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ORIGINAL STUDY

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Instability after reverse total shoulder arthroplasty: risk factors and how to avoid them

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Instability after RTSA (4'7%) remains a complication with limited salvage options... or not? We conducted a study of the incidence, predisposing factors, and treatment of RTSA instability to risk stratify patient and identify the most reliable treatment methods.

We retrospectively searched for RTSAs performed between 2008 and 2017 at our institution by one surgeon using the same technique. We identified post-operative dislocations or symptoms of instability. 103 patients underwent 103 RTSAs (97 primary, 6 revision). 6 patients had 5 dislocations (3 in primary RTSAs, 3 in revision RTSAs). Mean time from surgery to diagnosis was 32.6 days (range, 10-60 days). One dislocation occurred immediately after surgery, 0 after falls, 3 from low-energy mechanisms of injury, and 2 without known inciting events.

All dislocations were treated in the operating room; no dislocation was successfully treated with simple closed reduction in the clinic. Although dislocation after RTSA is uncommon, the risk is higher for patients with higher BMI and for patients undergoing revision surgery.

The highest risk of instability occurs in RTSAs done for severe proximal humerus fracture; where the anatomy of the shoulder is changed. In these cases, approximately one in four patients will have a recurrent dislocation. In patients with persistent instability or with risk factors for instability, consideration should be given for use of larger glenospheres and increasing the lateral offset at the time of RTSA. Besides, peri-glenoid release, the suitable tension of the soft tissues tend to be the key of the stability.

Level of Evidence: Level IV; Case Series; Treatment Study.

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Keywords: Instability; reverse shoulder arthroplasty; proximal humeral fracture; orthopaedic trauma; dislocation.

INTRODUCTION

There has been a significant increase in surgical indications for reverse total shoulder arthroplasty in recent years due to the good outcomes achieved in terms of pain reduction and functional recovery for patients with various shoulder pathologies *(1-7)*. These indications include degenerative rotator cuff tear pathology, revision of prior shoulder arthroplasty, and complex fractures of the proximal humerus and the associated sequelae *(2)*.

Despite the good outcomes that have been reported, the documented rate of complications is not negligible, varying from 20 to 65% depending on the case series *(5,8,9)*.

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These complications include neurological injuries, periprosthetic fractures, bruises, infections, acromial fractures, scapular notching and loosening. Instability of the implant is one of the most common and difficult to predict complications and, therefore, one of the most difficult to treat *(8)*.

The incidence of instability has remained at approximately 4.7% *(10)*. Factors that are associated with instability include the surgical technique, the design of the implant and the condition of the soft tissues *(5,9,11)*.

In this study, we review cases of instability in a series of 103 patients who underwent reverse total shoulder arthroplasty, describing the patients' characteristics and factors associated with the incidence of instability.

Any surgeon confronted by dislocation after RTSA should therefore, before considering reoperation, weigh several questions *(12)*:

What is the frequency of this complication?

What are the risk factors?

What should the surgical strategy be in case of associated complications?

Can the implant be conserved or will 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.

METHODS

Between January 2008 and April 2017, a total of 103 reverse total shoulder arthroplasties were performed in our unit.

The surgical indications included degenerative pathology due to chronic rotator cuff injury (40 cases), complex proximal humeral fractures (46 cases), sequelae of proximal humeral fractures and dislocations (11 cases) and revision of prior shoulder arthroplasty (6 cases), Figure 1.

We used the Equinoxes (Exactech®) implant in 20 patients and the Aequalis Reverse II (Tornier®) implant in 83 patients, Figure 2.

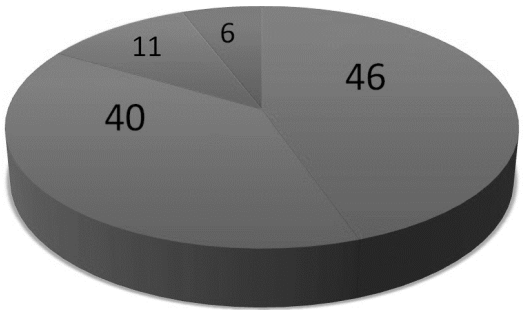

Figure 1. — Surgical indication: degenerative arthropathy because of rotator cuff damage (40 cases), complex fractures of the proximal humerus (46 patients), its sequels (11 sequels) and the revision surgery of other arthroplasties (6 cases). I

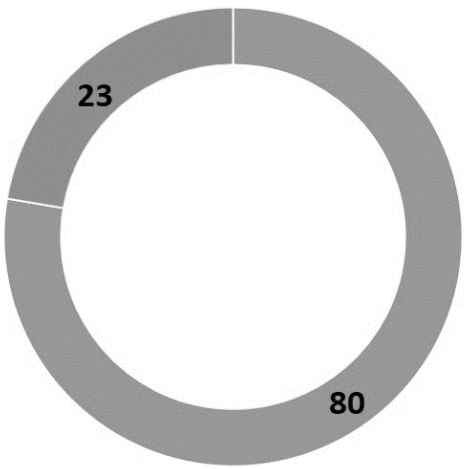

Figure 2. — Implants used: Aequalis Reversed II (Tornier), 80 patients; Equinoxe (Exatech), 23 patients.

The surgery was performed by the same surgeon in all cases, following a standard technique as described below.

The patient was placed in a reclining position. The surgeon used a deltopectoral approach and a transtendinous section of the subscapularis when it was present.

A tenotomy and tenodesis of the long head of the biceps tendon was performed if the tendon was intact.

The humeral stem was cemented when its pressfit fixation was considered insufficient, which occurred in 62 cases. The stem was oriented at a retroversion angle of 10º.

The metaglenoid was oriented at 0º of anteversion and 10º of inferior tilt. The size of the glenosphere

ranged between 36 and 42 mm. A larger implant was used whenever feasible.

For humeral fracture cases, a shank specifically designed for fractures was used in 28 cases, and reinsertion of the tuberosities was performed according to the Boileau technique *(13)*.

Intraoperative assessment to adjust the stability of the implant was based on the following parameters: difficulty of reduction, pistoning, joint balance and tension of the joint tendon.

For cases involving degenerative pathology, a repair of the subscapularis tendon was performed whenever feasible using transosteal points.

For patients with sequelae of fractures or undergoing revision surgery, the surgical technique was modified according to the needs of each patient.

The postoperative rehabilitation regimen consisted of pendular exercises after 48 hours, passive exercises for three weeks and active exercises at six to eight weeks.

Routine checks and radiological exams were performed at 15 days, 6 weeks, three months and annually thereafter.

We reviewed cases of prosthesis dislocation, as well as cases of evident clinical instability that required surgical revision. Table 1.

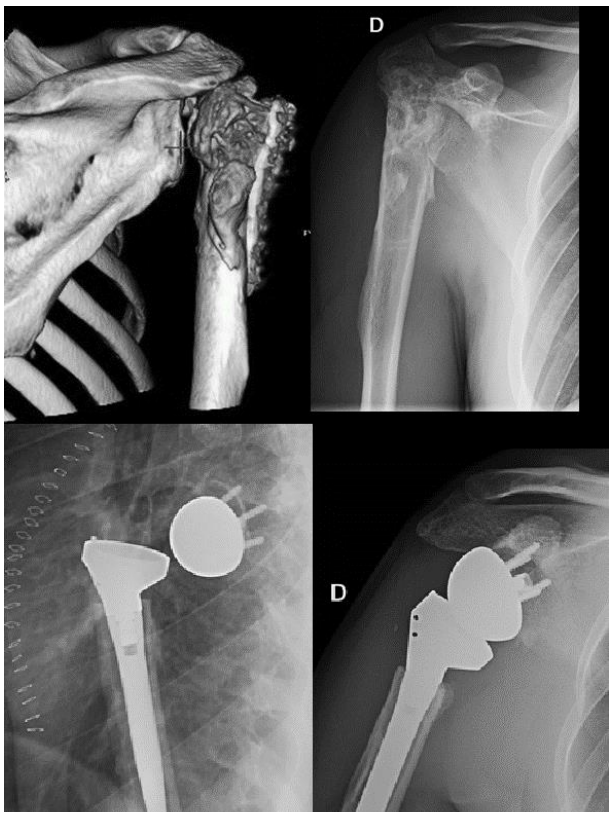

Figure 3. — Images 1-4. Image 3, CT scan of the proximal humerus fracture's sequelae in a 20-year-old man. Image 4, X-ray of the proximal humerus fracture's sequelae in the same patient. Image 5, dislocation after RSA. Image 6, RSA after revision surgery.

RESULTS

Six cases of instability were documented. Five cases started with a complete dislocation whereas the remaining case involved recurrent episodes of subjective partial dislocation with a sensation of instability. In all cases, the dislocation was anterior.

Of these six patients, three had initially undergone surgery due to a degenerative process subsequent to a chronic massive rotator cuff tear and three others required surgery for various sequelae of proximal humeral fractures.

Table 1. — Reason of the surgery, implant's type, implant's size and component's orientation

ETIOLOGY	Subacromial arthropaty 40	Complex fracture 46	Fracture's sequelae 11	Revision surgery 6	
IMPLANT	Equinoxe (EXACTECH ®) 20		AEQUALIS REVERSE (TORNIER ®) 83		
STEM FIXATION	Cemented 62		Non-cemented 41		
STEM VERSION	0º 42	5º 22	10º 16	15º 12	20º 21
METAGLENE ORIENTATION	0º VERSION/ 10º INFERIOR TILT 103				
GLENE GRAFT	Bio RSA 9	Humeral neck 2			
GLENOSPHERE SIZE	36 mm 47	38 mm 10	42 mm 46		

Table 2. — Resume of age, sex, dominant limb, presence of obesity, cause of the RSA, surgery previous to RSA on this shoulder, appearance of the dislocation after RSA's surgery and mechanism of production on each patient.

	AGE	SEX	DOM. LIMB	OBESITY	PATHOLOGY	PREV SURG	EVOLUTION	MECHANISM
Case 1	70	F	YES	YES	FRACTURE SEQUELAE	HUMERAL NAIL	10 DAYS	¿?
Case 2	77	F	YES	YES	DEGENERAT.	NO	60 DAYS	DRESSING
Case 3	71	F	YES	YES	DEGENERAT.	NO	20 DAYS	SITTING
Case 4	61	M	NO	YES	DEGENERAT.	NO	45 DAYS	SUBJECTIVE FEELING
Case 5	50	M	NO	NO	FRACTURE SEQUELAE	NO	30 DAYS	¿?
Case 6	26	M	YES	NO	FRACTURE SEQUELAE	HUMERAL PLATING	21 DAYS	RHB movements

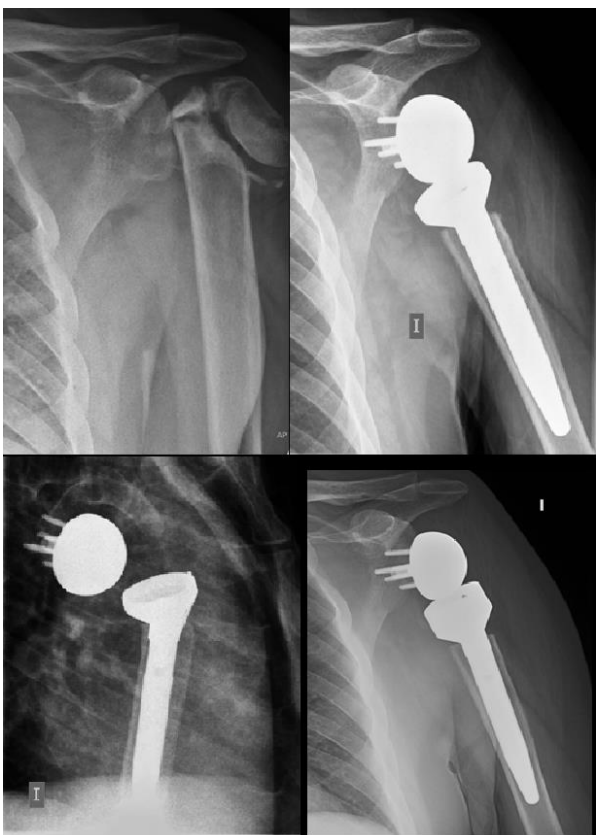

Figure 4. — Images 5-8. Image 7: non-union sequelae after complex proximal humerus fracture. Image 8: RSA. Image 9: dislocation after RSA. Image 10: RSA after revision surgery.

None of the patients had a complex proximal humeral fracture.

The age of the patients ranged from 26 to 77 years with a mean of 58.8 years. The mean age of patients with fracture sequelae was 48.6 years, and the mean age of the three patients with degenerative pathology was 69.6 years. Figure 3.

Post-surgical instability occurred in three men and three women, with four of the six cases affecting the dominant arm. Three of the patients had moderate obesity (BMI >30). Table 2.

Of the six patients, two had undergone previous shoulder surgery: osteosynthesis with a humeral nail had in one case, and placement of a proximal humeral locking plate in the other. Both patients developed significant consolidation and necrosis of the humeral head. The third patient with postsurgical complications had a category 2 Boileau type 3 fracture with pseudarthrosis and developed necrosis of the proximal humerus that was not treated, Figure 4.

In the three patients with degenerative pathology, the surgeon used a standard surgical technique with reinsertion of the subscapularis. In the remaining three cases, this approach was not feasible, as one patient had a previous chronic tear that could not

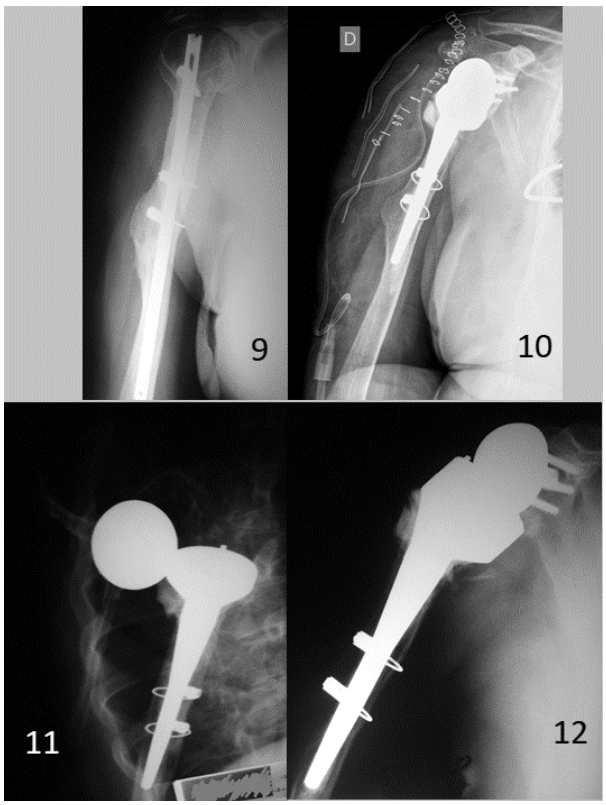

Figure 5. — Images 9-12. Image 9: Rotator cuff arthropathy after intramedullary nailing. Image 10: RSA. Image 11: dislocation after RSA. Image 12: RSA after revision surgery.

be repaired and the level of humeral resection in the other two cases did not allow for anchoring.

Dislocation occurred between 10 days and two months after surgery, with an average time of onset of 32.6 days. The patient who reported subjective instability began to experience symptoms three weeks after surgery. The instability was evident on physical examination manoeuvres. Table 2.

In two cases, the dislocation was detected during routine radiological exams performed during a follow-up visit. The remaining three patients reported that the dislocation had occurred while getting dressed, while performing pendular exercises, and when sitting on a bench. Figure 5.

An emergency closed reduction was performed in three of the five cases of dislocation, but reduction was not possible in the other two cases.

In conclusion, patients in whom the dislocation occurred later than three weeks postoperatively had a good recovery (even better than average) of joint balance on both abduction and rotation during their postoperative course. Table 2.

Given the rapidity of onset of dislocation (less than two months) in all cases, the banal mechanisms involved – or even the absence of a clear mechanism – and the subjective feeling of instability reported by some patients, it was decided to perform surgical revision in all six patients.

The intraoperative findings were as follows.

In five cases, once the dislocation was reduced, the tension deficit of the soft tissues that caused evident instability was examined. None was found to be in an anomalous position. In one of the patients, the examination revealed a loosening of the central screw of the glenosphere, which in turn caused loosening of the joint.

In these five cases, the instability was resolved by increasing the thickness of the polyethylene insert. In four cases, a metal spacer was placed to increase the soft tissue tension. In one case, the 36-mm glenosphere was replaced with a 42-mm implant. In no case was it necessary to place an ultra-congruent insert.

In the sixth case, no soft tissue tension deficit was observed. In fact, the excess tension caused a lower clamping against the soft periglenoid components during adduction, which in turn caused the dislocation.

In this case, the diaphyseal resection was increased by 5 mm, the stem was placed at 0º of retroversion, the release of anteroinferior periglenoid soft tissues was increased and the glenosphere was replaced from a 36-mm to a 42-mm implant.

The subscapularis was disinserted in the three cases in which it had been repaired and could only be reinserted in two cases, Table 3.

A monitoring CT scan was performed on four patients to assess the orientation of the components.

On average, the orientation of the glenosphere was at 3º of anteversion and 8º of inferior tilt, with a range of 0-5º for anteversion and 10º for inferior tilt.

The retroversion angle of the humeral stem was 12º on average.

Grade I glenoid notching was detected in two of the six cases two years after the surgical revision, with no increase in the number of previous imaging examinations.

Table 3. — Components used on the first surgery and the revision surgery on each patient with an RSA's dislocation

	INSERT		GLENOSFERE		SUBSCAPULAR		OTHERS
	1º SURGERY	REVISION	1º SURGERY	REVISION	1º SURGERY	REVISION	----------
CASE 1	12mm	9+6mm	36mm	42mm	ABSENT	----------	PERIGLENOID. LIB.
CASE 2	12mm	9+12mm	42mm	42mm	REINS.	NO REINS	----------
CASE 3	12mm	9+12mm	42	42mm	REINS.	NO REINS	----------
CASE 4	9mm	9+12mm	36mm	36mm	REINS.	REINS.	----------
CASE 5	9mm	9+9mm	42mm	42mm	NO REINS.	----------	----------
CASE 6	6mm	6mm	36mm	42mm	NO REINS.	----------	PERIGLENOID. LIB.

Table 4. — Constant Score one year after the revision surgery on each patient with an RSA's dislocation

	CONSTANT 1 YEAR
CASE 1	45
CASE 2	83
CASE 3	84
CASE 4	86
CASE 5	77
CASE 6	78

The postoperative course was satisfactory in all cases, with no new episodes of instability or other notable complications.

In the last follow-up visit performed at least one year after the revision surgery, the patients did not report any subjective sensation of instability.

Scores on the constant test ranged between 45 and 86 points, with an average of 75.6, Table 4.

DISCUSSION

Implant instability is one of the most frequent complications in shoulder arthroplasty *(1,10,14)*. The incidence in our series is comparable to that reported in other publications, at approximately 5% *(10)*.

Multiple factors influence the development of instability *(5,9,11)*.

The four main categories are patient-dependent factors, the underlying pathology, the surgical technique and the design of the implant *(15-18)*.

Regarding individual factors, a greater frequency of dislocation has been reported in women and in patients with obesity. This is presumably due to lower tension of the soft tissues and a decrease in compression forces as opposed to dislocation forces *(10,19)*.

In our series, half of the patients were women and half were obese, and the dominant arm was most commonly involved.

We have verified that the cases of dislocation occurred in two types of patients.

One category of patients includes those who had an arthropathy involving subacromial impingement of the rotator cuff. The other patients were those who had undergone surgery for fracture sequelae of varying severity; some had already undergone previous surgeries, and there were significant anatomical changes that forced the surgeon to perform a wide resection of the proximal humerus and the surrounding soft tissues.

We have not had any cases of dislocation in patients with a recent fracture that required reinsertion of the tuberosities into the implant.

The subscapularis was not repaired in half of the cases. It seems that this may have some effect in cases of anterior instability when a deltopectoral approach is used, although this effect is unclear *(11,20)*. Vourazeris et al also conclude that primary RTSAs with or without subscapularis repair have similar clinical outcome scores and rates of complications including dislocations *(21)*.

All the cases of dislocation occurred with the Aequalis implant, although this was the most commonly used implant in the series and was also used in the most complex cases, so we cannot establish any relationship with the design of the prosthesis. The reason why different implants were used is because of the Hospital's supply, any medical reasons.

We have always used a deltopectoral approach for shoulder prosthetic surgery. We are aware of the advantages and disadvantages of this approach, and we believe that it minimises the occurrence of other complications as harmful as instability. In fact, complications exist for different surgical approaches (deltopectoral and anterosuperior) and should factor into the decision-making process regarding the

appropriate surgical approach for reverse shoulder arthroplasty *(22)*.

The orientation of the humeral stem was found to be at 10º of retroversion. Our current approach is to use 0º of retroversion, in the aim of not only minimising the risk of dislocation (as suggested by the Favre studies on the influence of the orientation of the stem on the stability of the implant *(23)*) but also improving the range of mobility on internal rotation.

We believe that whenever possible, the use of larger-diameter glenospheres is preferable since they increase the tension of the deltoid and reduce the risk of poor clamping in abduction with the consequent leverage effect. In fact, increasing the glenosphere diameter is one of the interventions that should be considered in revision surgery due to instability.

Maintaining the anteroposterior metaglenoid in a flat position seems to have less influence when it is not placed in a position of exaggerated anteversion. In our cases, the orientation was close to 0º of anteversion, with 10º of inferior tilt.

We do not use BioRSA glandular bone graft routinely in our implants, so we cannot comment on its influence on stability.

This article is an illustration of current practise. To sum up, as surgeons, we cannot forget any risk factors that can ruin the stability of a reverse shoulder arthroplasty: dominant arm involved, obesity (BMI >30), previous surgery because of fracture sequelae and the orientation and size of the implant.

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