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Comparative study between delto-pectoral and deltoid splitting approach in surgical treatment of proximal humerus fractures using philos plating

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ABSTRACT

Background: The present study was done to compare the two approaches of proximal humerus PHILOS plating on the basis of functional outcome of patients and other perioperative parameters.
Methods: 40 patients with type 2 and type 3 proximal humerus were assigned to group A and B pre-operatively using random alternate allocation. Patients in group-A were operated with deltoid splitting approach while patients in group-B were operated with delto-pectoral approach. Functional outcome was assessed at 6 weeks, 3-months and 6-months. Perioperative parameters like duration of surgery, associated complications, and hospital stay were also noted and compared.
Results: In each group, there were 12 two-part fractures and 8 three-part fractures. For 2-part fractures the mean duration of surgery was 51.33 min for group A and 63.37 min for group B. While for 3-part fractures it was 67.5 min and 80 min respectively. Irrespective of fracture type, there was statistically significant difference between the constant scores in both groups at 3 months (2-part: group A: 67.67; group B: 44.7; p value=0.001. 3-part: group A: 66; group B: 48; p value=0.001). However, the difference between two groups at 6 months was not statistically significant.
Conclusions: Both approaches show satisfactory outcomes over a long period. However, the significantly less operative time and minimal soft tissue dissection in deltoid splitting approach can be used as an advantage in particular cases. Moreover, there was an early return to day-to-day activities for the deltoid splitting group which should be considered when treating an active individual.

Keywords: Humerus fracture, PHILOS, Humerus, ORIF humerus

INTRODUCTION

Proximal humeral fractures consist of fractures occurring at or proximal to the surgical neck of the humerus. It is the commonest fracture affecting the shoulder girdle in adults and its incidence is rising.

The present data indicate that 80% of all humerus fractures comprise of fractures of proximal humerus. Proximal humeral fractures comprise of 7% of all fractures in the body. It is the 2nd most common fracture of the upper extremity in patients above the age of 65. It is the 3rd most common nonvertebral osteoporotic fracture after proximal femur and distal radius.[1]

These fractures have more predilection for females. Although the incidence in males is 15-30%, it is likely to rise in future.[3] The average age of a patient presenting with proximal humerus fracture also appears to be rising. The average age of the presenting patient was 63 years in 2002 but it has increased to 66 in the year 2010. The majority of patients are 50 or older.[4]

Majority of proximal humerus fractures are managed conservatively. However, surgical management is being preferred. With modern advancements in surgery, fracture reconstruction is gaining popularity over prosthetic replacement. Surgical preference ranges from 10-40% in different institutions. Interestingly, in regions with lower incidence of fractures, surgical treatment is preferred.[5]

Many studies support good outcomes of non-operative management in non-displaced fractures but a recent prospective study shows that conservative management of undisplaced fractures of proximal humerus can cause significant functional impairment with 2/3rd of the patients complaining of chronic pain. This is commonly seen in the elderly with 2-part proximal humerus fractures who live independently with no additional nursing care. This accounts for considerably poor quality of life in these people.[4]

The modus operandi of management includes non-operative and operative (closed as well as open) treatments based on the fracture type and classification. Non-operative treatment consists mostly of sling immobilization but many variables are to be considered in this modality of treatment like age, fracture type, and displacement. Closed operative method consists of closed reduction and percutaneous pinning and can be done in 2-part and some 3-part fractures. The most common method still remains ORIF with plating. Other modalities are intramedullary nailing and hemi or complete arthroplasty for which indications are limited.

Pre-contoured locking compression plates are fixed angled devices which prevent subsidence in the metaphyseal areas. These plates alleviate the risk of malreduction and preserve the blood supply to the bone. Technique for the fixation of two-, three-, and four-part proximal humerus fractures has rapidly shifted towards the use of locking plates. Most commonly used is PHILOS plate. Now this open fixation is achieved by two approaches- deltoid splitting and delto-pectoral approach.

The anterior delto-pectoral approach has traditionally been the workhorse of surgeries around the shoulder since a long time.

Deltoid splitting approach is a relatively newer modality in which the proximal humerus is accessed from the lateral aspect and is believed to make the reduction of tuberosities and plate fixation easier. Deltoid splitting approach is also a relatively less invasive one. This approach allows a direct access to the greater tuberosity as well as the area between the greater and lesser tuberosities, just lateral to bicipital groove allowing direct manipulation of humeral head.[6] The hardware placement is also in line with the direction of incision.[7] Some surgeons avoid this approach due to potential risk of injury to the anterior branch of axillary nerve.[7] However, axillary nerve can be identified by direct visualization or palpation during surgery and protected.

The delto-pectoral approach provides direct visualization of the fracture site and the medial calcar. It uses the interval between pectoralis major and deltoid. Some previous studies suggest a better functional outcome with delto-pectoral approach then deltoid splitting.[8] However, it has been noted that difficulties arise in exposure of cases of greater tuberosity fractures and fractures with retroversion of humeral head.[7]

On the other hand, there are multiple studies that emphasize the ease of reduction and higher functional outcome in early stages for deltoid splitting approach.[6,9]

The aim of the study was to compare both the approaches and their functional outcome, based on constant Murley score. Also, various peri-operative and post-operative parameters have been compared between the two.

METHODS

After obtaining approval from the institutional research board and informed consent of the patient, this study was conducted on a sample size of 40 patients. The patients were distributed into two groups by random alternate allocation. Patients in group A were operated using the deltoid splitting approach while patients in group B were operated using delto-pectoral approach.

Patients with fractures of the proximal humerus classified as type 2 and type 3, according to Neer's classification and age greater than 18 years were included in the study. Patients with dislocation of head humerus, other bony injuries in the ipsilateral upper limb or neurological deficit of the upper limb were excluded.

Detailed history was taken, and thorough general examination was done with special emphasis on features of proximal humerus injuries. Systemic examination was also done along with routine blood investigations. The fractures were evaluated by antero-posterior and axillary view radiographs of the shoulder and a 3-D reconstruction computed tomography (CT) scan of the shoulder if required.

Patient were taken in a beach chair supine position.

For deltoid splitting approach, firstly the anatomical landmarks are marked- lateral border of the acromion and lateral aspect of the proximal humeral shaft. Skin incision is made from lateral border of acromion 5 cm distally along the shaft of the humerus. If the skin incision need be extended based on fracture pattern, then the incision is extended in the same plane as a separate distal incision, leaving 2 cm from the end of the proximal incision. This is done to protect the axillary nerve that has a very defined course through this part (Figure 1 showing two window

deltoid splitting approach). Or the axillary nerve was explored if the incision was single and extended.

Next, we split the acromial part of deltoid along its fibers through the mid raphe and humerus is exposed. This entire approach works through an almost avascular plane safe even from the circumflex arteries. The axillary band is digitally palpated and its location is identified. Reduction of fracture is done under imaging guidance. The axillary nerve band is digitally lifted from the humerus and PHILOS plate is slid beneath, along the bone. After achieving accurate reduction, the plate is fixed with appropriate number of screws- at least 5 in the head and 2 or more in the shaft. Thorough lavage of the joint is done to clear off any remaining debris. Deltoid is sutured in layers with no 2-0 vicryl with care to protect the axillary nerve followed by subcutaneous tissue. Skin is sutured with ethilon/skin staples. Compression bandage dressing done and an armsling pouch is applied.

In the patient operated with delto-pectoral approach. The landmarks which are marked are coracoid process, proximal humeral shaft and the acromion. A 12 cm long incision is taken from coracoid along the humeral shaft towards the insertion of deltoid. Interval is developed between the pectoralis major and deltoid taking care of the cephalic vein which should be retracted laterally or medially. Clavipectoral fascia is identified. Clavipectoral fascia is incised lateral to the conjoined tendon and inferior to coracoacromial ligament. The subscapularis tendon is identified and split vertically followed by a vertical capsulotomy. Traction over musculocutaneous nerve is avoided throughout the dissection.

The fracture is reduced under imaging guidance, medial calcar is reconstructed. Temporary k wires might be used for fixation. The plate is applied lateral to the bicipital groove. Plate is fixed using unicortical screws in the head and bicortical in the shaft. Reduction is again checked under imaging guidance. Capsule is sutured followed by fascia in layers with no 2-0 vicryl with care to protect the axillary nerve. Then subscapularis is repaired followed by suturing of the subcutaneous tissue layer. Skin is sutured with ethilon/skin staples. Compression bandage dressing done and an armsling pouch is applied.

Post-operatively on post op day-1 X-ray is done of the respective shoulder in AP and lateral views.

Patients were put on physiotherapy rehabilitation protocol the very next day irrespective of the group achieving full passive range of motion (ROM) within 4-6 weeks and full active ROM in 8-10 weeks followed by strengthening exercises.

Suture removal was done after 2 weeks. Patients were followed up at 6 weeks 3 months and 6 months. At each visit functional outcome was assessed using the constant Murley score. Patients were assessed for any complication.

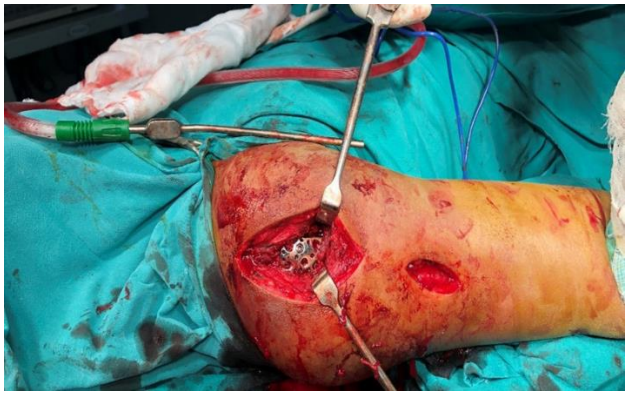

Figure 1: Two window deltoid splitting approach.

RESULTS

The mean age in our study was 38 years for 2-part fractures and 35 for 3-part fractures. The youngest patient was 18 years old and the oldest patient was 60 years old.

In our series of 40 patients, 32 patients (80%) were males and 8 patients (20%) were female, (male predominance). It may be because of the involvement of males in outdoor activities like sports and road traffic accidents. However, both groups had 16 males and 4 females.

In each group, there were 12 two-part fractures and 8 three-part fractures as classified according to Neer's criteria. The average duration of hospital stay was 4 to 5 days for both groups irrespective of the fracture type.

For 2-part fractures the mean duration of surgery was 51.33 min for group A and 63.37 min for group B. This difference in duration of surgery was found to be statistically significant i.e. p value <0.05 (p value=0.006). While for 3-part fractures the mean duration for surgery for group A was 67.5 min and 80 min for group B. This difference too was found to be statistically significant (p value=0.017).

Functional outcome was assessed using the constant-Murley score at the 6-weeks, 3 months and 6 months visit. For 2-part fractures, group A had mean constant score was 32.3 at 6 weeks, 67.67 at 3 months and 81 at 6 months. For group B the mean constant score at 6 weeks was 30.88, at 3 months was 44.7 and at 6 months was 79.67. There was statistically significant difference between the constant scores in both groups at 3 months (group A: 67.67; group B: 44.7; p value=0.001). But it was not significant at 6 months. Similarly for 3-part fractures also functional outcome was assessed using the constant Murley score at the 6-week, 3-month and 6-month visit. For group A the mean constant score at 6 weeks was 33.25, at 3 months was 66, at 6 months was 79.5. For group B the mean constant score at 6 weeks was 30.5, at 3 months was 48 and at 6 months was 77.50. There was statistically significant difference between the constant scores in both groups at 3 months (group A: 66;

group B: 48; p value=0.001). However, the difference between two groups at 6 months was not statistically significant.

Table 1 shows comparison of various parameters between both groups in 2-part fracture patients. All comparative data related to 3-part fractures is shown in Table 2.

Early superficial infection of suture site was present in only 1 case in group B with delayed wound healing. There was no deep infection. It was resolved by local wound care and oral antibiotics. No other complications were seen in any of the patients.

Signs of union were seen in all 40 patients at 3-month follow-up. Clinically it was assessed by absence of local tenderness and an acceptable active assisted range of motion. Radiologically callus formation and development of trabecular continuity were accepted as signs of union. The mean time to union for group A was 2.8 months (range 2.4 to 3.2 month) and for group B was 3 months (range 2.4 to 3.4). This difference was not significant.

Table 1: Functional outcomes of two-part fractures.

2 part	Group A (N=24)		Group B (N=24)		Z	P value
	Mean	SD	Mean	SD		
Age	37.83	19.416	38.17	13.243	-0.035	0.973
Hospital stay	4.50	0.548	4.67	0.516	-0.542	0.599
Operative time	51.33	4.546	63.67	7.394	-3.481	0.006
Constant-Murley score						
6 weeks	32.33	1.966	30.83	4.070	0.813	0.435
3 months	67.67	2.944	44.67	2.733	14.026	0.000
6 months	81.00	3.286	79.67	3.670	0.663	0.522

Table 2: Functional outcomes of three-part fractures.

3 part	Group A (N=16)		Group B (N=16)		Z	P value
	Mean	SD	Mean	SD		
Age	35.25	17.557	34.50	1.732	0.085	0.935
Hospital stay	4.25	0.500	4.75	0.500	-1.414	0.207
Operative time	67.50	2.887	80.00	7.071	-3.273	0.017
Constant-Murley score						
6 weeks	33.25	3.500	30.50	1.915	1.379	0.217
3 months	66.00	3.651	48.00	4.320	6.364	0.001
6 months	79.50	2.517	77.50	3.416	0.943	0.382

Figure 2: Case of 18-year-old male with H/O fall from bike operated with PHILOS platting using the deltoid splitting approach, (a) pre-op X-ray; (b) post-op X-ray; and (c) range of motion at 6 months. Post-operative outcome according to constant score at 6 months: good, complications: none.

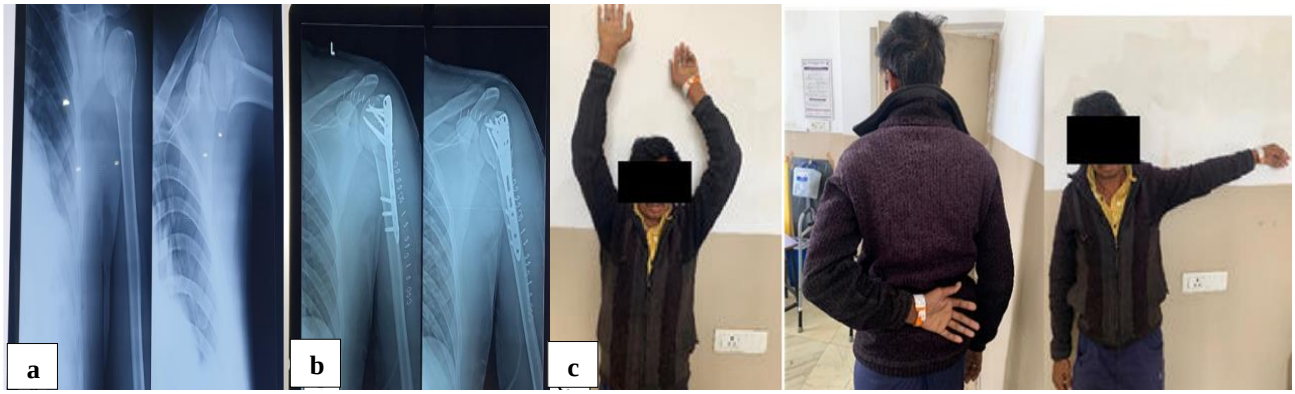

Figure 3: Case of 35-year-old male H/O fall from bike operated with PHILOS platting using the delto-pectoral approach (a) pre-op X-ray; (b) post-op X-ray; and (c) active forward flexion at 6 months. Post-operative outcome according to constant score at 6 months: good, complications: none.

DISCUSSION

The proximal humerus fractures are mainly the results of high impact injuries. As seen in this study, majority of these fractures have been found to be a result of road side accidents (75%). The prevalence of these fractures has been seen mostly in males, which shows that this injury mainly occurs in outgoing and active work-force, since it is the male who are predominantly involved in the "out of home" activities in the rural and semi urban areas.

Fractures of proximal humerus especially when 3-part i.e. accompanied by a greater tuberosity fragment or 4-part, need accurate reduction for proper functioning of the shoulder and to restore the range of motion at the shoulder. Besides accurate reduction of the fracture fragments, early shoulder mobilization is very important in their management. Hence these fractures need to be surgically fixed and stabilized so as to achieve the above given objectives. Conservative methods like the U slab and bracing have provided poor results. A retrospective study of 32 patients with these injuries has shown that non-operative management frequently results in persistent pain, stiffness and dysfunction of the shoulder.[10]

Surgical approach to the proximal humerus has more commonly been the deltopectoral since most surgeons are well versed with this approach. Deltoid-splitting approach is a good alternative to the standard deltopectoral approach when fixing proximal humerus fractures, since it gives good access to the displaced posteromedial greater tuberosity fragment as well as to the lateral shaft of humerus where the PHILOS plate is to be applied.[6]

Several studies by various authors have concluded that deltoid splitting approach is a good alternative to deltopectoral approach in the fixation of fracture proximal humerus without any significant complications encountered.[6,9,11] Study by Singh et al also concluded that deltoid splitting approach was a good alternative to the standard deltopectoral approach when fixing proximal humerus fractures. It is a safe approach and if the axillary nerve is well protected and identified, it does not amount to an increased rate of complications. The displaced greater tuberosity can be easily reduced and plate fixation on the lateral aspect of the proximal humerus is easier than the classic deltopectoral approach.[12]

Deltoid splitting approach in addition has the benefit of being minimally invasive thus leading to minimal soft tissue damage along with rapid and improved healing. Depending upon the fracture anatomy, the skin incision can be a continuous long incision, with complete exploration of axillary nerve in the fibers of deltoid. Otherwise, fixation can be done using two separate skin windows, as a minimally invasive technique without complete exploration but palpating the nerve.[6]

In our study we allotted the patients by alternate allocation to group A and group B. Patients in group A were operated using deltoid splitting approach while in group B were operated using delto-pectoral approach. The operating time was noted in our study for both groups. It was noted that there was statistically significant difference between the operating time of both surgical approach groups irrespective of the type of fracture (2-part: mean group A-51.3, group B-63.6, p value=0.006; 3-part: mean group A-67.5, group B- 80, p value=0.017). This difference is attributed to primarily the ease of the deltoid splitting approach and the relative safeness of the technique. Another factor that contributes to this difference is the ease of reduction of fractures through this approach, especially the greater tuberosity. Liu et al in their study also observed a significant difference in surgical time (81.8 for deltoid splitting versus 91 for deltopectoral).[13]

Moreover, decrease in operative time is particularly useful in patients with co morbidities on whom long surgeries should be avoided. As we saw proximal humerus fractures are a result of high energy road traffic accidents majorly, they may be associated with a lot of

other injuries which lead to a hemodynamically unstable patient. In such cases a lesser operative time is beneficial.

The mean time to union for group A was 2.8 months (range 2.4 to 3.2 month) and for group B was 3 months (range 2.4 to 3.4). This difference was not significant. Union was assessed clinically as no local tenderness and an acceptable active assisted range of motion. Radiologically callus formation and development of trabecular continuity were accepted as signs of union. In a study by Kohli et al the average union time was found to be 14 weeks which is similar to our study.[11]

Korkmaz et al evaluated eighty-six patients who underwent surgical treatment using both approaches. It was seen that tuberosity fragment and humeral head were better reduced with the lateral deltoid splitting approach. They further stated that patients in group A had a higher constant score in early stages of follow up.[9] In our study functional outcome was assessed using the constant score at 6 weeks, 3 month and 6-month follow-up. It was found in our study that the constant scores at 6- weeks and 6-month follow up in both the groups were similar. However, in both two-part and three-part fractures there was seen statistical difference in the 3-month constant score values of both groups (2-part: group A: 67.67; group B: 44.7; p value=0.001) (3-part: group A: 66; group B: 48; p value=0.001). Thus, it was noted that the patients that were operated using the deltoid splitting approach showed a significantly early return to day-to-day activities. They showed a higher range of motion and functional capability at the 3 month follow up. This early rehabilitation comes significantly into play when operating a young patient with active lifestyle or even an elderly who is not dependent on anyone for their daily routine.

The final follow-up at 6 months in all patients of both the groups showed good outcome (constant score 74-84). A concern for using deltoid splitting approach has been axillary nerve injury and resulting deltoid palsy and hence loss of abduction. However, no neurological complications were seen in our study. Studies in the literature as quoted above also do not report any incidence of axillary nerve injury. No cases of non-union were reported in our study; however, in a study by Papadopoulos et al in three patients operated with delto-pectoral approach, humeral head collapsed due to aseptic necrosis at a later stage following their union at 6-months.[14] No signs of necrosis of humeral head were noted in any patients in our duration of follow-up. No major complications were noted in our study during the duration stay of patient and during follow-up. One case of superficial wound infection was noted in group B which was treated by wound care and oral antibiotics.

CONCLUSION

We conclude that both approaches show satisfactory outcomes over a long period. However, certain factors need to be kept in mind and considered when selecting the approach. As we saw the significantly less operative time and minimal soft tissue dissection in deltoid splitting approach can be used as an advantage in particular cases. Moreover, there was an early return to day-to-day activities for the deltoid splitting group which should be considered when treating an active individual.

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