

Reverse Total Shoulder Arthroplasty Improves Function Compared to Hemiarthroplasty in Pediatric Proximal Humerus Tumor Reconstruction: A Multicenter Study

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Significance & Hypothesis: Reconstruction following proximal humerus tumor resection in pediatric patients remains challenging, with no consensus on the optimal approach. Hemiarthroplasty (HA) has historically been favored but is frequently associated with limited postoperative shoulder function. Reverse total shoulder arthroplasty (rTSA) has demonstrated improved function in adults, though its role in children remains unclear. We hypothesized that rTSA would provide improved postoperative shoulder function compared to HA, without a clear difference in early complication or reoperation rates.

Innovation: This study represents the first multicenter comparison of rTSA and HA in pediatric patients following proximal humerus tumor resection. By integrating functional outcomes with complication profiles—including anterior-superior escape—and reoperation data, this study provides clinically relevant insight into reconstructive decision-making in a rare population.

Approach: Following institutional review board approval, a retrospective multicenter study was performed across eight orthopaedic oncology centers. Pediatric patients (<18 years) undergoing HA or rTSA following proximal humerus tumor resection between 2010–2024 were included. Demographic, tumor, and surgical variables were collected, including preservation of the deltoid insertion. Outcomes included reoperation, complications (including anterior-superior escape and implant failure), range of motion, and overall survival. Reoperation was analyzed using competing risk methods with death as a competing event. Functional outcomes were compared using Fisher's exact testing, and survival was assessed using Kaplan–Meier analysis.

Results: Twenty-three patients were included (15 HA, 8 rTSA) (Table 1). Median follow-up was 21.9 months for HA and 41.1 months for rTSA. Reoperation occurred in 6.7% of HA patients (1/15; aseptic loosening) and 25.0% of rTSA patients (2/8; mechanical implant failure and deltoid tear) ($p = 0.29$, Table 2 and Figure 1). Anterior-superior escape was observed in 60% of HA patients (9/15). Functional outcomes differed significantly between groups. Among HA patients, 46.7% had 0–45° of forward flexion, 33.3% had 45–90°, and only 6.7% achieved >90°. In contrast, 75.0% of rTSA patients achieved >90° of forward flexion ($p = 0.005$) (Table 2). Deltoid insertion was preserved in 75.0% of rTSA cases compared to 20.0% of HA cases. Five-year overall survival was 50.5% (95% CI: 29.1–87.5%) with no difference between groups ($p = 0.70$) (Figure 1).

Discussion and Impact: Both HA and rTSA are viable reconstructive options following proximal humerus tumor resection in pediatric patients. HA is associated with a high rate of anterior-superior escape and limited function, whereas rTSA more reliably restores function. The improved motion observed with rTSA is likely multifactorial, including avoidance of anterior-superior escape and more frequent preservation of the deltoid insertion.

Importantly, these functional outcomes were observed at a median follow-up of over three years in the rTSA cohort, supporting early durability of these results. Interpretation remains limited by small sample size, heterogeneity in surgical techniques, and differences in follow-up duration between groups. Longer-term outcomes of rTSA in pediatric patients remain uncertain. These data support consideration of rTSA in appropriately selected patients when restoration of shoulder function is a primary goal, while emphasizing the need for larger studies with extended follow-up to better define long-term durability.

Table 1. Demographic, clinicopathologic, and treatment characteristics of study population.

	Hemiarthroplasty (N=15)	rTSA (N=8)	All cases (N=23)
Age at surgery (months)			
Median [Min, Max]	11.8 [6.59, 16.6]	12.8 [9.66, 16.5]	12.8 [6.59, 16.6]
Sex			
Male	8 (53.3%)	4 (50.0%)	12 (52.2%)
Female	7 (46.7%)	4 (50.0%)	11 (47.8%)
Race			
White	9 (60.0%)	7 (87.5%)	16 (69.6%)
Black	2 (13.3%)	0 (0%)	2 (8.7%)
Unknown	4 (26.7%)	1 (12.5%)	5 (21.7%)
Body mass index			
Median [Min, Max]	18.3 [13.0, 30.2]	22.8 [17.4, 37.5]	19.1 [13.0, 37.5]
Unknown	1 (6.7%)	0 (0%)	1 (4.3%)
Diagnosis			
Osteosarcoma	10 (66.7%)	6 (75.0%)	16 (69.6%)
Ewing sarcoma	4 (26.7%)	1 (12.5%)	5 (21.7%)
Giant cell tumor	1 (6.7%)	0 (0%)	1 (4.3%)
Chondroblastoma	0 (0%)	1 (12.5%)	1 (4.3%)
Disease state			
Localized	11 (73.3%)	5 (62.5%)	16 (69.6%)
Locally recurrent	1 (6.7%)	0 (0%)	1 (4.3%)
Metastatic	3 (20.0%)	3 (37.5%)	6 (26.1%)
Soft tissue mass			
No	5 (33.3%)	2 (25.0%)	7 (30.4%)
Yes	10 (66.7%)	6 (75.0%)	16 (69.6%)
Pathologic fracture at presentation			
No	8 (53.3%)	6 (75.0%)	14 (60.9%)
Yes	7 (46.7%)	2 (25.0%)	9 (39.1%)
Glenoid involvement			
No	14 (93.3%)	7 (87.5%)	22 (95.7%)
Yes	1 (6.7%)	1 (12.5%)	1 (4.3%)
Chemotherapy			
No	3 (20.0%)	0 (0%)	3 (13.0%)
Yes	12 (80.0%)	7 (87.5%)	19 (82.6%)

	Hemiarthroplasty (N=15)	rTSA (N=8)	All cases (N=23)
Radiation			
No	13 (86.7%)	7 (87.5%)	20 (87.0%)
Yes	2 (13.3%)	1 (12.5%)	3 (13.0%)

rTSA = reverse total shoulder arthroplasty

Table 2. Outcomes of study population.

	Hemiarthroplasty (N=15)	rTSA (N=8)	All cases (N=23)
Reoperation			
No	14 (93.3%)	6 (75.0%)	20 (87.0%)
Yes	1 (6.7%)	2 (25.0%)	3 (13.0%)
Indication for first reoperation			
Deltoid tear	0 (0%)	1 (12.5%)	1 (4.3%)
Mechanical implant failure	0 (0%)	1 (12.5%)	1 (4.3%)
Aseptic loosening	1 (6.7%)	0 (0%)	1 (4.3%)
Not applicable	14 (93.3%)	6 (75.0%)	20 (87.0%)
Anterior-superior escape or dislocation			
No	6 (40%)	8 (100%)	14 (60.9%)
Yes	9 (60%)	0 (0%)	9 (39.1%)
Glenoid aseptic loosening			
No	0 (0%)	8 (100%)	8 (34.8%)
Yes	0 (0%)	0 (0%)	0 (0%)
Not applicable	15 (100%)	0 (0%)	13 (56.5%)
Humerus aseptic loosening			
No	14 (93.3%)	8 (100%)	22 (95.7%)
Yes	1 (6.7%)	0 (0%)	1 (4.3%)
Local tumor recurrence			
No	12 (80.0%)	7 (87.5%)	19 (82.6%)
Yes	3 (20.0%)	1 (12.5%)	4 (17.4%)
Forward flexion at last follow-up			
0 to 45 degrees	7 (46.7%)	0 (0%)	7 (30.4%)
45 to 90 degrees	5 (33.3%)	2 (25.0%)	7 (30.4%)
Greater than 90 degrees	1 (6.7%)	6 (75.0%)	7 (30.4%)
Unknown	2 (13.3%)	0 (0%)	2 (8.7%)
Length of follow-up (months)			
Median [Min, Max]	21.9 [4.50, 155]	41.1 [4.80, 122]	22.7 [4.50, 155]

rTSA = reverse total shoulder arthroplasty

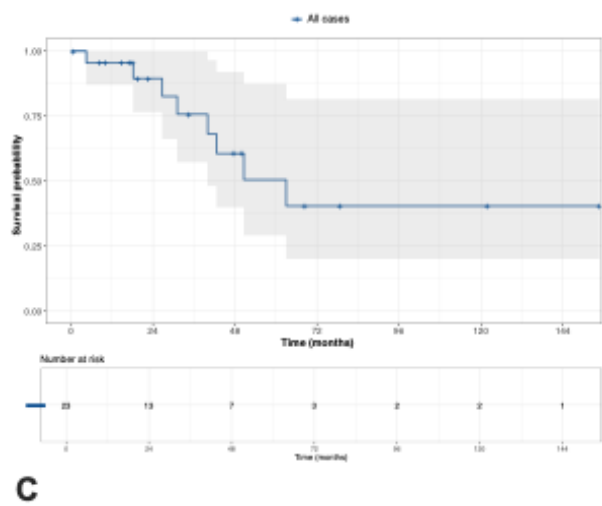
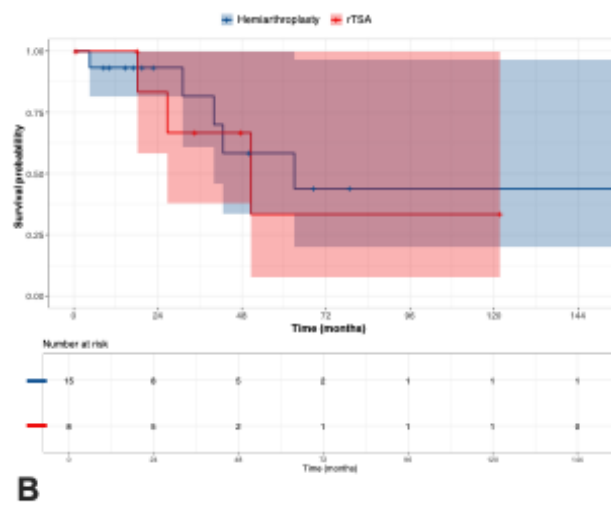
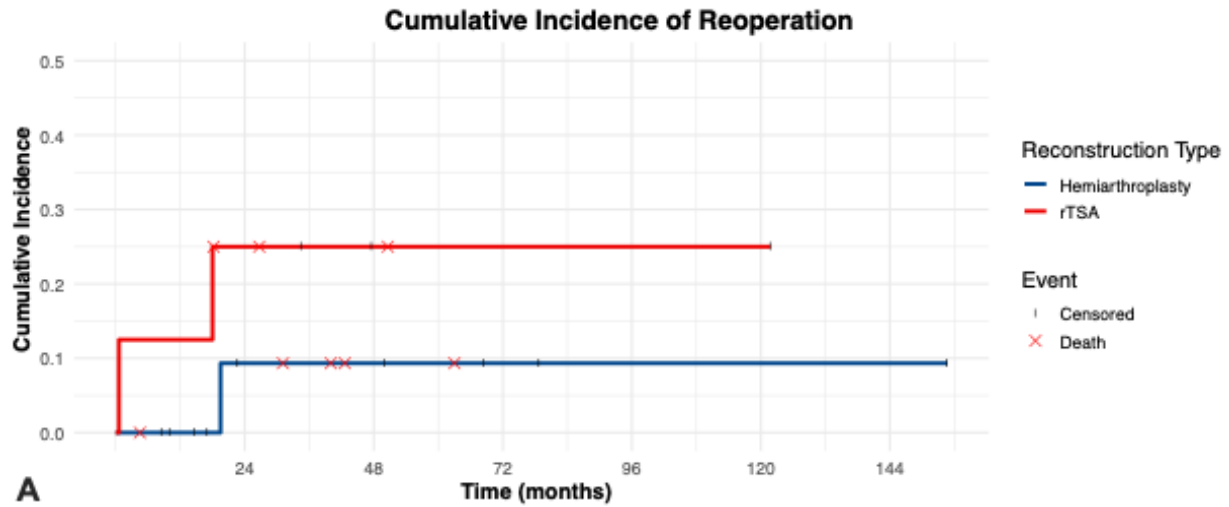


Figure 1. (A) The cumulative incidence of reoperation over time, in months, following hemiarthroplasty and rTSA. (B) The survival probability of hemiarthroplasty and rTSA patients over time, in months. (C) The survival probability for all patients included in the study over time, in months.