North American Academic Research

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Research

Outcome of distal radius fracture treated with external fixation

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Abstract: Nearly one-sixth of all fractures in a casualty environment are distal radius fractures. Restoring the function of the wrist joint, of which the distal radius is a crucial component, is typically the goal of treatment for distal radius fractures. There does not appear to be agreement on the best course of action for treating distal radius fractures, particularly when they are accompanied by instability of the distal radioulnar joint. In patients who initially have displaced distal radius fractures, to define the functional prognosis. 75 working-age (18 to 55 years) patients who presented with unilateral displaced distal radius fractures (apart from volar displacement) and were subsequently treated with fixation participated in observational research. At six months and a year after the surgery, the results of the patients were evaluated using the Green and O'Brien Scoring System as modified by Cooney et al. Additionally, radiographs were collected after surgery and throughout follow-up. The data were examined in terms of the percentage of patients who had satisfactory clinical and radiological results (using IBM SPSS software version 22 and Microsoft Excel). In 78.1% of the study group, acceptable functional outcomes (good and outstanding scores in the Green and O'Brien Scoring System) were seen. Although the younger age group had higher functional outcome scores, a statistically significant difference could not be found. Infection of the pin tracts complicated 9.4% of the cases, and 96.9% of the patients had acceptable radiological reductions. The difference between the outcome ratings at six months and one year following surgery showed a statistically significant improvement (p-value 0.0001). For treating displaced distal radius fractures, external fixation is a quick and efficient way to get good to excellent clinical results. Younger age groups and male patients had superior functional outcome scores, but there was no statistically significant difference between them.

Keywards: fractures, distal radius fractures

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Accepted: 09 August, 2022; **Published**: 18 August, 2022

How to cite this article: *Amit Ranjan Mishra, Sharad Yadav, Prakash Chand Yadav,* **(2022).** *Outcome of distal radius fracture treated with external fixation, North American Academic Research, 5(8), 150-158. doi: https://doi.org/10.5281/zenodo.7008321*

Conflicts of Interest: There are no conflicts to declare.

Introduction

As a disease, fracture is responsible for a considerable amount of the morbidity that occurs all over the world, and it is becoming recognized as an epidemic in the modern day. When a bone is subjected to a load that is more than what it is able to withstand, this might result in the bone breaking. Even a relatively mild blow can cause osteoporotic bone to fracture. The distal radius fracture is the one that occurs most frequently among all of the fractures. According to some estimates [1,] distal radius fractures account for one-sixth of all of the broken bones that are treated in a casualty environment. The incidence of these fractures exhibits a bimodal age distribution, with the first peak occurring among

young adults and the second peak occurring among the elderly. The mechanism of the fracture can be anything as easy as falling on an outstretched hand, particularly in the senior age group. When dealing with patients who are younger, a significantly greater amount of force is necessary to create fractures, such as in the case of sports injuries and motorcycle accidents [2]. The incidence of distal radius fractures is on the rise across the globe, particularly among those in the younger age group.

It is possible to argue that the distal radius is the most significant bone in the wrist joint. Any fractures to the distal radius will have a significant impact on the range of motion at the wrist joint. As a consequence, immediate treatment is necessary in order to restore the function of the wrist joint. With the radiographically acceptable reduction of the distal radioulnar joint (DRUJ), also known as an anatomical reduction, one can accurately anticipate the fate of distal radius fractures. The younger demographic of workers is where the benefits of anatomical reduction become most apparent. For instance, an athlete who is 23 years old would want to get back into competition, whereas a person who is 80 years old might merely want to get back to their normal activities of daily living. As a result, the intended outcomes of treatment need to be individualized for each patient. The treatment, on the other hand, ought not to be determined by age but rather by activity level [3].

The distal radius fracture treatment can vary greatly depending on the therapeutic aims, ranging from cast immobilization to surgery care of the injury. Despite the fact that there is a wide range of treatment options available for distal radius fractures, there does not appear to be a consensus regarding the most effective form of treatment [4]. Cast immobilization can lead to poor radiological outcomes, but the functional results are comparable to operative management in the elderly, as found in the study "Cast Immobilisation vs. Wire Fixation in the Management of Middle-aged and Elderly Patients with Distal Radius Fractures" by Jordan et al. [5]. This was found in the study "Cast Immobilisation vs. Wire Fixation in the Management of Middle-aged and Elderly Patients with Distal Nevertheless, unfavorable radiological results can bring about unfavorable functional effects, particularly in younger age groups. In order to achieve a better radiologically acceptable fracture reduction, operative procedures are increasingly being used to treat distal radius fractures. This has led to a rise in the prevalence of surgical fixation of distal radius fractures. According to Sander et al. [6], the criteria for surgery should coincide with the degree of severity of the fracture rather than the patient's age.

Surgery is the treatment of choice for fractures that cannot be reduced with closed manipulation and are displaced. Percutaneous pinning, external fixator, and open reduction with internal fixation are the three procedures that fall under the category of surgical treatment approaches. As a result of the improved patient outcomes that are associated with the anatomical reduction of the DRUJ and wrist joint, an increasing number of people are opting to undergo surgical fixing. In the treatment of fractures, external fixators are typically utilized so as to achieve and keep the desired degree of reduction during the entirety of the treatment process. This is done without directly touching the fracture site. The Joshi external stabilization system, also known as external fixation, is an external fixator that was invented by Dr. B. B. Joshi and his colleagues in Mumbai. Even though it is less effective than an Ilizarov fixator [7], a external fixation can be used for a variety of conditions, such as burn scar contracture and clubfoot [8,9], and it has a prominent place in the management of displaced distal radius fractures. [7] Cost-effectiveness and ease of application are the main reasons for this.

The method of skeletal immobilization known as external fixation involves inserting percutaneous pins into the bones and then connecting those pins to connecting rods that are inserted outside of the patient's body in order to create a rigid framework. An external fixator that utilizes the principle of ligamentotaxis, which involves applying a continuous force or distraction along a longitudinal axis in order to bring fracture fragments closer together. Because of the longitudinal distraction force, the soft tissues surrounding the fracture are able to assist in the molding of the bone fragments and facilitate the reduction process. When satisfactory radiological outcomes are required, EXTERNAL

FIXATION can be a great alternative to cast immobilization because it is straightforward, cost-effective, and has a small learning curve to master its application. external fixation is also a technique that can be used to immobilize a limb.
There are a few different scoring systems that can be used to evaluate the functional outcome of distal radius fractures, one of which is the Green and O'Brien Scoring System [10], which is quite popular. After some time, Cooney et al. made some adjustments to this method, which resulted in it having four categories now: pain, occupation, range of motion, and grip strength. In the event that the hand has been injured, the dorsiflexion-palmar flexion arc will be used for scoring rather than grip strength. During the follow-up periods that are required after the surgery, an assessment of the patient's level of function is possible.

Research Methodology

Study methodology

Patients who presented at the Janaki Medical College Teaching Hospital in Janakpur, Nepal, with fractures of the distal radius and were treated with external fixation between January 2017 and June 2018 were included in this prospective observational study. Fractures of the distal end of the radius were the inclusion criterion, and the age range of 18 to 55 years was the age range that was restricted. This age range was chosen because it is the age range that is most likely to benefit most from intervention. An undisplaced fracture of the distal end of the radius, for which the external fixation is not indicated, a fracture with volar displacement, for which plating is indicated, and a bilateral fracture of the distal radius, for which the wrist function cannot be compared against the function of the unaffected side were the criteria for excluding patients from the study. Patients' ages were further classified as being either less than or equal to 40 years old or older than 40 years old for the purpose of doing an analysis that was more straightforward.

The system for external stabilization

A method of external fixation that is derived from ligamentotaxy and its underlying concepts. When it comes to the treatment of distal radius fractures, external fixation entails inserting four pins into the radius and the second metacarpal, all of which are connected by a connecting rod that is either threaded or serrated, and it includes a distraction mechanism. Under direct vision, two Schanz pins measuring 3.5 millimeters each are inserted into the radius two to three centimeters proximal to the fracture. This is done so as to prevent injury to the superficial sensory branch of the radial nerve, which is located at the junction between the distal and middle thirds of the radius. Through the external fixation distractor slots, the two Schanz pins measuring 2.5 millimeters each are inserted into the proximal section of the bare area on the second metacarpal, which is located between the first dorsal interossei and the extensor tendons. After that, the distractor is utilized so that reduction can be achieved through ligamentotaxis. Figure 1 is an illustration that demonstrates external fixation's component parts and may be seen here.

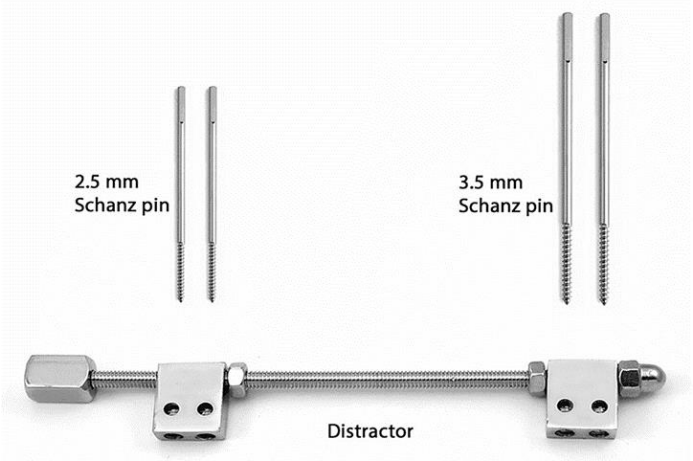

FIGURE 1: External stabilization system

Clinical assessment

Even though there have been advancements in imaging and other technical modalities for evaluating the wrist, the clinical examination is still the gold standard for functional evaluation [13]. Above the level of the elbow, the hand, the wrist, and the forearm need to be adequately exposed so they can be examined. In the course of the examination, we search for bulges, deformities, wasting of muscular tissue, scars, discolouration, engorged veins, and any other abnormalities in the skin and nails. The purpose of palpation is to determine whether or not there has been a localized increase in temperature or soreness. It is important to be able to feel any nodules, bone irregularities, thicker tendons, or nerves. It is important to check for radial and ulnar pulsations, as well as to do the Allen test.

In order to evaluate the condition of the hand's fragile vascular system, the capillary filling test may be performed. It is important to examine the sensations in the pertinent locations that are supplied by the radial nerve, the median nerve, and the ulnar nerve. The function of the wrist can be inferred, at least to some extent, from the movements of the wrist as well as the grip strength. In addition, specialized examinations like Phalen's and reverse Phalen's tests play a small part in the evaluation process. The Green and O'Brien Scoring System, which evaluates wrist function under four categories, namely pain, activity, range of motion, and grip strength, was utilized in order to analyze the results of the treatment that was administered after the external fixation fixation was performed. The lowest possible score is zero, and the highest possible score is twenty-five. The total score is determined by adding up all of these headers' individual scores and displaying the result. Table 1 provides further information regarding the modified Green and O'Brien Scoring System that was utilized in the research.

Following surgery, patients' outcomes were evaluated using a modified version of the Green and O'Brien Scoring System by Cooney et al. The evaluations took place six months and one year after surgery. Both a final score between 80 and 89, which is considered to be a good performance, and a final score between 90 and 100, which is considered to be an excellent result, are both acceptable outcome results. Microsoft Excel and the SPSS (IBM, Armonk, New York, USA) software, version 22, were utilized in order to sort the data and conduct the analysis. A t-test with two tails, assuming unequal variance, was carried out in order to compare the two age groups (those under the age of 40 and those over the age of 40), as well as the two gender groups (males vs. females).

Results

Every participant in this trial received outpatient care. The external fixation application process took, on average, roughly 25 minutes. For four weeks, the external fixation distractor was used, and for two more weeks, the cast was used to further immobilize the patient. The average age of the 32 patients who participated in the study was 39.8 years, and the standard deviation was 10.06. Nearly two-thirds of all patients were male and over the age of 40 on average. Nearly two-thirds of the fractures in the study's right-handed subjects all occurred on the right side. To guarantee that the functional outcome scores were determined objectively by comparing the function to the unaffected limb, patients with bilateral distal radius fractures were excluded from the study in accordance with the previously established exclusion criteria.

Due to the patient population's younger working age, high energy trauma, such as car accidents, was the main cause of the fracture in this study. Low-impact injuries are those caused by traumatizing events like falling from a standing height onto an outstretched hand. Because distal radius fractures are frequently observed in elderly individuals with osteoporosis, low energy impact damage is the most frequent cause of these fractures in the general population. Younger people have strong bones, therefore distal radius fractures take a lot of force to occur.

In one patient who had subpar functional outcome ratings at six months and a year, a radiologically acceptable decrease was not achieved. However, insufficient information was available to definitively establish a link between radiologic reduction and respectable functional results.

There was diabetes mellitus in three patients (9.38%). All three of them were taking medicines and had good glycemic control. Five (15.63%) individuals had hypertension, one of whom had diabetes. In the study cohort, there were no other comorbidities noted. Following the external fixation fixation, three patients (9.38%) experienced pin tract infection. One

of these patients had hypertension, and the other had diabetes mellitus. There were no infections detected within the open fracture group, and all cases of infection had closed fractures.

As far as the patient is concerned, pain management is the most important factor. In order to quantify morbidity reduction after therapy, returning to former activity is an important component of the functional outcome. When the patients were reassessed six months and a year after the treatment to assess the functional outcome using the Green and O'Brien score, it was discovered that the external fixation was effective in reducing pain in distal radius fractures, enabling the patient to resume previous activity. After the operation, all of the patients exhibited limited range of motion, perhaps as a result of wrist joint stiffness brought on by prolonged immobilization. By contrasting it with the unaffected opposite side, the grip strength was evaluated objectively. In comparison to the results after six months, the results after a year were significantly better. In individuals under 40 years, outcomes were far better, with just one patient receiving a low functional score.

Males had higher functional outcome scores on average than females. Table 1 provides more information on the distribution of functional outcome ratings.

TABLE 2: Distribution of functional outcome scores

Score Category	Mean ± standard deviation	
	6 months	1 year
Pain	19.8 ± 3.2	23.4 ± 2.4
Occupation	21.9 ± 4.7	23.9 ± 2.5
Range of motion	11.7 ± 3.7	15.3 ± 4.2
Grip strength	17.5 ± 6.5	21.1 ± 5.6
Total score 70.9 ± 14.6 83.8 ± 10.0		

For the purpose of comparing two age groups (=40 years vs. > 40 years) and two gender groups, a two-tailed t-test assuming unequal variance was conducted (males vs. females). Age group comparisons had a p-value of 0.2129, and gender comparisons had a p-value of 0.1679 The analyses were unable to disprove the null hypothesis (Ho). Therefore, there was no statistically significant difference between the age and gender groups. However, compared to the six-month levels, all groups displayed statistically significant improvement in the outcome score at one year (p-value 0.0001). The statistical comparison of the Green and O'Brien scores at six months and a year following the surgery is shown in Table 3.

TABLE 3: Comparison of functional outcome scores at six months and one year

Score Category	p-value
Pain	0.000004
Occupation	0.034344
Range of motion	0.000593
Grip strength	0.021069
Total score	**0.000121**

Discussion

Morphology of the distal radius

Radius, one of the two bones of the forearm, is located on the side. It is a long bone having a proximal head and neck, a slightly curved shaft, and a wider distal end. Throughout the majority of its length, the shaft of the radius has a triangular cross-section with three borders (anterior, posterior, and interosseous) and three surfaces (anterior, posterior, and lateral). The interosseous border is sharp and serves as the attachment point for the interosseous membrane that

connects the radius and ulna. However, distally the radius is quadrilateral and has two articular surfaces for the carpal bones and the ulna [15].

The distal end of the radius has a distinct articular surface with two facets for the carpal bones: scaphoid (triangular and placed laterally) and lunate (quadrangular and medially located). The ulnar notch is a facet on the distal medial surface of the radius that articulates with the ulna (sigmoid cavity). A broad ridge connects the base of the triangular articular disk to the carpal and ulnar articular surfaces; this disk isolates the DRUJ from the wrist joint.

The anterior and posterior surfaces of the distal radius are significantly larger than the medial and lateral surfaces. On the posterior aspect of the distal radius is a dorsal tubercle that functions as a pulley for the extensor pollicis longus tendon. The diamond-shaped radial lateral surface continues distally to produce the radial styloid process. On the posterior and lateral sides, the cortical bone is thinner, causing fractures to collapse dorso-radially. Attachments to the distal radius consist of the brachioradialis muscle, which inserts just above the styloid process, the pronator quadratus muscle, which inserts into the anterior surface, the extensor retinaculum, the interosseous membrane, the articular capsule of the wrist joint, and the articular disk.

In addition, a set of ligaments connect the distal radius to the carpal bones and ulna. The radioscaphocapitate, long radiolunate, radioscapholunate, and short radiolunate ligaments make up the palmar radiocarpal ligament complex. The ulnocarpal ligaments consist of the ulnocapitate, ulnolunate, and ulnotriquetral ligaments. The ulnocarpal ligaments do not link directly to the ulna, but rather to the palmar radioulnar ligament. On the dorsal side of the radiocarpal joint, the dorsal radiocarpal ligament extends. The triangular fibrocartilage complex (TFCC) connects the DRUJ to the fibrocartilaginous disk and palmar and dorsal radioulnar ligaments. Therefore, the danger of injury to these ligaments is inherent in distal radius fractures.

Physiology and classification

Using pressure sensors on cadaveric wrists under non-physiological conditions and on healthy volunteers under physiologic conditions supports the three-column hypothesis. According to this idea, the wrist has three load-bearing columns: radial, middle, and ulnar [16,17]. Radial column is made up of the radial styloid and scaphoid facet. The lunate facet with the sigmoid notch comprise the intermediate column. The ulnar column is composed of the ulnar head, ulnar styloid, DRUJ, and TFCC.

Through the radial column, lighter weights are transmitted. It serves as a stabilizer, a radial bony buttress (which limits radial deviation), and an attachment point for the ligaments (which limits ulnar deviation by a tension band mechanism). The primary function of the intermediate column is axial load transmission from the lunate and the proximal pole of the scaphoid. Approximately fifty percent of the load is transmitted via the triangular fibrocartilage and the ulnar column, which also serves as the stabilizing pivot of the wrist. The radius revolves around this ulnar joint.

Understanding the biomechanics of the distal radius has a significant impact on open reduction and internal fixation and serves as a foundation for classification systems based on the mechanism of damage. Hyperextension of the wrist, which is the single most important mechanism of distal radius fracture, can produce all forms of distal radius fractures. Even though numerous classifications exist for distal radius fractures, the patho-mechanical classification method of Fernandez based on the forces acting on the wrist at the moment of impact [18] is usually utilized. This categorization is often used to guide the treatment of fractures of the distal radius. Other classification systems are less useful than the Fernandez system for prescribing treatment methods. The joint involvement (radiocarpal and radioulnar), with or without the ulnar styloid fracture, determines the Frykman classification. Melone classifies intraarticular fractures into five kinds based on displacement. The categorization developed by the Arbeitsgemeinschaft für Osteosynthesefragen (AO) is more exhaustive but more difficult to use. There are further classifications, but their discussion is outside the scope of this study.

Treatment and side effects

The objective of fracture treatment is to restore functioning, which is contingent on the patient's prior degree of activity. Accurate anatomic reduction, restoration of anatomic connections, and early efforts to recover wrist and finger mobility are connected with a favorable prognosis. Non-operative and operative therapy procedures make up the majority of available options. Closed reduction with cast immobilization is the most usual therapy for distal radius fractures, especially in elderly patients with osteoporotic fractures. Extraarticular fracture, less than 5 mm radial shortening, and dorsal angulation less than 5 degrees or within 20 degrees of the contralateral distal radius after closed reduction are indications for this conservative treatment. The rupture of the extensor pollicis longus tendon, most likely as a result of ischemia, is a serious complication of conservative therapy. Additionally, it may result in acute carpal tunnel syndrome. Figure 1 depicts an X-ray image of a patient with a closed comminuted distal end of radius fracture.

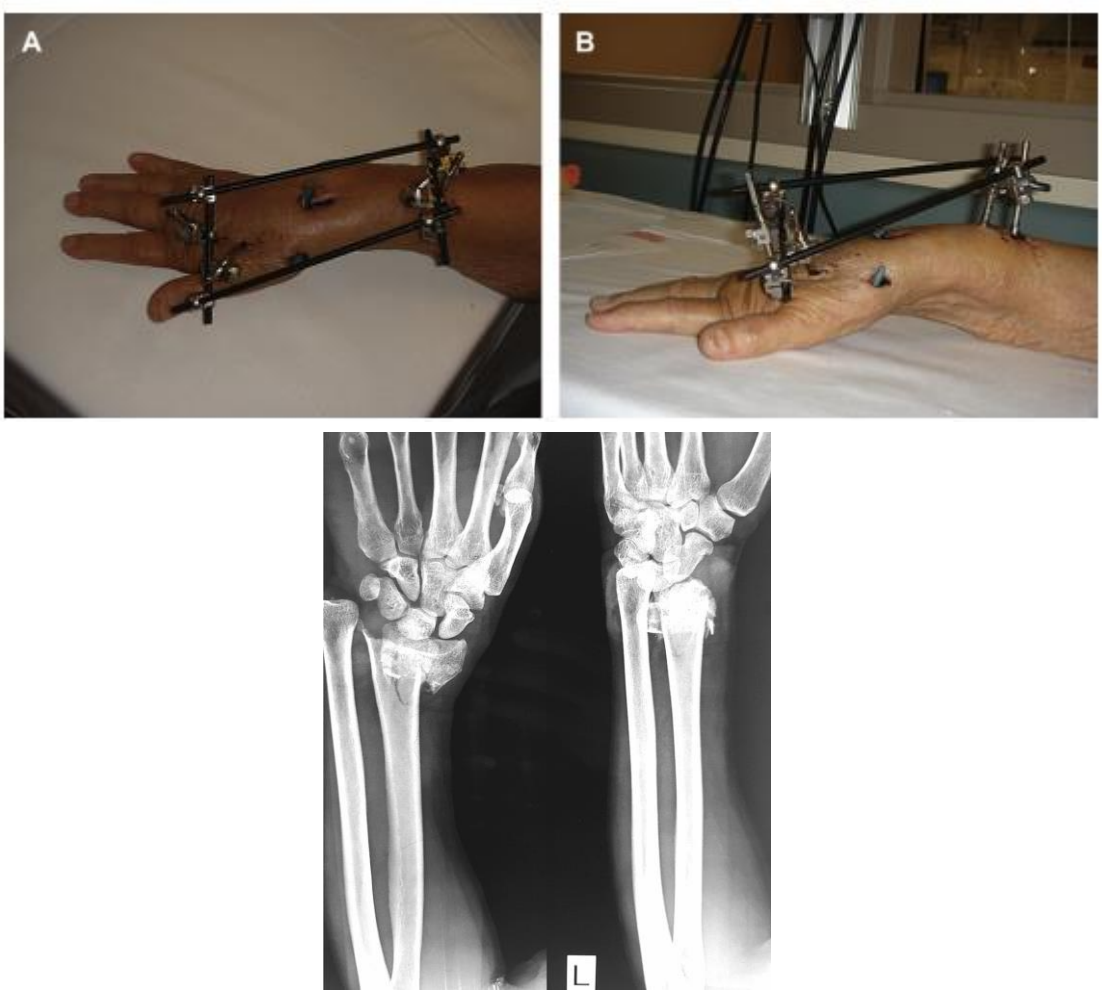

FIGURE 1: X-ray of a distal radius fracture before management

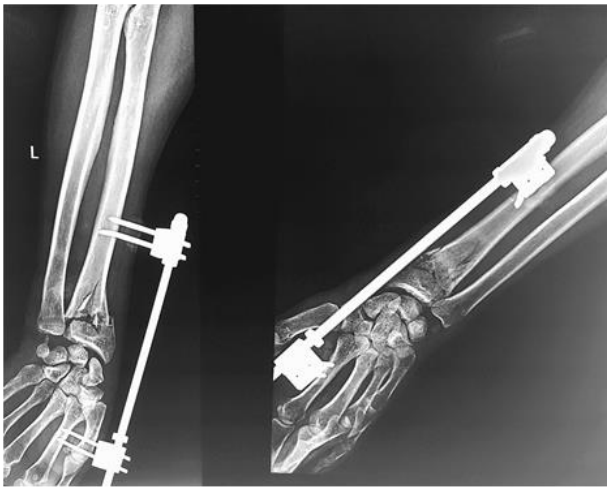

FIGURE 2: Distal radius fracture fixation

Research constraints

Even though the current study demonstrated satisfactory outcomes with external fixation fixation, no definitive conclusions could be drawn regarding the association between anatomic/radiologic reduction and outcome, and there was no significant difference between younger and older age groups. In the future, a study with more statistical power, maybe employing a bigger sample size, could overcome these shortcomings. The study also lacked a suitable reference group; consequently, the results should be compared to those of other studies.

Author Contributions: At first page.

Approval: All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: To appropriate authority of the hospital.

Informed Consent Statement: Approved.

Data Availability Statement: Not applicable

Acknowledgments: Not Mentioned.

Conflicts of Interest: The authors declare no conflict of interest.

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