Complications in shoulder surgery

David Limb

Abstract

Shared decision-making in orthopaedic surgery involves an honest and open discussion between the surgeon and patient concerning the treatment options (including no treatment) and the risks and rewards of each option. This includes a frank discussion of the potential complications of surgery and this often creates a conundrum for the patient – surgery may only offer pain relief and improved function but the list of potential complications seems endless. However the discussion of complications can itself be problematic – most are rare and the surgeon may have little or no experience of them, or at least insufficient to give the patient their own personal figures in percentage terms. An overview of the literature is helpful but, as this article will discuss, the data published can only be a guide. It is incumbent on all surgeons to consider their own skills, setting, access to equipment and technologies and the team they work with to develop an effective consent process that fully informs patients and helps them to make their choice comfortably. Data are discussed that aid the surgeon in developing their own personalized process for discussing the potential complications of shoulder surgery with their patients.

Keywords arthroplasty; arthroscopy; complications; infection; nerve injury; shoulder

Introduction

What is a complication? The scientific literature is inconsistent in reported rates of complications, partly because what one author sees as a complication another does not, such as wound problems never resulting in a positively diagnosed infection, or the 'routine' need to remove certain implants. Certainly we should all be aware of, and warn the patient about, potential adverse events and outcomes. These are commonly grouped into those that occur relatively frequently, such as retear after rotator cuff repair or recurrent dislocation after shoulder stabilization, and those that are rare but have serious consequences. The latter would include problems such as deep infection, nerve injury and the like. Patients need to be able to take into account the spectrum of potential complications in order to decide whether or not to consent to a procedure taking place. However everyone is different and what one patient may deem unimportant, another might be abhorred by. In the UK the impact of the Montgomery ruling on the consent process has been substantial and is highlighted in other papers in this issue of *Orthopaedics and Trauma*. This review cannot therefore be comprehensive but aims to broadly outline the complications that can occur across the whole spectrum of shoulder surgery, particularly those that can have medicolegal consequences for the surgeon, and forms a foundation upon which the surgeon can develop their own personalized approach to risk discussions with patients.

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Litigation in shoulder surgery

In 1995 the NHS litigation authority (NHSLA) was set up in the UK and its purpose was to indemnify larger medicolegal claims initially, but since 2002 it has dealt with all clinical negligence claims. Analysis of data from the NHSLA therefore gives an indication of what gives rise to claims and this provides valuable lessons. An analysis of these data for shoulder and elbow claims in 2014[1] reveals that the shoulder accounts for only 5.1% of claims in trauma and orthopaedic surgery. The most numerous claims do not relate to specific complications, however, but to errors in diagnosis (missed, delayed or incorrect) and management, together these accounting for 47% of settled claims with a mean cost of around £50k per claim.

The most frequent complication resulting in a settled medicolegal claim is neurological deficit (7.1%, mean cost still around £50k) followed by surgeon error (6.6%), perioperative injury (4.9%), technical error (4.4%) and infection (2.2%). Furthermore 2.7% of claims related directly to the consent process: the patient being deemed by the Court to have been inadequately informed of the risks and rewards of surgery before undergoing a procedure. Wrong site surgery is fortunately rare, with only two claims settled in the 17-year period studied, but resulted in the highest mean payouts (around £250k).

General complications

General complications include respiratory, cardiovascular and urinary complications that can occur after any operation. It is essential that any patient being offered a procedure under an anaesthetic is adequately assessed and the risks posed by the anaesthetic and the procedure are appraised in the context of the patients co-morbidities. These will not be dealt with in detail at this stage, as they are covered in most other articles in this issue and any specific issues relating to shoulder surgery are considered in the following sections on open and arthroscopic surgery.

Complications of anaesthesia and positioning

The first group of complications that will be discussed fall into the category of general complications. However, as has already been seen, the majority of claims against surgeons do not relate to the technical proficiency of the surgeon carrying out the operation they have recommended.

General anaesthesia

Difficulty in intubation can lead to dental trauma, soft tissue trauma and hypoxia – in the most severe cases resulting in abandoned surgery and even death.[2] Ventilation can be compromised by aspiration pneumonitis, especially in the unfasted patient or the patient with reflux. Hypotension can lead to myocardial ischaemia, cardiac arrest or even brain injury and this is critical to note in shoulder surgery patients, as the surgeon often asks for hypotensive anaesthesia to give a bloodless field or better arthroscopic view. Allergic (anaphylaxis) or idiosyncratic (e.g. malignant hyperthermia) drug reactions should be

considered along with administration errors, which can give rise to awareness. With an appropriately assessed patient and modern anaesthesia these risks are very low and if a particular patient is identified with high risk this should be picked up at preassessment and discussed as part of the risks and rewards discussion with the patient.

Regional anaesthesia

Shoulder surgery in the modern era makes extensive use of regional anaesthetic blocks, such as the interscalene block. This is associated with side effects that can be important (raised hemidiaphragm and reduced inspiratory effort due to phrenic nerve anaesthesia) or minor (Horner's syndrome, vascular puncture with bleeding). It can also be associated with specific complications, including pneumothorax, infection, nerve injury and total spinal anaesthesia. Overall the risk is very low, with the published risk of significant complications being as low as 1 in 10,000.

Positioning

The two main patient positions for shoulder surgery are the beach chair position and the lateral position: the former for arthroscopy and almost all open shoulder surgery, the latter for arthroscopy and some posterior open shoulder surgery. The beach chair position is preferred if conversion to an open procedure is likely. The lateral position gives better access for posterior stabilization surgery. Complications of the surgical approaches and specific procedures will be discussed separately, but there are specific problems that can be associated with the position itself if care is not taken.[3] It is important that the surgeon becomes involved in the process of positioning and ensures that the patient is properly padded. Whatever position used, the spine should be well supported along its length – take care to hinge the table at the hips for the beach chair position so that the lumbar spine does not arch over a gap; support the head to give a neutral cervical spine position when in lateral decubitus. An unsupported lumbar spine in the beach chair position can result in severe back pain. Hyperextension of the elderly cervical spine can even risk vertebral artery occlusion.

Beach chair position: a number of case series have been published indicating that the risk of complications related to positioning in shoulder surgery is very low. The beach chair position, especially in patients in which the blood pressure is lowered to reduce bleeding, carries a risk of cerebral hypoperfusion. Other rare complications relate to inadequate padding of the head (lesser occipital and greater auricular nerves) or arm table (ulnar nerve injury). Headstraps can also injure the eyes if the eyes themselves are not at least taped shut and preferably with gel pads. As the incision can be above the level of the heart, opening large veins (including the cephalic vein) carries a risk of air embolism.

Lateral position: again data are from small case series and comparison with the beach chair position is statistically impossible. Cerebral hypoxia has therefore also been reported in the lateral position but it seems that stroke and hypoperfusion are less likely than in the beach chair position. Given that more surgery is carried out in the beach chair position, there do seem to be more case reports of thromboembolic problems in the lateral position. There are less reports of nerve injury affecting the head, but more affecting the upper limb (not only ulnar but also musculocutaneous, axillary and digital nerves).

Arthroscopy in the lateral position also often employs traction and the position for traction can be important. An increased risk of brachial plexus injury has been identified with the arm in 45° of flexion and either 0° or 90° of abduction[4] and the recommendation is that around 30° of flexion and abduction is adequate.

Complications of surgical approaches

Deltopectoral approach

The deltopectoral approach is, with the posterior approach to the hip, probably the most frequently discussed surgical approach in postgraduate orthopaedic examinations. It is the workhorse approach for open shoulder surgery including fracture surgery. The skin incision is relatively free from the tendency to form numb patches due to cutaneous nerve division, as is common beneath the typical incision to approach the clavicle and lateral to a midline knee scar. The approach is then deepened through an internervous plane (deltoid served by axillary nerve and the pectoralis major from the medial and lateral pectoral nerves) and again nerve injury is rare at this level. Problems can occur after opening the thoracobrachial fascia and retracting the conjoint tendon medially: the nerve at risk is the musculocutaneous nerve. Likewise this nerve is at risk when any dissection takes place under the conjoint tendon, and some authors would deliberately identify the nerve and pass a sling round it so that it can be observed during subsequent parts of the procedure.

The musculocutaneous nerve is a terminal branch of the lateral cord of the brachial plexus containing fibres traversing the C5-7 roots. It innervates coracobrachialis, brachialis and biceps before terminating as the lateral cutaneous nerve of the forearm. It leaves the axilla to pierce coracobrachialis, forming a tether which makes it vulnerable to kinking as retractors are placed and used, particularly under coracobrachialis as is often done to expose subscapularis and the shoulder joint. It has quite a degree of variability in its course, however, and can also exchange fibres with the median nerve. It can pass under coracobrachialis rather than through it and may pass through the biceps muscle.

The effects of musculocutaneous palsy are weakness of elbow flexion and supination with numbness affecting the lateral forearm.

The axillary nerve is also at risk, though as it passes down the front of subscapularis it is quite medial. However it turns under the inferior capsule of the shoulder joint on its way to the quadrilateral space and is most at risk traversing beneath the axillary pouch of the shoulder, within 1 cm of the capsule. The effects of axillary nerve injury are discussed in the next section.

Excessive traction and/or rotation of the arm during the deltopectoral approach, as with other approaches, can cause a variety of brachial plexus traction lesions depending on the forces applied.

Anterosuperior approach/deltoid split

Often used for reverse arthroplasty, rotator cuff surgery and some fracture surgery, various forms of deltoid splitting

approaches are available and reduce the risk to the musculocutaneous nerve. However the axillary nerve is at greater risk and in some cases may actually have to be exposed and protected as it winds round the proximal humerus supplying the deltoid muscle. Of critical importance is the distance from the acromion to the course of the axillary nerve and this increases as the nerve passes from posterior to anterior. A safe zone has been identified that is related to the length of the patients arm[5] with the nerve being a mean 4.9 cm from the posterior acromion and 6.1 cm from the anterior acromion[4] which, when related to the arm length, gives a posterior safe zone of 0.16 of the arm length and an anterior safe zone of 0.2 of the arm length.

The effects of axillary nerve palsy are deltoid weakness and later wasting (Figure 1) and numbness in the regimental badge area. These effects are minimized in the anterosuperior approach to the shoulder as the nerve at this point is beyond its cutaneous branches and the functional effects of denervation of a thin anterior strip of deltoid are minimal.

Posterior approaches

The commonly used posterior approaches are the deltoid split (risks discussed above) and the posterior approach employing the intervervous plane between the infraspinatus (supplied by the suprascapular nerve) and the teres minor (axillary nerve). The nerve primarily at risk here is the suprascapular nerve as it winds lateral to the spinoglenoid notch to pass from the supraspinous fossa to the infraspinous fossa. Retractors, elevator, drills and other instruments carelessly used in this region can injure the nerve.

The effects of injury to the suprascapular nerve at the spinoglenoid notch are weakness of external rotation of the shoulder with wasting of the infraspinatus and consequential effects on rotator cuff function.

Arthroscopic surgery

Portals

The standard posterior portals, lateral portals and the anterior portal that is lateral to the tip of the coracoid, aiming into the rotator interval, are all safe but the anterior portal becomes progressively closer to neurovascular structures the more inferior it is placed.[6] The axillary nerve, closely related to the inferior shoulder capsule, is most at risk and this has been shown to be a particular risk in thermal capsulorrhaphy and stabilization procedures. Advanced techniques such as the arthroscopic Latarjet procedure involve using instruments in close proximity to the axillary nerve and great caution has to be exercised — this technique also brings the musculocutaneous nerve into the risk equation. As the scope of shoulder arthroscopy widens, newer techniques bring along their own risks and, for example, releases outside the shoulder and suprascapular nerve decompression surgery put the suprascapular nerve at risk and a detailed understanding of its course is required before embarking on such techniques.

Figure 1 Axillary nerve palsy after shoulder dislocation — note wasting of the right deltoid.

Infection

Arthroscopic procedures are associated with lower infection rates than open procedures, below 1%, but the rate increases substantially when conversion to an open procedure is required. Infection rates are affected by many factors and the rates documented in one unit or in one paper may not precisely reflect what is seen elsewhere; however rates of less than 3.5% are typically reported,[7] more usually fractions of a percentage point in large series and many case series document a rate of 0. Problems have occurred when arthroscopic instruments were sterilized in disinfectant solutions, and some instruments required this form of sterilization because of their construction, particularly if not cleaned properly before sterilization. It is now standard practice to steam sterilize arthroscopic equipment.

As in open shoulder surgery *Cutibacterium acnes* is a specific problem in shoulder surgery and can be difficult to identify, often taking 2 weeks to culture from specimens that prove to be positive. It should be considered in any case of unexplained postoperative pain.[8]

Thromboembolic complications

Most arthroscopic shoulder surgery involves mobile patients undergoing day case (outpatient) surgery to the upper limb and the risk of thromboembolic complications is very low. However all patients should be risk assessed and if there are other risk factors present (such as a history of malignancy, thromboembolism in the past, obesity or prolonged surgery expected) then thromboprophylaxis may be needed. A national database study in the UK documented a 0.1% pulmonary embolism rate in 65,302 shoulder arthroscopic procedures.[9] Interestingly there is no good evidence that thromboprophylaxis has any effect on the rate of symptomatic deep vein thrombosis or pulmonary embolism after arthroscopic shoulder surgery.

Specific conditions

The commoner shoulder surgery procedures will be briefly discussed. There are websites aimed at both patients and surgeons which intend to assist the consent process, though these are not comprehensive and often have limited detail, though this does of course make them more generalizable and unit-specific information can be added. Examples are www.orthoconsent.com and https://orthoinfo.aaos.org.

Arthroplasty surgery

Shoulder arthroplasty is increasingly commonly performed and, among the countries and regions that have substantial registry evidence, the rate increased 2.8-fold in the decade to 2017 and there was a six-fold variation between countries with the highest

rate seen in Germany and the lowest rate in the UK.[10] This study also demonstrated that in the two countries with sufficiently granular data to determine surgeon volumes, the average number of cases a surgeon performs a year is only 10–11. As in all areas of surgical practice, it is incumbent on the surgeon to consider whether their volume of specific surgical procedures is adequate to ensure that they are sufficiently proficient and able to deal with any unexpected events in surgery – it has been shown in many areas that complication rates tend to be lowest in high-volume centres and with high-volume surgeons.

A population-based analysis in the UK using hospital episode statistics revealed that for the elderly, shoulder replacement was usually a 'once in a lifetime' operation, with a lifetime likelihood of revision of 2.7% in women over 85 but rising to 24% in men under the age of 59.[11] This same analysis revealed that the risk of any further operation in these two subgroups was 3.7% and 32% respectively. Furthermore the risk of revision being needed was greatest within 5 years of the original implantation procedure.

The complications that arise in arthroplasty can be specific to a particular surgeons practice (team, positioning, approach, implants used etc) but this review will generalize only into two main groups, which differ in the patient population offered surgery and the implants used: anatomic shoulder replacement and reverse total shoulder arthroplasty.

Anatomic shoulder replacement

Again, even in this category one could consider differences between hemiarthroplasty and total replacement, resurfacing versus stemmed replacement and the differences between stemless total, short stems and long stems. For such implant-specific data further reading will be needed. Indeed it has been shown that complications vary substantially between implants – although the overall rates are similar the spectrum of complications and the frequency of each differs[12]

Adverse events occurring soon after surgery are usefully summarized in a paper that compares these in patients younger and older than 70 years.[13] The commonest adverse events were similar in both groups: urinary tract infection (0.22% vs 1.7%), thromboembolic events (0.43% vs 0.44%), wound infection (0.27% vs 0.11%) and the death rate was documented as 0.1 versus 0.22%.

Risks specific to the procedure may vary according to the specific situation and will be affected by variables such as prosthesis modularity and other factors. However overall figures have been published and can be used as a basis upon which to build one's own local information. The most widely reported complications after anatomic total shoulder replacement are as follows.

Common complications are bleeding, scarring and stiffness. To an extent these are expected in all patients. Keloid scar is rare unless the patient is predisposed. Stiffness depends to an extent on rehabilitation but there is still huge variation amongst patients and the range of movement can continue to improve for a year after shoulder replacement. Eventual failure of the prosthesis can fall into this category and for anatomic total shoulder replacement glenoid loosening is the commonest mode of failure and has been reported to have a prevalence of 6%, whilst the prevalence of humeral stem loosening was only 1%. Interestingly the solution to loosening may not be stronger fixation – the centre of rotation of an anatomic shoulder is within the metaphysis of the proximal humerus so the transmission of forces to the stem and shaft is totally unlike the situation seen in the hip, and many shoulder systems do not include any form of hydroxyapatite coating or other means of bonding in press-fit stems. A recent systematic review compared cemented and press-fit humeral stems and found the revision rate for loosening in humeral stems was 2.3% for cemented and 1.8% for press fit.[14]

Less common complications (1–5%) include:

- infection (*C. acnes* is more common than in other joint replacements)
- intraoperative periprosthetic fracture (commoner in uncemented prostheses)
- rotator cuff failure: subscapularis failure early causes anterior subluxation and is associated with increased passive external rotation. Superior cuff failure is observed with time and may be more common in the elderly such that some see this as a reason to consider primary reverse arthroplasty in the elderly, even with an intact rotator cuff
- nerve injury and arterial injury, as discussed in general complications'
- prosthesis-specific complications can include dissociation of modular prostheses.

Reverse shoulder arthroplasty

The spectrum and frequency of complications are similar to those for anatomic total shoulder replacement with some exceptions. Rotator cuff failure is not usually reported as a complication, as the main indication is an absent or torn cuff, but it is replaced by others including:

- infection may be slightly more common and this has been attributed to the large dead space under the acromion immediately after reverse shoulder replacement
- the design and mechanics of reverse arthroplasty mean that dislocation is more common than in anatomic replacement (around 2 -5% but substantially higher in some series)
- more unique complications are baseplate failure (akin to glenoid component failure), scapular notching and acromial stress fracture.

The relative rate of complications reported in a Current Concepts review published in 2017 identified an overall complication rate of 11% for total shoulder replacement and the relative frequency varied slightly between anatomic and reverse prostheses.[15] The complications of anatomic prostheses in descending order were component loosening > glenoid wear > instability > rotator cuff tear > periprosthetic fracture > neural injury > infection > haematoma > deltoid injury > venous thromboembolism. For reverse shoulder replacement the complications were instability > periprosthetic fracture > infection > component loosening > neural injury > acromial and/or scapular spine fracture > haematoma > deltoid injury > rotator cuff tear > venous thromboembolism.

Rotator cuff repair

Stiffness is to an extent to be expected after rotator cuff surgery, and in a small proportion of patients adhesive capsulitis/frozen shoulder can make this more significant and long lasting (but with some evidence that this slightly enhances healing rates). The incidence of frozen shoulder is reported to vary widely — from 1% up to more than 30%, but the definition of the condition is very inconsistent and explains this variation. Essentially the patient should be informed of the rehabilitation programme afterwards, which varies from unit to unit, and should expect to limit the range and function as part of that programme for weeks or months after surgery.

Another common occurrence after rotator cuff repair is retear (or failure of healing). This only correlates weakly with persistent symptoms and although almost all series of arthroscopic or mini-open cuff repair report 80–85% good to excellent results, it is true that a substantial proportion of these patients will not have a soundly healed tendon at the end of their rehabilitation! A large randomized multicentre trial in the UK comparing arthroscopic and open cuff repair techniques reported the expected good outcomes but part of the follow-up evaluation included an MRI at 12 months. The rate of retear observed was 46% for arthroscopic repair and 39% for open repair.[16]

The infection rate for cuff repair is around 1% and again *C. acnes* should be considered in any case of suspected infection, including persistent unexplained pain. Rarer complications include chondrolysis, nerve injury, complex regional pain syndrome and fracture.

Instability surgery

Again uncommon complications include infection, nerve injury, complex regional pain syndrome and the general complications described above. Whereas retear is the most likely unwanted occurrence after cuff repair, recurrent instability is the commonest untoward occurrence after instability surgery. The patient must be made aware of the local rehabilitation protocol before surgery including specifics about return to work and sport. Ideally one's own personal recurrence rate should be stated to the patient, but this may not be available or reliable until several years into one's practice. Quoting the recurrence rate of one's mentor may not be fair. Again the literature can provide a guide but bear in mind that publication bias has a huge effect — an editor is more likely to publish an article that reports unusually good or unusually bad results, particularly if it comes from a high volume centre where the surgeons may be more experienced than most. Finding the figures that reflect real-world practice can be difficult.

As a guide, the early days of arthroscopic stabilization, with recurrence rates of 50%, are behind us. The golden era of open stabilization with 95% success rates for Bankart repair are probably not achievable by most who are relatively deskilled in open stabilization. The two techniques are converging in terms of results and the choice depends more on a careful evaluation of the specific patient as well as an honest appraisal of the surgeons own skill set. For an active male between 20 and 40 years of age suffering two or three previous dislocations and only soft tissue lesions seen on scans a recurrence rate of 5–15% is a reasonable summary of what can be expected. Very young patients, those with many dislocations (particularly those with atraumatic dislocations and muscle patterning problems) and those with bone loss experience higher rates and need an individually tailored approach. Although the Latarjet or other bone block procedures are taken to be the 'belt and braces' for instability surgery even these have reported recurrence rates of up to 15%, though a recent systematic review found reported recurrence rates after arthroscopic stabilization, open stabilization and Latarjet repair to be 15.1%, 7.7% and 2.7% respectively.[17]

Shoulder fractures

In most elective surgical procedures the patient is miserable because of pain and poor function before the orthopaedic intervention and are much better afterwards therefore happy. In trauma surgery the patient was usually pain-free with good function before they fell and expect any surgical intervention offered to restore their shoulder — often there is a shortfall so overall patients are less happy. Dealing with patient expectations is critical — any patient suffering a significant shoulder fracture is unlikely ever again to feel as though their shoulder is 'normal'. However this applies even to non-operative treatment, with stiffness and pain being a diminishing feature often for months. There are some specific risks related to trauma surgery that will be discussed but once again this review cannot be comprehensive rates of specific complications such as screw penetration, screw pullout, implant breakage and migration can vary enormously from one implant to another and often an implant that gives an advantage in relation to one complication fares less well in relation to others.

However all patients undergoing fracture surgery should be made aware of at least the following potential problems.

Stiffness

It bears repeating as the shoulder capsule reacts to tearing and the presence of blood and marrow components by shortening and thickening — loss of range of motion is an inevitable accompaniment to shoulder fractures and patients should expect this. Indeed it is so prevalent that rehabilitation exercises should be started as soon as possible and this usually means before fracture healing. In the Profher trial non-surgical and surgical treatment of displaces proximal humeral fractures gave the same results at all time points and the non-surgical protocol involved support in a simple collar and cuff followed by physiotherapy beginning at 3 weeks.[18] Delaying rehabilitation for fear of causing fracture displacement simply increases the extent and duration of stiffness. Of course patients should be warned of the risk of fracture displacement but the management of expectations includes advising that this risk is offset by the risk of significantly poorer range and function without early movement.

The risk of severe stiffness or frozen shoulder introduces unknowns however. Frozen shoulder is much more common in diabetics (1 in 3 lifetime risk) and seems to have genetic factors involved. A proportion of patients even with minor undisplaced shoulder fractures will develop a very painful stiff shoulder and interventions such as distension injection, manipulation (after union) or surgical release may be considered. This also includes a spectrum of generalized joint stiffness whereby the elbow and hand can become stiff even though uninjured (just as a frozen shoulder can develop after a hand or elbow injury). Certainly the

patient should be cautioned to keep the elbow and hand moving as their shoulder fracture management occurs and if needed appropriate physiotherapy for associated joints should be offered.

Infection

The risk of infection is low (less than 5%) but higher than seen in elective surgery. This is a multifactorial problem however so direct comparisons cannot be made. In the trauma setting management of comorbidities to optimize the patient is often not possible and both surgeon and patient may have to take into account a higher infection risk in diabetics, smokers and those with skin ulcers, for example, in deciding whether or not surgical intervention has advantages over non-surgical management (which itself may be at increased risk of non-union, for example, because of the same factors.

Nerve injury

The risk associated with patient positioning and the surgical approach is discussed above – the axillary nerve is particularly at risk in deltoid splitting approaches for plate fixation of proximal humeral fractures. Of note radial nerve injury following plate fixation of the humeral shaft has a risk approaching 10% and although 90% of these are neurapraxia and recover fully, up to 10% do not.

Implant failure/loss of position

Two aspects the patient should be aware of are implant failure (breakage of screws, cut out of sutures etc) and failure of bone resulting in a change in position of the fracture fragments around a rigid implant. Cut out of screws is often perceived by the patient as a failure of the device the surgeon has inserted whereas what is happening is usually failure of the patients bone around the device (though this in turn may be due to poor judgement by the surgeon in relation to the quality of bone and fixation). Rates of screw penetration into the glenohumeral joint of up to 30% have been reported with locking plate and screw constructs, whilst similar rates of loss of position of the humeral head and varus tilting can occur with intramedullary nails when used for 3 and 4 part fractures. Whilst few observe these rates in clinical practice (so is this an example of publication bias?) it is true that these complications are *commonly* seen – and realistically many surgeons would quote a 5–10% rate of complications of fixation for which reoperation might be needed. The important points here are that the patient needs to be aware that fixation and maintenance of reduction depends on the interplay between their bone and the device and problems arising do not automatically mean the device or surgery are inadequate, and that reoperation is a real possibility to deal with problems that may arise in treatment.

Malunion

Malunion does not necessarily mean a failure of treatment – when looked at critically there is a degree of malunion in most healed fractures, whether treated surgically or nonsurgically. Because of the deforming forces on the proximal humerus the most common form of symptomatic malunion that occurs is with an anterior position of the greater tuberosity and varus position of the humeral head. Osteotomy can be considered in the young but shoulder replacement is more often the option in the elderly. This form of malunion does poorly if managed by anatomic total shoulder replacement and it seems reverse shoulder replacement is more satisfactory. The actual need for conversion to total shoulder replacement is low in large multicentre studies (less than 5%) but nevertheless it is an issue that patients should be warned about at the outset of treatment of a displaced proximal humeral fracture.

Avascular necrosis

Avascular necrosis is a problem that often becomes apparent months after injury, often after poor progress through rehabilitation, and patients may interpret late diagnosis as a problem that the surgeon has missed. Certainly with displaced fractures the patient should be warned at the outset and this is another situation in which shoulder replacement may become needed (though in these circumstances an anatomic replacement may be entirely satisfactory). The risk of avascular necrosis depends on fracture displacement but according to Neer the rates in four-part fractures and fracture dislocations are so high as to be almost inevitable. However it is increasingly recognized that ischaemia results at a cellular level after all fractures and a process of revascularization[19] (which may be impaired by factors such as smoking and diabetes) means that avascular necrosis and collapse is nowhere near as common as avascularity of the humeral head in the weeks after trauma. MRI cannot, for example, be used to predict avascular necrosis and collapse ans many ischaemic heads revascularise and survive. From the point of view of the patient being treated it is worth mentioning to all that problems can arise that make shoulder replacement a possible future option. For very displaced fractures the patient should be aware that arthroplasty can be amongst the choices for initial treatment or for managing sequelae.

Summary

Patients undergoing any surgical procedure should be informed of the potential risks and rewards associated with the procedure as well as alternative treatments, in order for them to make an informed choice. In shoulder surgery there are general and specific complications that occur relatively predictably, but the rates vary with patient, unit and surgeon factors that demand a tailored discussion as part of informed consent. There are web resources that can assist in the process of informing the patient but these do not contain detailed estimations of risk rates, for very good reasons. Surgeons should not only be aware of the published risks of the procedures they use but also of the findings of population based studies, which often reveal a combined rate of potential adverse outcomes than is apparent from unit based research studies. ◆

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