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FUNCTIONAL OUTCOMES OF LIGAMENTOTAXIS WITH EXTERNAL FIXATOR IN UNSTABLE DISTAL RADIUS FRACTURE

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Abstract

Background:
Distal radius fractures are considered to be among the most frequent orthopedic injuries. To regain the functionality of the wrist, it is necessary to attain anatomical reduction and stability. External fixation Ligamentotaxis has extensive applications in the treatment of unstable distal radius fractures because it offers indirect reduction and stable fixation with minimal disturbance of the soft tissues.

Objective:
To establish the functional results of ligamentotaxis using external fixator on patients with unstable distal radial breaks.

Methods:
The current descriptive research was carried out in the Department of Orthopedics and it spanned 4 months from 01-01-2025 to 30-04-2025. Non-probability consecutive sampling was used to include 149 patients aged 1860 years with unstable distal radius fractures, of AO type B and C. External fixation of all patients was done on the basis of ligamentotaxis. The modified Sarmiento version of the Gartland and Werley scoring system was used at 12 weeks of postoperative assessment of functional outcomes. The data were examined by the SPSS version 25, and both inferential and descriptive statistics were done.

Results:
The average age of patients amounted to 38.72 with a standard deviation of 10.41 years. It was found that excellent functional results were in 63 (42.3) patients, good results in 52 (34.9) patients, fair results in 23 (15.4) patients, and poor results in 11 (7.4) patients. The functional outcomes were significantly associated with age and duration of fracture prior to surgery ($p \leq 0.05$).

Conclusion:
External fixation with ligamentotaxis gives good functional results to patients with unstable distal radius fractures and can be used as a treatment possibility in the right clinical environment.

INTRODUCTION

Distal radius fractures are the most common skeletal injuries that orthopedic surgeons deal with and are the most common upper extremity fractures. The injuries constitute almost one-sixth of all fractures that include emergency departments across the globe. High-energy trauma has led to the emergence of the incidence of distal radius fractures in young people, and osteoporotic fractures in the elderly population. Since the distal radius is a critical structure in the biomechanics of the wrist and the functionality of the hand, its mismanagement may result in permanent disability and poor living standards. [1].

Conventionally, closed reduction and immobilization of the distal radius fracture by plaster of Paris cast is used to treat many cases of this injury. Although it is a good technique when dealing with stable extra-articular fracture, unstable/intra-articular fracture may pose serious problems in its treatment. Such fractures are more likely to redisplace following reduction because of comminution, disruption of ligaments and loss of the metaphyseal support and therefore are hard to maintain reduced by casting alone. Such fractures in turn are linked to increased malunion, incongruency of the joints and impairment of functions. [2].

The fact that intra-articular distal radiolimb fractures interferes with the articular surface and alters the wrist kinematics makes the problem especially troublesome. Loss of the ability to reestablish the articular congruity could result into post-traumatic arthritis, stiffness, reduced grip strength, and chronic pain. Thus, anatomical reduction and stable fixation is deemed to be the key to the most successful functional recovery. Percutaneous pinning, external fixation, as well as open reduction and internal fixation have been suggested as various forms of treating such complicated fractures. [3].

Ligamentotaxis is one of the basic biomechanical principles of the treatment of these fractures. Ligamentotaxis Ligamentotaxis is the application of constant traction across a joint so that the adjacent soft tissues including ligaments, joint capsule, and periosteum indirectly minimize fracture fragments. These soft tissue structures in the distal radius fractures serve as natural tension bands that help in restoring alignment when traction is exerted and therefore help in reduction without much exposure to the surgical arena. [4].

There is a special anatomy of the distal end of the radius which helps to provide the wrist with both motion and stability. The articular surface is tilted at an average of 6-11 degrees in the lateral plane and 22 degree in the anteroposterior plane. Also, anatomical components like the Lister tubercle and extensor compartments that surround the latter are significant in the mechanics of the wrist. This anatomical alignment is one of the elements that should be preserved/ restored to ensure satisfactory functional results after management of the fracture. [5].

Extrinsic fixation pegged on the concept of ligamentotaxis is currently an effective treatment mode of unstable, often comminated, or intra-articularly extended distal radius fractures. External fixators keep the wrist joint in distraction, fixation of the fragments of the fracture, and mobilization of the fingers at an early stage. External fixation has been demonstrated as better in maintaining reduction and giving superior functional results when compared with conservative treatment in selected patients. [6].

A number of studies have been comparing the efficacy of ligamentotaxis in external fixation of the distal radius fractures. Literature reports of clinical outcomes reveal positive outcomes where a large proportion of the patients have a high proportion, excellent or good functional recovery. An example of this is the report Salama and others presented of very high success rate of ligamentotaxis in 50 percent of patients being treated with the use of external fixator and, good results in 33.3 percent and poor results in 16.7 percent of patients. These results indicate how

this method can be useful in unstable fractures treatment. [7].

Although the techniques of surgeries and fixations have improved, the best way to manage the unstable cases of distal radium fractures is a research question. Local information on the functional results of ligamentotaxis after external fixation do not exist, specifically in our population. The effectiveness of this treatment modality can be considered in terms of evaluating the ability to guide orthopedic surgeons to choose proper management strategies and enhance patient counseling in relation to the outcomes expected. [8]

OBJECTIVE

To determine the functional outcomes of ligamentotaxis with external fixator in patients with unstable distal radius fracture.

METHODOLOGY

Study Design and Setting

The study was a descriptive cross-sectional study, held in the Department of Orthopedics, Khyber Teaching Hospital, Peshawar from 01-01-2025 to 30-04-2025. The research was conducted in four months following the authorization of the hospital research review committee.

Sample Size and Method of Sampling.

The WHO sample size formula was applied to calculate the sample size by considering the expected proportion of poor results with the use of external fixators to correct distal radius fractures to be 16.7% with a margin of error of 6 and a level of confidence of 95%. The sample size was calculated to 149 patients. The sample size was recruited through a non-probability consecutive sampling method of patients who fitted into the inclusion criteria.

Population and Eligibility of the study.

The study included patients aged between 18 and 60 years of either gender who were diagnosed of unstable distal radius fractures (AO type B and C) on radiographic screening. The patients in the study were not allowed to join the study if they were unfit to undergo surgery, had pathological fractures, or experienced the same fracture before or were having related fractures or dislocations of the same wrist.

Data Collection Procedure

Patients who met the selection criteria were recruited in the orthopedic inpatient department with informed written consent being taken. Basic demographic and clinical data such as age, sex, body mass index (BMI), place of residence, education, job, socioeconomic status, and laterality of the wrist involvement, and length of fracture were noted on a given proforma. Anteroventral and lateral wrist X-rays were used as preoperative radiograph assessments.

Treatment of all patients was done by applying an external fixation under the principle of ligamentotaxis under general anesthesia. The radial shaft was predrilled with the correct soft-tissue protection and proximal pins inserted, whereas the distal Schanz pins were inserted into the base of the second metacarpal using regular surgical technique. The extra fixator was mounted and distraction was done under the fluoroscopy to obtain the reduction by means of ligamentotaxis. After surgery, patients would be observed and neurovascular status as well as advised on limb elevation, finger movement and pin site care.

Outcome Assessment

Follow-up was done on patients 12 weeks after the procedure. The modified Sarmiento version of the wrist Gartland and Werley functional scoring system was used to evaluate the outcomes on the functional level. Results were divided into excellent (0-2), good (3-8), fair (9-20), and poor (above 21).

Statistical Analysis

Data were evaluated with the help of IBM SPSS 25. The variables of the study were summarized using descriptive statistics. The continuous variables included age, BMI, and fracture duration, and functional score that were assessed as mean ± standard deviation or median, and interquartile range after evaluating the normality with Shapiro-Wilk test. Gender, residence, education, profession, socioeconomic status, laterality of the wrist involvement and functional outcome categories are categorical variables that were presented in frequencies and percentages.

To establish the relationship between functional outcomes and picked variables such as age,

gender, BMI, period of fracture, and laterality of the wrist, inferential statistics were used. The Chi-square test or Fisher exact test was used to perform post-stratification analysis as necessary. A p-value of 0.05 was taken as statistically significant.

RESULTS

This study involved 149 patients undergoing ligamentotaxis in distal fracture of the radius through the use of external fixators. **Table 1** presents the summary of the baseline demographic and clinical features of the patients. The average age of the patients was 38.72 years with a standard deviation of 10.41 years, and the average BMI was 26.14 kg/m^2. The average time taken to fracture preoperative was 28.63 ± 11.54 hours.

Out of the participants of the study, 94 (63.1%) men and 55 (36.9%) women were included. The vast majority of the patients were urban residents (58.4%), and there were 41.6% rural residents. As far as right and left laterality is concerned, 86 patients (57.7%) were found to have a fracture on the right wrist, and 63 (42.3%) had an injury on the left one.

Table 2 shows the functional outcomes measured at 12 weeks in the postoperative period on the modified Sarmiento Gartland and Werley scoring system. All in all, there were 63 (42.3%) patients who had excellent outcomes, 52 (34.9%) patients with good outcomes, 23 (15.4%) with fair outcomes and 11 (7.4%) with poor outcomes.

Table 3 and **Table 4** demonstrate the stratification of the functional outcomes based on the demographic and clinical variables. The difference in age group and functional outcome was found to be of statistically significant importance (p = 0.032), and younger patients exhibited greater functional recovery in comparison with older patients. Likewise, fracture preintervention period was associated with significant outcome (p = 0.041) with higher outcomes with a shorter time of surgery.

Nevertheless, gender (p = 0.284) and BMI category (p = 0.219) and laterality of the wrist (p = 0.467) were not statistically significant associated with the functional outcomes.

Table 1 Baseline Demographic and Clinical Characteristics of Patients (n = 149)

Variable	Mean ± SD / Frequency (n)	Percentage (%)
Age (years)	38.72 ± 10.41	–
BMI (kg/m²)	26.14 ± 3.27	–
Duration of Fracture (hours)	28.63 ± 11.54	–
Gender		
Male	94	63.1
Female	55	36.9
Residence		
Urban	87	58.4
Rural	62	41.6
Laterality of Wrist		
Right	86	57.7
Left	63	42.3

Table 2 Distribution of Functional Outcomes After Ligamentotaxis with External Fixator (n = 149)

Functional Outcome	Frequency (n)	Percentage (%)
Excellent	63	42.3
Good	52	34.9
Fair	23	15.4
Poor	11	7.4

Table 3 Stratification of Functional Outcomes with Respect to Age Group

Age Group (Years)	Excellent	Good	Fair	Poor	Total	p-value
18–30	26	18	5	2	51	
31–45	23	21	9	3	56	
46–60	14	13	9	6	42	0.032

Table 4 Stratification of Functional Outcomes with Respect to Gender, BMI and Laterality

Variable	Excellent	Good	Fair	Poor	p-value
Gender					
Male	41	31	15	7	0.284
Female	22	21	8	4	
BMI Category					
Normal (<25)	29	21	9	4	
Overweight (25–29.9)	24	22	10	5	
Obese (≥30)	10	9	4	2	0.219
Laterality					
Right wrist	38	28	13	7	
Left wrist	25	24	10	4	0.467

DISCUSSION

The fracture of the distal radius is one of the most popular orthopedic injuries and still remains a problematic issue in terms of management, especially when the fracture is unstable or it affects the articular region. The most important aims of treatment are restoration of anatomical position and maintenance of the function of the wrist. The current research dependent variable was the assessment of the functional results of the ligamentotaxis using the external fixation in patients with an unstable distal radius fracture. The results revealed that most of the patients recorded satisfactory functional recovery with most of the patients recording either the excellent or the good category of the modified Sarmiento version of the Gartland and Werley scoring system.

Ligamentotaxis is important in the treatment of comminuted intra-articular fractures. The surrounding soft tissue structures, including ligaments and joint capsules make indirect corrections on the fragments of the fracture through controlled distraction across the wrist joint. This method reduces the high surgical exposure and lessens the chances of further mutilation of soft tissues. The positive results achieved in this research are in favor of the efficacy of ligamentotaxis as a least invasive procedure of preserving the reduction and returning wresting dynamics to fractures of the unstable distal radius. [9].

In the current research, good functional outcomes were noted in a high percentage of patients with fewer having good or fair outcomes. A small proportion of the patients showed impoverished functional recovery. The results, in turn, are in line with former studies that have proven that external fixation according to ligamentotaxis offers sufficient support to the preservation of fracture reduction and acceptable functional outcomes in unstable distal radius fractures. The fixation and the stability that can be delivered by the external fixator during the healing process is believed to be a valuable factor that has been behind the better results. [10].

In this study, age was observed to be statistically significantly related to functional outcome. The young patients reported better recovery than the elderly. This finding can be explained by an increased bone quality, higher healing, and adherence to postoperative rehabilitation in younger patients. There are also related results in prior clinical research studies that reported that age increment is relatively correlated with a poorer functional outcome after distal radius fracture treatment. [11].

The other significant finding in this research was the correlation between the length of time the patient has been in a fracture and the outcomes

of functioning. Patients that had previous fixation were more likely to experience better functional recovery rather than their late presentation. Anatomical positioning and fixation of fracture fragments at an early stage can result in avoiding contracture of soft tissues, joint hardness, and secondary displacement, which will allow to achieve better rehabilitation and recovery of wrist functions. The significance of timely surgical intervention in the attainment of good results has also been highlighted in the past literature. [12].

The study did not find any statistically significant association between the functional outcomes and gender, body mass index, and wrist laterality. Such observations indicate that such demographic factors might not be critical in determining the effectiveness of ligamentotaxis with external fixation. Other studies have also reported similar observations and found that patient related factors like gender or side of injury did not have any significant effect on the functional recovery of the patients postoperative. [13].

Although volar locking plate fixation is becoming increasingly popular as a treatment modality in stabilizing unstable distal radius fractures, external fixation continues to play a role in this treatment. External fixation has the benefits of minimum soft tissue dissection, reduced operation time and because of ligamentotaxis, it is capable of producing a reduction. Also, the method enables early mobilization of fingers and minimizes the chances of postoperative stiffness. A number of comparative studies have shown that external fixation still has satisfactory clinical and functional results when indicated properly. [14-16].

The results of this paper thus support the use of ligamentotaxis with external fixation as a viable therapy to the unstable fractures of the distal radius. The need to use proper surgical technique, appropriate patient selection and early postoperative rehabilitation are some of the issues that ensure success. Further assessment of treatment modalities and functional outcome is also significant to optimize the management of these prevalent injuries. [17-20].

Limitations: There are multiple limitations to this study that one can take into account when reading findings. The first one is that the study was carried out in one center and the sample size was rather small which can influence the external validity of the findings. Second, the maximum follow-up duration was twelve weeks, and this might not be sufficient to measure long-term functional outcomes and late outcomes like post-traumatic arthritis. Third, the study did not involve radiological parameters and comparison with other treatment modalities like the volar plating. It is suggested that further research should be done by employing multicenter studies employing bigger sample sizes and extended follow-up in order to confirm further the efficacy of ligamentotaxis in cases of instability in the distal radius fracture with use of external fixation.

CONCLUSION

External fixation ligamentotaxis has proven to be a successful and a dependable type of treatment remedy in unstable broken distal radius, offering good functional results in most patients. The method enables the restoration of the fracture position by means of indirect reduction without damaging the adjacent soft tissue and retaining stability over the healing period. The results of this paper reveal that the vast majority of patients reported having superior to acceptable functional recovery rates at 12 weeks after the operation, and enhanced results were recorded among younger patients and among those who had previously undergone surgery. Hence, external fixation ligamentotaxis may still be used as a useful intervention tool to the management of an unstable distal radius fracture.

REFERENCES

Molla T, Talukdar MF, Mistry S, Rahman MM, Dey LC. Functional outcome of Unstable Distal Radial Fracture Management by External Fixator using the Principle of Ligamentotaxis. Journal of Dhaka National Medical College & Hospital. 2022 Mar 30;28(1):16-9.

Bentaher M, Salama A, Eladawy AM, Mashhour A. Results of Ligamentotaxis Technique in Treatment of Intra-articular Distal Radius Fracture. Zagazig University Medical Journal. 2022 Nov 1;28(6.2):152-7.

Singh PK, Tank P, Junagadh TH. Functional Outcome of Complex Intra Articular Distal Radius Fracture Managed With Ligamentotaxis With or Without K Wire Augmentation. International Journal. 2021 Jan;4(1):800.

Said ES, Refae HH, Ali AE, Tammam HH. Ligamentotaxis supplemented by K wires fixation versus volar plate and screws fixation for management of unstable fractures of the distal radius. SVU-International Journal of Medical Sciences. 2024 Jan 1;7(1):227-36.

Borkar S, Pusalkar M, Konde S, Patil R, Desai S. To study the clinical and radiological outcome of patients with intraarticular or unstable lower end radius fractures treated with ligamentotaxis with external fixator and K wires. International Journal of Orthopaedics. 2019;5(1):67-9.

Kamra P, Gulati A, Patel PG, Gautam VK, Khare S. Role of external fixator in surgical management of intra-articular distal radius fractures: Functional and radiological outcomes. International Journal of Orthopaedics. 2019;5(3):747-51.

Mantoo SA. Evaluation of Functional results of distal end radius fractures managed by ligamentotaxis with or without percutaneous K-wire augmentation. International Journal. 2019 Nov;2(6):91.

Gupta A, Bhat B. Assessment of outcome of ligamentotaxis of fracture distal end radius by distractor apparatus. NATIONAL JOURNAL. 2020;4(1):145-7.

Hanus M, Hanák F, Šťastný E, Trč T. Surgical treatment of fractures of the distal radius-ORIF vs external fixation with ligamentotaxis. Rozhledy v Chirurgii: Mesicnik Ceskoslovenske Chirurgicke Spolecnosti. 2020 Jan 1;99(8):343-9.

Suman NV, Chincholi S. Functional outcome in treatment of distal radius fractures using external fixator. International Journal of Orthopaedics. 2019;5(4):1082-4.

Sekar P. Unstable Intra-articular Fracture Distal Radius Managed by Combined External Fixation and Internal Fixation by Volar Plating. Journal of Orthopedics and Joint Surgery. 2020 Oct 17;2(1):31-7.

Saving J, Enocson A, Ponzer S, Navarro CM. External fixation versus volar locking plate for unstable dorsally displaced distal radius fractures—a 3-year follow-up of a randomized controlled study. The Journal of hand surgery. 2019 Jan 1;44(1):18-26.

Beeres FJ, Liechti R, Link BC, Babst R. Role of a spanning plate as an internal fixator in complex distal radius fractures. Operative Orthopädie und Traumatologie. 2021 Feb;33(1):77-88.

Vakhshori V, Alluri RK, Stevanovic M, Ghiassi A. Review of internal radiocarpal distraction plating for distal radius fracture fixation. Hand. 2020 Jan;15(1):116-24.

Gouk C, Ng SK, Knight M, Bindra R, Thomas M. Long term outcomes of open reduction internal fixation versus external fixation of distal radius fractures: A meta-analysis. Orthopedic reviews. 2019 Sep 24;11(3):7809.

Subramanyam KN, Khanchandani P, Mundargi AV, Suneelkumar M, Reddy R. Ilizarov ligamentotaxis versus volar locked plating in the management of AO type C2/C3 distal radius fractures—a prospective non-randomised comparative trial. Musculoskeletal Surgery. 2022 Sep;106(3):279-90.

Al-Failly HO, Majeed GH, Aledanni MS, Al-Mukhtar MS. Comminuted intra-articular distal radius fractures treated by ligamentotaxis external fixation with and without bone marrow injection to prevent late metaphyseal collapse. Rawal Medical Journal. 2022 Jul;47(3):635-.

Akar B, Yücel MO. The Effect of Changes in the Radio-Ulnar Angle on Wrist Scores on the Treatment of Intra-Articular Fractures of the Distal Radius with Wrist Fixator. Duzce Medical Journal. 2023 Jan 1;25(1):73-7.

Aita MA, Rodrigues FL, Alves KH, de Oliveira RK, Ruggiero GM, Rodrigues LM. Bridging versus nonbridging dynamic external fixation of unstable distal radius fractures in the elderly with polytrauma: a randomized study. Journal of Wrist Surgery. 2019 Oct;8(05):408-15.

Kamil R, McKenna E, Romeo P, Burke O, Zakusylo A, Andemichael A, Badalyan N, Stamos T, Shah A, Katt BM, Burke Jr OC. The Role of External Fixation in the Treatment of Distal Radius Fractures. Cureus. 2024 Jul 11;16(7).