The Impact of Reduction on Survivorship and Outcomes Following Locked Plate Fixation of Proximal Humerus Fractures

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Purpose: Treatment of proximal humerus fractures may be influenced by fracture pattern, age, bone quality, and surgeon expertise. We aimed to assess survivorship and outcomes in proximal humerus fractures (PHFs) treated with locked plating and the association between fracture reduction and outcome.

Methods: This IRB-approved cohort study identified 153 sequential, displaced PHFs treated with locked plate fixation from a single institution (2008-2020). Minimum follow-up was 12 months. Data including surgical, radiographic, and patient-reported outcome measures (PROMs) were collected. Kaplan-Meier method was used to assess survivorship free from revision.

Results: Mean age was 59 years (±15), 104 (68%) were female, and mean follow-up was 66 months (±37; range, 12-173) (Table 1). Fracture types included 77 four-part (50%), 56 three-part (37%), and 20 two-part (13%), 16 head-splits (11%), and 16 fracture-dislocations (11%). Postoperative coronal alignment was 135° (±11°). Adequate coronal alignment (120°-150°) was achieved in 139 (95%) and neutral coronal alignment (130°-140°) in 81 (53%). Sagittal reduction was neutral in 144 (94%). In 121 (79%), the medial column was restored with anatomic reduction, adequate calcar screw, or medialization and impaction of the shaft (Gardner criteria). Mean time to union was 5 months (±4). Survivorship free from revision was 93% at 1 year, 92% at 2 years, and 89% at 5 years. Revision for failure was performed in 15 (10%). Osteonecrosis was identified in 11 (7%). Arthroplasty was performed for posttraumatic arthritis or osteonecrosis in 9 (6%). Preoperative factors associated with postoperative failure included female gender, fracture-dislocation, valgus coronal alignment, fracture-dislocation, and medial calcar displacement ($P < 0.05$). Coronal alignment outside 120°-150° and sagittal malreduction were associated with failure ($P < 0.001$, $P = 0.045$; respectively). PROMs were visual analog scale (VAS)-Pain 1 (±1), American Shoulder and Elbow Surgeons (ASES) 84 (±20), QuickDASH (an abbreviated version of the Disabilities of the Arm, Shoulder and Hand [DASH] questionnaire 14 (±18), Constant score 83 (±16), Short Form (SF)-12-Physical 51 (±8), and SF-12-Mental 53 (±8). Mean active forward flexion was 147° (±32°), 142° (±32°) for active abduction, and 74° (±24°) for active external rotation. VAS-Pain, ASES, QuickDASH, SF-12 Physical, Constant score, and active forward flexion were significantly improved in patients without revision compared to those with revision ($P < 0.05$).

Conclusion: Excellent survivorship and outcomes were found following locked plate fixation of PHFs in this large cohort. Factors associated with failure included gender, fracture pattern (fracture-dislocation and calcar displacement), and reduction (coronal and sagittal alignment). Locked plate fixation continues to be a viable option for management of unstable PHFs.

Table 1. Baseline characteristics of the entire cohort and per group

Variables	All patients (N = 153)
Age (years); mean ± SD	59 ± 15
Age >65 years; N (%)	58 (38%)
Follow-up (months); mean ± SD (range)	66 ± 37 (12 – 173)
Female gender; N (%)	104 (68%)
Fracture type AO/OTA; N (%)	
11A	23 (15%)
11A1.1	0 (0%)
11A1.2	0 (0%)
11A2.1	13 (8%)
11A2.2	1 (1%)
11A2.3	8 (5%)
11A3	1 (1%)
11B	40 (26%)
11B1.1	34 (22%)
11B1.2	6 (4%)
11C	75 (49%)
11C1.1	17 (11%)
11C1.3	0 (0%)
11C3.1	60 (39%)
11C3.2	5 (3%)
11C3.3	8 (5%)
Coronal alignment (degrees); mean ± SD	141 ± 37
Coronal alignment (type)	
Varus (<130 degrees)	62 (41%)
Neutral (130-140 degrees)	11 (7%)
Valgus (>140 degrees)	80 (52%)
Sagittal alignment (type)	
Anterior	5 (3%)
Neutral	59 (39%)
Valgus	89 (58%)
Head split (>20%)	20 (13%)
Fracture dislocation	27 (18%)
Medial calcar displacement (mm); mean ± SD	10 ± 9
Metaphyseal extension (mm); mean ± SD	9 ± 11
>8mm	69 (45%)

SD indicates standard deviation; N, number