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Primary reverse total shoulder arthroplasty in patients older than 80 years: clinical and radiologic outcome measures

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Background: The use of reverse total shoulder arthroplasty (RTSA) has spread worldwide as a result of an expansion of indications and an aging society. However, the value of RTSA for very old patients is rarely analyzed. This study was conducted to investigate the outcome of primary RTSA in patients older than 80 years.

Methods: We identified 171 shoulders (159 patients) treated with RTSA at an age of more than 80 years between January 2005 and March 2018. The primary outcome parameters were Subjective Shoulder Value (SSV) and the Constant-Murley score, mortality, complications, and reoperation rates. Secondary outcomes were adverse radiographic outcomes. A minimum follow-up of 1 year was accepted in 14 patients (8%) because of these patients' older age.

Results: We included 171 cases (159 patients; 120 female) with a mean age of 84 ± 3 years (range 80.1-94). The main indication for RTSA was cuff tear arthropathy (43%), isolated rotator cuff tear (22%), and fracture (21%). A total of 136 patients (79%) were eligible for physical examination with a mean follow-up of 41 ± 25 months (12-121). Relative Constant-Murley scores improved significantly from 39% ± 19% to 77% ± 16% and SSV from 31% ± 18% to 74% ± 22%. The range of motion and force improved significantly as well. The surgical site complication rate was 30%, with a reoperation rate of 8% (13 patients) mainly due to fracture and glenoid loosening. The overall mortality was 16% with a mean time to death of 53 ± 31 months (95% confidence interval 15, 120), thereby no higher than the age-adjusted, expected mortality rate without this procedure.

Conclusion: Despite a quite high postoperative complication rate, RTSA is a valid therapeutic option in patients older than 80 years, with an unexpectedly low medical complication rate and good to excellent improvement of shoulder function and pain.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Shoulder; arthroplasty; reverse total shoulder arthroplasty; aging society; Constant Score; functional outcome evaluation

Reverse total shoulder arthroplasty (RTSA) implantation rates continue to grow worldwide due to an extension of the indications as well as an aging society.[7,16,20,24,27] The original Grammont prosthesis was used for rotator cuff arthropathy associated with pseudoparalysis of elevation.[12] Since then, reliable clinical results have expanded the range of indications. Nowadays, RTSA is used for rheumatoid arthritis, osteoarthritis especially with B and C glenoids,[2,30] massive rotator cuff tears, primary treatment of proximal humeral fractures, as well as an elegant salvage option for failed open reduction and internal fixation (ORIF) of shoulder fractures or shoulder prostheses.[10]

The Cantonal Ethics Committee Zürich approved this study (no. 2018-01494).

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Another aspect of the rising number of implantations might be an aging society with a mean life expectancy higher than 80 years in Western countries.[15,18] Anatomic shoulder arthroplasty has yielded promising results in elderly patients,[9] with a complication rate comparable to that in younger patients.[8,23]

The outcome of RTSA in patients older than 80 years is underreported, with only a few studies in the current literature.[5,19,29] Recently, Clark et al[5] published a series of 179 patients, 81 of them personally followed up after primary RTSA mainly for cuff tear arthropathy (80%) and osteoarthritis (8%), and found satisfactory improvement in clinical outcomes and an acceptable surgical complication rate of 12%. The main complications were acromial fracture in 4%, delayed wound healing in 3%, and heterotopic ossification in 1.7%. Mangano et al[19] and Triplet et al[29], studying 2 cohorts smaller than 33 patients with a follow-up between 24 and 87 months, reported promising improvement in clinical outcomes and a surgical nonsystemic complication rate of 10% and 15%, respectively. These complication rates resulted in very low reoperation rates between 0 and 2%.[17-19] Clark et al[5] described an overall mortality of 19% in the median time to death of 67.7 months in the study population. The data are promising and lend support to RTSA for elderly patients. Nevertheless, the overall reported patient numbers are small, and further research is justified.

Therefore, this study aimed to evaluate the complication rate and subjective and objective outcomes of RTSA in patients older than 80 years in a comprehensive patient cohort. We hypothesized that RTSA is a treatment that (1) reliably improves function and pain and (2) has a low overall risk for surgical site complications or major medical complications (measured as death, pulmonary embolism, deep vein thrombosis, acute coronary syndrome, renal failure, stroke) and a low revision rate.

Materials and methods

Patient selection

Our institutional RTSA database documents 1172 consecutive RTSA procedures between January 2005 and March 2018. Of these, 186 surgeries were performed in patients older than 80 years. To be included in the study, patients had to be older than 80 years, the operation had to be a primary RTSA, and a complete clinical and radiographic follow-up as well as informed consent to participate in the study had to be available. All revision arthroplasties were excluded. Of the 186 cases, 15 were revision arthroplasties, leaving 171 cases for this study (Fig. 1).

Clinical and radiologic examination

All patients underwent a standardized clinical and conventional radiographic examination by an examiner different from the operating surgeon sequentially at each regular consultation. The clinical examination included assessment of the Subjective Shoulder Value (SSV)[11] and functional[21] scoring according to Constant-Murley[6,11] including measurement of abduction strength with a validated dynamometer.

Mortality, complications, and revision surgery

The overall mortality was evaluated. As major medical complications, we included stroke, acute coronary syndrome, pulmonary embolism, pneumonia, renal failure, and deep vein thrombosis. All revision surgeries were recorded.

Surgical technique

The surgeries were performed by 11 different, fellowship-trained staff shoulder surgeons in a specialized academic unit. The operations were done in a standardized manner. Antibiotic prophylaxis with cefuroxim 1.5 g (Fresenius Kabi, Kriens, Switzerland) was administered intravenously 30 minutes before skin incision. The patient was placed in a beach chair position. For patient-controlled pain control, an interscalene catheter with ropivacaine (Sintetica, Switzerland) was installed preoperatively and withdrawn 2 days postoperatively in most patients.[3,4] The surgery was done using additional general anesthesia in 116 cases and under regional anesthesia and sedation alone in 55 cases. Disinfection with Betaseptic (Mundipharma Medical Company, Basel, Switzerland) and draping was done with 3 rectangular drapes, 2 U-shaped drapes, and an adhesive incisional drape (Ioban, 3M, Saint Paul, MN, USA) in all the patients. A deltopectoral approach was used in 166 cases, leaving the cephalic vein laterally. The other 5 patients were operated with a superolateral, deltoid-splitting approach. The humeral head was resected, and the stem was inserted in 0°-20° of retroversion. Additional cementation was decided on intraoperatively, depending on bone quality and press-fit stem fixation. The glenoid was reamed to create a flat surface. Subchondral bone was only removed if it prevented stable positioning of the prosthetic component with the baseplate flush with the inferior glenoid rim. The baseplate was implanted with a neutral version and neutral to slight inferior inclination not exceeding 10°. All patients received a Zimmer Anatomical/Reverse RTSA with a standard or fracture shaft. If possible, a transosseous subscapularis refixation using No. 2 FiberWire (Arthrex, Naples, FL, USA) was carried out. Aftercare consisted of wearing a sling for 6 weeks allowing passive mobilization and minimal active use of the arm. Active range of motion exercises were carried out without weight through weeks 7-12.

Data collection, statistical analyses, and literature review

The patient's data were collected in REDCap Electronic Data Capture system version 8.6.1 (Vanderbilt University, Nashville, TN, USA) anonymously.[14]

All statistical analyses were performed with SPSS software, version 24.0 (IBM, Armonk, NY, USA). The normal distribution of variables was tested with the Shapiro-Wilk test and compared pre- and postoperative scores with the paired *t* test (parametric data) or the Wilcoxon rank-sum test (nonparametric distribution). Fisher exact test was used for categorical variables. A *P* value of

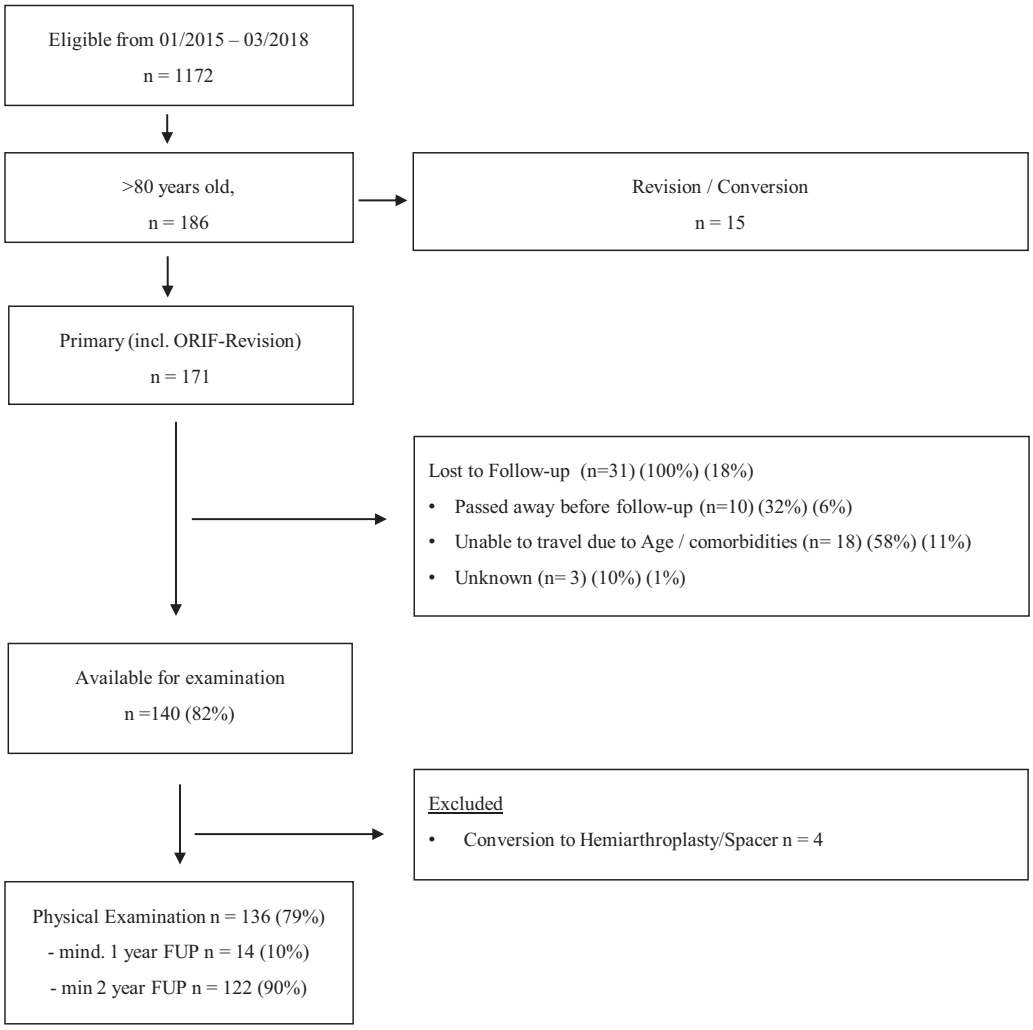

Figure 1 Flowchart demonstrating patient selection. *FUP*, follow-up period; *ORIF*, open reduction and internal fixation.

less than .05 was considered significant. Because of the given population of patients older than 80 years, no power analysis was carried out.

Results

Patients and demographics

One hundred fifty-nine patients with a total of 171 shoulders were included. The mean age at surgery was 84 ± 3 years (80.1-94) for the 39 men (25%) and 120 women (75%); the dominant side was affected in 61% of the cases. The mean body mass index was 25.9 ± 4. The most common ASA classification was grade II in 83 cases (49%) and grade III in 82 cases (48%), followed by 5 cases (3%) grade I and 1 (1%) case grade IV. The underlying pathology was cuff tear arthropathy in 74 cases (43%), massive rotator cuff tear in 38 cases (22%), osteoarthritis in 21 cases (12%), primary fracture treatment in 23 cases (13%), conversion from fracture treatment with ORIF in 13 cases (8%) and 2 cases (1%) of shoulder instability. The humeral stem was cemented in 54% of the cases (92 shoulders). Of the identified 171 shoulders (159 patients), 31 (18%) (30 patients) were not available for further clinical examination. Ten patients (6%) passed away before regular follow-up; none of these deaths could be related to the implantation of the prosthesis. Eighteen patients (11%) were unable to travel for further examination because of high age or poor health, 3 patients (1%) could not be contacted. This left a total of 140 cases. Four of these were excluded for further analysis because of glenoid component dislocation with massive bone loss. They were revised to hemiarthroplasty in 3 cases and persistent implantation of a spacer in 1 case.

A total of 136 cases (79%) were followed up clinically and radiologically. Fourteen (10%) had a minimum follow-up of 1 year and 122 (90%) of at least 2 years. The mean

follow-up was 41 ± 25 (minimum 12, maximum 121) months.

Mortality

Of the 159 patients older than 80 years who received an RTSA, a total of 26 patients (16%) in 30 cases (18%) died during the follow-up period. They passed away at a mean time of 53 ± 31 months (95% confidence interval 15, 120), all unrelated to the implant surgery. The earliest post-surgical death occurred at 15 months postoperatively.

Complications and revisions

During the hospitalization, no major medical complications occurred. There were 3 patients with treatment-requiring dyspnea. In 2 cases, the dyspnea was explained by the regional anesthesia that involved the diaphragm. Pulmonary embolism was ruled out in these 2 cases but confirmed in the third. There were 2 cases of acute decompensation of chronic heart failure, which could be treated conservatively. No patient died within the first 15 months postoperatively. No other major complications were reported to us in the postoperative period.

A total of 30 (18%) local complications occurred, requiring reoperation in 13 cases (8%). These were periprosthetic fractures of the humeral stem in 6 cases (4%), fractures of the acromion in 5 cases (3%), and the scapular spine in 3 cases (2%). All fractures occurred postoperatively, and 38% were related to a fall. Five of the 6 stem fractures were treated operatively; all acromion and scapular spine fractures were treated conservatively. There were 9 cases (5%) of glenoid loosening potentially related to a fall. Four of them with complete displacement (2 following a definite fall) underwent revision surgery. Overall, there were 4 periprosthetic infections (2%), of which 2 needed multiple revisions surgeries. The other 2 were treated with antibiotics without revision surgery. In 2 cases, a transient neurologic lesion of the radial or axillar nerve was recorded. There were 2 postoperative hematomas; 1 was treated surgically. Another patient underwent débridement for painful scarring.

Clinical and radiographic follow-up

A total of 136 cases were followed up for this study: the Constant-Murley scores as well as SSVs ($P < .01$) significantly improved over the preoperative state. The mean pain score was reduced from 6 ± 4 points preoperatively to 14 ± 2 Constant-Murley score points, where 15 points are defined as no pain and 0 points as the worst imaginable pain[21] ($P < .01$). The mean active anterior elevation improved from 64° ± 41° to 109° ± 29°, the mean active abduction from 62° ± 37° to 113° ± 34°, and the mean internal rotation from 4 ± 2 to 5 ± 3 (Constant-Murley score rating). External rotation did not change significantly. The mean strength improved significantly from 0 ± 1 kg preoperatively to a low 2 ± 2 kg. Overall, 76% of the patients rated their outcome as good or very good. The Constant-Murley scores and SSVs categorized by indication are shown in Table I.

A subgroup analysis between primary fracture treatment and revision following ORIF showed significantly superior results for primary fracture treatment. The comparison of primary fracture arthroplasty vs. ORIF revisions were 62 ± 15 vs. 48 ± 15 ($P = .026$), 78% + 17% vs. 64% ± 18% ($P = .035$), and 79% ± 18% vs. 58% ± 21% ($P = .009$) for the Absolute Constant Score, Relative Constant Score, and SSV.

In the follow-up period, 69 cases (40%) of notching and 31 cases (18%) of heterotopic ossifications were recorded. A subgroup analysis for notching and heterotopic ossifications revealed no statistically significant difference in the Constant-Murley score or SSV.

Discussion

The use of reverse total shoulder replacement is increasing worldwide because of an expansion of indications and the aging of society.[16,24,32] In the United States, RTSA surpassed the use of aTSA already in the year 2014—increasing by 75% from 2011 through 2014.[21] In addition, the continuously aging society will challenge the health care systems substantially. The elderly candidate for a total joint replacement may have more medical and surgical complications, a longer hospital stay, higher mortality, and probably higher morbidity because of complicating conditions such as diabetes or peripheral vascular disease and the high risk of low-energy injury during recovery.[13,22,28,31] Therefore, the benefit of joint replacement surgery has to be documented, and relevant predictors for poor clinical outcomes have to be identified. The literature concerning RTSA in patients older than 80 years contains only a few studies with mostly small cohorts.[1]

This study presents an analysis of the results in 136 shoulders of 127 octogenarians receiving a primary RTSA. The overall outcome was good or excellent in 76% of the patients, with a significant improvement in the Constant-Murley score and SSV. According to Simovitch et al,[26] the minimal clinically important difference for the Constant-Murley score was reached by 95% of the patients. The procedure did not increase the mortality over age-adjusted, expected mortality of an overall population.[25] Morbidity was unexpectedly low in these patients uniformly treated with the assistance of regional anesthesia. Pain was well controlled, and activities of daily living requiring the assistance of the arm were significantly improved.

Overall, the SSV and the results of the functional scores essentially and often at least doubled in each of the indications studied except for instability: instability patients had the highest preoperative scores, obtained a smaller gain

Table I Diagnosis and pre- and postoperative scores of the 136 patients available for personal follow-up

	CMS, points						CMS %						SSV %						Follow-up period, mo		
	Preoperative			Follow-up			Preoperative			Follow-up			Preoperative			Follow-up					
	n	Mean ± SD	95% CI	n	Mean ± SD	95% CI	n	Mean ± SD	95% CI	n	Mean ± SD	95% CI	n	Mean ± SD	95% CI	n	Mean ± SD	95% CI	n	Mean ± SD	Min, max
CTA	56	28 ± 14	25, 32	58	58 ± 14	54, 61	56	40 ± 18	35, 44	58	75 ± 16	70, 79	54	30 ± 20	24, 35	55	68 ± 24	61, 74	58	39 ± 21	12, 85
MRCT	27	35 ± 13	30, 40	29	64 ± 13	59, 69	27	47 ± 18	40, 54	29	81 ± 14	76, 87	25	39 ± 15	32, 45	27	83 ± 15	77, 89	29	41 ± 28	12, 121
OA	19	27 ± 12	21, 33	19	66 ± 13	60, 72	19	38 ± 16	31, 46	19	84 ± 15	76, 91	18	31 ± 14	24, 38	19	86 ± 16	77, 94	19	39 ± 21	12, 84
Acute Fx	3	7 ± 8	0, 26	16	62 ± 15	54, 69	3	7 ± 8	0, 26	16	78 ± 17	69, 87	3	10 ± 17	0, 53	16	79 ± 18	69, 89	16	38 ± 2	12, 84
Revision ORIF	12	21 ± 12	13, 28	12	48 ± 15	38, 57	12	29 ± 16	19, 39	12	64 ± 18	53, 75	12	24 ± 12	16, 31	12	58 ± 21	44, 71	12	67 ± 32	24, 120
Instability	2	43 ± 27	NA*	2	60 ± 27	NA*	2	52 ± 40	NA*	2	78 ± 30	NA*	2	40 ± 42	NA*	2	71 ± 29	NA*	2	42 ± 26	24, 61
Overall	119	29 ± 14	26, 31	136	59 ± 14	57, 62	119	39 ± 19	36, 43	136	77 ± 16	74, 80	114	31 ± 18	28, 34	130	74 ± 22	70, 78	136	41 ± 25	12, 121

CTA, cuff tear arthropathy; *MRCT*, massive rotator cuff tear; *OA*, osteoarthritis; *Fx*, fracture; *ORIF*, open reduction and internal fixation; *CMS*, Constant-Murley score; *SD*, standard deviation; *CI*, confidence interval; *SSV*, Subjective Shoulder Value.

* Not available because of a small number of patients.

but essentially an outcome of three-quarters of a normal shoulder. In contrast, the final absolute outcome, however, was inferior in revisions of ORIF than in any other indication studied. Although this was not the scope of this study, as the results of primary RTSA for acute fractures were much better than those of revisions of ORIF, an attempt at ORIF may need to be only very carefully be considered in this age group. On the other hand, if ORIF has failed, a revision to RTSA is well worthwhile as the gain in each score is approximately the same as in any other indication.

These findings are corroborated by reports on smaller cohorts that in addition have a much lower follow-up rate. Based on 179 octogenarians of whom unfortunately only 81 (45%) could be followed up for a mean of 27.4 months, Clark et al[5] reported good improvement on strength and range of motion. Triplet et al[29] showed good clinical results in 18 patients with TSA and 33 patients with RTSA at an age older than 80 years. Mangano et al's[19] data on 27 of 52 elderly patients (reexamination rate of 51%), showed a satisfying quality of life as measured by the 12-Item Short Form Health Survey and scored well on the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form.[5,19,29]

This study documents that RTSA performed under regional or combined regional anesthesia in such patients is associated with no increase in mortality and has a low morbidity. This may be due to good patient selection among others reflected by 97% of the patients having ASA II and III scores. The role of regional anesthesia or experienced treatment teams cannot be quantified in this study, because there was no alternative treatment protocol. Despite the low general health risk of the procedure and the good clinical outcome testified by a high satisfaction rate of the patients, the postoperative local complication rate was 18% and the reoperation rate was 8%. This is high but compatible with the literature.[1] Clark et al[5] had in their study 12% surgical and 3% major medical complications and need of reoperation in 1.7% (2 dislocations, 1 glenoid loosening). Triplet et al[29] described a rate of 15% surgical complications but no reoperation. Mangano et al[19] reported 3 surgical complications but only 1 reoperation following an iatrogenic shaft fracture.[18] Koh investigated the 30-day complication rate of RTSA vs. anatomic shoulder arthroplasty (82.9%) or hemiarthroplasty (17.1%) in 11,450 patients and found significant differences in complication rates with 15.3% for "very old" (>80 years, 1708 shoulders), 8.2% for "elderly" (65-79 years, 6073 shoulders), and 6.8% for "young" (<65 years, 3669 shoulders) patients.[17] A major factor in the development of short- and long-term complications can be the increased tendency of elderly patients to fall in combination with poor bone quality. We detected 9 cases (5%) of glenoid loosening, and 2

definitively related to a fall. Furthermore, 38% of the fractures of the humeral stem, the acromion, and the scapula spine were related to a fall.

Our study has limitations. First is the lack of personal follow-up in 18% of the cases. Given the patients' age, the authors believe that this rate is acceptable. Thirty-two percent (10 shoulders) in the lost-to-follow-up group passed away and 58% (18 shoulders) were unable to travel to our institution for follow-up because of very high age and comorbidities. For all except 1 of those 31 cases, telephone calls could exclude major complications. Another obvious limitation is the minimum follow-up of 1 year in 8% of the examined cases. This was knowingly accepted given the patients' high age and the generally limited data available on this topic. Furthermore, this study was a retrospective case series; nevertheless, the follow-up and data assessment of the patients occurred on a regular and prospective basis with a standardized follow-up after 2-4 years postoperatively.

Despite these limitations, this represents the largest cohort of octogenarians with an RTSA and systematic follow-up. Our study shows that improvement of pain and functional status of the upper limb can be dramatically improved with RTSA without inappropriate risk to the general health of these patients.

Conclusion

RTSA performed with the assistance of regional anesthesia is a valid therapeutic option, with an unexpectedly low medical complication rate and a good to excellent subjective and objective clinical outcome in patients older than 80 years.

Disclaimer

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