Is a Lateralized Humeral Reverse Total Shoulder Prosthesis Equally Effective In Treating Patients of Shorter Height: A Comparison of Patients of Short and Average Height at Short and Long-Term Follow-up

Josie Elwell; PhD; Pierre-Henri Flurin, MD; Thomas W Wright, MD; Joseph D Zuckerman, MD; Christopher Roche, MSE, MBA

Disclosures: J.A. Elwell: 3A; Exactech, Inc. P. Flurin: 3B; Exactech, Inc.. 7A; Exactech, Inc. J. Zuckerman: 3B; Exactech, Inc.. 7A; Exactech, Inc. T. Wright: 3B; Exactech, Inc.. 7A; Exactech, Inc. C. Roche: 3A; Exactech, Inc.. 4; Exactech, Inc..

Introduction: Reverse total shoulder arthroplasty (rTSA) is increasingly used as the prosthesis of choice for patients with end-stage degenerative conditions of the shoulder. rTSA prosthesis designs are offered in various sizes and styles to accommodate varying patient anatomy, morphology, and wear/deformity patterns. There is some belief that more medialized humeral prosthesis design styles perform better in shorter patients than lateralized humeral prosthesis designs due to relative differences in tension of the remaining musculature; there is no study that has objectively demonstrated any difference in outcomes between design styles. The purpose of this study is to analyze an international database of a single shoulder prosthesis to compare clinical outcomes associated with patients of short and average height when treated with a lateralized humeral design style.

Methods: An international database of a single shoulder prosthesis was analyzed to evaluate the impact of patient stature on clinical outcomes from short to long-term follow-up. Primary rTSA patients were included in this study if they had available demographic information related to height to classify as short or average stature as defined by Matsuki et al.[1], 2-year minimum follow-up, and were treated with 38mm or 42mm glenospheres. Matsuki et al.[1] defined short-stature patients as being <155cm tall and defined average-stature patients as being 162-178cm tall. Patients were excluded if 1) indicated for surgery by fracture or revision arthroplasty or 2) were outside of the specified short stature and average stature height ranges. Patients were evaluated pre-operatively and post-operatively using patient reported outcome measures (PROMs) including SST, UCLA, ASES, Constant, and SAS scoring metrics; and using VAS pain and global shoulder function. Range of motion was quantified for active abduction, forward elevation, and internal/external rotation. Revision rates were also determined. To analyze the impact of patient height on outcomes, stature cohorts were compared at latest follow-up and also at defined post-operative intervals of 2-3 years (short-term) and 8+ years (long-term) follow-up. The cohorts were compared at each timepoint using student's t-test for continuous variables and a Wilcoxon-rank-sum test for ordinal variables.

Results: The clinical outcomes of 2,154 primary rTSA patients were analyzed in this study. 528 (516F/12M) primary rTSA patients were included in the short-stature cohort and 1,626 (870F/756M) primary rTSA patients were included in the average stature cohort. Several differences were observed between cohorts. Small stature patients were significantly ($p<0.0001$) older at 73.7 ± 7.9 years as compared to average stature patients who were 71.5 ± 7.7 years at the time of surgery. The cohort of small stature patients was 97.9% female, with significantly ($p<0.0001$) more female patients than in the average stature cohort, which was 53.5% female. Small stature patients had 5.5% of patients with a diagnosis of Rheumatoid arthritis (RA), which was significantly ($p=0.0002$) greater than the 2.3% of patients with RA in the average stature cohort. Interestingly, 43.8% of average stature patients had their subscapularis repaired at the time of surgery, which was significantly ($p=0.0256$) more than the 38.1% of small stature patients. Small stature patients received smaller diameter glenospheres, where 45 patients (8.5%) received a 42mm glenosphere which was significantly ($p<0.0001$) less than the 710 patients (43.7%) in the average stature cohort.

As described in Table 1, prior to surgery several differences were observed between small and average stature cohorts. Pre-operatively, small stature patients had significantly more pain ($p<0.0001$), significantly less function ($p=0.0010$), and significantly lower outcome measures as described by the SST ($p<0.0001$), Constant ($p=0.0209$), ASES ($p<0.0001$), and UCLA ($p=0.0013$) metrics. At latest follow-up, small stature patients had an average follow-up of 52.2 ± 28.4 months, which was significantly more than the average follow-up of 48.2 ± 25.9 months for average stature patients. At latest follow-up, average stature patients generally performed better than small-stature patients as measured by each outcome measure, a trend which was also apparent in the short-term PROMs, but not ROM (Table 2). However, likely due the pre-operative differences between the two cohorts, the only significant differences in pre-to-post-operative improvement between the groups were in internal rotation (1.2 vs. 0.9, $p=0.034$), external rotation (20.0 vs. 16.6º, $p=0.0125$), and the Constant score (33.7 vs. 29.2, $p=0.0004$) where average stature patients experienced greater improvement in each. As shown in Table 2, no significant differences were observed at long-term follow-up between small stature and average stature cohorts as was observed at short-term and latest follow-up. However, small stature patients had a significantly ($p=0.0449$) lower revision rate of 0.6% as compared to the average stature patients revision rate of 1.8%. Finally, no difference in radiographic outcomes were observed, where small stature and average patients had scapular notching rates of a 10.0% and 9.8%, respectively.

Discussion: The results of this study demonstrate that both small and average stature patients achieved favorable outcomes and a low revision rate out to long-term follow-up with a lateralized humeral rTSA prosthesis. Some statistical differences in clinical outcomes were observed between small stature and average stature cohorts, but few differences in improvements were found. This study has several limitations. The 2 cohorts had numerous differences in pre-operative measures and surgical factors, which may have confounded our findings. Most significantly, 97.9% of the small stature cohort was female as compared to 53.5% of the average stature cohort. Additionally, the small stature cohort was significantly older and had a different distribution of diagnoses as compared to the average stature cohort, where specifically the small stature cohort had a larger percentage of patients with RA. Related to the implant choice and surgical technique, 8.5% of the small stature cohort received 42mm diameter glenospheres as compared to 43.7% of the average stature cohort; 38.1% of small stature patients had their subscapularis repaired versus 43.8%, in the average stature cohort, potentially affecting post-operative internal/external rotation capacity. These difference in gender, age, and diagnosis, implant size, and surgical technique most likely describe the observed differences in pre-operative and post-operative outcomes. Interestingly, both cohorts achieved similar levels of clinical improvement despite these differences. Future work should seek to match for age, gender, diagnosis, and glenosphere size and diameter when comparing outcomes of different stature patients.

Significance: In conclusion, this large-scale clinical outcome study of 2,154 rTSA patients demonstrates that a lateralized humeral rTSA shoulder prosthesis can be used to successfully treat both small stature and average stature patients with equivalent outcomes.

References: 1. Matsuki K, et al. Outcomes of reverse shoulder arthroplasty in small- and large-stature patients. JSES. 2018 May;27(5):808-815.

Table 1. Comparison of rTSA Patients of Short and Average Height, Pre-operative, at Latest Follow-up, and Pre-to-Post-operative Improvement

	Patient Height	Abduction	Forward Elevation	IR Score	Ext. Rotation	VAS Pain	Global Shoulder Function	SST	Constant	ASES	UCLA	SAS
Pre-op	≤155cm	73.8 ± 34.0	88.3 ± 40.3	3.1 ± 1.9	20.1 ± 19.9	6.7 ± 2.2	3.5 ± 2.3	3.1 ± 2.5	34.4 ± 14.1	32.1 ± 15.4	12.7 ± 4.2	44.9 ± 12.1
Pre-op	162-178cm	74.5 ± 38.2	87.6 ± 39.3	3.1 ± 1.8	18.8 ± 21.9	6.0 ± 2.2	3.8 ± 2.0	3.9 ± 2.5	36.4 ± 14.1	37.1 ± 15.8	13.5 ± 4.1	45.9 ± 12.2
Pre-op	P Value	0.6911	0.7317	0.7848	0.2819	**<0.0001**	**0.0010**	**<0.0001**	**0.0209**	**<0.0001**	**0.0013**	0.1263
LFU	≤155cm	115.7 ± 31.3	136.6 ± 29.0	4.0 ± 1.9	35.7 ± 17.4	1.5 ± 2.3	7.9 ± 2.2	8.9 ± 2.9	63.6 ± 14.3	77.9 ± 20.7	29.5 ± 5.3	73.0 ± 12.4
LFU	162-178cm	123.1 ± 31.7	141.6 ± 27.0	4.3 ± 1.8	38.2 ± 18.2	1.2 ± 2.0	8.2 ± 2.0	10.0 ± 2.6	70.0 ± 14.4	83.2 ± 18.2	30.4 ± 5.0	75.8 ± 12.2
LFU	P Value	**<0.0001**	**0.0010**	**0.0088**	**0.0115**	**0.0011**	**0.0090**	**<0.0001**	**<0.0001**	**<0.0001**	**0.0034**	**<0.0001**
Improve	≤155cm	43.8 ± 41.2	49.2 ± 43.7	0.9 ± 2.2	16.6 ± 23.1	5.2 ± 2.9	4.4 ± 2.9	5.9 ± 3.4	29.2 ± 17.9	46.0 ± 23.7	16.8 ± 6.3	28.8 ± 15.9
Improve	162-178cm	48.2 ± 41.0	53.3 ± 42.9	1.2 ± 2.2	20.0 ± 23.4	5.0 ± 2.7	4.3 ± 2.6	6.1 ± 3.4	33.7 ± 17.2	46.0 ± 21.1	16.8 ± 5.8	30.0 ± 15.0
Improve	P Value	0.0616	0.1018	**0.0341**	**0.0125**	0.0736	0.4917	0.3336	**0.0004**	0.9786	0.8039	0.2026

Table 2. Comparison of rTSA Patient Outcomes at Short-term & Long-term Follow-up for Patients of Short and Average Height

	Patient Height	Abduction	Forward Elevation	IR Score	Ext. Rotation	VAS Pain	Global Shoulder Function	SST	Constant	ASES	UCLA	SAS
2-3 years	≤155cm	120.2 ± 30.2	138.1 ± 27.0	4.3 ± 1.8	36.2 ± 16.5	1.3 ± 2.1	8.0 ± 2.0	9.3 ± 2.7	65.9 ± 13.1	80.0 ± 18.6	29.8 ± 4.9	74.5 ± 10.8
2-3 years	162-178cm	122.1 ± 31.2	142.5 ± 25.0	4.4 ± 1.7	38.1 ± 17.9	1.1 ± 1.9	8.3 ± 1.8	10.2 ± 2.3	70.5 ± 13.5	84.2 ± 16.8	30.6 ± 4.7	76.5 ± 11.6
2-3 years	P Value	0.3810	**0.0130**	0.1312	0.1046	0.0698	**0.0124**	**<0.0001**	**<0.0001**	**0.0002**	**0.0139**	**0.0120**
8+ years	≤155cm	100.1 ± 23.1	129.2 ± 27.3	4.5 ± 1.9	26.9 ± 21.1	1.9 ± 2.9	7.5 ± 2.5	8.3 ± 3.4	61.6 ± 16.5	73.4 ± 25.4	28.7 ± 7.0	70.6 ± 15.6
8+ years	162-178cm	106.5 ± 30.5	124.1 ± 31.6	4.2 ± 1.9	26.6 ± 20.6	1.1 ± 1.9	7.3 ± 2.4	8.4 ± 3.3	60.9 ± 18.8	76.5 ± 21.8	27.0 ± 7.3	68.3 ± 16.0
8+ years	P Value	0.1676	0.3197	0.3589	0.9254	0.3705	0.5633	0.8691	0.8199	0.3167	0.1642	0.4028