

## Bridging External Fixator with Percutaneous Pinning in Comminuted Distal Radius Fractures

### Abstract

**Background:** Distal radius fractures are among the most common fractures. They can happen at any age group, and there are several treatment options and several classification systems for these fractures. One of these classifications is that of Fernandez. In this study, we evaluated the results of treatment of distal radius fractures by bridging external fixator and percutaneous pinning.

**Methods:** In a cross-sectional study, 72 patients with Fernandez type 3, 4 and 5 that underwent external fixation and percutaneous pinning for comminuted distal radius fractures were followed and assessed after 3 and 6 months.

**Results:** The 72 patients had mean age of 44.2 years. 55% were male. The most common cause of fractures was vehicle accidents. 4 cases of malunion, 4 radial nerve injuries, 2 fixator loosening and 6 cases of infection were encountered.

**Conclusion:** External fixator supplemented by percutaneous pinning is an efficient technique for treatment of unstable distal radius fractures. It has low rate of complication and high rate of patient's satisfaction.

**Keywords:** Distal radius fractures, External fixator, Postoperative complications, Fracture fixation

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### Introduction

Distal radius fractures are one of the most common fractures and one of the primary reasons for referral to the emergency department. It imposes a heavy burden on the health system <sup>(1)</sup>. The prevalence of these fractures is increasing due to factors that have not been all known correctly <sup>(2, 3)</sup>. These fractures can occur at any age. However, children (first decade of life) and elderly people (above the sixth decade of life) are at greater risk of these types of fractures. The fracture mechanism is commonly caused by falling and accidents <sup>(4-8)</sup>.

There are various methods to classify this type of fracture. Nowadays, Fernandez's classification is used more. Fernandez's classification system was first introduced in 1993 with the primary goal of focusing on the mechanism of injury. It is an attempt to standardize treatment, which also reports stability and accompanying injuries <sup>(9)</sup>. Casting can be used for the treatment of simple and non-displaced fractures in the elderly. However, surgery and fixation of the fracture are necessary to prevent further complications in displaced and comminuted fractures due to initial instability <sup>(10)</sup>.

Open reduction and fixation with plate and screw are used in cases where there is a possibility of internal fixation. However, external fixation is used in cases where the fracture is accompanied by crushing, collapse, and shortening of the radius bone. It is a less invasive method and helps maintain the length and natural alignment of the bone. Malunion is the common complication of this fracture. It occurs due to non-anatomic reduction, shortening of the bone length, and disturbance of the bone distal radiographic indices <sup>(11)</sup>. The external fixator function is based on the principle of ligamento taxis. This device preserves reduction and stability at the fracture site and provides the conditions

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to start the initial movements in the forearm and hand<sup>(12)</sup>. The use of percutaneous pinning with a small incision on the skin to help more stability of the fracture parts and to avoid excessive stretching of the hand during reduction has also been suggested. It is used as a separate treatment method or in combination with an external fixator. However, there is no consensus regarding the use of this method of pinning along with the fixator<sup>(13)</sup>. In Fernandez's classification, type 1 is usually treated conservatively if it is stable. It is treated by percutaneous pinning (PCP) or an external fixator if it is unstable. Type 2 is usually treated with open reduction and internal fixation (ORIF). Type 3 is mostly treated conservatively and with the help of PCP and an external fixator if necessary. Type 4 is treated by open or closed reduction with the help of pins, and screws (fixation or tension wiring). Finally, type 5 is treated with a combination of all the cases mentioned<sup>(14,15)</sup>. The goal of treatment in cases of distal radius fracture is to correct the upper limb part to have suitable mobility and durability<sup>(16)</sup>. Given the existence of different treatment methods, it is necessary to conduct more studies on the benefits and side effects of these types of treatments and to select the best treatment method. The present study examines the results of the treatments used for distal radius comminuted fractures using the bridging external fixator (BEF) method along with percutaneous pinning (PCP).

## Methods

The present cross-sectional study was conducted on patients who underwent an external fixator with PCP treatment due to a comminuted fracture of the distal radius between 2018 and 2021 in Shahid Ayatollah Kashani Hospital in Isfahan. In this study, all people aged between 30 and 60 years who suffered a comminuted fracture of the distal radius with Fernandez type 3, 4, and 5 and were treated in the teaching center of Kashani Hospital in Isfahan city for three years and had informed consent to participate in the study. The exclusion criteria included the people who had a disease or underlying

problem such as blood diseases, nervous system diseases, diabetes, etc., people who were out of the reach of the researcher, and people who did not have the necessary cooperation in conducting this research. Also, people who had a previous fracture in the same area or a similar upper limb were excluded from the study due to intervening in the results. People with known psychological problems or mental problems were excluded from the study. People who did not have proper reduction after the operation were excluded from the study. The proper reduction criteria were radius shortening of less than 2 mm, less than 10 degrees of lateral angulation, and less than 2 mm step at the articular level. Sampling was not done in this study and all eligible people were included in the study. In all patients, external fixators and pins were maintained until the 6<sup>th</sup> week. After the 6<sup>th</sup> week, they were removed and the range of motion of the patients began. Demographic characteristics of patients, including age, gender, and mechanism of injury were entered in the checklist. AP and lateral wrist radiographs were taken every two weeks from all patients until two months after the operation. All these people were visited and examined by an orthopedic specialist at intervals of 3 and 6 months after the treatment. The disability of shoulder performance was evaluated by the disability of the arm, shoulder, and hand (DASH) questionnaire. DASH is a 30-question questionnaire, each question of which is scored on a scale from 1 to 5. It measures the performance of the person's upper limbs in the last week. In this questionnaire, questions are included to measure the level of the person's difficulty in doing daily tasks, the intensity of pain during sleep and activity, joint stiffness, and the effect of the upper limb on social activities and jobs. One should answer at least 27 out of 30 questions to use the results of the questionnaire. The total score of this questionnaire is 100. A closer score to 100 indicates the greater disability of the person. The validity and reliability of the Persian version of this questionnaire have been examined<sup>(17-19)</sup>. Pain intensity was measured using a visual analogue scale (VAS).

It includes the range of numbers from 1 to 10, where the number 1 indicates the lack of pain and the number 10 indicates the most severe or unbearable pain. The visual analogue scale is a fast, easy, fluent, and reliable tool used in many studies and medical clinics<sup>(20, 21)</sup>. The range of motion was calculated and recorded at each turn. The range of motion needed to perform daily and natural activities includes 60 degrees of extension, 54 degrees of flexion, 40 degrees of ulnar deviation, and 16 degrees of radial deviation, which is a total of 170 degrees. Sarmiento's scoring system was used to evaluate the quality of patients' performance. The obtained information was entered into the research checklist while maintaining the principle of confidentiality. After data collection, SPSS version 21 software was used for data analysis. This project was approved by the Ethics Committee of Isfahan University of Medical Sciences with a code of IR.MUI.MED.REC.1399.989.

## Results

This study was conducted on 79 patients with Fernandez type 3, 4, and 5 distal radius comminuted fractures that were referred to Kashani Hospital in Isfahan between 2018 and 2021. Three patients were excluded from the study due to a lack of proper reduction after surgery, and 4 patients were lost during the follow-up period. Finally, 72 patients were included in the study. Among the examined samples, 55% were male and 45% were

female. The mean age of the patients was 44.2 (range of 20-70 years old). The most common cause of fractures was vehicle accidents, which accounted for 59.7% of patients, followed by falls. Based on the Fernandez classification, 30 patients were type 3, 20 patients were type 4 and 22 patients were type 5. Regarding complications after treatment, 55 patients (77%) had no complications, 6 patients (8.3%) had superficial infections, 4 patients had malunion, and 4 patients had nerve damage (5.5%). Also, two cases of fixator loosening were observed in the study.

The mean of VAS in patients was 1.5. The mean score of the DASH questionnaire was 12.7 in the third month and 6.7 in the sixth month. The mean wrist Range of Motion (ROM) of the patients was 140 degrees in the third month and 156 degrees in the sixth month. Due to the non-fulfillment of the assumption of normality of the measured variables at times 3 and 6, the non-parametric Wilcoxon test was used and the assumption of equality of distribution of the variables at times 3 and 6 was rejected. The DASH variable decreased at time 6 months and the ROM variable increased at 6 months. Based on the Sarmiento results evaluation system, 44 patients had excellent results, 19 patients showed good results, 5 patients showed moderate results and 4 patients had poor results. The course of patients' treatment is shown in Figures 1, 2, and 3.



Figure 1: The graph of Fernandez type 5 distal radius fracture



Figure 2: The graph of distal radius fracture after surgery



Figure 3: The graph of distal radius fracture 6 weeks after the surgery when complete fusion

## Discussion

Selecting an appropriate treatment method, including correct and anatomical reduction of the wrist and maintaining it with the help of fixators, especially in young and active people, is crucial to prevent its subsequent complications<sup>(22, 23)</sup>. Several studies have indicated a direct relationship between the results and anatomical reduction. The lack of anatomical reduction leads to the creation of a deformed and weak wrist. Closed reduction and casting may give a good initial appearance. However, unstable cases of reduction are lost after one to two weeks. Also, open reduction and internal fixation are possible in the young age group with good bone quality. However, it is not very possible in elderly people with osteoporosis with poor bone quality. The external fixator is used for the definitive treatment of a large number of open and closed intra- and extra-articular fractures of the distal radius.

This device works based on the principle of ligamento taxis. Accordingly, it neutralizes the axial pressure on the wrist and causes reduction and maintaining the length of the radius bone by stretching the ligaments and muscles. Distal radius fractures are generally more common in elderly people who have osteoporosis. Its primary reason in this age group is falling<sup>(24)</sup>. The mean age of patients in our study was 44.2 years, and 55% of them were male. It is because types 3, 4, and 5 of Fernandez fractures, examined in this study, usually occur in cases of high-energy trauma such as road accidents and vehicle accidents, which are more common in the young population. The rate of complications in our study was relatively low.

In this study, 5.5% of patients suffered from malunion, and 5.5% suffered from superficial radial nerve damage. No case of deep infection was observed in our study and only 6 cases of superficial infection (8.3%) were observed, all of which were treated with antibiotics. One case of fixator loosening was observed. Based on the Sarmiento scoring system, 44 patients showed excellent results, 19 patients showed good results, 5 patients

showed moderate results, and 4 patients showed poor results.

A study by Talmac et al. compared the results of the treatment of comminuted fractures of the distal radius by 3 different methods, including volar locking plate (VLP), non-bridging external fixator (NBEF), and bridging external fixator between 2010 and 2014. In a group treated by bridging external fixator, 9.6% had complications of infection and 3.2% of patients had complications of superficial radial injury. In this group, the median of the VAS score was 2 and the median of the quick DASH score was 13. The lower percentage of nerve damage in the mentioned study compared to our study could be the lack of using a pin. The most significant positive point of using external fixators is their easy placement, fewer traumas during surgery, and maintaining proper alignment and reduction<sup>(25)</sup>. In a study by Mansouri, et al.<sup>(26)</sup> 44 patients with distal radius fracture who were in Group 2 based on the universal classification and in Groups 2 and 3 based on Alder's classification<sup>(27)</sup> were treated using closed reduction and percutaneous pinning. In this study, given the method of examining clinical results with the help of Demerit's modified<sup>(28)</sup> criteria, 84% of patients reported excellent results, and only two cases of superficial infection were reported. The study concluded that the closed reduction method with pinning is a suitable treatment method for distal radius fractures, especially with dorsal crushing. In a study by Mirza, et al. 21 patients with distal radius fractures were treated with BEF treatment along with PCP. The mean age in this study was 54 years and the patients were followed for one year. During this period, one case of nerve damage was reported and no case of infection or nonunion complication was reported. Thus, it is a suitable treatment method for displaced extra-articular fractures and intra-articular fractures with or without displacement, which has few complications<sup>(29)</sup>. Dasht Bozorgh et al. compared the treatment methods of external fixators with or without the pin in 62 patients with type 3 distal radius fracture. In this study, 30 patients were treated with an external fixator without pins and 32 patients were treated with an external

fixator with pins. Among the 30 people treated without a pin, 23 people had high satisfaction, 6 people had moderate satisfaction, and 1 person had no satisfaction. Also, in the group treated with a pin, 22 people out of 32 people had high satisfaction and 10 people had moderate satisfaction. In this group, 5 cases of superficial infection were observed at the pin site, and no case of deep infection or nerve damage was reported, and the two groups showed the same treatment results<sup>(30)</sup>. The study by Khosravi et al. presented similar results to our study. In this study, 9% of superficial infections and one case (4.4%) of radial nerve sensory disorder were reported. According to the Sarmiento scoring system, 54.5% showed excellent results and 18.3 showed poor results. The presence of lower nerve damage compared to our study in this study might be due to the closure of all fractures in this study and the absence of accompanying lesions in the same organ and the lower mean age of the patients<sup>(31)</sup>. The DASH and the ROM of the patients increased significantly, indicating the improvement of the results in the long term and the positive effect of physical therapy.

In the study by Atroshi, the mean DASH questionnaire was 22 in the 10<sup>th</sup> week and 10 in the 26<sup>th</sup> week in the BEF group. The higher value of this number compared to our group may be due to the higher mean age of this study compared to our study<sup>(32)</sup>. Another study conducted by Uchikura et al. compared the types of bridging and non-bridging external fixators. In this study, 42 patients were included in each group. The mean age of the bridging group was 64 years and most of the fractures were comminuted colles fracture. In this group, only two cases of carpal tunnel syndrome were observed. In terms of functional scoring, 25 patients showed excellent results, 15 showed good results, 1 patient showed moderate result, and one patient showed poor results<sup>(33)</sup>. A study by Joosten et al. also showed 29.3% of excellent results, which is considered with our study<sup>(34)</sup>. Our study suffered some limitations. Our data were collected from a center in Kashani Hospital in Isfahan City. It can

potentially affect the generalizability of the research results to the whole population. Another limitation was the small number of samples collected in 4 years, indicating the need to conduct more studies with a higher population and a longer number of years. The lack of a control group was another weakness of this study.

## Conclusion

External fixator along with PCP is considered a suitable treatment method for the treatment of unstable fractures of the distal radius, which is associated with a few side effects. Many unwanted side effects can be avoided by selecting the right patients and following the principles of using this device. It is recommended to future studies follow up with more patients for a longer period. To identify the best treatment method, external fixator treatment should be compared with other methods available for the treatment of distal radius fractures.

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