Impingement Syndrome and Tears of the Rotator Cuff

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Impingement is a very common problem in which the tendons of the rotator cuff (predominantly supraspinatus) rub on the underside of the acromion (the bone at the point of the shoulder). This causes pain due to the repeated rubbing of those tendons and it is especially bad with certain positions of the arm. In particular it is difficult to put the arm behind the back and to use it in the elevated position. This makes it difficult to drive, change gears, hang clothes, comb one’s hair, and even to lie on the affected shoulder.

The cause of this problem can be:

1) A muscle imbalance problem due to poor functioning of the rotator cuff tendons themselves; thus allowing the arm to ride up and rub on the acromion, squashing the rotator cuff tendons in the process; or

2) A mechanical problem where the space for the tendon is inadequate. One way this can occur is with an injury to the tendon itself which causes swelling of that tendon such that it becomes too large for the space at hand (primary tendonitis (inflammation of the tendon) with secondary impingement [rubbing of the tendon on the bone]). Alternatively, and most commonly, the space itself can be narrowed. Usually this is when the acromion itself is large and prominent, leading to a narrow space beneath it for the tendons (primary impingement with secondary tendonitis). A large acromion can occur as part of normal growth or, later in life, spurs can develop along the front of the bone and can dig into the tendon. If this is bad enough these spurs can actually damage the tendon to such an extent that the tendon becomes eroded away and tears.

How does the shoulder work?

The shoulder, like the hip, is a ball and socket joint (like a tow bar). Unlike the hip however, the socket is very small and is not big enough to hold the head of the humerus (the ball) in place. This gives the joint a large range of motion but, as a consequence, it also means that it is potentially unstable. To function normally, muscles on both sides of the joint must work together to hold the joint in place during movement. This means that when the deltoid muscle (see diagrams) lifts the arm out from the side of the body, the supraspinatus and other muscles of the rotator cuff must pull down on the top of the humerus. This causes a levering out of the humerus with the rotator cuff muscles working in conjunction with the deltoid. The rotator cuff thus prevents the deltoid from driving the humerus up into overhanging acromion.

In the normal shoulder this mechanism is so finely tuned that it always keeps the reaction force of the humerus at right angles to the socket. The joint is therefore always stable, unless taken unawares.

Normal anatomy
How does the problem start?

The rotator cuff tendons can be injured by a single traumatic event such as a fall onto the point of the elbow (which drives the humerus up into the acromion and squashes the tendons), a fall onto the shoulder, or a traction injury. A single incident may not always be the cause however and the tendons can be injured by overuse activities such as swimming or jobs involving raising of the arms for long periods of time (ceiling fixing or plastering).

As the rotator cuff muscles are small in comparison to the deltoid they fatigue more easily and hence, when tired, they can no longer resist the upward thrust of that muscle. With the deltoid now overpowering the rotator cuff muscles the reaction force starts to be upward rather than across the joint (see diagram). This means that the cuff tendons start to become squashed when the arm is raised. Thus, damage to the tendons begins, and the symptoms, like the damage, may start slowly but gradually become worse.

Why does it progress?

Once the tendons have been damaged they become inflamed and swollen, and thus start to fill the gap between the head of the humerus and the acromion (the sub-acromial space). As this occurs, impingement occurs more easily and with less movement. The ache may thus become worse, may occur with smaller movements or even become constant (especially at night). With time, the problem becomes compounded because the tendon, previously mildly damaged, now impinges and becomes increasingly inflamed and sore. With this increase in pain there is a concomitant decrease in function, thus causing more and more muscle imbalance, further impingement and a spiralling of problems.

Is age a factor?

It can generally be said that different age groups tend to have different types of pathology at presentation, even though we believe that the course of the disease is similar in each case. Usually those under 25 years present at the stage of swelling and inflammation, those between 25 and 35 present with fibrosis and scarring, and those over 35 present with tendon degeneration and sometimes tendon tearing. The problem becomes increasingly common with age as spurs develop on the anterior acromion and, by the age of 65 years, this is an extremely common condition.

What about the other shoulder?

In cases where the primary problem is the shape or size of the acromion (primary impingement) it would seem reasonable that the opposite shoulder might be similar. Studies in fact show that this is the case 60% of the time, and hence, the chances of the other shoulder becoming involved to some degree is of that order.

If the primary problem is an injury to the tendon rather than a narrow gap for the tendon (primary tendonitis), then the other shoulder is likely to also have a normal gap. In this situation therefore, the other shoulder may never be affected.

What is the treatment?

All those in stage 1 (swelling and inflammation - an acute injury) and about half of those in stage 2 (fibrosis and scarring - chronic problem) can be treated by conservative means. This means treatment for the local pain and swelling (which may include injection of an anti-inflammatory agent such as cortisone) and a therapy program to re-balance the shoulder by strengthening the supraspinatus and other rotator cuff muscles. Once these muscles are functioning again they will hold the humerus down and prevent further impingement. The tendon injury will then gradually resolve, or settle.

Those with more advanced disease generally will come to operative treatment. This includes long standing problems, rotator cuff tears and cases where the acromion is so large that impingement will clearly continue unless the bone is trimmed to widen the gap for the tendons.

Physiotherapy

Therapy consists of two things. The first is instruction in how to avoid further damage to the rotator cuff tendons (which must still be intact). The second is to strengthen those tendons and make them functional. Initially, this means stopping or modifying all activities that cause pain (so, for swimmers and throwing athletes for example, a style modification may be needed so that they can keep doing some training).

Resting the injured shoulder may be accompanied by local heat and, often, a cortisone injection. The initial aim is to settle the tendon swelling and the pain. Then secondly, as the pain settles, a strengthening program is begun, with emphasis on strengthening supraspinatus and infraspinatus (which are the main two muscles involved in this process). Often it is not possible to work on these muscles straight away and, supraspinatus exercises particularly, may cause pain. If this is the case, then scapula stabilizing exercises will need to be done first: and this will require the supervision of a therapist skilled in this area.

If flare-ups occur during treatment, a further injection and another period of rest may again be required.
**Cortisone injection**

For people who present with impingement, with no large spurs, an intact tendon and symptoms that have been going for only a few months, the initial treatment of choice is usually a cortisone injection. Cortisone is a substance that is made by the body and which is essential for life: we all make and have cortisone in us. One of its most used properties is that of a strong anti-inflammatory agent. It is much stronger than oral anti-inflammatories because it works through several different pathways rather than just one single pathway. When placed in the sub-acromial space (between the tendon and the acromion), it acts to reduce swelling in the rotator cuff tendons. This reduction in tendon size may, in turn, lead to considerably less impingement and much less pain.

If a first cortisone injection helps for a long period of time, and if the tendons are intact and not being damaged, then a further injection may be indicated. If relief from the first injection was incomplete however, then it is unlikely that the second one will be any better. Whilst repeated injections may not damage the tendon, if relief is incomplete, then surgery may be a better long term prospect.

**Sub-Acromial Decompression**

The surgery for this condition is called sub-acromial decompression. The main part of this procedure is called an acromioplasty whereby the acromion is reshaped and the prominent underside is removed to increase the size of the space beneath it. This is done as an arthroscopy (through a telescope) which means that the shoulder itself is never actually opened. This means that the arm may have a full range of motion within 12 hours of surgery and that it can be done as day surgery. Despite this good early range of motion however, it has been found that most shoulders do not show marked improvement for 2 or 3 months, and thereafter they gradually improve over 6 - 9 months. It is thought that the reason for the delay in recovery is that the tendons still have to recover even after any rubbing has ceased and, like tendons elsewhere, this takes several months and involves a fair degree of rest.

Where impingement is the primary problem (that is, there is a narrow gap for the tendon) the tendon recovers well, and hence the chances that a normal shoulder will result is about 95%. Where tendonitis is the primary problem (where there is a tendon injury or tendon inflammation leading to swelling of the tendon) and where the impingement develops because of the swelling of those tendons, surgery seems less effective. A successful outcome here is only seen in about 85% of cases or less. Here the tendons seem to have more intrinsic damage and take longer to recover. That recovery may also be less complete leaving minor symptoms.
**Indications for surgery include:**

Pain that has not responded to conservative care, including injections of cortisone to the sub-acromial space

Any damage to the rotator cuff tendons, including any tearing of those tendons

Rupture of the biceps tendon but leaving residual pain (this usually indicates that the rotator cuff tendons are now impinging and may also go on to tear)

Impingement that has gone on for more than 1 year

Impingement that is exercise related, where it is desirable to continue with that exercise (for example - swimming to help back pain etc.). The usual situation is that the problem improves with rest or activity modification but tends to return on re-commencement of the aggravating activity: and in general, even months or years of rest will not cause full resolution of this problem.

Impingement pain where the opposite shoulder has had a tendon tear. If one shoulder has gone on to a tendon tear the other one, if symptomatic, will almost certainly go the same way.

**A-C Joint resection**

The A-C (acromio-clavicular) joint lies between the end of the collar bone (clavicle) and the acromion process of the scapula (wing bone). It is a small joint but takes a lot of force, given that it is the only joint that directly connects the arm to the body. Because of the large forces involved, arthritis (wearing out) of the joint is common; be that because of age or following injury.

When the arthritis has been present for a long time the joint is very stiff and doesn’t move much. In this situation it is often not that sore. Earlier on however, when the joint is still quite mobile, the joint can be very symptomatic. In this situation the damaged ends move over each other whenever the joint is loaded up. The consequence of this is localised pain in the area of the A - C joint itself, and quite often, referred pain which may be widespread but commonly goes posteriorly (to the back of the shoulder).

The other problem with an arthritic A - C joint is that it can produce spurs which protrude inferiorly, and can therefore directly impinge on the supraspinatus tendon, just medially to where the acromion impinges. If this is occurring, or if the A - C joint is symptomatic in its own right, then the treatment of choice is to excise the outer centimetre of the clavicle. This achieves a removal of the painful joint surfaces and leaves enough gap so that the ends won’t touch again: hence removing the pain. The reason that this works is that the clavicle is actually still held to the acromion by virtue of 2 strong ligamentous bands (the coraco-clavicular ligaments) which pass from the underside of the clavicle directly down to the coracoid process beneath it. Both the coracoid process and the acromion are parts of the same bone (the scapula or wing bone) and hence are directly attached. So, by having a ligamentous connection that holds the clavicle to the coracoid process, means that the clavicle is indirectly held to the acromion, even when the actual joint between them is missing. For this reason the shoulder still functions normally or very near normally when the A - C joint is excised.
Like decompression, excision of the outer end of the clavicle can be performed arthroscopically and it can be done concomitantly with decompression if indicated. Initial bruising is greater (particularly across the anterior chest and upper breast area) and initial recovery is a little slower than with decompression alone but, within a few weeks, the progress and function is similar. As a consequence of this, there can be an argument made to excise the outer clavicle in every case but, whilst some surgeons do that, there are equally compelling reasons not to remove a joint that is not symptomatic and is still functioning well.

**Rotator Cuff Repair**

If there is a major tear of the tendons, then an attempt should be made to repair this if possible. If the tear is very large then this sometimes cannot be done but, in most cases, it is possible. Once the stage is reached where the tendons require a large repair, the results tend not to be as good as they are when the tendons are intact or when only a small repair is needed. When irreparable, pain relief can often be achieved by decompression and clean up of the tear. However, without those tendons functioning normally, the shoulder will be weak and, in the worst case scenario, the ability to raise up the arm will be lost.

Rotator cuff repair is almost always preceded by sub-acromial decompression, this being necessary to not only remove any damaging spurs but also to widen the space to allow for the actual repair. The decompression is always done first and this is an arthroscopic procedure which also allows viewing of the tendon and any tears. When necessary, it is followed by a repair of the tear which, if small, can often be done arthroscopically. Once the tear gets a little bit larger or more complicated however, then it is more likely that an open repair will achieve the best results. Whilst this does lead to a slightly bigger scar, the recovery is still pretty much identical to an arthroscopic repair. Indeed, there is no difference in post operative pain, time in hospital, rate of healing, time in a splint and so forth, between arthroscopic and open repair.

To achieve this outcome, the decompression has to be done arthroscopically so that the deltoid muscle does not have to be detached from the acromion. The repair can then be done through a split in the deltoid muscle, which has the advantage of not damaging or weakening that muscle in any way, hence allowing full recovery of strength and function.

The tendon repair is achieved by suturing the tendon ends into a roughened area on the bone. This can be done either by passing the sutures through holes in the bone and tying them there or by using anchors which have sutures attached to them. These are put into the bone itself: and the suture ends then can be used to sew the tendon directly to the bone (see diagram on left illustrating a so-called double row repair). Anchors, which are the most popular method of attachment, are usually made of a plastic material, be that permanent (PEEK - polyetheretherketone) or absorbable (PLLA - poly-l-lactide acid). A variety of different materials are available for use, but the optimal material, one which will ultimately dissolve and be totally replaced by bone, has yet to be perfected. Nevertheless, major strides towards developing this sort of technology have been made.

Tendon healing is slow, taking about 8 weeks for the repair to be strong enough to allow the arm to be raised up under its own power. It then takes another 2 months for the tendon to heal fully into the bone, which it does by re-forming the special cartilaginous attachment fibres known as Sharpey’s fibres. This means that any attempt to exercise the shoulder before that time may result in a breakdown of the repair. If the tendon is allowed to heal satisfactorily however, then the results of repair can be expected to be good. Pain relief is almost universal, with function and return of power progressively returning (at a rate and degree dependant upon the quality of the tendon tissue and the degree to which it heals).
Surgery

This is carried out under general anaesthesia. It takes about 45 minutes of anaesthetic to perform a decompression but usually it is possible to get home within 4 - 6 hours of the surgery. If a tendon repair has to be performed it may take another 30 minutes or so to do the surgery, depending on how large and how difficult a repair is required. Any repair however, does make the operation bigger and more painful, and it almost always means a night in hospital and a sling for 4 - 6 weeks to protect it. The sling is full time but, whilst in the hospital, you will be shown how to remove it and protect the repair whilst showering and dressing.

Post operative course

One thing about this operation is just how variable the recovery is. Some people really progress quickly whilst others seem to progress much more slowly. There are however some average guidelines that can be stated.

For decompression alone

The usual recovery is such that:

In the first 3 weeks - rest is important but the arm may be used for most activities below shoulder height

At 3 weeks - the shoulder may be pushed along a little bit

By 6 weeks - the shoulder should probably feel like it did before surgery, no better

By 12 weeks - the shoulder should be about 90% better. Swimmers can begin training, tennis players can do ground shots etc.

By 6 months - it should take moderate effort to cause any pain

By 12 months - the shoulder should feel normal. No pain and suitable for any activity

For a tendon (rotator cuff) repair

The time course is slower but the end result should be similar. The tendon must be allowed to heal before motion can be regained. This means 4 - 6 weeks in an abduction sling to begin with.

In the second 6 weeks passive motion is performed, taking the arm up in the forward direction 2 - 3 times per day. The aim is to get about 90% of the motion back in that second 6 weeks. It is important that the repair is not stressed however, which means mobilising slowly. Quicker is not better.

Generally the arm will go to about 75º of elevation when it has been out of the sling for a few days. To increase the motion over a 6 week period means achieving about 15º more motion each week - and no more. To reach full elevation within a week of removing the sling is to put the repair at substantial risk. It is not a sign that the shoulder is doing well.

After 3 months the shoulder can be used more actively and, as the strength of the repair increases, so the use be increased. The tendon is first thought to be solidly healed into bone at 4 months (when Sharpey’s fibres first appear) and both tendon and muscle strength continues to improve up to the 12 - 15 month mark. By then, if the tendon is of reasonable quality, shoulder function should be near normal.

Complications and Problems

Bleeding and Bruising are relatively common problems. The shoulder has a good blood supply and the bone does bleed quite freely. As much bleeding as possible is controlled at the end of the procedure but some swelling under the deltoid (upper arm) is common. Similarly, some bruising around the incisions is usual.

More moderate bruising may be seen when the end of the clavicle has been removed to deal with A-C joint problems. This is seen over the front of the chest and in the upper breast area. It is however normal, and it will resolve.

The deep bruising that does not appear for some days is sometimes of more concern, causing more ache and decreasing motion, hence slowing recovery. This is unpredictable and is very variable in its extent. Similarly, there is very little that can be done in the post operative phase that will help, other than trying to keep the shoulder moving.

D.V.T. (deep vein thrombosis) and P.E. (pulmonary embolism) are both very rare in shoulder surgery. Clots in arm veins are possible but the problem is small compared to that which occurs in lower limb or abdominal surgery. Prophylaxis is therefore only given to high risk individuals, albeit knowing that this will increase the bleeding and bruising a bit.

Infection is very uncommon in decompression alone (less than 1 in 1000). It is slightly more common (but still less than 1%) where there has been a tendon repair and where there are stitches, anchors and other foreign materials in the site. To get infection rates this low when a tendon is repaired, prophylactic antibiotics are routinely given. This of course does not guarantee that there will be no infections but it keeps the percentages low, knowing that, in a repair, because of all the foreign material used, infection can be difficult to eradicate. Indeed, full resolution often requires one or two washouts of the joint plus removal of all the anchors and sutures. The end result of such a deep infection is that the
tendon will then need to be re-repaired at another time, if that is still possible.

Capsulitis or Frozen Shoulder is the most common complication of sub-acromial decompression, probably occurring to some degree in about 10% of cases. This is an inflammatory condition that occurs some 5 - 6 weeks after surgery and not initially. No one really understands how or why this develops but it causes an increase in pain (particularly night pain) and a concomitant decrease in motion. The treatment of this condition is to deal with the inflammation, which means resting the shoulder and, almost always, giving an injection of cortisone into the joint itself. This generally leads to a quite dramatic resolution of the pain and gets the shoulder motion back on track.

Occasionally, the response to injection is less than ideal and the problem either lingers on for some months or keeps recurring, requiring on-going injections and rest. Eventually however, this problem does tend to resolve, and usually it leaves no sequelae.

Capsulitis also occurs after tendon repair; however, it is harder to diagnose because the shoulder is already stiff from being kept still in a sling after surgery. Also, the tendon repair may be a bit sore in its own right for a few weeks, thus masking any symptoms from capsulitis. A further problem after repair is that the joint cannot be injected until the tendon is fairly well healed because cortisone interferes with the healing process. Generally therefore, it is about 3 - 4 months from the time of surgery before injection can be undertaken safely. What is known however, is that if a frozen shoulder occurs after tendon repair, then the healing is actually better, and the long term breakdown and failure rate is less. We also know that a lot of these shoulders will start to free up and come good at the 4 - 5 month mark, even without treatment.

Where cortisone cannot be injected, and where the pain remains significant despite a reasonable passage of time, oral cortisone (tablets) may sometimes be indicated. This treatment is often not as effective as local injection, but can still lead to a significant improvement in the inflammation of the capsule and hence the pain and range of motion.

A-C joint pain may occur for a couple of reasons. Firstly, some degeneration or arthritis of the is joint is common and, what might have been an asymptomatic problem, can be stirred up by surgery that is within millimetres of, or may involve, this joint. Sometimes, as part of a sub-acromial decompression, not only is the underside of the acromion removed to increase space, but the underside of the outer clavicle, which is adjacent to this, needs to be removed. This is called co-planing, and probably is required in the majority of standard decompressions. When this is done, it does necessarily open the joint between these bones (the A.C. or acromio-clavicular joint). This opening of the joint because of the loss of some joint capsule, can lead to some progressive looseness of the joint, which in turn is thought to be the cause of some of the pain that may develop in this joint over the months after the initial surgery.

Often, given enough time, this pain will resolve. If it does not, or if it is disabling, then the next step is a cortisone injection into the joint to try and remove any inflammation from it (and hence to remove the pain). Frequently this is enough to settle things down without further intervention becoming necessary. If the pain persists however, or if there is painful arthritis of this joint to begin with, then the treatment of choice is to excise the end (1 cm) of the clavicle (collar bone). This literally removes the joint so that the bone ends no longer touch. Fortunately, this tends not to lead to any noticeable instability of the outer clavicle and it is highly likely to remove the A.C. joint pain.

Persistent and/or Recurrent Impingement may occur. Despite what seems to be a wide decompression at the time of initial surgery, this sometimes proves inadequate. Only time delineates this and only a revision of the decompression will fix it. Fortunately, at second look arthroscopy, the cause of the persistent impingement can generally be seen. Usually it is the very outside edge of the acromion or the outer end of the clavicle that is the cause and, either way, a further bone removal from one or both bones should fix the problem.

Late recurrence of impingement is uncommon but does occur. Frequently it takes a decade or more to re-present and treatment is exactly the same as for the first time. Sometimes what appears to be recurrent impingement turns out to be degenerative tendon disease with tearing due to failure of poor quality tendon. This is harder to treat but sometimes a repair can be successfully achieved.

Re-tear of the Tendons may occur. Sometimes this just represents incomplete healing in the first place: and certainly not all tendons will heal. Sometimes however, the reason for tendon failure is degenerative disease of that tendon, possibly due to poor blood supply and nutrition. Essentially, these tendons can die and the dead or damaged areas can be absorbed by the body. This then leaves a defect in the tendon, often quite large, which may look no different to any other tear. Needless to say however, repair of such poorly viable tissue may well be unsuccessful and, in the longer term, larger areas of the tendon may breakdown, leading to an even larger tear than the one that was originally repaired. This situation may culminate in an irreparable tendon with concomitant weakness and loss of function. Ultimately, if bad enough, the humerus will ride up until it hits the acromion, which is then used as a fulcrum to lift the arm up or out from the side (see picture below). This means that the ball
of the shoulder joint is no longer in the centre of the socket but, instead, rests on the upper edge of that socket. This mismatch, in turn, leads to the edge of the socket gradually wearing away the lining of the ball (humeral head) which ultimately manifests as osteo-arthritis (wear of the bearing surface) of the shoulder joint.

The above situation, where loss of tendon function leads to osteo-arthritis, is generally known as ‘cuff tear arthropathy’ and, fortunately, is relatively uncommon. As expected, it is mostly seen in the elderly, who are more likely to have degenerate tendons.

Reverse Replacement

For most people who have cuff tear arthropathy, the associated pain and swelling can be managed with injections. Often the decreased available range of motion and strength can be accepted, particularly if one shoulder remains in reasonable shape. If this is not the case however, then the alternative of choice, in the older patient, is to put in a reverse shoulder replacement where the ball is on the glenoid side and the socket is on the humeral side. What this does is to push the arm downwards preventing upward migration, re-tensioning the deltoid to allow it to work, and hence to provide more strength and usually more motion. It is a very good pain relieving procedure and it does provide more motion in most instances. The mechanics of this however, are somewhat different to the normal shoulder, and hence mechanical failure occurs with time in a not insignificant percentage of cases. What this means therefore, is that it is not suitable for every case and, preferably, it should not be performed in younger patients because of the poorer long term results and the difficulty of revision of this construct.

Latissimus Dorsi Transfer

In the younger patient with an irreparable tear, it is often the case that decompression alone will improve pain and function. In this age group, the remaining tendons are often strong enough to make up for some of the deficit. Whilst the shoulder may be weak therefore, it may function well, and for a long time.

When this does not happen, and the shoulder remains sore or very weak, a muscle / tendon transfer may be indicated. The commonest of these is to transfer latissimus dorsi, the large muscle behind the shoulder, so that it passes through the sub-acromial space and attaches where supraspinatus used to attach. This then makes it function like the missing rotator cuff, both to increase strength and to prevent ongoing upward migration. Unfortunately however, the tendon that is available for transfer is generally small in comparison to that which it is supposed to replace. It is also short and may not reach to quite where it should for optimal function. Because
of this and the resulting mixed results, this procedure is regarded as a measure of last resort, and hence, is performed very infrequently. In some instances however, the results can be quite gratifying.

**Alternative transfers** involve using both Latissimus Dorsi and Teres Major. This combination transfer is rarely performed but, in selected individuals, may improve the resulting arm strength more than a single transfer.

Whilst transfers can be used as described above, they are sometimes performed without major re-routing of the tendon(s) into the sub-acromial space. In these instances, the tendons are simply taken from the inside of the humerus where they normally attach and are moved onto the outside of the bone. This reverses their role from internal rotation (turning the arm in) to external rotation (turning the arm out). This re-balances the shoulder by replacing the external rotation power that is lost when there is massive rotator cuff tendon tearing and, accordingly, provides better function. This re-balancing does not aim to put tendon between the humeral head and the acromion, but rather seeks to balance the forces so that the muscles themselves can make the shoulder function better. As a procedure this is very new but it is showing some promise in selected cases.

Sometimes, these sort of transfers are performed at the same time as reverse replacement, to try and restore some of the function that may be lost in massive, irreparable tears of the rotator cuff.

### Sub-scapularis tears

Sub-scapularis is a muscle at the front of the shoulder. It is part of the rotator cuff but, fortunately, is mostly spared in the impingement process when the other tendons tear. In some instances however, it may tear, either by itself, or because the biceps tendon which lies in a groove just above it, slips out of that groove and begins to cut its way through it.

Sub-scapularis may also be torn acutely, usually when falling and reaching out to save the fall. Typically, this is a fall down a flight of stairs where the balustrade is grabbed, wrenching the arm out from the side of the body. This leads to weakness of internal rotation and to shoulder function and, in general, needs repair. Unlike the other rotator cuff tendons however, the diagnosis of a sub-scapularis tear can be harder to make, particularly if it is incomplete. It is hard to reliably see this tendon on either ultrasound or on MRI, and it is hard to see more than a centimetre of the tendon at arthroscopy. This means that there is a high reliance on clinical testing to suspect that this tendon is torn and, unfortunately, this is not always reliable either. With a combination of all of the above however, these tears can mostly be identified and can frequently be repaired. Unlike the other tendons however, this tendon is much harder to repair in the chronic situation. Hence, early diagnosis and treatment is important.

Repair of the sub-scapularis tendon is not only open surgery, but it often has to be done through a different incision to a repair of the supraspinatus and infraspinatus tendons. Hence, in some instances where there are tears of all these tendons, two separate incisions may be required. Again however, the incisions are such that the deltoid muscle is split and not cut, and thus not weakened.

Repair of this tendon involves splinting in a modified sling for 4 - 6 weeks, depending on how good a repair has been achieved. Poor tendon leads to a weak repair that needs more protection than the strong repair which can be achieved where there is good healthy tendon in a young individual.

### Biceps Tendon Disease

The biceps tendon lies just in front of the supraspinatus tendon and just above the sub-scapularis tendon. Generally, impingement related tears first occur at the very front of the supraspinatus tendon and, as they progress, they extend towards the infraspinatus tendon (that is: they start at the front and move towards the back). Given where they usually begin however, which is just behind the biceps tendon, it is not hard to see that a small variation in anatomy could lead to the impingement process beginning at the biceps tendon. When this occurs it leads to pain which radiates down the biceps tendon, sometimes extending as far as the elbow where the tendon at the other end inserts.

If the biceps tendon tears right through and ruptures, the muscle will retract down towards the elbow leading to what is commonly termed the 'Popeye muscle'. When this happens the biceps pain is usually dramatically relieved, being replaced by some focal muscle pain which usually disappears with time. There is only minimal strength loss when this occurs, and hence, these tears are not usually repaired (repair usually being carried out only for cosmetic reasons and not for function).
Biceps subluxation and dislocation may occur when the sheath that covers the groove that the biceps lies in becomes damaged by impingement (or occasionally by trauma). The sheath may be eroded away or damaged such that it leaves the tendon unroofed, and this, in turn, may allow the tendon to gradually work its way out of its groove and ultimately, in some instances, to erode into and damage the subscapularis tendon that lies just in front of it (see below). If this happens, sub-acromial decompression to remove the cause, in association with a biceps tenodesis is the treatment of choice. Attempts to relocate the biceps tendon, and to repair the sheath that normally lies over it, generally do not work. Such a repair usually leads to the tendon becoming glued to the bone and sheath, and hence it can no longer slide in its sheath. This can lead to residual pain, albeit that function can still be quite good. Because of this, a better option is to cut out the damaged portion of the tendon and to then secure the cut end of tendon to the upper humerus (tenodesis). This leads to relief of the biceps pain with minimal, if any, loss of function. As such, it has become the standard treatment for biceps problems and can be performed alone or in association with other tendon repairs if necessary.

Progressive Osteo-arthritis

Osteo-arthritis is a wearing out of the shoulder joint. This may not cause too many symptoms initially but, as the joint starts to tighten and lose range of motion, the humerus is pushed up causing secondary impingement. For a while this can be helped by sub-acromial decompression. Ultimately however, if the arthritis progresses enough, symptoms directly related to it can be felt. If bad enough, this leads to shoulder replacement, where the ball and socket are both replaced. To achieve good function with this, the rotator cuff tendons need to be normal or very near normal. If this is not the case, the humerus will upwardly migrate, just like in cuff-tear arthropathy, and the socket will prematurely wear and loosen. This will then require conversion to a reverse replacement, a procedure that can be very difficult to perform.

Further information can be obtained on this and other related topics at: www.keithholt.com.au