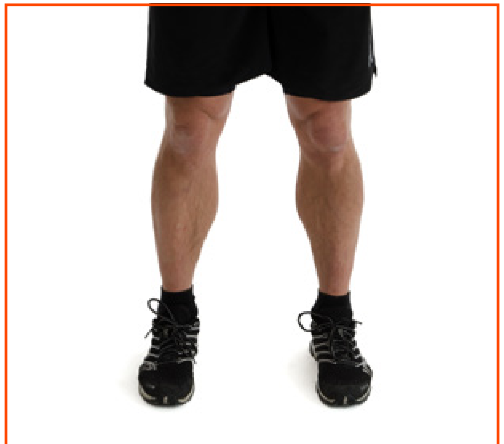
Correct breathing pattern in the squat movement can potentially improve the load shifted during the movement, as bracing position and trunk stability may be enhanced through correct breathing.

The general breathing recommendations do not differ largely when comparing various lifts. For the squat, a deep inhalation prior to movement will provide the best opportunity for correct bracing and even pressurisation. As renowned weightlifting coach Greg Everett suggests, adding a few seconds to each repetition is a favourable trade-off for lifting with a safe, strong and stable base.

The held breath should be maintained throughout the movement, in particular at the bottom of the squat. It is at this point that the body is in the most vulnerable position, and therefore a held breath which maintains intra-abdominal pressure and a rigid torso is critical. On the ascent, short, sharp exhalations are acceptable. It is important not to fully exhale as this will diminish the rigidity of the back and spine through the relationship between exhalation and diaphragm relaxation.

FOOT POSITION / STANCE

MODERATE SQUAT STANCE
(FEET AT 30°)

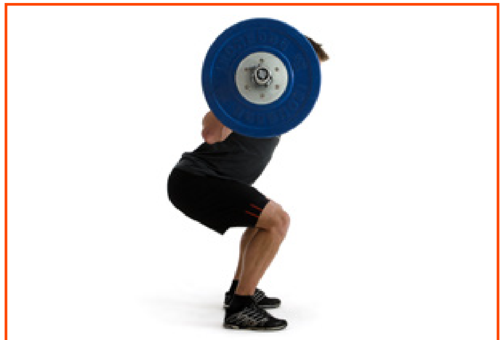


NARROW SQUAT STANCE
(FEET MOVE FORWARD)

SQUAT

RISING ONTO TOES

KNEES CAVING IN



SHALLOW

TAIL TUCK (TOO DEEP)

COMMON ERRORS AND CORRECTIONS

This section will briefly touch on some common errors associated with the squat, and some techniques to improve mechanics.

1. Rising Onto The Toes

This is a common trait in lifters with poor ankle mobility as they try to go deeper into a squat. This can cause overbalance issues and also diminishes the force being able to be transferred through the ground, as the contact with the lifting surface is reduced. Cue the lifter to push their weight through their midfoot, or at least keep the heels in contact with the ground. In some cases a heel raise can be beneficial to promote a forward shin inclination and allow the lifter to achieve maximal depth, as well as prevent rising up onto toes. Pushing weight through the heels will also limit the distance knees can travel forward, further assisting mechanics of the lift and maximising muscle activation.

2. Knees Caved In

When the knees come together during a squat, muscle mechanics dictate a reduced muscle activation of groins and abductors. The cause of this is often weak hips adductors, unable to hold pelvic position. On the descent phase, knees should push out away from each other, as this increases muscle activation. Greater muscle activation allows for increased loads to be overcome, leading to more effective adaptations. Unstable knees that cave in also create a stability risk with heavy loads, and should be avoided.

To correct this, use micro bands to cue the lifter to 'push knees out'. Alternatively, a coach can place their hands on the outside of the knees of the lifter and implement the same cue. These methods can increase kinaesthetic awareness of knee position and aim to prevent the knees from caving inwards during the squat.

3. Not Enough Depth

The generally accepted aim in terms of depth is full range of motion, with hips dropping below the top of the patella. An individual's squat depth will be largely determined by their hip mobility, and those with a lack of mobility will struggle to reach this depth.

Therefore other mobility drills and exercises should be included in the training program. Squatting will improve hip mobility also, so should not be avoided if someone does have limited depth.

Partial Squats are repetitions that do not qualify as full squats, i.e are not deep enough. These type of squats should rarely be included in training someone who can reach a full squat (i.e. injury-free clients), as they will cause an imbalance by increasing load through the knees and quadriceps without activating the gluteal group to a large degree[24]. Further, they can be dangerous as loads may be increased significantly in partial squats (due to limited range of motion) and therefore the stress transmitted through the body is much greater than what can be safely braced for.

4. Tucking The Tail

A common squat error involves the lifter 'tucking the tail under' at deep range. Basically, this refers to the tailbone 'tucking' under the spine through posterior pelvic tilt, losing the lumbar curve. This will cause a loss of neutral spine, and is originally caused by a lack of hip flexion. A body position lower than the onset of tucking, and the spine is manipulated into an unsafe lumbar flexion position with heavy loads. In the original screening process, an air squat should be performed with particular reference to the point at which the tail tucks under the bottom.

To prevent a tail tuck (possibly due to either short hamstrings that pull the pelvis to the posterior or a weak anterior core that cannot counteract the pelvic tilt), a couple of techniques can be implemented. Lengthening hamstrings should be a focus in all training, as tight hamstrings are very common. More importantly, anterior core strength should be worked on through various drills such as planks, ab wheel rollouts and chopping exercises.

OVERHEAD PRESS

KEY TECHNIQUE POINTS

- Breathe in and brace, perform the press then breath out at the top.
- Maintain brace, breath in, lower under control and breath out at the bottom.
- Keep the body locked and still through the press.
- Press the bar directly vertical, tucking the head without compensating by moving the body.
- Focus on extending through the whole body and kinetic chain, by pressing downward through the feet and into the floor, aiming to press from the ground up.
- Keep the hips strong and stable and in a neutral position.
- Maintain neutral posture throughout.
- Lock the legs tight and straight, neutralising the pelvis and connecting the abdominals to the rib cage.
- Wrap your fingers and thumbs completely around the bar, trying to crush and bend the bar as you press.

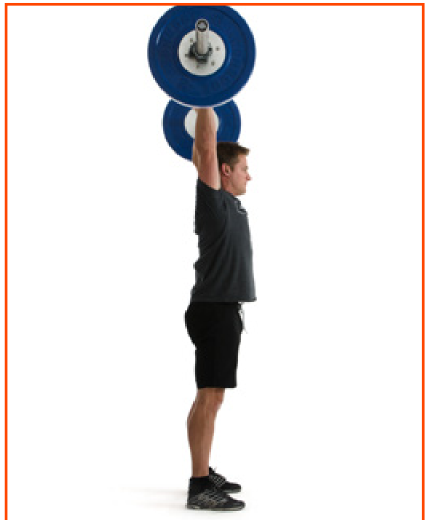
The transmission of force throughout the entire body from feet-to-overhead relates closely to sporting movements and will assist in the performance of daily activities for most individuals. Training all components of the shoulder complex is beneficial for mobility, joint health, posture, scapula control and injury prevention.

BODY POSITION AND GRIP

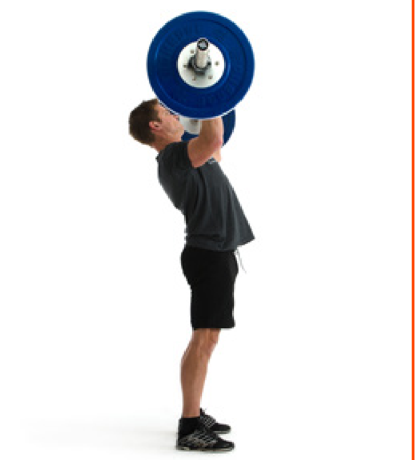
The starting position for an overhead press is critical, as there is limited body movement throughout the lift and therefore little opportunity to correct any positional flaws. Gripping the bar correctly will minimise any unnecessary moment arms the lifter will have to overcome to perform the lift. Hands should be in a position that allows the forearms to be as vertical as possible, with the bar in the heel of the palm facing forward. The wrist shoulder be straight, positioning the barbell directly over the forearm. Any different position (hands too wide, too narrow, palms facing up, bar in fingers) will mean the lifter has to work against a lever throughout the lift, that can simply be eliminated by a proper grip[8].

Ideally, the bar should sit across the front of the deltoids or as close as possible determined mobility. This allows the bar to be pressed overhead in a straight line, maximising movement efficiency. The superior muscles of the erector spinae should contract, both to begin bracing the kinetic chain for the lift but also to lift the chest up to achieve correct alignment throughout the thoracic spine.

As the bar travels overhead throughout the press, to maintain a vertical bar path the head and chin must get out of the line of action. If not, the lifter will press the bar into their chin, which is not ideal. To do this, a coordinated movement occurs where the back remains rigid and braced, the hips drive forward and therefore takes the head back slightly to allow the bar to travel vertical. As the bar passes the forehead the hips re-align and the head comes back to the starting point, with the barbell now directly overhead.



CORRECT OVERHEAD PRESS



INCORRECT OVERHEAD PRESS

BAR POSITION

The further away from the shoulders and the line of the body the bar is, the more inefficient the movement. This creates a longer moment arm (horizontal distance between the line of action and axis of rotation), as does 'looping' the bar caused by pushing the bar away from the face and then upwards. The ideal bar path is directly vertical from the shoulder girdle, which minimises the length of the moment arm. As with the squat, there should be a vertical line between the midfoot and the barbell. Positions that lengthen the moment arm and decrease movement efficiency

- Starting the bar too far out in front (away from the face)
- Pressing the bar with a curve
- Failing to 'tuck' head under bar as it travels vertically, loading up shoulders and maintaining a long moment arm

Having the bar in a truly overhead position, aligned with head, shoulders, hips and feet allows for transfer for force from the muscles (which produced the movement to get the bar overhead), to the skeleton, which can better absorb the compressive forces and is more fatigue-resistant than the muscular system.

IRONEDGE

OVERHEAD PRESS

FOOT POSITION

The foot position in an overhead press does not have as much of an impact on mechanics or performance as a squat or a deadlift as there should be no extension of the lower limb in the movement. The only thing to concern yourself with is the balance issues that may arise from an overly narrow stance, and having a wide stance will possibly lead to knee's collapsing medially inwards and produce a competing moment arm. A comfortable, shoulder width stance will suit most individuals.

LOAD/RESISTANCE

With increasing load in the overhead press, care should be taken that the lift doesn't turn into a push press with involvement of the leg flexion and extension. It is obvious that with recruitment of the large leg extensor muscles, more weight will be able to be shifted due to greater force production. The overhead press is a fantastic upper-body strength developer, however when the legs become involved the shoulders are able to relax as the load through the shoulder girdle is lower and the load becomes easier to lift due to momentum created in the flexion/extension process. In essence when the overhead press turns into a push press the entire muscle recruitment pattern is altered.

This is not to say the push-press is a damaging exercise, and inclusion within the training program can be beneficial for particular clients, dependent on training goals.

MOVEMENT SPEED

As with the squat and deadlift, the overhead press is primarily a strength exercise, therefore movement should be controlled and fluent (see force-velocity curve, page10). The lockout position (bar held overhead with arms straight) should be held for a second before the barbell descends. When movement in the overhead press becomes jerky or too quick, the bracing of the core may not be able to handle the increased compressive forces and injuries may result. If training for power gains, a push-press or split-jerk may be more appropriate. Proper technique must be learnt and achieved in the overhead press before these exercises are conducted. the legs become involved the shoulders are able to relax as the load through the shoulder girdle is lower and the load becomes easier to lift due to momentum created in the flexion/extension process. In essence when the overhead press turns into a push press the entire muscle recruitment pattern is altered. This is not to say the push-press is a damaging exercise, and inclusion within the training program can be beneficial for particular clients, dependent on training goals.

BREATHING

It is best to implement the Valsalva manoeuvre (deep breath, hold, forcefully exhale against closed glottis) for the overhead press. From the start position, with intra-abdominal pressure high, drive the bar overhead to lockout. Maintain the brace and held breath as the bar descends back to the shoulders. It is recommended to exhale at this position and re-set the brace whilst the bar is in a safe position on the shoulders. It is difficult, and unsafe, to repeat many repetitions under a single breath[8].

OVERHEAD PRESS

COMMON ERRORS AND CORRECTIONS

Errors with the press can lead to injury, therefore it is very important to ensure and faults and errors are remedied as soon as they are identified.

1. Positional Errors

Not getting into the correct starting position will lead to an increased risk of injury and an unsuccessful lift. In the starting position it is critical to set-up correctly and be tight through the core, with the chest up. Without a high chest, the back loses structure and is put under greater stress.

A low chest will also cause the back to round and reduce shoulder mobility and range of motion, as well as improper distribution of force through the vertebrae 8. Another positional error is derived from shoulders and elbows dropping slightly, lengthening the bar path required for a complete repetition.

2. Bar Path Errors

A common mistake in the press is doing more 'work' than necessary and placing the body through undue stress. As briefly discussed, lengthening the moment arm in the press can decrease efficiency but also put regions of the body under greater stress than is able to be withstood. Taking the barbell away from the shoulder girdle increases the moment arm, and leads to a bar path that is not truly vertical.

When the barbell moves to a more forward position, the back must shift in the opposite direction to maintain the centre of mass within the base of support. This increases forces on the back and relates to a loss of power as the bar is now out of alignment with the prime movers (deltoids and triceps).

Trainers should screen for sufficient shoulder mobility in a passive state to ensure that they correctly extend their arm overhead. If they cannot reach the desired position without any load, they should be excluded from pressing overhead until mobility is increased and they are able to perform the correct movement patterns.

3. Excessive Lumbar Curve

Often at the lockout stage of an overhead press, those lifters with insufficient core stabilisation in the overhead position will produce a body posture that places great load through the lumbar spine.

This position increases spinal injury and posterior muscle trauma, as the load is disproportionally distributed throughout the vertebrae. Further, it slightly alters the muscle mechanics and activation, shifting the muscular demand from the deltoids to the upper pectoralis major8. Weaknesses in the lumbar curve and thoracic spine tightness should be addressed prior to increasing load in the overhead press. Other correction cues can include 'pulling the head back' and pressing vertical.

4. Failure To Lockout Overhead

Achieving a lockout position at the top of an overhead press is vital, as it shifts load from the muscular system to the skeletal system, which is much more capable of holding force for a longer period. If an individual cannot achieve proper lock-out position (elbows fully extended, arms directly overhead), there may be a number of causes. Shoulder mobility issues or muscle tightness through the upper back/upper chest may limit the range of motion overhead. This should be screened for before any external load is lifted. If the screening process failed to detect any issues with achieving an overhead position, it may be a confidence issue, as holding a load overhead is not comfortable for everyone.

5. Including a Knee-Bend to Push-Press the Bar Vertical

With heavier weights, sometimes clients will involve a knee-bend in their lift to recruit greater muscle mass in order to achieve a successful lift. There is nothing wrong with a push-press as an exercise, however it is a separate movement and elicits different training adaptations that a regular overhead press. The overhead press should be staple for training programs, with a push-press included if power development or some variety is required.

If a push is being used to press a weight overhead, it is likely that the load is too heavy, and the lifter cannot press the load without recruiting greater musculature. Scale the load back, and focus the lifter on eliminating any dip or knee-bend, initiating movement from the shoulder girdle instead.

DEADLIFT

KEY TECHNIQUE POINTS

- Activate the lats by pulling the shoulders into the body trying to generate tension in your armpits.
- Use your breathing to re-enforce position and generate maximal levels ofl intra-abdominal pressure.
- Push your feet through the floor to initiate the lift.
- Remove the slack from the bar before you ascend.
- Address the bar from the top down.
- Position feet so the bar sits over your midfoot.
- Position shoulders in front of the bar.
- Squeeze the bar as tight as you can, trying to bend and crush the bar as you lift.
- Maintain a strong alignment by generating strong tension throughout the body.
- Keep the bar path as close to the body as you can.
- Aim to push feet through the floor, and stand up strong.
- Breath in and start the lift, then breath out at the top. Breath in again, and out once you reach the floor.
- Keep a neutral alignment throughout.

If done with proper technique and correct body alignment, the deadlift is a fantastic posterior-chain developer and will transfer to safer and more effective lifting. However if completed incorrectly, the deadlift can be a harmful exercise with high injury risk[25], therefore it is important to learn and teach correct mechanics when performing the exercise.

A deadlift cannot occur with a loose trunk. Holding the trunk rigid through isometric contraction of anterior and posterior trunk musculature is critical, as this stabilises the spine and provides a strong pulling base from which further segmental force can be produced.

BACK POSITION

The back must be in a neutral position at the beginning of the deadlift. Rounding of the back may increase injury risk, and for the majority of lifters any rounding should be minimised. Likewise, an overarched lumbar spine also causes a safety risk. For this reason, it is important to train the correct back position and provide correct cues to your clients. e.g. chest up, head up and aligned, butt out.

DEADLIFT

DEADLIFT

FOOT POSITION

There are two distinctly different feet positions to choose from when deadlifting:

1. Feet inside the arms: "Conventional"
2. Feet outside the arms, pointed out: "Sumo"

The conventional stance lengthens the distance the bar travels, and therefore requires 25-30% greater mechanical work as the bar will be displaced further from the starting point than the sumo deadlift[26]. During a conventional deadlift, feet are pointed out at approximately 10-15 degrees, compared to up to 45 degrees in the sumo style, and with the wider stance employed during a sumo deadlift the centre of mass is closer to the ground than in a conventional lift[27].

ADDRESSING THE BAR

As the exercise sounds, a true deadlift is initiated from a dead position from the floor. Because of this unique starting position, there are inherent risks associated with bending down to approach the lift, in terms of activation and engagement and more so for beginners and for novice lifters. Essentially there are two ways you can approach this lift, either by bending down and setting yourself up and engaging, or by starting from the standing position, bracing and engaging then lowering into a strong starting position. Either way, by creating a set protocol of tension and engagement, or by addressing the bar or lift correctly from the very start, will lay the safest and strongest foundation for any deadlift.

For the novice lifter, understanding the importance of a strong starting position is half the battle, so it stands to reason that setting yourself up strong, before to descend into the start position is one of the best ways to establish great form and mechanics from the beginning. This method of addressing the bar is performed by, stepping toward the loaded barbell, and placing the middle of the foot directly under the bar in your correct stance.

Next, stand up tall, brace and engage forcefully taking a strong breath in. Hinge and lower into the start position, gripping the bar firmly. Pull on the bar generating even more tension by squeezing the shoulders and lats into the body, push your feet through the floor and lift the bar.

By adopting this direct approach, you are ensuring the quality of movement from the start, and minimising the potential for starting the lift in an incorrect position. This is an essential component for any lift, but more importantly for novices to understand what it means to get strong and stable during the deadlift.

HAND POSITION: GRIP AND WIDTH

Arm and hand position during the deadlift are important, as subtle changes in positioning can alter muscle activation and mechanics.

CONVENTIONAL-STYLE SNATCH GRIP

The snatch grip deadlift shortens the displacement of the barbell, as the arms are effectively 'shortened' by going wider. Having a wider grip also alters the back angle, the hip must flex to a greater magnitude in order to achieve the wide hand position. An increased back angle results in greater upper back activation, as well as other aspects of the posterior chain such as hamstrings and gluteals. Using a snatch grip will lower the load able to be lifted (due to increase stress on the back), but is important to include in the training program as it has alternative benefits to conventional grip deadlifts.

CONVENTIONAL-STYLE SHOULDER WIDTH GRIP

A shoulder width grip (just outside the knees) allows the bar to be raised without interference from the lower limbs and as the load gets heavier, a double-overhand grip is essential for shoulder stability. This should be the standard width for most deadlifts as muscle recruitment is greater.

HOOK GRIP

The hook grip an alternative deadlift grip for heavy loads. Positioning the thumbnail under the middle finger provides a secure grip and takes stress away from the forearms flexors, which can tire easily. This grip slightly increases the lever of the arms, as the bar sits more in the fingers than the palm of the hand. Often used for single reps, due to the need to re-position the thumb after most reps, it does have a large transfer effect to Olympic Lifting.

ALTERNATE GRIP

Commonly used but often misunderstood, the alternate grip involves one hand supinated and one hand pronated. The alternate grip causes an asymmetry in shoulder mechanics and muscle recruitment in the back is limited with a supine hand position. It is also not transferable to other lifts. For RDL's, avoid the alternate grip as the latissimus dorsi cannot 'pull' the back close to the body on the supinated hand side, causing further imbalances8. If an alternate grip is implemented, the lifter should interchange which hand is pronated and which hand is supinated in between sets or sessions, as this may prevent asymmetries.

DEADLIFT

CONVENTIONAL DEADLIFT

A conventional deadlift is the most popular deadlift technique in competition and in gym settings, especially for heavier loads, and involves knees 'inside' each elbow[26]. Due to body position at set-up, the conventional deadlift has an increased range of motion at the ankle, knee and hip. Having greater range of motion increases the lengths of muscles involved, and therefore could be favourable for muscle development. Increased hip flexion and therefore increased hamstring stretch and activation of the lower back musculature have been shown in the conventional deadlift. This increases the ability of the conventional deadlift to serve as a hamstring and lower back strength developing exercise when compared to the sumo style deadlift.

SUMO DEADLIFT

A sumo deadlift is characterised by having knees outside of the elbows when lifting, resulting in a wider stance. A wider deadlift stance and narrower grip in effect 'shortens' the legs, resulting in a decreased bar displacement from bottom-to-top. This is turn allows for a more upright trunk and back position, which reduces stress through the lower back via a shorter moment arm[25]. Furthermore, the upright position increases muscle activation of the quadriceps[27]. A more upright back position does increase ankle and knee forces however, but also serves to reduce shear forces in the lumbar spine compared to the conventional deadlift.

ROMANIAN DEAD LIFT

A slight variation of the deadlift is the Romanian Deadlift (RDL), which loads up the posterior chain to a greater extent and is another useful and functional exercise. The RDL involves almost exclusively hip extension, with very little knee extension or quadriceps involvement, and therefore is also known in some circles as a Straight Legged Deadlift. Therefore the movement relies heavily on glute and hamstring involvement to 'pull' the barbell up to the top position, with bracing of the lower back and trunk extremely important to maintain the neutral spine.

Treating and mentally imagining the hip as the axis of rotation will lead to better performance in the RDL and also ensure that correct posture is maintained, while knee-angle should remain fairly constant throughout the movement. Whilst hip angle opens up as the movement takes place, the back should remain in the same alignment. As the hip opens, the back will naturally become more vertical and finish the movement with the lifter standing vertical with neutral spine.

DEADLIFT

LOAD

External load may influence the technique and therefore the mechanics of the deadlift. For heavier loads the conventional deadlift appears to be more popular, which is likely due to the increased range of motion and therefore muscle activation, which leads to greater muscle fibre recruitment to aid in lifting heavier loads. For lighter loads, competition analysis has reported a more even split between the conventional and sumo techniques[26].

In terms of grip, there is less research available for analysis. However in an alternate grip, the recruitment of the latissimus dorsi on the supinated hand side of the body is limited therefore should not be chosen for heavier loads.

TYPE OF BARBELL USED

The deadlift can be completed with many heavy implements. A common piece of deadlift equipment seen in training programs and many gyms is the Trap Bar, otherwise known as the hexagonal barbell. This allows the lifter to stand in the middle of the barbell, and as such slightly changes technique and load capacity of a deadlift. The Trap bar was originally developed to reduce the length of the moment arm distance between the barbell and the body, and can do so by up to 75%[28].

Biomechanical studies have shown that stress magnitude is less in the spine, hip and ankle when a trap bar deadlift is completed compared to a straight barbell, as the barbell is able to remain as close to the body as possible[28,29].

Heavier loads and greater peak force were also demonstrated with trap bar deadlifts, as stress on the back decreases due to a more upright position allowable due to the standing position, which is essentially within the barbell[28,30]. The type of barbell for a deadlift should be considered by trainers when screening their clients and prescribing exercise. For those clients who have back pain or hip mobility issues, a trap bar deadlift has been suggested to be more appropriate due to its ability to more evenly distribute force throughout the involved joints[28].

MOVEMENT SPEED

The deadlift is a strength-orientated movement, and as such is not required to be performed rapidly. In fact, a rapid, jerky deadlift will place increased stress on the muscles involved and is unsafe. What you should be looking for and training is a smooth, fluent movement that is coordinated and sequential. Rushing up or down in the deadlift will cause increased compression and shear forces at the joint level, movement inefficiency, increased hamstring and other posterior chain strain and ultimately will not lead to positive training adaptations. This increased force can be described by the simple force equation, where force is equal to mass multiplied by acceleration. Therefore as acceleration increases, force increases. Increasing movement speed increases acceleration, which in turn increases the force and stress on the back and hamstrings which may lead to injury.

BREATHING

As is the case in the squat and overhead press, breathing control during the deadlift is important to consider. Again, increasing the intra-abdominal pressure through diaphragm breathing is the critical skill to master in order to brace effectively. Inhaling deeply prior to the initial pull off the ground will result in a rigid torso and provide foundational strength, increasing safety and the potential for heavy loads.

An important cue to achieve diaphragm breathing is to breath into the 'belly'. If the lifter is wearing a lifting belt, the belly should push out against the belt as a cue of increasing intra-abdominal pressure. If no belt is being used, the lifter should kinaesthetically feel the belly fatten.

It is ideal to maintain the breath throughout the entire lift, although there are times when this is not possible, such as in longer, heavier lifts. In this case, as in the previous lifts, it is acceptable to exhale in short, sharp breaths to increase comfort and prevent dizziness. Exhaling in full however will cause a loss in trunk tightness and may increase injury risk or prevent the lift from being completed.

TRAP BAR DEAD LIFT

DEADLIFT

COMMON ERRORS AND CORRECTIONS

There are a lot of mechanical errors possible in such a complex movement as the deadlift.

1. Bouncing the Bar at the Bottom

The deadlift should be just that; a lift from a dead position. Whilst a squat movement utilises a controlled bounce when transferring from descent-to-ascent, the deadlift should not implement this pre-stretch reflex. This is critical when completing a set of deadlifts involving multiple repetitions, ensuring the bar is stationary on the ground after the opening repetition before completing subsequent repetitions.

2. Bending Arms

In the deadlift, the arms serve as simply an extension of the body and a connection between the bar and the lifter. The arms should not do any 'lifting' as such, and muscling the bar up with elbow flexion with such heavy loads increases elbow injury risk. Elbows should be locked throughout a deadlift, as any bend will increase the distance the bar must travel and also create an inefficient movement where the elbows expend force that should of been directed into the bar. For a lifter that is tending to muscle the bar up with bent arms, simply cue "Straight Arms!".

3. Incorrect Back Position

Having a rounded back (spinal flexion) or an overarched back (spinal extension) at either the beginning, during or end of the lift sets up the lifter for energy leakages throughout a movement as well as an uneven distribution of force. Whilst powerlifters may use a rounded back in competition, it is important to recognise they are highly trained and do so with conscious effort. For beginners and the vast majority of resistance trainers, rounding the back should be avoided due to the increased injury risk. To correct a rounded back, scale the weight back and ensure the chest remains tall throughout the lift, especially on lift-off.

4. Failure in Bracing at the Hips

The hip joint is the major area undergoing 'work' in the deadlift. Bracing through the hips and glutes for the entirety of the lift is imperative, as weaknesses in the area will prevent the lift from being loaded heavy as the origin of force production will shift from the hips (large muscles) to the arms (small muscles). Failure to brace through the hips will also result in decreased spinal support and less core stabilisation, increasing injury risk as the forces on the spine intensify. Correct bracing techniques should be taught and trained prior to increasing loads.

5. Bar Too Far Away from Base Of Support

A common error involves the bar moving too far away from the base of support, increasing the moment arm between the load and the base of support, and in turn increasing load through the spine. As with the squat and overhead press, the bar path should travel directly vertical in a straight line. Any deviation from a straight-line bar path causes mechanical inefficiency and disproportional load. Cue the lifter to 'drag' the bar up the body, keeping the bar in contact with the legs as it ascends.

6. Losing Shoulder Stability

Although the deadlift is primarily a back and lower body exercise, the shoulders are required to remain stable throughout the movement. As the arms are an extension of the body in the deadlift, stable shoulders are required to hold the back in a strong position and remove any risk of a rounded back. Contracting the muscles surrounding the shoulder maintain scapula position in a neutral position and develops correct spine position under tension. Unstable shoulders may also cause the bar to flay around when lifted, whereas stable shoulders prevent energy leakage through maintenance of straight arms and a bar path close the body. It is important to cue the lifter to actively contract and activate the shoulders prior to movement, and to maintain the activation throughout the lift.

BAR TOO FAR AWAY
FROM BASE OF SUPPORT

IRONEDGE

PULL-UP

KEY TECHNIQUE POINTS

- Create a strong hollow body position.
- Use a full grip around the bar and squeeze tight.
- Aim to squeeze the glutes and point the toes throughout the chin up.
- Pull the bar down toward the body, bringing in to touch the top of the chest.
- Always complete a full and complete range of motion.
- Always aim for quality repetitions and complete ranges of motion, sacrificing the total number of repetitions to do so.

The pull-up is a paramount exercise in many programs, designed to develop posterior upper body strength. The upper-body equivalent of the deadlift, the pull-up can be performed almost anywhere and can be used for strength, conditioning or endurance purposes. The mechanical principles discussed throughout the manual still apply to the chin-up, despite the feet being off the ground.

BODY POSITION

Keeping the body aligned during a pull up is important and will make it much easier on the body. By maintaining neutral alignment and bracing through the trunk and glutes, the body becomes a tight, single unit where energy leakage is minimal. This position should replicate the hollow body position described earlier. When the head is not stable, stress is placed on the cervical spine and injury risk increases, and when legs are not engaged and become slack they can increase momentum in a non-efficient path and be detrimental to the performance of a pull-up.

GRIP

- The grip used in a chin up alters the demands of the exercise.
- A traditional overhand grip (pull up) targets the back musculature, namely the lower trapezius and latissimus dorsi.
- A wide overhand grip activates the latissimus dorsi to an even greater degree, as well as the teres major.
- An underhand grip (chin-up) differs slightly in muscle engagement, with greater activation of both biceps brachii and pectoralis major.
- A neutral grip (palms facing each other) again changes the activation of muscle slightly, increasing activation of rhomboids.
- Ideally, various grips are programmed into the training to target maximal muscle activation and strengthen shoulder stability in various positions.

SCALING AND LOADING

As lifting their own bodyweight can be difficult for some clients, assistance in the form of bands may be required in some cases. Using bands can reduce the resistance, and can make pull-ups accessible to those individuals who may need assistance. It can be a great introduction into the pull-up, and through using a range of resistance bands progression can be made simple.

At the other end of the spectrum, there may be clients who can successfully perform many pull-ups continuously. For these clients, the demand can be increased by loading the pull through a weight-belt with weight plates attached. Technique should not alter a great demand with external load..

MOVEMENT SPEED

The cadence of a chin-up is dependent on the technique to begin with. For a strict pull-up, repetitions should occur through a full range of motion and not have any 'kip' involved. Full range of motion involves hang from a 'dead position' (straight arms) at the bottom to a top position where the chin is an equal height to the bar.

A pull-up variation that involves a more rapid movement speed is the 'kipping pull up'. The kipping pull up is a totally different exercise, with different muscle demands. Kipping chin-ups allow the lifter to use momentum to help achieve a repetition, and recruits more muscles (abs/hip flexors/lower back) therefore takes away from developing the upper back. Chins can be performed quicker when they involve a kip, due to the utilisation of momentum to assist in the speed on both the up and down phase. This relates to the differences between a strength squat and a jump squat. In essence they are a similar movement, however the momentum derived from the more powerful movement assists in the performance of following repetitions.

The increased speed on the down phase of a kipping pull-up raises the risk of injury also, as the shoulders must be able to absorb the momentum and then counteract the movement. A weak shoulder complex and insufficient shoulder mobility will increase injury risk with a kipping pull-up.

For a strict chin-up though, no kip should be implemented. This will mean that movement will be a bit slower, but also concentrates the movement on developing the desired strength in the upper regions of the back. Strict chin-ups should be learnt and proficient before kipping chin ups are included in the training program.

PULL-UP

COMMON ERRORS AND CORRECTIONS

Incomplete Range of Motion

The movement is either cut short at the top or the bottom of the chin-up. This limits the muscle development at each end, which is not recommended as it can lead to dysfunctional muscles.

Elbows Finishing Behind the Body at the Top

This causes anterior tilting of the scapula, and places greater stress on the shoulder girdle. Keeping the elbows in line with the body is critical for shoulder joint integrity over time. Cue the lifter to maintain elbows pointing towards the floor, which may assist in alignment.

Loose Core/Glutes

Bracing the anterior core is critical as it sets the whole body up in an effective system to link the kinetic chain, so when the lift occurs the trunk and lower limbs are in compact, secure position which minimises energy leakage. Loose glutes often occur when a bent-leg lifting position is used, as activation in the glutes is restricted by a bent leg and the hamstring shortened state that is a result of the bent legs.

CHIN-UP
CORRECT POSITION

CHIN-UP
INCORRECT POSITION

IN-LINE CHIN-UP VARIATION

WIDE CHIN-UP VARIATION

POWER BAND ASSISTED CHIN-UP VARIATION

RELATED PRODUCTS

Competition Weightlifting Pack

Shop Now

Weightlifting Essentials Pack

Shop Now

Safety Squat Bar

Shop Now

Squat Stands

Shop Now

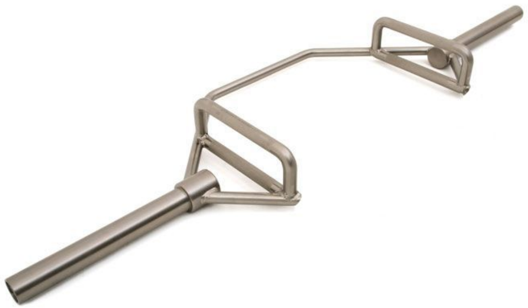
Elite Bumper Plate Set

Shop Now

Wrist Wrap - Standard (Pair)

Shop Now

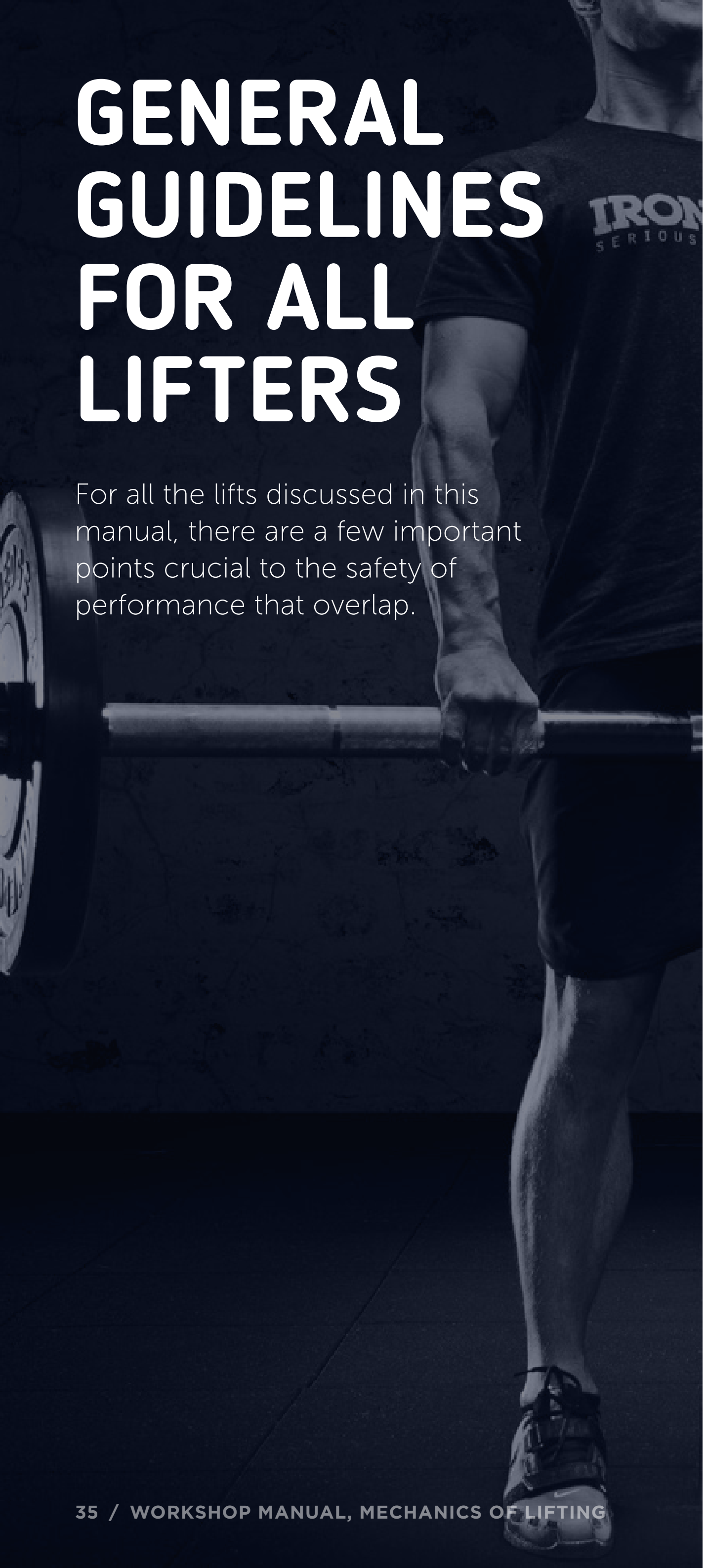
Trap Bar 2.0



Shop Now

20kg Black Hard Chrome Barbell (Bearing)

Shop Now



GENERAL GUIDELINES FOR ALL LIFTERS

For all the lifts discussed in this manual, there are a few important points crucial to the safety of performance that overlap.

TECHNIQUE DIFFERENCES

Importantly, it should be realised by trainers and coaches that everyone's technique is inherently different. Slight differences away from the idealistic form should not be viewed critically, unless they have potential to lead to detrimental adaptations in the future. Technique is not a 'one-size-fits-all' element, and differences in technique between two individuals can still lead to both having safe, efficient techniques.

SCREENING MOBILITY AND FLEXIBILITY OF INDIVIDUAL

Screening movement patterns prior to any lifting is essential. Individuals should be assessed for mobility of the major joints (shoulder, hip, ankle, thoracic, wrist).

Insufficient mobility will limit the range of motion and the ability to get into a correct starting position in a number of lifts. For example, limited shoulder mobility will not allow some people to grip the bar properly for a front squat, hamstring tightness/shortness will increase the strain on RDL's and ankle mobility issues will make squatting to a deep position difficult. However these exercises should not be avoided, as there are tools (straps/heel raises) that can still allow the exercise to be completed while mobility is worked on elsewhere in the training program.

ANTHROPOMETRIC CONSIDERATIONS

If you have ever worked with a group of athletes or a number of clients, you will have realised early on that there are technique differences between individuals. Often, this will relate to subtle differences in limb length and morphological characteristics.

Long or short segments can hamper achievement of certain positions, and the coach should be aware of what can and can't be done by their client/athlete.

Those with relatively long femurs will struggle to get into a deep squat position, and when deadlifting will also have difficulty achieving large hip flexion. Shorter thighs will allow a deeper squat, as the hip has a decreased displacement. In a pressing scenario, shorter arms will be beneficial as the bar has to travel less distance to achieve lock-out, whereas someone with longer arms has to move the bar a greater distance for a single rep.

SOUND TECHNIQUE BEFORE LOAD PROGRESSION

Before lifting with heavy weights or increasing the load of a lift at all, the lifter should be competent at a base level. It can be extremely difficult to achieve 'perfect' form, and everyone will have slight variations in technique, but it is critical to be proficient in the key teaching areas for each lift before increasing resistance.

BALANCE/PROPERTIES OF THE OBJECT BEING LIFTED

Once mastered with a barbell, the squat, deadlift and overhead press can all be performed with other implements. Unstable objects, such as power bags, aqua bags and slosh balls increase the demand on the strength of a lifter due to their unpredictable nature. This is especially true when pressing overhead, as the centre of gravity moves further away from the lifting surface and therefore is easier to drift outside the base of support. It should be ensured that the correct technique is mastered with a more stable load before jumping into using unstable objects.

HEAD POSITION AND NEUTRAL SPINE

Maintaining head position is crucial throughout all lifts. When there is rotation along with compressive forces, injury risk increases immensely. Looking laterally (e.g. trying to look in a mirror) during a squat or deadlift should be avoided, as shifting head position can in turn shift shoulders and rotation is the resultant factor. The head should maintain its position over the shoulders throughout all sections of a lift, with eyes in front of the body or slightly down.

Therefore in a RDL, where the hip flexes and trunk undergoes inclination, the head should move with the trunk and shoulders. Having two reference points for the eyes (one at the start of the lift and one at the finishing position) can assist in making sure the head is tracking in line with the body. Likewise in an overhead press, having the head in line with the shoulders, hips and midfoot allows for an efficient line of force, and also encourages the skeleton to remain strong and support the lift.

When squatting, if eyes are looking at the roof then the head is tilted backwards. This hinders position of the chest and reduces the ability to drive through the hips, whilst again placing the neck and upper spine under enormous pressure and increasing the risk of injury, especially at the bottom of the squat.

SOME GENERAL TIPS FOR IMPROVING LIFTING MECHANICS

As a trainer or coach, it is your duty to ensure the individuals you train are doing so in a safe manner and with correct technique. However different people will require different coaching methods and what follows in this section is a brief description of some handy tips and tools for improving lifting mechanics of your clients.

SCREEN CLIENTS PRIOR TO BEGINNING EXERCISES

There cannot be enough emphasis on this point. Some functional flexibility and mobility screening prior lifting can minimise injury risk and give you, as a coach, a better idea of the capabilities and deficiencies of your client. Assessing hamstring flexibility and joint mobility (ankle/hip/shoulder/thoracic/wrist) may be able to prevent an injury before it happens, and allow for prescription of some flexibility exercises into the training program to assist in training down the track.

TRAINING PROGRESSIONS AND REGRESSIONS OF VARIOUS EXERCISES

In some cases, a client may struggle with a particular section of a lift (e.g. locking out arms in an overhead press, achieving proper depth in a squat, the pull phase of a clean). A good option when this is the case is to break up the exercise into various regressions, and train these as separate exercises. This not only will improve the core lift, whatever that may be, but also can add variety to the training program. An example of such a regression may be including a push-press in the training program for an Olympic weightlifter, as the movement is similar to that required in the clean and jerk.

TRAINING THE SKILL

Certain aspects of lifting do require skill, and like any other skill the more it is effectively trained the more proficient the skill will become[31,32]. Coaches and trainers are critical in the skill-learning process, and effective coaching is required from the start to ensure proper movement patterns.

STAYING TALL AND STABLE

In most lifts it is important to not hunch over or round the shoulders. By staying tall, the lifter will almost automatically achieve neutral spine and decrease the compressive loads on the spine. The head will align over the shoulders and this will set the body in a strong, safe position for movement. Staying upright is vital in the overhead press, the squat and its variations, the deadlift and an array of other resistance training exercises.

Joint stability throughout a lift, regardless of which one, is imperative. Whilst mobility is important for attaining proper technique and range of motion, if a joint is too mobile and not stable enough it can cause issues. Think about the squat; the ankle and hip joints need to be mobile to achieve sufficient dorsiflexion and flexion, however the knee joint has to remain stable to prevent valgus and maintain the position of knees over toes.

GLOSSARY

BASE OF SUPPORT

The area bordered by the points of contact between a body and a surface.

BIOMECHANICS

The combination of mechanical concepts of motion to biological scenarios.

BRACING

A technique involving co-contraction of trunk musculature to stabilise the spinal column and protect from injury.

CENTRE OF MASS

Pinpoint area at which the mass and weight of the body is perfectly balanced.

COMPRESSION FORCE

Any force which acts to reduce the length of the body it is acting upon.

CONVENTIONAL DEADLIFT

A deadlift movement with hands gripping the bar on the outside of the knees, with feet inside the arms.

ENERGY

Describes the capacity to perform mechanical work.

FORCE-VELOCITY CURVE

Describes the parabolic relationship between force and velocity. When force is high, velocity must be low and vice-versa.

FRONT SQUAT

A squatting movement performed with the barbell positioned across the front of the deltoids.

GROUND REACTION FORCE

The force from the ground returned into a body, proportional to the force the body exerted on the ground.

HIGH BAR BACK SQUAT

A squatting movement performed with a barbell positioned on the upper back, across the upper trapezius muscles above the acromion.

HOLLOW BODY

A position whereby the spine is straight and head aligned with the spine, to train stability through the mid-section.

ISOMETRIC CONTRACTION

Contraction of a muscle that does not result in a change of length of the muscle.

KINETIC CHAIN

The sequencing of force production and movement throughout the body.

KINETIC ENERGY

The energy of a body in motion.

LEVER

A simple mechanical machine, made up of a rigid structure that can be made to rotate around a pivot point.

LINE OF FORCE

An axis through the body outlining the direction of which force is produced in a movement.

LOW BAR BACK SQUAT

A squatting movement performed with a barbell positioned across a shelf formed by the rear deltoids, slightly below the acromion.

MOMENT ARM

The perpendicular distance between the axis of rotation and the line of action.

NEUTRAL SPINE

Natural position of the spine, with regular cervical, thoracic and lumbar curves. This position reduces stress through the vertebrae and will reduce injury risk.

POWER

The ability to produce force over a period of time.

ROMANIAN DEADLIFT

A deadlift performed with almost straight legs, involving almost exclusively hip extension, with very little knee extension or quadriceps involvement.

ROTATIONAL FORCE

See torque.

SHEAR FORCE

A sliding force that acts parallel to the body surface that it is working upon.

SUMO DEADLIFT

A deadlift movement with the hands gripping the bar medial to the knees, with feet outside the arms.

TENSION FORCE

Any force which acts in a pulling or stretching fashion, to lengthen the body that it is acting upon.

TORQUE

Force multiplied by moment arm length, describes the rotary effect of force around a fulcrum.

TRAP BAR

A specially designed barbell for deadlifting, whereby the lifter essentially stands in between the two lateral barbell sleeves. Allows for a more upright trunk position when deadlifting, reducing lumbar force and allowing for heavier loads to be lifted.

WORK

The amount of force applied against a resistance multiplied by the change in distance travelled.

REFERENCES

1. Grimshaw, P., et al., BIOS *Instant Notes in Sport and Exercise Biomechanics.* 2004: Psychology Press.

2. Adams, M.A. and P. Dolan, *Spine biomechanics.* Journal of biomechanics, 2005. 38(10): p. 1972-1983.

3. Blazevich, A., *Sports Biomechanics: The Basics: Optimizing Human Performance.* 2007: A&C Black.

4. Boyle, M., *Functional training for sports.* 2004: Human Kinetics 1.

5. Boyle, M., *Advances in Functional Training.* Santa Cruz, Calif: On Target Productions, 2010: p. 31-56.

6. Hall, S.J., *Basic biomechanics.* 2007: McGraw-Hill Boston, MA:.

7. Behnke, R.S., *Kinetic anatomy.* 2012: Human Kinetics 1.

8. Rippetoe, M., *Starting Strength: Basic Barbell Training.* 3rd Edition ed. 2011, USA: The Aasgaard Company.

9. Newton, R.U. and W.J. Kraemer, *Developing explosive muscular power: implications for a mixed methods training strategy.* Strength & Conditioning Journal, 1994. 16(5): p. 20-31.

10. Lyman, S., et al., *Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers.* The American journal of sports medicine, 2002. 30(4): p. 463-468.

11. McGill, S.M., *Linking latest knowledge of injury mechanisms and spine function to the prevention of low back disorders.* Journal of Electromyography and Kinesiology, 2004. 14(1): p. 43-47.

12. Troke, M., et al., *A new, comprehensive normative database of lumbar spine ranges of motion.* Clinical rehabilitation, 2001. 15(4): p. 371-379.

13. Billson, J.H., et al., *Comparison of home-and gymnasium-based resistance training on flexibility in the elderly.* South African Journal for Research in Sport, Physical Education and Recreation, 2011. 33(3).

14. Morton, S.K., et al., *Resistance training vs. static stretching: effects on flexibility and strength.* The Journal of Strength & Conditioning Research, 2011. 25(12): p. 3391-3398.

15. McGill, S.M., A. McDermott, and C.M. Fenwick, *Comparison of different strongman events: trunk muscle activation and lumbar spine motion, load, and stiffness.* The Journal of Strength & Conditioning Research, 2009. 23(4): p. 1148-1161.

16. Cholewicki, J., M.M. Panjabi, and A. Khachatryan, *Stabilizing Function of Trunk Flexor-Extensor Muscles Around a Neutral Spine Posture.* Spine, 1997. 22(19): p. 2207-2212.

17. Hamlyn, N., D.G. Behm, and W.B. Young, *Trunk muscle activation during dynamic weight-training exercises and isometric instability activities.* The Journal of Strength & Conditioning Research, 2007. 21(4): p. 1108.

18. Clark, D.R., M.I. Lambert, and A.M. Hunter, *Muscle activation in the loaded free barbell squat: A brief review.* The Journal of Strength & Conditioning Research, 2012. 26(4): p. 1169.

19. Newton, H.S., *Explosive lifting for sports DVD.* 2005: Human Kinetcs.

20. Gullett, J.C., et al., *A biomechanical comparison of back and front squats in healthy trained individuals.* The Journal of Strength & Conditioning Research, 2009. 23(1): p. 284-292.

21. Chandler, T.J. and M.H. Stone, *The squat exercise in athletic conditioning: A position statement and review of the literature.* CHIROPRACTIC SPORTS MEDICINE, 1992. 6: p. 105-105.

22. Fry, A.C., J.C. Smith, and B.K. Schilling, *Effect of knee position on hip and knee torques during the barbell squat.* The Journal of Strength & Conditioning Research, 2003. 17(4): p. 629-633.

23. Escamilla, R.F., et al., *A three-dimensional biomechanical analysis of the squat during varying stance widths.* Medicine and science in sports and exercise, 2001. 33(6): p. 984-998.

24. Caterisano, A., et al., *The effect of back squat depth on the EMG activity of 4 superficial hip and thigh muscles.* The Journal of Strength & Conditioning Research, 2002. 16(3): p. 428-432.

25. Cholewicki, J., S. McGill, and R. Norman, *Lumbar spine loads during the lifting of extremely heavy weights.* Medicine and science in sports and exercise, 1991. 23(10): p. 1179.

26. Escamilla, R.F., et al., *A three-dimensional biomechanical analysis of sumo and conventional style deadlifts.* Medicine and science in sports and exercise, 2000. 32(7): p. 1265-1275.

27. Escamilla, R.F., et al., *An electromyographic analysis of sumo and conventional style deadlifts.* Medicine and science in sports and exercise, 2002. 34(4): p. 682-688.

28. Swinton, P.A., et al., *A biomechanical analysis of straight and hexagonal barbell deadlifts using submaximal loads.* The Journal of Strength & Conditioning Research, 2011. 25(7): p. 2000-2009.

29. Graham, J.F., *Exercise: deadlift.* Strength & Conditioning Journal, 2000. 22(5): p. 18.

30. Gentry, M., D. Pratt, and T. Caterisano, *STRENGTH TRAINING MODALITIES: Introducing the Trap Bar.* Strength & Conditioning Journal, 1987. 9(3): p. 54-56.

31. Chiu, L., *Powerlifting versus weightlifting for athletic performance.* Strength & Conditioning Journal, 2007. 29(5): p. 55-56.

32. Piper, T.J. and L.D. Erdmann, *A combined weightlifting/powerlifting program.* Strength & Conditioning Journal, 1998. 20(6): p. 15-19.

33. Eric Cressy (2007, July) *20 Things from Dr. McGill.* Retrieved from http://www.ericcressey.com/20-things-from-dr-mcgill-2-of-4

IRONEDGE

P: 1300 85 40 50 | IRONEDGE.COM.AU

OFFICE: 244 ST KILDA RD, ST KILDA