The Influence of Calcar Comminution on Outcomes After Locked Plate Fixation of Proximal Humerus Fractures: An Analysis of Complication Rates, Range of Motion, and PROMIS

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Purpose: The purpose of this study is to compare outcomes up to 1 year after proximal humerus open reduction and internal fixation (ORIF) between fractures with or without calcar comminution. We hypothesized that calcar comminution would lead to higher complication rates and poorer functional outcomes.

Methods: Patients who underwent proximal humerus ORIF were retrospectively identified. Injury radiographs were reviewed to assess for calcar comminution, defined as at least 1 intermediate fragment in the area of medial curvature below the anatomic neck. Visual analog scale (VAS) pain scores and PROMIS (Patient-Reported Outcomes Measurement Information System) physical function (PF), pain interference (PI), and depression scores were obtained up to 1 year postoperatively. Range of motion (ROM) values including active forward flexion (AFF), passive forward flexion (PFF), and external rotation (ER) were recorded. Complications (screw cut-out, symptomatic hardware, avascular necrosis, hardware failure, deep infection, adhesive capsulitis) and reoperations (revision ORIF, conversion to arthroplasty, removal of hardware, irrigation and debridement, lysis of adhesions, biceps tenotomy) during the first postoperative year were identified. Outcomes were compared between those with and without comminution.

Results: From 2015-2018, a total of 75 patients met inclusion criteria. Of the 75 patients, 26 had calcar comminution and 49 without comminution. All results are listed in Table 1. Comminuted fractures had a higher complication rate than those without comminution (34.6% vs 14.3%, $P = 0.04$). Comminution was also associated with significantly higher revision/conversion rates (23.1% vs 2.0%, $P<0.01$). Comminuted fractures experienced decreased AFF at 3 and 6 months, ER at all time points except 2 weeks, and decreased PFF at all time points. No differences in VAS pain scores or PROMIS PF, PI, or depression scores were identified at any time point.

Conclusion: Calcar comminution is associated with higher complication and reoperation rates and decreased ROM during the first year after proximal humerus ORIF. However, this did not lead to worse patient-reported outcomes at any time point. This highlights the importance of medial support for successful proximal humerus ORIF. Greater consideration of alternative surgical options may be warranted when calcar comminution is present.

Table 1. Outcomes*

	Not Comminuted (N=49)	Comminuted (N=26)	†p-value
Any Complication (n) ǂ	**14.3% (7)**	**34.6% (9)**	**0.04**
Revision/Conversion (n) §	**2.0% (1)**	**23.1% (6)**	**<0.01**
Other Reoperations (n) ϕ	8.2% (4)	3.9% (1)	0.65
Malunion (n)	**10.2% (5)**	**50.0% (13)**	**<0.01**
Active Forward Flexion (Mean ± SD, °)			
2-week follow up	2.0 ± 13.4	2.6 ± 9.7	0.85
6-week follow up	38.6 ± 46.8	37.5 ± 32.7	0.92
3-month follow up	**107.6 ± 38.9**	**72.5 ± 40.2**	**<0.01**
6-month follow up	**124.8 ± 28.3**	**102.1 ± 32.3**	**<0.01**
1-year follow up	129.1 ± 32.3	107.5 ± 33.7	0.15
Passive Forward Flexion (Mean ± SD, °)			
2-week follow up	**30.8 ± 42.7**	**9.9 ± 26.0**	**0.03**
6-week follow up	**91.2 ± 46.6**	**59.9 ± 41.9**	**<0.01**
3-month follow up	**130.2 ± 31.7**	**94.6 ± 51.1**	**<0.01**
6-month follow up	**145.6 ± 20.9**	**117.2 ± 18.3**	**<0.01**
1-year follow up	**162.8 ± 15.4**	**106.4 ± 45.9**	**0.02**
External Rotation (Mean ± SD, °)			
2-week follow up	2.8 ± 10.0	1.4 ± 6.0	0.52
6-week follow up	**26.2 ± 21.7**	**10.9 ± 12.1**	**<0.01**
3-month follow up	**42.3 ± 18.6**	**29.5 ± 21.8**	**0.03**
6-month follow up	**51.4 ± 20.4**	**37.7 ± 19.6**	**0.04**
1-year follow up	**55.8 ± 21.3**	**30.6 ± 18.8**	**0.04**
VAS Pain Score (Mean ± SD)			
2-week follow up	2.6 ± 2.5	3.3 ± 3.2	0.33
6-week follow up	2.0 ± 2.1	2.2 ± 2.5	0.65
3-month follow up	1.6 ± 2.0	1.9 ± 2.2	0.58
6-month follow up	1.6 ± 2.1	2.5 ± 2.8	0.17
1-year follow up	1.0 ± 1.5	0.8 ± 1.2	0.68
PROMIS Pain Interference (Mean ± SD)			
2-week follow up	62.5 ± 6.7	64.8 ± 6.1	0.22
6-week follow up	58.3 ± 5.6	59.6 ± 6.0	0.40
3-month follow up	55.1 ± 7.6	55.8 ± 8.4	0.75
6-month follow up	53.3 ± 8.9	53.6 ± 7.7	0.90
1-year follow up	52.3 ± 8.7	51.9 ± 8.2	0.90
PROMIS Physical Function (Mean ± SD)			
2-week follow up	34.1 ± 7.7	30.5 ± 7.1	0.10
6-week follow up	37.9 ± 5.5	36.7 ± 8.2	0.51
3-month follow up	40.2 ± 8.3	39.9 ± 7.2	0.89
6-month follow up	43.1 ± 8.3	43.7 ± 8.2	0.82
1-year follow up	44.7 ± 7.3	44.2 ± 6.3	0.87
PROMIS Depression (Mean ± SD)			
2-week follow up	50.4 ± 10.8	51.7 ± 7.8	0.65
6-week follow up	50.0 ± 9.5	52.0 ± 7.4	0.41
3-month follow up	47.3 ± 10.2	47.4 ± 8.5	0.96
6-month follow up	48.0 ± 10.5	49.2 ± 9.1	0.72
1-year follow up	46.5 ± 11.3	46.4 ± 8.0	0.98

SD = Standard deviation; VAS = Visual analog scale; PROMIS = Patient reported outcomes measurement information system

***Boldface** indicates statistical significance.

†p-values calculated using independent t-tests, chi square analysis and fisher's exact test

ǂ Complications: Not Comminuted - intraarticular screw cutout (1), symptomatic hardware (1), avascular necrosis (2), hardware failure (1), deep infection (1), adhesive capsulitis (1), Comminuted – intraarticular screw cutout (5), avascular necrosis (1), hardware failure (3)

§ All conversions to RSA except 2 revision ORIF (Comminuted)

ϕ Other Reoperations: Not Comminuted –biceps tenotomy (1), removal of hardware (1), irrigation & debridement with removal of hardware (1), lysis of adhesions (1), Comminuted – removal of hardware (1)