Demographic and Radiographic Predictors of Achieving the Minimum Necessary Internal Rotation After Reverse Shoulder Arthroplasty

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INTRODUCTION: Although reverse shoulder arthroplasty (RSA) is generally associated with excellent outcomes, attainment of patient satisfaction is often limited by insufficient internal rotation (IR) postoperatively. Prior studies have suggested that patients capable of reaching their thumb to or above the L3 vertebral level have the minimum necessary IR (MNIR) to perform activities of daily living. The purpose of this study is to determine which preoperative and intraoperative factors are predictive of patients achieving the MNIR as well as any improvement in IR after primary RSA using a lateralized humeral design.

METHODS: Primary RSAs performed using a single implant design (lateralized humerus, medialized glenoid) between January 2007 and December 2018 with minimum 2-year follow-up and complete preoperative and intraoperative data were included. Patients were excluded if they underwent revision or had an adverse event. Shoulders were grouped based on whether they achieved the MNIR and if IR score improved, did not improve, or stayed the same postoperatively. Factors evaluated included age, sex, body mass index (BMI), preoperative and postoperative active range of motion (IR score), and length of follow-up. Radiographic data analyzed included amount of humeral lengthening, prosthesis-–scapular neck angle, and inferior glenosphere overhang distance. Univariate and multivariate logistic regression were performed and odds ratios with 95% confidence intervals were reported.

RESULTS: 225 RSA patients were included. Demographic and perioperative shoulder characteristics (including radiographic data) were similar between patients with improvement in their IR versus patients with the same or worse IR post RSA (Table 1). Patients with improved IR score had lower preoperative and greater postoperative IR score compared to patients that experienced same or worse IR ($P < .001$ for both). On univariate logistic regression, preoperative IR score was the only metric that predicted postoperative IR, with higher preoperative IR predicting achieving the MNIR (1.23 [1.106,1.41], $P = 0.005$) and lower preoperative IR predicting improved IR (0.46 [0.37,0.57], $P < .001$) (Table 2). On multivariate logistic regression, the only predictor of achieving the MNIR was higher preoperative IR (1.21 [1.04,1.4], $P = .013$) while predictors of achieving any improved IR included male sex (2.12 [1.06,4.25], $P = .034$) and lower preoperative IR (0.42 [0.33,0.54], $P < .001$) (Table 2).

DISCUSSION AND CONCLUSION:

Our results suggest that the most reliable predictors of achieving MNIR and improved postoperative IR are preoperative IR and sex, while the amount of humeral lengthening, inferior glenosphere overhang, and prosthesis–scapular neck angle are not influential using a lateralized humerus, medialized glenoid design. Non surgeon modifiable factors may play a larger role in restoration and improvement of IR after RSA.

Table 1. Comparison of demographics and perioperative shoulder characteristics between patients with improvement in their IR score versus patients that were the same or worse.

Characteristic	Improved (ΔIR score > 0) (N = 135)	No change or worse (ΔIR score ≤ 0) (N = 90)	P value
Age at surgery (years)	70.9 ± 7.2	71.4 ± 7.8	.624
Body mass index (kg/m^2)	30.3 ± 6.5	28.9 ± 5.7	.090
Follow-up (years)	5.7 ± 2.6	5.7 ± 2.7	.828
Dominant side surgery	61.5% (83)	65.6% (59)	.682
Female sex	48.9% (69)	45.6% (49)	.723
Preop. IR score	2.5 ± 1.6	4.6 ± 1.6	**<.001**
Postop. IR score	5.0 ± 1.2	3.8 ± 1.6	**<.001**
Humeral lengthening (mm)	28.0 ± 9.6	29.3 ± 9.7	.337
Prosthesis-scapular Neck Angle (°)	92.9 ± 5.5	92.0 ± 6.3	.254
Overhang (mm)	8.1 ± 3.6	8.3 ± 2.6	.745

IR, internal rotation; Overhang, inferior glenosphere overhang.
Bold values indicate statistical significance.

Table 2. Preoperative predictors of achieving the MNIR (IR ≥ L3) postoperatively and having an improved IR score postoperatively after RSA using univariate and multivariate logistic regression analysis.

Preoperative Predictor	Univariate		Multivariate	
	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
IR ≥ L3				
Age at surgery (years)	0.99 (0.96,1.03)	.703	0.99 (0.95,1.02)	.431
Male sex	1.07 (0.63,1.8)	.813	0.94 (0.54,1.62)	.813
Body mass index (kg/m^2)	0.96 (0.92,1.00)	.054	0.97 (0.92,1.02)	.178
Preop. IR score	1.23 (1.06,1.41)	**.005**	1.21 (1.04,1.4)	**.013**
Humeral lengthening (mm)	1.00 (0.97,1.03)	.933	0.99 (0.97,1.03)	.997
Overhang (mm)	1.03 (0.95,1.12)	.472	1.06 (0.97,1.15)	.220
Prosthesis-scapular Neck Angle (°)	1.03 (0.99,1.08)	.190	1.04 (0.99,1.09)	.160
ΔIR score > 0				
Age at surgery (years)	0.99 (0.96,1.03)	.616	1.00 (0.95,1.04)	.911
Male sex	1.14 (0.67,1.95)	.624	2.12 (1.06,4.25)	**.034**
Body mass index (kg/m2)	1.04 (0.99,1.09)	.101	0.98 (0.93,1.04)	.549
Preop. IR score	0.46 (0.37,0.57)	**<.001**	0.42 (0.33,0.54)	**<.001**
Humeral lengthening (mm)	0.99 (0.96,1.01)	.334	0.98 (0.94,1.01)	.171
Overhang (mm)	0.99 (0.91,1.07)	.759	1.00 (0.90,1.12)	.988
Prosthesis-scapular Neck Angle (°)	1.03 (0.98,1.08)	.241	1.03 (0.98,1.10)	.249

CI, confidence interval; IR, internal rotation; Overhang, inferior glenosphere overhang.
Bold values indicate statistical significance.