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RESEARCH ARTICLE

INTRA-ARTICULAR FRACTURES OF DISTAL HUMERUS MANAGED WITH ANATOMIC PRE-CONTOURED PLATES VIA OLECRANON OSTEOTOMY APPROACH

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Abstract

The treatment for displaced intra-articular fractures of the distal humerus is open reduction and internal fixation with early rehabilitation. Best exposure of both columns and articular surface of the distal humerus is achieved through olecranon osteotomy approach and fixation of two columns of distal humerus with orthogonal plate construct which will allow absolute stability and early rehabilitation to restore early elbow joint function. 16 cases of intra-articular fractures of distal humerus were treated by open reduction and internal fixation (ORIF) with orthogonal plate construct via olecranon osteotomy approach. Chevron type olecranon osteotomy was performed and fixed with tension band wiring using 6mm CCS and SS wires in all cases. Radiological evaluation and regular clinical examination were done as per Mayo elbow Performance score. All fractures united within average duration of 3 months. More than 100° range of motion is attained in 14 of cases. The mean Mayo Elbow Performance Score was 90.01 indicating excellent results. The factors for a successful outcome of intra-articular fractures of the distal humerus depends upon anatomic reduction, surgical technique, stable internal fixation, and early rehabilitation. ORIF with orthogonal plate construct securing both humeral columns via olecranon osteotomy approach results in excellent healing and functional outcomes.

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Introduction:-

Distal humerus fractures comprise 2-6% of all fractures. They are commonly comminuted and occur in osteopenic bone with limited options for internal fixation. Treatment outcomes are often associated with elbow stiffness, weakness, hardware symptoms and pain. A painless, stable and mobile elbow joint is desired as it allows to conduct the activities of daily living. Therefore, distal humerus intra-articular fractures require anatomic intraarticular reduction, and early mobilisation^[1-2]. Traditionally, these fractures had been managed in an operative fashion with various extensor mechanism-disrupting surgical approaches^[3-10]. Various extensor mechanism-sparing approaches that provide bi-columnar exposure of the distal part of the humerus have been described, including triceps-splitting and reflecting techniques^[5,8-10]. The principles set out by the Association for the Study of Internal Fixation, AOASIF group, including anatomic articular reduction and rigid internal fixation and early postoperative range of motion. Recent advances in the understanding of elbow anatomy, improvements in surgical approaches, new

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innovative fixation devices led to improved outcomes in intra-articular distal humerus fractures. Pre-contoured locking plates for lateral and medial columns and for fixation of olecranon osteotomy by AO group is new and effective method of fixation in distal humeral fractures and more effective in osteoporotic bone ^[1-2] So, in younger patients, open reduction and internal fixation of distal humerus fractures using modern fixation principles should be considered. Hence, the present study is undertaken to evaluate the management and outcome of two column fixation of intra-articular fracture of distal humerus in adults by orthogonal anatomic plates construct via olecranon osteotomy (using 6mm CCS and SS wires) approach.

Materials And Methods:-

This was a retrospective interventional study which included 16 consecutively cases of intra-articular fractures of distal humerus carried out in Department of Orthopaedics, Govt. Medical College, Jammu from January 2019 to August 2021 after getting the approval from ethical committee and complete informed written consent from all patients. Fractures were classified as per AO fracture classification system.

Inclusion criteria:-

AO Type C fractures in adults (18-65 years). Most of the fractures were of C1 type in 7 cases, C2 in 5 and C3 in 4 cases.

All the patients underwent ORIF of distal Humeral fractures with orthogonal anatomic plate construct via olecranon osteotomy approach after general anaesthesia or supra-clavicular block. Olecranon osteotomy posterior approach was used for reduction and fixation.

In our study we used 6mm CCS and stainless steel wires for tension band wiring of osteotomised olecranon and pre-contoured anatomic plates for medial and lateral columns.

Surgical Technique:-

Patient was placed in a lateral decubitus position. A midline posterior incision was made over the distal humerus. The Ulnar Nerve was identified, explored and protected. An olecranon chevron osteotomy was performed for the exposure of the joint surface. Later on osteotomy was fixed with tension band wiring using 6mm CCS and stainless steel wires in all cases. The articular fragments were reduced and held with a partially threaded K-wires (temporarily), cancellous screw or cortical screws. In all cases two pre-contoured anatomical plates (3.5mm) were used to the distal humerus. Plates applied on distal humerus at right angle to each other. Plates ended at different levels on humeral shaft to minimize the stress riser. Each plate should have at least 2-3 bi-cortical screws proximal to metaphyseal comminution ^[1-2]. After fixation, ulnar nerve was secured in soft tissue or anteriorly trans-positioned in cases of tension on the nerve, wound closed in layers under suction drain. Post operatively a hinged brace was applied over dressing and gentle active or active-assisted exercises were carried out on 2nd post-operative day or as soon as possible as pain allows. All patients were followed up at twice a month for 3 months and monthly intervals for next 3 months then quarterly. During this period patient was motivated for physiotherapy and gradual normal use of the affected limb, fracture union was assessed clinically and radiologically (Fig.4) and elbow function on the operated side was evaluated and compared with the normal side as per Mayo elbow score ^[11] by the same observer. Mayo Elbow Performance Score ^[11] which is based on 100-point scale with maximum of 45 points for Pain, 25 points for Function, 20 points for Range of Motion and 10 points for stability.

Results:-

Among the patients, 10 were males and 6 were females. The mean patient age was 48 years. The right side was involved in 12 cases. All fractures were closed and open fractures were excluded from the study. The mechanism of injury was fall (9 cases) in most of cases followed by RTA (7 cases). Any patient with other associated injuries on the same limb were excluded. Co-morbid conditions were also encountered in 6 cases like Diabetes mellitus, Hypertension and Hypothyroidism. All the patients were operated within 48 hours of injury. The mean duration of follow up was 12 months, ranging from 8 to 16 months. The duration of fracture healing was 3 months, ranging from 10 weeks to 16 weeks. The flexion at the elbow joint ranged from 50° to 140° with an average of 120° (Fig. 5). 14 patients had a flexion beyond 110°. And average loss of extension ranged from 0° to 20° with an average of 14°. More than 100° of range of movement is obtained in 14 (87.5%) of cases. The mean motion of arc was 115°. In most the cases functional arc of motion (30° to 110°) is preserved (Fig. 5). Scoring of range of motion is done as per Mayo Elbow Performance Score ^[11] which was calculated as 90.01 (Table-3). The final functional outcome was

excellent in 10(62.5%), good in 5(31.25%), 1 fair (6.25%) results (Table-4). All of the fixations were stable. No patient suffered from iatrogenic neuro or vascular injury. Painful hardware in 4, superficial infection in 2, non-union of olecranon osteotomy in 0, elbow stiffness in 2.

Discussion:-

Final outcome of painless, functional range of motion at elbow causing no disability is more important. At the average follow up of 16 months, the average flexion achieved was 120° degrees and the average loss of extension was 14° . The mean Mayo Elbow Performance score was 90.01 comparable with other studies and signifies excellent results by maintaining functional arc of motion (30° to 110°)^[3,19,21]. Within the last two decades, a two-column theory of the distal humerus anatomy has been advocated whereby the coronal plane of the distal humerus is in the shape of a triangle, with the coronoid fossa and olecranon fossa accounting for the majority of the central area, and the medial and lateral condyles forming two strong columns by proximal extension^[8,12]. The articular segment functions architecturally as a tie arch^[1-2]. There are several options for fixation between the condyle and humeral metaphysis. These include the use of J-shaped plates, single plates, double K-wire, and K-wire together with tension band wiring^[13,14]. The aim is to facilitate biomechanical reconstruction of the two column structure. We found that plates applied in orthogonal fashion overcome the bending forces and securing the two columns^[3,22]. Rigid fixation and early rehabilitation are the most important goals in treatment of type C elbow fracture. In our study, posterior approach with olecranon osteotomy was used in distal humerus fracture. This approach gives the better exposure of articular surface^[3,15,16] and both columns as well as it provides easy access to ulnar nerve and negates the risk of compromising extensor mechanism. Good exposure is mandatory for the fixation of Type C3 fractures and to provide good fixation. We found the operative field to be extensive, fracture reduction satisfactory and the implementation of early functional exercises easily possible. The most important step in these fractures is the early rehabilitation^[22]. We started gentle active or active assisted exercises immediately after surgery and active exercise around the third week. In each case, fracture reduction was satisfactory, fixation was strong and durable, fracture site was stable and early post-surgical functional exercise was possible. In our series, any patient with associated neurovascular injuries or injury at other site on same limbs were not included. Post-operatively, 2 patients had superficial infection which got better with antibiotics and dressings. More than 15 degree of stiffness is seen in 2 patients. Other complications encountered in our series were, 4 patients had mild pain and hardware symptoms and 10 patients had no pain at all. There was no case of heterotopic ossification. Sodegard et al (1992)^[18] in his series of 96 patients encountered 6 post-operative infections. 12 neural injuries and 16 fixation failures. Thus the complications in our study were comparable studies. Manjit S. Daroch et al (2016)^[23] in his series of 40 cases encountered, 2 patients had transient ulnar nerve Neuropraxia, 3 patients had superficial infection, more than 20 degree of stiffness is seen in 3 patients, mild varus deformity in 2 patients, hardware failure in 1, non-union of olecranon osteotomy in 1 patient, 15 patients had mild pain. Almost the complications like pain and ROM loss in our study was comparable to other studies.



Fig 1:- Antero-posterior and lateral radiographs of 40 years old patient immediately after injury showing AO Type C fracture.



Fig 2:- Intra-op pic showing reduction and provisional fixation with K-wires.



Fig 3:- Antero-posterior and lateral radiographs immediately after surgery (1st post-op day).



Fig 4:- Antero-posterior and lateral radiographs showing fracture union at 12 weeks after surgery.



Fig 5:- Clinical picture showing functional outcome at 12 weeks after surgery.

Table 1:- Technical Objectives for Fixation of Distal Humeral Fractures.

Every screw should pass through a plate.
Each screw should engage a fragment on the opposite side that is also fixed to a plate.
As many screws as possible should be placed in the distal fragments.
Each screw should be as long as possible.
Each screw should engage as many articular fragments as possible.
Plates should be applied such that compression is achieved at the supracondylar level for both columns.
Plates used must be strong enough and stiff enough to resist breaking or bending before union occurs at the supracondylar level
From Sanchez-Sotelo J, Torchia ME, O'Driscoll SW: Principle-based internal fixation of distal humerus fractures, Tech Hand Upper Extremity Surg 5:179, 2001

Table 2:- Mayo Elbow Performance Score.

FUNCTION	MEAN SCORE (POINTS)
Pain(Max 45 points)	
None(45) Mild(30) Moderate(15) Severe(0)	
ROM(Max 20 points)	
>100° (20), 50° to 100° (15), <50°(5)	
Stability (Max 10 points)	
Stable(10) Moderately Stable (5) Unstable(0)	
Function (Max 25 points)	
Comb(5) Feed(5) Personal(5) Shirt(5) Shoes(5)	
Mean Total (maximum 100 points)	
Interpreting the Mayo Elbow Performance Score:	Score
Excellent	90
Good	75-89
Fair	60-74
Poor	Below 60

Table 3:- Mayo Elbow Performance Score.

Function		No. of Patients	Percentage	Mean score
Pain (Max points 45)	None(45)	10	62.5	37.5
	Mild(30)	4	25	
	Moderate(15)	2	12.5	
	Severe(0)			
ROM (Max 20 points)	>100 (20)	14	87.5	19.38
	50-1000 (15)	2	12.5	
	<50 (5)			
Stability (Max 10 points)	Stable (10)	14	87.5	9.38
	Moderately (5)	2	12.5	
	Unstable (0)			

Function (Max 25 points)	Comb (5)	13	81.25	23.75
	Feed (5)	16	100	
	Personal (5)	16	100	
	Shirt (5)	16	100	
	Shoes(5)	15	93.75	
Mean Total (Max 100 points)				90.01

Table 4:- Final Functional Outcome.

Grading	No. of Patients	Percentage
Excellent	10	62.5
Good	5	31.25
Fair	1	6.25
Poor	0	0

Limitations:-

In our study sample size was small and inadequate follow-up in some cases.

There is limited literature regarding objective extensor mechanism strength assessment in our study.

In summary, we found that use of a olecranon osteotomy approach gives adequate view to intra articular distal humeral fractures. Anatomic reduction and stable rigid fixation is important in Type C intra-articular distal humerus fractures for early post-operative rehabilitation. Complications were minimal and healing satisfactory. We advocate the use of this approach for repair of type C distal humerus fractures with pre-contoured anatomic plates and fix the osteotomy site with 6m CCS and stainless steel wires for better functional outcomes.

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