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Full Length Research Paper

Efficacy of compression application in instable intraarticular distal radius fractures, treated with external fixator

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This research studied the efficacy of compression application in patients with instable intraarticular distal radius fractures. Here, results for 44 patients (32 males 12 females, mean age 36, distribution 21 to 59), with instable distal radius fracture, was retrospectively assessed. 22 patients who have received conventional closed reduction prior to external fixation and 22 patients, who have received compression in anterior-posterior plate, were included in the study. Same brand of external fixator was applied to all fractures and in addition, Kirchner wire was also used together with fixator for the fixation of fracture to a total of four cases, including two cases from compression group and two cases from control group. For two groups, radiologic AO classification was used. In both groups, radial curve angle, palmary curve angle and radial length data were compared. Functional results were assessed in line with Modified Sarmiento scale. Six of the fractures were open fractures. According to AO classification, 6 of the fractures were of type B1, 4 fractures B2, 14 fractures C2 and 10 fractures C3. The term of external fixation application was an average of 5 weeks in both groups and the follow up term of the patients was average 7.6 months (distribution 4 to 19 months). There were no significant differences from radiological aspect between the two groups ($p>0.05$). In the functional assessment, the results of the patient group, subject to reduction with compression technique, were better compared to control group ($p<0.05$). The application of compression in the treatment of instable and intraarticular distal radius fractures, improve clinical and radiological outcomes. This described technique, is an easily applicable and safe method.

Key words: Radius fracture, external fixator, intraarticular fracture.

INTRODUCTION

The frequency of radius lower end fractures is around 15 to 20% among extremity fractures (Pogue et al., 1990). In these frequently seen fractures, the chosen treatment method affects results (Sarmiento et al., 1975). method must provide the restoration of radial length, radial inclination and palmary tilt and in addition, must allow a good functional result (Fernandez, 2000; Sanders et al., 1991).

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(a)

(b)

Figure 1. (a) Patient's preoperative AP and (b) Lateral radiographs of instable intraarticular distal radius fractures.

While closed reduction and plaster fixation is successful in the treatment of simple radius lower end fractures, problems are encountered in the treatment of instable intra-articular distal radius fractures (IADRF) (Sanders et al., 1991; Young and Rayan, 2000). In the treatment of these fractures, application of open reduction and internal fixation method is technically difficult and may fail in the restoration of many parts (Young and Rayan, 2000). Successful results may be obtained with external fixation, following closed reduction (Huch et al., 1996). External fixation is a method, which may be easy and quick; by displacement with ligament taxis or by distracting impacted fragments, it may maintain the continuity of reduction (Hanel et al., 2002; Trumble et al., 1994). However, metaphases separation problem could not be completely resolved with this method.

Different types of fractures occur in the intraarticular distal radius depending on regional anatomy and type of injury (Bass et al., 1995; Tsukazaki et al., 1993).

As there is no only single method or material for the treatment of distal radius fractures, surgeons should be familiar with all alternatives (Rogachefsky et al., 2001; Trumble et al., 1998). Determination of most appropriate methods and materials for different types of distal intraarticular radius fractures is only possible through comparative studies (Grala et al., 2005; Margaliot et al., 2005; McQueen et al., 1992).

In our study, in the treatment of IADRF, the radiological and functional results in the patients, who were applied external fixation, following closed reduction, made by applying compression force to restore metaphases separation, were compared to the results of the patients, who received standard reduction and external fixation.

MATERIALS AND METHODS

The results for 44 patients (32 males 12 females, mean age 36, distribution 21 to 59), with IADRF, was retrospectively assessed after obtaining the consent of the ethical board of our hospital. 22 patients (Group 1) who were applied closed reduction by applying anterior-posterior reduction in the fracture line before external fixation, and 22 patients (Group 2) who were applied conventional closed reduction technique, were examined as 2 separate groups (Figüre 5a and b). The x-ray archives and file records of the patients were accessed and in addition, they were invited to follow-up and were assessed radiologically. The fractures were grouped according to AO classification radiological. Patients with no neurological deficits, with closed epiphysis and intra-articular fractures, whose pre-surgery straight x-ray and tomography could be achieved, were enrolled in our study (Figure 1a and b). The patients, who had metaphyseal fractures, unrelated to the joint, which did not come to last visits and did not participate in post-operative rehabilitation processes, were excluded from the study. All clinical and radiological assessments and measurements were made by the same orthopedist.

Three of fractures were open fractures and according to Gustily-Anderson classification, 4 fractures were of type II and 2 fractures were of type III open fractures. 34 of the fractures were in dominant arm, including 32 on the right and 12 of the fractures were in left arm. Etiological factors consisted of high-energy trauma in 30 patients (20 traffic accidents, 8 patients falling from high places, 2 work accidents) 8 patients simple falling and 6 patients sports activities. According to AO classification, 6 of the fractures were of type B1, 4 fractures B2, 14 fractures C2 and 10 fractures C3 (4). The term, from the formation of fractures until surgical intervention was mean 3 days (1 to 5 days) and the term of stay in hospital was mean 5 days (distribution 2 to 7 days).

Surgical technique

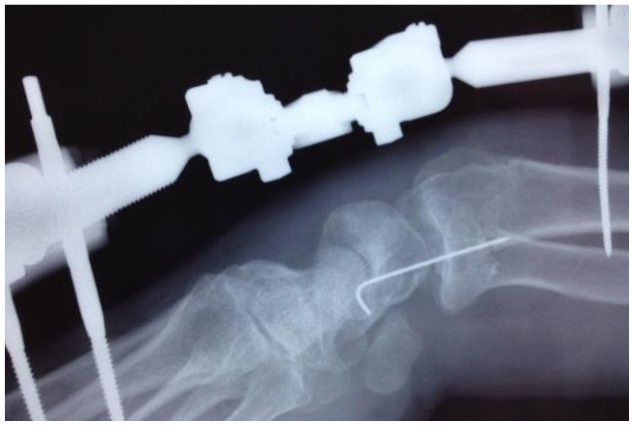
All cases were operated under axillaries peripheral block anesthesia, using fluoroscopy. The compression group was first applied a longitudinal traction of 8 to 10 kg, using finger traps. Then a surgical cover is placed on the volar of wrist, after flexion and ulnar deviation is provided in the wrist; compression was applied 6 to 8 times in anterior-posterior plane from dorsal of the wrist with the fist of the surgeon (Figure 2a and b). After it is seen that the reduction was provided with scope, in all fractures, after 2 Schanz nails of 4 mm to radius and 3 mm to metacarpus, distraction was made with the same brand of articulated external fixator (Biomet®) (Trumble et al., 1994).

The second group was also applied conventional reduction procedure distraction with the Biomet® type external fixator performed following closed reduction under fluoroscopy; the upper limit for distraction was the second finger reaching the distal palmar

(a)

(b)

Figure 2. Methods of compression group was first applied to (a) longitudinal traction and (b) compression:



(a)

(b)

Figure 3. Patient fragments were (a) reduced and (b) fixed with K-wires.

flexor fold with passive flexion (Figure 5a, b and 6a, b). For additional stability, some patient's fragments were reduced and fixed with K-wires. Two patients from both groups (totaling 4 patients) were administered K wire together with fixator (Figure 3a and b).

The term of external fixation application was an average of 6 weeks in both groups and the follow up term of the patients was average 7.6 months (distribution 4 to 19 months) (Figure 4a and b).

After the surgery, starting from the first day, active and passive finger exercises started. In the third week, Kirschner (K) wires were withdrawn and wrist was moved. In the sixth week, fixation was removed and rehabilitation program was initiated. The patients were assessed functionally during pre-surgery and their final visits and their ROM compared (Figure 7a and b).

For radiological assessment, radial curve angle, palmary curve angle and radial length data were compared (Table 1).

For functional assessment, the Modified Sarmiento scale system, prepared by Sarmiento et al. based on Gartland and Werley system, was used (Akmaz et al., 2003; Schaaf et al., 2010) (Table 2).

Statistical assessment

As standard measurement values, radial curve angle was mean 23° (distribution 13 to 33°), palmary curve angle, mean 10 to 12° (distribution 4 to 22°) and radial length average 12 mm (distribution 10 to 18 mm).

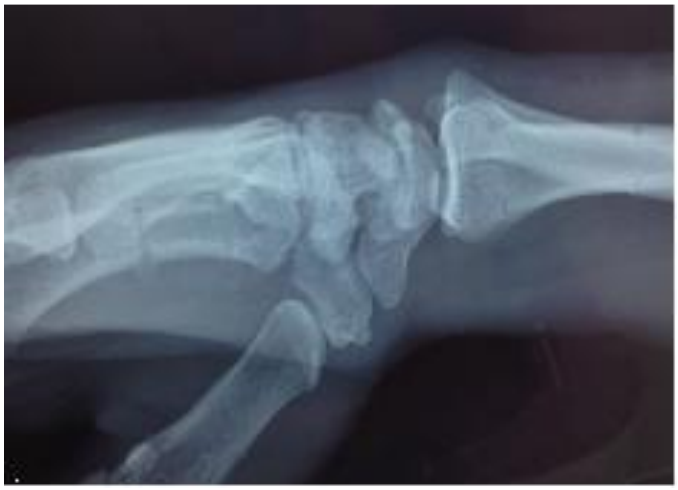
Statistical analyses were performed using both groups. The changes in the measurement results in pre-operative and post-heal x-rays, were compared with two sample t test, and it is assessed whether the provided data are within the standard reference values, aimed to be provided with a chi-square test (Kural et al., 2010; Mudgal and Jupiter, 2008).

So differences between the two groups were analyzed using the chi-square test, Mann-Whitney U-test, and Sample t-test where appropriate. The results were evaluated with a 95% confidence interval, and a *p* value of less than 0.05 was considered significant (Kiliç et al., 2009; Oyen et al., 2011).

In functional assessment, subjective-objective scores and median nerve compression data according to Modified Sarmiento scale were classified as excellent (0 to 2), good (3 to 8), moderate (9 to 14) and poor (> 15) and were assessed with Mann-Whitney U Test.

RESULTS

In our age, ımproved methods of communication and the ease of reaching information allow patients to participate more in the treatment process. The contemporary



(a)

(b)

Figure 4(a, b). Same patient postoperative 6 month radiographs

(a)

(b)

Figure 5(a, b). Preoperative radiographs of conventional closed reduction technique used groups.

approach to intra-articular and comminuted distal radius fractures is to determine the best fracture-specific treatment method, with consideration of the main goals (Gereli et al., 2010; Sügün et al., 2012).

The limitations of our study are along with the small number of patients, failure to assess the efficacy of the treatment separately in young and elderly patients and lack of longer follow-up terms. It is known that radiographic angular changes may continue for up to one year. Concerning this issue, prospective studies with greater number of patients with longer follow-up term, are required.

In both groups, although reference values, deemed as standard are achieved and acceptable results are provided; in functional assessment, the results of the patient group, reduced with compression technique were better compared to other group ($p<0.05$).

We think these good results in our study were contemplated to be related to the correct placement of fragments with compression.

DISCUSSION

The fractures of lower end of radius are complicated fractures, which reach into the joint and caused by high-energy trauma. The treatment methods for these fractures are diverse and complicated (Wigderowitz et al., 2000). The provision of sufficient functional and radiographic results depended on careful planning prior to surgery and applied surgical technique; it is obvious that full joint movement depends on precise joint surface restoration (Khan et al., 2001). Proper classification before the treatment of distal radius fractures is important in the determination of treatment plan. Type C fractures according to AO classification, are difficult to treat surgically due to significant intraarticular extensions and metaphysis defects (Clayton et al., 2009). Multifragmentary nature of fracture shows the severity of trauma and its high energy (Fernandez, 2000).

In order to restore distal radius as close to original as possible, different treatment approaches have been

(a)

(b)

Figure 6(a, b). Postoperative radiographs of conventional closed reduction technique used groups.

(a)

(b)

Figure 7(a, b). ROM of compression group.

developed and different complications have been seen in all of them. The anatomical nature of reduction gains importance for functional results. External fixation is frequently used in instable intraarticular and extraarticular distal radius fractures. This method helps in the reduction of fracture fragments with the effect of ligamentotaxis (Kamano et al., 2005). In radius lower end fractures, as the fragmentation in joint face and cortex increases, loss in radial length, decrease in radial curve angle and palmar curve angle increases.

Trumble et al. (1998) have determined that in single cortex fragmentation in young patients, closed reduction alone and K wire fixation was sufficient in provision of radial length and in intraarticular fractures with two or more cortex fragmentation, fixation for preservation of radius length, such as severe reduction and external fixator were required (Kelsey et al., 2005).

Grala et al. (2005) have determined stiffness in wrist and fingers and reflex sympathetic dystrophy in cases, where complete reduction cannot be provided in long lasting distractions with ligamentotaxis effect of external fixators, bridging the joint (McQueen and Caspers, 1998).

Margaliot et al. (2005) have emphasized the importance of the placement of all small fragments, precisely to their respective locations for complete movement of joint in distal radius fractures, fixed with K wire, where losses in palmar curve angle are seen (Leung et al., 2000).

Improved new imaging methods providing better understanding of fractures and elucidation of the effects of all injury type on fracture formation and factors leading to instability have given way to new reduction and fixing methods and materials appropriate for the fracture, resulting in today's treatment options in distal intraarticular radius fractures (Leung et al., 2000; Gereli et al., 2010).

Different types of fractures may occur due to the anatomy of the intraarticular distal radius and the effects of forces in different directions. It is often not possible to have a successful outcome using the all time same approach and materials for different types of fractures (Gehrmann et al., 2008; Gereli et al., 2010).

In IADRF, following treatment, median nerve compression findings may be seen (Goldhahn et al., 2008). With the used compression technique, no damage finding in the median nerve was found and even, the number of patients, showing compression findings was less than the control group. While in one patient in compression group, had these complaints, in two patients in control group, median new compression findings were detected.

The other complications of external fixation; Reflex sympathetic dystrophy, fixation loss, pin tract infections, injury to the sensory branch of the radial nerve, and joint stiffness in the wrist are amongst the known (Gereli et al., 2010).

We know that in distal radius fractures, excessive

Table 1. Radiographic measurement results.

Group	Palmary curve angle (°)		Radial curve angle (°)		Radial length (mm)	
	Pre-operative	Post-operative	Pre-operative	Post-operative	Pre-operative	Post-operative
1	26.5	10.1	15.5	23.1	7.3	12.4
2	25.3	13.1	14.1	20.2	8.2	11.5

Table 2. Assessment of functional results according to Modified Sarmiento scale; Subjective-objective median nerve compression scores.*

A.

Pain	Movement restriction	Inadequacy	Activity restriction	Score
None	None	None	None	0
Rare	Mild	None	None	2
Rare	Mild	None when cautious	Yes	4
Frequent	Yes	Yes	Severe	6

B.

Movement	ROM	Score
Dorsiflexion	<45°	5
Palmary flexion	<30°	1
Ulnar deviation	<25°	3
Radial deviation	<15°	1
Supination	<50°	2
Pronation	<50°	2
Circumduction	Loss	1
Finger flexion	Does not reach distal crisis	1
Grabbing	Loss of strength	1

C.

Level	Score
Mild	1
Moderate	2
Severe	3

*Functional result; sum of A, B and C: Excellent: 0-2; Good: 3-8; Moderate: 9-14; Poor: >15 ($p<0.05$).

distraction may not provide sufficient reduction of free fragments that do not respond to ligamentotaxis or involve the joint surface. Before open or K-wire augmented reduction, we can use the compresion method considered in these patients (Gereli et al., 2010; Sakai et al., 2008).

In both groups, radiological data has shown significant improvement post-operatively, compared to pre-operatively. There were no significant differences from radiological aspect between the two groups ($p>0.05$). The results of the patient group, reduced with compression technique was radiologically significantly better compared to the results of the other group ($p<0.05$).

Conclusions

The radiological results in both groups were summarized in Table 1 and functional results in Table 3. In both groups, significant improvement was seen in radial curve angle, palmary curve angle and radial length data. There were no significant differences from radiological aspect between the two groups ($p>0.05$). In all patients, reference values, accepted as standard were reached in all patients. In the functional assessment between two groups, in 10 patients in compression group excellent, in 7 patients good, in 2 patients moderate and in 2 patients poor functional result was provided and in control group,

Table 3. Functional Assessment: For two groups, subjective-objective scores according to Modified Sarmiento scale and median nerve compression data.

Sum of A, B and C	Excellent	Good	Moderate	Poor
Group 1	10 patients	8 patients	2 patients	2 patients
Group 2	4 patients	6 patients	8 patients	4 patients

in 4 patients excellent, in 6 patients good, in 8 patients moderate and in 4 patients poor functional results were found.

The results of the patient group, reduced with compression technique was significantly better compared to the results of the other group ($p<0.05$). In one patient in compression group and two patients in control group, median new compression findings were detected. No complications were seen other than pin site infection in two patients.

Conflict of Interest

The authors have not declared any conflict of interest.

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