Pain Ther
https://doi.org/10.1007/s40122-020-00186-0

REVIEW

Management of Painful Shoulder Arthroplasty: A Narrative Review

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Received: April 20, 2020

ABSTRACT

Despite the recent advances in surgical techniques, the percentage of painful shoulder arthroplasties is still high (more than 10%). The causes of residual pain after shoulder arthroplasty, and the resulting treatment solutions, are many and different. The most common complications of shoulder prosthesis are infections, aseptic loosening, modular components disassembling, metal hypersensitivity, and instability. There are also implant-related complications such as glenoid wear in hemiarthroplasty, rotator cuff tear in anatomical total shoulder arthroplasty, scapular notching, and acromion fracture in reverse shoulder arthroplasty. Several of these complications can be avoided with a careful selection of the implants, a proper surgical technique and a precise implant positioning. The execution of a more accurate preoperative planning and the possible use of patient-specific implants are expected to translate into better clinical results in the future. We provide the reader with recent evidence on the causes and therapeutic options of this condition.

Keywords: Failure of shoulder replacement; Residual pain in shoulder arthroplasty; Revision shoulder arthroplasty; Shoulder complications

Digital Features To view digital features for this article go to https://doi.org/10.6084/m9.figshare.12593828.

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Published online: 16 July 2020

Key Summary Points

This study is a general overview of painful shoulder arthroplasties.

The aim of our study is to evaluate the main causes of pain after shoulder replacement and the treatments option available.

The rate of common or implant-related complications is still high in shoulder prosthesis.

The use of new technologies like pre-operative planning software, robotic surgery, and custom-made implants will probably improve clinical results and reduce the percentage of failure in shoulder arthroplasties.

INTRODUCTION

Prosthetic shoulder surgery is a relatively recently introduced type of surgery, but over the last decades, considerable changes and improvements have occurred. Research has focused on the modularity and adaptability of implants in order to improve clinical results and to limit implant-specific complications. Despite the progress of the technique and the strict criteria of choice among the various kinds of implants, the percentage of failure, responsible for ''painful shoulder arthroplasty'', is still significant.

In a recent review, Bohasali et al. reported a complication rate of 11% on more than 19,000 implants, including anatomical total shoulder arthroplasty (TSA) and reverse shoulder arthroplasty (RSA), with an average follow-up of 40.3 months. Although this percentage shows a decreasing trend compared to the previous decade, the result is probably underestimated due to the short-term follow-up [1].

In fact, studies with long-term follow-up showed higher rates of failure in shoulder replacement. Raiss et al. reported a revision rate of 31% and radiographic signs of glenoid loosening in 73% of patients underwent TSA with a minimum follow-up of 15 years [2]. In RSA, Favard et al. showed a survival rate (defined as a value of Constant Score greater than 30) of 72% and a revision rate of 11% at 10 years of follow-up [3].

We know it is normal to complain of pain several months after a shoulder implant. Although, in both TSA and RSA, pain after surgery decreased rapidly and the 85–86% of the improvement was seen at 3 months [4], there is a huge variation in duration and intensity of post-operative pain. Usually, if the patient shows a gradual improvement in pain, it can be considered a normal post-operative recovery. On the other hand, an increasing pain or stiffness developed after a period of normal recovery, suggest the onset of a complication in the shoulder prosthesis.

There are several reasons for a painful shoulder arthroplasty. It can be connected to the design of the implant, comorbidities of the patient, or an improper surgical indication or technique.

The causes of painful shoulder arthroplasty present in all kinds of implants are infection, aseptic loosening, disassembly of prosthetic components, metal hypersensitivity, and instability, although some of these complications are more frequent in specific implant designs. Moreover, implant-related causes of pain after shoulder replacement include glenoid wear in shoulder hemiarthroplasty, rotator cuff rupture in anatomical TSA, scapular notching, and acromion fracture in RSA.

Finally, medical conditions such as fibromyalgia syndrome may be associated with shoulder arthropathy and be the cause of unsatisfactory surgical treatment. In patients reporting pain after arthroplasty, fibromyalgia should be ruled out and managed in order to avoid surgical overtreatment of a medical condition [5].

The aim of this review is to provide an overview of the main causes of pain after a shoulder prosthesis and the various treatment options.

METHODS

A review of scientific studies listed in PubMed database was performed in October 2019. The following keywords were used: "shoulder replacement", "shoulder prosthesis", "total shoulder arthroplasty", "hemiarthroplasty", "reverse total shoulder arthroplasty", "failure", "revision surgery", "pain", "complications". Inclusion criteria were reviews, observational studies, or clinical trials concerning complications of shoulder arthroplasty. We retrieved 1920 articles that were screened by two authors (CF and MV) based on the inclusion criteria and their experience. Titles and abstracts were screened and the full text was retrieved when a study seemed appropriate to be included in our review. The search was restricted to the last 15 years and to English language literature. The papers included in our review are summarized in Table 1.

This article is based on previously conducted studies and does not contain any studies with human participants or animals performed by any of the authors.

RESULTS

Approach in Patient with Pain After Shoulder Arthroplasty

In a painful shoulder arthroplasty, it is important to try to determine early the cause of pain because, in many cases, complications of the implant can be treated successfully, although there is a group of patients with unexplained pain and stiffness.

Unfortunately, the characteristics and intensity of the pain are very subjective because they are influenced by physical, psychological, and socio-cultural factors and, therefore, alone they are unlikely to lead us to a diagnosis.

For this reason, in the evaluation of a painful shoulder arthroplasty, other clinical tools should be used right away to identify the underlying causes: a careful patient history (onset of the pain, possible trauma), clinical examination (occurrence of stiffness, loss of strength, swelling, warmth, erythema), imaging (X-ray modification compared with the post-operative images) and laboratory tests (increase of white blood cells and inflammation indexes, positive culture of joint fluid). However, some features of pain can guide the surgeon in the diagnosing process. An acute pain after a significant trauma can be caused by fractures (scapula, humerus, or clavicle), dislocation of the implant or prosthetic components disassembly. An acute pain early onset in the post-operative period without trauma may indicate a fatigue fracture of acromion or scapular spine.

In all these cases, the pain is usually more intense when the patient tries to use the arm and reduced when the arm is at rest. On the other hand, a chronic pain at rest and stiffness should lead to a high suspicion of rotator cuff tear (with a characteristic pain during the night), infection, or metal hypersensitivity. A chronic pain increased by shoulder movements, rather suggests a glenoiditis or an aseptic loosening.

Also, the location of the pain may be useful. A diffuse pain in the proximal part of the upper arm can indicate humeral loosening, rotator cuff tear, or infection. Instead, a well-localized pain over the shoulder can indicate an acromial fracture.

Infection

Peri-prosthetic infection is one of the most severe complications and the second leading cause of revision after aseptic loosening with an overall prevalence of 1.2% and almost six times higher risk for the RSA than for the TSA [1].

Patients' advanced age, co-morbidities (diabetes, rheumatoid arthritis, chronic corticosteroid therapy), intra-operative technical complications and prior shoulder surgery are common risk factors [6]. Concerning RSA, an increased rate may be due to the more frequent formation of hematomas and the so-called "dead space" caused by the lack of a rotator cuff and distalization of the implant.

S. aureus and *S. epidermidis* are traditionally the most common pathogens. In addition, recent studies indicate *Propionibacterium acnes* as

Table 1 Summary table of studies included in our review

Authors	Publication's year	Country	Study	Follow-up (m = months; y = years)	No. of implants		Complications		Note
Bohasali et al.	2017	USA	Review	40.3 months	19,262	4124 RSA[a]	16.1%	5% Instability 3.3% Periprosthetic fracture 2.9% Infection 1.8% Component loosening 1% Acromial and/or scapular fracture	
						3360 TSA[a]	10.3%	1% Instability 0.69% Periprosthetic fracture 0.51% Infection 0.9% rotator cuff tears 2.3% Glenoid wear 3.9% Glenoid loosening	
Raiss et al.	2014	France	Longitudinal observational study	15–20 years	45 TSA		31%[b]	29% Glenoid loosening 2% Rupture subscapularis tendon	73% of implants had a glenoid radiolucent line at final follow-up > 15 years
Favard et al.	2011	France	Review	> 2 years	509 TSA		11%[b]	6.6% Infection 4.4% Glenoid problems	

Table 1 continued

Authors	Publication's year	Country	Study	Follow-up (m = months; y = years)	No. of implants		Complications		Note
Papadonikolakis et al.	2014	USA	Systematic review	5.8 years for metal-backed glenoid components 7.3 years for all polyethylene components	4606 TSA	1571 Metal-backed glenoid components	14%[b]	5.3% Loosening 8.7% Other complications (component fracture, screw breakage, component dissociation, polyethylene wear, metal wear, and rotator cuff tear)	
						3035 All polyethylene components	3.8%[b]	2.9% Loosening 0.9% Other complications	
Cil et al.	2010	USA	Case series, treatment study	20 years	1584	472 Hemi	4.4%[b]	1.7% Arthritis 0.4% Arthritis + humeral loosening 0.6% Arthritis + rotator cuff tears 0.8% Infection 0.4% Instability 0.2% Periprosthetic fracture 0.2% Humeral loosening	
						1112 TSA	9.3%[b]	1.2% Glenoid loosening 1.7% Glenoid and humeral loosening 0.8% Infection 2.5% Instability	

Table 1 continued

Authors	Publication's year	Country	Study	Follow-up (m = months; y = years)	No. of implants	Complications		Note
Merolla et al.	2017	Italy	Retrospective study	49 months	157 RSA[c]	7%[b]	1.9% Glenoid loosening 1.9% Instability 1.9% Humeral component disassembly 0.6% Humeral loosening 1.2% Infection	
Werner et al.	2005	Switzerland	Case series	–	58 RSA	50% (33%[b])	20.7% Hematoma 8.6% Dislocation 10.3% Infection 1.7% Nerve injury 5.1% Glenoid loosening 1.7% Humeral loosening 6.9% Acromial or/and spine fracture 1.7% Polyethylene inlay disassembly	1 Infection occurred after surgery, while five infections were pre-existent 96% Scapular notching without effects

Hemi hemiarthroplasty, *RSA* reverse shoulder arthroplasty, *TSA* total shoulder arthroplasty

[a] Studies with mixed types of arthroplasties were excluded

[b] Data refer to revision surgery

[c] RSA for revision of shoulder hemiarthroplasty (127 for rotator cuff tears and 30 for glenoid wear)

the pathogen responsible for 31–70% of infections in shoulder prosthetic surgery [7].

The diagnosis is often challenging, especially when the infection is caused by *P. acnes*, a slow-growing and low-virulence pathogen. The treatment strategy depends on the timing of the infection, the responsible pathogen, and the general health status of the patient.

For acute infections, the goal is to preserve the stable implant and reduce the bacterial load. The procedure consists of repeated washing (with sterile physiological solution and iodopovidone) with extensive debridement and replacement of the modular components. In the case of chronic infections, one-stage or two-stages surgical revision can be considered. In a recent systematic review, Kunutsor et al. showed that one-stage revision is comparable to two-stages revision in terms of reducing the rate of re-infection, improving function and reducing non-infectious complications [8]. However, if the general clinical conditions of the patient allow it, the authors prefer to perform two-stage revision in late and delayed infections which occurred at least 3 months after surgery (Fig. 1).

Aseptic Loosening

Glenoid Component

Loosening of the glenoid component represents 12.4% of all complications and it is much more frequent in anatomical TSA than in RSA [1]. Aseptic painful glenoid loosening in TSA has an incidence of 1.2%/year with a surgical revision rate of 0.8%/year [9]. It is caused by a combination of factors, some of which are patient-specific (rotator cuff status, glenoid morphology, and infections) and others related to the surgical technique and implant design.

The risk of revision in case of aseptic glenoid loosening in TSA was threefold higher for metal-backed implants than for implants with an all-polyethylene glenoid component [10]. The incidence of this complication can be decreased by preserving subchondral bone, concentric reaming, and using pegged prosthetic implants.

If the rotator cuff is intact, revision surgery consists of replacing the loose components maintaining an anatomical implant. In these patients, the presence and amount of bone loss

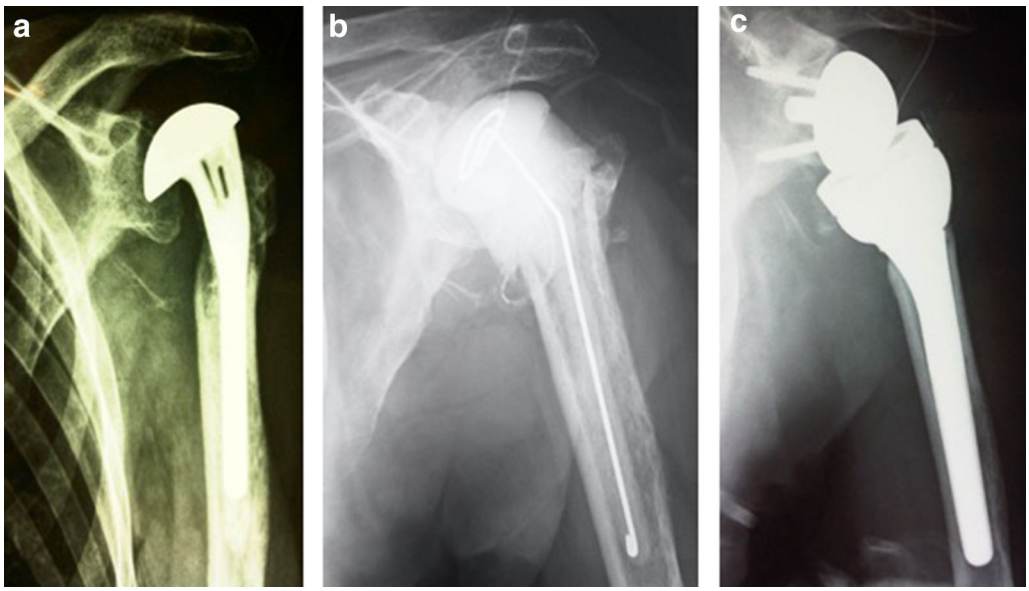

Fig. 1 Prosthetic infection in hemiarthroplasty. **a** Deep infection in cemented hemiarthroplasty implanted in sequelae of proximal humerus fracture treated with K-wires percutaneous osteosynthesis. **b** Removal of prosthetic components and antibiotic spacer implant. **c** Post-operative X-ray after removal of the spacer and implant of revision RSA

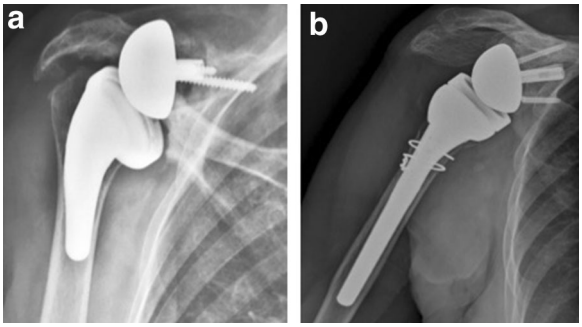

Fig. 2 Aseptic loosening of glenoid component in RSA. **a** Post-traumatic loosening of glenoid component 9 months after shoulder reverse arthroplasty surgery. **b** X-ray 1 year after the replacement of both glenoid and humeral components of the RSA with revision implant

have to be carefully evaluated and eventually treated with a bone graft. On the other hand, in patients with an insufficient rotator cuff, an RSA must be performed.

The loosening of the glenoid component in RSA is less frequent than initially assumed (Fig. 2). In fact, the original designs of the implant predicted greater stress on the bone–prosthesis interface and a medialization of the glenosphere that could also potentially cause loosening. Today, despite the availability of more lateralizing implants, the problem is still present and therefore probably due to an incorrect surgical technique (superior-lateral surgical access and superior inclination of the glenosphere) or to patient-specific factors (age < 70 years and female sex). The main issue in revisions of RSA is the residual glenoid bone stock after removing the metaglene, which often needs to be corrected by bone grafts.

Humeral Component

Loosening of the humeral component is a rare and clinically less serious complication compared to the loosening of the glenoid component. Most cases of isolated humeral loosening are, in fact, asymptomatic.

In a large sample of 1112 TSA, isolated loosening of the humeral component was observed in 0.3% of cases. Furthermore, it was found that 83% of humeral component revisions are a consequence of glenoid component loosening or implant instability [11].

For RSA, humeral loosening is a rare event with an incidence rate of 0.74%. However, uncemented stems seem to demonstrate a higher risk of loosening or developing radiolucent lines compared to cemented stems (26.4 vs.14%) [12].

Although revision of the humeral component is an uncommon occurrence, it is still accountable for a high rate of complications such as, in particular, intraoperative humeral fractures.

Instability

Instability is a common complication of anatomical TSA and RSA with a prevalence of 1% and 4.7%, respectively [1, 13]. In RSA, where this complication is more frequent, the instability is antero-superior and occurs as a result of combined adduction, extension, and internal rotation movements. The patient may experience crepitation, articular noises, and apprehension suggestive of sub-luxation or maltracking in specific directions.

There may be several explanations for this complication: inadequate deltoid tension, acromial fractures, axillary nerve injury, mechanical impingement, or improper size of the glenosphere.

At present, the stability of implants has been improved through the modification of the various components with larger glenospheres, lateralized implants, and components with different offsets that improve the tension of the deltoid without the need of lengthening the humeral component.

In an implant dislocation without radiographic signs of component loosening, the surgeon should firstly attempt a closed reduction under anesthesia. Otherwise, in patients with locked (> 3 months) or recurrent dislocation or with a bone loss of the proximal humerus, a prosthetic revision surgery is required using metallic spacers and thicker polyethylene inserts, cemented humeral stems, and bone grafts.

Metal Hypersensitivity

Over the last years, metal hypersensitivity has been a highly discussed cause of pain and early failure of prosthetic implant. There are no reliable data concerning a cause–effect relationship between hypersensitivity and failure of the prosthesis. The prevalence of hypersensitivity, mostly to nickel, is reported in up to 15% of the general population and up to 60% of painful implants. It is not clear yet whether the failure is the result of a pre-existing hypersensitivity causing implant loosening or whether metal sensitization is secondary to the failure of the prosthesis with a possible release of metal ions.

The patient generally experiences pain and limitation of motion. Local signs of hypersensitivity such as rash or itching are often absent, which makes the diagnosis more challenging.

In many cases described in the literature and in our experience, the revision of implants with hypoallergenic arthroplasties has led to satisfactory results and a resolution of painful symptoms (Fig. 3) [14].

Prosthetic Components Disassembly

Although disassembly may occur with any kind of modular implant, it is more frequently associated with RSA. It is often the consequence of a surgical mistake (wrong engagement of the glenosphere Morse taper on the metaglene, insufficient tightening of the central screw), while in other cases it is the consequence of a trauma. Once the cause has been properly defined, the disassembled modular components are replaced during a revision surgery (Fig. 4).

Hemiarthroplasty

Glenoiditis

Glenoiditis is the most common complication of shoulder hemiarthroplasty and is characterized by an erosive process of glenoid cartilage. It occurs in one-third of the implants at an average follow-up of 2.5 years [15]. The patient complains of pain and progressive limitation of motion.

Cartilage wear occurs more rapidly in younger patients due to increased joint stress. This condition may be caused by oversized humeral heads and insufficient joint release.

The mechanical strength of the glenoid cartilage is an important factor in determining the prognosis. In fact, this complication occurs most frequently in young women, in patients with early osteoarthritis and rheumatoid arthritis, and in implants with a prosthetic humeral head positioned in valgus.

The use of innovative materials for humeral heads, such as pyrocarbon, which has an elastic modulus similar to cortical bone, seems to be

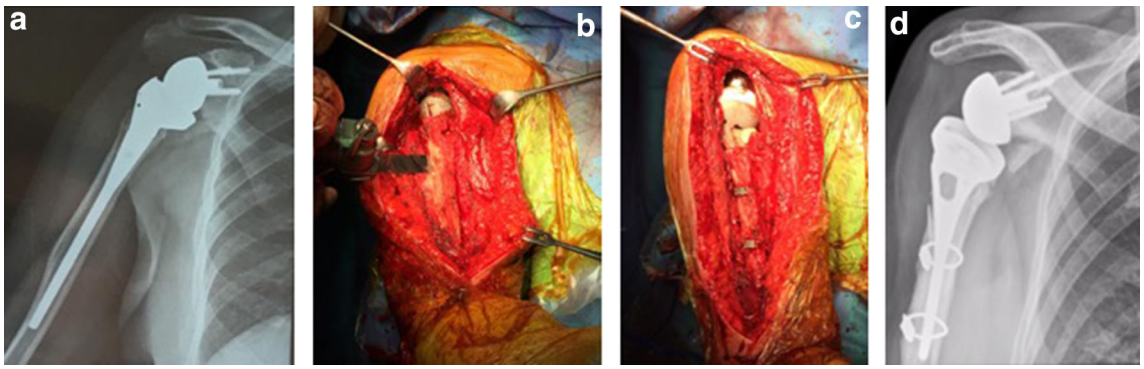

Fig. 3 Painful RSA in a patient with a documented nickel and palladium allergy. **a** Absence of radiographic signs of loosening in patient with a painful RSA in proximal humeral fracture sequelae. **b** Opening of the humeral diaphysis for removal of prosthetic component. **c** Implantation of hypoallergenic prosthetic components after synthesis of the humeral diaphysis with two titanium metal cerclages. **d** X-ray 1 year after revision with hypoallergenic RSA

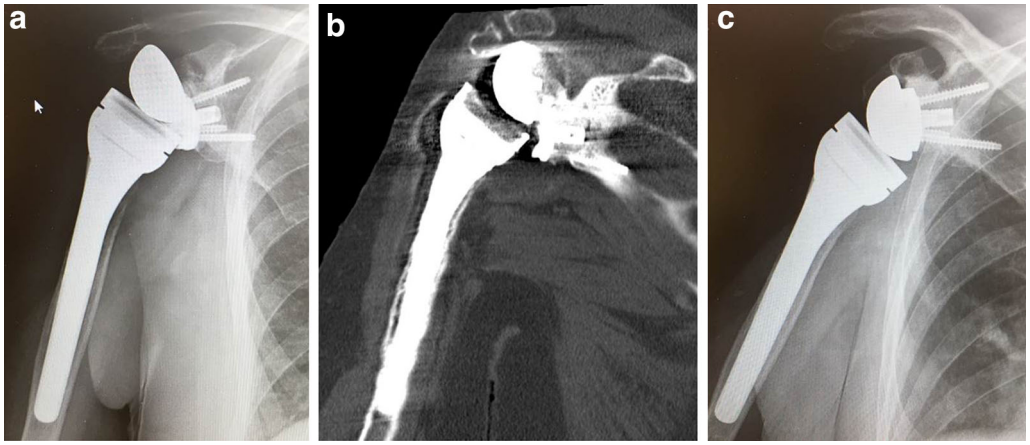

Fig. 4 Disassembly of the prosthetic components in RSA. **a** Disassembly of the glenosphere in RSA. **b** Pre-operative CT in disassembly of glenosphere without baseplate loosening. **c** Post-operative X-ray after revision with glenosphere replacement

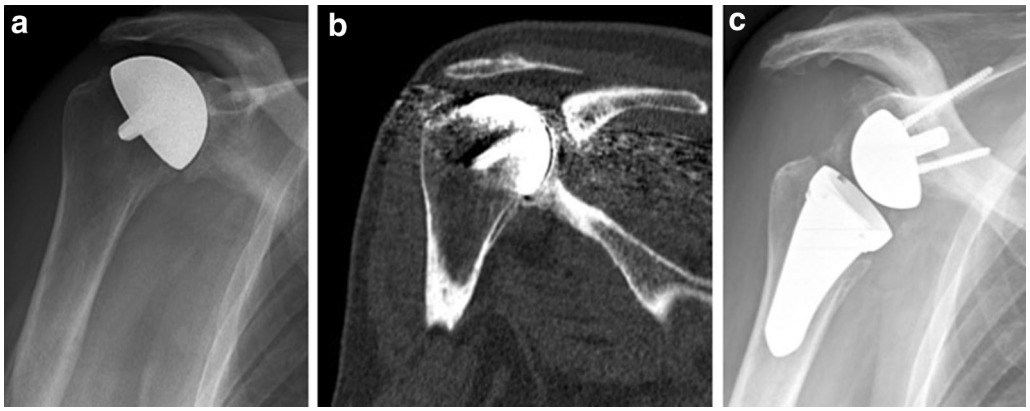

Fig. 5 Glenoiditis in hemiarthroplasty. **a** Radiographic signs of glenoiditis in surface replacement hemiarthroplasty at 12 years of follow-up. **b** Pre-operative CT in glenoiditis. **c** Post-operative X-ray after revision with RSA

the new frontier in the prevention of glenoiditis in shoulder hemiarthroplasty and preliminary clinical results appear to be encouraging [16].

The glenoiditis inevitably results in a revision with an anatomic TSA and, if glenoiditis is associated with rotator cuff tear, RSA is implanted with satisfactory clinical results (Fig. 5) [17].

Anatomical Total Shoulder Arthroplasty

Rotator Cuff Tear

Rotator cuff tear is a late complication of anatomical TSA with an incidence of 1.3–7.8%, mainly involving supraspinatus and infraspinatus tendon [1]. The risk factors are long-term follow-up, increased superior tilt of the glenoid component and infraspinatus atrophy. The patient may experience pain, instability, and limitation of motion. Radiographic imaging, in the case of a massive tear, shows a superior subluxation of the humeral head. In this situation, despite the different salvage surgical techniques for rotator cuff tears described in the literature, the conversion to RSA is the most effective solution (Fig. 6).

Reverse Shoulder Arthroplasty (RSA)

Scapular Notching

Scapular notching is the most common complication of RSA caused by mechanical

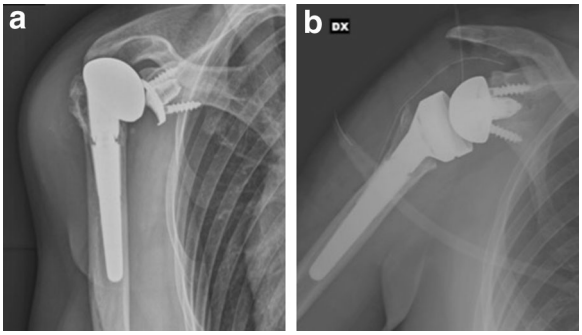

Fig. 6 Rotator cuff failure in TSA. **a** Superior subluxation of the humeral head in TSA due to rotator cuff failure 6 years after surgery. **b** Post-operative X-ray after revision surgery with RSA facilitated by the use of a primary anatomic implant with a completely convertible system

impingement between the humeral component or the metaphyseal bone with the lower scapular neck. The prevalence varies between 10% and 96% [13]. The correspondence between this complication and the painful symptomatology remains controversial in the literature. In their study, Werner et al. reported a prevalence of 96% at 38 months of follow-up but none of the patients complained painful symptoms related to this complication [18]. Other studies, however, show that scapular notching is associated with onset of pain, reduced shoulder functionality, and early aseptic loosening of glenoid and humeral components. The incidence and severity of scapular notching are closely related to patient-specific risk factors, the type of prosthetic design, and the surgical approach and technique.

The use of large glenospheres, the baseplate positioning on the inferior glenoid rim with an inferior tilt, and the implant of lateralized humeral components (on-lay implants and stems with a reduction of the cervical-diaphyseal angle) seem to prevent scapular notching.

In symptomatic patients, a revision surgery with debridement, implant replacement, and reconstruction of the glenoid bone defect with bone grafts is required.

Acromial Fractures

Acromial fractures are an uncommon cause of painful implants with a prevalence of 1.5% [13]. Patients with osteoporosis or prior acromioplasty have a higher risk of developing this complication. Patients usually experience sudden lateral shoulder pain and limitation of motion, usually between 30 and 90 days after surgery.

In many cases, conservative treatment with joint immobilization results in satisfactory functional recovery. A similar fatigue fractures can happen at the level of the scapular spine, with patients referring a relevant pain in the back of the shoulder.

CONCLUSIONS

Shoulder arthroplasties are showing encouraging results and the number of implants is growing worldwide. However, the complications (common or implant-related) are still frequent, resulting in a quite high rate of painful shoulder arthroplasties. Several of these complications can be avoided with a careful selection of the implants, a proper surgical technique, and a precise implant positioning. In the future, pre-operative 3D planning software, patient-specific guides, robotic surgery, and custom-made implants will be probably useful to reduce the rate of failure and complications.

ACKNOWLEDGEMENTS

Funding. No funding or sponsorship was received for this study or publication of this article.

Authorship. All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published.

Disclosures. Chiara Fossati, Marianna Vitale, Tommaso Forin Valvecchi, Roberta Gualtierotti, and Pietro S. Randelli have nothing to disclose.

Compliance with Ethics Guidelines. This article is based on previously conducted studies and does not contain any studies with human participants or animals performed by any of the authors.

Data Availability. Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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