SHOULDER INJURIES

prevention & treatment

A SPECIAL REPORT FROM

PEAK PERFORMANCE

The research newsletter on stamina, strength and fitness

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From the publisher

If, as somebody once said, the knee was designed when God's attention was distracted, the shoulder was created when He was at the height of his powers. Consider what the shoulder does, and how many athletes – swimmers, tennis players, bowlers, baseball pitchers, javelin throwers – take it for granted. The shoulder can assume no less than 1,600 different positions and, as Dr Simon Kemp points out early in this special report, there is more movement at the shoulder joint than at any other joint in the body. A truly remarkable invention.

Until it goes wrong! I'm not suggesting that God is anything less than infallible, but even He couldn't have anticipated the stress and punishment that the shoulder is subjected to in the modern sports world. And that's where this special report comes in. Prepared by the combined experts of *Peak Performance* and *Sports Injury Bulletin*, it looks at every aspect of shoulder care and injury prevention. It starts with an overview on the subject by an eminent physiotherapist, who also includes a number of canny DIY ideas for improving performance and avoiding injury. This is followed by a study of rotator-cuff injuries, the most common cause of shoulder pain, and a number of exercises designed to prevent them. Thereafter, three distinguished surgeons take the knee apart, literally, and explain how and why it goes wrong and what you can do about it. And that's not all...!

I hope you enjoy this special report and find it useful.

J. A. Pye.

Jonathan A Pye
Publisher

For athletes who rely on their shoulders, here are the five main ingredients for keeping them injury-free

There is perhaps no joint in the human body as complex, fascinating, or baffling as the shoulder. It can leave clinicians scratching their heads, wondering why a problem they have solved many times before is this time so stubborn. And shoulder problems can certainly be stubborn! That's why, in every case, prevention is so much better than cure. Rarely is a pain that has surfaced a simple matter of applying some ice – it is more likely to be the tip of an iceberg!

An athlete's shoulder is either a joint that he/she has never given a second thought to, or it is ever-present in their minds – it is either no problem, or a problem they cannot ignore. It has been said that the design elements that make up the shoulder are either near perfection, or near disaster! Now, of course, this greatly depends on the sport you are in: cross-country runners are unlikely to have the shoulder difficulties that javelin throwers or swimmers may encounter. However, it is rare for athletes who use their shoulders as part of their main routine not to carry at least a niggling pain, while many have a history of a significant shoulder problem.

This article takes a good look at the big picture of shoulder injury management, and tries to empower and educate athletes with some DIY home injury prevention and performance enhancement techniques. It aims to present, as simply as possible, some complex concepts, and is therefore in no way an exhaustive explanation or listing of exercises, just a sufficient one.

Preliminary precautions

If you have a shoulder injury and would like to try to treat yourself, please remember:

- It would be wise to rule out structural damage first, via X-rays, CT-scan, US scan or MRI, particularly if your shoulder joint experiences sharp catching pains, locking sensations, clunks, pins and needles or numbness, looseness or laxity, or if the history of the injury was in any way traumatic, involving body contact or a fall.
- The length of time it took to develop your problem will give you some indicator of how long you will need to persist with correcting the faults before the results will be felt. Don't forget, as I've said, that the pain is often only the tip of the iceberg, directing you to the real issue.
- However intelligent and self-aware you are, you will probably need the help of professionals – for treatment, guidance, feedback and motivation.
- Some treatment 'pain' is allowed, but only really what is associated with muscle fatigue as opposed to soft-tissue strain (therapeutic massage is an exception: no pain, no gain!).
- If you are already training and competing at high levels and have no difficulties with your shoulder, then be extremely careful how many new exercises you take on during the competitive season. It's better to wait until the off-season to make sure you don't overload your shoulder or throw it off balance by adding new demands.

Treatment, prevention and performance enhancement

The advice that follows relates to the prevention and treatment of overuse injuries of the shoulder, not the management of acute or traumatic injuries (see later in this special report) such as glenohumeral dislocation, clavicular fractures, or tears of the labrum ('cartilage').

However, the broader principles of rehabilitating a shoulder that has been surgically repaired, or been stuck in a sling for four weeks, are no different, although there may be restrictions and time constraints imposed by orthopaedic surgeons.

The most important principle of shoulder management is: start working on it now. Don't wait until your shoulder starts to hurt!

But, in addition, the preventative measures outlined below are guaranteed to improve your performance – they will genuinely improve the way your shoulder works, and thus it will be stronger, more coordinated, reach further and last longer before fatigue sets in. All the experts say it: injury prevention equals performance enhancement.

Some simple anatomy of the shoulder complex

The shoulder joint actually comprises four joints – see if you can feel them on yourself:

- Sternoclavicular (SC) joint (between the sternum and the collar bone) – this is actually the only bony connection that the shoulder has with the main skeleton;
- Acromioclavicular (AC) joint (between the collar bone and the point of the shoulder called the acromion, which is part of the scapula or shoulder blade);
- Glenohumeral (GH) joint between the glenoid part of the scapula – the socket – and the head of the humerus (HOH) – the ball; and the
- Scapulothoracic (ST) joint (the 'false joint' between the scapula and the rib cage that it rides over).

The GH joint is the most susceptible to injury as it is entirely dependent on non-bony connections for integrity. Whereas the hip joint (also a 'ball and socket joint') has a deep socket formed by the bone of the pelvis, the GH joint relies on the balance, strength and control of muscles, ligaments/capsule and labrum (cartilage) to function properly. The labrum acts like the edges of a skateboarding rink in preventing the HOH from spinning/sliding too far from the centre as it acts to deepen the socket. In an attempt to describe the delicate balance of the HOH sitting on the scapula, the GH joint has been likened to a seal balancing a ball on its nose.

The rotator-cuff muscles

Without learned muscle control, any overhead activity, let alone just lifting the arm, would be impossible – the GH joint would dislocate or the HOH would jam under the arch of the acromion. The muscle group we rely on for this control is the rotator-cuff (RC) muscles – the infraspinatus, supraspinatus, teres minor, and subscapularis muscles (an anatomy book will show where they lie). They all originate from the scapula and are coordinated together to keep the HOH spinning/rotating as close to the centre of the glenoid as possible with movement. The long head of biceps tendon running over the front of the GH joint also has a stability role to play in conjunction with the RC, especially with the throwing action.

The muscles primarily designed to position the scapula for overhead movement are the trapezius (especially lower trapezius), and serratus anterior – called therefore the 'scapular stabilisers' – with counterforces being produced by levator scapulae, rhomboids and pec minor muscles.

The larger and more powerful muscles that generate movements of the arm are the deltoids, latissimus dorsi, and pectoralis major. So while the RC muscles coordinate the proper positioning of the HOH by acting close to the centre of the joint (the 'inner core'), the larger muscles with long lever arms move the arm with speed and force (the 'outer core').

The five ingredients: balance through control

Let us now unpack what could be considered the five most essential ingredients for an athlete whose main weapon is the shoulder:

1. Sports-specific technique.
2. Flexibility.
3. Core stability.
4. Rotator-cuff control.
5. General strength.

The primary goal of these five areas of intervention is, in a word, balance. And the way to achieve it? Control. The higher your levels of performance, the greater the control required to maintain balance – just as a Formula 1 car needs much higher levels of balance and control than does a standard road car. A deficit in any one area will ultimately cause muscle imbalances to develop, which lead to soft-tissue breakdown and later even joint degenerative change. Picture a bike wheel where one spoke in the wheel is bent out of shape: a gradual warping takes place with use which creates an imbalance that further damages other spokes until the whole system comes to a grinding halt.

The more elite the athlete, the more committed he/she needs to be to getting professional help in fulfilling and maintaining these principles. You will also save yourself much time and anguish if you seek experienced help as a preventative measure, rather than only asking for treatment once the problem has surfaced. Having a regular tune up/service can be done in the form of screening, where a sports-experienced physiotherapist will run you through a series of tests to find out if any of the areas below are not being adequately dealt with.

1. Sports-specific technique

Poor performance and shoulder pain very commonly originate in bad habits of technique. Often they are only clearly seen when muscle fatigue sets in. However, a good coach will be able to pick up when this is happening and realise it's time for rest and recovery.

As a general rule, technique work should be done after a thorough warm-up (or even as part of a warm-up), while the muscles and the brain-connections are still fresh and strong. On the other hand, when fatigue sets in can occasionally be a good time to do specific drills that do not load the shoulder, yet will reinforce good movement patterns. The only proviso is that one must be extra diligent to see when compensation strategies are setting in, and call a halt immediately.

Without wanting to state the obvious, practice is the key! Once you have mastered a new aspect of technique it must be repeated around 10,000 times before it becomes an engraved on your brain, in other words, the point at which the movement pattern becomes subconscious and feels ‘natural’.

There are many ways to find out if your technique is faulty, but one of the best is video recording in order to slow down the action and break it into smaller components. The better the technology, the better the result, but for real value it comes down to the experience of the person evaluating the picture. Using a mirror is rarely effective since the position of the head focusing on the mirror can greatly affect the shoulder position. The two most important sources of feedback in this regard are your coach and a biomechanist, and often a sports physiotherapist who has had a lot of experience in your sport.

What faults to look for

The variety of overhead movements required for each sport gives rise to very subtle and unique technique faults. The following are some examples of what to look out for:

Tennis serve/smash: insufficient trunk twisting to open up chest in cocking position, ball toss too close to body or too far behind body, cutting follow-through short by whipping racquet.

Javelin/water polo/baseball throw: side-arm action, elbow behind the shoulder during follow-through, insufficient trunk rotation at late cocking phase to open up the chest and at end of follow-through to dissipate forces after release of the object. The closer the line of the upper arm can follow the line of the front of the chest, the less strain there will be on the shoulder joint, and the more rotation that can be harnessed from the shoulder, the less the strain on the elbow joint.

Freestyle swimming: insufficient body roll, only ever breathing to one side, catching the water too close to the midline, not keeping the shoulder blade stabilised on the trunk during pull phase, not keeping the elbow high enough during recovery phase (a sign of insufficient flexibility).

2. Flexibility

The purpose of flexibility varies for the different muscles around the shoulder. For the major power muscles, it is important that flexibility allows freedom of movement for the pelvis, trunk, scapula, and humerus. For the rotator cuff, the critical issue is the balance of forces centring the head of humerus, and to a lesser degree, freedom of movement. It is more critical that the internal and external rotators are equally flexible, rather than how flexible they are.

A warning: to have too much flexibility at the expense of strength and control can be dangerous because of the excessive shear forces causing wear and tear in the joint. This is particularly true of the glenohumeral joint where the primary source of stability are the rotator-cuff muscles working in conjunction with other soft-tissue structures such as the capsule, ligaments and cartilage. Too much flexibility at the expense of muscle control puts strains on the soft tissues and causes injuries such as rotator-cuff tendinitis and degeneration, labral tears, subluxations and possibly even a dislocation.

Do not begin a flexibility programme until you have seen a sports doctor or physiotherapist if:

- your shoulder has ever had an episode of instability, such as rapidly popping out and in again, or if it has ever dislocated;
- you have other joints in your body that are very loose, or double-jointed, eg your elbows bending too far back; or
- your shoulder clunks or pops excessively.

Stretching

Stretching to increase flexibility should never be done prior to training or competition, but instead done during ‘down’ times in the week. This is because of the suppression of the ‘stretch reflex’ that takes place during sustained passive stretching of muscle tissue (ie repeated holds of 20-30 seconds). If one were to do rapid forceful movements such as throwing straight after such passive stretching, there would be an increased chance of muscle and tendon tears. For flexibility every muscle needs to be stretched three to four times at 20-30 seconds each, and repeated three to four times per week.

The most important areas for regular flexibility sessions are:

- Infraspinatus/teres minor (posterior rotator cuff and capsule).
- Pectoralis major/minor.
- Latissimus dorsi.
- Biceps/triceps.
- Thoracic spine (between shoulder blades).
- Upper trapezius/scalenes/levator scapulae.
- Gentle nerve stretching (oscillations).

The best way to learn how to stretch the above areas is to be taught by a sports physiotherapist, sports conditionist or personal trainer.

It is important not to stretch the ligaments of the shoulder, which in due time can cause laxity of the joint and potential instability. The most common example I see? Athletes stretching their pec muscles and ending up with their arm behind them against the wall, but with their shoulder rolled forward, feeling the stretch on the front of the point of the shoulder.

What's being stretched here are the anterior ligaments ('capsule'), not the muscle, which is better stretched by pulling the scapula back and twisting from the trunk away from the shoulder (hand still on the wall). One then feels the stretch a lot more down on the chest area where it should be.

Warm-up practice and theory

The shoulder should be warmed up thoroughly with gradually increasing movements – big circles, across-body movements, trunk twists, shoulder-blade rolls and forward and backward squeezes. The purpose of this is to increase blood flow and temperature, thereby increasing the elasticity and 'give' in the soft tissues. A series of short-duration stretches (ie five to ten seconds) of all the main muscle groups should follow and then finally a session of more sports-specific drills. These are used to warm up the brain's connection to the muscle, ie to reinforce correct motor patterns, and also to set the right neural reflexes in the muscle.

Massage

One of the most important functions of massage is to reduce the build-up of 'trigger points' – areas in the muscle that literally seize up due to excessive loading. This may cause a muscle imbalance or be the result of one – either way it must be 'released' via massage. All the muscles described above that are necessary to stretch are susceptible to trigger points and can become tight and/or weak because of them. It is not uncommon for a trigger point to develop in the muscle as the first structure to begin breaking down, slowly dragging other muscles, nerves, and the glenohumeral joint down into a cycle of pain and inflammation.

The best way to begin is to get a hard tennis ball to do your massage with, then try these two ideas:

Pectoralis minor/ major 'release': This is a critical muscle to keep loose because if becomes too tight, it binds the scapula forward, resulting in the head of the humerus being thrown off centre, especially in overhead positions. Hold the tennis ball to the soft muscle overlying the chest right at the front of the shoulder. Lean towards a door frame and allow the tennis ball to press against it, with the same side arm halfway up the wall, palm facing towards the wall. Search for the tender trigger points, and when you find one, stay with the pressure on to it until it softens and the pain eases.

Rotator cuff 'release': Often accompanying the above condition is tightness and overactivity of the infraspinatus and teres minor, the net effect of which is also to push the head of the humerus forward from its centre of rotation. Hold a tennis ball to the back of the shoulder on the scapula, and press the back and side of the scapula onto the wall. The arm that is being worked on should be cradled in the opposite hand. Allow it to dig deep!

3. Core stability

Core stability has become a whole science in itself in the last decade as all manner of sports professionals have realised how critical it is for the inner core of the body, namely those joints closer to the spine, to be supported by the postural muscles designed to do so. For the shoulder, the critical areas are the lumbar and cervical spine, and the scapulothoracic joint. If these areas are not stable, then significant extra loading and strain will be passed on to the shoulder joint.

The stability of the lumbar spine is achieved by the combined effects of transversus abdominis and multifidus acting on the thoracolumbar fascia. Pulling in the lower navel area while tensing the lower-back muscles slightly activates the 'corset'. The cervical spine is stabilised by the upper cervical flexors in conjunction with the lower cervical extensors, to achieve a 'tall' neck position with the chin slight drawn into the neck. Keep in mind that this is easier for some than others, depending on how your body has been trained – for instance, ballet dancers will find the stable position of the neck comes naturally, rugby players may not. Activating the muscles is the first stage of the learning process; practise the position until you are ready to incorporate it into simple movements that are relevant to your sport.

The scapulothoracic joint is the most relevant 'joint' for the shoulder, because the glenohumeral joint is formed by the glenoid (the socket) of the scapula and the humerus (the ball). The muscles most directly responsible for its stability are the trapezius muscle (especially its middle and lower fibres) acting with the serratus anterior muscle – together they act to hold the scapula in a neutral position whether the arm is by the side or above the head. The neutral position is where the glenoid socket is most ideally orientated for the rotator cuff to control the HOH .

Imitate the action of the seal

Remember the earlier picture of a seal with a ball on its nose? The seal is the scapula trying to balance the ball of the humeral head using the rotator-cuff muscles. How amazing it is to think that such high levels of balance are being utilised when we do overhead activity!

Deficiencies of core stability are always found with chronic shoulder injuries, or after surgery or trauma, because pain tends to inhibit the postural muscles so they cannot do their job properly.

The way to activate the lower trapezius/serratus anterior muscles is to sit in a relaxed tall posture, arms relaxed across your thighs. Gently pull the inner borders of your scapula together and down with the minimum of effort, and hold it there for 10 seconds. Don't pull too far back or you will over-activate other muscles that are not designed to be the main core stability muscles – it is always a subtle and relaxed action with a 10-second hold. When you have practised this for a few days as often as you can, experiment with 'setting' your scapula into the neutral position with your arms out to the side, with your arms on your hips, up behind your head, etc.

Once you have mastered the 'setting', add small movements of your arm while holding the set position, and gradually over a few weeks you can increase the complexity, speed and loading of your arm. Finally you are doing the setting at the same time as you are carrying out the rotator-cuff strength and control exercises described below.

4. Rotator-cuff strength and control

The rotator-cuff muscles are dependent on the good positioning of the scapula for effective control. If the scapula is angled too far forward or downward, for instance, while the tennis player reaches overhead to smash, the RC muscles are biomechanically disadvantaged and may fail to keep the HOH centred. The role of the RC muscles therefore is to maintain the position of the HOH while the prime mover muscles generate power.

As you improve your scapular control, the RC muscles are able to act more efficiently and independently of the scapular control muscles. That is to say that you should be able to hold the scapula quite still in the neutral position while you independently move your arm. This skill is called 'glenohumeral dissociation'.

Thus with each of the exercises following, it is assumed that the scapula is being held as close as possible to neutral:

Internal/external rotation with arm by the side. Standing. Rolled towel held between elbow and ribs. Attach one end of an elastic or theraband to a door knob and hold the other end in your hand with elbow bent 90 degrees. Set scapula. Slowly pull across body at the same time – 3x10 pulling to right, 3x10 pulling to left.

Internal/external rotation with arm at 90 degrees away from body. Lying on back. Attach one end of an elastic or theraband to a chair leg and hold the other end in your hand with elbow bent 90 degrees resting on ground. Set scapula. Pull hand forward until limit of flexibility and slowly release – 3x10. Opposite movement – pulling hand up above head – 3x10.

End-of-range gentle flicks. Standing. Elastic tied to doorknob. Face away from doorknob, holding arm up above head with elastic in hand on tension. Allow arm to slightly drop backwards from elastic tension, pull forward slightly on tension. Repeat slowly, gradually increasing speed and tension over the following two or three weeks. Monitor any shoulder soreness the next day to determine whether you've gone too hard!

Stand facing wall with ball (Swiss or other) held up on wall at head height. Step back so you're leaning onto ball. Set scapula. Make small circles on the wall with outstretched hand on ball – 5x10 anti/clockwise each. Rest and repeat.

Squeeze tennis ball in hand. Go through throwing motion slowly while squeezing ball. Set scapula at outset of throw, slowly releasing and doing an exaggerated follow-through with whole-body motion. Repeat 10-20 times. Excellent for co-contraction of RC muscles to increase their activity and control of the HOH.

5. General muscle strength

Once the foundational issues of technique, flexibility, core stability, and rotator-cuff control are being implemented, we must look at the bigger picture of the 'outer core'. What is the rest of your body like – does it help or hinder the performance of your shoulder?

In every sport that relies heavily on the shoulder, it is vital to see it as only one link in a ‘kinetic chain’ – all the other links must also be sufficiently developed to aid in the development of rotary torque or the shoulder will be overloaded. There is a ‘winding up’ and an ‘unwinding’ that takes place at a rapid speed starting from the legs, progressing through the hips, pelvis, lumbar spine, thoracic spine, shoulder, elbow, and wrist. And each must be taught to absorb its fair share. Golf is the classic sport to use as a clear example of this transfer of rotary power – a series of wind-ups finally being unwound as the stable base of the hips whips back in the opposite direction.

To this end there is a whole section that could be written on the value of plyometrics, the exercise science concerned with harnessing the eccentric strength of muscles to gain greater power. The rotary power of the body is greatly strengthened by developing the eccentric contraction strength between the kinetic links described earlier – and this is where medicine balls, harnesses, and other strength and conditioning equipment come in.

Avoid this imbalance

It is clear to most athletes that a gym routine needs to include strengthening work for the deltoids (three heads), latissimus dorsi, pec major, upper trapezius, and the rectus abdominis because they are the prime movers of the shoulder. Often what is critically overlooked, however, is the imbalance that can develop between the front of the shoulder and the back.

In those athletes that are carrying an overuse injury in the shoulder, nine times out of ten they have overdeveloped pecs and lats relative to their trapezius, rhomboids, posterior deltoids, and posterior rotator cuff. In these situations, flexibility must often be improved, scapular setting must be taught, and the focus of gym exercises changed towards the back. Seated and upright row, dumbbell flies for the back, bench pull, and lat pull-downs with the bar behind the head are all exercises that must take greater priority.

During all gym work it must be stressed that scapular setting and the activation of core stability muscles for good posture are vital for injury prevention.

Summary

So there we have it – the big picture of injury prevention and performance enhancement for athletes who depend on their shoulders for playing their sport. Decide today which one of these issues you might need some more work on, try some of the home exercises, and perhaps seek professional help to maximise the results of your efforts.

Ulrik Larsen

A specialist in treating sports injuries explains how overhead athletes can prevent chronic shoulder pain

Does your shoulder ache after overhead activity? Is it getting worse and now restricting that activity? Has a period of rest apparently resolved the problem only for the pain to recur when you returned to sport? Chronic shoulder pain is unfortunately an all-too-common consequence of repetitive 'overhead activity', such as serving and smashing in tennis, freestyle or butterfly swimming, bowling in cricket, javelin, or baseball throwing and above-shoulder weight-training exercises. Chronic pain in the 'overhead' athlete is usually the result of damage to the rotator-cuff muscles of the shoulder (a group of four, small, deeply situated, strap-like muscles). This article will look at how such repetitive damage is caused and how the athlete may be able to prevent it occurring in the first place.

Structure of the shoulder

As Ulrik Larsen has already explained in the previous article,the shoulder joint complex is in fact made up by four joints: the glenohumeral joint (the 'ball-and socket' joint between the upper arm or humerus and the shoulder blade or scapula, which most non-experts consider to be the shoulder joint), the acromioclavicular joint (the joint between the lateral end of the collar bone or clavicle and the scapula), the sternoclavicular joint (the joint between the medial end of the clavicle and the breast bone or sternum) and the scapulothoracic joint (the 'virtual' joint between the undersurface of the scapula and the chest wall). Problems at any of these four joints may result in ineffective function of the shoulder-joint complex and consequently pain.

There is more movement possible at the shoulder joint than at any other joint in the body. Over 1,600 positions in three-dimensional space can be assumed by the shoulder. The price to be paid for such an extreme range of movement is an inherent lack of stability.

To achieve peak performance during overhead activity, there must be optimal balance between mobility and stability. It is well known that swimmers who over-stretch their shoulders in an attempt to increase the range of their stroke, without improving their functional stability, are at increased risk of injury to the rotator cuff. Tennis players and throwing athletes, activities that are essentially asymmetrical, tend to develop greater shoulder external rotation in their dominant shoulder and this is commonly associated with functional instability. Shoulder-injury prevention strategies need to focus on improving shoulder stability.

Impingement and the rotator cuff

The bony anatomy of the glenohumeral joint comprises a large ball (the head of the humerus) and small socket (the glenoid of the scapula) with the muscles of the rotator cuff and scapular rotating (stabilising) muscles acting as the most important dynamic stabilisers of the joint. The muscles of the rotator cuff envelop the glenohumeral joint itself, and comprise the supraspinatus, infraspinatus, teres minor and subscapularis muscles. Supraspinatus abducts the arm (moves it laterally away from the side of the body), infraspinatus and teres minor externally rotate the shoulder, and subscapularis is principally an internal rotator of the shoulder. Sitting above the cuff is the coracoacromial arch, made up of the coracoid and acromion bony processes of the scapula and a ligament connecting the two processes. As the arm is abducted away from the body or flexed (brought forward), 'impingement' or squeezing of the rotator cuff between the head of the humerus below and the coracoacromial arch above can occur. The healthy, conditioned rotator cuff functions effectively as an integrated unit to stabilise and depress the head of the humerus, opposing the action of the large deltoid muscle and thereby preventing impingement.

Any overhead activity that involves the arm being taken often enough from below the shoulder level to above shoulder level has the capacity to damage the rotator cuff. With repeated impingement, a poorly conditioned cuff can become damaged, and a cycle of cuff damage, impaired function, further impingement and worsening cuff damage is initiated.

This form of primary impingement is most commonly seen in weight trainers who overemphasise the development of their 'prime moving muscles' (pectoralis major, latissimus dorsi and deltoid) at the expense of their rotator cuff. It seems to be increasingly common in athletes as they reach their thirties. Primary impingement is preventable and, if the cuff is appropriately conditioned, exercises such as behind-the-neck press, incline bench press and extended front laterals, will not lead to pain.

Differences in the shape and bony configuration of the undersurface of the acromion may dispose an athlete to this particular injury. A Type II (curved) or Type III (hooked) acromion will reduce the effective space through which the supraspinatus tendon slides during abduction. Plain X-rays should enable these two variations to be identified.

Secondary impingement refers to impingement secondary to underlying glenohumeral instability, when the rotator cuff is fatigued by its efforts to keep the humerus centred on the glenoid and consequently allows the head of the humerus to ride up, reducing the subacromial space. This is probably the most common mechanism of cuff injury seen in younger athletes, particularly those with increased joint laxity, and is seen frequently in swimmers and throwers. The primary problem here is instability and, unless this is treated, pain will be ongoing and progressive.

Scapular stability

A strong and healthy rotator cuff is essential to the overhead athlete. In recent years, the role of the scapula-stabilising muscles in positioning the glenohumeral joint for optimal rotator-cuff function has been increasingly emphasised. Coordinated action of this group of muscles is needed to provide a stable base for pain-free overhead activity. The overly simplistic 'ball and socket' model of the shoulder joint has been superseded by a model similar to the performing seal that can balance a ball on its nose. The seal equates to the scapula, and constant small adjustments by the seal (scapula) are needed to prevent the ball falling off its nose (glenoid). Overhead athletes must be able to effectively control the position of their scapula for optimal cuff function.

Injury prevention strategies

Most cuff injuries can be prevented relatively simply. The crucial point is not to overwork the rotator cuff by increasing shoulder work too rapidly. Keeping increases in workload to less than 10% per week will significantly reduce the risk of injury.

The important balance between stability and range of shoulder movement has already been emphasised. Athletes with access to sports medicine support will benefit from a formal assessment of dynamic shoulder function. This should encompass a comprehensive review of static and dynamic anatomy, range of motion at all four joints of the shoulder joint complex, muscle strength and balance (particularly of the rotator cuff and scapular stabilisers) and an assessment of inherent glenohumeral stability in all three planes. Significant abnormalities detected need to be addressed and corrected. Such screening is becoming increasingly routine for the more elite overhead athlete and validated assessment and treatment protocols have been defined.

Technique should be evaluated by the coach and appropriate technical changes integrated into the rehabilitation programme.

The role of the kinetic chain

Increasingly, the role of force generation by other body components is being assessed. For instance, the power generated by the shoulder in the tennis serve has been preceded by power generated by the legs, trunk and back. The muscle mass of the shoulder is relatively small, and if inadequate power is generated by the preceding links in the kinetic chain the shoulder has to play 'catch-up' and generate power rather than acting as a force regulator. Improving the server's leg action, lumbar strength and trunk rotation during the serve will reduce the incidence of rotator-cuff injury. Such biomechanical analysis is difficult but, in skilled hands, is a crucial and effective element in injury prevention.

How can an athlete prevent injury?

Although shoulder rehabilitation protocols after injury need to address subtle muscle imbalances and joint restrictions, and thus need supervision, isolated rotator-cuff strengthening exercises can be very effective as part of a pre-participation conditioning programme and can be done using the following three simple exercises. The key is to strengthen the internal rotator (subscapularis), external rotators (infraspinatus and teres minor) and abductor (supraspinatus) muscles of the shoulder. This is most easily and safely done using the variable resistance of a cliniband – a length of flat rubber available from large chemists in varying resistances. You will need about two metres; start with the lowest resistance and work up!

To strengthen the right scapularis muscle, start by holding your right arm by the side of your body with your elbow bent/flexed at 90 degrees (the forearm will be at right angles to the upper arm and the line of the forearm points forward). Attach or loop one end of the cliniband over a door handle to the right of your body and hold the other in your right hand. Internally rotate your humerus against the resistance of the cliniband (seen from above, the forearm moves in anti-clockwise direction towards the left) while keeping your elbow bent at 90 degrees and at the side of your body. Let your forearm return to its starting position by the pull of the cliniband in a controlled fashion.

The external rotators are strengthened by the opposite action. From the same starting position but with the cliniband looped over a door handle to your left, externally rotate your right humerus against the resistance of the cliniband (seen from above, the forearm moves in a clockwise direction to the right) while the elbow is again kept to the side of the body at 90 degrees. The forearm is again allowed to return to the starting position in a controlled fashion. Single sets comprise a minute of either external or internal rotation exercises and can be repeated three to five times a day. The cliniband needs to follow you around during the day! To strengthen the internal and external rotators of the left shoulder requires similar but mirror-image manoeuvres.

Supraspinatus conditioning requires abduction work and initially should be performed below shoulder level. The starting position is quite different from the previous two exercises. To strengthen your right supraspinatus, place one end of the cliniband under your left foot and extend (keep straight) your right elbow. Hold the other end of the band in your right hand and then internally rotate your right arm so that your right thumb points towards the floor and the back of your right hand faces forwards. Then, keeping your elbow extended, move your right arm away from your body (keeping the elbow straight) against resistance to just below shoulder level, and then let it return to the starting position in a controlled fashion. An easy refinement is to combine pure abduction with a little flexion so that you bring the arm forward as you move it away from your side.

Pinch your scapulae together

Pain should not be felt during any of the three exercises. Three-to-five minute sets over the course of a day will produce a conditioning effect. By shortening the length of the band you will be able to progressively increase resistance. There are a huge number of variations on the exercises described which achieve similar conditioning gains, and I make no claims for the superiority of the chosen three. However, they have worked well in my clinical practice and rarely cause unanticipated problems. Similar exercises can be carried out using the pulley systems found in most gyms and with further adaptations can be done with free weights. Maintaining scapular retraction (the scapulae are 'pinched together' towards the middle of your back and 'pushed down') while carrying out these exercises enables you to develop your scapular stabilising muscles at the same time.

Strengthening the scapular stabilisers without expert supervision is more difficult, but there is benefit from integrating wall leans (standing push-ups against a wall), knee push-ups and regular push-ups in any conditioning programme. Seated rowing will strengthen the latissimus dorsi and should be undertaken while attempting to maintain scapular retraction.

Simon Kemp

A sports fitness expert suggests further exercises to help you avoid shoulder pain

In the previous article, Dr Simon Kemp described the functional anatomy of the shoulder and explained how a weakness in the rotator cuff and an inability of the scapula to stabilise the shoulder are the major contributors to shoulder impingement injuries. He also described three important exercises for strengthening the rotator cuff and suggested ways to improve scapula stabilisation. This article offers more exercise suggestions and gives further practical guidelines to help athletes avoid shoulder pain.

1. Balance your upper-body workouts

A good way to avoid shoulder injuries is to make sure your upper-body strength sessions are balanced. This means that every push or press exercise must be balanced with a pull or row exercise. Too many athletes and weight trainers focus on developing the 'mirror muscles', the upper trapezius, anterior deltoid and pectorals. As a consequence, the 'non mirror-muscles', lower trapezius, rhomboids, latissimus dorsi and rear deltoid, are underdeveloped. This leads to a muscular imbalance about the shoulder, which results in poor scapular stabilisation since the non-mirror muscles are the ones that work to stabilise the scapula. In addition, over developed mirror muscles can lead to a round-shouldered posture, which incorrectly places the scapula up and forward. Redressing this imbalance is very important for the prevention and rehabilitation of shoulder impingement injuries.

The following is an example of a balanced upper-body workout which I would recommend. Note the 1:1 ratio between push/press and pull/row exercises.

- Bench press (pectorals, anterior deltoid).
- Seated row (rhomboids, mid-trapezius, latissimus).
- Flies (pectorals).
- Rear lying prone flies (rhomboids, mid-trapezius, rear deltoid).
- Lat raises (anterior mid deltoid, upper trapezius).
- Lat pull downs wide grip (latissimus, lower trapezius).

For those who are prone to shoulder pain or are recovering from a shoulder injury, I would recommend changing the ratio to 2:1 in favour of the non-mirror muscles. Remember, it is the push/press exercises that cause the problems, so you should change your emphasis until the imbalances have been redressed. Other pull/row exercises include: bent-over row, single-arm dumbbell rows, single-arm cable pulls, bent-over rear fly, pull-ups (wide or narrow), stiff-arm pull-downs with cable/flexaband.

2. Limit your range of movement, and take it easy

Rehabilitation from a shoulder impingement injury should focus on rotator-cuff strengthening, as explained in Dr Kemp's article. However, it's important to remember that when it comes to re-introducing your weight-training exercises, you must progress slowly. Often this means avoiding certain ranges of motion where the shoulder joint sub-acromial space is compressed the most. The impingement zone to avoid is between 70 and 120 degrees of shoulder abduction (when you move the arm laterally away from the side of the body).

To start training the non-mirror muscles, begin with the seated row, because the shoulder joint is not abducted in this exercise. Once the pain is completely gone, then introduce the overhead exercises such as pull-ups and lat pull-downs. You should be even more careful when it comes to the mirror-muscle exercises. I would avoid lateral raises, upright rows and shoulder presses completely for a while. However, incline bench press with arm abducted to 45 degrees would be a good choice to start again. Slowly build up to the normal bench-press range as strength improves.

It is also important that you don't increase your weights too soon. Remember that the ligaments and tendons have to adapt to exercise as well as the muscles, and they may take longer to do so. I would suggest staying in the 12-20 rep range for a time before pushing up the weights, especially with the mirror-muscle exercises. While I realise that it is important for many athletes to be strong at exercises like the bench and shoulder press, I would recommend that you build up slowly to maximum strength. Reducing your reps by two every two weeks is a good guideline. During heavy workouts, ensure that you warm up the shoulder joint and rotator cuff thoroughly prior to lifting.

3. Correct scapula positioning when performing exercises

The correct position for the scapula (shoulder blade) is back and rotated down. Essentially, this means maintaining a good 'military posture', with shoulders back and chest out. A round-shouldered or hunched posture is to be avoided at all times. To achieve the correct position, you need to use your rhomboids, mid and lower trapezius muscles to retract the shoulder and pull the scapula down.

When you perform any upper-body weight-training exercise, always get into the habit of starting with good upper-body posture and pinching the shoulder blades together. You should feel that the scapula is a solid platform which keeps the shoulder correctly positioned while you perform the exercise. As mentioned by Dr Kemp, a good way to learn the correct position is during the seated row exercise by keeping your scapula back and down while you move your arms. During the exercise, you should feel that the rhomboids and trapezius muscles are statically contracting to hold the scapula in place, and the latissimus is working to perform the movement. Once you have the feel for maintained scapula stability during the seated row, try to achieve it during all upper-body exercises. What you might find is that exercises such as the press-up or front raise, where the shoulder may become impinged, will not be painful if you stabilise your scapula correctly. In effect, by using the scapular muscles you can achieve better shoulder mechanics and avoid injury.

Correct scapular stability is difficult to learn and demands a great deal of practice and concentration during your training sessions. You first need to understand what the correct position is, and often this requires a trainer/physio to guide you. Then, during training sessions, instruction and observation from a trainer can help you achieve and maintain the correct shoulder position.

4. Sports-specific exercises – plyometrics for the shoulder

Just as rehabilitation training for leg injuries requires a functional progression from simply strength exercises to sports-specific exercises, so does rehab for the shoulder. This means that for the athlete, eg a thrower or tennis player, conventional resistance exercises in the gym may not be enough to allow a full return to competition. Often what is needed to bridge the gap are plyometric exercises for the shoulder that mimic sports-specific movements. Plyometrics for the shoulder usually involve medicine balls of various weights.

Plyometric exercises have two advantages. First, they are performed fast, and second, they involve stretch-shortening-cycle movement patterns. This means they are much more sports-specific than conventional resistance exercises. In particular, plyometric exercises for the rear-shoulder and external rotator muscles are very useful because they provide eccentric training for these muscles. This improves their ability to control the shoulder during the powerful concentric actions of the pectorals and anterior deltoid involved in throwing or serving. Thus it's important to ensure that your plyometric workouts are balanced between the prime movers (pectorals, latissimus, anterior deltoid) and the rear-shoulder and upper-back muscles. I would recommend incorporating shoulder plyometrics during general conditioning workouts to prevent injuries and in the later stages of shoulder rehabilitation to guarantee a functional progression back to competition.

Here are two suggestions. The key to both these exercises is that the medicine ball is caught, the impact quickly absorbed (fast eccentric phase) and then thrown back explosively (powerful concentric phase).

a. Power drops (pectorals, anterior deltoids). This exercise is like a plyometric bench press, using a medicine ball instead of a barbell.

Lie on your back, legs bent and lower-back flat down. Partner stands above your head and drops ball (3-6kg). You catch ball with straight arms and then quickly let the ball drop to your chest, flexing your arms, and then immediately throw the ball back, powerfully extending your arms. Make sure you keep your back flat down, concentrating your effort on your arms only. Perform sets of 8-12 reps.

b. Catch and throw backhands (external rotators). This exercise is a plyometric version of the external rotator exercise described by Dr Kemp in the last article, and is similar to a backhand shot in tennis.

Stand with your feet shoulder-width apart, with a stable base and good posture. Bend your arm to 90 degrees and tuck your elbow into your side. Keeping your trunk facing forward, rotate your arm out ready to catch. Your partner stands to your right and throws a small ball (1kg) to your hand. You catch it, then quickly take the ball back across your body, rotating your arm inwards, and then immediately throw the ball back, powerfully rotating your arm out.

Make sure you don't use your trunk, and keep your elbow tucked into your side at all times, concentrating the effort on your rear shoulder and external rotator muscles. Repeat for the left side. Perform sets of 12-20 reps.

Raphael Brandon

An orthopaedic surgeon explains why shoulders go wrong and what can be done to repair them

The shoulder joint is often injured in the throwing athlete because it has a greater range of movement than any other joint in the body, and because its stability depends upon intact muscles and ligaments rather than supporting bony structures.

Phases of throwing

The five phases of throwing are wind-up, cocking, acceleration, deceleration and follow-through. The forces generated during these phases are considerable and the resulting stresses generated around the shoulder joint make it prone to acute and chronic inflammatory conditions and injuries. A poor throwing technique will exacerbate the potential for chronic inflammatory shoulder conditions.

A good throwing technique requires the athlete to use his body weight and the large muscle groups of the legs, back and trunk to generate kinetic energy across the shoulder in the direction of the thrown object. After the object is thrown, the retained energy in the throwing arm needs to be dissipated back to the large muscles which then absorb it. Poor mechanics during the wind-up and cocking phases require the shoulder muscles themselves to generate the extra required energy to propel the object being thrown. This leads to fatigue of the shoulder muscles, and will ultimately result in injuries.

Once the object is thrown, a poor follow-through will result in excess energy being retained in the soft tissues of the shoulder, rather than returning to be absorbed by the large muscles described above, causing local tissue damage. Dynamic electromyographic analysis has substantiated much of this theory(2,3,4).

Simple anatomy and biomechanics

The shoulder (glenohumeral) joint is a ball (the humeral head) and socket (the glenoid fossa of the scapula) joint which is supported by the glenohumeral ligaments and labrum. The glenohumeral ligaments (inferior, middle and superior) are discrete capsular thickenings that limit excessive rotation and translation of the humeral head. In the overhead throwing athlete, the inferior glenohumeral ligament is the primary anterior stabiliser when the arm is abducted beyond 90 degrees and externally rotated. The labrum is a thickening surrounding the glenoid which acts to deepen the glenoid cavity (the socket).

The shoulder is stabilised by both static and dynamic restraints. Static restraints include the articular anatomy, the labrum, the glenohumeral ligaments and the negative pressure within the joint. Dynamic restraints include joint compression and the steering effect of the rotator-cuff muscles (the very important small muscles around the shoulder).

The rotator-cuff muscles consist of the supraspinatus, infraspinatus, teres minor and subscapularis. The subscapularis is an internal rotator of the glenohumeral joint, whereas the infraspinatus and teres minor muscles are external rotators. The rotator cuff as a whole functions to centre the humeral head in the glenoid for stability and to allow maximal leverage during shoulder movements.

Shoulder injuries in the throwing athlete

Any of the dynamic or static restraint mechanisms may be damaged by the throwing actions of the athlete, and there is a considerable overlap of injuries. Additionally, an untreated or unrecognised injury may progress to further injuries within the shoulder.

Common acute overuse injuries include rotator-cuff tendinitis and biceps tendinitis. Common chronic injuries include impingement syndrome, rotator-cuff tears, glenoid-labrum tears and shoulder instability.

The athlete will usually complain of anterior shoulder pain that is worst when attempting to increase the speed or power of his/her throw.

Primary instability and secondary impingement

Most athletes with anterior shoulder pain have positive impingement signs and until a few years ago it was believed that they all had primary impingement. They subsequently underwent anterior acromioplasty (removal of the anterior part of the acromion process – the acromion is a bony shelf that juts up from the shoulder blade to provide a kind of protective roof over the shoulder joint) with rotator-cuff repair as needed and the results of surgery proved to be inconsistent[5]. It is now known that symptomatic throwing athletes often have a primary instability of the shoulder with secondary impingement[6,7]. Anterior acromioplasty with excision of the coracoacromial ligament in such individuals may actually increase shoulder instability and magnify symptoms.

Anterior instability may develop after a high-energy trauma but in the throwing athlete it starts as an overuse injury. Chronic overuse can stretch the static stabilisers of the shoulder, causing instability. The scapular and rotator-cuff muscles act out of synchrony with each other putting an increased stress on the rotator cuff to keep the head of the humerus in the centre of the glenoid. As the rotator-cuff muscles weaken, the head subluxes anteriorly (moves forward) when the arm is abducted and externally rotated. This anterior subluxation causes a secondary impingement (compressing against) of the rotator cuff on the acromion and the coracoacromial ligaments, bringing on pain.

Clinical examination

Active and passive range of motion, shoulder strength and areas of tenderness should be elicited. Most athletes with shoulder pain have positive impingement signs. Pain during forward flexion while the examiner stabilises the scapula is the primary impingement sign. Pain during active abduction of the internally rotated arm is the secondary impingement sign.

Examination of shoulder stability is important and the signs may be subtle. The apprehension test can be used to detect anterior instability and involves abduction of the shoulder to about 90 degrees followed by external rotation. As the external rotation is increased, the athlete with anterior instability will feel as if the shoulder is going to 'pop out' or sublux forward. He/she will try to guard against further external rotation and become very apprehensive.

The relocation test is performed in a similar way with the patient lying supine (on his/her back) and applying anterior pressure to the posterior aspect of his humeral head while abducting and externally rotating the arm. If there is anterior instability, this will be painful, but by applying a posteriorly directed force to the humeral head, the pain will ease as the humeral head is placed in the anatomic position.

The presence of posterior capsular tightness may be elicited by the presence of decreased internal rotation of the shoulder.

Imaging

Recent studies indicate that MRI is superior to ultrasound and CT scanning in evaluating shoulder pain caused by rotator-cuff tears, subacromial impingement and osteoarthritis of the glenohumeral and acromioclavicular joints[8,9,10]. Ultrasound examination in the hands of a good musculoskeletal radiologist is considerably cheaper, however, and allows dynamic evaluation. With a good history and examination, however, such imaging may not be required in the vast majority of cases.

Plain radiographs should be taken to exclude bony pathology such as fractures, calcific tendinitis, metastatic disease and osteoarthritis. Axillary views may demonstrate signs of instability, namely spurring or erosion of the anterior glenoid or a Hill-Sachs lesion (osteochondral depression on the posterior humeral head caused by impaction of the dislocated humeral head on the glenoid rim).

Other diagnostic tools

Selective local anaesthetic injections can help pinpoint the painful area in the shoulder.

Diagnostic arthroscopy allows excellent visualisation of the glenohumeral joint and the subacromial space with little soft-tissue destruction and short rehabilitation period. Whilst the patient is anaesthetised, the presence, degree and direction of the shoulder instability may be evaluated(11). Of course, it is possible to proceed to repair or correct many of the pathological conditions in the shoulder arthroscopically.

Non-operative treatment

The mainstay of initial treatment for primary instability and secondary impingement is non-operative(12). A large study of non-operative management for subacromial impingement syndrome demonstrated that non steroidal anti-inflammatory drugs with specific rehabilitation programmes gave satisfactory results in 67% out of 616 patients and that only 28% needed a subacromial decompression(13). There should be a period of 'relative rest' where overhead activity is avoided(14). An individualised physiotherapy programme should then be commenced. Stretching of tight muscle groups whilst avoiding stretching the anterior muscles and capsule in a patient with anterior instability should be followed by strengthening exercises for the scapular rotators and rotator-cuff muscles. This should continue for six to 12 months under supervision. If at this time throwing is still not possible because of pain, a surgical procedure to address the problem with the anterior capsule and labrum should be sought. Athletes with documented rotator-cuff tears, labral lesions or loose bodies should have these lesions repaired or debrided.

Operative treatment

The athlete with chronic shoulder instability whose ligaments are incompetent, resulting in capsular laxity, needs to have a surgical adjustment to the ligament tension in order to restore ligament balance if non-operative measures have failed. Such procedures are termed capsulorrhaphies or capsular shifts (they effectively involve a tightening of the capsule to stop unwanted movement). The adjustment is made medially, inferiorly or laterally in the capsule(15,16). Other procedures have been described but are controversial as they work by limiting the range of movement so that the end-range laxity is not challenged. This is obviously not ideal for the athlete. Recent work has been published on laser-assisted capsulorrhaphy(17) and thermal-assisted capsular shrinkage(18) – the jury is still out on these techniques.

Primary or secondary impingement can be surgically treated by open or arthroscopic acromioplasty. Care must be taken to avoid removal of the lateral acromion, to prevent deltoid detachment and to remove just enough bone. The aim is that by removing the source of mechanical abrasion of the supraspinatus tendon of the rotator cuff, progression of impingement to partial and full thickness tears will be stopped. However, poor vasculature, tendon nutrition, established fibrosis and composition changes in the tendon mean that the process of degenerative disease and cuff tearing continues despite relief of painful symptoms(19).

The expected outcome after acromioplasty for impingement syndrome, whether performed as an open or arthroscopic procedure, is comparable(20). Approximately 80% of patients will experience satisfactory pain relief(21,22). There are, however, a lack of any standardised assessments, so an accurate comparison between studies is not really possible.

Post-operative rehabilitation initially involves the restoration of a pain-free passive range of movement and then the development of active strength. The results of surgery often appear poor for the first three months but tend to improve over the first year.

The main advantages of arthroscopic surgery include the shorter hospital stay, less anaesthetic morbidity and reaching rehabilitation landmarks faster(23). Sadly, some studies suggest poorer results where patients are involved in compensation claims(24).

Referred pain from neck pathology should always be excluded. Repetitive stress may also injure the acromioclavicular and sternoclavicular joints. Finally, less common causes of shoulder pain in the throwing athlete should be borne in mind. These include quadrilateral space syndrome, suprascapular nerve entrapment, axillary artery occlusion, axillary vein thrombosis, posterior capsule laxity and glenoid spurs. These diagnoses lie in the domain of the specialist shoulder surgeon.

Alex Watson

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How a keen club golfer was cured of a nagging shoulder pain

Here's a pertinent quote from the late lamented author of *Letter From America*, Alistair Cooke: 'To get an elementary grasp of the game of golf, you must learn, by endless practice, a continuous and subtle series of highly unnatural movements, involving about 64 muscles, that result in a seemingly "natural" swing, taking all of two seconds from beginning to end.'

A good friend who is an avid club golfer with a handicap of 4 and a right-handed stroke asked for help with his nagging L shoulder pain that had recently become markedly worse and finally was threatening to stop him playing. He said he knew he should have asked for help sooner, but he thought it would just go away (one of the most commonly heard statements by treating practitioners!), and it had now been hanging around for about six months in total, despite regular coaching.

He said that originally it only used to hurt when he caught his chipper in the grass and disrupted his follow-through, but now whenever he used an iron he would feel a sharp pain unless he happened to stroke the ball perfectly. It would also ache when he slept on that side, and after playing a full round it ached for some days. He had tried a million different stretches and even seemed quite flexible with certain movements around the shoulder. In addition, for some years he had battled with R low-back pain and anterior hip pain that, when really bad, would leave him limping for a couple of days after an 18-hole round.

Assessment

Examination showed all the signs of rotator-cuff tendinitis (inflammation and microscopic breakdown of tendon), with accompanying weakness of the muscle itself, leading, over time, to excessive anterior translation of the head of his humerus (extra shearing of the ball in his socket joint) on follow-through. This would likely cause an impingement of his already thickened tendon under the bony acromial arch of the shoulder, giving him the sharp stabs of pain he complained of more recently.

His standing posture gave us the most obvious clues as to why this had developed, without ever needing to video his stroke biomechanics: rounded shoulders and a very noticeable low-back arch (lumbar lordosis) are classic signs of poor postural control leading to wrong movement patterns in his stroke. Gradually over time something had to give – often it is the non-dominant arm.

Had he been middle-aged, we might have X-rayed his shoulder to look for any calcification of his tendon (he had just turned 30), and only if progress wasn't going well would we consider doing an ultrasound scan to determine the extent of scarring and tendon breakdown.

Treatment

Rehabilitation would take a good month or two if all went according to plan – the main unknown factor would be how well he would take on the challenge of holding his shoulders and pelvis differently; this re-education process is often the most difficult. The overall treatment process would first involve improving flexibility so that proper posture positions could be held – most of us get stiffness in some of our joints because of gravity wrecking our good posture.

Recent developments in sports physiotherapy have improved the speed of this process significantly. Apart from a systematic stretching regime by the patient, we 'release' muscle tightness by deep-tissue massage and trigger-point therapy, heat, a home programme of self-pressure massage with a tennis ball, and mobilising of the tight parts of the capsule of the shoulder with seat-belts. Tightness in the posterior rotator-cuff muscles of this particular patient took a lot of work to free out, and lat dorsi and pec major/minor were also big players.

In addition, he had significant stiffness in his thoracic spine, especially with extension and L rotation, so that was worked loose, as were certain gluteal and hip-flexor muscles.

The next two phases

Secondly, postural muscles needed to be ‘turned on’, ie recruited properly, and a programme of gradual strengthening of their ability to control the joints for which they are responsible began. In this case the critical ones were the mid and lower trapezius and transversus abdominus muscles – we also taped them up occasionally to help him remember to keep using them, until it became more habitual.

Around this time, pain was becoming less and less of a problem and his postural control was developing well. He was able to return to his coach and start using the positional changes in his stroke, gradually increasing the stroke distance and frequency and all the while maintaining his flexibility with the tennis ball. This third phase, which involves incorporating the right posture into the stroke, is critically to do with the coach, and requires significant discipline on the part of the athlete to ensure he stays within the realms of what his new system can tolerate without being overloaded. He can still overdo it!

All went well, with the golfer achieving one of his best-ever scores in the Queensland Open Tournament three months later. However, two weeks after that he dived badly in a game of rugby and twisted the same L shoulder and ripped the same rotator-cuff tendon he had worked so hard to mend... sometimes life just isn’t fair!

Ulrik Larsen

Two surgeons discuss the diagnosis and treatment of acromioclavicular injuries in athletes

Acromioclavicular (AC) joint injuries most commonly occur in athletic young adults involved in collision sports, throwing sports, and overhead activities such as upper-extremity strength training. They account for 3% of all shoulder injuries and 40% of shoulder sports injuries. Athletes in their second and third decade of life are more commonly affected[1], and men are injured more commonly than women (5:1 to 10:1)[1,2].

Acromioclavicular dislocation was recognised as early as 400 BC by Hippocrates[3]. He cautioned against mistaking it for glenohumeral (shoulder joint) dislocation and recommended treating with a compressive bandage in an attempt to hold the distal (outer) end of the clavicle in a reduced position. Nearly 600 years later Galen (129 AD) diagnosed his own acromioclavicular dislocation, which he sustained while wrestling[3]. He soon abandoned the tight bandage holding the clavicle down as it was too uncomfortable. In the modern era this injury is better recognised, but its treatment remains a source of great controversy.

Anatomy

The acromioclavicular joint joins the collarbone to the shoulder blade and hence links the arm to the axial skeleton. The articular surfaces are initially hyaline cartilage, which changes to fibrocartilage toward the end of adolescence. The average joint size is 9mm by 19mm[4]. The acromioclavicular joint contains an intra-articular, fibrocartilaginous disc that may be complete or partial (meniscoid). This helps absorb forces in compression. There is marked variability in the plane of the joint.

Stabilisers

There is little inherent bony stability in the AC joint. Stability is provided by the dynamic stabilisers – namely, the anterior deltoid muscle arising from the clavicle and the trapezius muscle arising from the acromion.

There are also ligamentous stabilisers. The AC ligaments are divided into four – superior, inferior, anterior and posterior. The superior is strongest and blends with muscles. The acromioclavicular ligaments contribute approximately two-thirds of the constraining force to superior and posterior displacement; however, with greater displacement the coracoclavicular ligaments contribute the major share of the resistance. The coracoclavicular ligament consists of the conoid and trapezoid. The conoid ligament is fan-shaped and resists forward movement of the scapula, while the stronger trapezoid ligament is flat and resists backward movement. The coracoclavicular ligament helps couple scapular and glenohumeral (shoulder joint) movement and the interspace averages 1.3 cm.

Mechanism of injury

The athlete who sustains an acromioclavicular injury commonly reports either one of two mechanisms of injury: direct or indirect.

Direct force: This is when the athlete falls onto the point of the shoulder, with the arm usually at the side and adducted. The force drives the acromion downwards and medially. Nielsen[5] found that 70% of acromioclavicular joint injuries are the result of a direct injury.

Indirect force: This is when the athlete falls onto an outstretched arm. The force is transmitted through the humeral head to the acromion, therefore the acromioclavicular ligament is disrupted and the coracoclavicular ligament is stretched.

On examination

The athlete presents soon after the acute injury with his arm splinted to his side. The patient may state that the arm feels better with superiorly directed support on the arm. Most movements are restricted secondary to pain at the top of the shoulder; the degree varies with the grade of sprain. The hallmark finding is localised tenderness and swelling over the acromioclavicular joint.

In dislocations, the outer part of the collarbone appears superiorly displaced with a noticeable step deformity (in fact, it is the shoulder that sags below the clavicle). Occasionally, the deformity may only be apparent later, if initial muscle spasm reduces acromioclavicular separation. Forced cross-body adduction (pulling the affected arm across the opposite shoulder) provokes discomfort. The clavicle can often be moved relative to the acromion.

Acromioclavicular visualisation

The normal joint width measures 1-3mm. It is regarded as abnormal if it is greater than 7mm in men, and 6mm in women.

Routine anteroposterior views of the shoulder show the glenohumeral joint; however, the acromioclavicular joint is overpenetrated and therefore too dark to interpret. Reduced exposure improves visualisation. The patient stands with both arms hanging unsupported, both acromioclavicular joints on one film. Weighted views (stress X-rays) are taken with 10-15lb weights not held but suspended from the patient's wrists. They help distinguish type II-III injuries, but are of little clinical value and are no longer recommended in our practice.

Classification of AC separation

The importance of identifying the injury type cannot be overemphasised because the treatment and prognosis hinge on an accurate diagnosis. The injuries are graded on the basis of which ligaments are injured and how badly they are torn.

Allman[6] classified acromioclavicular sprains as grades I, II and III, representing respectively, no involvement, partial tearing, and complete disruption of the coracoclavicular ligaments. More recently, Rockwood[1] has further classified the more severe injuries as grade III-VI.

The injuries are classified into six categories:

Type I This is the most common injury encountered. Only a mild force is needed to sustain such an injury. The acromioclavicular ligament is sprained with an intact coracoclavicular ligament. The acromioclavicular joint remains stable and symptoms resolve in seven to 10 days. This injury has an excellent prognosis.

Type II The coracoclavicular ligaments are sprained; however, the acromioclavicular ligaments are ruptured. Most players can return to their sport within three weeks. There is anecdotal evidence to suggest that steroid injections into the acromioclavicular joint speed up the resolution of symptoms, but this practice is not universal.

Type III The acromioclavicular joint capsule and coracoclavicular ligaments are completely disrupted. The coracoclavicular interspace is 25-100% greater than the normal shoulder.

Type IV This is a type III injury with avulsion of the coracoclavicular ligament from the clavicle, with the distal clavicle displaced posteriorly into or through the trapezius.

Type V This is type III but with exaggeration of the vertical displacement of the clavicle from the scapula-coracoclavicular interspace 100-300% greater than the normal side, with the clavicle in a subcutaneous position.

Type VI This is a rare injury. This is type III with inferior dislocation of the lateral end of the clavicle below the coracoid.

Treatment

The treatment of acromioclavicular joint injuries varies according to the severity or grade of the injury.

Initial treatment: These can be very painful injuries. Ice packs, anti-inflammatories and a sling are used to immobilise the shoulder and take the weight of the arm. As pain starts to subside, it is important to begin moving the fingers, wrist and elbow to prevent stiffness. Next, it is important to begin shoulder motion to prevent shoulder stiffness.

Undisplaced injuries only require rest, ice, and then gradual return to activity over a two to six week period. Major dislocations require surgical stabilisation in athletes if their dominant arm is involved, and if they participate in upper-limb sports

Type I & II: Ice pack, anti-inflammatory agents and a sling are used. Early motion based on symptoms is introduced. Pain usually subsides in about 10 days. Range-of-motion exercises and strength training to restore normal motion and strength are instituted as the patient's symptoms permit. Some symptoms may be relieved by taping (taking stress off acromioclavicular joint). The length of time needed to regain full motion and function depends upon the severity or grade of the injury. The sport and the position played determine when a player can return to a sporting activity. A football player, who does not have to elevate his arm, can return sooner than a tennis or rugby player.

When a patient returns to practice and competition in collision sports, protection of the acromioclavicular joint with special padding is important. A simple 'doughnut' cut from foam or felt padding can provide effective protection. Special shoulder-injury pads, or off-the-shelf shoulder orthoses, can be used to protect the acromioclavicular joint after injury.

Some type II injuries may develop late degenerative joint changes and will need a resection of the distal end of the clavicle for pain relief. It is important to note that after a resection of the distal end of the clavicle, particularly in a throwing athlete, there may be formation of heterotopic bone on the under surface of the clavicle which can cause a painful syndrome which presents like shoulder impingement.

Type III: The treatment of type III injury is less controversial than in past years. In the 1970s, most orthopaedic surgeons recommended surgery for type III acromioclavicular sprains[7]. By 1991, most type III injuries were treated conservatively[8]. This change in treatment philosophy was prompted by a series of retrospective studies[9]. These showed no outcome differences between operative and nonoperative groups.

Furthermore, the patients treated nonoperatively returned to full activity (work or athletics) sooner than surgically treated groups[10, 11]. The exceptions to this recommendation include those who perform repetitive, heavy lifting, those who work with their arms above 90 degrees, and thin patients who have prominent lateral ends of the clavicles. These patients may benefit from surgical repair[12].

Any discussion on the management of acute injuries to the AC joint must confront not only which of the many methods of surgical treatment described is best, but whether surgery should be considered at all. Surgery is generally avoided in athletes participating in contact sports as they will often re-injure the shoulder in the future.

Type IV-VI: Account for more than 10-15% of total acromioclavicular dislocations and should be managed surgically. Failure to reduce and fix these will lead to chronic pain and dysfunction.

Surgery

Surgical repair can be divided into anatomical or non-anatomical, or historically into four types:

- Acromioclavicular repairs (intra-articular repair with wires/pins, percutaneous pins, hook plates).
- Coracoclavicular repairs (Bosworth screws[13], cerclage, Copeland and Kessel repair).
- Distal clavicular excision.
- Dynamic muscle transfers.
- Disadvantages of surgery are that there are risks of infection, a longer time to return to full function and continued pain in some cases.

For the patient with a chronic AC joint dislocation or subluxation that remains painful after three to six months of closed treatment and rehabilitation, surgery is indicated to improve function and comfort.

For sequelae of untreated type IV-VI, or painful type II and III injuries, the Weaver Dunn technique is advocated. This involves removing the lateral 2cm of the clavicle and reattaching the acromial end of the coracoacromial ligament to the cut end of the clavicle, thus reducing the clavicle to a more anatomical position.

Postoperatively, the arm is supported in a sling for up to six weeks. After the first two weeks, the patient is allowed to use the arm for daily activities at waist level. After six weeks, the sling or orthosis is discontinued, overhead activities are allowed, formal passive stretching is instituted, and light stretching with elastic straps is started. Stretching and strengthening are progressed gradually. The athlete should not return to sport without restriction until full strength and range of motion have been recovered. This usually occurs four to six months after surgery.

Conclusions

AC joint injuries are an important source of pain in the shoulder region and must be evaluated carefully. The management of these injuries is nonoperative in the majority of cases. Type I and II injuries are treated symptomatically. The current trend in uncomplicated type III injuries is a non operative approach. If the athlete develops subsequent problems, a delayed reconstruction may be undertaken. In athletes involved in heavy lifting or prolonged overhead activities, surgery may be considered acutely. Type IV-VI injuries are generally treated operatively.

No matter what form of treatment is chosen, the ultimate goal is to restore painless function to the injured AC joint in order to return the athlete safely and as quickly as possible back to their sport. This is possible in the majority of acromioclavicular joint injuries.

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Raphael Brandon assesses the latest research into shoulder problems and gives practical advice on achieving balanced upper-body development

Chronic shoulder injury is a common problem, and not just for athletes. Among the population at large, day-to-day activities such as DIY or gardening can produce chronic pain, as can resistance work in the gym, when enthusiasts pile on the weight without paying heed to the need for balanced strengthening. Adults beyond the age of 50 are more vulnerable in general to rotator-cuff tears, the incidence increasing with age[1].

Among sportspeople, a large group, known as the 'overhead athletes', are at increased risk of chronic shoulder injuries. The overhead group covers a broad range of sports including swimming, tennis, cricket, javelin and baseball, all of which involve variations on the generic throwing action where the arm moves above the head (see box overleaf).

The throwing movement recruits a large number of muscles and combines a large range of arm motion with high forces or speeds at the shoulder joint. All overhead athletes tend to perform many repetitions of the movement, usually with a dominant arm only, as part of their sports training.

For the shoulder and arm to move efficiently requires coordinated movement of the scapula and humerus, known as scapulo-humeral rhythm. For example, arm abduction is accompanied by some upward rotation of the scapula, allowing the deltoid muscle to maintain a good length-tension relationship throughout the full 180 degrees of abduction.

Scapular and humeral coordination also involves the stabilising muscles of the scapula working in concert with the rotator-cuff stabilising muscles of the glenohumeral joint. If the scapula holds its position correctly, the rotator cuff will do its job more effectively. Or, to put it another way, active stability is necessary to avoid excessive stress in the shoulder joint.

Get the balance right

The importance of rotator-cuff muscle strength in throwing was examined by a research team from the West Point Army Hospital in the US[2]. Scoville et al looked at the strength of

Throwing: the stretch-shortening cycle

Movement 1: the arm horizontally extends and laterally rotates backwards. The rear deltoid and lateral rotators are working concentrically and the pectorals, anterior deltoids and medial rotators are being stretched. At the end range of motion the medial rotators will be working eccentrically to control the movement back at the top of the cock position.

Movement 2: the arm horizontally flexes and medially rotates, accelerating the hand to throw. This involves the pectorals, anterior deltoid and medial rotators working concentrically (or shortening, hence stretch-shorten cycle). The pre-stretch facilitates elastic energy return from the muscle tendon unit, making the movement both more powerful and fatigue resistant. At the end range of medial rotation the lateral rotators will be working eccentrically to decelerate the arm, controlling shoulder joint forces. This means that the end range of motion concentric medial rotation force must be controlled by eccentric lateral rotation force and vice versa.

normal subjects without any shoulder injury symptoms, comparing strength ratios of the end range of lateral and medial rotation. Subjects were assessed on an isokinetic dynamometer (which measures joint strength). Full range of motion (ROM) was defined as 90 degrees of lateral rotation (forearm vertical) to 20 degrees of medial rotation (forearm 20 degrees below the horizontal). The average force produced in the last 30 degrees of each direction was assessed as end ROM.

The group average strength ratios results are as follows:

Concentric lateral rotation: concentric medial rotation (full ROM)	2:3
Concentric lateral rotation: eccentric medial rotation (end ROM)	1:2.4
Eccentric lateral rotation: concentric medial rotation (end ROM)	1.05:1

The concentric lateral rotation to eccentric medial rotation ratio of 1:2.4 suggests that the medial rotators have easily enough strength to decelerate the arm as it moves back to the cock position. The eccentric lateral rotation to concentric medial rotation ratio of 1.05:1 suggests that the lateral (external) rotators are capable of decelerating the forward motion, but only just.

The results of Scoville's study suggest that normal adults with no shoulder problems possess sufficiently balanced strength for efficient biomechanics of throwing. But it also reveals how important it is for overhead athletes to maintain this balance of muscular strength, otherwise the lateral rotators may not be able to cope with the stronger medial rotation force, compromising the shoulder joint.

Problems tend to arise when athletes focus their training solely on the prime mover muscles, such as pectorals and deltoids, resulting in a relative weakness of the rotator-cuff and scapular stabiliser muscles. It is common practice now for overhead athletes to pay extra attention to lateral rotator strengthening. The same advice would apply to all adults who do resistance training: be sure to include exercises for the rotator-cuff and scapular stabilisers in order to develop balanced strength in the upper body.

While the Scoville study examined rotation strength alone, we have already noted above that throwing combines rotation with horizontal extension and flexion movements. The rear deltoid muscles must also therefore act eccentrically to decelerate the arm during the end range when the pectorals and anterior deltoid are working concentrically. So strengthening programmes must also pay attention to rear shoulder strength, incorporating pulling and rowing movements to balance pressing movements.

Here, again, gym-goers tend to be most unaware of the need for balanced development, typically focusing on the 'mirror muscles' (pectorals, deltoids and biceps) and neglecting the back. The best programme will be one that promotes strength in all muscle groups and develops a balanced physique, front and back.

What goes wrong

Recent research by Kibler and McMullen[3] uses the concept of 'scapular dyskinesis': an alteration in the normal position or motion of the scapula during coupled scapulo-humeral movements. They suggest that a variety of symptoms share the same biomechanical fault – the inhibition or disorganisation of activation patterns in scapular stabilising muscles, leading to altered scapular function.

This idea is supported by research from a team from Belgium[4]. Cools et al investigated the timing of trapezius muscle activity during a sudden downward falling movement of the arm, comparing the performance of 39 overhead athletes with shoulder impingement against that of 30 overhead athletes with no impingement. The trapezius operates on the scapula in three sections: the lower portion depresses, the middle portion retracts, and the upper portion raises it.

Cools measured the time that the muscles took to switch on in all three parts of the trapezius and in the middle deltoid,and discovered significant differences between the two groups. Those with impingement showed a delay in muscle activation of the middle and lower trapezius – the muscles that are important for maintaining good shoulder positioning.

Another study from Cools and his team[5] investigated whether 19 overhead athletes with impingement symptoms had differences in their scapular muscle force (measured by isokinetic dynamometer) and electromyographic activity on the affected and uninjured sides. They found that the injured side showed significantly lower peak force during protraction, a significantly lower ratio of protraction to retraction force and significantly lower electromyographic activity in the lower trapezius during retraction.

Together these findings support the concept of scapular dyskinesis involving abnormal recruitment timing and strength of the trapezius muscle – specifically the lower and middle portions. These results underline the importance for injury prevention of good scapular stability in the depression and retraction movements.

Research from Germany highlighted changes in flexibility in the shoulders of overhead athletes[6]. Using ultrasound-based measurement, Schmidt-Wiethoff et al found that the dominant arm in a group of pro tennis players had a significantly greater range of external rotation than the non-dominant arm, while their internal rotation showed a significant deficit relative to the non-dominant arm. Moreover, the total rotational range of motion of the dominant arm was significantly less than that of the non-dominant arm or of a control group. Among the control group (not involved in any overhead sports), there were no significant differences in flexibility between their shoulders.

How to protect your shoulders

It would seem from the research that incorrect muscle function (developed through sport-specific demands or injury) is most evident in the lower and middle trapezius and lateral rotator-cuff muscles. From a practical viewpoint this means overhead athletes and people involved in weight training need to spend time on specific strengthening exercises to promote injury prevention and ensure balanced strength and good posture.

Step 1: equalise front and rear strength

The starting point is a balanced programme for front and rear shoulder muscle development. Opposing muscle groups must be trained equally. While exercises for the anterior shoulder and pectorals develop power, to train just these muscles will unbalance the shoulder. The better approach is to programme exercise pairs that work opposing muscles (see Table 1). Coaches and therapists should check that equal numbers of sets from each column are written into strength programmes.

Table 1: Front and rear shoulder exercise pairs

Press or push exercise	Opposing pull or row exercise
Bench press	Bench pull or seated row
Dumbbell press	Single arm row
Shoulder press	Lat pulldown
Flyes	Prone flyes or bent-over lateral raise
Lateral raises	Cable lateral pulldowns

Step 2: develop good pulling form

It is essential to perform pull or row exercises with correct technique in order to ensure that the middle trapezius, rhomboids and lower trapezius muscles are properly recruited.

For example, the lat pulldown is a popular exercise for the upper-back and rear-shoulder muscles, involving adduction of the arm. The exercise begins with the arms above the head. During the pulldown movement the exerciser must focus on using the lower trapezius muscles to depress the scapula while the large latissimus dorsi muscles pull the elbows downwards. And during the return movement, it is important to make the lower trapezius muscle 'keep hold' of the scapula as the arms rise with the weight.

This recruitment creates the correct scapulo-humeral rhythm. Without correct use of the lower traps, the lat pulldown is performed in a hunched shoulder position, which promotes poor mechanics.

The same coaching principle applies to rowing exercises. These involve horizontal extension of the arm, using the strong latissimus dorsi muscles, and require concurrent scapular retraction from the middle trapezius and rhomboids. Exercisers should focus on retracting the scapula at the same time as the elbow is pulled back and keeping the scapula retracted as the arm goes forwards with the weight on the return movement. If the scapula is not stabilised the athlete will perform the exercise in round-shouldered (kyphotic) posture, which again results in poor shoulder joint mechanics.

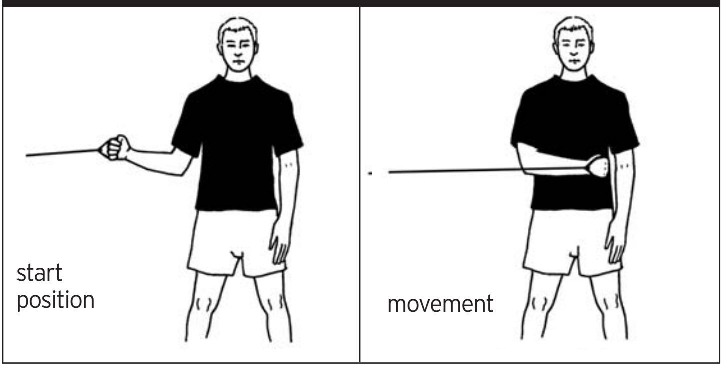
Step 3: isolate the rotator cuff

The small but crucial muscles of the rotator cuff should be targeted alongside the lower traps to avoid developing dysfunction or weakness. In the following four exercises, pay attention to the coaching points.

Exercise 1: internal shoulder rotation

Use a resistance band or a pulley cable machine for this movement.

Exercise 1: Internal shoulder rotation



Muscles targeted
Subscapularis and pectoralis minor, the shoulder's medial rotators.

Start position
- Stand with good posture, abs in and shoulders wide.
- Grasp the handle out to the side, palm facing forward.
- Tuck your elbow firmly into your side and fix an elbow angle of 90 degrees.

Movement
- Pull arm across your body.
- Finish with the palm facing into your body.
- Keep the elbow positioned close to your side to ensure the movement targets shoulder rotation alone.
- Hold upper body still, to prevent other muscles assisting the shoulder. Only your arm moves.
- Return to the start position slowly, under control, and repeat.

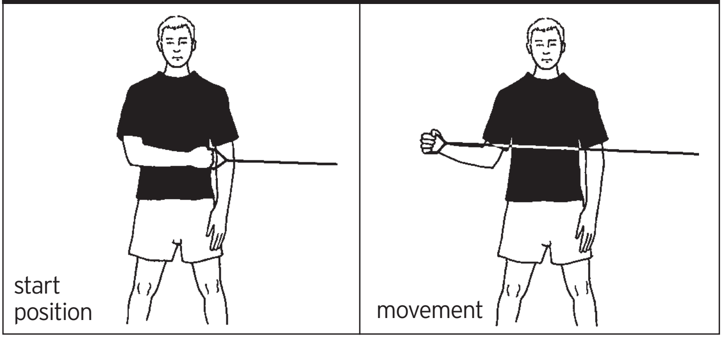
Exercise 2: external shoulder rotation
Use a resistance band or pulley machine.

Muscles targeted
Infraspinatus and teres minor, the shoulder's external rotators

Start position
- Stand with good posture, abs in and shoulders wide.
- Grasp the handle with your forearm across your body, palm facing into your body.
- Hold your elbow close to your side and fix an elbow angle of 90 degrees.

Movement
- Pull the arm out and away from your body.
- Finish with the palm facing forward.
- Keep the elbow positioned close to your side to ensure the

Exercise 2: external shoulder rotation



movement targets shoulder rotation alone.

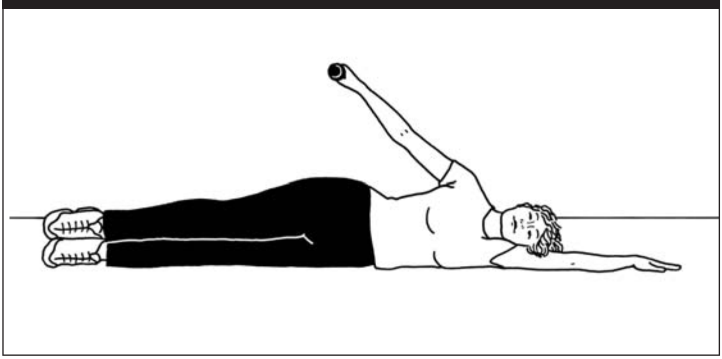
- Hold upper body still, to prevent other muscles assisted the shoulder. Only your arm moves.
- Return to the start position slowly, under control, and repeat.

Exercise 3: side lying raise

Muscles targeted

Supraspinatus (top of the rotator cuff), assisted by the deltoid and infraspinatus. This exercise is particularly effective at recruiting rotator-cuff muscles while avoiding putting the shoulder joint through a stressful range of motion. It is therefore beneficial for those with shoulder injury.

Exercise 3: side lying raise



Start position

● Lie on your side with your body straight.

● Place top arm straight so your hand lies by your hips, holding a dumbbell.

● Use your scapular muscles to pull your top shoulder into a wide position. Avoid hunched or rounded top shoulder.

Movement

● Lift the dumbbell straight up until your arm makes a 45 degree angle.

● Ensure your body does not roll or sway, only your arm moves.

● Lower the arm slowly, under control, and repeat.

Exercise 4: human arrow

Muscles targeted

Lower trapezius, focusing on scapular depression. This movement can take a little time to learn, so don't expect clients to get it first time.

Start position

● Lie on your front with your arms by your sides.

● Have your palms facing up and fingers pointing towards your feet.

● Eyes look down into the floor, nose just off the ground.

● Do not lift your head, so your neck remains relaxed.

● Engage your abdominals and pelvic floor to keep your lumbar spine in place.

● Let your shoulders fall forward and rounded to the floor. Upper back starts relaxed.

Movement

● Pull your shoulder blades back and down so that your fingers slide down your side towards your feet. Feel that you are extending your arms down.

● Your upper back will extend slightly and all your muscles around your scapula will feel strong. You will feel your shoulder blades pull downwards into your back if you engage the lower traps correctly.

- Do not extend your lumbar spine and lift up off the floor. The low back should remain flat as the exercise is designed to isolate the scapular muscles. It is not a dorsal raise.
- Hold the position for 10 seconds and relax.
- Repeat 10 times.

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