

ORIGINAL PAPER

[Translated article] Gender and diabetes mellitus do not influence the outcomes of patients with proximal humeral fractures treated with a reverse shoulder arthroplasty



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Abstract

Background and objective: Some studies have described that gender and the diabetes mellitus may impact the outcomes of reverse shoulder arthroplasty (RSA). The objective of this study was to compare the functional outcomes and survival of RSA based on the patient's gender and the presence or absence of diabetes mellitus as independent variables.

Materials and methods: This retrospective study included all patients who underwent RSA for acute proximal humeral fracture with a minimum follow-up of 2 years. Two independent stratifications were conducted to assess the influence of female gender and diabetes on RSA outcomes. The primary outcome variable was the Constant score. Additionally, the QuickDASH and UCLA functional scales were evaluated, as well as estimated survival using the Kaplan–Meier method.

Results: The final sample comprised 131 patients. The final Constant scores were 47.0 in women and 51.8 in men ($p = .198$), and 48.4 in diabetics and 45.3 in non-diabetics ($p = .347$). There were also no significant differences in the secondary functional scales. The estimated 12-year survival rate was 94.4% in women and 94.7% in men ($p = .543$), and 80.2% in diabetics and 97.8% in non-diabetics ($p = .141$).

Conclusions: In acute proximal humeral fractures treated with RSA, neither female gender nor the presence of diabetes had an impact on functional outcomes at 2 years postoperative follow-up.

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PALABRAS CLAVE

Hombro;
Prótesis;
Mujeres;
Diabetes;
Resultados;
Supervivencia

El género y la diabetes mellitus no influyen en los resultados de los pacientes con fractura de húmero proximal tratados mediante prótesis inversa de hombro

Resumen

Antecedentes y objetivo: Algunos estudios han descrito que el género y la diabetes mellitus pueden influir en los resultados de la prótesis inversa de hombro (PIH). El objetivo fue comparar los resultados funcionales y la supervivencia de la PIH según el género del paciente y la presencia o no de diabetes mellitus, como variables independientes.

Materiales y métodos: Estudio retrospectivo incluyendo todos los pacientes intervenidos mediante PIH por fractura aguda de húmero proximal con seguimiento mínimo de 2 años. Se realizaron 2 estratificaciones independientes para examinar la influencia del género femenino y la diabetes en los resultados de la PIH. La variable principal de resultado fue la puntuación en la escala de Constant. Además, se evaluaron las escalas funcionales QuickDASH y UCLA, así como la supervivencia estimada con el método de Kaplan-Meier.

Resultados: La muestra final estuvo constituida por 131 pacientes. Las puntuaciones finales de Constant fueron de 47,0 en las mujeres y de 51,8 en los varones ($p=0,198$), y de 48,4 en los diabéticos y de 45,3 en los no diabéticos ($p=0,347$). Tampoco hubo diferencias significativas en las escalas funcionales secundarias. La supervivencia estimada a 12 años fue del 94,4% en las mujeres y del 94,7 en los varones ($p=0,543$), y del 80,2% en los diabéticos y del 97,8% en los no diabéticos ($p=0,141$).

Conclusiones: En las fracturas agudas de húmero proximal tratadas mediante PIH el género femenino o la presencia de diabetes no influyeron en los resultados funcionales a los 2 años de seguimiento postoperatorio.

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Introduction

Previous studies have reported mixed results for patients undergoing total hip and knee arthroplasty, depending on gender.^{1–3} Although limited, the current literature suggests that gender may also influence the outcomes of patients undergoing shoulder arthroplasty, with worse outcomes observed in women than in men.^{4–8} Furthermore, some authors have found that diabetes mellitus is an independent predictor of increased postoperative complications in patients undergoing hip, knee, and shoulder arthroplasty.⁹ Although diabetes has been associated with higher perioperative morbidity and mortality, as well as poorer functional outcomes after total hip and knee arthroplasty,^{10,11} there are few data available on its influence on the outcomes of reverse shoulder arthroplasty (RSA).¹²

Thus, the current literature on the impact of these variables on patient outcomes following RSA remains limited and contradictory. Furthermore, most previous research has focused on elective surgeries^{4,5,8,12–14} or other types of shoulder arthroplasty,^{6,7,15} without analysing the influence that these variables may have on long-term implant survival.

This study aimed to compare the results of RSA according to patient gender and the presence or absence of diabetes mellitus as independent variables. It was hypothesised that female patients and patients with diabetes who underwent RSA for proximal humerus fractures would have similar functional outcomes and long-term implant survival compared to male patients and non-diabetic patients.

Material and method

Retrospective study including all patients who underwent RSA for acute proximal humerus fracture at the shoulder unit of our hospital between 2010 and 2022. The study was approved by our department's clinical research ethics committee (PI2024-013). As this study involved a review of medical records and required no additional clinical reviews beyond the usual care system, informed consent from the patients was not necessary. At all times, individuals' right to privacy was fully respected, noting that personal and clinical data were completely anonymised.

Patients over 50 years of age who had suffered an acute proximal humerus fracture and were treated with primary RSA were included in the study. A minimum postoperative follow-up of 2 years was required. Patients with simultaneous fractures to the upper limbs were excluded from the study in order to generate comparable groups and exclude reasons that could significantly influence the results.

Two independent stratifications were performed for the comparative analysis. To examine the influence of female gender on RSA outcomes, the series was divided between women and men. Next, to study the influence of diabetes mellitus on RSA outcomes, the series was divided between diabetic and non-diabetic patients.

Surgical procedure

All operations were performed by two orthopaedic surgeons from the shoulder unit with extensive experience in pros-

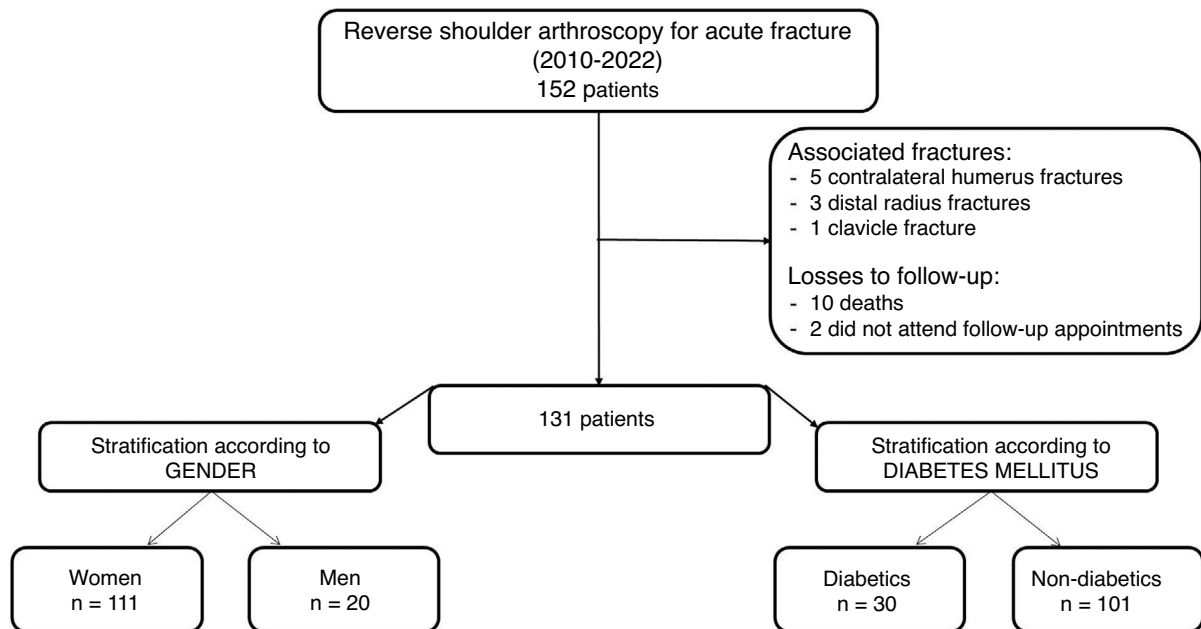


Figure 1 Flow chart of study patients.

thetic surgery. The same standardised procedure was used for all patients, involving fixation of the tuberosities using high-strength sutures and tenodesis of the long head of the biceps brachii. All patients received an RSA implant with a standard uncemented humeral stem (Lima Corporate, Italy). All patients received antibiotic and thromboembolic prophylaxis. As standard practice, continuous passive movement of the shoulder began on the first postoperative day under the supervision of a physiotherapist, with active movement permitted from the third week after surgery onwards.

Evaluation

All patients were systematically evaluated at 1, 3, 6, 12, and 24 months after surgery. At our centre, data are routinely collected at each follow-up visit and included in a shoulder arthroplasty registry. Therefore, this study is based on a review of prospectively collected data, including the Constant, QuickDASH, and UCLA scales.

The primary outcome variable was the Constant score. Functionality was also assessed using the QuickDASH and UCLA questionnaires, while implant survival was evaluated as a secondary outcome measure. Rotations were measured according to the Constant scale score.¹⁶ Data collected at the two-year follow-up were used for statistical analysis. All reviews were performed by the surgeons who implanted the RSA. Demographic data (age, gender, body mass index [BMI], Charlson comorbidity index [CCI], and American Society of Anesthesiologists [ASA] group), surgery-related parameters (surgical delay, operating time, and length of hospital stay after RSA) and postoperative complications were also collected.

Statistical analysis

Statistical analysis was performed using SPSS version 25. The Kolmogorov–Smirnov test was used to assess the distribution

of continuous variables. The χ^2 test examined associations between qualitative variables and the Mann–Whitney *U* test compared means between independent samples. Kaplan–Meier survival curves with 95% confidence intervals were generated, with RSA revision surgery established as the endpoint. The log-rank test was then used to determine whether there were significant differences in survival times. In all analyses, a *p*-value of less than .05 was considered significant.

Results

A total of 152 patients who were treated between 2010 and 2022 and had undergone at least two years of postoperative follow-up were identified. However, 21 patients were excluded from the study. Therefore, the final study sample comprised 131 patients (Fig. 1). The baseline characteristics of each group are presented in Tables 1 and 2.

With regard to gender, women had a lower mean postoperative Constant scale score than men, though the differences were not significant. On the functional scales included as secondary outcome variables, the women also had worse scores than the men, although this did not reach statistical significance (Table 3). There were also no significant differences between the two groups with regard to RSA mobility (Table 3).

With regard to post-surgical complications, there were 7 (6.3%) in women and 2 (10.0%) in men (*p* = .626) (Table 4).

Regarding the diabetes variable, the diabetic patients had a lower mean postoperative Constant scale score than the non-diabetic patients, but this difference was not statistically significant. Secondary functional assessments revealed that the diabetic patients had lower scores than the non-diabetic patients, though this was not statistically significant except on the QuickDASH scale, where both groups obtained similar averages (Table 5). There were also

Table 1 Baseline data for groups according to patient gender.

Variable	Females (n = 111)	Males (n = 20)	p
Age (in years)	73.8 (6.1)	72.0 (7.9)	.265
BMI (kg/m ²)	29.8 (5.2)	29.2 (3.0)	.500
CCI (score)	3.9 (1.4)	4.0 (1.6)	.841
ASA (I–II/III–IV) (n)	70/41	14/6	.552
Surgical delay (in days)	4.3 (1.9)	5.4 (2.4)	.036
Operating time (in minutes)	98.9 (36.1)	102.0 (51.2)	.757
Hospital stay following surgery (in days)	3.5 (1.6)	3.3 (1.3)	.687
Diabetes mellitus (n)	25	5	.808

ASA: American Society of Anesthesiologists; BMI: body mass index; CCI: Charlson Comorbidity Index.

Table 2 Baseline data for the groups according to the presence or absence of diabetes.

Variable	No diabetes mellitus (n = 101)	Diabetes mellitus (n = 30)	p
Gender (female/male) (n)	86/15	25/5	.808
Age (in years)	73.8 (6.4)	72.8 (6.3)	.507
BMI (kg/m ²)	29.5 (4.8)	30.7 (5.5)	.272
CCI (score)	3.7 (1.4)	4.8 (1.4)	.002
ASA (I–II/III–IV) (n)	70/31	14/16	.023
Surgical delay (in days)	4.4 (2.1)	4.6 (1.9)	.759
Surgical time (in minutes)	96.7 (37.0)	109.7 (42.8)	.138
Hospital stay following surgery (in days)	3.4 (1.4)	3.7 (1.9)	.331

ASA: American Society of Anesthesiologists; BMI: body mass index; CCI: Charlson Comorbidity Index.

Table 3 Results of the groups according to patient gender.

Variable	Females	Males	p
Constant (score)	47.0 (16.4)	51.8 (16.7)	.198
Adjusted Constant (score)	67.7 (22.1)	70.0 (23.4)	.712
QuickDASH (score)	30.5 (14.0)	27.5 (13.4)	.350
UCLA (score)	21.9 (7.3)	23.4 (8.0)	.417
Abduction (°)	99.4 (30.9)	106.0 (30.0)	.389
Anterior flexion (°)	111.7 (32.8)	117.2 (37.9)	.478
External rotation ^a	4.7 (2.8)	4.4 (2.8)	.622
Internal rotation ^a	2.9 (1.6)	3.2 (1.3)	.347

^a Rotations were measured according to Constant scale score.
Data are presented as mean (standard deviation).

Table 4 Postoperative complications.

Complication	Time ^a	Age	Gender	Diabetes	Treatment
Periprosthetic fracture of humerus	7 years	73	Female	Yes	Stem change
Periprosthetic fracture of humerus	11 months	78	Male	Yes	Stem change
Periprosthetic fracture of glenoid	Intraoperative	79	Female	No	Conservative
Glenoid loosening	2 years	70	Female	No	Glenoid change
Radial nerve neuropraxia	Intraoperative	68	Female	No	Medical-rehabilitation
Radial nerve neuropraxia	Intraoperative	68	Female	No	Medical-rehabilitation
Axillary nerve neuropraxia	Intraoperative	60	Male	No	Medical-rehabilitation
Deep infection	8 months	76	Female	No	Surgical cleaning
Haematoma	6 days	74	Female	No	Surgical drain

^a Time between arthroplasty surgery and complication.

Table 5 Outcomes of the groups according to presence or otherwise of diabetes mellitus.

Variable	No diabetes mellitus	Diabetes mellitus	<i>p</i>
Constant (score)	48.4 (17.2)	45.3 (13.6)	.347
Adjusted Constant (score)	69.1 (23.1)	64.4 (19.0)	.269
QuickDASH (score)	30.1 (14.4)	30.0 (12.0)	.893
UCLA (score)	22.2 (7.6)	21.7 (6.7)	.637
Abduction (°)	102.1 (31.2)	94.8 (28.8)	.243
Anterior flexion (°)	114.2 (34.9)	107.1 (28.1)	.230
External rotation ^a	4.7 (2.8)	4.6 (2.8)	.858
Internal rotation ^a	3.1 (1.7)	2.6 (1.0)	.339

Data are presented as mean (standard deviation).

^a Rotations were measured according to Constant score.

no significant differences between the groups in terms of RSA mobility (Table 5).

There were only two complications in the diabetic patients that required secondary surgery, necessitating replacement of the humeral stem due to periprosthetic fractures of the humerus (Table 4).

Estimated survival at 12 years according to gender was 94.4% (95% CI: 87.0–100) in the women and 94.7% (95% CI: 85.0–100) in the men. No significant differences were observed between the groups ($p = .543$) (Fig. 2). Regarding diabetes, the estimated survival rate at 12 years was 80.2% (95% CI: 51.0–100) in the diabetic patients and 97.8% (95% CI: 95.0–100) in the non-diabetic patients. No significant differences were observed between the groups ($p = .141$) (Fig. 3).

Discussion

The main finding of this study was that the functional outcomes and long-term survival of the RSA after an acute proximal humerus fracture are not inferior in women or diabetic patients. These results are consistent with those obtained by some authors,^{14,15} although others did observe negative influences of female gender^{4,13} or diabetes¹² on functional outcomes after shoulder arthroplasty.

In their 3-year prospective study, Jawa et al.¹⁵ found similar American Shoulder and Elbow Surgeons (ASES) and 12-Item Short Form Survey (SF-12) scores between men and women. Similarly, Forlizzi et al.¹⁴ found no gender differences in their retrospective study of 388 patients with a minimum follow-up period of two years.

However, Wong et al.⁸ found that men achieved significantly higher scores than women on both the ASES questionnaires and the physical component of the SF-12. In a study of 660 patients with rotator cuff tear arthropathy treated with RSA, Friedman et al.⁴ found that female gender was an independent risk factor for poorer clinical outcomes after RSA. In their recent publication, Ahmed et al.¹³ evaluated the results of 230 patients with glenohumeral osteoarthritis and intact rotator cuffs who were treated with RSA. They determined that male gender was significantly associated with excellent results on the ASES questionnaire. More recently, Hochreiter et al.⁵ found that female gender was a predictive factor that negatively affected the final Constant score following RSA. However,

these differences did not reach the minimally clinically important difference, suggesting that the main reason for the poorer outcomes in female patients is a combination of a higher incidence of fractures and greater preoperative disability. Griffin et al.¹⁷ used a Nationwide Inpatient Sample to analyse 58,790 patients undergoing total shoulder arthroplasty or hemiarthroplasty. They found that female sex was a predictor of mortality after shoulder arthroplasty.

Some authors have argued that women undergo shoulder arthroplasty at a later age than men and may have higher levels of preoperative disability and different expectations before surgery,¹⁸ raising the question of whether the association between gender and postoperative outcome reflects a true cause-and-effect relationship or is simply a consequence of poorer preoperative scores.^{4,5,15,19}

With regard to postoperative complications, we found no significant differences between genders. However, some authors have found that women had a significantly higher number of both intraoperative and postoperative fractures,^{5,20} as well as a higher incidence of prosthetic component loosening.²⁰ Furthermore, others have also observed that women required a longer hospital stay following shoulder replacement surgery,^{7,21} and that this was an independent risk factor for postoperative transfusion.²²

Furthermore, in our study, diabetes mellitus was not associated with worse outcomes, in line with other studies.¹³ However, other authors found that this comorbidity had some influence on the outcomes of RSA. Recently, Tagliero et al.¹² found that diabetes increased the likelihood of reoperation after RSA in the treatment of bone consolidation defects following proximal humerus fractures. Duey et al.²³ concluded in their study of 113 patients from a national registry that diabetes increased the risk of reoperation and infection after shoulder arthroplasty, while McElvany et al.²⁴ found that patients with severe diabetes who underwent traumatic shoulder arthroplasty were more likely to be readmitted within 90 days. Similarly, Lung et al.²⁵ also observed that diabetic patients had a higher risk of readmission and non-routine discharge, while Ponce et al.²⁶ established that diabetes was independently associated with in-hospital mortality, perioperative complications, and prolonged hospital stay after shoulder arthroplasty. Some authors have argued that diabetic patients had lower self-perceived function and health status prior to surgery compared to non-diabetic patients, which may influence postoperative outcomes.²⁷

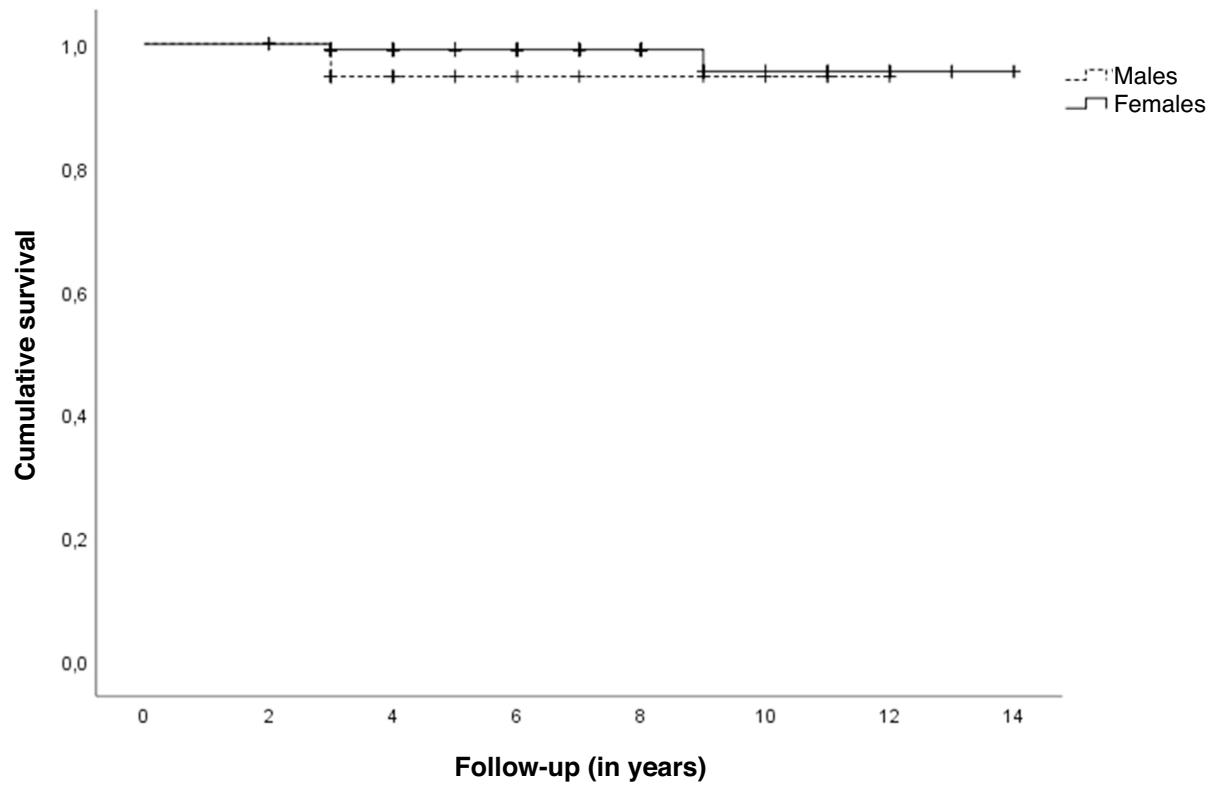


Figure 2 Estimated survival curves for RSA at 12 years, by gender.

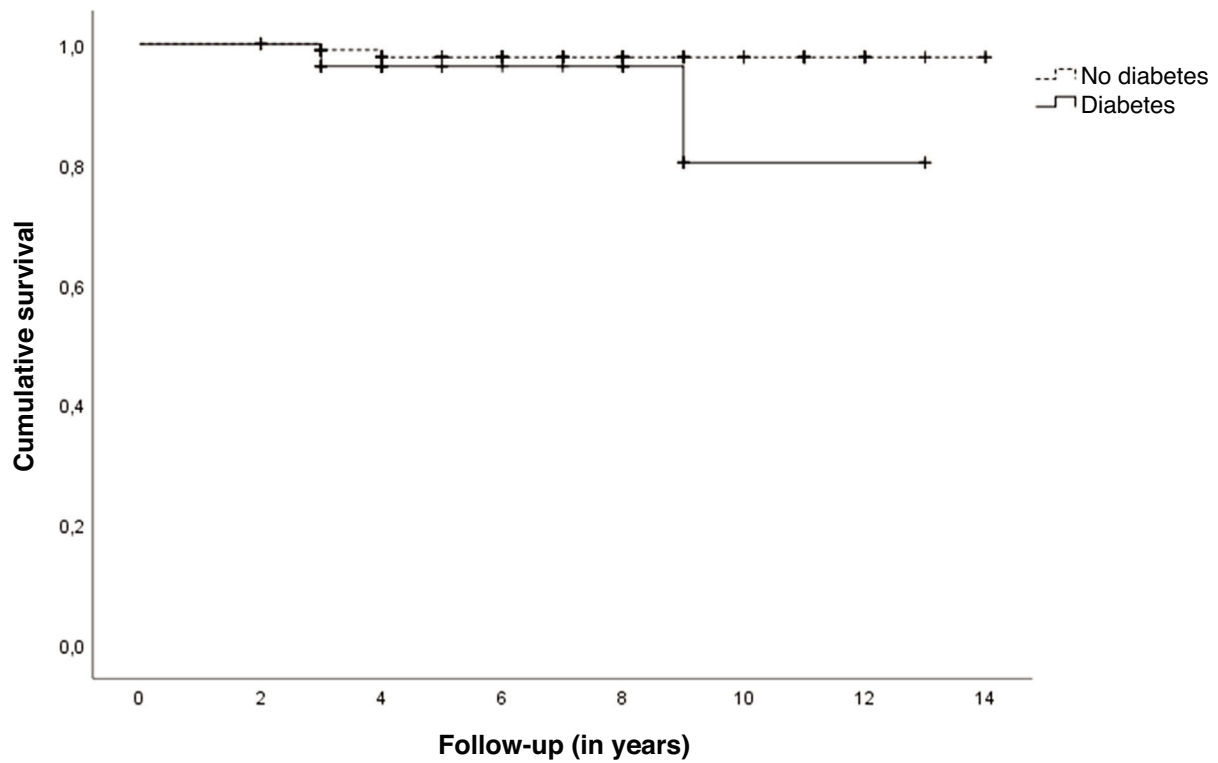


Figure 3 Estimated survival curves for RSA at 12 years, according to the presence or absence of diabetes mellitus.

In their study of 5918 cases of shoulder arthroplasty, Fu et al.²⁸ identified that diabetic patients were associated with multiple postoperative complications, higher blood transfusion rates, and prolonged hospital stays. However, only patients dependent on insulin were identified as a risk factor for these complications in the multivariate analysis.

Unlike other studies that analysed elective surgeries^{4,5,8,12–14} or other types of shoulder arthroplasty,^{6,7,15} our patient cohort is homogeneous, with the entire sample undergoing RSA for acute fracture. This may present challenges when performing a comparative analysis with other studies. Furthermore, studies usually do not include estimated implant survival curves beyond 10 years. However, this study has some limitations. Although the data were collected prospectively from those included in our centre's shoulder arthroplasty registry, it is a retrospective study. The sample size is smaller than that of previous studies. No radiological evaluation was performed, despite previous studies having already shown that certain radiological variables do not influence functional outcomes.²⁹ The groups are heterogeneous in terms of the number of cases in each subgroup, mainly due to gender and the significantly higher incidence of proximal humerus fractures in women.^{4,5,14,29}

Conclusion

In acute proximal humerus fractures treated with RSA, neither female gender nor the presence of diabetes influenced the range of motion or functional outcomes at 2 years postoperative follow-up, nor did they influence estimated survival of the shoulder arthroscopy at 12 years.

Therefore, despite contradictory results in the literature, we believe that the results of this study enable us to provide an accurate functional prognosis and manage patient expectations for this procedure, regardless of gender or diabetes status.

Level of evidence

Level of evidence: III.

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Conflict of interest

The authors have no conflict of interest to declare.

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