Distal clavicle excision is not associated with adverse outcomes after reverse total shoulder arthroplasty

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INTRODUCTION: **:** Open distal clavicle excision (DCE) can be used to treat symptomatic acromioclavicular joint (ACJ) osteoarthritis (OA) in the setting of reverse total shoulder arthroplasty (RTSA). During RTSA, the coracoacromial (CA) ligament may be transected to assist in exposure. However, this may also lead to increased stress on the acromion and scapula spine during deltoid activation. If the ACJ assists in dissipating forces around the shoulder, then DCE could theoretically increase the risk of acromial stress fractures (ASF's) by affecting the stabilizing properties of the ACJ. Thus, the purpose of this study was to evaluate, in patients undergoing RTSA, the effect of concomitant open DCE on the clinical outcomes, including incidences of ASF's.

METHODS: All patients who underwent primary elective RTSA from 2015 to 2019 with minimum follow-up of 6 months were identified from an institutional database. Cases involving proximal humerus fractures or revision procedures were excluded. Subjects were grouped into RTSA or RTSA-DCE cohorts based on whether DCE was performed concomitantly with RTSA. Data including pre-operative and post-operative range of motion, Visual Analogue Scale (VAS) pain scores, and the incidence of adverse outcomes including ASF's and re-operation rates were collected and analyzed for differences between cohorts.

RESULTS:

One hundred and fifty-nine patients (62 RTSA, 97 RTSA-DCE), with a mean age of 70 years were included the final analysis. Demographics for the cohorts are shown in **Table 1**. There were no significant differences between the RTSA-DCE and RTSA cohorts in the rates of stress reaction (9% vs 8%, p = 0.79), stress fracture (2% vs 0%, p = 0.52), all-cause reoperation (3% vs 10%, p = 0.16), all-cause revision (3% vs 6%, p = 0.43), non-infectious revision (1% vs 3%, p = 0.56), or PJI (1% vs 3%, p = 0.56) between the RTSA-DCE and RTSA cohorts. Incidence of adverse outcomes, including ASF's and VAS pain scores for both cohorts are summarized in **Table 2**. Compared to the RTSA cohort, the RTSA-DCE cohort experienced significantly greater pre-to-postoperative improvement in flexion (44° vs 57°, $p \leq 0.05$) and greater reductions in VAS pain scores (-4.3 vs -3.1, p = 0.02). Data regarding ROM are summarized in **Table 3**. Multivariate analysis results are summarized in **Table 4**. In multivariate analysis, DCE was found to be an independent predictor of pre-to-postoperative improvement in flexion ROM (p = 0.04) and IR ROM (p = 0.03).

DISCUSSION AND CONCLUSION: Concomitant distal clavicle excision in RTSA does not increase the risk of acromial stress fracture but results in greater improvements in forward elevation and pain relief. Open DCE can be used for the treatment of symptomatic ACJ OA in the setting of RTSA, even when the CA ligament is transected, without increased risk of adverse outcomes.

Table 1. Study Demographics

	All (n = 121)	RTSA (n = 50)	RTSA-DCE (n = 71)	p-value
Age (years)	69 ± 9	68 ± 9	70 ± 9	0.18
Sex				< 0.001*
Male	44 (36%)	30 (60%)	14 (20%)	
Female	77 (64%)	20 (40%)	57 (80%)	
BMI	31 ± 7	31 ± 7	31 ± 7	0.67
ASA				0.34
1	1 (1%)	0 (0%)	1 (1%)	
2	46 (38%)	21 (42%)	25 (35%)	
3	68 (56%)	25 (50%)	43 (61%)	
4	6 (5%)	4 (8%)	2 (3%)	
Smoking history				0.03*
0	58 (48%)	19 (38%)	39 (55%)	
1	56 (46%)	30 (60%)	26 (37%)	
2	7 (6%)	1 (2%)	6 (8%)	
Diabetes	33 (27%)	11 (22%)	22 (31%)	0.27
Chronic kidney disease	17 (14%)	6 (12%)	11 (15%)	0.59
Rheumatological disease	13 (11%)	3 (6%)	10 (14%)	0.16
Cuff tear arthropathy	69 (57%)	30 (60%)	39 (55%)	0.71
Osteoporosis	17 (14%)	6 (12%)	11 (15%)	0.59
Preoperative VAS	6.1 ± 2.8	5.6 ± 2.5	6.4 ± 3.0	0.09
Follow-up time (months)	23 ± 14	24 ± 16	23 ± 13	0.73

All continuous variables reported as a mean ± standard deviation. All categorical variables reported as a count (% of cohort). The results of independent t-tests for continuous variables or chi-squared tests for categorical variables are shown as a *p* value. Significance was set at p≤0.05.

RTSA = reverse total shoulder arthroplasty; RTSA-DCE = reverse total shoulder arthroplasty and concomitant open distal clavicle excision.

Table 2: Postoperative Outcomes

	All (n = 121)	No AC resection (n = 50)	AC resection (n = 71)	p-value
Stress reaction	12 (10%)	4 (8%)	8 (11%)	0.76
Stress fracture	1 (1%)	0 (0%)	1 (1%)	1.00
All-cause reoperation	8 (7%)	5 (10%)	3 (4%)	0.27
All-cause revision	6 (5%)	3 (6%)	3 (4%)	0.69
Non-infectious revision	3 (2%)	2 (4%)	1 (1%)	0.57
Prosthetic joint infection	3 (2%)	2 (4%)	1 (1%)	0.57
Postoperative VAS	2.3 ± 2.7	2.2 ± 2.7	2.3 ± 2.6	0.82
Change in VAS	-3.2 ± 3.1	-3.3 ± 2.6	-4.1 ± 3.5	0.14

All continuous variables reported as a mean ± standard deviation. All categorical variables reported as a count (% of cohort). The results of independent t-tests for continuous variables or chi-squared / Fischer's exact tests for categorical variables are shown as a *p* value. Significance was set at p≤0.05.

RTSA = reverse total shoulder arthroplasty; RTSA-DCE = reverse total shoulder arthroplasty and concomitant open distal clavicle excision; VAS = visual analogue scale for pain.

Table 3: Preoperative and Postoperative Shoulder Range of Motion

	All (n = 121)	RTSA (n = 50)	RTSA-DCE (n = 71)	p-value
Preoperative flexion (degrees)	91 ± 38	101 ± 39	85 ± 36	0.02*
Postoperative flexion (degrees)	144 ± 29	143 ± 31	144 ± 27	0.92
Change in flexion (degrees)	53 ± 36	44 ± 39	59 ± 33	0.04*
Preoperative ER (degrees)	27 ± 16	29 ± 17	26 ± 15	0.33
Postoperative ER (degrees)	41 ± 10	41 ± 11	41 ± 9	0.91
Change in ER (degrees)	14 ± 17	12 ± 18	15 ± 16	0.39
Preoperative IR (scale)	3.3 ± 1.6	3.7 ± 1.6	3.0 ± 1.6	0.03*
Postoperative IR (scale)	3.9 ± 1.4	4.0 ± 1.5	3.9 ± 1.4	0.68
Change in IR (scale)	0.7 ± 1.7	0.3 ± 1.6	1.0 ± 1.7	0.051

All continuous variables reported as a mean ± standard deviation. The results of independent t-tests for continuous variables are shown as a *p* value. Significance was set at p≤0.05.

RTSA = reverse total shoulder arthroplasty; RTSA-DCE = reverse total shoulder arthroplasty and concomitant open distal clavicle excision; ER = external rotation; IR = internal rotation; VAS = visual analogue scale for pain.

Table 4: Results of Multivariate Analysis of Predictors of Outcomes.

	Odds ratio with 95% CI or regression coefficient with SE
Stress reaction	CTA (OR 16.3 [1.7 - 155.3], p = 0.02)
Stress fracture	No predictors
Reoperation	BMI (OR 1.3 [1.1 - 1.7], p = 0.008)
Prosthetic Joint Infection	No predictors
Change in flexion (degrees)	AC resection (β 19.0 [7.8], p = 0.02)
Change in ER (degrees)	No predictors
Change in IR (scale)	AC resection (β 0.872 [0.429], p = 0.05)
Change in VAS	No predictors

CTA = cuff tear arthropathy; BMI = body mass index; OR = odds ratio; CI = confidence interval; DCE = concomitant open distal clavicle excision; ER = external rotation; IR = internal rotation