



Original article

Epidemiology and mortality in older patients treated by reverse shoulder arthroplasty for displaced proximal humerus fractures[☆]Emmanuel Maugendre^a, Benjamin Gadisseux^a, Christophe Chantelot^a, Philippe Clavert^b, Nassima Ramdane^c, Jean-David Werthel^d, Pascal Boileau^{e,*}, SOFCOT^f^a Service de traumatologie, CHRU de Lille, hôpital Roger Salengro, 2, avenue Oscar-Lambret, 59037 Lille, France^b Service d'orthopédie-traumatologie, centre de chirurgie orthopédique et de la main, service de chirurgie orthopédique, avenue Baumann, 67400 Illkirch, France^c EA 2694 – santé publique: épidémiologie et qualité des soins, université de Lille, CHU de Lille, 59000 Lille, France^d Hôpital Ambroise-Paré Paris, 9, avenue Charles-de-Gaulle, 92104 Boulogne-Billancourt, France^e iULS – Institut universitaire locomoteur and sport, CHU de Nice, hôpital Pasteur 2, 30, voie Romaine, 06000 Nice, France^f Société française de chirurgie orthopédique et traumatologique, 56, rue Boissonnade, 75014 Paris, France

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ABSTRACT

Introduction: Reverse shoulder arthroplasty (RSA) is rapidly becoming the preferred treatment for displaced proximal humerus fractures in older patients. However, few studies have analyzed the target population and the effect of RSA on survival, although the socioeconomic impact of this type of surgery is considerable.

Patients and methods: This was a retrospective epidemiological study of all patients with a displaced proximal humeral fracture treated by RSA in 14 public and private hospitals throughout France between 1995 and 2016. The French hospital discharge database (PMSI) was analyzed to isolate an 898-patient cohort who underwent RSA within 6 weeks of the fracture event. In 87% of cases, this was a 3- or 4-fragment fracture. We analyzed the epidemiological characteristics of the patients at the time of fracture, their survival (Kaplan-Meier estimate) and factors that may impact survival.

Results: The mean age at the time of fracture and surgery was 79 years (46–98 years). Eighty percent of the cohort was female (sex ratio: 0.18 [$p = 0.0042$], with 21% obesity rate [BMI > 30]) and 60% of patients were ASA 1–2. The most common comorbidities were cardiovascular and neurological. The survival rate after RSA was 94% at 1 year and 73% at 5 years. At the latest follow-up of 19 years, 42% of patients were still alive. In 18% of cases, the patient died within the first 15 days. The presence of comorbidities (ASA score > 3–4) ($p < 0.004$) and/or cognitive disorders ($p < 0.0001$) were risk factors for early mortality. The time to surgery, type of fracture, associated fractures and discharge destination (return home, transfer to nursing home) had no effect on postoperative mortality in our cohort.

Conclusion: Despite being older (79 years) at the time of proximal humerus fracture, patients who underwent RSA treatment had a high survival rate (94% at 1 year, 73% at 5 years), which is better than the survivorship reported after surgical treatment of femoral neck fractures (81–87% at 1 year, 38% at 5 years). The presence of comorbidities (ASA > 3–4) and/or cognitive disorders are risk factors for early mortality and should be taken into account to prevent early death.

Level of evidence: IV, Retrospective study.

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1. Introduction

Proximal humerus fractures make up about 5% of all fractures in older adults [1–3]; 5% of these fractures are 3-fragment or 4-fragment displaced fractures in the Neer classification [4]. They very often occur in osteoporotic bone and mainly impact older adults [5]. In this population, they are the third most common type of fracture after femoral neck and distal radius fractures [3,6,7]. It is commonly accepted that only 20% of proximal humerus fractures

require surgical treatment [8,9]. With aging of the global population, the frequency of these fractures has clearly increased in recent years (+243% in women, +153% in men between 1970 and 2002) [3,10,11], making them a public health concern. They mainly occur in older women [12].

Surgical care of displaced proximal humerus fractures has greatly changed in recent years because of the development of specific fracture fixation devices (plates, locked nails) and shoulder replacement implants. Following the work of Grammont and the development of specific fracture implants, reverse shoulder arthroplasty (RSA) is becoming the preferred treatment for displaced proximal humerus fractures in older patients [13–19].

Unlike femoral neck fractures where the epidemiology is well known, the characteristics of the affected population and the impact of these fractures and their treatment has not been studied extensively. Despite the considerable socioeconomic impact of this type of surgery, there are no published studies describing the population affected and the consequences in terms of survival.

This aim of this study was to determine the epidemiology of a large cohort of patients with a displacement proximal humerus fracture treated surgically by RSA, and to compare the mortality with femoral neck fractures.

2. Patients and methods

This was a retrospective, descriptive, epidemiological study of patients treated at 14 public and private hospitals in France between 1 January 1995 and 15 February 2016. This clinical study was done under the auspices of the French Orthopedics and Traumatology Society (SOFOT) and approved by the French Health Authority (HAS) and French data protection authority (CNIL) (approval No. 16-003).

The French hospital discharge database (PMSI) was consulted to capture all the patients with a displaced proximal humerus fracture treated by RSA within 6 weeks of the fracture event during the study period. Also included were patients who underwent RSA within 6 weeks of the fracture event after failed conservative treatment or fracture fixation. Excluded were patients who had pathological fractures and those operated for sequelae more than 6 weeks post-fracture.

The following epidemiological data were analyzed: patient age at the time of fracture, body mass index (BMI), sex ratio, comorbidities, associated injuries, fractured side (dominant/non-dominant), ASA score [20]. We also analyzed the risk factors for mortality and

statistical relationship with the mortality rate at different time points (1 year, 5 years, and 19 years – latest follow-up). Along with the epidemiological data, we analyzed the outcome of the patients in the first 6 weeks after the fracture and the following years.

The epidemiological data were analyzed with the Chi² test using a Cox model for the quantitative variables, and the Log-rank and Mann-Whitney tests for the qualitative variables. Lastly, survival curves were estimated using the Kaplan-Meier method based on different variables. The significance threshold was set at $p < 0.05$.

3. Results

The cohort identified consisted of 898 patients. The average follow-up was 62 months (range 11–228). The proximal humerus fracture was a displaced 4-fragment fracture in 70% of cases, 3-fragment in 17.4% of cases, 2-fragment in 11.8% of cases, and split fracture of the articular surface in 0.8% of cases. Recourse to arthroplasty in patients with minimally displaced and/or 2-fragment fractures was justified at certain hospitals by the presumption of faster return to autonomy, which is known to be important in older adults, as it allows rehabilitation to resume earlier than with conservative treatment or fracture fixation. It has also been shown that the length of hospital stay is shorter in patients who undergo RSA than other surgical treatments [21]. The RSA implants used had three types of humeral stems: standard ($n = 256$, 28.5%), fracture filling ($n = 281$, 31.3%), fracture non-filling ($n = 361$, 40.2%), which allowed a metaphyseal bone graft to be added from the fractured humeral head. A superolateral surgical approach was used in 75% of cases; the humeral stem was cemented in 90% of cases, a 36–38 mm diameter glenosphere was used in 92% of cases, a lateralized glenosphere in 5% (MIO- or BIO-RSA) and a retaining insert in 29%. The tuberosities were sutured around the humeral stem in 70% of cases and excised in the other 30%.

3.1. Epidemiology

The mean age of the patients (Fig. 1) at the time of the fracture and surgery was 79 years (range 46–98). The sex ratio was 0.18 ($p = 0.0042$) with the 763 women in the cohort having a mean age of 79 years (46–98) vs. 135 men with a mean age of 76 years (51–91). The shoulder on the dominant side was fractured in 58% of cases (57% right, 43% left).

The majority of patients (66%) had cardiovascular comorbidities, namely high blood pressure (59%), while 19% were diabetic, 8%

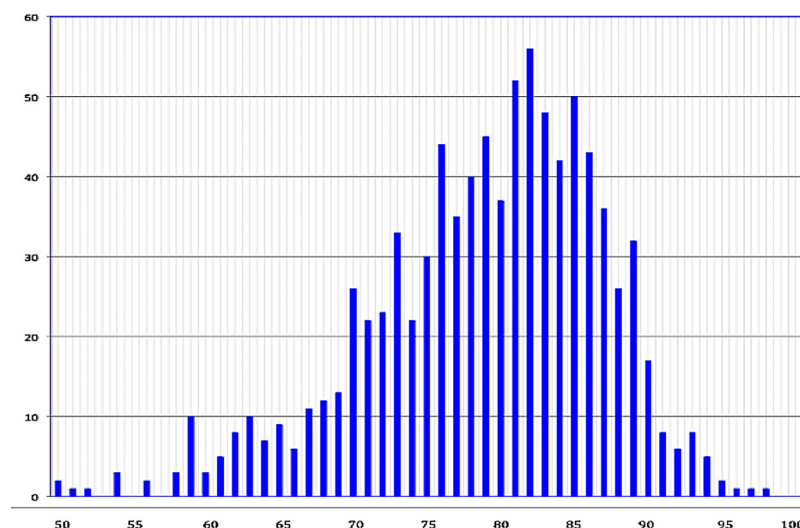


Fig. 1. Age distribution of our cohort.

were smokers and 3% had previously undergone radiation therapy for cancer. On the neurological front, 4% had previously suffered a stroke, 8% had known cognitive disorders, and 3% were being treated for Parkinson's disease. The mean BMI was 26 (range, 16–64) and 21% of patients were obese (BMI > 30).

Other injuries were present in 18% of patients: 38% upper limb, 34% lower limb and 35% trunk or head. Multiple fractures were present in 16% of patients including nine facial bone fractures and one spinal fracture.

At the latest follow-up, 43 patients (5%) had been reoperated: 29 revisions with partial or total implant change, 3 closed reductions under general anesthesia, 2 for lavage, 4 for lavage with spacer left in place and 5 for fixation of periprosthetic fractures.

3.2. Mortality

During the first year post-fracture, 54 patients died (6%): 10 patients (18%) in the first 15 days, 16 patients (31%) in the first month and 41 patients (76%) in the first 6 months. Substantially more early deaths occurred in men than in women (12.5% vs. 5.4%). The 5-year mortality rate was 21% (34.5% in men and 20.4% in women). When the fracture occurred in patients less than 75 years of age, the 1-year mortality rate was 4% and the 5-year rate was 10%. After 75 years of age, the mortality rate was 7% and 23%, respectively. At the latest follow-up (19 years), it was 58% (Fig. 2).

At 19 years (latest follow-up in our study), 67% of men had died vs. 51% of women ($p = 0.041$). The men also died more quickly than the women (3.6 years vs. 9.5 years; $p = 0.0007$). Of the 60% of patients with an ASA score of 1–2, their mean age was 80 years, while the 40% with an ASA score of 3–4 had a mean age of 78 years. In the patients with an ASA 1–2, none died within 1 year, while 8.8% of those with an ASA 3–4 died. This difference was still present in the following years: 18% vs. 27% at 5 years, and 34% vs. 58% at 10 years (Fig. 3). Mortality was significantly correlated with age > 75 years ($p < 0.0005$) (Fig. 4), > 80 years ($p < 0.001$), ASA 3 or 4 ($p < 0.004$) and presence of cognitive disorders ($p < 0.0001$). There was no statically significant relationship between mortality and time to surgery ($p = 0.081$), associated fractures ($p = 0.558$), dominant side ($p = 0.246$), type of fracture ($p = 0.245$), fracture displacement ($p < 0.25$) or discharge destination ($p = 0.573$).

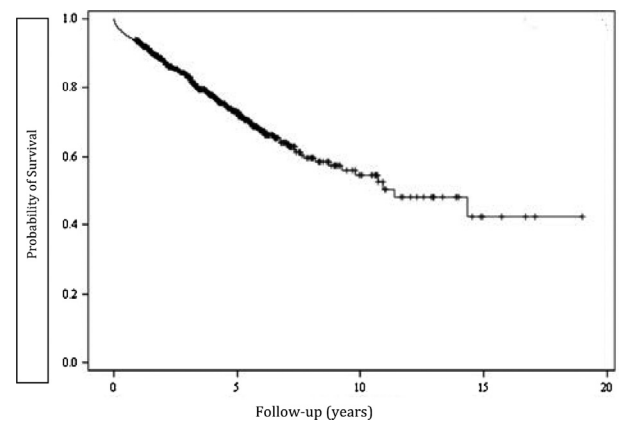


Fig. 2. Survival curve for the entire study cohort.

The time to surgery, type of fracture, associated fractures, and discharge destination had no effect on postoperative mortality in this cohort.

4. Discussion

Although RSA is becoming the preferred treatment for displaced proximal humerus fractures in older adults and the socioeconomic impact of this type of surgery is high, there is little information about the epidemiology of this population and their survival post-fracture. Our study found that proximal humerus fractures treated by RSA mainly occur in females, with a mean age of 80 years at the time of the fracture. This female predominance (5 × more than men) has also been reported for femoral neck fractures, but to a lesser extent [17,22–24].

In 66% of cases, the patients have comorbidities, namely cardiovascular and neurological. In 18% of patients, another injury occurred at the same time as the fracture. Surprisingly, there was an inverse relationship between comorbidities and age in our cohort, with the patients who had a higher ASA score (3–4) being younger (78 years) than those who had a lower ASA score (1–2). The high proportion of obese patients (21%) suggests there may be a link between this comorbidity and the occurrence of a proximal humerus fracture. This is partly explained by the fact that the men,

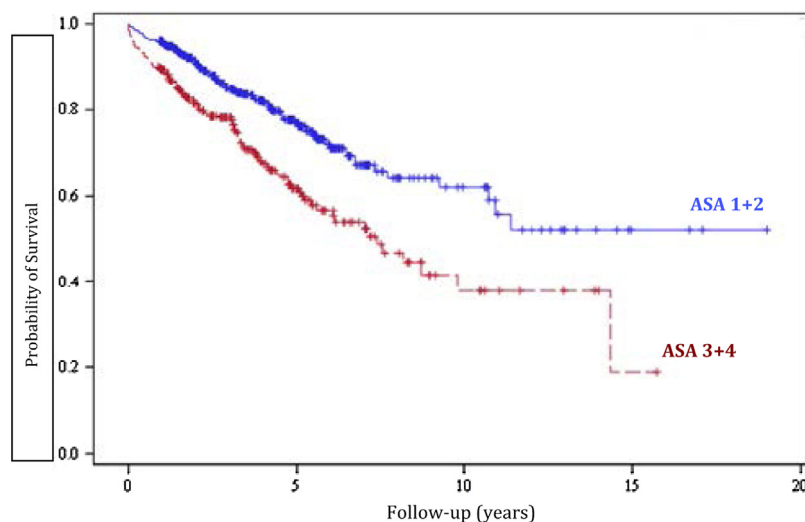


Fig. 3. Survival curves by ASA score (1–2 and 3–4).

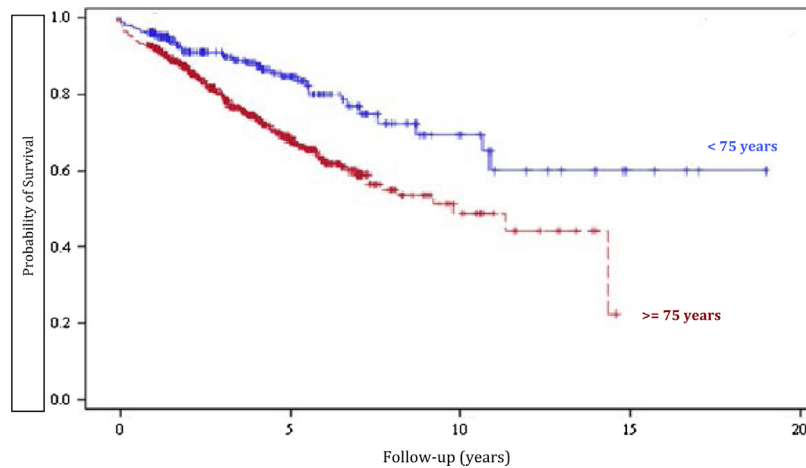


Fig. 4. Survival curves for the two age groups (<75 and ≥75).

Table 1
Survivorship for femoral neck fractures treated by arthroplasty.

Time References	6 months	1 year	2 years	3 years	5 years	10 years
2017 SOFOT Symposium (Hemi + THA)	95.5	94	88	83	73	55
Boukebous et al. [25] (Hemi + THA)		85				
Duriez et al. [26] (THA dual mobility)	75					
Svenoy et al. [27] (Hemi)		81				
Wang et al. [28] (Hemi + THA)			69			
Maceroli et al. [29] (Hemi + THA)		82.2				
Tol et al. [30] (Hemi + THA)		86.1			38.3	
Nich et al. [31] (THA dual mobility)		81	65.5			
Burgers et al. [32] (Hemi + THA)		87				

Hemi: hemiarthroplasty; THA: total hip arthroplasty.

who were younger than the women, had more comorbidities, thus a higher mortality rate in the first year post-fracture (12.5% vs. 5.4%).

The survivorship of patients who undergo RSA because of a displaced proximal humerus fracture was high: 94% at 1 year. Five years after the RSA surgery, 73% were still alive (Fig. 2) and 42% were still alive at the latest follow-up (19 years) in our study. Hence, the survival is much better than after femoral neck fractures treated by hip arthroplasty (80% at 1 year, etc.) [25–32] (Table 1). After 75 years of age, the mortality rate is 7% at 1 year for proximal humerus fracture vs. more than 30% for femoral neck fracture. A recent epidemiology study on femoral neck fractures found that only 43% were still alive 4 years after surgical treatment, in a population of comparable age (80.8 years) [24]. While these results are good, it is important to keep in mind that humeral fracture patients are less likely to suffer complications of being bed-ridden, which is a major contributor to mortality, than patients who suffer a femoral neck fracture.

While the survival rate is better for proximal humerus fractures, 18% of deaths occur during the first 2 weeks postoperative. Like in femoral neck fractures, sex, age and comorbidities are risk factors for early mortality after surgical treatment [33–35]. The mortality rate is higher in men [12] and the time to death after the fracture is shorter. This trend was also found for femoral neck fractures [29,34,36]. However, the time to surgery does not affect the survival after proximal humerus fracture [17,37–39]. Nevertheless, given the lack of control group and similar epidemiology data, we cannot use our study's findings to state that there is an increased risk of mortality in this population relative to the general population or patients who are treated conservatively.

The revision rate was particularly low, only 5% (43/898), with only half requiring a full implant change. But this result must be interpreted cautiously as the older patients in this cohort may

not have had the opportunity to use their limb enough to induce implant wear. However, the high survival rate means that we cannot claim that patients would die before a potential mechanical complication occurs. A large study focused on the revision rate of RSA performed for various indications found a higher revision rate (10.2%) [40].

Our study also found that comorbidities (ASA 3–4) and/or cognitive disorders were risk factors for early mortality during the first year postoperative. However, we found no impact of time to surgery, presence of other fractures and discharge destination (return home or transfer to nursing home) on the early mortality rate.

Disclosure of interest

Christophe Chantelot: consultant for Evolutis.
Philippe Clavert: consultant for Tornier/Wright.
Pascal Boileau: consultant for Tornier/Wright, and also Smith & Nephew, Conmed not related to this study.
The other authors declare that they have no competing interest.

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Contribution

Emmanuel Maugendre: study design, writing and editing article.
Benjamin Gadisseux: writing and editing article.
Christophe Chantelot: study design, writing and editing article.
Philippe Clavert: writing and editing article.
Nassima Ramdane: statistical analysis.

Jean-David Werthel: writing and editing article.
 Pascal Boileau: study design, writing and editing article.

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