S ORIGINAL ARTICLE

Shoulder & Elbow

Shoulder & Elbow
2021, Vol. 13(1) 51–57

DOI: 10.1177/1758573219864266
journals.sagepub.com/home/sel
SAGE

Risk factors for instability after reverse shoulder arthroplasty

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Abstract

Background: This study aims to identify risk factors related to postoperative instability after reverse shoulder arthroplasty and evaluate the modalities and results of treatments in a large series of patients, with medium to long-term follow-up.

Methods: Retrospective multicenter series of 1035 consecutive Grammont type reverse shoulder arthroplasties implanted between 1992 and 2010. 19.9% had a reverse shoulder arthroplasty with bony lateralization on the glenoid side. Patients were reviewed and radiographed with minimum five years' follow-up.

Results: At a mean follow-up of eight years, the overall rate of postoperative instability was 3.0%. Instability was more frequent in case of reverse shoulder arthroplasty for revision surgery, in younger patients, in case of scapular notching, and tuberosity resorption. Lateralized reverse shoulder arthroplasties were associated with a lower instability rate. A reoperation to restore stability was needed in 70% of cases. The improvement in Constant Score was lower in patients with unstable reverse shoulder arthroplasties when compared to stable reverse shoulder arthroplasties.

Conclusions: Younger patients are at higher risk for instability after Grammont type reverse shoulder arthroplasty implantation. Conversely, lateralized reverse shoulder arthroplasties resulted protective. When conservative treatment had failed, shoulder stability can be obtained with reoperation or prosthetic revision (needed in 70% of the cases), but to the price of lower functional results.

Keywords

BIO-RSA, deltoid tensioning, dislocation, humeral lengthening, prosthetic instability, reverse shoulder arthroplasty complication

Date received: 1st February 2019; revised: 3rd June 2019; accepted: 4th June 2019

Introduction

The popularity of reverse shoulder arthroplasty (RSA) is continuously increasing, as successful outcomes have been shown for a variety of end-stage shoulder pathologies.[1–9] Although postoperative problems are frequent, postoperative instability is the most common complication[10] reported from 2.4% to 31%[11,12] in the current literature.

In order to prevent this complication, great effort has been done to identify the risk factors for instability, with conflicting reports. In literature, instability of a RSA seems to be related to the etiology,[12–15] subscapularis management,[15,16] surgical approach[17] and prosthetic design.[2,4,18–20]

Recent literature reports a lower rate of RSA instability; if compared to the first reports, this could also be related to a better surgical technique.[11,12]

The optimal management of the RSA instability is also still controversial. Many surgeons recommend an initial attempt of closed reduction and conservative treatment,[12,21] while others report a high failure rate of non-operative treatment, especially in cases of early dislocations, reporting successful result in 44%–62% of

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cases. In contrast, Gerber et al. have stated that early dislocations are most likely secondary to surgical error and less likely to be successfully treated with closed reduction compared with late dislocations.[22] Boileau et al. also reported 67% failure rate of the conservative management.[23]

Surgical strategies to address instability range from adding a metallic spacer and/or substituting the polyethylene insert with a thicker one, to replacing the humeral stem with a longer cemented one, to increase the glenoid offset or lateralize the glenosphere and/or reconstruct the glenoid bone loss to gain more stability.[23–25]

The purpose of this study was to identify the risk factors for the instability of Grammont type RSA (155° neck-shaft angle, inlay design) and to evaluate the treatments of postoperative instability in a large series of patients.

Materials and methods

A multicenter retrospective analysis of all RSAs was used to evaluate post-operative instability. The inclusion criteria were Grammont type RSA with a minimum five-year follow-up. Preoperative, intraoperative and postoperative data were collected. Preoperative characteristics of the patients, including age, sex, preoperative diagnosis and previous operations were evaluated. Intraoperative data included surgical approach, implant characteristics, subscapularis repair (as reported in the operatory report) and adjunctive bone graft procedures. Postoperative data included time to dislocation and its treatment.

Between 1993 and 2010, 1953 RSAs were performed in seven orthopedic centers, specialized for shoulder surgery. Of these, 1035 had a minimum of five-year follow-up, including 77% of women, with a mean age at surgery 71.6 years. The right shoulder was involved in 69% of cases.

All implants were Grammont type with 155° inclination and humeral inlay design. A delto-pectoral approach was used in 78% of shoulders, and the implants were Aequalis Reverse (Tornier) in 73% and Delta III (DePuy) in 14% of cases. In the remaining 13% other, other Grammont type implants were used. Two-hundred and six shoulders (19.9 %) had an RSA with bony lateralization (BIO-RSA) with addition of 10 mm disk of cancellous bone under the baseplate after glenoid reaming.[24] There were 919 primary RSAs and 116 revision RSAs.

Ethical committee allowed this study since this project does not infringe the French ethical rules and the privacy of the patients.

Statistical analysis

The Wilcoxon test was used to compare the differences in numeric outcomes between last follow-up and preoperative values, and the Mann-Whitney test or the Kruskal-Wallis test was used for between-groups differences. The Fisher's exact test or the Chi-square test were used to find the associations between qualitative variables.

For univariate analysis, we included the following variables: gender, age at surgery, dominant side, primary or revision arthroplasty, approach, type of implant (Delta or Aequalis), Bony Lateralized RSA, glenosphere size and subscapularis repair. Preoperative rotator cuff fatty infiltration could not be studied, as it was known only for 11 patients of the 32 dislocation cases. Student's t-test was used for continuous variables and Chi-square or Fisher's exact tests were used for discrete outcomes.

A multivariate binomial logistic regression model was developed to study the risk of postoperative instability, including parameters that had a p-value below 0.1 in the univariate analysis. Year of surgery and type of implant were statistically associated as Delta implants were progressively replaced by Aequalis implants in our services. Therefore, from these two variables, we only included the type of implant in the regression model.

Statistical analysis was performed with EasyMedStat (www.easymedstat.com) and R (version 3.4.2.; www.r-project.org). Significance level was set to 0.05.

Results

Out of 1035 prostheses, at a mean follow-up of eight years (5 to 20 years), 31 cases of postoperative instability in 31 patients were identified, representing an overall rate of 3.0%. The first dislocation occurred in the first three months for 48% of cases, and in the first year in 66% of cases.

Risk factors for instability

These 31 cases were younger at time of surgery (67 vs. 72) and were more frequently revisions (Table 1). There were no differences regarding gender, operated side or dominance (Table 1).

Bony lateralized RSA was more frequent in the stable shoulders, and the Delta III implant was more frequently used in unstable RSA. There was no difference between groups regarding the approach, the size of the glenosphere or the repair of the subscapularis (in cases of delto-pectoral approach).

Table 1. Patients' demographics and the operative details in stable and unstable RSA.

Parameter	Unstable RSA N = 32	Stable RSA N = 1003	p
Univariate analysis			
Female (%)	34%	22%	0.113
Age at surgery (y)	67 (±10)	72 (±9)	0.002*
Year of surgery	2004 (±4)	2006 (±4)	0.010*
Follow-up duration (months)	113 (±39)	98 (±33)	0.010*
Dominant side operated (%)	68%	69%	0.87
Revision arthroplasty (%)	25%	11%	0.021*
Approach = DP (%)	81%	78%	0.83
Implant = Delta (%)	28%	15%	0.042*
Bony lateralized RSA (%)	3%	20%	0.011*
36 mm-glenosphere (%)	93%	87%	0.57
Subscapularis repair (%) in case of DP approach	73%	64%	0.35
Parameter	**Odds-Ratio**	**95% CI OR**	**p**
Multivariate analysis			
Age at surgery (1-year increase)	0.953	0.924–0.987	0.004*
Follow-up duration (1-month increase)	1.004	0.994–1.015	0.439
Revision arthroplasty	2.264	0.876–5.348	0.073
Implant = Delta	1.363	0.518–3.273	0.507
Bony lateralized RSA	0.166	0.009–0.837	0.044*

AIC = 275.5; R2 = 0.084.
DP: delto-pectoral approach; RSA: reverse shoulder arthroplasty.

After multivariate analysis, only the time of surgery and the lateralization of the implant resulted significantly associated with prosthetic instability (Table 1).

Management and complications

Twenty-two patients were treated by closed reduction. Nine patients (29%) were treated with open reduction for persistent instability or irreducible dislocation. In these nine patients, eight had associated procedures including change of the PE insert (eight), humeral metallic spacer (four), and excision of the greater tuberosity (one) because of a cam effect.

Instability led to a revision in 13 cases (42%), 8 of which were early dislocators and revision surgery was performed in the two years following the implantation; 2 of the 13 revision surgeries were performed at least 10 years after initial surgery.

Revision surgeries were 1-stage bipolar exchange in six cases (46%), humeral revision for two cases, glenoid revision for another two, revision to hemi-arthroplasty in two patients, and resection arthroplasty in one case.

Table 2. Differences between last FU and preoperative clinical outcomes.

Variable	Unstable RSA N = 31	Stable RSA N = 1004	p
Δ constant score (/100)	+22 (±21)	+38 (±18)	0.014
Δ adjusted constant score (/100)	+28 (±33)	+49 (±27)	0.003
Δ active forward elevation (°)	+44 (±55)	+57 (±43)	NS
Δ active external rotation, arm at side (°)	−1 (±22)	+5 (±23)	NS
Δ active internal rotation (/10)	+0.7 (±4.2)	+1 (±3.5)	NS

NS: not significant; Δ: Difference between last FU and preoperative value.

Table 3. Radiological outcome at last follow-up.

Variable	Unstable RSA N = 31	Stable RSA N = 1004	p
Scapular notch (%)	95%	55%	<0.001
Scapular notch stage 3 or 4 (%)	20%	21%	NS
Greater tuberosity resorption or missing (%)	90%	47%	<0.001

NS: Not significant.

Two patients remained unstable after revision and led to two other revisions for each, with low final Constant score (29 and 33).

Following revision surgeries, two patients suffered component disassembly required component revision (one stem revision and two glenosphere revision) and one suffered humeral loosening that led to a new bipolar revision with a longer stem and larger glenosphere.

Overall, seven patients (23%) did not require any reoperation or revision following their dislocation.

Outcomes at last follow-up

The improvement in Constant Score was lower for unstable RSA at last follow-up, but the improvement of range of motion was not different between groups (Table 2).

Scapular notching was observed in 95%, and greater tuberosity resorption in 90% of unstable RSA, more frequently than in stable RSA (Table 3).

Discussion

The purpose of the present study was to identify the risk factors for instability after implantation of Grammont type RSA (155° neck-shaft angle, inlay design) and to evaluate the treatments of postoperative instability in a large series of 1035 patients reviewed with a minimum five-year follow up. In this study, the dislocation of the RSA was more frequent within the first three months, and that the overall rate of postoperative dislocation was 3.0%. The outcome of conservative treatment was better in patients with early dislocation, while reoperation or revision surgery was needed in 78% of cases.

Factors related to RSA instability

Shoulder instability has been found to be more frequent in RSAs implanted for revision surgery (7.2% vs. 1.9%), likely due to inadequate tension of the deltoid related to humeral shortening and excessive medialization, than in primary RSA. These results support data from other studies, in which revision surgery was related to higher rates of instability.[10,23,26] Another recent study from Alentorn-Geli et al.[27] reports a higher rate of dislocations in case of revision surgery.

In this series, RSA instability has been found to be more frequent in younger patients. Others have related patient demographics finding male gender, body habitus, and previous operations related with early dislocations.[21]

RSA instability has been found to be associated with scapular notching on last radiographs. This may be related to glenoid implants with a too medial position, leading to both instability and scapular notching.

Scapular notching and the lack of impingement-free arc of motion has been found to be related to RSA instability by other authors.[3,15,19]

In this series, absent or resorbed greater tuberosity has also been related to RSA instability. Resorption of the greater tuberosity is possibly related to low humeral implantation that can lead to inadequate soft tissue tensioning, which is considered one of the main factors predisposing instability.[3,10,23]

In this series, subscapularis management, surgical approach and glenosphere size did not affect the rate of RSA instability, as opposed to other authors.[28,29]

Prevention of instability in RSA

The results of this study confirm the effect of glenoid bony lateralization to protect from instability. Lateralization may be obtained performing metallic or bony lateralization of the sphere. Metallic lateralization (metallic increased offset (MIO)), as proposed by Frankle does not seem to prevent instability, as the percentage of instability reported in a large series of 1293 cases is 2.3%,[12] which is not very different from the rate observed in this series with a more medialized center of rotation. In this study, the rate of instability after bony lateralization-RSA was significantly lower than the cases without lateralization. Alentorn-Geli et al.[27] compared the rate of instability in RSAs implanted in medialized center of rotation designs and lateralized center of rotation designs through a delto-pectoral approach. They found a lower rate of instability in the latter group.

Before implanting a RSA for a fracture sequelae or a failed HA for fractures, the surgeon must perform a careful surgical planning to determine the height of implantation of the humeral implant. Preoperative bilateral scaled X-rays allow to predict humeral implant position (i.e. need to implant humeral prosthesis proud), whereas glenoid CT scan images allow to anticipate glenoid implant position (i.e. need to lateralize the glenoid implant).

Treatment of RSA instability

Although the treatment of prosthetic instability can be conservative, revision surgery is needed in 42% of the patients. Shoulder stability can be obtained with prosthetic revision, but to the price of lower functional results.

The treatment of the instability of reverse prosthesis is also subject to controversy.[12,23] Most of unstable patients in this series were successfully treated by increasing the length of the humerus (thereby increasing the tension of the deltoid), with a higher polyethylene insert or by adding an additional metallic spacer. We failed to find in literature a strong evidence regarding the use of a larger glenosphere or that a lateralization of the glenoid allows efficient treatment of re-dislocation.[3,18,28]

Correct restoration of deltoid length and lateralization are key factors for reverse prosthesis stability. When dealing with dislocation, it is advisable to evaluate the length of both humeri, and in the case of inadequate humeral length, a thicker polyethylene insert with a metallic spacer can allow for up to 15 mm (+6 and +9 mm) of correction. Greater degrees of correction will require prosthetic revision surgeries with re-implantation of a prouder humeral implant.[4,23] If the length appears correct, reduction under anesthesia followed by a period of three to six weeks of immobilization in abduction pillow or simple sling, depending on examination under anesthesia, is sufficient for maintaining stability. However, this may come at the expense of some stiffness and decrease in range of motion.

Study limitations and strengths

This study has some limitations. Its retrospective multicentric design can be responsible of methodological and statistical bias. The surgical indication and technique, postoperative management may vary between surgeons and centers. However, its strengths are related to the large cohort from orthopedic units specialized in shoulder surgery, with minimum five years of follow-up, the standard use of a prosthetic design with a humeral neck-shaft angle of 155°, an inlay design and medialized center of rotation for all patients.

Conclusions

Overall, postoperative instability was found in 3% of patients operated with a Grammont (medialized, inlay) type RSA.

The first instability episode occurred in the first three months in half of cases, and in the first year for two-third of cases. After multivaritate analysis, prosthetic instability after RSA resulted more frequent if implanted in younger patients. Conversely, lateralized implants were associated with significantly lower instability rate. After univariate analysis, prosthetic instability was more frequent also in case of revision surgery than in primary RSA, in case of scapular notching, and in case of absent or resorbed greater tuberosity on last radiographs. Other factors such as delto-pectoral approach, subscapularis repair and the size of the glenosphere were not related to prosthetic instability.

To obtain stability, re-intervention was required in more than 70% of cases. Shoulder stability can be obtained with reoperation or prosthetic revision but to the price of lower functional results.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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