Orthopaedics & Traumatology: Surgery & Research 102 (2016) S33–S43

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Review article

Complications and revision of reverse total shoulder arthroplasty

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ARTICLE INFO

Article history:
Received 14 May 2015
Accepted 19 June 2015

Keywords:
Reverse shoulder arthroplasty
Complications
Reoperation
Prosthetic revision

ABSTRACT

The most common causes of revision surgery after reverse total shoulder arthroplasty (RTSA) are, in decreasing order: prosthetic instability (38%), infection (22%), humeral problems (21%) including loosening, unscrewing and fracture, and, lastly, problems of glenoid loosening (13%). Complications leading to reoperation are often multiple and their association is underestimated. It is not uncommon for patients to be reoperated several times due to the persistence of the same complication, failure to diagnose associated complications, or onset of an additional complication. Although it may require a number of procedures in the same patient, it is very often possible (in 90% of cases, in our experience) to conserve or replace the RTSA, allowing patients to recover a functional shoulder. However, the functional results of revised RTSA are inferior than for primary prostheses, and depend on the surgeon's experience and the number of RTSAs performed, suggesting that patients should be referred to a tertiary center.

1. Introduction

Reverse total shoulder arthroplasty (RTSA) was initially intended to treat osteoarthritis of the shoulder with rotator cuff deficiency in elderly patients with loss of active elevation of the arm (pseudoparalytic shoulder). In the light of the successes reported, indications were extended to younger patients with irreparable rotator cuff lesion, fracture or fracture sequelae, inflammatory arthritis, failure of anatomic arthroplasty, or tumor [1–3]. Over the last decade, the rate of RTSA has risen exponentially, and this has entailed an increasing number of complications and reoperations [4].

The complications leading to surgical revision of RTSA are multiple and frequently associated. It is a difficult procedure, and thought should be given to treatment strategy. The surgeon confronted by one or several complications following RTSA should therefore, before considering reoperation, weigh a number of questions:

- What are the possible complications, with what frequency and risk factors?
- What should the surgical strategy be in case of associated complications?
- Can the implant be conserved or will it be necessary to remove it definitively?
- When is one- or two-step reimplantation indicated?
- What would be the impact of implant replacement on functional outcome?

The present study will seek to provide answers to the above.

2. Epidemiology

In a literature review including 782 RTSAs of varying etiology (566 primary prostheses and 216 revisions of hemiarthroplasty or anatomic prosthesis), Zumstein et al. [4] reported a 20% rate of postoperative complications; 105 implants required reintervention: 79 (10.1%) surgical revisions and 26 (3.3%) reoperations (Table 1).

The complication rate was almost 3-fold higher in cases of revision for failure of anatomic implant than in primary RTSA: 33.3% vs. 13.4%.

Our own experience comprises 825 RTSAs performed between 1996 and 2013; 84 reinterventions, including 60 revision surgeries, were performed in 54 patients. The most frequent reasons were, in decreasing order: prosthesis instability (38%), infection (22%), humeral complications (21%) (implant and intraprosthetic screw loosening), fracture and bone defect, glenoid complications and glenoid component loosening (13%) and other rarer causes (6%) (Table 2).

In our early experience, patients were sometimes reoperated on several times due to persistent complications, undetected associated complications or onset of further complications: 18 patients were reoperated on more than once and four times.

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http://dx.doi.org/10.1016/j.otsr.2015.06.031
1877-0568/

Table 1
Complications and reintervention rates (Zumstein et al. [4]).

Number of RTSAs	782
Postoperative complications	164 (20.9%)
Instability	4.7%
Infection	3.8%
Glenoid loosening	3.5%
Glenosphere disassembly	1.5%
Acromion/scapular spine fracture	1.5%
Intra-implant unscrewing	1.5%
Periprosthetic fracture	1.4%
Humeral loosening	1.3%
Neurologic complications	1.2%
Other	0.5%
Reintervention	105 (13.4%)
Reoperation	3.3%
Revision	10.1%

Table 2
Rates of complications requiring reintervention (Nice University Hospital, 1996–2013).

Reasons for reintervention (Nice University Hospital, 1996–2013)	Percentage
Instability	38
Infection	22
Humeral complications	21
Humeral loosening	10
Intra-implant unscrewing	7
Periprosthetic fracture	4
Glenoid complications	13
Glenoid loosening	9
Glenosphere unclipped	3
Scapular fracture	1
Other complications	6
Hematoma	2
Isolated active external rotation loss	3
Stiffness	1

3. Preoperative planning

There are many types of complications requiring reintervention, and associations tend to be underestimated. Three associations at least need to be kept in mind:

- implant loosening and infection;
- implant instability and humeral shortening due to bone loss;
- implant instability and excessive medialization (glenosphere too small and/or glenoid bone defect) [5].

If not all complications are detected at the outset, they may show up consecutively, leading to iterative reintervention [5]. For this reason, before any surgical revision, preoperative work-up should comprise at least:

- comparative humeral radiographs with millimeter scale to quantify bone defect and humeral shortening by measuring the two humeri following Walch and Lädermann [6];
- comparative AP shoulder radiographs in neutral rotation are useful for quantifying excessive humeral and/or glenoid medialization; we recommended measuring the distance between the lateral edge of the acromion and the intramedullary humeral axis (horizontal acromiohumeral distance) [5];
- shoulder CT is indispensable to assess medialization, the orientation of implants in the axial plane, glenoid and humeral bone stock, and fatty infiltration of the rotator cuff muscles;
- finally, biological assessment, with blood count, sed rate and CRP to screen for associated latent infection; bone scintigraphy and/or joint aspiration may be needed for definitive proof.

4. Prosthetic instability

Prosthetic instability after RTSA is the main cause of reintervention. It is the most difficult complication to manage, as seen from the high rate of recurrence [4,7–11].

4.1. Risk factors for instability

There are multiple risk factors to be taken into account before considering reintervention [7,12,13]:

- previous surgery: RTSA for failure of osteosynthesis, hemiarthroplasty, anatomic prosthesis or reverse prosthesis is 3 times as likely to show instability as primary RTSA: 7% versus 2% [8];
- a deltopectoral approach is associated with 10% instability, versus 0% for a superolateral deltoid approach [8];
- "cam effect" mediated by soft tissue or bone block:
  - obesity is protective against scapular notching, but induces a cam effect through fat in the upper limb and trunk [14],
  - humeral malunion or ossification may strike against the scapular pillar or glenosphere, inducing a leverage effect (Fig. 1);
- the two main causes (often associated) are:
  - humeral or glenoid bone loss,
  - soft-tissue deficiency: subscapularis absent or non-inserted and/or anterior deltoid atrophy [5].

The patients at risk are those with:

- shortened humerus due to a proximal bone loss (implant migration, greater tuberosity lysis or resection secondary to acute fracture or fracture sequalae, humeral resection for tumor), hemiarthroplasty failing to restore humeral length;
- excessive glenoid medialization due to glenoid bone defect and/or use of a small glenosphere (36 mm) in tall (male) patients [5,15];
- implant malpositioning in the horizontal plane (humeral and/or glenoid version on CT) and/or vertical plane (humeral and/or glenoid component too high).

Overlooking or ignoring any of the above can lead to malpositioning new implants and failure to restore humeral length and lateralization, with risk of recurrent instability and multiple reintervention.

4.2. Management of unstable RTSA

4.2.1. Early dislocation (within the first 3 months)

In early dislocation (within the first 3 months), when there is no bone defect or impairment of implant rotation, strategy should be non-operative, with one or more attempts at closed reduction under general anesthesia; efficacy is between 30% and 50% [8].

After reduction, we recommend strict immobilization with an abduction splint or in a thoracobrachial cast: this position promotes deltoid shortening and enhances the implant's coaptation force.

Teusink et al. [16] confirmed this attitude, with 62% of implants (13/21) stabilized at 28 months. Our own experience is less satisfying: after attempted reduction (sometimes repeated), 59% of implants remained unstable.

Recurrence is mainly due to underestimating humeral shortening and/or glenoid medialization, the two often being associated [5,8].

4.2.2. Late dislocation (after 3 months)

In late dislocation (after 3 months), reintervention is necessary, especially when there have been technical mistakes that can be corrected. Instability is usually due to insufficient deltoid tension in

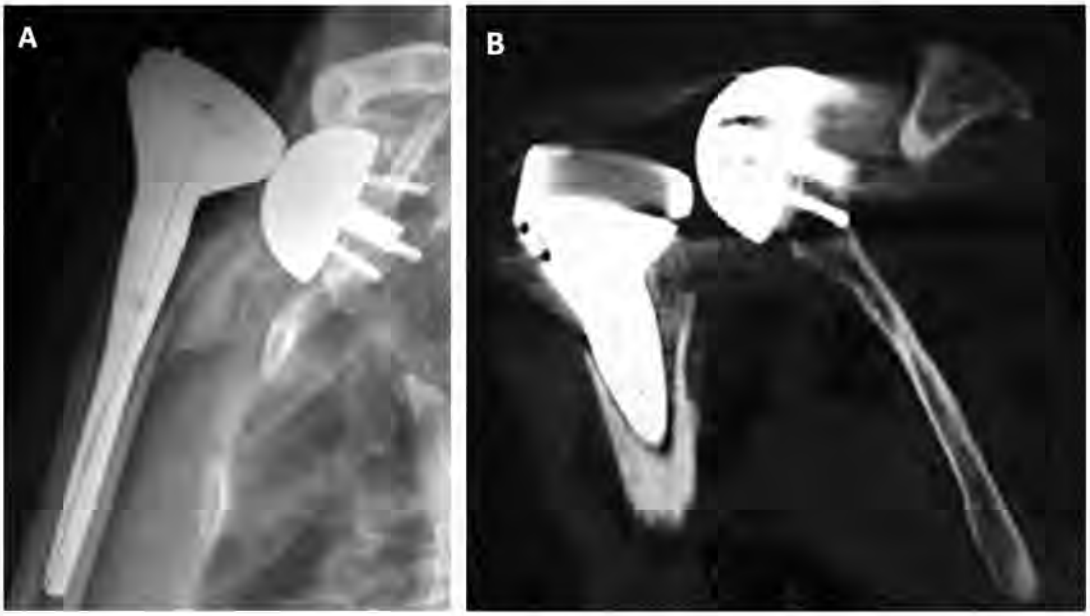

Fig. 1. Recurrent instability because of (1) humeral shortening, (2) medialization and superior orientation of the glenoid, and (3) medial cam effect by medial humeral ossification. A. Radiograph. B. CT.

the vertical (humeral shortening) and/or horizontal plane (excessive medialization). Deltoid tension can be difficult to restore on revision, as the proximal humeral landmarks are lacking, especially when the greater tuberosity is damaged or has migrated backward (after failure of implantation for proximal humerus fracture). Complete imaging examination is indispensable to determine:

- the theoretic height of the humeral revision implant (tangent to the theoretic position of the greater tuberosity);
- whether a reconstruction implant and/or humeral graft is required;
- whether the glenoid component needs to be materalized (bone graft and/or lateralized implant).

We have drawn up a decision tree, taking account of humeral shortening and excessive medialization (Fig. 2).

4.2.2.1. Management of humeral shortening. When shortening is less than 15 mm, humeral height can be restored by adding a metal (+9 mm) and/or thicker 12-mm polyethylene heightener (+6 mm), achieving 15 mm lengthening without changing implants. This is only possible if there is no humeral malpositioning or loosening and the glenosphere is not medialized and/or positioned too high.

The humerus can also be lengthened and lateralized by a few more millimeters on the glenoid side, by: (1) a larger glenosphere (e.g., 42 instead of 36 mm) and/or (2) an inferiorly-centered glenosphere (+2 mm). In glenoid replacement, the glenoid baseplate should be positioned as low as possible (tangential to the lower glenoid edge), with a slight inferior tilt to improve coaptation between the two components.

When shortening exceeds 15 to 20 mm, the humeral implant may need to be replaced and positioned at "the right height": i.e., higher than the theoretic position of the greater tuberosity (based on measurement of the length of the contralateral humerus). In such cases, there is often a humeral defect, for which treatment is detailed below.

When shortening exceeds 5 cm, structural humeral bone graft (or massive reconstruction prosthesis) can improve shoulder stability by increasing deltoid coaptation force and neutralizing forces tending to induce implant loosening (Fig. 3).

4.2.2.2. Management of excessive medialization. In case of persistent instability despite correction of humeral length, excessive glenoid (and therefore humeral) medialization is often implicated. The glenoid bone loss then needs to be reconstructed and/or the glenosphere to be lateralized to restore stability.

When humeral medialization is minimal (< 15 mm), replacing a small-diameter glenosphere (36 mm) by a larger one (39 or 42 mm) is the first thing to do, especially in tall patients (male): it increases the deltoid coaptation or "wrapping" angle, thus improving stability [2,17] (Fig. 3).

If lateralization remains insufficient, stability can be improved by further lateralizing the glenosphere, to further enhance deltoid coaptation force:

- either by bone grafting under the metal plate, with a standard glenosphere (BIO-RSA: bony-increased offset reverse shoulder arthroplasty) [18];
- or implanting a lateralized glenosphere (MIO-RSA: metallic-increased offset reverse shoulder arthroplasty);
- or both: glenoid bone graft + lateralized glenosphere (MIO + BIO-RSA).

4.2.2.3. Choice of humeral implant (lateralized versus medialized). Grammont humeral stems have an intraosseous metal inlay that medializes the humerus. There now exist RSAs with a lateralizing extraosseous "onlay". In changing prostheses, humeral length and lateralization can be increased by changing from inlay to onlay. Onlay implants usually have less inclination (145° rather than 155°), increasing humeral lateralization. Some of the most recent models include an intermediate "variable inclination" part.

4.2.2.4. Management of soft tissue and postoperative course. Reinsertion of the subscapularis tendon and capsule (when still present) should be systematic. The arm should be immobilized in an abduction splint for 4–6 weeks, to promote deltoid shortening and thus increase the implant's coaptation force.

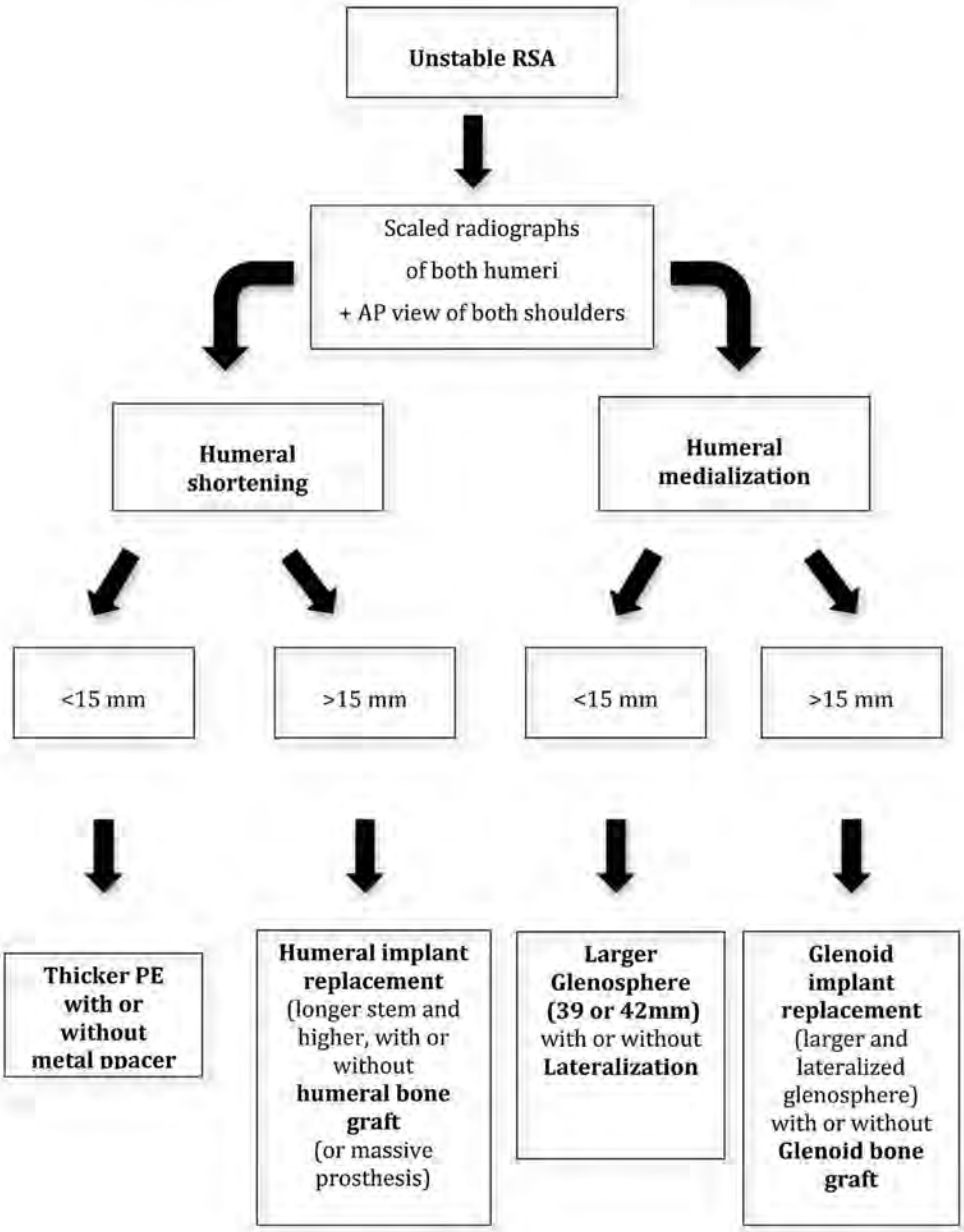

Fig. 2. Treatment algorythm for instability after Reverse Shoulder Arthroplasty (RSA).

5. Infection

5.1. Risk factors

Infection is the second most common cause of revision. It is most frequent in cases of previous surgery (osteosynthesis, instability surgery, rotator cuff repair, or anatomic prosthesis failure), with risk increasing with the number of surgeries [5,19]. The most frequently implicated bacteria are *Propionibacterium acnes*, *Staphylococcus epidermidis* and *Staphylococcus aureus* [9,20].

Incidence is probably underestimated, as many stiff and/or painful shoulders may in fact be infected.

5.2. Management of infection

Strategy depends on the patient's general and functional status and on onset modalities (postoperative, early or late, hematogenous). Collaboration with a multi-disciplinary team, including an infectious disease specialist is mandatory. Prolonged, tailored antibiotic therapy should be systematically associated to surgery [21]. Five samples should always be taken intraoperatively for bacteriological analysis, and prolonged culture should be prescribed to explore for slow-growing bacteria (Propioni).

5.2.1. Acute infection (within the first 3 months)

Irrigation plus debridement is often curative and does not affect functional outcome. Intraoperatively, all parts that are easy to remove should be replaced: polyethylene insert and glenosphere.

5.2.2. Chronic infection (after 3 months)

The patient should be informed that, whatever the choice of treatment, functional outcome will often be imperfect and certainly poorer than for a primary prosthesis [20]. Apart from abstention in cases where surgery is not feasible, there are three options:

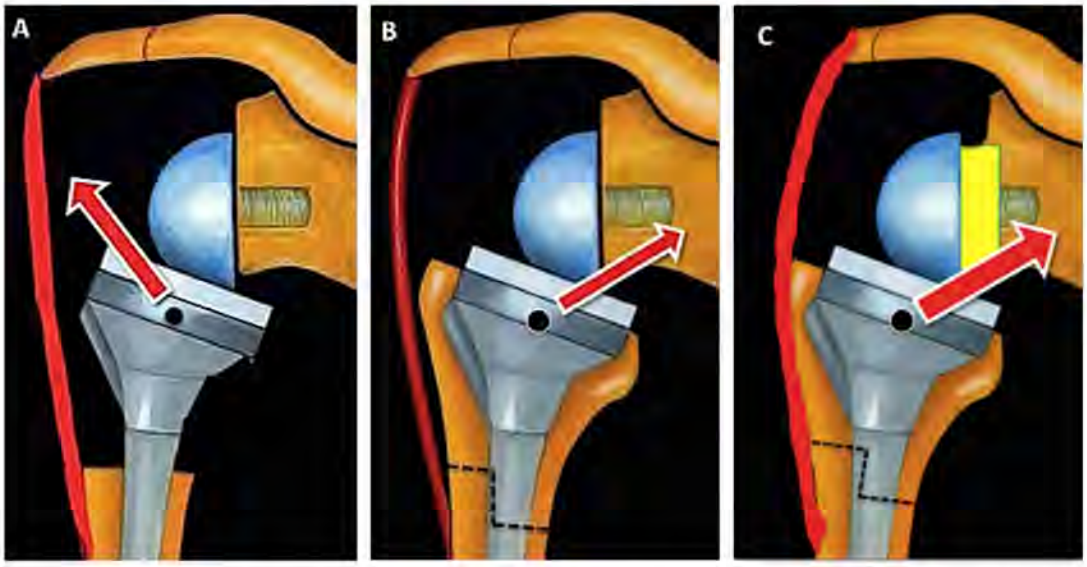

Fig. 3. Deltoid wrapping angle. A. Implant instability with proximal humeral bone defect by loss of deltoid wrapping angle. B. Proximal humeral bone graft, improving deltoid wrapping angle. C. Glenoid bone graft (BIO-RSA) increasing humeral lateralization and deltoid wrapping angle (increased deltoid coaptation force).

- irrigation + debridement is no longer a current attitude and often result in failure;
- prosthesis removal (resection arthroplasty) is a salvage option, indicated in fragile patients, resistant infection or after failure of other surgical techniques associated to adapted antibiotic therapy. Functional outcome is poorer than when the implant is conserved or replaced [5,20];
- implant replacement is the attitude of choice, but involves heavier surgery due to possible intra- and postoperative complications. The technical difficulty lies in removing the implant, with risk of humeral fracture and bone defect, the former increasing with the number of prior procedures. Knowing implant extraction to be likely difficult (absence of loosening), we perform first-line humerotomy followed by cerclage using flexible sutures [22] (Fig. 4).

5.3. One- or two-step replacement?

One-step replacement gives better functional results, with lower rates of morbidity and complications, but with greater risk of recurrent infection. For Beekman et al. [23], it is systematic, whereas Jacquot et al. [20], in a multicenter study, concluded that one-step replacement (humeral component fixed with antibiotic-bearing cement) is indicated only if the implicated bacteria are known in advance.

Otherwise, a two-step procedure is preferable, despite greater morbidity, with insertion of an antibiotic-bearing cement spacer to fill the resulting space and provide local antibiotic therapy for 6 to 8 weeks. This is the attitude we recommend in chronic infection, especially in case of history of previous surgery (osteosynthesis, hemiarthroplasty, TSA prior to RTSA) and if the bacteria are unknown or multiresistant [5].

6. Humeral problems and loosening

Initially, surgeons expected to face glenoid complications and loosening with RSA, but experience showed that loosening and complications (bone lysis, intra-implant unscrewing) were more frequent on the humeral side [5]. This is logical biomechanically, as stress is reduced on the glenoid side by implant medialization and is greater on the humeral side.

6.1. Risk factors

Proximal humeral bone loss is the main risk for humeral loosening and/or intra-implant unscrewing. It is frequent after RSA for fracture or fracture sequelae, due to lysis or posterior migration of the greater tuberosity and after tumor resection. In the absence of the greater tuberosity, the humeral component is fixed only distally and undergoes considerable rotational stress, leading to loosening and/or intra-implant unscrewing (in modular implants) [5,24].

Osteoporosis in elderly patients and more intense physical activity in younger patients accelerate the process.

These mechanical factors are often aggravated by osteolysis in reaction to polyethylene and metal debris (inflammatory granuloma), which is especially frequent in case of impingement between humeral socket and scapular pillar (scapular notching) or recurrent dislocation.

6.2. Management of humeral loosening or implant unscrewing with bone defect

While there is no difficulty in removing a loose implant, humeral reconstruction may involve technical problems that should be planned for.

6.2.1. < 5 cm humeral defect in elderly patients

A simple inexpensive way to reconstruct the proximal humerus is to create a cement collar around the implant (cementoplasty reconstruction).

The other solution is a massive reconstruction implant.

6.2.2. > 5 cm humeral defect

In humeral defects exceeding 5 cm, we, like Chacon et al. [17], recommend reconstruction by massive humeral allograft:

- to restore humeral bone stock;
- to enhance implant stability by restoring humeral length and increasing deltoid coaptation force ("wrapping angle");
- to limit the risk of humeral implant loosening by reducing rotational and valgus stress.

The long-stemmed humeral implant is often cemented into the proximal humeral graft, and then fixed distally by press-fit

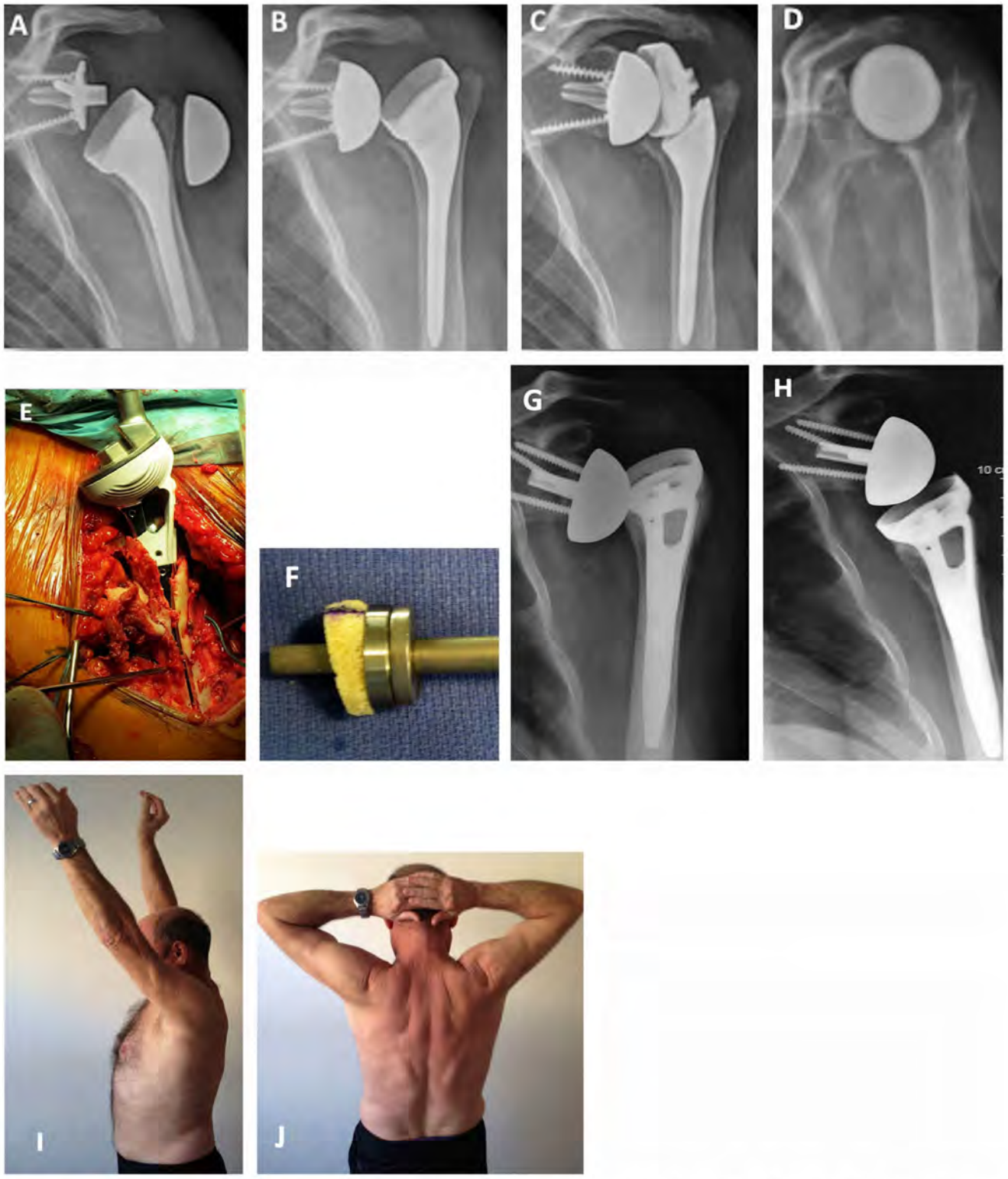

Fig. 4. Example of associated complications after multiple reoperations (7 surgeries in 3 years). A. Glenosphere dislocation and disassembly. B. Implant dislocation. C. Cup dislocation and disassembly. D. Revision with spacer for infection. E. Cerclage with flexible sutures after split humerotomy. F. Glenoid lateralization by cancellous allograft (OsteoPure™). G. Early dislocation by loss of muscle tonus; reduction under general anesthesia and 4 weeks' immobilization in abduction splint. H. Stable prosthesis at last follow-up. I, J. Result at 2 years post-revision: infection cured, stable and pain-free shoulder.

or cement. Rotational stress should be neutralized by a "step-cut" between graft and shaft (Figs. 3 and 5). When proximal humeral resection is considerable, we prefer an uncemented humeral implant locked by screws to neutralize rotational force.

The subscapularis is reinserted if present (which is in fact rare in revision surgery) and latissimus dorsi muscle-tendon transfer on the humeral allograft is performed in case of external rotator deficit (Fig. 6).

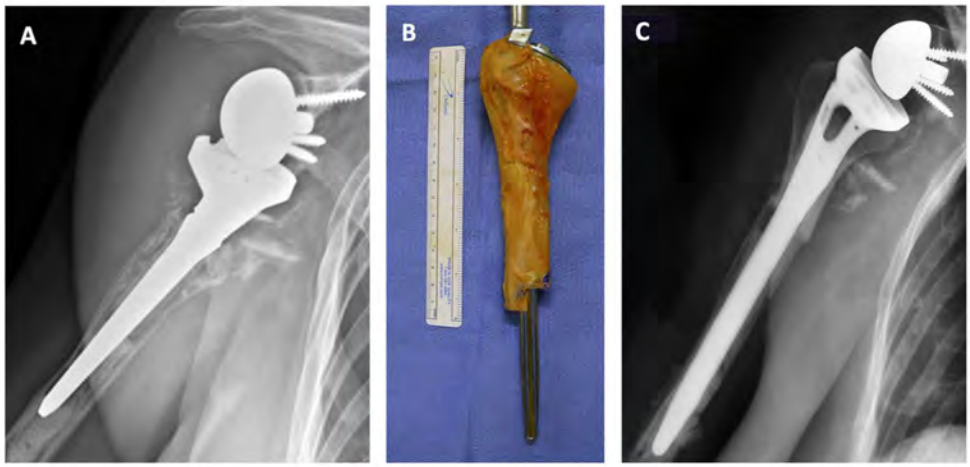

Fig. 5. Example of humeral loosening with severe bone defect. A. Preoperative radiograph. B. Humeral allograft with "step-cut". C. Postoperative radiograph.

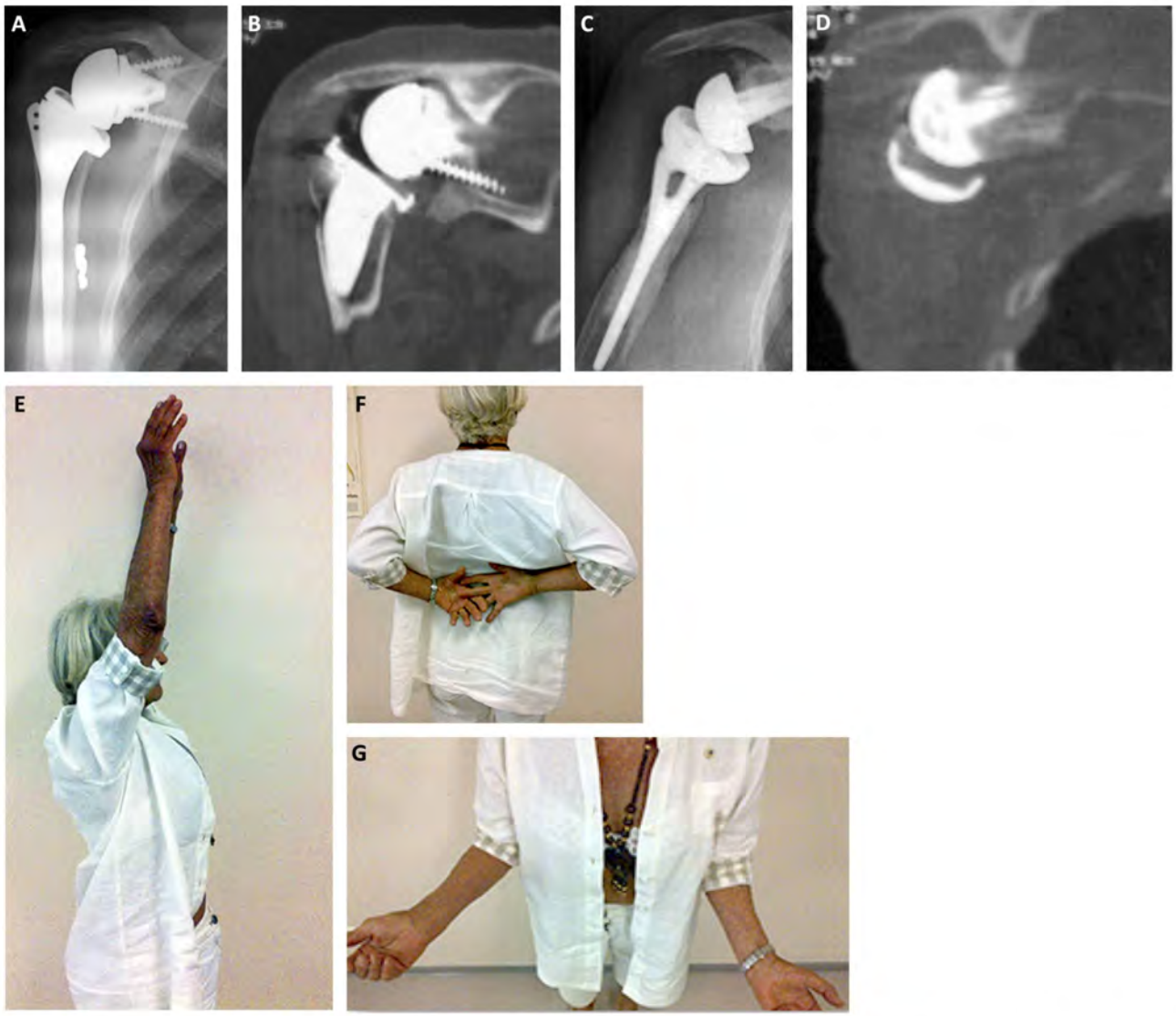

Fig. 6. Bipolar loosening 2 years after RSA with pseudoparalysis and loss of active external rotation (CLEER). A, B. Preoperative radiography and CT. C, D. Postoperative radiography and CT: glenoid defect reconstructed by cancellous allograft impacted in cavity defect; glenoid implant lateralization by addition of cancellous bone disk (BIO-RSA); latissimus dorsi and teres major muscle-tendon transfer to restore active external rotation. E–G. Functional result at 2 years. Note restored active external rotation.

Fig. 7. Example of humeral loosening 7 years after RSA. A. Radiograph with millimeter scale of both humeri, quantifying bone loss and theoretic height of humeral component. B. Immediate postoperative radiograph: proximal defect (−5 cm) reconstructed by uncemented locked prosthesis with humeral allograft. C. Radiography and CT at 2 years, showing allograft consolidation onto native humerus ("step-cut" is useful to control rotation). D. Functional result at 2 years.

6.3. Revision of malpositioned humeral implant without loosening

What should be done if the humeral implant has been positioned too low and/or with an error of version inducing complications (instability), although without loosening? Explantation involves technical problems that need planning for. After ablating the proximal cement, extraction is performed by hammer blows along the prosthesis axis guided by a graft tamp leaning on the medial part of the prosthesis. A prosthesis extractor can be very useful.

In case of difficulties, to avoid intraoperative fracture, primary humerotomy may be considered. Lateral humeral split is the simplest and least aggressive means of extracting a well-fixed humeral implant [5,22]. Osteotomy is performed behind the bicipital groove, first using a motorized saw, then an osteotome; the idea is to split the bone and cement and open the cortical bone to free the implant. We do not have experience in other techniques such as Cofield's and Nicholson's diaphyseal cortical window [1] or Gohlke's humeral window [25], which are more agressive.

The new humeral stem may be cemented or not: press-fit, possibly reinforced by screwing (Fig. 7). Measuring the theoretic humeral length, on bilateral scaled radiographs, is critical to positioning the stem at the right height [5,6]. We perform humeral osteosynthesis using flexible suture loops, having given up metal wire and cables more than 10 years ago.

6.4. Management of humeral fracture

Humeral fracture may be traumatic (e.g., fall) or iatrogenic, occurring during attempted implant extraction and/or humerotomy. Treatment depends on associated complications and fracture type:

- in displaced transverse fracture, plate osteosynthesis with autologous (iliac) bone graft is mandatory;
- in transverse or spiral fracture with minimal displacement, non-operative treatment may ensure consolidation. Splint immobilization in neutral rotation or abduction is preferable, to avoid diaphyseal rotational malunion;
- in case of associated loosening and/or instability, implant replacement is required, using a long stem to bridge the fracture.

6.5. Management of loss of active external rotation

Definitive loss of active external rotation of the limb is due to the absence of the infraspinatus and teres minor muscles.

Without external rotator musculature, functional results are decidedly poorer: despite normal active elevation-abduction, patients are unable to position the hand in space or hold an object, be it a simple toothbrush or a comb.

The solution is latissimus dorsi, or latissimus dorsi and teres major (L'Episcopo procedure) transfer to the posterolateral side of the humerus [5,26,27]. This is feasible only if the proximal humerus is intact. In case of humeral defect and in young patients, the muscle-tendon transfer may be fixed onto a humeral bone allograft.

7. Glenoid loosening and complications

7.1. Risk factors

Technological progress has more or less done away with disassembly between the glenosphere and baseplate.

Aseptic glenoid loosening is rare. Latent underlying infection should be screened for; if negative, loosening is always due to technical error: glenoid component positioned too high and/or in superior inclination. Such malpositioning induces severe shear stress, impairing fixation [8,28]. If glenoid bone graft was included in implantation, loosening may be due to lack of implant fixation in native bone (implant with short central peg not reaching the scapula) [5,8].

7.2. Recommended procedure in glenoid loosening with bone defect

Glenoid loosening almost always involves bone defect, which can be classified in 3 grades according to location and severity as assessed on CT: cavity defect (A), uncontained wall defect (B), or complex defect (C) (Fig. 8).

7.2.1. Cavity bone defect (type A)

Cavity bone defect (type A) can be filled by impacted allograft, avoiding the morbidity associated with iliac crest harvesting, and shortening operating time. We prefer cancellous wedges (15-mm OsteoPure™ wedge), fashioned and fixed using a long-peg plate or long (≥ 25 mm) screws implanted in the native bone. Fragmented grafts are to be avoided as they would lack mechanical stability.

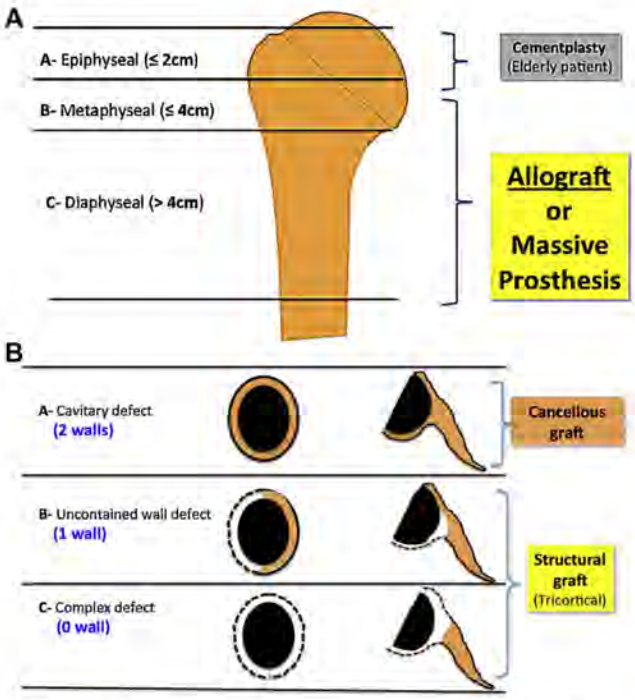

Fig. 8. A. Classification of humeral bone defects and strategy. B. Classification of glenoid bone defects and strategy.

7.2.2. Uncontained or complex defects (type B, C)

Uncontained or complex defects (type B, C) are reconstructed by autologous tricortical bone graft harvested from the iliac crest (Fig. 9). This is the most reliable means, as autologous bone can consolidate without resorption. The graft is prepared *in situ*, at the ipsi- or contralateral iliac crest, following Norris et al. [29]. For this we use BIO-RSA™ K-wire guided instrumentation, including cannulated drills and hole-saw.

We recommend:

- implanting the metaglene as low as possible, at the scapular pillar, in approximately 10° inferior inclination to avoid harmful superior shear stress;
- sculpting the tricortical graft so that it is self-stable and inclined downward;
- positioning compression screws supero-inferiorly and locking screws anteroposteriorly;
- using a glenoid component with a long central peg (25, 30 or 35 mm) and long screws (40–50 mm).

Digitized planning of graft shape and size on CT, whether for autograft or allograft, is now possible using dedicated software [30].

7.2.3. One- or two-step glenoid reconstruction?

Glenoid reimplantation is almost always feasible, as the metaglene provides an osteosynthesis plate to fix the bone graft. However, if the glenoid defect is severe and graft osteosynthesis unsure, humeral reimplantation and reduction may be dangerous, due to excessive stress on the bone graft and its fixation. There are then three options:

- one-step procedure, as long as bone reconstruction is stable and implant reduction is easy, without excessive tension. Three conditions have to be met:
  - sufficient graft stability (impaction),
  - central peg (or screw) implanted in native scapular bone for at least 5 mm,
  - central peg (or screw) supported by screw stilts in the scapula (coracoid pillar and base);
- a two-step procedure is preferable if the above conditions are not met:
  - primary bone reconstruction by iliac autograft, with implantation of metaglene (to fix the graft) and glenosphere. Spherical reaming of the humeral epiphysis (36 or 42 mm) and reinsertion of the subscapularis by transosseous sutures stabilize the prosthesis awaiting the second step. The humeral component is not implanted, as it would induce excessive glenoid stress with risk of loosening,
  - second step: humeral implant, 3–6 months later after bone graft consolidation;
- an alternative to the two-step procedure is a "protected step" with abduction splint immobilization. We often take this option, although it requires the prosthesis to be easily reducible. It avoids a second surgical step, but at the cost of 6–8 weeks' immobilization to allow for bone graft consolidation. Abduction is in 60° for 3 weeks, reduced by 10° steps weekly over the following 3 weeks.

8. Functional results with RTSA

Although sometimes requiring several procedures, implant conservation or replacement is feasible and restores a functional shoulder (Fig. 6) [5].

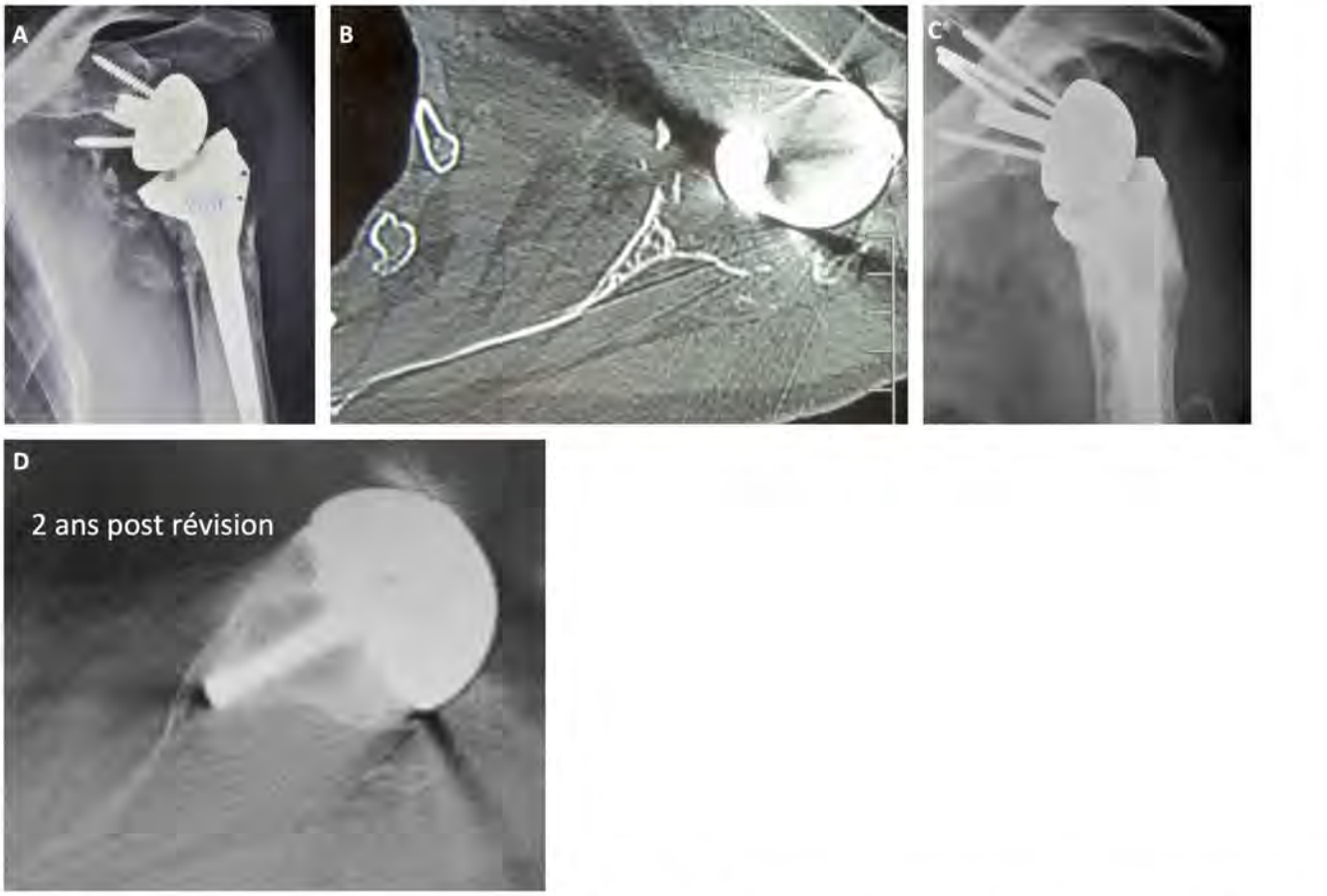

Fig. 9. Example of aseptic glenoid loosening 7 years after RSA. A. Glenoid implant too high, with severe glenoid bone loss, humeral loss (3 cm) because of tuberosity resorption. B. Preoperative CT, showing complex glenoid bone defect. C. Reconstruction by iliac tricortical graft with long-peg (30 mm) glenoid component; proximal humeral reconstruction by cement. D. Postoperative CT: reconstituted glenoid bone stock and perfect glenoid graft consolidation.

Table 3
Functional results at a mean 45 months' follow-up in 49 patients still with RSA after revision surgery.

	Preoperative	Last FU 45 months (12–177)	*P* value
Constant score	21 (2–72)	47 (13–78)	<0.001
Adjusted Constant score	26 (4–80)	62 (17–122)	<0.001
Active anterior elevation	77° (0–140°)	107° (40°–170°)	<0.001
Active external rotation	5° (−30°–70°)	4° (−30°–50°)	NS
Satisfaction		76% S or VS	

S: satisfied; VS: very satisfied.

In our experience, implants could be conserved or replaced in 90% of patients (49/54). In 2 patients (4%), RTSA was converted to hemiarthroplasty; 3 other fragile elderly patients (6%) required definitive explantation due to severe infection.

Functionally, however, results for revision surgery are poorer than for primary RTSA [5,9], notably in terms of Constant score and range of motion (Table 3). Patients subjectively assessed their shoulder at last follow-up at a mean of 60% (range, 10–95%) of normal (SSV – Subjective Shoulder Value).

9. Conclusion

The most frequent reasons for RSA revision are, in decreasing order: instability, infection, humeral loosening and glenoid loosening. RSA revision is a technical challenge, and functional results are systematically poorer than in primary arthroplasty. It is a difficult and risky surgery, with complications and reoperation rates of 10–50%, depending on the surgeon's experience. Less experienced surgeons should therefore entrust cases of RTSA failure to a reference center. Iterative revision is due to underestimating associated complications (especially humeral bone defect and excessive medialization) and failure to diagnose latent infection, which is frequent in RSA implanted for failure of previous surgery.

Shoulder function is conserved after RSA revision in 90% of cases. Conversion to hemiarthroplasty or resection arthroplasty is indicated only when all other options have been exhausted and/or the patient is too old and fragile. Awareness of the main risk factors for complication (humeral shortening, excessive medialization and latent infection) should improve the quality of primary RSA.

Disclosure of interest

The author has connections with Tornier Inc., Imascap and Smith & Nephew.

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