Quantifying Distal Deltoid Disruption with Linear vs. Curvilinear Plating of Proximal Humerus Fractures: A Cadaveric Study

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Background: Multiple surgical options exist for treating proximal humerus fractures, including closed reduction percutaneous pinning, open reduction internal fixation (ORIF), nailing, and arthroplasty. Within the realm of ORIF, linear plates placed anterolateral to the biceps groove have arguably been the gold standard. However, fixation of the distal aspect of these plates is associated with some degree of deltoid disruption. Given the recent rise in reverse shoulder arthroplasty (RSA) and its indication in the setting of failed ORIF, deltoid integrity merits discussion. As such, the purpose of this study is to quantify deltoid release (disruption) with standard linear vs. curvilinear plates utilized ORIF of proximal humeral fractures.

Methods: Eight nonpaired, fresh-frozen clavicle-to-fingertip cadaveric shoulders were acquired for the study (6 Left, 2 Right). Four different samples of proximal humerus hardware were obtained from local manufacturer representatives (R/L Arthrex AOS proximal humerus plate, R/L Stryker AxSOS 3 Ti Proximal Humerus Plating System 4-hole and 3-hole, R/L Synthes LCP® Periarticular Proximal Humerus Plate (3.5mm) 3-hole. The average age of the cadavers was 79.5 years (range: 64-92). A deltopectoral approach was carried out on all specimens. Upon further examination, 1 of the L-sided specimens had a prior history of malunion proximal to the deltoid insertion and was therefore only included to assess the average size of deltoid insertion. Subsequently, the plates were placed in the seven remaining cadaveric shoulders in the proper location. The amount of removal was measured. Plate manufacturer types and sizes were compared based on the amount of deltoid insertion necessary to release for proper plate positioning. Statistical analysis was completed using basic univariate statistics and a paired t-test.

Results: The average length of the deltoid insertion was 39.45 ± 9.33mm (n=8). The curvilinear AOS plate required an average release of 4.06 ± 4.45 mm (12.09%) (p=0.872) (n=7). The linear 3-hole plate required an average release of 11.46 ± 7.09 mm (32.68%) (p=0.0052) (n=7). The linear 4-hole plate required an average release of 18.79 ± 6.74 mm (48.94%) (p=0.0003) (n=7). The linear Synthes 3-hole plate required an average release of 23.00 ± 6.7 mm (62.76%) (p=0.0001) (n=7).

Discussion: The current study demonstrates that linear plates require 19—48% more deltoid release than curvilinear plates. Given the inferior results of RSA in the setting of prior ORIF when compared to cuff tear arthropathy (CTA), rotator cuff tear, and glenohumeral degenerative joint disease indications, distal deltoid disruption may be another variable affecting outcomes in these patients. Further studies assessing deltoid integrity and clinical outcomes post RSA (after failed ORIF) are warranted.

Clinical Relevance: This study can be used to guide surgeons when selecting hardware for proximal humerus fracture ROIF. If a patient is likely to have a RSA in the future, utilizing a curvilinear plate may lead to more favorable outcomes than traditional plates as they lead to significantly less deltoid disruption, as demonstrated in this study.

Table 1: Amount of Deltoid Insertion Disruption by Plate Type

Table 2					
Amount of Deltoid Insertion Disruption (mm)					
Plate	Type	Curvilinear	Linear	Linear	Linear
	Design	Arthrex	Stryker 4 hole	Stryker 3 Hole	Synthes 3 hole (mm)
Specimen	LS1	6	10.9	0	22.1
	LS2	11.7	21.1	21.1	34.7
	LS3 (Malunion)	N/A	N/A	N/A	N/A
	LS4	0	25	11.5	19.5
	LS5	4	27.9	14.6	27.9
	LS6	0	19.5	5.9	20
	RS1	0	9.8	9.8	13.7
	RS2	6.7	17.3	17.3	23.1
Disruption	Average	4.06	18.79	11.46	23.00
	Std Deviation	4.45	6.74	7.09	6.70
% of Deltoid Released	Average	12.09	48.94	32.68	62.76