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CLOSED REDUCTION AND PLASTER CAST IMMOBILIZATION VS. EXTERNAL FIXATION IN COMMINUTED INTRA-ARTICULAR FRACTURES OF DISTAL RADIUS

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ABSTRACT

Background: Comminuted intra-articular fractures of distal radius often result in a painful, stiff, dysfunctional wrist. They may be treated by external fixators or by closed reduction and plaster. **Methods:** Fifty-five patients of comminuted, intra-articular fractures of distal radius were treated randomly either by closed reduction and plaster immobilisation or by external fixation. The radiological results, functional results and complications in both the groups were analyzed. **Results:** The outcome of external fixation was significantly better as compared to cast immobilization ($p < .05$). Incidence of loss of reduction was significantly improved by external fixation as compared to cast immobilization ($p < .001$). There was a strong positive correlation between restoration of normal anatomy (radiological results) and functional outcome ($r = .811$). Complications were seen in 43% of patients in POP group and 33% of patients in external fixator group. **Conclusion:** We conclude from this study that external fixator is a better modality of treatment as compared to plaster cast immobilization for intra-articular distal radial fractures. It is also reliable in maintaining the reduction of unstable fractures however it is inadequate in attaining anatomical reduction in many cases when used exclusively. Complications of external fixation, although less frequent than cast immobilization, are potentially serious in nature.

KEYWORDS: Intra-articular fractures; Distal radius; External fixation.

INTRODUCTION

It is now well recognized that describing every fracture of the distal radius by the eponym of Colles' fracture is no longer relevant,[1,2] Comminuted intra-articular fractures of distal radius are common injuries that will not do well, unless certain treatment criteria are met and result will be a painful, stiff, dysfunctional wrist.[1-4] The goal of the treatment is to achieve and maintain certain extraarticular and intra-articular criteria during healing.[1] Numerous techniques have been described and developed to treat these complex fractures in an effort to improve the outcome.[1,2,5] This prospective randomized study was designed to compare the results and complications of conventional POP immobilisition after closed reduction and external fixation in intra-articular fractures of the distal radius.

MATERIAL AND METHODS

This study was conducted on 55 patients of intra-articular fractures of distal radius. Extraarticular fractures and minimally displaced intra-articular fractures (step off<1mm, dorsal angulation <10 degree) were excluded from the study. Forty nine patients sustained high velocity injury as a result of RTA or fall from height. Twelve patients had associated injuries: skull fracture in four patients, femoral fracture in three, stable thoracic spine fractures in two, cervical spine fracture without neurological deficit, mandible fracture and ipsilateral scaphoid fracture in one patient each. There were two patients with open grade I and one with grade II fractures. Postero-anterior and lateral radiographs of the wrist were taken and fractures were classified according to Frykman's classification. Patients were randomly treated either by external fixator or by closed reduction and POP cast.

A below elbow plaster of Paris cast was applied after closed reduction under regional anesthesia and patient was called for inspection after 24 hours to assess distal circulation, swelling and tight plaster. External fixator (Orthosys/Inor) was applied under general or regional anesthesia. This fixator consists of a ball and socket joint attachment with the Schanz pins. After cleaning and draping, a three cm incision was given over bare area of radius, just proximal to the crossing of the musculotendinous junction of abductor pollicis longus. Dissection was carefully carried out to protect the superficial branch of radial nerve and the plane between

brachioradialis and extensor carpi radialis longus was developed to expose.

Fig. 1: Preoperative radiograph of (a) comminuted destal radial fracture, (b) after reduction and immobilisation in external fixator, and (c) after six months follow up.

The radial shaft. Two 3.5 mm Schanz pins were inserted in the proximal radius. Stab incisions were given at the base and the shaft of 2nd Metacarpal and two 2.5 mm Schanz pins were inserted after flexing the metacarpophalangeal joint to avoid tethering of extensor hood. All the four pins were inserted in a plane that was at 45^0 to the vertical and true lateral. Closed reduction was done under X-ray control and assembly was fixed using spanners with distraction forces maintained across the wrist joint. Ball and socket joints allowed the wrist to be placed in slight extension or neutral position without compromising fracture reduction in most cases.

Active movements of fingers and thumb were encouraged as soon as tolerated by the patient. Most of the patients could hold pens, cups within one week of surgery and felt comfortable with frames. Patients were instructed to clean pin tracts daily with saline and to do shoulder and elbow mobilization exercises.

On demonstration of the radiological union, the external fixator/POP was removed and physiotherapy of the wrist was commenced. In both groups, check X-rays were taken at 1st and 2nd weeks during immobilization to detect any loss of position. The study protocol stipulated that if reduction of the fracture had been lost to an unacceptable position by first follow up visit, it would be remanipulated. An unacceptable position was defined as a dorsal angulation of more than 10, articular step off >2mm and radial shortening of more than 3mm. Displacements in position occurring after 10 days of the initial treatment were not considered for remanipulation.

All patients were observed for any possible complications. Grip strength was measured using a dynamometer and range of motion was measured using goniometer. Anatomical assessment providing radiological scoring included radial length, radial angle and volar tilt. Assessment of any incongruity of the radio carpal and radio ulnar joint was noted. The data obtained were tabulated, analyzed and subjected to standard

statistical methods. Standard error of difference between two means was used to compare the anatomical parameters, standard error of difference between proportions was used to compare the incidence of loss of reduction and overall results were compared using Chi squared test. Correlation between anatomical and functional score was calculated using coefficient of correlation-r.

RESULTS

Twenty seven fractures were immobilised by external fixation and 28 by plaster. The average duration of follow up was 24.4 months (range 14-35 months). The average duration of treatment in external fixation group was 44 days and in close reduction and POP cast group was 41.5 days. Forty five fractures were Frykman grade VII or VIII. The mean age of the patients was 37.8 years (17-79 years) and 41 were males.

Both groups were comparable with respect to age, sex and Frykman's grading of the fractures (Table 1)

Table I. Demographic parameters of the two groups

	External Fixator group	Closed reduction and POP group	Stastical # significance
Mean Age	37.5±12.1	38.1±11.88	
M : F ratio	3.6 : 1	2.85 : 1	p > .5
Fr (VII/VIII)*	85.7%	77.7%	p > .5
Mean Rx**	44.4	41.5	

* Frykman grade VII or VIII

** Mean duration of treatment in days

\# Chi squared test

Seventeen patients treated by cast immobilization lost position on subsequent check X-rays at follow up visits. Of these, seven patients had re-manipulation under regional anesthesia as per criteria mentioned previously. Two patients treated by external fixation also lost fracture reduction in the third week of treatment; however re-manipulation was not attempted in these patients.

Table II : Anatomical and functional parameters in two groups

Parameters	External Fixator	Closed reduction & POP	Statistical Significance
ANATOMICAL			
· Mean articular step off	0.51±.64mm	0.96±.83mm	p≤ .05
· Mean radial length	10.07±1.93mm	8.21±1.66mm	p≤ .001
· Mean radial angle	19.4°±3.50°	15.96°±3.15°	p≤ .001
· Mean palmar tilt	+3.37°±6.16°	-2.57±8.22°	p≤ .002
FUNCTIONAL *			
· Grip Strength	82.88%	72.89%	
· Palmarflexion	64.5°	52.3 °	
· Dorsiflexion	65.4°	53.6°	
· Pronation	75.9°	67.8°	
· Supination	63.29°	58.1°	

* Mean values

Both the groups were evaluated radiologically and functionally (Table II) using the criteria of Jakim et al[6]. Overall the results were graded as acceptable (sum of excellent, good and fair) or poor. Twenty two of 27 patients treated by external fixation and 15 of 28 patients treated by cast had acceptable results (Table III). This difference is statistically significant as calculated by Chi square test ($p < .05$). The grip strength was calculated as the percentage of the contralateral side.

The average grip strength in external fixation was 82.8% while in POP group it was 72.89%.

Table III. Overall Results

Final result	External Fixator group	Closed reduction and POP group
Excellent	7 (26%)	2 (7.1%)
Good	9 (33.3%)	5 (17.8%)
Fair	6 (22.2%)	8 (28.5%)
Poor	5 (19%)	13 (46.5%)

Follow up visit (table II). Radiological parameters were significantly better in external fixation as compared to POP group as determined by student t test ($p < .001$ for radial length and radial angle, $p < .002$ for palmar tilt and $p < .05$ for articular step). There was a strongly positive co-relation between functional and radiological result as seen in the scatter diagram (Fig 4) and as determined by co-efficient of correlation ($r=0.81$).

Complications were seen in 12 out of 28 patients in POP group (43%): seven patients required re-manipulation due to significant loss of position, three patients had obvious wrist deformity that required osteotomy and two patients developed transient median nerve compression. Nine patients in external fixation group (33%) developed

complications. The commonest complication was pin tract infection, which was seen in six patients, two patients lost position leading to malunion and of these, one patient also developed reflex sympathetic dystrophy. A sixty-year-old female developed iatrogenic fracture of the 2nd metacarpal during the fourth week necessitating fixator removal. Pin tract infections in five patients were superficial and responded to oral antibiotics. In all the five patients proximal radial pin was the site of infection. One patient presented with a grade 2 compound fracture 72 hours after the injury, with an abscess (infected hematoma) over the fracture site. He developed pin tract infection leading to osteomyelitis and nonunion of the fracture. We did not encounter any iatrogenic damage to superficial branch of radial nerve or tendon injuries. Fracture was anatomically reduced in fifteen patients and ten patients had a residual step of 1mm at the time of healing in external fixator group. Two patients treated by external fixation had a residual step of 2 mm and both these patients developed grade I arthritis on subsequent follow up. In POP group five patients developed grade I and two patients had grade II arthritis. In this group twenty patients had a residual articular step off of 1-3 mm. Grading of arthritis was based on the scoring system of Knirk and Jupiter.[1] Six patients treated by POP complained of regular wrist pain requiring analgesics on heavy work. Two of them had to change their jobs as a result. Two patients managed by external fixation had wrist pain limiting heavy work. Of these one had developed osteomyelitis resulting in nonunion and other had lost the fracture reduction leading to malunion.

DISCUSSION

Intra-articular fractures of the distal radius are commonly encountered complex fractures. These fractures usually occur as a result of high-energy trauma and are often unstable. Current treatment goals are centered on restitution of bony anatomy of the distal radius (radial angle, radial length and volar tilt), with specific attention to restoration of articular surfaces of radiocarpal and radioulnar joints.[3,4,7] Past decade has witnessed various modalities of treatment in an effort to improve the outcome of these fractures.[5] The external fixator is a versatile tool that is now well established in the treatment of these fractures. It has several distinct advantages over conventional POP cast and plate fixation.[8,9]

External fixator is very useful in maintaining restored axes and length. The principles of external fixation involve longitudinal traction (ligamentotaxis) and, most importantly, palmar translation.[10] Longitudinal traction alone cannot restore palmar tilt.[11] In our study the ball and socket attachment facilitated not only palmar translation (thereby achieving significantly improved palmar tilt at union), but also allowed wrist to be placed in a neutral or extended position without compromising the reduction. Wrist extension helps in flexing the metacarpo-phalangeal joints and allows active hand function while the fracture unites. Conventional POP cast places the wrist in flexed position that tends to extend MP joints causing MP joint stiffness and also predisposes the wrist to median nerve compression.

It has been well documented that external fixation maintains the reduced position significantly better as compared to cast immobilization[8] In our study only two (7.4%) patients treated by external fixation lost reduction where as loss of position was seen in seventeen (60.7%) patients treated by POP immobilization ($p < .001$). However, twelve patients treated by external fixation did not achieve anatomical reduction: ten patients had a residual step of 1mm which couldn't be improved by closed manipulation under fluoroscopy and two fractures slipped later leading to an articular step of 2mm at healing. This can be explained because external fixation alone does not expand crushed cancellous bone, and it cannot work without soft tissue hinges. Therefore satisfactory reduction may not be achieved in fractures with depressed articular fragments and in highly comminuted fractures. In these circumstances external fixation has to be augmented by mini open procedure to elevate articular depressions and supplement fixation with K-wires or bone grafting. Klein et al have reported on a series of 103 distal radial fractures that were treated by external fixator.[12] In 61% of the cases, adjuvant procedures were required to obtain and maintain satisfactory reduction. Similarly, Rikli et al achieved satisfactory reduction in 74% of cases treated exclusively by external fixator however 26% required additional intervention in the form of K-wires, bone grafting, screw fixation or volar plate.[i3] Functional score and final outcome also depends upon the initial severity of injury and compounding.[14] Three fractures were compound of which, two had poor results while one had fair functional outcome.

This study shows that functional results and restoration of anatomical parameters were significantly better in the group treated by external fixator as compared to POP immobilization. However results of external fixation in our series were not comparable to those reported in literature. Klien et al and Rikli et al reported that more than 80% of patients treated by external fixator achieved excellent or good results,[12,13] but in our study 60% patients achieved the same and 22 % patients had fair results. The difference in the results can be explained by the fact that, unlike above studies we used external fixator exclusively without augmenting it with any form of adjuvant treatments.

Although, the complications were less frequent in external fixator group but they were more serious in nature. Most complications have been previously reported and were related to pin tracts.[15] They included superficial pin tract infection, chronic osteomyelitis, iatrogenic fracture and reflex sympathetic dystrophy. Since radial pins were inserted through a 2-3 cm incision after identifying structures, we did not encounter any damage to superficial branch of radial nerve or adjacent tendons. One patient with AO type-B fracture

with a volar fragment (reversed Barton) did not achieve anatomical reduction and subsequently lost position leading to an intrarticular step of 2mm. External fixation for this fracture pattern has been found to be inadequate in achieving and maintaining reduction, and it is best treated by a volar buttress plate.[2,13]

We conclude from this study that external fixator is a better modality of treatment as compared to POP immobilization for intra-articular distal radial fractures. It is reliable in maintaining the reduction of unstable fractures, however it is inadequate in attaining anatomical reduction in many cases when used exclusively. When required, this shortcoming can be overcome by supplementing external fixation with additional procedures that can attain the articular congruity, like limited open reduction with or without bone grafting. Complications of external fixation, although less frequent than cast immobilization, are potentially serious in nature.

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