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"A Study of Management of Comminuted Fractures of Lower End Of Radius By External Fixator with Ligamentotaxis Vs or if with Plating A Prospective Comparative Study"

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Abstract
Background and purpose: *In unstable communited distal radial fractures that are impossible to reduce or to maintain in reduced position, the treatment of choice is operation. The type of operation and the choice of implant, however, is a matter of discussion. Our aim was to compare between external fixator with Ligamentotaxis and open reduction and internal fixation with volar plate in respect of anatomical and functional variables.*
Methods: *30 patients with an unstable or comminuted distal radius fracture were selected ,15 were treated with closed reduction and bridging external fixation and 15 were treated with open reduction and internal fixation using volar plate. Patients were reviewed for follow up after 1 week with check X-ray, then in every 2 weeks upto 6 weeks. Patients were evaluated on 3rd and 6th month after surgery for analyzing results.*
Results: *At the end of study, Mean functional score of patients treated with external fixator preoperatively was 48.00 which has increased to 89.67 at the end of follow up while in patients treated with platting preoperatively mean functional score was 48.73 which has increased to 78.93 at the end of 6 months follow up. P value for external fixator group was more significant (P-0.004, highly significant) than platting (P-0.01) group (although significant difference in both groups). Overall, mean anatomical score of patients treated with external fixator has increased significantly to 90.55 degree from 48.93 at the end of 6 months follow up, which was statistically highly significant (P-0.006). While in patients treated with platting anatomical score increased less significantly (P-0.04) (although significant difference in both groups).*
Interpretation: *Although both functional and anatomical evaluation shows difference were significant in both group between preop and post op values but external fixator is better than platting to improve overall anatomical landmarks and functional variables, platting was better than external fixator only to restore volar tilt, in all other criteria fixator was better than platting.*

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I. Introduction

Fractures of the distal radius remain the most common fractures approximately one-sixth of all fractures treated in emergency departments. Fractures of the distal radius have been associated with colorful history since first description by Ponteau in 1783 and later by Abraham Colles in 1814.[1] Risk factors are - decreased bone mineral density, female gender, ethnicity, heredity & early menopause.[2] For decades, the primary treatment method for distal radial fractures was with plaster cast, but this treatment modality frequently leads to early loss of reduction and poor functional outcome, with intraarticular fractures being at particularly high-risk. With operative fixation, patients may require shorter periods of immobilization and may be able to return to normal activities sooner.[3] Fractures that were once thought to be non-reconstructible may now fairly well functional after meticulous joint surface reconstruction. Although closed reduction and cast immobilization continues to be adequate for many distal radius fractures, facilities are increasing with percutaneous and intrafocal pinning, external fixation, and open reduction and internal fixation. Recent advances with arthroscopically assisted reduction and fixation have further expanded therapeutic armamentarium. When a decision must be made between imperfect closed reduction and better reduction and fixation by semi open or formal open techniques, it is believed that the later is warranted. [4]

So finally we should strive to attain the goals of Abraham Colle who suggested, "that the limb will again enjoy perfect freedom in all its motions and be completely exempt from pain.[5]

There have been many complications reported with the use of plate-and-screw fixation around the wrist, including irritation or rupture of extensor tendons and intra-articular penetration of hardware. [6]

External fixation has enjoyed success, but also has been associated with complications such as stiffness of the fingers, loss of reduction, problems with the radial sensory nerve and pin-track infection.[7] The recent advances in locking-plate technology have been applied to distal radial fractures. These implants are used for the treatment of many types of fracture pattern of the distal radius through a volar approach which may be less prone to the complications seen with a dorsal approach.[8] Our aim therefore in this prospective study was to compare the radiological, clinical and functional outcomes of two groups of patients treated either by bridging external fixation or volar locked plating for a fracture of the distal radius.

II. Material And Methods

Over a period of one year (between 1st January 2013 to 31st December 2013) , 30 patients with fractures of the distal radius who met the inclusion criteria, were selected from those admitted in the indoor ward of Department of Orthopedics at Batra Hospital & Medical Research Center, New Delhi. 15 cases were operated by External fixator with Ligamentotaxis and other group of 15 cases were operated by ORIF with Plating. Patients were reviewed for follow up after 1 week with check X-ray, then in every 2 weeks upto 6 weeks. Patients were evaluated on 3rd and 6th month after surgery for analyzing results.

Exclusion criteria included volar and dorsal shear fractures, skeletal immaturity, pathological fractures and refusal to participate. The Institution Review Board approved the study and the patients gave informed consent. A complete history was taken and physical examination performed. Standard radiographs were obtained at presentation including anteroposterior (AP), lateral views. Clinical evaluation was done using a predesigned and pretested proforma with respect to history, clinical examination, radiological and functional assessment during preoperative and specific postoperative visits. The fractures were classified according to Fraykman criteria[9] (Table 1). All displaced fractures were initially treated by closed reduction and application of a splint. Measurements of the anatomical and functional variables were done according to Saito and stewart scoring system. (Table II).

Patients who met the criteria for initial closed treatment were reviewed within one week and reexamined clinically and radiologically to assess the maintenance of their reduction. These criteria included residual dorsal angulation of < 10° (from neutral), loss of height of < 2 mm compared with the contralateral side, articular step-off of ≤ 1 mm and no associated instability of the distal radio-ulnar joint. If the reduction was maintained the patient was reviewed weekly for three weeks with radiological assessment. Surgery was recommended if reduction was lost, due to the presence of any three of the following: initial dorsal angulation > 20°, initial shortening > 5 mm, dorsal comminution > 50%, an intra-articular fracture, age > 60 years and an associated ulnar fracture23 or a fracture-dislocation of the wrist. All the operations were performed under regional or general anaesthesia. The external fixation group underwent closed reduction with the placement of two pins in the base of the second metacarpal and two in the distal third of the radius. (Fig. 1). ll the patients in the plate group underwent a standard volar approach of Henry. All the fractures were reduced in an open manner and stabilised by a pre-contoured volar plate (Fig. 2). After two weeks the dressings and sutures were removed. All patients had formal physiotherapy emphasising active and passive finger movement, wrist movement and forearm movement. At each assessment the range of movement of the wrist and fingers was measured by using a goniometer.

Subsequently patients were followed upto 6 months and all measurements were taken according to above described classification with a predesigned performa.

III. Statistical Methods Employed

All data tabulated into various categories and mean, standard deviation was evaluated. Continuous data was evaluated with student t test, p value was calculated for each group with respect to mean and SD, then same process is done for second group and p value was evaluated for this group also, and difference in p value is taken as parameter to decide which group is better than other. Chi-square test was done to evaluate qualitative data, the Chi-Square Test procedure tabulates a variable into categories and computes a chi-square statistic. This goodness-of-fittest compares the observed and expected frequencies in each category to test either that all categories contain the same proportion of values or that each category contains a user-specified proportion of values. then p value was evaluated for both groups and difference in p value is taken as parameter to decide which group is better than other. All the statistical operations were done through SPSS for Windows. Version 10.0 (SPSS Inc, 1999 NewYork) (Statistical Presentation System Software).

Table1. Frykman's classification[9]

Type I	Extra articular fracture(A)
Type II	Extra articular fracture with ulnar styloid fracture(B)
Type III	Radio carpal articular involvement(C)
Type IV	Radio carpal involvement with ulnar styloid fracture(D)
Type V	Radio ulnar involvement(D)
Type VI	Radio ulnar involvement with ulnar styloid fracture(E)
Type VI	Radio ulnar & radio carpal involvement(F)
Type VIII	Radio ulnar & radio carpal involvement with ulnar styloid fracture(G)

Results

In our study, Frykman's classification was used for classification of the fracture type.

- Out of 30 patients, 18(60%) were males and 12(40%) were females. Maximum number of patients was between to 31-40 years of age. In our series, maximum 23 (76.67%) patients had fracture of dominant wrist while 7 (23.33%) patient had fracture of non dominant wrist.
- Out of total 30 patients, Frykman Type 7 (9, 30.00%) patients was the commonest type, subsequently 6 (20.00%), 5 (16.66%), 5 (16.66%), 3 (10.00%), 2 (6.66%) had fracture of Frykman's type 3, 4, 6, 5 and 8 respectively.
- Mean duration of stay in hospital for patients who were operated with external fixator was around 2 days and Mean duration of stay in hospital for patients who were operated with platting was around 3 days, There was statistically significant difference P value-<0.05.(0.01).

All the patients were followed for a minimum period of 6 months. At each visit, the patient was evaluated clinically and radiologically and the final results were analyzed with the help of Stewart et al anatomical and functional criteria.

A. Anatomical Evaluation

1. Mean radial angle of patients treated with external fixator preoperatively was 13.6 degree which has increased to 19.5 degree, while in patients treated with platting preoperatively mean radial angle was 14. 3 which has increased to 17.9 degree. There was statistically difference between the two group, P-0.001, highly significant value for external fixator group, than platting group (P-0.01).
2. Mean radial length of patients treated with external fixator preoperatively was 6.7 mm degree which has increased to 9.2 mm, while in patients treated with platting preoperatively mean radial length was 7.2 mm which has increased to 9 mm. There was statistically significant difference for external fixator group (P-0.002), and non significant for platting group (P-0.29).
3. In term of restoration of volar tilt, there was no statistically difference between two group, although platting (P-0.02) is little better than external fixator(P-0.03).
4. External fixator is better than platting to restore joint congruency, P value for external fixator group was statistically significant (P-0.04) and non significant in platting (P-0.14) group.
5. Also, external fixator is better than platting to restore normal relationship of radio ulnar joint. P value for external fixator group was statistically significant (P-0.01) and non significant in platting (P-0.22) group.
6. Overall, mean anatomical score of patients treated with external fixator has increased significantly to 90.55 degree from 48.93 at the end of 6 months follow up, which was statistically highly significant (P-0.006). While in patients treated with platting anatomical score increased less significantly (P-0.04). (Figure 3 & 4

So, external fixator is better than platting to improve overall anatomical landmarks, platting was better than external fixator only to restore volar tilt, in all other criteria fixator was better than platting.

Functional Evaluation

1. Mean pain and function score of patients treated with external fixator preoperatively was 19 which has increased to 45 degree at the end of follow up while in patients treated with platting preoperatively mean pain and function score was 23.33 which has increased to 41.33 degree at the end of follow up. P value for external fixator group was significant (P-0.01) while non significant in platting (P-0.08) group.
2. Mean mobility score of patients treated with external fixator preoperatively was 13.6 which has increased to 25 degree at the end of follow up while in patients treated with platting preoperatively mean mobility score was 13.3 which has increased to 21.3 degree at the end

Table 3: Shows the P value of different variables included in study compared for each group separately (Fixator and Platting) at 6 month follow up to preop values.(to know the difference was significant or not i.e. p value<.05 is significant) of follow up. P value for external fixator group was more significant (P-0.002) than platting (P-0.02) group.

Variable	**P Value (**When Compared Pre Op And 6 Month Follow Up**)**	
	Ef	**If(Platting)**
Radial Angle	0.001	0.01
Radial Length	0.002	❖ 0.29
Volar Tilt	0.03	0.02
Joint Incongruency	0.04	❖ 0.14
Pain Score	0.01	❖ 0.08
Mobility Score	0.002	0.02
Grip Score	0.006	0.01
Deformity Score	<0.0001	<0.0001
❖ Non Significant Difference Between Preop Values And At The End Of Follow Up.		

3. External fixator is better than platting to restore grip strength. P value for external fixator group was more significant (P-0.006) than in platting (P-0.01) group.
4. Mean deformity score of patients for both external fixator and platting had increased significantly. P value for external fixator group as well as platting was highly significant (P-<0.0001) this denotes external fixator and platting both are highly effective modalities for reducing the deformity.
5. Mean functional score of patients treated with external fixator preoperatively was 48 which has increased to 89.67 at the end of follow up while in patients treated with platting preoperatively mean functional score was 48.73 which has increased to 78.93 at the end of 6 months follow up. P value for external fixator group was more significant (P-0.004, highly significant) than platting (P-0.01) group. (Figure 5)
   This denotes external fixator is better modality of treatment than platting to improve overall functional score.

IV. Discussion

The Colles' fracture is extremely common, and a large majority of cases were treated non-operatively. But now, recognition of the patterns, which are inherently unstable and therefore need additional forms of fixation to secure and maintain reduction and avoid late collapse, is a key to successful management of the more complex fractures of the distal radius. Thus, distal radial fractures are now virtually segmented as a different entity than that of Colles' fracture, which is for extra articular distal radial fractures only. Frykman's assification is useful for categorizing distal radial fractures as it covers all the types and eliminates the confusion created by outdated terms used to classify these fractures. The use of external fixation in management of the fractures of the distal radius needs careful assessment of fracture patterns, appropriate patient selection, aggressive early rehabilitation and careful post operative monitoring. External fixation allows fracture fragments to fall in place and brings about reduction and maintains the distraction force during fracture healing. It is particularly useful when fracture fragments are very small and sufficient purchase cannot be achieved.

Ligamentotaxis is useful in restoring skeletal length and wrist position can be adjusted i. e. dorsiflexion to help bring about reduction of the fracture by the volar ligaments and avoids finger stiffness simultaneously.

Thus, the distinctive advantages of external fixator are its superior mechanical efficiency, its capacity for fracture adjustment during the healing period and unimpeded access to wounds in open cases. External Fixation with Ligamentotaxis allows more accurate treatment by giving good anatomical reduction. After reconstruction of the joint under direct vision and re-establishment of radial length, both intermediate and lateral columns can be realinged.

We find in this study that external fixator with Ligamentotaxis is better than internal fixation in treatment of distal radial fractures. We came to this conclusion by looking at the statistical figures which show that anatomical and functional results were excellent and good in more than 90% in patients treated with external fixator with Ligamentotaxis. On the other hand, less than 80% in patients treated with internal fixation had excellent and good results. This study clearly supports that precise identification of the unstable fractures of distal end of radius and a good anatomical restoration results in good functional end results.

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Table 2: Functional Scoring Demerit Point System (Saito) Score

Clinical Subjective (Normal 50 points)	Pain \ function	None \ Normal	50
		Mild occasional \ Slight Limitation	40
		Moderate, needs Analgesics\some limitation	25
		Server \ week with loss	00
Clinical Objectives (Normal 50 points)	Mobility	Normal	25
		Less than 30% loss of range	20
		Minimal functional	10
		Less than minimal	00
	Grip*	Normal	20
		15% loss	15
		16%-30% loss	10
		More than 30% loss	00
	Deformity	None	05
		Slight	03
		Obvious	00

Radiological Scoring:- Anatomical (Stewart et al 1984)

		Score
Radial angle (Degrees)	(1) 23 to 18 (2) 17 to 13 (3) 12 to 10 (4) Less than 10	30 24 18 00
Radial length (mm)	(1) 12 to 10 (2) 9 to 7 (3) 6 to 5 (4) Less than 5	40 32 24 00
Volar tilt (Degree)	(1) 11 to 7 (2) 6 to 3 (3) 2 to 0 (4) Negative	30 24 18 00
Incongruency (mm)	(1) 1 to 2 (2) More than 2 (3) More than 2 with fragment rotation	-10 -20 -30
Radio-Ulnar joint	(1) Subluxation (2) Dislocation	-10 -20

***Results will graded in four groups:-**

Grade	Functional	Anatomical
Excellent	100-85	100-85
Good	85-70	85-70
Fair	70-60	70-60
Poor	<60	<60

Figure 1. Shows preoperative and post operative photographs of patient operated with external fixator.

Figure 2. Shows preoperative and post operative photographs of patient operated with plating.

Figure 3 :

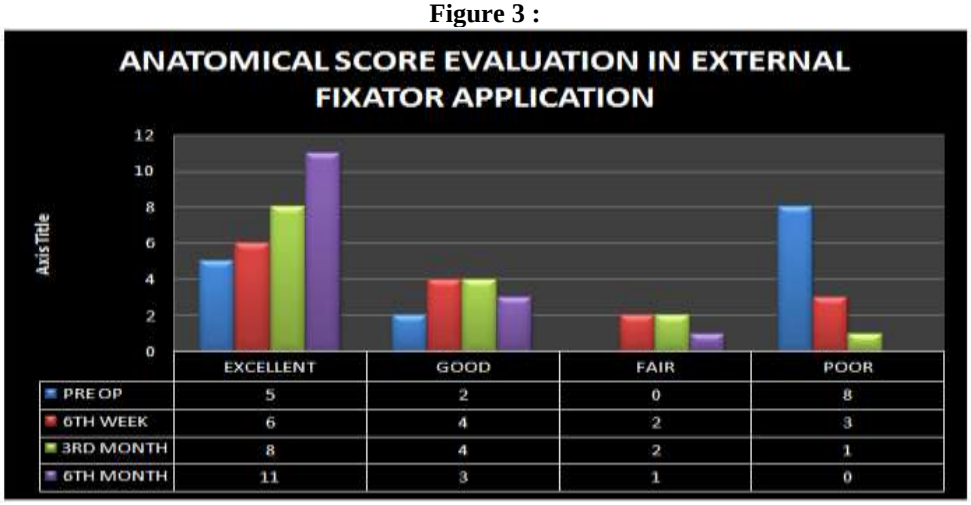


Figure 4 :

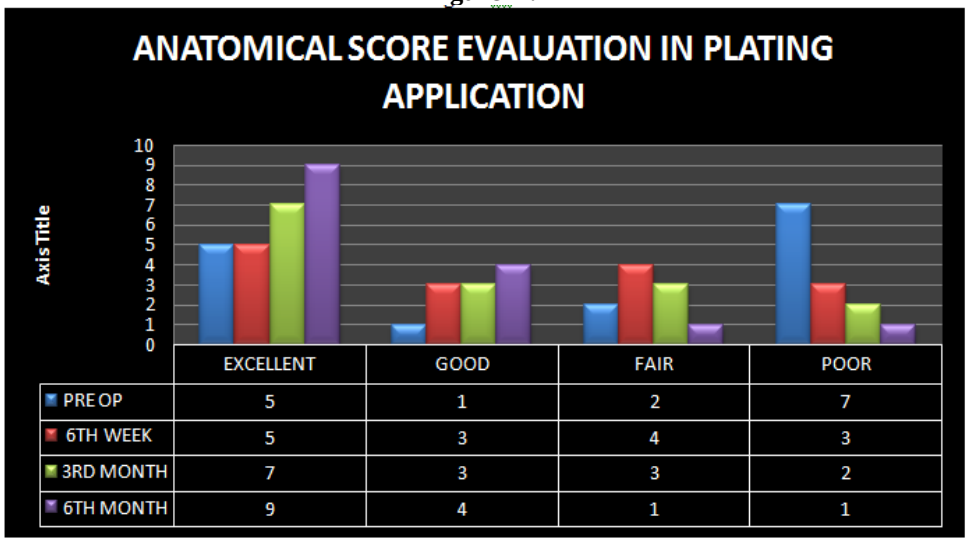
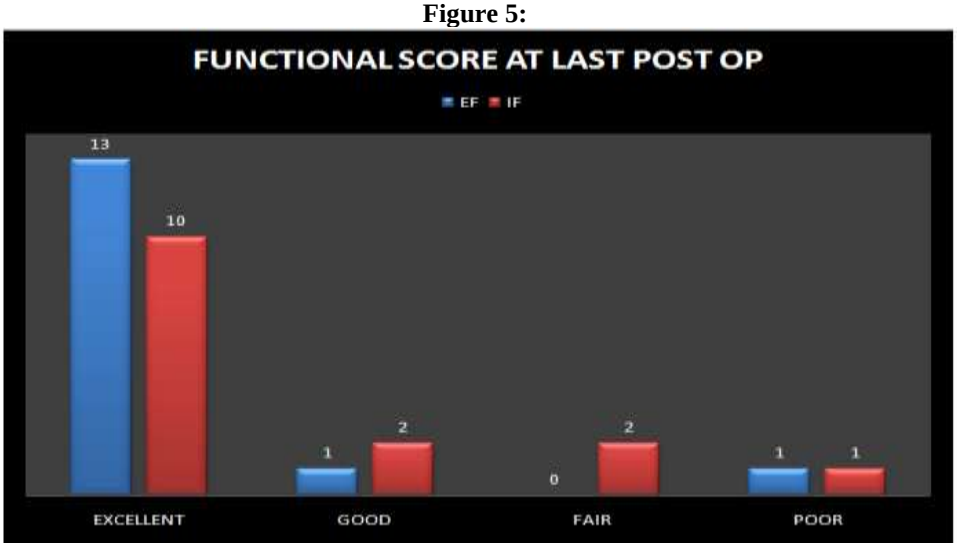


Figure 5:



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