



Triceps sparing versus olecranon osteotomy for open reduction internal fixation: Analysis of 71 cases of fracture distal humerus

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ABSTRACT

The purpose of the study was to compare triceps sparing approach with olecranon osteotomy regarding the effects on functional outcomes of fracture of distal humerus managed with open reduction internal fixation (ORIF), by reviewing 71 cases of fracture distal humerus surgically managed with either of approaches during December 2012 to September 2016. The medical reports and radiographs of 42 males and 29 females patients with a mean age of 38.12 ± 15.06 and 34.87 ± 14.11 for olecranon osteotomy and triceps sparing approach respectively and a mean follow up time of 10.2 months (range 3-18 months) were retrospectively and prospectively reviewed. Flexion, extension, range of motion, Mayo Elbow Performance Score (MEPS), Disability of Shoulder Arm and Hand Score (DASH SCORE), duration of surgery and blood loss were used to assess the functional outcome of fracture distal end humerus treated with ORIF through the triceps sparing approach or olecranon osteotomy. According to AO Foundation (AO) Classification there were 2 cases of type A, 2 cases of type B, 22 cases of type C1, 26 cases of type C2 and 19 cases of type C3 fractures. Although there was no overall statistically significant difference in the average flexion, extension, ROM, MEPS AND DASH SCORE between the triceps sparing group ($n=47$) and olecranon osteotomy group ($n=24$). Out of 24 patients of group OO, 9(37.5%), 9(37.5%), 6(25%) and out of 47 patients 24(51%), 16(34%), 7(15%) obtained excellent, good, fair MEP score respectively. No patient fallen under poor category of MEP score. On the basis of MEPS, DASH, flexion, extension and ROM results were better in type A, B, C1 AND C2 by using triceps sparing approach and the results were better in type C3 fracture by using of olecranon osteotomy approach.

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Introduction

Fractures of the distal humerus are uncommon injuries, constituting between 0.5% and 7% of all fractures and 30% of all elbow fractures.¹ Up to 96% of these injuries are intercondylar, or AO type C, distal humeral fractures involving the articular surface.² These fractures are notoriously difficult to treat, presenting the surgeon with multiple challenges including the complex anatomy of the elbow joint itself, articular surface comminution and frequently, osteopenic or osteoporotic bone stock. Anatomic reduction of the joint surface, restoration of the overall anatomic axes of the extremity and stable fixation allowing for early elbow mobilization are keys to achieving a good surgical outcome. Early motion is critically important after open reduction and internal fixation (ORIF) of these fractures³ because the elbow joint capsule is very prone to scarring, and immobilization past 3 weeks has been linked with poorer outcomes.²

Olecranon osteotomy is considered gold standard for treating intercondylar distal humerus fracture because it provides excellent articular exposure. One alternative technique to approach through the posterior elbow is triceps sparing approach describe by Bryan and Morrey. Which was first used in total elbow arthroplasty. In this technique the triceps mechanism is spared and reflected from the medial to

the lateral direction without being detached satisfactory functional outcome has been achieved when using this technique to treat complex type C fracture of distal humerus.

Aims and objectives

To study olecranon osteotomy and Triceps Sparing approach in intraarticular distal humerus fracture.

To compare the functional outcome of olecranon osteotomy and Triceps Sparing approach for management of intraarticular distal humerus fractures to meet out following parameters:

- Accuracy of articular reduction
- Functional range of movement
- Operative time
- Immediate, early and late complications

Material and methods

This prospective study will be hospital based, conducted in the Department of Orthopaedics at LLR and Associated Hospital, GSVM Medical College, Kanpur. A clearance from ethical committee of institute was obtained. Written informed consent would be obtained from all the patients or their family for participation in the study. The study was conducted from December 2012 to September 2016.

Study design

Retrospective and Prospective study Two groups will be generated in the age group 12-72 years.

Group A: Operated with olecranon osteotomy.

Group B: Operated with triceps sparing approach

Criteria

All closed as well as Type-1 (Gustillo and Anderson) open fractures of distal humerus.

Fractures with intraarticular involvement.

Patients in age group 18-60 years.

Exclusion criteria

Type-IIB & III (Gustillo and Anderson) open fractures of distal humerus.

Patients with open physis.

Fractures with associated vascular injuries.

Uncooperative patient.

More than 3 weeks old injury.

All pathological distal humeral fractures that include secondary to neoplastic, infective (active or sequealae) pathology.

Patient

40 patients prospective(25M/15F) with mean age of 38.12 ± 15.06 for OO and 34.87 ± 14.11 for TS . according to

the medical report and radiograph of 71 patients with fracture distal humerus treated with ORIF via triceps sparing and olecranon osteotomy in department of orthopaedics at LLRH and associated hospital G.S.V.M. Medical College , Kanpur during December 2012- September 2016 . of the 71 patients there were 30 patients retrospective(17M/13F) and AO classification there were 23cases of type C1, 26 of typeC2, 19 of typeC3 and 4 of typeA& B. 9(3TS/6OO) patient had compound injury of GUSTILO ANDERSON type 1

Surgical treatment

ORIF was performed using technique according to AO principle. For olecranon osteotomy intraarticular chaverson osteotomy performed approx. 2cm distal to tip of olecranon. ORIF by olecranon osteotomy performed in 24patients and triceps sparing approach was used in 47 cases.

Postoperative management

The subcutaneous drain was removed between 24 to 48 hrs postop.

The extremities were immobilised for 3-7 days and rehabilitation of elbow was started immediately in patients who had stable fixation. For some patients early immobilisation of elbow was

Delayed for a week because adequate stabilisation was not achieved. Active elbow flexion and extension exercise lasting for 20-30mins were begin and gradually increased to 3 or 4 times a day while the patient was in hospital and thereafter discharge . the ROM was set at 0° - 30° - 110° for extension and flexion during week 1 and 2 and 0° - 20° - 120° during week 3 and 4 and 0° - 10° - 130° during week 5 and 6 after which full ROM was allowed . full weight bearing exercise were only allowed after the fracture was fully healed. Indomethacin 75mg once a day for 3 weeks po.stop was prescribed to prevent heterotopic ossification

Elbow rehabilitation

Elbow rehabilitation is an important part of the surgical procedure, however it should be supervised so as avoid disruption of the extensor mechanism and the stiffness resulting from prolonged immobilization.

Ring et al (2003) in their study followed the regimen with gravity assisted active elbow range of motion, including active extension, that was initiated the morning after surgery.¹²

Mishra et al and O'Driscoll et al followed a physical therapy program including active and passive motion on the third post operative day on the heels of pain. All patients were permitted active use of hand and were instructed not to lift anything heavier than a glass of water or a telephone receiver for first six weeks.^{44,45}

Mean follow up time for this study was 10.2months (3-18months). Total no. of 24patients were treated with olecranon osteotomy (GroupA) and 47 patients were treated with triceps sparing approach (GroupB). The average age in Group A was 38.12 ± 15.06 and in Group B was 34.87 ± 14.11 years(p value>0.05). according to AO classification in group A there were 5C1, 6C2, 13C3 fractures while in group B there were 17C1,20C2,6C3 fractures.

Results

	GROUP A(OO) n=24	GROUP B(TS) n=47	
Age	38.12 ± 15.06	34.87 ± 14.11	P VALUE>0.05 T=1.07
Blood loss	222.78 ± 34.93	121.61 ± 19.85	P value<0.01
Flexion	104.16 ± 9.16	105.42 ± 12.99	P value>0.05 T=0.41
Extension	12.87 ± 4.83	12.76 ± 7.63	P value>0.05 T=0.03
ROM	91.04 ± 13.51	92.65 ± 19.07	P value>0.05 T=0.53
MEPS	82.91 ± 11.60	86.38 ± 10.45	P value>0.05 T=1.15
DASH	36.00 ± 8.26	34.51 ± 9.50	P value>0.05 t=0.49
Duration of operation	92.67 ± 8.73	8.63 ± 7.02	P value<0.001 T=4.64

Analysis of various types of fractures

Approach	A	B	C1	C2	C3
Group A	0	0	5(20.83%)	6(25%)	13(54.16%)
Group B	2	2	17(36.17%)	20(42.53%)	6(12.7%)
Z	NC	NC	1.41	1.53	3.67
P	NC	NC	<0.05	<0.05	<0.001
Inference			Significant	Significant	Highly Significant

Quality analysis of MEPS

	Excellent(90 & above)	Good (75-89)	Fair(60-75)	Poor (<60)
Group A	9 (37.5%)	9(37.5%)	6(25%)	0
Group B	24 (51%)	16 (34%)	7(15%)	0

9 patients (6 of group A and 3 of group B) had Gustilo type I fracture. Operation details for the patients are shown in the table.

Group A and Group B are further divided into mini groups A, B, C1, C2, C3 on the basis of type of fracture. These subgroups were compared on the basis of duration of surgery, MEPS, DASH score, flexion, extension and ROM by using the MANNWHITNEY TEST which was significant for type C1 and C2 fracture and highly significant for type C3 fracture as illustrated in above mentioned table.

Discussion

Intra-articular fractures of the distal humerus are difficult to treat and functional outcome can be variable. Because of the low incidence of these fractures, only a few series, with a considerable number of cases, have been reported. It is generally agreed that open reduction and internal fixation is standard treatment, with the aims, as described by O'Driscoll, being:

- 1) soft tissue healing without infection
- 2) restoration of diaphyseal bone stock
- 3) union between the distal fragments and the shaft
- 4) a stable, mobile articulation.⁴⁷

Poor long-term functional outcome is most commonly associated with decreased range of movement because of stiffness from prolonged immobilization. Therefore, the key is stable fixation to allow early movement of the elbow postoperatively.^{27,48}

Numerous surgical approaches have been described for the fixation of distal humerus fractures. All of these involve a posterior skin incision with various strategies of working through or around the triceps. The various approaches are olecranon osteotomy, TRAP approach, triceps splitting, triceps reflecting and paratricipital approaches.^{23,25}

As of now the surgeon opinion regarding the optimal approach to distal humerus is widely divergent and there are no randomized control trials in the literature to solve this dilemma. The quality of evidence in literature is either level III or level IV.

The experience reported with the use of the triceps-sparing approach to treat distal humerus fracture in adult patients is scant. To our knowledge, only two other studies have compared the functional outcomes of the triceps-sparing approach with olecranon osteotomy for ORIF management of intercondylar distal humerus fractures.^{40,43}

Hence this study envisages to compare the olecranon osteotomy and Triceps sparing approaches for comparison of optimal exposure and functional outcome of these fractures.

seventy patients with AO type A, type B, Type C fractures of the distal humerus in which 24 patients were treated by olecranon osteotomy (Group A) and 47 patients were treated by triceps sparing approach (Group B). In this study there is 30 retrospective and 41 prospective cases were included. Only closed and open Grade-I (Gustillo and Anderson) fractures were included as the open fractures of higher grade would have led to confounding of the result due to triceps injury or laceration or contamination.

The average age in our series being 36.505 years with SD=14.5. The mean age of Group A and Group B was 38.12 and 38.47 respectively. The mean age of both the groups was comparable. In other studies mean age group was 32.5 and 41 years which is comparable to our study.^{38,49} The majority of the patients were in the age group of 28-45 years which reflects a more active lifestyle in this age group.

The majority of the patients were males 42(59.15%) out of 71 patients. This male dominance was also seen in other studies done by Ali AM et al and Eugene et al.^{38,49} The higher male incidence reflects the male subjectivity to more outdoor activities, making them more prone to injury due to road traffic accidents(50.7%), which is the most common mode of trauma in our study and in study done by Chen G. et al followed by slip on ground(25.35%).^{10,40}

In current study, the incidence of open fractures was 12.6% (n=9), and all the patients underwent definitive fixation within a week, 6 by olecranon osteotomy and 3 by triceps sparing approach respectively because only open grade-I (Gustillo and Anderson) fractures were included in our study. The incidence of open fractures encountered was comparable to previous studies by Eugene et al, Ali AM et al and J.A. Fernandez et al.^{49,38,42} Ali AM et al in his series of 22 patients, reported 3 cases of open injury in his study. All patients underwent definitive fixation on day of injury.

In our study 26(36%) patients out of 71 were type C2 fracture, 23(32%) were type C1 and 19(26%) patients were type C3. Rest(5%) of cases are type A and B. In current study, good quality of X-rays of each patient were done and they were classified accordingly. In this study, 6 type C2 fractures were operated in group A and 20 in group B. Five and seventeen type C1 fractures were operated in group A and group B respectively. 13 type C3 were operated in group A and 3 type C3 in group B.

Eugene et al reported 5 out of 8 (62.5%) cases in his series as AO/OTA type-C2.⁴⁹ Ali AM et al and Zhang et al, had also reported a high incidence of AO/OTA type-C2 fractures of distal humerus, i.e. 11 out of 22 (50%) and 25 out of 67 (37.3%) respectively.^{38,43}

In the present study, the triceps-sparing approach allowed to visualize and reduce the fragments properly comparable to study done by Ek ET et al.³⁹ It has been demonstrated by Wilkinson and Stanley⁵⁰ that the difference of visualization between the triceps-sparing and the olecranon approach is the lack of visualization of an 11% of the surface and that even the olecranon osteotomy leaves a 43% of the surface unseen. According to Eugene et al also that triceps sparing approach provide adequate exposure to fracture site.⁴⁹

The mean operative time in triceps sparing (group B), the time for fracture exposure to wound closure was less as compared to olecranon osteotomy (group A). In group A and B, operative time was 92.62 and 78.63 minutes respectively. The operative time difference was statistically highly significant.

Similar results were also observed in study done by Zhang et al. Duration of operation in olecranon osteotomy and triceps sparing group was 113.89 and 89.03 mins respectively which was significant statistically.⁴³

The outcome assessment of the study was done using the scoring system. In current study, two scoring systems were used. Mayo Elbow Performance Score (MEPS),⁵¹ which is physician rated questionnaire uses clinical and functional measurement. Disability of arm, shoulder and hand (DASH)⁵², which was a patient rated questionnaire assess subjective component of the condition. At present there are no control or normal values for the DASH scores. The mean DASH scoring for the study was 35.255. The average DASH for olecranon osteotomy was 36.00 and for Triceps sparing approach it was 34.51 while mean DASH score was 17.9 points in the study done by Eugene et al.⁴⁹

The mean MEPS for the study was 84.645 (range 65-100). For olecranon osteotomy, the average MEPS was 82.91 and for triceps sparing approach it was 86.31. In this study according to MEPS, the results were graded as excellent in 9 (37.5%) patients, good in 9 (37.5%), fair in 6(25%) patient in group A while in group B, excellent results were found in 24(51%) patients, good in 16(34%), fair in 7(15%) patient. No poor result was obtained in either group.

This result is comparable to study done by Zhang et al. which shows mean MEPS of 85.56 and 87.71 in olecranon osteotomy and triceps sparing group respectively.⁴³ Ali AM et al and Fernandez et al reported mean MEPS of 84 , 93.3 points respectively.^{38,42} Eugene reported good result in MEPS in all his 7 patient.⁵⁴ Chen G.et al. reported only 37.5% of patients over age 60 years obtained excellent/good MEPS , rate increased to 100% in patients aged less than 40 years when treated with triceps sparing approach.⁴⁰

The average elbow range of motion of our study was from 12.81° with extensor lag to 104.7° (90°-130°) of flexion, The mean flexion of the study at final follow up was 104.79° (range 30-140°) with mean extension of 12.81° (range 0-40°). The mean arc of motion was 91.84°.

The mean flexion for olecranon osteotomy was 104.16°, while for Triceps sparing approach it was 105.42. The mean extension for olecranon osteotomy was 12.87° while for triceps sparing approach it was 12.76°.

Thus the average arc of motion was 91.84° which is comparable to the results in other studies. Eugene et al and Fernandez et al in their series had reported an average arc of motion of 90° and 112° respectively.^{49,42} Ring et al reported an arc of 103° in their series of olecranon osteotomy.¹² Mckee et al noted an arc of 108° in his comparative study.³¹

In this study out of 24 patient which was operated by using of olecranon osteotomy approach 5 (20.83%), 6 (25%) and 13(54.16%) patient were type C₁, C₂ and C₃ respectively. Out of 47 patients which was operated by triceps sparing approach 17 (36.17%), 20 (42.53%) and 6 (12.7%) patient were type C₁, C₂ and C₃ respectively on the basis of duration of surgery, MEPS, DASH, Score, flexion, extension and ROM. The outcome was good in triceps sparing approach in type C₁, C₂ and outcome was good in Olecranon Osteotomy approach in type C₃.

Complications

	GROUP A	GROUP B
Soft tissue infection	3	2
Ulnar nerve neuropraxia	2	1
Heterotopic ossification	3	1
Implant prominence	3	1
Delayed union of olecranon process	1	0
Radial nerve neuropraxia	1	1

Wound related complications (7.04%)

Out of 24 patient 3 and out of 47 patient 2 patient get wound related complication in group A and group B respectively. In these cases discharging sinus was noted after 2 weeks during stitch removal at tip of olecranon. Following serial dressing 3 out of 5 sinus was healed, it does not healed. In case 2 debridement and TBW removal was done after 8 month and infection healed. The MEPS was 95, 85 and 60 for group A and 95 and 65 for group B.

Ulnar nerve neuropraxia

Incidence for ulnar nerve neuropraxia was 8.33%, 4.25% in OO and TS sparing which was fully recovered after two months which is similar to the overall rate(10%) reported by

Allende et al.⁵³ In study done by Chen G.et al. 2 out of 34 patients (6%) of osteotomy group showed symptoms of ulnar nerve parasthesia which recovered by 3 weeks.⁴⁰

Heterotopic Ossification

The incidence rate of heterotopic ossification was 12.5% and 2.12% in OO and B group respectively due to post operatively message of elbow done by patient noted in X-ray in 3 months according to the Hastings classification scale⁵⁴. Elbow arthrolysis with implant removal was planned but patient refused for procedure.

Zhang et al and Chen G. et al reported 4 out of 36 cases and 4 out of 33 cases respectively of HO in their osteotomy group series. Gofton et al. found that 13% of patients with type C distal humerus fractures exhibited postoperative HO.^{43,40}

Implant Prominence

The incidence Rate of Implant prominence 12.5%, 2.12% in OO and TS sparing approach respectively. Implant removal was planned at 1 year follow-up, but patient was not willing for implant removal.

Zhang et al. reported 6 out of 36 patients of implant prominence in osteotomy group.⁴³ Jupiter et al reported, 5 cases of symptomatic olecranon implants.¹⁷ Mckee et al noted 27% of the olecranon osteotomies required reoperation for removal of symptomatic internal fixation.⁵⁴

Delayed union

All the fractures in our study had healed both clinically and radiologically by the end of 3 months (range;2.5-4), both at fracture and the osteotomy site, except in 1 patient (case 4.16%) which had delayed union of the osteotomy site at 3 months. TBW revision was done after 6 months.

2/36 and 2/33 patients had delayed union in osteotomy patients series reported by Zhang et al and Chen G et al.^{43,40}

Radial nerve Neuropraxia

There is only one complication of radial neurapraxia was seen in 1 patients (4.16%) in triceps sparing group which got recovered fully after 3 months.

We did not observe any case of infection, non union, delayed union, implant prominence, implantation breakage or loosening in triceps sparing group which is comparable to study done by Zhang et al.⁴³

Goldwasser et al also published no case of complication in series of 7 patients of intercondylar humerus fracture managed by triceps sparing approach.⁵⁵

Summary & conclusion

The study entitled "comparative study of fracture distal humerus fractures managed by triceps sparing approach versus transolecranon approach represents the study of 71 cases with fracture distal humerus fractures. All patients were admitted in the department of orthopaedics, G.S.V.M.college, Kanpur.

Total 71 patients were included in the study, age ranged from 12 -72 years.

Most of the patients (66.7%) were of physically active age group.

Out of the 71, 42(59.15%) were males and 29(40.84%) being females.

Out of 70 fractures, 9 were of open (Gustilo and Anderson grade 1).

Most common cause of injury was RTA (road traffic accident) being 50.7%.

The maximum number of fractures in our study were AO type C₂ (n=2; 36.6%),

Both the approaches were equally good for exposures of the distal humerus.

Operative time in triceps sparing approach (group B) was 78.63 mins which was less as compared to olecranon osteotomy approach (group A) which was 92.62 mins with p-value of <0.001 which was highly significant.

The outcome assessment of the triceps sparing with MEPS were slightly better as compared to olecranon osteotomy group but showed no significant difference statistically.

The outcome assessment of the olecranon osteotomy with DASH were slightly better as compared to triceps sparing group but showed no significant difference statistically.

Complication rate was higher in the olecranon osteotomy approach as compared to triceps sparing approach.

All patients were allowed for early mobilisation that is on day 5.

To conclude, Our study revealed that triceps sparing approach is a fast approach, easy to perform and makes it possible to achieve good reduction in fractures with large sizeable fragments (AO type C1,C2) and olecranon osteotomy approach is better for fixation of type C3 fracture. Although this study is promising a large patient population is necessary to confirm our findings.

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