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Short-stem uncemented anatomical shoulder replacement for osteoarthritis in patients older than 70 years: is it appropriate?

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Background: Despite a new trend to systematically use reverse shoulder arthroplasty (RSA) in elderly population regardless of the indication, total anatomical shoulder arthroplasty can get good functional results in this population. The purpose of this study was to evaluate clinical and radiological outcomes of uncemented short-stem anatomic total shoulder arthroplasty (TSA) for primary glenohumeral osteoarthritis in patients older than 70 years and to compare these results to a matched population with an uncemented short-stem RSA.

Methods: In this retrospective monocentric study, clinical outcomes were based on constant score (Cst), subjective shoulder value (SSV) score, and range of motion. The aim of radiographic analysis was to identify glenoid component loosening and humeral bone remodeling around the uncemented short stem.

Results: At an average follow-up of 44 ± 12.5 months, 32 uncemented short-stem TSA in 31 patients with a minimum of 2 years of follow-up were included and were compared to 32 uncemented RSA. Fifty three percent of the patients had "a forgotten prosthesis". ROM was significantly improved in all cases. Cst reached 73 ± 9 pts and SSV 90 ± 10.8% ($P < .001$). In 8 patients with repairable supraspinatus tendon tears, clinical outcomes were not statistically different from patients with an intact rotator cuff: Cst (77 ± 6.2 points vs 72 ± 9.6 points, $P = .3$) and SSV (88 ± 11.5% vs. 91 ± 10.5%; $P = .59$). The type of glenoid wear (A vs B) did not influence the constant score: 73 ± 9 points versus 74 ± 11 points respectively; $P = .81$. Despite a complication rate of 6% (n = 2), no prosthesis revision was performed. At last follow-up, range of motion was better in the TSA group compared to the RSA group for internal (7.8 ± 1.3 vs 6.25 ± 2; $P = .001$) and external (47 ± 14 vs 24 ± 21; $P < .001$) rotations. The postoperative SSV score was also better in the TSA group (91.3 ± 10% vs 82.2 ± 13%; $P = .002$).

Conclusions: At medium-term, uncemented short-stem anatomic TSA in patients older than 70 years provided satisfactory clinical results. Patients have forgotten their prosthesis in over 50% of cases. This prosthetic design is still indicated in this patient population in case of primary osteoarthritis with a functional rotator cuff with an almost normal rotator cuff muscle trophicity.

The number of shoulder arthroplasties has increased significantly over the last decade.[23] In an elderly population, 2 options are available to replace shoulder joint: anatomical total shoulder prosthesis (TSA) and reverse shoulder arthroplasty (RSA).

TSA in the elderly with a functional rotator cuff provides satisfactory clinical results.[9,18] Restoration of external/internal rotation appears to be greater[18,20] with TSA compared to RSA. In bilateral arthroplasty, TSA allows better internal rotation and facilitates hygienic care. Recovery after TSA is no longer than for RSA. However, RSA is now the most frequently performed arthroplasty, regardless of etiology in the elderly population.[22] An analysis of registries has shown that there is a tendency to use RSA after a certain age due to the increasing number of rotator cuff injuries.[33]

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Toulouse University Hospital signed a commitment of compliance to the reference methodology MR-004 of the French National Commission for Informatics and Liberties (CNIL). After evaluation and validation by the data protection officer and according to the General Data Protection Regulation*, this study completing all the criteria, it is register in the register of retrospective study of the Toulouse University Hospital (number's register: RnIPH 2020-39) and cover by the MR-004 (CNIL number: 2206723 v 0). This study was approved by Toulouse University Hospital and confirm that ethic requirements were totally respected in the above report.

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Whether it is an anatomical or a reverse prosthesis, the use of short uncemented stems is increasingly common nowadays. Uncemented stems with porous coating protect against humeral stresses and are supposed to decrease the rate of loosening in the long term.[6,32] The interest of cemented stems has only been found in fractures.[28,31]

To our knowledge, bone remodeling around short uncemented humeral stems has not been specifically studied in the elderly population.[3,29,30]

The objective of this study was to evaluate clinical and radiological outcomes of uncemented short-stem anatomic TSA for primary glenohumeral osteoarthritis in patients older than 70 years. The hypothesis of our study was that uncemented short-stem TSA gives satisfactory results in the mid-term in the elderly population with a functional rotator cuff with a low complication rate.

Materials and methods

From September 2013 to March 2017, (1) all patients 70 years or older in whom (2) a TSA with uncemented humeral short-stem implant was performed (3) for primary glenohumeral osteoarthritis, (4) and who were reassessed within a minimum period of 2 years, were included in this retrospective monocenter study. All patients had been medically treated (physical therapy combined with steroid injections and analgesics) without reliable results after more than 6 months. Patients with an unrepairable full thickness tear of the supraspinatus, a history of rotator cuff repair and/or with fatty infiltration greater than 2 of the rotator cuff muscle were excluded.[17,18]

We compared our results with another series performed in our department of short-stem RSA. The inclusion criteria for patients with RSA were (1) patients over 70 years, with (2) follow-up of more than 2 years. Patients with a lesion of the subscapularis were excluded as well as CLEER and ILER patients[2] - CLEER (combined loss of active elevation and external rotation) corresponds to a loss of active anterior elevation and active external rotation elbow to body and ILER (isolated loss of active external rotation) corresponds to an isolated loss of external rotation with preservation of active anterior elevation. The Ethics Committee of our institution approved this study (IRB 01-526) and patients gave their informed consent for the exploitation of their radiological and clinical data.

Surgical technique

All surgeries were performed by 2 senior surgeons (P.M., N.B.) with patients in a beach chair position under general anesthesia associated with an interscalene block. A deltopectoral approach was used in all cases with biceps tenodesis. The subscapularis was either tenotomized 1-cm medial to the tendon insertion or a subscapularis peel was performed directly off the lesser tuberosity. Intraoperatively, a superficial ($n = 4$) or deep ($n = 4$) partial tear of the supraspinatus tendon and one full-thickness tear were identified. Superficial supraspinatus lesions were incomplete lesion of the supraspinatus with tears of the bursal side and continuity of the intra-articular supraspinatus tendon. On the other hand, deep lesions involved the intra-articular side of the tendon with an intact tendon on the bursa side.

An uncemented humeral short stem (Ascend Flex, Wright Medical) with a cemented pegged glenoid component (Perform Glenoid, Wright Medical) were implanted in all cases. In case of a rotator cuff tear of the supraspinatus tendon, a transosseous repair was performed. During the first 6 postoperative weeks, the shoulder was maintained in sling for protection and passive range of motion recovery was started with limitation of external rotation to 20°, under the supervision of a physiotherapist. Active range of motion was then allowed at 6 weeks without strengthening exercise before 3 months. All patients had the same rehabilitation protocol.

Table I
Preoperative radiographic analysis.

Features	Results
Etiology	POA: 32 (100%)
Glenoid type	A1: 7 (22%)
	A2: 11 (34%)
	B1: 14 (44%)
Amyotrophia	No: 28 (87.5%)
	Yes: 4 (12.5%)
Fatty infiltration	0: 8 (25%)
	1: 20 (62.5%)
	2: 4 (12.5%)
Tingart index	3.9 ± 07

POA, primary osteoarthris.
Glenoid type according to Walch classification[26]; amyotrophia according to Thomazeau[24]; fatty infiltration according to Goutallier[19]; Tingart index.[25]

Clinical assessment

Time of hospitalization was analyzed and postoperative hemoglobin levels were monitored on day 2.[21] Range of motion was measured with a goniometer preoperatively and at the last follow-up with specific attention paid to internal and external rotation. Pain level (visual analogic scale), Constant[4] score and subjective shoulder value (SSV)[12] were evaluated preoperatively and at the last follow-up. At last follow-up, all patients were asked if the prosthesis was “forgotten”: the question was “do you still feel the presence of the prosthesis or was your shoulder like a normal shoulder?”. The prosthesis was defined as forgotten if the shoulder was considered as a normal shoulder without the sensation of the prosthesis by analogy to subjective results in hip arthroplasty.[27] All complications were recorded for each patient.

Radiographic analysis

Preoperative assessment was based on an A/P view, a lateral view on plain X-rays, and a CT scan to evaluate the glenohumeral joint, rotator cuff muscle trophicity[35] and fatty infiltration,[10,14] Tingart index,[36] and the type of glenoid wear. The modified Walch[1] classification was used to evaluate glenoid wear. Data are reported in Table I.

On the postoperative A/P view, the alpha angle described by Schnetzke et al[29] was used to measure the alignment and inclination of the stem by measuring the angle between the axis of the humeral shaft and the line passing through the center of the prosthetic head and the distal end of the stem (Fig. 1). The metaphyseal and diaphyseal filing ratios were also calculated (Fig. 1).

At the last follow-up, on the A/P view, signs of glenoid loosening were analyzed according to the Mole classification[24]: the Mole score analyzes the radiolucent lines (RLL) around the glenoid implant in 6 areas: RLL less than 1 mm was rated 1 point, RLL between 1 and 2 mm was rated 2 points, and RLL greater than 2 mm was rated 3 points. A score higher than 12 corresponds to a glenoid component loosening. In addition, signs of bone remodeling were assessed[33]: condensation lines, cortical bone narrowing osteopenia, and spot welds. The features of bone remodeling on each zone

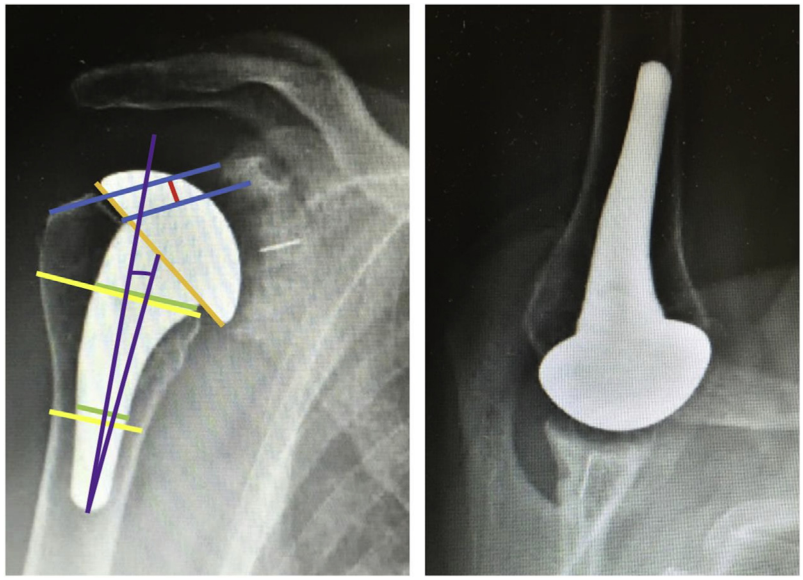

Figure 1 Postoperative "ideal" X-rays of TSA with some measurements. Anteroposterior and lateral X-rays of TSA with so-called ideal placement and a low-filling stem centered in the humeral shaft. The – reprsent the lines for measuring the height of the humeral stem: straight line drawn between the lateral edge of the greater tuberosity and the upper edge of the glenoid and parallel to this line passing through the most proximal and lateral point of the stem. The – corresponds to the distance between the 2 –: potential subsidence of the stem. – = size of the humeral head. – and – = metaphyseal and diaphyseal filing ratio. The angle alpha in violet corresponds to the angle between the line passing through the center of the humeral head and the distal end of the stem and the line representing the axis of the humeral shaft.

were summarized and the bone adaptation was classified as none (no features or one feature of bone remodeling), mild (2 or 3 features), moderate (between 4 and 6), or severe (7 or more features). Humeral and glenoid remodeling were evaluated separately by 2 blinded observers. Bone remodeling was defined as low if the patient was classified as having no adaptation or mild adaptation and as high if the patient was classified as having moderate or severe adaptation.[6,9] In case of a disagreement, X-rays were viewed together by the 2 observers and a consensus was reached. The radiographs were interpreted by 2 senior surgeons independently and more than a week apart.

The height of the prosthetic stem between the immediate postoperative period and the last follow-up was measured. For this purpose, a straight line was drawn between the lateral edge of the greater tuberosity and the upper edge of the glenoid. The parallel to this straight line passing through the most proximal and lateral point of the stem was also plotted (Fig. 1). Finally, the distance between these 2 straight lines between the postoperative and at last follow-up was measured. We made a rule of 3 with the measurement on the radiograph and the size of the humeral head. Then, we analyzed if there was a subsidence of the humeral stem.

Statistical analysis

Means and standard deviations were calculated for continuous variables. Quantitative variables were analyzed by the Mann-Whitney and Wilcoxon tests. The chi-square and Fisher's exact tests were used for the analysis of qualitative variables. The value of $P < .05$ was considered to be statistically significant. To assess reproducibility of measurements, intraclass correlation coefficient (ICC) (intrarrater reliability) and Cohen's Kappa (interrater reliability) are evaluated. ICC values under 0.40 indicated poor agreement, 0.4-0.75 fair, 0.60 and 0.70 good and more than 0.75 excellent agreement. In addition, kappa values ≤ 0 indicated no agreement, 0.01-0.20 none to slight, 0.21-0.40 fair, 0.41-0.60 moderate, 0.61-0.80 substantial, and 0.81-1.00 almost perfect agreement. The software XL Stat (Addinsoft) has been used.

Results

Clinical results

Thirty-two anatomic TSAs in 31 patients (one case of bilateral prosthesis) met the inclusion/exclusion criteria. Thirty-one patients (32 RSA with one bilateral prosthesis) were also included for comparison: 34% (n = 11) of primary glenohumeral osteoarthritis with B2 glenoid, 34% (n = 11) of eccentric osteoarthritis (Hamada IV or V)[16] and 32% (n = 10) of non-repairable lesions of the rotator cuff without osteoarthritis (supraspinatus ± infraspinatus stage 3 or 4).[34] Patients were comparable in gender, age, rate of dominant limb surgery, ASA score, and length of follow-up.

In the TSA group, 21 women (66%) and 10 men underwent surgery with an average age at the time of surgery of 75 years (range 70-85). The patients underwent surgery on their dominant side in 77% of the cases. Two patients (6%) were ASA I, 23 patients (72%) were ASA II, and 7 patients were (22%) ASA III.

Clinical results are summarized in Table II and Table III.

Comparison between short-stem TSA and short-stem RSA (Table IV)

The 2 groups were comparable preoperatively regarding constant score, SSV score, and mobility.

With an average follow-up of 44 ± 12.5 months, 53% (n = 17) of the patients had "a forgotten prosthesis"[27] at the last follow-up in TSA group and no patient in RSA group. Rotation level and SSV score were better in the TSA group when compared to the RSA group.

At last follow-up, ROM was better in the TSA group for internal (7.8 ± 1.3 vs 6.25 ± 2; $P = .001$) and external (47 ± 14 vs 24 ± 21; $P < .001$) rotations. The postoperative SSV score was also better in the TSA group (91.3 ± 10 vs 82.2 ± 13; $P = .002$) without difference on the postoperative total constant score.

Radiographic results (Tables V and VI)

Twenty-three (71%) stems were well positioned in relation to the axis. A varus was identified in 8 cases (26%) and a valgus in one

Table II
Results of preoperative and postoperative range of motion and pain.

	Preoperative	Postoperative	*P* value
AAE	99 ± 15 (80;130)	137 ± 18 (110;160)	<.001
ER1	11 ± 19 (−25;50)	47 ± 14 (10;80)	<.001
ER2	14 ± 19 (0;60)	64 ± 12 (40;90)	<.001
IR	3.6 ± 2.1 (2;8)	7.8 ± 1.3 (6;10)	<.001
Hand behind head	7 (22%)	32 (100%)	<.001
Hand to the top of the head	9 (28%)	32 (100%)	<.001
Pain	7.4 ± 1.1 (5;9)	0.3 ± 0.7 (0;3)	<.001

AAE, anterior active elevation; *ER1*, external rotation 1; *ER2*, external rotation 2; *IR*, internal rotation.
AAE, ER1, ER2 are expressed in degree; IR is expressed in level reached by the thumb on the spine; pain level is evaluated using a visual analogic scale [VAS].

Table III
Results of preoperative and postoperative constant Score and SSV.

	Preoperative	Postoperative	*P* value
Total constant score	31 ± 10 (17;60)	73 ± 9 (62;84)	<.001
Pain constant score	5 ± 2.7 (1;10)	15 ± 1.1 (7;15)	<.001
Activity constant score	8,5 ± 2.3 (5;12)	18 ± 2.1 (12;20)	<.001
Mobility constant score	14 ± 4.5 (8;20)	34 ± 4.6 (24;40)	<.001
Strength constant score	3 ± 3 (0;10)	8 ± 3.2 (3;14)	<.001
SSV	31 ± 9.9 (10;50)	90 ± 10.8 (70;100)	<.001

SSV, subjective shoulder value.
Constant score, pain level, activity, mobility, and strength are expressed in points; SSV is expressed in percentage of a normal shoulder.

Table IV
Clinical results comparison between TSA and RSA.

	TSA (n = 32)	RSA (n = 32)	*P* value
Follow up (months)	44 ± 12.5	42 ± 14	.7
VAS (pts):			
Preop	7.4 ± 1.1	6.8 ± 2.2	.08
Postop	0.28 ± 0.7	0.25 ± 0.9	.88
AAE (°):			
Preop	99 ± 15	93.1 ± 28	.29
Postop	137 ± 17	137 ± 17	.94
ER (°):			
Preop	11 ± 19	18 ± 20	.184
Postop	47 ± 14	24 ± 21	<.001
IR (pts):			
Pre op	3.6 ± 2	4.5 ± 2.5	.11
Post op	7.8 ± 1.3	6.25 ± 2	.001
SSV (%):			
Preop	30.8 ± 10	28.4 ± 13	.43
Postop	91.3 ± 10	82.2 ± 13	.002
Total constant score (pts):			
Preop	31.2 ± 9	32 ± 13	.79
Postop	73.3 ± 9	71 ± 13	.49

AAE, active anterior elevation in degrees; *ER*, external rotation in degrees; *IR*, internal rotation (points); *SSV*, subjective shoulder value; *VAS*, visual analogic scale (0 = no pain to 10 points = unbearable pain).

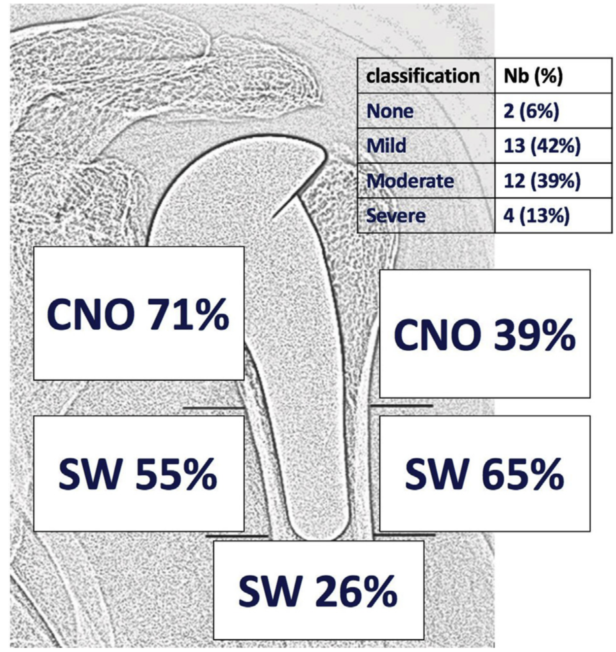

Figure 2 Most frequent feature for each zone at last follow-up. *CNO*, cortical bone narrowing osteopenia; *SW*, spot welds.

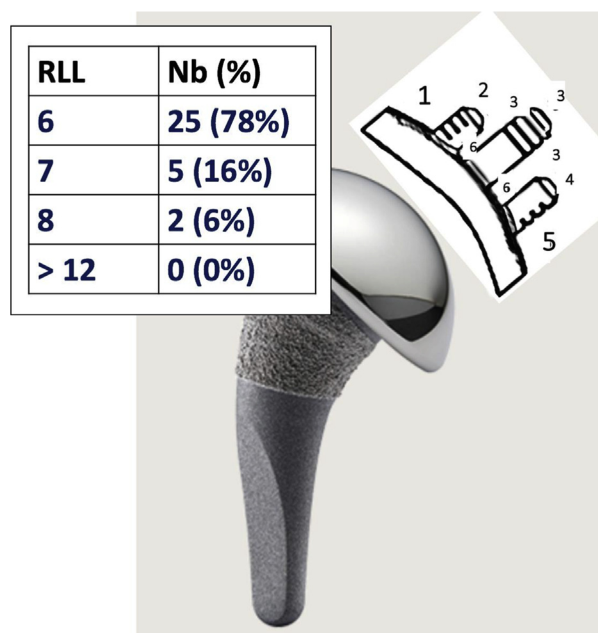

Figure 3 Radiological results according to MolÃ with RLL score at last follow-up. *RLLs*, radiolucent lines.

case (3%). Fig. 2 shows the most frequent changes. No subsidence of the humeral stem was observed at last follow-up. Fig. 3 shows the summary of the radiological analysis of the glenoid. There was no glenoid component loosening at follow-up.

Intra-rater reliability was excellent (ICCs between 0.858 and 1) for postoperative humeral radiological analysis and for humeral bone remodeling at last follow-up. Inter-rater reliability was substantial for postoperative humeral radiological analysis and humeral bone remodeling at last follow-up (k = 0.766 and 0.771).

Complications and revisions

In the TSA group, one intraoperative complication occurred with a calcar humeral fracture requiring the use of a cemented short-stem arthroplasty (Fig. 4). In another patient, a wash out of a compressive hematoma with neurological deficit was necessary on day 2. One patient reported a type 1 complex regional pain syndrome (CRPS).

In the RSA group, 2 intraoperative fractures required stitching with wires around the humeral neck. During follow-up, 4 complications were found in the RSA group: monitoring for ulnar nerve neurapraxia, orthopedic treatment for a slightly displaced humeral diaphyseal peri-prosthetic fracture, reoperation for hematoma

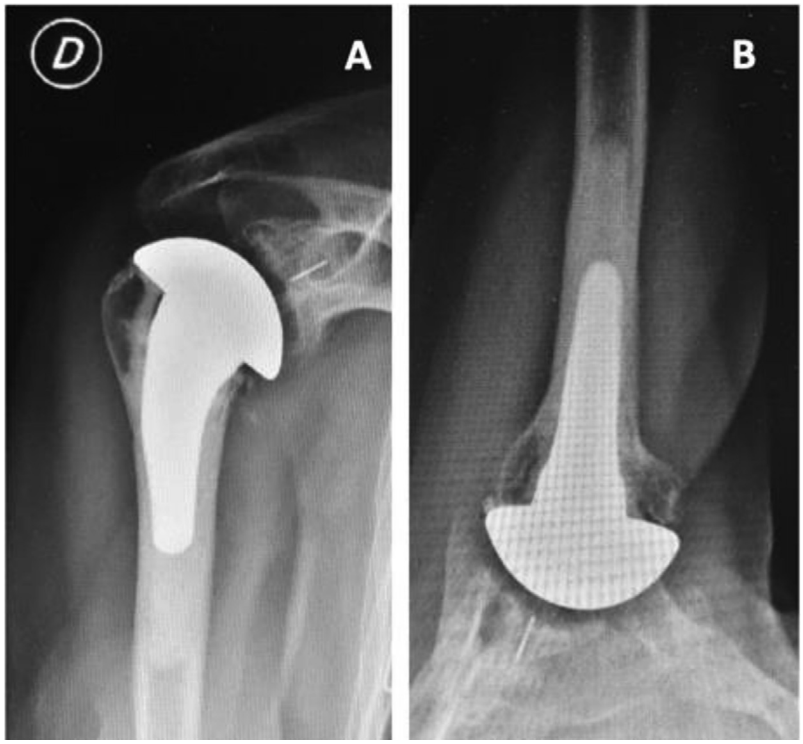

Figure 4 Intraoperative complication: intraoperative metaphyso-humeral fracture requiring cemented humeral short stem (anteroposterior view [**A**] and Bernageau profil view [**B**]).

evacuation, and stem revision for sepsis with cemented stem and 3 months of antibiotic therapy.

Statistical analysis and prognostic factors of TSA

Supraspinatus tendon

No significant difference was found between patients with supraspinatus tears (n = 9) and those without: SSV (88 ± 11.5% vs. 91 ± 10.5%; $P = .59$) and constant score (77 ± 6.2 points vs 72 ± 9.6 points, $P = .3$).

Glenoid wear

The clinical results for type A (n = 18) and type B1 (n = 14) glenoid wear were not significantly different. The Constant score was 73 ± 8.4 points for type A glenoid wear and 74 ± 9.8 points for type B1 glenoid wear ($P = .75$). SSV was 92 ± 9.6% for type A glenoid wear and 88 ± 11.9% for type B1 glenoid wear ($P = .55$).

Humeral stem positioning

The clinical result was not affected by a change in varus/valgus positioning of the stem. The SSV score was 89% ± 11 in the varus/valgus group versus 91% ± 10 in the normal axis group, $P = .66$. The total Constant score was 75 ± 7.4 in the varus/valgus group versus 73 ± 9.7 in the normal axis group, $P = .48$.

There was no statistically significant difference in proximal filing ratio between patients with varus/valgus versus normal-axis stem, (0.45 ± 0.06 versus 0.48 ± 0.07 respectively, $P = .066$) nor in the distal filing ratio (0.48 ± 0.07 versus 0.49 ± 0.08 respectively, $P = .132$).

In the varus/valgus group, bone remodeling was defined as low for 3 patients (33%) and high for 6 patients (67%). In the normal-axis group, 12 patients had low bone remodeling and 10 patients had high bone remodeling. There was no significant difference in bone remodeling between the varus/valgus and normal-axis groups ($P = .3$). Moreover, no correlation was found between the Tingart's index and bone remodeling ($P = .2$). No significant subsidence was found for all patients in TSA group.

Discussion

In our series, uncemented short-stem anatomic shoulder prostheses provided excellent objective and subjective clinical results in patients 70 years of age and older with a functional rotator cuff and an almost normal muscle trophicity - more than 50% reported “having forgotten their prosthesis”. The clinical outcomes of short-stem TSA were better than RSA in our selected population, especially for rotations and patient satisfaction.

A meta-analysis[8] on short-stem TSA from 13 studies with a short follow-up of less than 3 years as well as 2 other studies[29,30] found excellent clinical and radiological results with a low rate of revision and complications which is comparable to our study: no revision and 6% complications (one intraoperative fracture and one hematoma under anticoagulation treatment).

The stems used in this series were short stems with metaphyseal support. Even when the bone quality was not optimal, the size of the stems should not be increased up to the distal diaphyseal support. If the humeral stem was oversized in order to achieve greater primary stability, the stresses increased with an increased risk of calcar fracture and loosening. This concern has already been reported in the literature for hip replacement which advocated the use of cemented implants in patients older than 70 years.[13] At the beginning of our experience with this short-stem prosthesis, 3 intraoperative fractures occurred (1 in TSA group and 2 in RSA group) necessitating to switch to a cemented component in TSA group or use wires around the humeral neck in the RSA group. Oversizing an uncemented short stem would increase the long-term rate of bone remodeling with a high risk of stress-shielding effect.[3,29,30] In this series, cortical proximal thinning and distal

Table V
Postoperative humeral radiological analysis.

Features	Results ± SD
Filing ratio proximal	0.59 ± 0.09
Filing ratio distal	0.5 ± 0.07
Tingart index	3.9 ± 0.7
Alpha angle	5.5 ± 2.1

Proximal and distal filling ratio and Tingart's index[25] are measurement ratios in millimetres. The proximal and distal filling ratio are measured using the Schnetzke method[15,18]; the alpha angle[15] is measured in degrees.

Table VI
Humeral bone remodeling at last follow-up.

Last FU nb (%)	M1 (%)	M2 (%)	US (%)	L1 (%)	L2 (%)
None	7 (23)	12 (39)	17 (55)	11 (35)	6 (19)
CL	4 (13)	9 (29)	5 (16)	8 (26)	6 (19)
CNO	7 (23)	4 (13)	1 (3)	12 (39)	4 (13)
Spot Welds	22 (71)	17 (55)	8 (26)	20 (65)	20 (65)

CL, condensation lines; *CNO*, cortical bone narrowing osteopenia.
The areas around the humeral stem were classified according to Nagel's initial method and adapted for short stems.[15,18] For each area, we looked for bone remodeling according to the Schnetzke[15,18] method including the following criteria: condensation lines, cortical bone narrowing osteopenia and spot welds.

welds spots were reported. This remodeling was low in half of the cases (n = 15) and high in the other half of the cases but did not impact clinical outcomes at the last follow-up. Even if the stem was not perfectly aligned in the axis of the humeral shaft (varus or valgus position), it did not seem to increase bone remodeling.

Our series concerned a select population of patients over 70 years of age with probably a high level of osteoporosis. No significant stem subsidence was observed between the immediate postoperative period and the last radiological follow-up. These data confirmed that it was essential to respect metaphyseal fixation and support even if the stem was in varus or valgus position. There were no clinical or radiological consequences related to stem positioning. One of the important conclusions of this study was to limit diaphyseal contact or support in order to avoid creation of significant stresses, which could lead to osteolysis and loosening.

Patients with supraspinatus tendon wear (28%) were included in our series. No difference in terms of clinical outcomes was identified compared to patients without any tears. This finding was consistent with the findings of previous literature which reported that minimally retracted or nonretracted supraspinatus tendon tears did not affect TSA clinical results.[7]

The analysis of glenoid radiolucent lines in our study showed satisfactory results without sign of glenoid component loosening, which was consistent with literature.[5,11] No glenoid bone grafts were required contrary to other studies that have reported TSA results in elderly patients.[4]

The use of TSA for type B glenoid wear is likely to lead to poorer results and a higher rate of complications, especially for type B2 glenoid.[22] Despite the development of augmented glenoid implants, the rate of loosening remains higher in the B2[15] glenoid group. Therefore, we have limited the indication of anatomical prostheses in this series to patients with B1 glenoid wear and we advocated RSA in case of B2 glenoid wear whatever the rotator cuff tendons and muscle status.

The main objective of functional surgery in an elderly population is to maintain and/or regain a significant level of autonomy. Our series have found better improvement of range of motion in rotation with TSA compared to RSA which was a real benefit for our patients for activity of daily leaving, for hygiene, autonomy and communication. Patients were more satisfied with a shoulder considered native for more than half of them with the absence of major radiological changes. Certainly, the functional demand of a population over 70 years of age may be different and lower than that of younger patients. Patients over 70 years of age may still be very active today. The possible decrease in the level of activity may affect and decrease the revision rate in the long term. In addition, certain underlying medical comorbidities may contraindicated revision surgery even if it is necessary in the long term.

This study had several limitations because it was retrospective and nonrandomized. The 4-year follow-up was too low to confirm the efficiency of anatomical shoulder replacement in a patient population with a life expectancy of more than 10 years. However, to the best of our knowledge, this was the first study to analyze the results of uncemented short-stem TSA in patients over 70 years of age with a functional rotator cuff. Furthermore, a comparative study could be performed for a matched population using RSA with the same type of prosthesis especially the humeral stem. Although patients were comparable in the 2 groups concerning preoperative status, there were differences: in the TSA group glenoid wear were classified as type A or B1 according to Walch's classification, with an almost intact rotator cuff tendons, whereas in the RSA group glenoid wear were mostly of B2 type with or without nonrepairable rotator cuff lesions. No patients were lost to follow-up and the number of patients in this specific population was high enough to get valuable data. In addition, the implant used was the same throughout the series, with the same surgical technique performed by 2 experienced shoulder surgeons.

Conclusion

At medium-term, uncemented short-stem anatomic TSA seemed appropriate in patients older than 70 years providing satisfactory clinical results. Patients have forgotten their prosthesis in over 50% of cases. This prosthetic design is still indicated in this patient population in case of primary osteoarthritis with a functional rotator cuff and an almost normal muscle trophicity.

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