Management of painful reverse shoulder arthroplasty

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Abstract

Even though reverse shoulder arthroplasty is a very successful procedure, painful complications occur. During the initial postoperative years, the most common reasons for pain are instability, postoperative fracture of the acromion or spine, and periprosthetic infection. Later, aseptic loosening, with humeral loosening being more frequent than glenoid loosening, can be a source of pain and reduction in function. A careful patient history, clinical examination, plain radiographs, computed tomography and blood tests give an explanation for the pain in most cases. The majority of these complications can be successfully treated, maintaining a functional reverse shoulder arthroplasty. However, if all examinations are normal, it is important to remember that nonshoulder conditions such as tumour of the lung or degenerative changes of the cervical spine can give shoulder pain.

Keywords

infection, instability, pain, reverse arthroplasty, scapular spine fracture

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Introduction

The indications for reverse shoulder arthroplasty (RSA) have expanded over the last 20 years and, in some centres, more reverse arthroplasties than anatomical shoulder replacements are performed. Table 1 illustrates my indications for RSA. The majority of patients scheduled for a RSA have significant pain, even though the procedure is sometimes performed just to restore function in pseudoparalytic shoulders. Because more reverse arthroplasties are being carried out, the number of patients with a complication is increasing. Some of these complications are painful. The majority of patients who are dissatisfied with the procedure complain of pain.

Here, a review of how to approach a painful reverse arthroplasty is provided, based on published reports and 20 years of personal experience of the RSA.

Postoperative recovery

It is normal to have pain several months after surgery.^{1,2} There is a huge individual variation in the duration and intensity of postoperative pain. Levy et al.¹ found that shoulder function improved during the first postoperative year after an RSA. Pain, measured by

visual analogue scale, decreased postoperatively and 85% of the improvement was seen at 3 months. Simovitch et al.² found that most of the improvement after RSA occurred during the first 6 months after surgery, and there was maximum improvement after 12 months to 24 months.² In my institution, we inform patients that, 3 months to 4 months after surgery, most patients are significantly better than pre-operatively regarding range of motion and level of pain, although it will take a year until they achieve the best possible outcome. Some patients recover very quickly and stop taking analgetics after a few weeks, whereas others continue to use analgetics for several months. As long as gradual improvement is seen, it is most likely a normal postoperative recovery. However, if there is increasing pain or stiffness developing after a period of normal recovery, this could indicate a complication.

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Table 1. Indications for reverse arthroplasty at the author's institution, 2006–2016 ($n = 967$)

Diagnosis	Number of cases	% of cases
Acute proximal humeral fracture	208	21.5%
Cuff arthropathy	167	17.3%
Revision of failed arthroplasty	165	17%
Massive rotator cuff tear without arthritis	135	14%
Malunited fracture	76	7.9%
Osteoarthritis with thin cuff	72	7.4%
Rheumatoid arthritis	65	6.7%
Infected arthroplasty	28	2.9%
Non-union, proximal humerus	19	2%
Miscellaneous	21	2.2%
Osteoarthritis with B2- or C-glenoid	11	1.1%

Analysis and Aetiology of pain

It is important to determine whether or not there was a trauma before the onset of pain, and whether the pain occurs at rest or when using the arm. Acute pain after a significant trauma can be caused by fractures (scapula, humerus or clavicle), dislocation or rotator cuff injuries. Acute pain can also occur without trauma, and the most common aetiology during the initial postoperative years is a fracture of the acromion or spine of scapula.^{3–7} In a few cases, sudden pain has been caused by spontaneous periprosthetic fractures (Figure 1) and coracoid process fractures.⁸ In these cases, the pain is usually more intense when the patient is trying to use the arm and reduced when the arm is at rest. A gradual increase in pain at rest and stiffness should lead to a high suspicion of infection.^{9,10} Diagnosis of an infection after RSA can be challenging, particularly if the blood tests [erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP)] are normal.^{11–16} Loosening of the prosthetic components can cause pain and loss of function, although aseptic loosening is rare during the initial postoperative years.^{17–20}

Location of the pain can guide the surgeon in the diagnosing process. Thus, pain in the proximal part of the upper arm can indicate humeral loosening, spontaneous periprosthetic fracture or infection; pain over the scapula can indicate a fracture of the spine of scapula or suprascapular nerve irritation by the superior screw of the glenoid component. In the author's series, the acromioclavicular (AC) joint has become

painful after surgery in a few cases. The pain is usually located over the AC joint and injection of local anaesthesia can confirm the diagnosis.

Diagnosis

When facing a patient with a painful RSA, it is important to have a structured approach based on the most common complications seen after RSA.^{7,9,21–23} Table 2 reports the common clinical characteristics of the three most common complications after RSA.

The first step is a careful patient history, which can give valuable information and, in many cases, a preliminary diagnosis that must be confirmed using various diagnostic tools. Physical examination to record passive and active range of motion, strength, atrophies and local tenderness is performed. Standard radiographs are taken and compared with the postoperative images. It is crucial that optimal postoperative images are available. At the author's institution, all postoperative radiographs are taken under fluoroscopic control 2 days after surgery, aiming to achieve optimal views. These images are analyzed regarding signs of implant loosening or dissociation, radiolucencies, infection, dislocation, glenoid notching, fractures of the acromion or spine of scapula, humeral fissure or fracture, base of coracoid fracture, and possible screw problems (Figure 2). It is difficult to diagnose some of these complications on plain radiographs. If the standard radiographs do not give a clear diagnosis, a computed tomography (CT) scan is performed. This is particularly helpful in diagnosing a suspected fracture of the

Figure 1. (a) Postoperative radiographs after revision of a failed anatomical arthroplasty to a reverse shoulder arthroplasty. (b) Radiographs showing a spontaneous periprosthetic fracture causing intense pain. Treated non-operatively in a brace. (c) Radiograph showing callus formation and clinical improvement.

Table 2. Clinical characteristics of periprosthetic infection, dislocation, and postoperative fractures of the acromion or scapular spine after reverse total shoulder arthroplasty

Pain	Range of motion	Diagnosis
Gradual increase in pain at rest	Increasing stiffness	Periprosthetic infection
No or limited pain	Sudden loss of active elevation	Dislocation
Sudden severe pain	Sudden loss of active elevation	Fracture of scapular spine

acromion or scapular spine. Routine blood tests, including leukocytes, ESR and CRP, are performed.

The most common complications reported after RSA are infection, dislocation, glenoid or humeral loosening, fractures of the acromion or spine of scapula, periprosthetic fractures, and glenoid notching.^{7,9,21–25} The author has used the RSA since 1995, and the same system of RSA has been used since 2006 (Delta Xtend; DePuy Synthes, Warsaw, IN, USA). The complications have been reduced compared to the first series of RSAs conducted between 1995 and 2006. The most common complications in the author's series since 2006 (1255 RSA) have been dislocation (1.4%), acromion and scapular spine fractures (1.3%), infection (1.2%), and humeral loosening (0.5%) (Table 3). Based on the patient history, clinical examination, radiographs, CT scan and blood tests, an attempt should be made to determine the aetiology of the painful RSA. If the

Figure 2. Radiograph showing superior screw that caused irritation of the suprascapular nerve, resulting in pain over the scapula. The screw was removed and the pain disappeared.

more common complications have been ruled out, it is important to look for other possible causes of pain, such as lung tumour, referred pain from the neck, protruding cement around the humerus, AC joint pain, and overstretching of the brachial plexus.^{26,27}

Instability

Instability is usually diagnosed during the first year, although late instability can be seen after several years as a result of polyethylene wear and stretching of the soft tissues.^{7,11,21,28–33} At the time of diagnosis, a chronically dislocated RSA is often seen on plain radiographs (Figure 3). However, recurrent dislocations or subluxations have also been reported.^{11,21,29,30,34} In the author's series, patients with a chronically dislocated RSA had no or very little pain. The most important symptom was loss of function. However, Black et al.²⁸ reported six cases of instability with an average pain score (visual analogue scale) before revision surgery of 6.9. Thus, instability can be very painful. Diagnosis is usually easy. However, the author has seen three cases of painful, stiff RSA where open biopsies were performed to rule out a low-grade infection. The biopsies were negative but, at the time of surgery, there was an instability in the system (increased separation between the components when pulling on the arm). The humeral component was lengthened, with a significant reduction of pain and improved function in these three cases. The patients had not experienced any feeling of instability before revision surgery. , we now call this condition, 'painful micro-instability' (Figure 4).

Treatment of instability depends on the causative mechanisms.³⁵ In most cases, the instability is caused

Table 3. Complications recorded between 2006 and 2016 in 1259 reverse shoulder arthroplasties: 13 patients had a second complication after the first, and four patients had a third complication

Type of complication	First complication, n (%)	Second complication, n (%)	Third complication, n (%)
Instability	15 (1.2)		2 (0.2)
Postoperative acromion or spine fracture	14 (1.1)	3 (0.2)	
Periprosthetic fracture	11 (0.9)	4 (0.3)	
Infection	10 (0.8)	3 (0.2)	2 (0.2)
Loosening of humeral component	6 (0.5)		
Loosening of glenoid component	3 (0.2)		
Haematoma, needed evacuation	1 (0.1)		
Miscellaneous	11 (0.9)	3 (0.2)

Figure 3. (a, b) Images showing a dislocation of a reverse arthroplasty and a non-union of the scapular spine. (c) The patient was treated by lengthening the humeral component.

Figure 4. (a) Radiograph of a patient with a painful reverse arthroplasty that was found to have ‘micro-instability’. (b) This was treated with lengthening of the humeral component.

by insufficient soft tissue tensioning. Other causes are poor implant positioning, impingement, scar tissue (bony fragment) or medialization of the glenosphere (poor deltoid wrapping angle). Instability has also been reported to be associated with infection and post-operative fractures of the scapular spine.^{11,34}

Closed or open reduction has been attempted, although the results have been modest. In three reports of revision of failed reverse shoulder arthroplasties, a total of 25 cases of instability were treated with closed or open reduction.^{29,31,33} Seventeen (68%) of these failed and needed further surgery. Boileau et al.²⁹ had 10 out of 15 cases failing closed or open reduction, Stephens et al.³³ had five out of five cases failing, and Farshad et al.³¹ had two out of five cases failing. The most common procedure for instability of RSA is release, removal of scar tissue and bony fragments, and lengthening of the humeral component. Boileau et al.²⁹ found humeral shortening of more than 15 mm and medialization of the humeral axis of more than 15 mm (measured from the border of the acromion) to be significant risk factors for instability. Humeral shortening was treated with metallic spacer

or by cementing a humeral component higher. Medialization of the glenoid was treated with a larger glenosphere, a lateralized glenosphere or a bone graft on the glenoid. However, instability remains a challenge. The author has revised 28 cases of instability with an overall success rate of 82%.³⁰ Humeral lengthening was performed in 18 patients and, in 10 patients, other procedures were needed. Two patients developed periprosthetic infection. We now consider closed reduction only during the initial postoperative weeks, when the deltoid muscle is still affected by the surgical procedure. After that, instability is treated with revision surgery, most often humeral lengthening.

Infection

In a recent literature review of complications after reverse arthroplasty, the infection rate was 3.8%.⁷ However, new implants and improved surgical technique have reduced the incidence of infection and, in our unit, it is 1.2% (1255 RSAs performed in the period 2006 to 2016). Periprosthetic joint infection of the shoulder can have a different clinical picture to

that of hip and knee replacement.³⁶ The patient often has few general signs of infection such as fever. The surgical wound may look normal, and blood tests such as white blood cell count (WBC), ESR and CRP are often normal or only slightly elevated.³⁷ Besides staphylococcus, *Propionibacterium acnes* has been reported as an important pathogen in the shoulder.^{12,16,38,39} Radiographs are rarely helpful because these are usually normal with no signs of loosening. Thus, diagnosing a periprosthetic joint infection in the shoulder remains a challenge.^{36,40,41} If radiographs and blood tests are normal, an aspiration can be attempted.³⁶ However, many of these infections are 'dry' (i.e. no fluid can be aspirated). In painful RSAs, arthroscopic or open biopsies can be very helpful to rule out a low-grade infection.⁴² The author prefers open biopsies (at least five) taken from around the implants and, at the same time, old permanent sutures are also sent for microbiology. The cultures are kept for a minimum of 2 weeks because *P. acnes* is a slow-growing organism. Recently, serum or synovial levels of interleukin-6 and α -defensin have been studied for diagnosis of a periprosthetic joint infection.^{13,14} Further studies are needed before the value of these tests can be determined.

Early postoperative periprosthetic infections, within the first 4 weeks to 6 weeks, are treated with lavage and exchange of modular parts of the implant (DAIR: debridement, antibiotics and implant retention).¹⁵ The same approach can be used in acute haematogenous infection. Late infections are treated with complete one- or two-stage revisions.^{10,15,16,38,43-45} The author considers a one-stage revision if the causative organism is known.

Whenever an RSA is performed in a shoulder where previous surgery has been performed (arthroscopically or open), it is important to routinely take at least five biopsies for microbiology. Unexpected positive cultures have been found in as many as 26% of patients undergoing revision arthroplasty with no clinical signs of infection.^{12,39}

Postoperative acromion and scapular spine fractures

The reported incidence varies between 1% and 7%.³⁻⁶ These values are probably an underestimate of the true incidence because this complication is often missed and under-reported. Otto et al.⁶ showed that only 79% of the fractures were identified by blinded reviewers using plain radiographs alone. The fractures can occur spontaneously or after trauma. A careful patient history gives a high suspicion of an acromial or scapular spine fracture. The patient usually has a normal recovery after surgery and usually very good function of the shoulder

Figure 5. (a) A plain radiograph with the 'tilted acromion sign'. (b) Computed tomography scan with a non-union of the scapular spine.

at the time of fracture. Suddenly, the patient experiences rather severe pain over the shoulder and is unable to lift the arm. The majority of cases occur during the first year, although fractures after many years have been reported.⁶ Physical examination reveals tenderness over the posterior part of the acromion and scapular spine. A plain radiograph can be diagnostic, although any fracture is often missed. Thus, a computed tomography should be performed if the patient history or clinical examination leads to suspicion of a fracture. 'The tilted acromion sign' is often seen on plain radiographs (Figure 5).

These fractures can be treated non-operatively in a sling or abduction brace or by open reduction and internal fixation. Most of the reported fractures have been treated non-operatively.³⁻⁶ The author considers open reduction and internal fixation in displaced fractures of the scapular spine, although there is currently insufficient literature available to give guidelines regarding the best management of these fractures.

Spontaneous periprosthetic fracture

Most periprosthetic fractures occur after a significant trauma. However, a painful RSA can be caused by a fissure or fracture around the implant that happens during activities of daily living (Figure 1). A 74-year-old woman had revision arthroplasty performed. She had significant proximal humeral bone loss. Eleven months after surgery, she reported having increasing pain in the shoulder. Radiographs showed a spontaneous periprosthetic fracture, which was treated in a brace for 10 weeks. Follow-up visits showed callus formation, and the fracture healed. This complication can

be missed on plain radiographs, although computed tomography is usually diagnostic. Patients undergoing RSA as a revision procedure, resulting in humeral bone loss, are at risk.

Coracoid base fracture

Pain over the anterior part of the shoulder around the coracoid process can be caused by a spontaneous fracture at the base of the coracoid. The author has seen one case, which was treated non-operatively in a sling. Anakwenze et al.⁸ recently described two similar cases

Figure 6. Glenoid component loosening (a) with severe glenoid bone loss (b), treated with glenoid reconstruction with a large bone graft and revision reverse shoulder arthroplasty (c).

that occurred at 3 months and 15 months after RSA. Computed tomography was diagnostic, and non-operative management resulted in the resolution of symptoms. Coracoid fractures are most likely a result of excess stretch imposed on the conjoint tendon because of lengthening of the arm.

Humeral loosening

In a review of the literature, Zumstein et al.⁷ found an incidence of humeral loosening of 1.3%. Gilot et al.¹⁷ reported an incidence of radiographic humeral stem loosening of 0.74%. In the author's series, six cases (0.5%) have been revised for this complication. In symptomatic loosening, the patient has pain in the upper part of the arm, particularly when rotation of the shoulder is performed. Plain radiographs and computed tomography can confirm the diagnosis. Prosthetic failure within the first 2 years gives a high degree of suspicion of an infection.²⁰ Symptomatic loosening is treated with revision arthroplasty.

Glenoid loosening

Glenoid loosening after RSA is rare with modern implants and careful surgical technique.^{7,11,18,22,31} The author has revised three cases in a series of 1255 RSAs using modern implants. All three could be successfully revised by inserting a new reverse glenoid component. Holcomb et al.¹⁸ reported on 14 revisions for failed baseplate in RSA with a lateralized center of rotation design. Revision restored pain relief and function to pre-failure levels. Two patients needed a second revision: one for baseplate failure and one for dislocation. Figure 6 shows a case of glenoid component loosening and its management.

Notching

Inferior scapular notching is commonly seen after RSA. It has been reported in up to 96% of cases.^{7,9,11,24,25,46} RSA with a lateralized center of rotation has less notching. The incidence of notching can be affected by the position of the center of rotation, humeral inclination, size of glenosphere, cup depth, downward tilt of the baseplate and position of the baseplate.^{10,46,47} The most important factor is low placement of the baseplate, resulting in an inferior overhang of the glenosphere.^{46,47} Glenoid notching results in bone loss; it is therefore important to try to minimize the risk of notching. However, the clinical impact of glenoid notching is unclear (Figure 7). The author has not performed any revision for glenoid notching since the first RSA was implanted in 1995. In four reports of revision of RSA, with 205 revision procedures in total, none of

Figure 7. (a) Early postoperative radiograph of a reverse arthroplasty. (b) An image 10 years later, showing asymptomatic inferior glenoid notching.

them were for glenoid notching.^{28,29,31,33} Farshad et al.³¹ reported one case of metallosis as a result of impingement with the inferior screw. The question of whether notching can result in pain and reduced shoulder function remains unanswered.

Suprascapular nerve

The suprascapular nerve is at risk when placing the superior screw in the baseplate. The author has seen one case with posterior shoulder pain after RSA, caused by irritation of the suprascapular nerve in the groove. Computed tomography confirmed the diagnosis (Figure 2). The superior screw was replaced with a shorter screw and the pain disappeared.

Stretching of the brachial plexus

The arm is lengthened by 15 mm to 27 mm after reverse total shoulder arthroplasty.⁴⁸ Nerve monitoring during shoulder arthroplasties has shown more nerve alerts during RSA than during anatomical total shoulder arthroplasty.⁴⁹ Lenoir et al.⁵⁰ found that the axillary and radial nerves were often stretched during the procedure. The author has seen several cases of postoperative numbness in the hand, particularly in the ulnar nerve area. However, it is unclear whether this can cause postoperative pain in the shoulder and arm. Further research is needed.

Summary

Reverse total shoulder arthroplasty can relieve pain and restore function in many different shoulder conditions. However, painful complications can occur and it is important to try to determine the cause of pain because many of these complications can be treated successfully. During the first year, infection, postoperative fracture of the acromion or scapular spine and dislocation are the most common reasons for pain. A careful patient history, clinical examination, standard radiographs and routine blood tests (ESR, CRP and WBC) are the first steps in evaluation of a painful RSA. Computed tomography can add valuable information, although magnetic resonance imaging is rarely used by the author. The challenge is to diagnose a low-grade infection as the source of pain, and aspiration combined with arthroscopic or open biopsy may be necessary. In most cases, the aetiology of pain can be determined and it can be treated, although there is a group of patients with unexplained pain and stiffness.

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