

Original research article

Study of Functional Outcome of Proximal Humerus Fracture Fixation Using Modified Deltoid Splitting Approach with Axillary Nerve Bundle Mobilization

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Abstract

Introduction: Proximal humerus fracture patterns being mainly distributed bimodally differentiating between young male and elderly female patients due to high energy trauma like vehicle accident and osteoporosis respectively. The broad majority of proximal humeral fractures are handled non-operatively but few critical fractures need surgery. The purpose of this study was to describe a modified deltoid splitting approach with axillary nerve bundle mobilization in the treatment of proximal humeral fractures and to assess its clinical outcomes.

Material And method: Forty consecutive patients with proximal humeral fractures were treated with by using a modified deltoid splitting approach with axillary nerve bundle mobilization. Among forty patient five patients were lost to follow up, thirty-five patients were reviewed in our department and had regular follow up.

Results: The mean age of the study population was (53.97±11.80 years). One patient had clinically detectable sensory deficits in the axillary nerve later improved by physiotherapy. Two patients had implant failure for which revision was done and one patient had superficial infection improved by antibiotic coverage according to culture sensitivity report and one patient had deep infection improved by debridement and higher intravenous antibiotic coverage according to culture sensitivity report. Major complications, such as avascular necrosis of the humeral head and varus collapse at the fracture site, were not observed. The mean visual analog score for patient satisfaction was 9.1 (range, 6–10), and the mean neer scores were 83.46±7.11. Distribution of cases as per neer's score we have found that most of the cases i.e. 45% belong to good followed by 35% belong to excellent and 7.5% belong to fair outcome.

Conclusion: The use of a modified deltoid splitting approach with axillary nerve bundle mobilization in the treatment of proximal humeral fractures yielded excellent outcomes. This approach is a useful alternative to the deltopectoral approach.

Keywords: Proximal humeral fracture, Deltoid splitting approach, Deltopectoral approach

Introduction

Proximal humerus fracture is becoming increasingly prevalent with rapidly expanding population, accounting for 6% of all fractures in the human body [1] Fracture patterns being mainly distributed bimodally (2), differentiating between young male and elderly female patients due to high energy trauma like vehicle accident and osteoporosis respectively (3). The broad majority of proximal humeral fractures are handled non-operatively but few critical fractures need surgery. The optimal treatment for proximal humeral fractures is controversial [4]. It includes conservative treatment, open reduction internal fixation (ORIF), minimal invasive plate osteosynthesis (MIPO), intramedullary nailing and arthroplasty reported in literature [5,6,], however most of the fracture fixation via deltopectoral approach.[7]. Advantages of this approach are potential wide exposure, minimal bleeding and while disadvantages are massive devascularization of soft tissue, difficulty in exposing the glenoid, greater tuberosity and rotator cuff. [8,9]. Minimally Invasive Plate Osteosynthesis (MIPO) is a recent technique that focus on the use of preserving the blood supply of bone and less devascularization of soft tissue [9]. Another surgical approach is Modified Deltoid splitting **enables** reduction & plate fixing without powerful retraction & soft tissue injury, providing effort less entry to posterior tubercular fragment. Modified deltoid splitting approach, by inspecting the axillary nerve, is a helpful surgical technique which gives a comprehensive & multi-dimensional control avoiding endangers the deltoid muscle function & the axillary nerve. (10). The location of anterior branch of the axillary nerve is consistent and is rarely associated with anatomic variations. A 2-cm extension of the conventional deltoid splitting approach incision results in good exposure of the axillary nerve bundle. Isolation and mobilization of this bundle may improve the exposure of the fracture site and aid in reinforcing the plate fixation with additional screws [11]. The purpose of this study was to describe a modified deltoid splitting approach with axillary nerve bundle mobilization in the treatment of proximal humeral fractures and to assess its clinical outcomes.

Material And Methods

After obtaining clearance and approval from the institutional ethical committee and patients fulfilling the inclusion/ exclusion criteria were included in the study .Patients of age >18 irrespective of sex with displaced proximal humerus fracture and who have given written consent for participation in study were included. . Patients aged less than 18 years, patient unfit for surgery due to medical ailment, patient with pathological fracture, associated fracture on ipsilateral humerus, associated dislocation of humeral head , presented more than 2 weeks were excluded.

Surgical Technique

The approach is done in a supine position, with a bump or roll placed under the spine or ipsilateral scapula elevation of the head of the table reduces venous pressure in the operative field alternatively, a 'beach chair' positioning adaptor may be used depending on surgeon preference. Intraoperative imaging by C-arm can either come from above the head or across the bed from the opposite side of the table ensure adequate fluoroscopic views can be obtained prior to preparation and draping. 5 cm incision is made from the tip of the acromion distally in line with the arm this is generally made at the posterior edge of the clavicle, but can be adjusted according to pathology. For Superficial dissection, deltoid is split in line with its fibers no more than 5 cm distal to the lateral edge of acromion (to protect the axillary nerve), a stay suture is placed at the inferior apex of the split to prevent propagation of the split .For Deep dissection, subacromial bursa lies directly deep to the deltoid muscle and can

be excised to reveal the underlying rotator cuff insertion and proximal humerus. distal extension is only possible by performing a second, separate deltoid split distal to the axillary nerve the approach can be extended proximally parallel to the spine of the scapula to expose the entire supraspinatus. Axillary nerve leaves posterior aspect of axilla by traversing quadrilateral space (teres minor, teres major, long head of triceps, medial border of humerus) ,it travels around the humerus coursing anteriorly and laterally to enter and innervate the deltoid via its deep surface at this point, it runs transversely 5-7 cm distal to the edge of the acromion from posterior to anterior cannot extend split further due to risk to denervation of anterior deltoid need to make a second incision distally in order to provide a safe "second window" if distal extension is needed (generally for fractures).



Postoperative evaluation and management

Following surgery patients were hospitalized for required period of time (usually 5 to 7 days) and followed up for 6months and Functional outcome measured using neer, vas score and manual muscle strength grading. Rehabilitation by Arm Sling applied immediately post op, Limb elevated, Passive elbow, wrist and hand movements started on the day of surgery. This continued for one week. Passive range of movements of shoulder started at 2 weeks. First forward elevation, external rotation and pendulum exercises started. Passive exercise for 4-6 weeks. If healing adequate active exercise after 4-6 weeks. Strengthening exercise after adequate ROM is achieved, Free mobilization out of sling after 6 weeks.

Statistical analysis: The collected data were revised, coded, tabulated and introduced to a PC as master sheet. The data was compiled using MS-Excel worksheet and analyzed using primer and SPSS software(trial version). The data were presenting in table and graphs wherever applicable. Quantitative variables were expressed as mean and SD. Qualitative variables were expressed as frequencies and percent. A significance level of $P < 0.05$ was used.

Results

In the study, Mean age was 53.97 ± 11.80 years. RTA injury was most common followed belong to slip and fall. 47.5% belong to 3 Neer parts followed by 27.5% belong to 2 Neer parts. NEER score (Mean \pm SD) was for Baseline, 2 weeks, 6 weeks and 6 months of timeframe i.e. 52.23 ± 4.20 , 59.34 ± 4.42 , 69.11 ± 5.09 and 83.46 ± 7.11 respectively Functional outcome assessed by NEER Score was continuously improved with the follow up. Pain assessment was done by using VAS score. Mean \pm SD values of VAS for baseline, 2 weeks, 6 weeks and 6 months were 9.23 ± 0.81 , 8.26 ± 0.82 , 5.74 ± 1.01 and 2.91 ± 1.25 respectively. VAS Score was continuously improved with the follow up. Axillary nerve injury was most common peripheral nerve injury observed and strength of this was assessed by deltoid muscle strength and teres muscle strength. As per deltoid muscle strength, 47.5% cases belong to 4 strengths followed by 20% cases

belong to strength 3 and so on. The least one was 5% for strength grade 2. As per teres muscle strength, 35% of cases belong to strength 4 followed by 32.5% for strength 5 and so on. The least one i.e., 5% for strength 2. The deltoid splitting approach is very good option for treating Neer's type 2,3,4 and repair of rotator cuff is also feasible. The disadvantage is that fracture dislocation is difficult to manage and it requires most of the time deltopectoral approach. Early complication was observed in axillary nerve palsy (2.5%) and superficial infection (2.5%) while late complications were implant failure in two cases (5%) and deep infection in one case (2.5%) was observed in one case only. In superficial infection higher antibiotic coverage according to culture sensitivity report and deep infection was treated by debridement + higher antibiotic coverage. In implant failure Revision was done.



Distribution of cases as per Neer's score we have found that most of the cases i.e., 45% belong to good followed by 35% belong to excellent and 7.5% belong to fair outcome.

Table1: CHARACTERISTICS OF THE STUDY POPULATION

		Number	Percentage (%)
	Number of cases		40
Age	<40	6	15
	41 to 50	9	22.5
	51 to 60	11	27.5
	61 to 70	12	30
	>70	2	5
			53.97±11.80 years
Gender	Female	18	45
	Male	22	55
Fracture Side	Right	24	60
	Left	16	40
Mode of Injury	RTA	36	90
	Slip and Fall	3	7.5
	Assault	1	2.5
Associated injury	Shaft ulna	2	5
	Legbone left	1	2.5
	Chest injury	1	2.5
	Distal humerus	1	2.5
	Soft right	1	2.5

Table 2: NEER SCORE AND VAS SCORE

		BASELINE	2 weeks	6 weeks	6 months
Neer Score (N=35)	Mean	52.23	59.34	69.11	83.46
	Std. Deviation	4.2	4.42	5.09	7.11
VAS (N=35)	Mean	9.23	8.26	5.74	2.91
	Std. Deviation	0.81	0.82	1.01	1.25

Table 3: VAS SCORE AND NEER SCORE (PAIRED TEST)

	VAS SCORE					NEER SCORE				
	Mean ± S D	Std. Deviation	95% Confidence Interval of the Difference		P Value LS	Mean ± SD	SD	95% Confidence Interval of the Difference		P Valu LS
			Lower	Upper				Lower	Upper	
2wk baseline	-0.97	0.3	-1.07	-0.87	<0.001 S	7.11	2.42	6.28	7.95	<0.001 S
6 wk baseline	-3.49	1.2	-3.9	-3.07	<0.001 S	16.89	3.33	15.74	18.03	<0.001 S
6m baseline	-6.31	1.28	-6.75	-5.88	<0.001 S	31.23	7.19	28.76	33.7	<0.001 S
6 wk -2 wk	-2.51	1.27	-2.95	-2.08	<0.001 S	9.77	2.34	8.97	10.58	<0.001 S
6m -2wk	-5.34	1.33	-5.8	-4.89	<0.001 S	14.34	6.01	12.28	16.41	<0.001 S
6 m- 6wk	-2.83	1.12	-3.21	-2.44	<0.001 S	24.11	6.84	21.77	26.46	<0.001 S

Table 4: OUTCOME ANALYSIS

		NUMBER	PERCENTAGE (%)
Deltoid muscle strength (N=40)	0	0	0
	1	0	0
	2	2	5
	3	8	20
	4	19	47.5
	5	6	15
	Lost to follow up	5	12.5
Management of complication	Debrid + Higher antibiotic	1	2.5
	Higher antibiotic	1	2.5
	Physiotherapy advised	1	2.5
	Revision done	2	5
Teres minor muscle strength	0	0	0
	1	0	0
	2	2	5
	3	6	15
	4	14	35
	5	13	32.5
	Loss to follow up	5	12.5
Early complication (n=40)	Axillary nerve palsy	1	2.5
	Superficial infection	1	2.5
Late complication	Deep infection	1	2.5
	Implant failure	2	5
	Varus malunion	0	0
	Screw cut-out	0	0

Discussion

This study is a prospective functional outcome analysis post fracture fixation of proximal humerus fractures using Modified deltoid splitting approach. The total patients were 40. All were evaluated clinically and radiologically and classified according to Neer's classification. All patients underwent fixation using Modified deltoid splitting approach. The proximal humerus fractures are common in old age and osteoporotic bone. Proximal humeral fractures follow the standard bimodal distribution in trauma, resulting from high-energy mechanisms in young patients (often motor vehicle collision or fall from height), and low-energy mechanisms in elderly patients (often ground-level falls) [12]. In our study, we have found that 30% belong to 61 to 70 years of age group followed by 27.5% for 51 to 60 years, 22.5% for 41 to 50 years, 15% for less than 40 years and least was 5% for greater than 70 years of age group. The maximum cases were observed in 51 to 60 age groups. In age groups <60, 65% were observed and in >60 age groups 35% cases were observed in the study Mean age was 53.97 ± 11.80 years. In this approach, neurovascular bundle was mobilized from fracture site and aid in reinforcing the plate fixation with additional screws. During the dissection there is a risk of damaging axillary nerve [13] and coexisting posterior humeral circumflex artery which was recently considered to be one of the main blood suppliers to the humeral head [14], we isolated the NV bundle along with the adjacent soft tissues without dissection [15,16]. As a result, one of the patients had any axillary nerve injury related symptoms but muscle strength improved by physiotherapy. Major complications, such as avascular necrosis of the humeral head and varus collapse at the fracture site, were not observed.



Varus deformity at the fracture site is the main cause of treatment failure in proximal humeral fractures [17]. All the fractures were classified as per Neer's classification. In our study we have observed that 47.5% belong to 3 Neer parts followed by 27.5% belong to 2 Neer parts and 25% belong to 4 Neer parts. Our findings were correspondence with other studies too, Vijayvargiya M et al 2016 [18]. 15 % were most common fracture type III, followed by type II. In Lokesh Sharma D et al 2019 [19] Outof the 34 cases in this study, 13 cases (38.2%) were Neer's 2-part fractures. 15 cases were found to be Neer's 3-part fractures (44.1%), 6 cases were Neer's 4-part fractures and they were fixed with either modality of internal fixation selected randomly.

It is observed that young adults mostly males have better functional outcome than old age patients.

Mostly because of early reporting to hospital, good bone stock, no comorbidities and good patient compliance in rehabilitation follow up. In old age group functional demands are less and they can well manage with an outcome of fair to good. The simpler the fracture pattern and early reduction using this approach gives excellent results. Type 2 and 3 are best to treat with

this approach providing excellent results. The importance of physical rehabilitation cannot be ignored. The strict rehabilitation protocol should be followed. Even if there is minor malreduction, with proper rehabilitation good functional outcome can be achieved. The patients who will develop stiffness during the course of treatment can be rehabilitated with aggressive physiotherapy. The deltoid splitting approach is very good option for treating Neer's type 2, 3, 4 and repair of rotator cuff is also feasible. The disadvantage is that fracture dislocation is difficult to manage and it requires most of the time deltopectoral approach.

Summary and Conclusion

Fractures of the proximal humerus have varied patterns and are complex injuries to manage. The options as to the management modality used depend on the pattern of the fracture, age of the patient, the quality of the bone encountered, the patient's goals and the surgeon's familiarity with the techniques. The modified deltoid splitting approach with axillary nerve bundle mobilization yielded excellent radiologic and functional outcomes in the treatment of proximal humeral fractures type 2,3,4. It is a viable and easy approach for proximal humerus fracture fixation type 2,3,4. This approach is associated with low incidence of malreduction. In this study the functional outcome is found to be good. This approach was not associated with AVN, varus deformation, sensory deficits of axillary nerve territories, or weakness of the anterior deltoid muscle. This approach would be a useful alternative to the deltopectoral, or deltoid splitting approaches in the treatment of proximal humeral fractures 2,3 4.

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