RESULTS OF PROXIMAL HUMERUS FRACTURE TREATED WITH LOCK PLATE THROUGH A DELTOPECTORAL VERSUS AN ANTEROLATERAL DELTOID- SPLITTING APPROACH

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ABSTRACT

BACKGROUND

Proximal humerus fractures account for 4-5% of all fractures with a prevalence of 70 per 100,000, raising to 405 per 100,000 in population aged over 70 years. Current study was performed to evaluate the results of displaced proximal humeral fractures after locking plate osteosynthesis through deltopectoral and Deltoid-splitting approach, and to find out whether the type of surgical approach has any influence on functional outcome and complication.

MATERIAL & METHODS

The study was done from July 2014 to June 2016 and 46 skeletally mature patients were selected and randomised into group A (Deltopectoral) and group B (Deltoid splitting) after taking informed consent, Fracture-dislocation. Out of 23 patients in Group A, 1 patient did not turn for followup. Whereas, out of 23 patients in Group B, 2 did not turn for followup. The functional outcome analysis was done using CMS Scores and Pain (VAS) Score along with other variables such as amount of blood loss, operation time, union time were measured and compared between the study Groups. Statistical Analysis was done with the help of Paired ‘t’ test for intra-group analysis and Unpaired ‘t’ test for analysis between the two groups. The categorical data were analysed with the help of Fisher Exact Test.

RESULTS

The average duration of Hospital stay, injury treatment interval, mean operating time were similar for both the Groups. Blood loss with Deltopectoral approach was more (192.18 mL in Group A and 174.29 mL in Group B). All patients achieved successful union in average 11.49 weeks. Mean CMS Scores and Pain (VAS) Scores difference between the Groups, were found to be statistically significant at 6 weeks and 12 weeks, but statistically insignificant at 6 months.

CONCLUSION

From the study, we found that the functional results in terms of improvement in pain and mean Constant Murley Scores, were significantly better at 6 weeks and 12 weeks with Deltoid Splitting approach when compared with Deltopectoral approach.

KEYWORDS

Proximal Humerus Fracture, Deltopectoral Approach, Deltoid Splitting Approach.

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INTRODUCTION: Proximal humerus fractures account for 4-5% of all fractures with a prevalence of 70 per 100,000, raising to 405 per 100,000 in population aged over 70 years. Displaced fractures of the humerus are preferably treated by means of surgical intervention. Various implants have evolved over a decade like percutaneous pinning, osteosynthesis using cancellous screws, intramedullary nails, open reduction and internal fixation with T buttress plate and hemiarthroplasty, but all are associated with persistent failure and high complication rate. The locked screw-plate devices are the latest generation fixed angle device which provide angular and axial stability.

However, data suggest that even with experienced hands, they do not always provide the good result, and hence associated with variable complications. This observation forced us to look for the other potential causes of implant failure and choice of surgical approach could be an important cause. For many years, the Deltoprotoral approach to the proximal humeral region was seen as the gold standard.

But, many surgeons now argue that it may not be the best option due to the substantial soft tissue dissection, partial release of the deltoid muscle, difficulty in accessing the lateral aspect of the humerus and posterior aspect of GT. Additionally, the exposure places the anterolateral ascending branch of the anterior humeral circumflex artery at risk, which may further compromise the critical blood supply of the humeral head leading to AVN. On the other hand, the Deltoid-splitting approach, originally described for rotator cuff repair and intramedullary nailing, is an attractive alternative for proximal humerus osteosynthesis as it avoids many of the pitfalls associated with Deltopectoral approach.
This provides direct visualisation of the lateral aspect of the proximal humerus without compromising the vascular supply to the humeral head. Chances of injury to the Axillary nerve was historically seen as the limitation of this approach. But, as confirmed by various anatomical studies, the Axillary nerve proceeds in a predictable way and injury to it can be best avoided with careful dissection and knowledge of its course in the deltoid muscle. The best surgical approach for internal fixation of displaced proximal humerus fractures is still being debated, and the choice of approach to the proximal humerus may influence the functional outcome. Therefore, the current study was performed to evaluate the results of displaced proximal humeral fractures after locking plate osteosynthesis through Deltoperatoral and Deltoid-splitting approach, and to find out whether the type of surgical approach has any influence on functional outcome and complication.

**MATERIAL & METHODS:** We enrolled a total of 46 adult patients with proximal humerus fracture in our study.

1. **Study Design:** Randomised Controlled Trial.
   Randomisation took place after written informed consent was obtained from the study participants and baseline information was gathered. Randomisation was 'Adaptive', done by Block Randomisation method to ensure equal sample size in each group. Consenting patients were randomised by computer generated, simple randomisation in permuted blocks of four into Deltoperatoral Group or Deltoid Splitting Group (meaning that there were two Deltoperatoral Groups and two Deltoid Splitting Groups in random order within each block of four patients). The sealed pre-numbered envelopes containing the assignments were kept by the front desk and a register was maintained by the observer.

2. **Sample Size and Power Calculation:** Power calculations were performed to determine the sample at the study design stage, assuming a power of 80% (β=0.2) and a Type 1 Error (α) of 0.05. The primary outcome measure, determined before the start of the study was the Constant Murley Score (CMS) at 6 months. Previous studies found that differences in the CMS of 10 indicate clinically important improvement (or worsening) of shoulder function.1,2 This means that an increase in the CMS of 10 indicated clinically significant improvement in shoulder pain and function. Likewise, a decrease in the CMS of 10 indicated worse shoulder pain and function. Thus, sample size calculations were based on the ability to detect a difference between treatment groups of 10 in CMS. The Standard Deviation was assumed to be 11 as per previous study. Using this parameter, we calculated that a sample size of 22 subjects per group (Using software G*Power 3.1) would be adequate with 80% power to detect such a difference at the 5% level of significance (2-sided tests). Allowing for a maximum drop-out rate of 5%, the sample size was increased to 23 per group.

3. **Time Period:** One year (July 2014 to June 2015).
4. A permission was obtained from the Ethical Committee of the institute before starting the research.
5. **Study Sample:** After taking clinical history and performing a thorough General, Systemic & Clinico-Radiological examination, patients were selected as per the following:

**Inclusion Criteria:**
5.1. Closed displaced Neer's two-part, three-part and four-part proximal humerus fractures.
5.2. Fracture of <3 weeks' duration.
5.3. Age >18 years.
5.4. Patients who gave informed consent.

**Exclusion criteria:**
6.1. Age <18 years.
6.2. Fracture of >3 weeks' duration.
6.3. Open fractures.
6.4. Poly-trauma patient.
6.5. Associated other fracture in ipsilateral limb or any Neuro-vascular injury.
6.6. Pathological fractures secondary to neoplasm or infection.
6.7. Isolated greater tuberosity fracture in Neer's two-part fracture.
6.9. Patients who did not give informed consent.

All patients were operated by senior authors, in supine position using either deltopectoral or deltoid-splitting approach under image intensifier control. In deltopectoral approach, incision started anteriorly from coracoids process and extending laterally toward the shaft. After cutting skin and subcutaneous tissue, deltopectoral groove is identified, using cephalic vein as a landmark. Deltoid is retracted laterally, while pectoralis major is retracted medially along with cephalic vein to expose the fracture site. In deltoid-splitting approach, patient was placed in supine position and incision started laterally from the tip of acromion process and extended distally up to 8 cm. Fascia over deltoid muscle cut in line with skin incision and the avascular anterior deltoid raphe between the anterior and middle third of the deltoid muscle was identified. A 2 cm incision in the deltoid raphe beginning at its attachment on the acromion was made. After spreading the incision bluntly, a finger was inserted laterally beneath the raphe to sweep the undersurface of the deltoid from the proximal humerus.

Finally, the cordlike axillary nerve could be palpated on its undersurface. Further, fine dissection of the axillary nerve was not done, and a "Zone of Danger" containing a cuff of deltoid, the terminal branches of nerve, and its attendant vessels, were protected during surgery. For maximal exposure, deltoid was split up to the margin of the acromion but not beyond 5 cm distally from its origin to avoid damage to the Axillary nerve. Fracture fragments were reduced with indirect reduction techniques, working within the tuberosity fracture lines if necessary.
After exposing fracture, reduction and preliminary fixation was done with K wires. PHILOS plate was applied on lateral surface, proximal and distal locking done under image intensifier control. Closure done in layers and arm was placed in sling postoperatively. Passive range of motion exercises started after first day as patients started tolerating pain. The most useful rehabilitation protocol is the three-phase system devised by Hughes and Neer, and the same was used for our patients. The patients were followed up at 6 weeks, 12 weeks and 6 months after surgery. Out of 23 patients in Group A, 1 patient did not turn for followup. Whereas, out of 23 patients in Group B, 2 did not turn for followup. Hence, they were left out from the study. Thus, 22 patients in Group A and 21 patients in Group B were evaluated in terms of:

a. Fracture healing.
b. Implant related problems - screw perforation, screw loosening or backing out, plate pull off or breakage.

The Functional outcome using CMS Scores and Pain (VAS) Score along with other variables such as amount of blood loss, operation time, union time were measured and compared between the study Groups. Statistical Analysis was done with the help of Paired 't' test for intra-group analysis and Unpaired 't' test for analysis between the two groups. The categorical data were analysed with the help of Fisher Exact Test.

RESULTS: In our study, the average age was 53.72 years (Group A - 55.45 years; Group B - 51.90 years) with majority of the patients i.e. 34 out of 43 (79.06%) between 41 to 70 years. Majority were females (62.79%), with female to male ratio of 1.7:1. Group A comprised of 13 females and 9 males, whereas Group B comprised of 14 females and 7 males. Right side in Group A (59.10%) and Left side in Group B (52.38%) was involved more commonly, with overall Right side involvement in 53.49% cases. Common to both the Groups, the most common mode of injury was Simple Fall (68.19% in Group A and 57.14% in Group B), followed by RTA and Fall from height. Out of total 43, 9 (5 in Group A; 4 in Group B) had Neer’s two part, 23 (11 in Group A; 12 in Group B) had three part, while 11 (6 in Group A; 5 in Group B) had four part fracture pattern. Three part fracture pattern was found as the most common for both the Groups. The average duration of Hospital stay and Injury treatment interval was similar for both the Groups, with difference being statistically insignificant. The mean operation time was 91.14±11.52 min in Group A and 89.52±10.43 min in Group B, with difference being statistically insignificant.

We found significantly more blood loss with Deltoid approach when compared with Deltopectoral approach (192.18 mL in Group A and 174.29 mL in Group B). All patients achieved successful union in average 11.49 weeks. Statistically significant improvement of results in terms of Pain and Mean Constant Scores were noted for both the Groups at 6 weeks, 12 weeks and 6 months followup. On comparing Mean CMS Scores and Pain (VAS) Scores between the Groups, the difference was found to be statistically significant at 6 weeks and 12 weeks, but statistically insignificant at 6 months; suggesting better early functional results with Deltoid Splitting approach.

### Constant Murley Scoring During Followups

<table>
<thead>
<tr>
<th>Constant Murley Scoring During Followups</th>
<th>Group A (Deltopectoral)</th>
<th>N</th>
<th>Group B (Deltoid Splitting)</th>
<th>N</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Weeks</td>
<td>37.95±4.13</td>
<td>22</td>
<td>42.81±4.48</td>
<td>21</td>
<td>0.0006*</td>
</tr>
<tr>
<td>12 Weeks</td>
<td>53.50±7.33</td>
<td>22</td>
<td>64.05±7.69</td>
<td>21</td>
<td>0.0001*</td>
</tr>
<tr>
<td>6 Months</td>
<td>69.77±9.99</td>
<td>22</td>
<td>72.95±10.55</td>
<td>21</td>
<td>0.31</td>
</tr>
</tbody>
</table>

**Table 1**

### Neer's Type (No. of Cases)

<table>
<thead>
<tr>
<th>Neer's Type (No. of Cases)</th>
<th>Constant Murley Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excellent (&gt;75)</td>
</tr>
<tr>
<td>Group A- Deltopectoral (22)</td>
<td></td>
</tr>
<tr>
<td>2 Part (5)</td>
<td>1(20%)</td>
</tr>
<tr>
<td>3 Part (11)</td>
<td>2(18.18%)</td>
</tr>
<tr>
<td>4 Part (6)</td>
<td>-</td>
</tr>
<tr>
<td>Group B- Deltoid Splitting (21)</td>
<td></td>
</tr>
<tr>
<td>2 Part (4)</td>
<td>2(50%)</td>
</tr>
<tr>
<td>3 Part (12)</td>
<td>3(25%)</td>
</tr>
<tr>
<td>4 Part (5)</td>
<td>1(20%)</td>
</tr>
</tbody>
</table>

**Table 2**

At final followup of 6 months, 9 patients (3 in Group A; 6 in Group B) had Excellent results, 28 (16 in Group A; 12 in Group B) had Good-to-Fair results, and 6 patients (3 in each Group A and B) had Poor results.
The number of patients having Excellent, Good/Fair, or Poor results in each Group were similar.

In our study, a total of 9 patients (5 in Group A and 4 in Group B) developed complication (20.93%). The complication rate between the two study Groups was similar.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Group A (Deltopectoral Approach)</th>
<th>Group B (Deltoid Splitting Approach)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 part</td>
<td>3 part</td>
</tr>
<tr>
<td>Infection</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Impingement</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Stiffness</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Varus malreduction</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Screw cut</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GT displacement</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Oblique plate positioning</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total (%)</td>
<td>5 (22.72%)</td>
<td>4 (19.04%)</td>
</tr>
</tbody>
</table>

Table 3

No deep wound infection, major Neurovascular injury, implant breakage/failure, Avascular necrosis (AVN) were found in our study. Impingement and Stiffness were found in both the Groups. In Group A, we found superficial infection (Improved with antibiotics), Oblique positioning of plate, Secondary displacement of GT as main complication. Whereas, intra-articular screw placement and varus malreduction were encountered in Group B patients.
result for function, pain, activity levels, radiographic evaluation, and complications between the groups. Study concluded that the choice of approach for exposure of the proximal humerus region may influence the functional outcome. Stable osteosynthesis is important, but the outcome of operatively treated proximal humerus fractures is dependent on soft tissue management as well. Isiklar et al(7) in his study observed better radiological and functional outcome with deltoid-splitting approach and recommended deltoid-splitting approach in management of AO (Arbeitsgemeinschaft fur Osteosynthesefragen) types B and C proximal humeral fractures. Wu, Chin-Hsien et al(8) in their retrospective study compared the anterolateral approach with the deltopectoral approach for proximal humerus fracture in 63 patients. There were no significant differences between the groups with regard to demographic data, preoperative radiographic findings, and duration of followup.

They concluded that the surgical approach of choice lies considering the fracture pattern and displacement, possible necessity for arthroplasty, surgical experience, and skill; both approaches are suitable when performed appropriately. Shah Waliullah et al(9) in their study divided 57 patients into Group A (29) and Group B (28) who were treated with PHILOS plate via classical deltopectoral and deltoid-splitting approach respectively. Author recommended that deltoid-splitting approach can be used in 3-part and 4-part complex proximal humeral fractures and in posterior fracture dislocation shoulder, which are difficult to approach with deltopectoral approach; however, care should be taken while inserting calcar screw in PHILOS plate fixation to avoid iatrogenic axillary nerve injury. Buecking et al(10) evaluated 120 patients who were treated with proximal humerus lock plate via one of the two approaches (60 for each). There was no difference between the groups with regard to preoperative data, length of hospital stay, operation time and blood loss. Although they found the different distribution of complications for both approaches, the complication or reoperation rates between the approaches were no different. Both approaches showed a similar constant score and average pain score at any point time. The author concluded that locking plate is reliable using both the approaches.

For a definitive recommendation for one of these approaches, further studies with appropriate sample size are necessary. Chen et al(11) conducted a study on 49 patients with proximal humeral fractures who were treated with locked plate fixation. The authors concluded that both the approaches are effective in treating Neer two- and three-part proximal humeral fractures, and can obtain excellent outcomes. Moreover, anterolateral acromial approach has advantage of less trauma, less blood loss, shorter operative time, rapid recovery of shoulder joint function and fracture.

**CONCLUSION:** From the study, it can be concluded that though stable osteosynthesis is important, the early outcome of displaced proximal humerus fractures treated with Proximal Humerus Locking Compression Plate is also dependent on choice of surgical approach.
On comparing Deltopectoral and Deltoid splitting approach for treating proximal humerus fractures in our study, we found that the functional results in terms of improvement in pain and mean Constant Murley Scores, were significantly better at 6 weeks and 12 weeks with Deltoid Splitting approach when compared with Deltopectoral approach. However, at 6 months the results were similar with both the approaches.

The rate of complication was also similar between both the groups in our study. All fractures united successfully and there was no major complication like injury to any Neurovascular structures with either of the approach. The traditional Deltopectoral approach has some inherent disadvantages like, increased risk of AVN, substantial soft tissue dissection and manipulation, difficulty in exposing lateral surface and partial release of the deltoid insertion, making this approach less attractive for the fixation of proximal humerus fracture.

In contrast, Deltoid Splitting approach involves the risk of injury to Axillary nerve. However, we did not find any such case and it can be best prevented by anatomical knowledge of its course, careful dissection and leaving a cuff of deltoid with Axillary nerve and accompanying vessels while passing the plate. Decreased blood loss and better reduction of fracture fragments under direct vision are added advantage with this approach. Thus, Deltoid splitting approach can be a better alternative to Deltopectoral approach which provides direct exposure to the lateral surface, have similar complication rates and better early clinical outcomes after surgical treatment of proximal humerus fractures.

REFERENCES