Indian Journal of Orthopaedics Surgery 2023;9(2):53–60

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Orthopaedics Surgery

Journal homepage: https://www.ijos.co.in/

Original Research Article

Intra-articular distal humerus fracture – TRAP or olecranon osteotomy

Rohit Jain[1,*], **H. C Frank**[1], **K. K Dutta**[1], **Kishore Hazarika**[1]

[1] *Dept. of Orthopaedics, Guwahati Medical College and Hospital, Guwahati, Assam, India*

ARTICLE INFO

Article history:
Received 02-03-2023
Accepted 11-04-2023
Available online 30-05-2023

Keywords:
Intraarticular distal humerus fracture
TRAP
Olecranon osteotomy
MEPS

ABSTRACT

Introduction: Intra-articular distal humeral fractures can be approached in a variety of ways. The purpose of this study is to evaluate and compare the functional outcomes of two approaches: one with olecranon osteotomy and other with triceps-lifting approach; for the treatment of intra-articular distal humeral fractures.

Materials and Methods: In this study, 10 patients in Group A were compared with 10 patients in Group B. Both the groups were comparable in terms of age, gender, duration of injury and degree of comminution of the fracture. Results were compared in terms of operative time, hospital stay, union, range of motion and complications. Functional evaluation was done using the Mayos' elbow performance score (MEPS).

Results: Patients were followed for a minimum of 12 months. Fracture union was seen at or before 4 months in all the patients of both the groups, except in 1 case of Group A where it was seen at 7 months. Average time to union was comparable in both the groups. In Group A, mean range of flexion was found to be 118 degrees (SD 7.33) and extension lag was found to be 11 degrees (SD 3.84). In Group B, mean degree of flexion was found to be 118.25 (SD 4.94) and extension loss of 12 degrees (SD 4.70). Average range of motion was comparable in both groups. There were no significant differences noted between the two groups in terms of mean MEPS (p= 0.573). The overall complication rate was 40% in the TRAP group and 30% in the olecranon osteotomy group.

Conclusion: Intra-articular distal humerus fractures mandate surgical fixation for best functional outcomes. Although technically demanding, TRAP exposure can prove to be as effective as olecranon osteotomy approach. Both approaches appear to yield no significant differences in clinical and functional results for intra-articular distal humerus fracture management.

1. Introduction

Intra-articular distal humerus fractures are rare among adults, and their incidence differs with age and gender. Among all fractures in the body, the incidence of distal humerus fracture is about 0.5%–2%, and among distal humerus fractures, 30% are intraarticular.[1,2] These fractures are a challenge to even the most experienced surgeon due to the complex anatomy of the elbow, multiple fracture fragments, and limited subchondral bone.[3–5] The outcome of distal humerus fracture depends on fracture type, age, gender, implant choice, and surgical approach.[6]

Intraarticular distal humerus fracture requires anatomic reconstruction, rigid fixation, and early mobilization to achieve good functional outcome[7,8] and so the best treatment for this fracture is open reduction and internal fixation. Surgical approach, implant type, and their placement have been the topic of debate in such fractures for a long and still, the literature is inconclusive about the best approach for the treatment of these fractures.

* *Corresponding author*.
E-mail address: drri0708@gmail.com (R. Jain).

https://doi.org/10.18231/j.ijos.2023.014

Bicolumnar fixation with two plates placed in a 90-90 pattern is an effective way to treat these fractures[9] and so was used in our study with 2 plates placed orthogonally.

Various approaches used for these types of fractures include triceps lifting (Campbell's approach), triceps splitting, triceps sparing, and olecranon osteotomy.[10,11] There are inherent advantages and disadvantages to each approach.

The most commonly used and considered best among the above approaches is olecranon osteotomy as it gives maximum exposure and effective articular reduction can be done with good proven functional outcomes.[12,13] However, this approach has its complications like prominent hardware, delayed union, and non-union of the osteotomy site.[14]

O' Driscoll et al in 2000, suggested an alternative exposure which is Triceps Reflecting Anconeus Pedicle approach via midline posterior incision to expose these fractures.[15] This approach avoids the complications of the osteotomy and also provides almost the same exposure, and has the added advantage of retaining the whole olecranon to use as a template against which articular fragments of the trochlea can be assembled. Furthermore, the neurovascular supply of the anconeus is preserved, which maintains the stability of the elbow.[15] Other approaches like the Triceps-sparing approach have less exposure and limited extensibility[10] and with the Triceps-splitting approach, exposure to the intra-articular humeral fractures is limited.[11]

A study done by Zhang et al., in 2013 in Shanghai noticed a reduction in procedure time, blood loss, complication rate, and improved outcome (all $P < 0.01$) with the triceps-reflecting approach compared to olecranon osteotomy.[16] While Chen et al., in 2010 found no statistically significant difference in functional outcomes between both approaches. The indications and superiority are still a question of debate among these two approaches. On review of the literature, conflict persists regarding the choice of an ideal approach.[17,18]

Our study aimed to compare the Triceps Reflecting Anconeus Pedicle (TRAP) and widely used olecranon osteotomy for the fixation of these fractures. We hypothesize that the functional outcomes in comminuted intraarticular distal humerus fractures depend on the surgical approach and that olecranon osteotomy provides better functional outcomes than TRAP.

2. Materials and Methods

In our study, 23(N=23) consecutive patients with intraarticular fracture of the humerus falling in the age group of 18 to 70 years from June 2021 to June 2022 were included. They were randomized into 2 groups: Group A (TRAP Group) and Group B (Olecranon Osteotomy Group) on an odd/even date presentation basis. Approval for the study was taken from the institutional research cell and ethical committee. Fractures were classified in the Emergency department according to the AO classification of humerus fractures after obtaining standard AP and Lateral view (Figures 7 and 8).

2.1. Inclusion criteria

Age 18 to 70 years, closed and Grade 1 open fractures, fresh fractures < 3 weeks, no neurovascular involvement, no associated fracture in the same limb, and Type C (AO/ASIF classification).

2.2. Exclusion criteria

The patient is medically unfit for surgery, Grade 2 & 3 open fracture, associated neurovascular deficit, >3 weeks old fractures, associated ipsilateral upper limb fractures.

Informed consent and departmental permission were taken before operating on the patients. We lost the follow-up of 3 patients and the 20 remaining patients constituted our study with Group A (10 patients) and Group B (10 patients) (Table 1).

2.3. Statistical analysis

Statistical Package for Social Sciences 18.0 (SPSS Inc., Chicago, IL, USA) software was used to perform statistical analyses. Student t-test, chi-square, and Fischer's exact test were used to analyze the difference in means between the 2 groups. A p-value of <0.05 was considered statistically significant.

2.4. Surgical technique

Preanesthetic check-up was done after routine preoperative investigations and after assuring fitness, patients were taken up for surgery. Patients were operated on under general anaesthesia or regional block, in lateral decubitus position with the arm supported in an armrest or a bolster and the forearm hanging by the side. A digital pneumatic tourniquet was routinely applied as proximal as possible in the arm.

Preop antibiotics were given. Under all aseptic precautions painting and draping were done. Around 14-16 cm midline skin incision curving over the tip of the olecranon was used. Medial and lateral full-thickness flaps were developed and first, the ulnar nerve was identified and tagged with an infant feeding tube or surgical gloves. Dissection of the nerve was done from proximal to distal, starting from the medial edge of the triceps tendon to its first motor branch to the flexor carpi ulnaris muscle (Figure 1). Now further dissection was carried out according to the approach used.

In Group A, the TRAP approach as described by O Driscoll et al. was used for the exposure.[15] The approach begins laterally between the extensor carpi ulnaris and the anconeus, similar to the Kocher approach. The precaution

Fig. 1:

Fig. 2:

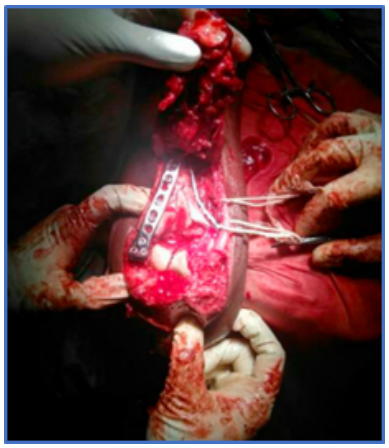

Fig. 3:

was taken not to cut the lateral collateral ligament and anular ligament. Sub-periosteal dissection of the anconeus was done and it was raised with the triceps and posterior capsule to expose the distal humerus (Figures 4 and 5).

In Group B, while protecting the insertion of the triceps over the olecranon, the muscle was elevated from medial and lateral intermuscular septae. A sponge or artery was put across the articular surface for protection. Intra-articular distally oriented chevron (reverse V) osteotomy was then performed with an oscillating saw to the subchondral bone. Then an osteotome was used to complete the osteotomy and the olecranon was raised with triceps off the posterior aspect of the humerus extraperiosteally (Figure 2).

In both the groups, the first articular reduction was done with a pointed clamp and provisionally fixed with k wire which later was replaced with a 4mm cannulated cancellous screw. The medial or lateral column was then fixed with an articular fragment followed by the remaining column. The medial column was fixed along its medial surface while the lateral column was fixed along its posterior surface with pre-contoured locking anatomical or recon plates. Care was taken to ensure the proper fit of the plates to the bony surfaces (Figures 3 and 6).

Intraoperative imaging was done to confirm reduction and proper plate placement. Flexion, extension to check motion arc and varus, and valgus stability test was done for elbow stability.

In Group A, the triceps was sutured back to olecranon using drill holes with interrupted no.2 vicryl suture. In Group B, tension band wiring with 2 k wire of olecranon osteotomy was done. The tourniquet was then released and homeostasis was achieved before the wound closure in layers over a suction drain. Aseptic dressing and posterior slab were applied.

2.5. Post-operative care and follow-up

2.5.1. Postoperative care

In all patients, the posterior slab was applied in 90 of flexion and to prevent oedema, the limb was elevated for 2 days. Patients were discharged around the 5^{th} post-op day and were called for stitch removal at 2 weeks, the splint was also removed during the same time. A physiotherapy program was started with passive gentle range of motion exercise and increased slowly. In the TRAP group, active elbow

Fig. 4:

Fig. 5:

Fig. 6:

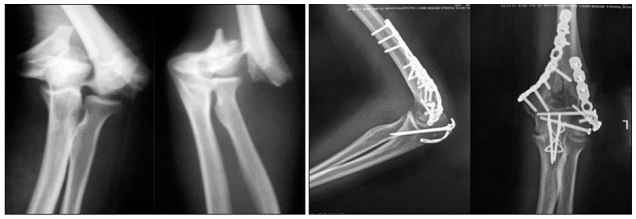

Fig. 7:

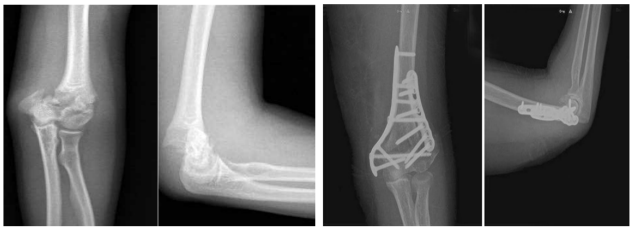

Fig. 8:

extension was restricted for 6-8 weeks while it was started after two weeks in the osteotomy group.

2.5.2. Follow up

The first follow-up was done at 2 weeks post-op when the splint and suture were removed depending on the wound condition. Next at 6 weeks, followed by 12 weeks and 18 weeks, and after that at every two months till the last follow-up. At each follow-up, patients were evaluated for any symptoms like pain, swelling, signs of infection, and ROM at the elbow. AP and lateral view of the affected elbow was also done at each follow-up. At the final follow-up visit at 12 months, elbow range of motion, triceps strength, and Mayo's elbow performance score (MEPS) were calculated.

3. Results

20 patients were included in our study conforming to the acceptance criteria. Age, gender, side, and duration of injury were of no difference in both groups. According to AO classification, C1, C2, and C3 fractures were 4, 4, and 2 in Group A and they were 3, 6, and 1 respectively in Group B

(Table 1). The fracture was seen more in females and with a left-sided preponderance (Figures 9 and 10). The most common cause of injury was self-fall (Figure 11). Head injury and vertebral fracture were commonly associated with these fractures (Figure 12).

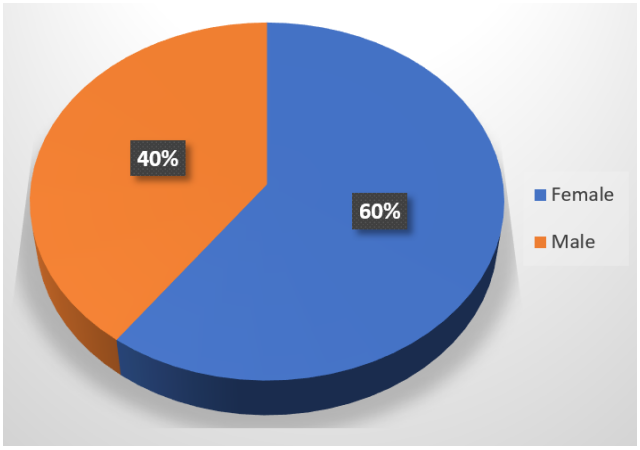

Fig. 9: Sex distribution

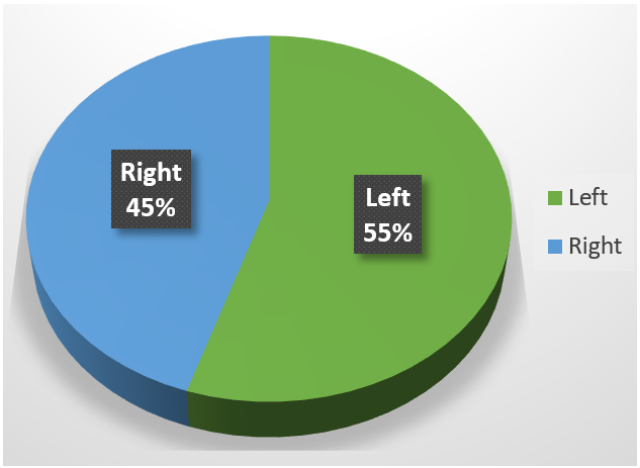

Fig. 10: Side involved

The operative time and hospital stay both were significantly more for Group A than Group B. In both groups union of fracture was noted at almost the same post-op period (Table 2). Range of Motion parameters like flexion, extension loss, pronation, and supination were also similar in both groups (Table 2). At the final follow-up, function evaluation utilizing average MEPS calculation was done (Table 2) and was not significantly different.

Complications were treated appropriately. Hardware prominence was seen in 1 case of Group B and none in Group A. patient had to undergo implant removal at 6 months for the same. Deep infection was not seen in any case while 2 cases in Group A and 1 in Group B got a superficial infection which resolved with regular dress

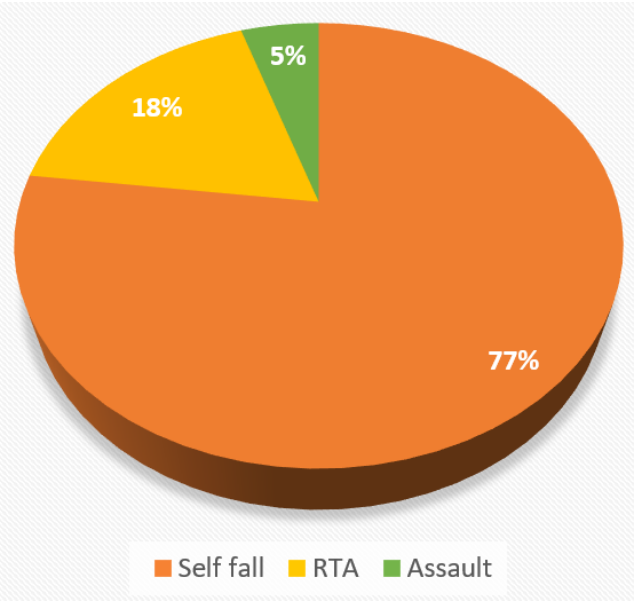

Fig. 11: Mode of injury

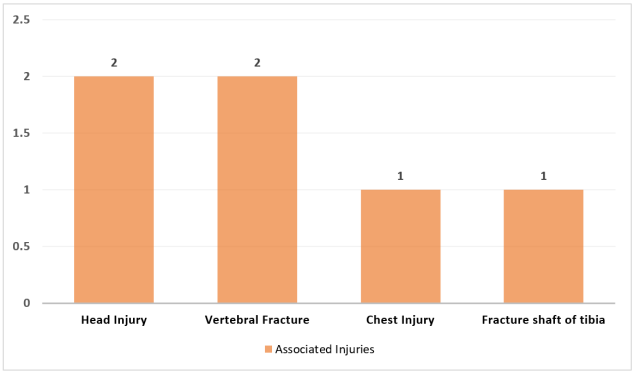

Fig. 12: Associated injuries

Fig. 13: Post operative movements

Table 1:

Parameters		Group A	Group (B)
Average Age		43.2	37.45
Sex	Male	3	5
	Female	7	5
Side	Right	6	3
	Left	4	7
Time Interval Between Trauma and Surgery		5.55 days	5.05 days
Fracture Type			
C1		4	3
C2		4	6
C3		2	1

Table 2:

Summary of Results	TRAP	Olecranon Osteotomy	P value
Operative time	119.5 min	111.25 min	0.0067
Blood Loss	226 ml	200 ml	
Duration of stay	9.85 days	5.45 days	0.0001
Union of fracture	13.05 week	12.85 week	0.67
Functional Result (MEPS)	84.25	86.25	0.573
ROM			
Flexion	118 degrees	118.25 degree	0.90
Extension Loss	11 degrees	12 degrees	0.465
Supination	72.25 degree	73 degrees	0.697
Pronation	80.75 degree	79 degrees	0.247

ings and antibiotics. In each group, 1 patient had mild ulnar nerve neuropathy which improved completely at 2 months with conservative treatment. Complications like loss of articular reduction, implant breakage, or wire breakage were not seen. Problems related to olecranon osteotomies like non-union, malunion, or heterotopic ossification were also not seen in our series. No evidence of AP or varus-valgus instability was found (Table 3). Overall, complication rates between the two groups were not statistically significant.

4. Discussion

The goal of treatment in a patient with intraarticular distal humerus fracture like any other joint fracture is anatomical restoration, stable fixation, and early rehabilitation.[19,20] To achieve this good exposure is needed that allows us to see articular fragments and their proper reduction. For these approaches like olecranon osteotomy, triceps reflecting, triceps splitting, and TRAP approaches were defined.[6,15] But due to a lack of proper guidelines, the approach that is taken usually depends on the surgeon's training and comfort.

Olecranon osteotomy is one of the most common approaches used for these fractures because of its familiarity among surgeons and also is very effective. But there are associated complications like osteotomy site delayed or non-union, and hardware prominence.[6,17,19,20] There is also a probability of denervation of the anconeus muscle.[15] Most of the osteotomy complications are due to the transverse osteotomy technique and have been reduced with the use of chevron osteotomy.[21,22] It is a v-shaped osteotomy that increases the surface area of healing, facilitates reduction, and is more stable because of the inherent translational and rotatory stability provided by its structure.[21] An apex distal chevron osteotomy was done in our study. Delayed union was observed in one patient and it united without intervention. In the current study, one patient had hardware prominence due to tension band wiring done for osteotomy which was removed after the union.

Wilkinson et al.[23] in a cadaveric study, have compared the triceps split, TRAP, and olecranon osteotomy techniques to differentiate joint surface exposure between them. They found maximum exposure was with olecranon osteotomy (56%) followed by TRAP (46%). However, we can increase exposure in TRAP by increasing flexion of the elbow and thus can overcome this disadvantage.

Triceps-elevating exposures were generally claimed to cause weakness of extension or rupture of the triceps.[24] But in our study, no case of triceps rupture was seen, while weakness was present in a few cases. However, the cause of weakness may be due to trauma also, as 1 patient with triceps weakness also had weakness in the flexor muscle. The main disadvantage of the TRAP approach is that it usually requires more operative time and has a long learning curve. No patient in our study had a second surgery in the TRAP group.

Table 3:

Complications	TRAP	Olecranon Osteotomy
Superficial infection	2	1
Deep infection	0	0
Non union	0	0
Hardware Prominence	0	1
Ulnar Neuropathy	1	0
Delayed Union at Osteotomy Site	Not applicable	1
Extensor Weakness	1	0

Table 4: Results in terms of MEPS grading

Approach	Excellent	Good	Fair	Poor
Trap	4(40%)	4(40%)	1(10%)	1(10%)
Osteotomy	5(50%)	4(40%)	1(10%)	0
Total	9(45%)	8(40%)	2(10%)	1(5%)

In our study, no significant differences were found in clinical and functional outcomes between the two approaches. But our study has several limitations like the small group of patients and retrograde study. Patients above 70 years were not included. Most of the cases in our study were operated around the 5^{th} day due to institutional and other reasons. Most implants used were locally made due to financial constraints. And finally, a CT scan was not done in all our cases preoperatively.

Future studies consisting of specific age groups, and homogeneous sub-group types, with a similar degree of osteoporotic bone, can give us more accurate results on indications and effectiveness of the TRAP and olecranon osteotomy approaches. Although olecranon osteotomy provides the best exposure, the effect of olecranon osteotomy on the development of osteoarthritis is not well-known. It should be evaluated in long-term studies.

5. Conclusion

The intercondylar humerus fracture is relatively uncommon. Direct falls and road traffic accidents are the two most common modes of injury. Treatment of choice is open reduction and internal fixation, while conservative treatment is kept only for non-operable patients. The goal of surgical therapy is to obtain good fracture reduction and stable fixation to enable immediate function after treatment. The type of implant and construct (90-90 or parallel) has always been a controversial issue, in our study we have used both recon and anatomical plates in the 90-90 construct.

The trans olecranon and TRAP approach both provide good visualization of the articular surface. However, TRAP needs more time for exposure but can avoid osteotomy and related complications.

In our study, both approaches provide almost the same functional and clinical outcome. This study indicates that early accurate surgical fixation coupled with adequate post-op physiotherapy protocol is the key to offering pre-injury status to all patients.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Rose SH, Melton LJ, Morrey BF, Morrey BF, Ilstrup DM, Riggs BL. Epidemiologic features of humeral fractures. *Clin Orthop Relat Res*. 1982;168:24–30.
2. Ilyas A, Jupiter J. Treatment of distal humerus fractures. *Acta Chir Orthop Traumatol Cech*. 2008;75(1):6.
3. Wagner M. General principles for the clinical use of the LCP. *Injury*. 2003;34(Suppl 2):31–42.
4. Lawrence TM, Ahmadi S, Morrey BF, Sánchez-Sotelo J. Wound complications after distal humerus fracture fixation: incidence, risk factors, and outcome. *J Shoulder Elbow Surg*. 2014;23(2):258–6.
5. Cannada L, Loeffler B, Zadnik MB, Eglseder AW. Treatment of high-energy supracondylar/intercondylar fractures of the distal humerus. *J Surg Orthop Adv*. 2011;20(4):230–5.
6. Jupiter JB, Neff U, Holzach P, Allgöwer M. Intercondylar fractures of the humerus. An operative approach. *J Bone Joint Surg Am*. 1985;67(2):226–39.
7. Sanchez-Sotelo J, Torchia ME, O'Driscoll SW. Complex distal humeral fractures: internal fixation with a principle-based parallel-plate technique. *J Bone Joint Surg Am*. 2007;89(5):961–9.
8. Eralp L, Kocaoglu M, Sar C, Atalar AC. Surgical treatment of distal intraarticular humeral fractures in adults. *Int Orthop*. 2001;25:46–50.
9. Jung SW, Kang SH, Jeong M, Lim HS. Triangular Fixation Technique for Bicolumn Restoration in Treatment of Distal Humerus Intercondylar Fracture. *Clin Orthop Surg*. 2016;8(1):9–18.
10. Ziran BH, Smith WR, Balk ML, Manning CM, Agudelo JF. A true tricepssplitting approach for treatment of distal humerus fractures: a preliminary report. *J Trauma*. 2005;58(1):70–5.
11. Archdeacon MT. Combined olecranon osteotomy and posterior triceps splitting approach for complex fractures of the distal humerus. *J Orthop Trauma*. 2003;17(5):368–73.
12. Mühldorfer-Fodor M, Bekler H, Wolfe VM, Mckean J, Rosenwasser MP. Paratricipital-triceps splitting "two- window" approach for distal humerus fractures. *Tech Hand Up Extrem Surg*. 2011;15(3):156–61.
13. Bryan SR, Morrey FB. Extensive Posterior approach to the elbow. *Clin Orthop*. 1982;166:188–92.

14. Bass RL, Stern PJ. Elbow and forearm anatomy and surgical approaches. *Hand Clin*. 1994;10(3):343–56.
15. O'driscoll SW. The triceps-reflecting anconeus pedicle (TRAP) approach for distal humeral fractures and nonunions. *Orthop Clin North Am*. 2000;31(1):91–101.
16. Zhang C, Zhong B, Luo CF. comparing approaches to expose type C fractures of the distal humerus for ORIF in elderly patients: six years clinical experience with both the triceps-sparing approach and olecranon osteotomy. *Arch Orthop Trauma Surg*. 2014;134(6):803–11.
17. Chen G, Liao Q, Luo W, Li K, Zhao Y, Zhong D. Triceps-sparing versus olecranon osteotomy for ORIF: analysis of 67 cases of intercondylar fractures of the distal humerus. *Injury*. 2011;42(4):366–70.
18. Pankaj A, Mallinath G, Malhotra R, Bhan S. Surgical management of intercondylar fractures of the humerus using triceps reflecting anconeus pedicle (TRAP) approach. *Indian J Orthop*. 2007;41(3):219–23.
19. O'driscoll SW, Sanchez-Sotelo J, Torchia ME. Management of the smashed distal humerus. *Orthop Clin North Am*. 2002;33(1):19–33.
20. Atalar AC, Demirhan M, Salduz A, Kiliçoğlu O, Seyahi A. Functional results of the parallel-plate technique for complex distal humerus fractures. *Acta Orthop Traumatol Turc*. 2009;43(1):21–7.
21. Ring D, Gulotta L, Chin K, Jupiter JB. Olecranon osteotomy for exposure of fractures and non-unions of the distal humerus. *J Orthop Trauma*. 2004;18(7):446–9.
22. Mckee MD, Kim J, Kebaish K, Stephen DJ, Kreder HJ, Schemitsch EH, et al. Functional outcome after open supracondylar fractures of the humerus. The effect of the surgical approach. *J Bone Joint Surg Br*. 2000;82(5):646–51.
23. Wilkinson JM, Stanley D. Posterior surgical approaches to the elbow: A comparative anatomic study. *J Shoulder Elbow Surg*. 2001;10(4):380–2.
24. Pierce TD, Herndon JH. The triceps preserving approach to total elbow arthroplasty. *Clin Orthop Relat Res*. 1998;354:144–52.

Author biography

Rohit Jain, Senior Fellow Orthopedics Trauma https://orcid.org/0000-0003-1060-912X

H. C Frank, Professor and HOD

K. K Dutta, Assistant Professor

Kishore Hazarika, Assistant Professor

Cite this article: Jain R, Frank HC, Dutta KK, Hazarika K. Intra-articular distal humerus fracture – TRAP or olecranon osteotomy. *Indian J Orthop Surg* 2023;9(2):53-60.