International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
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ARTICLE TITLE	TREATMENT METHODS OF DISTAL RADIUS FRACTURES. A LITERATURE REVIEW

DOI	https://doi.org/10.31435/ijitss.2(50).2026.5306
RECEIVED	06 March 2026
ACCEPTED	03 June 2026
PUBLISHED	10 June 2026

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TREATMENT METHODS OF DISTAL RADIUS FRACTURES. A LITERATURE REVIEW

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ABSTRACT

Background. Fractures of the distal radius are a significant problem in orthopedics considering their frequency and high cost of treatment.
Aim. Due to these factors and the development of technology, the aim of the study is to review available treatment methods.
Material and methods. A review of treatment methods of distal radius fractures is presented based on the available literature of PubMed, Scopus and Google Scholar.
Result. Treatment of a fracture of the distal part of the radius should begin after its correct diagnosis, based on an interview, physical examination and a properly taken X-ray. The choice of treatment method depends on the type of fracture suffered by the patient and its impact on the patient's anatomy and functioning.
Conclusion. The most common type of fracture is Colles fracture, and the most popular method of treating DRF is closed reduction of bone fragments and conservative treatment with plaster cast. However, volar plating is becoming a modern option and provides an opportunity for early mobilization and a fast return to work.

KEYWORDS

Radius, DRF, Reduction, Immobilization, Stabilization, ORIF

CITATION

Daniel Grobecki, Damian Machaj, Aleksandra Mazurek, Barbara Bicka, Wojciech Nowicki, Szymon Pieczara, Jakub Polak, Wiktoria Józefowicz, Jakub Lis. (2026) Treatment Methods of Distal Radius Fractures. A Literature Review. *International Journal of Innovative Technologies in Social Science*. 2(50). doi: 10.31435/ijitss.2(50).2026.5306

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Introduction

Distal radius fractures (DRF) account for 17.5% of fractures diagnosed by orthopedic surgeons [1]. In general, the fracture occurs 2 cm below the articular surface of the distal epiphysis during a fall from one's own height. Most often, the distal fragment is displaced dorsally [2]. 16% of cases are treated surgically. The average cost of surgical treatment for DRF ranges from $4,548 to $5,261 [3-4]. Numerous treatment methods have been described in the literature, ranging from plaster casts to ORIF (open reduction internal fixation). The aim of the article is to present the types of fractures of the distal radius and currently used treatment methods, including rehabilitation.

Methodology

This literature review was conducted to summarize the current state of knowledge regarding various management strategies for distal radius fractures, ranging from conservative methods to advanced surgical procedures. A comprehensive search was performed across major medical databases, including PubMed, Scopus, and Google Scholar, focusing on peer-reviewed articles, clinical trials, published primarily within the last decade. The selection process prioritized studies comparing functional outcomes, such as the DASH score and range of motion, with radiological parameters like radial inclination and volar tilt. Key treatment modalities analyzed include closed reduction with casting, percutaneous K-wire fixation, and open reduction with internal fixation using volar locking plates. Special attention was also given the role of early mobilization in post-operative rehabilitation. The gathered data were qualitatively synthesized to provide a clear overview of the advantages and limitations of each method in relation to fracture stability and patient age.

Result

The diagnosis of a fracture of the distal radius is based on an on a patient interview, physical examination, and analysis of an X-ray image, at least in two projections: AP and a lateral one (Fig.1). The choice of treatment method depends on many factors, the most important of which are: the degree of displacement, the degree of involvement of the joint, the stability of the fracture, the number of fragments, the quality of bone tissue, the age of the patient, and the possible diagnosis of additional injuries.

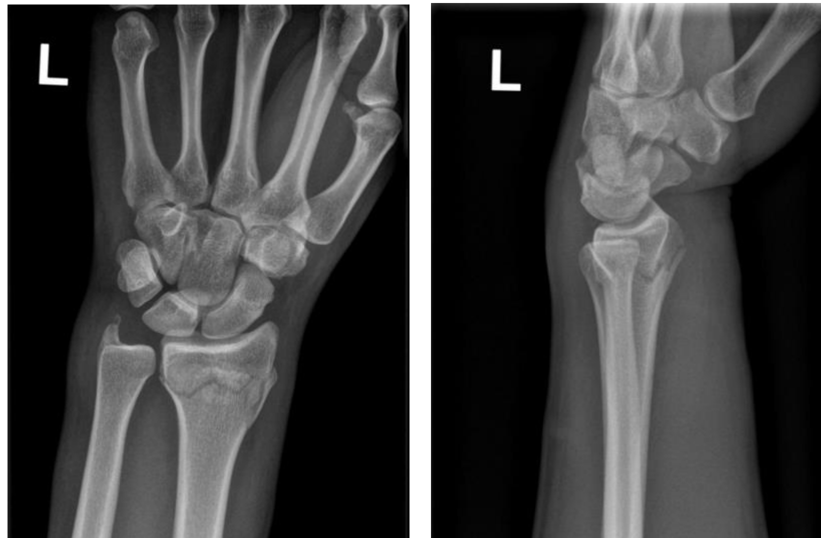

Fig. 1

Left: The AP radiograph demonstrates a transverse fracture line of the distal radius. A proximal radial-sided bony fragment is visible adjacent to the main fracture line. Right: The lateral radiograph confirms the transverse distal radius fracture, with the proximal radial-sided fragment again identifiable. No significant displacement is noted in the sagittal plane.

In the treatment of fractures of the distal radius, closed reduction and external stabilization or open reduction and internal stabilization are used. The next stage should be immobilization of the limb in a forearm or shoulder plaster cast, depending on the type of fracture and the treatment method used [6, 7, 8].

The most popular method of treating DRF is closed reduction of bone fragments and conservative treatment with a plaster cast (Fig. 2). This procedure includes non-displaced intra- and extra-articular fractures, displaced stable fractures after fragment reduction, and displaced fractures in elderly people where non-anatomical positioning of fragments is accepted to exclude the risk associated with the surgical procedure [5]. Fracture reduction is performed by traction of the wrist and manual manipulation of the fragments. To assess the effectiveness of closed reduction, a follow-up X-ray is taken to assess whether the anatomical position and congruence of the joint have been achieved. As a result of this, the doctor can decide to try the reduction again or decide on surgical treatment. This allows us to exclude instability in the distal radiocarpal joint or post-traumatic arthrosis [24]. To ensure immobilization, we use a plaster cast for 3-6 weeks. During the treatment process, we perform subsequent control X-rays to assess bone union.

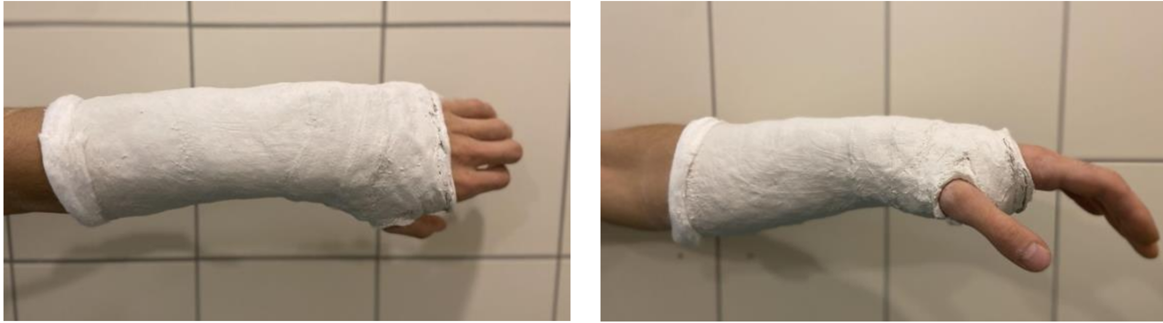

Fig. 2
Left: The dorsal view shows a properly applied short arm plaster cast. It starts just below the elbow and ends at the level of the metacarpal heads, so the MCP joints remain uncovered. With this length and positioning, the cast effectively blocks wrist flexion, extension, radial and ulnar deviation, and also significantly limits forearm pronation and supination Right: On the lateral view, the wrist is held in approximately 15–20° of volar flexion, which helps prevent a secondary dorsal angulation. The layers of the cast are even, with no obvious pressure points.

For unstable distal radius fracture, percutaneous Kirchner-wire fixation (Fig.3) is commonly used as a treatment method. In the scientific article entitled "Results of surgical treatment of unstable fractures of the distal radius using percutaneous stabilization with Kirschner wires", the authors analyzed a group of 112 patients diagnosed with a fresh unstable fracture of the distal radius, operated on using the method of percutaneous stabilization with Kirschner wires. After the operation, the limb was immobilized in a forearm plaster splint. After being discharged from the ward, the patients were treated in the hospital clinic. There, the study subjects had control photos taken between 7 days and 2 weeks post surgery., on average 10 days after surgery. The aim was to assess possible secondary displacements and after removal of the plaster immobilization [6]. In order to properly assess the treatment results, the Disabilities of the Arm, Shoulder and Hand (DASH) and Gartland-Werley scales were used [6,9,10]. Radiological assessment was performed based on the Lidstrom scale [6,11]. The study proved that the use of percutaneous stabilization of unstable distal radius fractures with Kirschner wires gives good treatment results and significantly prevents secondary fragment displacements in patients with diagnosed type A2, A3, B1, B2, C1, C2 fractures. However, this method was not found to be useful in the surgical treatment of type C3 fractures. According to the literature, better treatment effects were achieved by authors who used external fixation, open reduction and stabilization in the treatment of type C3 fractures [6,8,12,13,14,15].

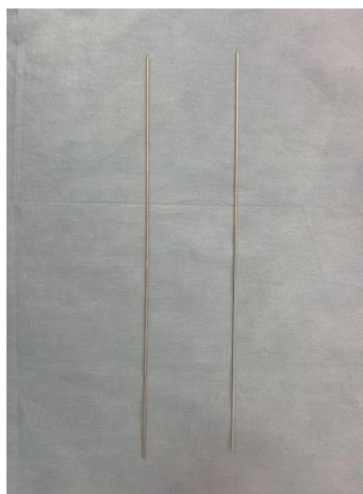

Fig. 3
Percutaneous placement of Kirschner wires allows for stable fracture fixation while preserving a minimally invasive approach and reducing soft-tissue disruption. The wires can be introduced in various diameters, enabling tailored mechanical support depending on fracture morphology and bone quality.

Already in 1886, Carl Hansmann used a nickel-plated steel plate to fix fractures of the tibia, femur, mandible and radius. Over the years, there has been a dynamic development of both materials and surgical techniques. The newest plates are made of, among others, titanium or stainless steel. The study entitled Titanium versus Stainless-Steel Plating in the Surgical Treatment of Distal Radius Fractures: A Randomized Trial showed no differences in surgical complications resulting from the material used [16]. The most popular approaches are the Henry approach, and the trans-FCR approach, performed from the palmar side [17]. The plates currently used are a development of DCP and LC-DCP plates (Fig. 4). They have both blocking and non-blocking functions [18]. Their design allows the use of both cortical and locking screws to achieve the desired compression.

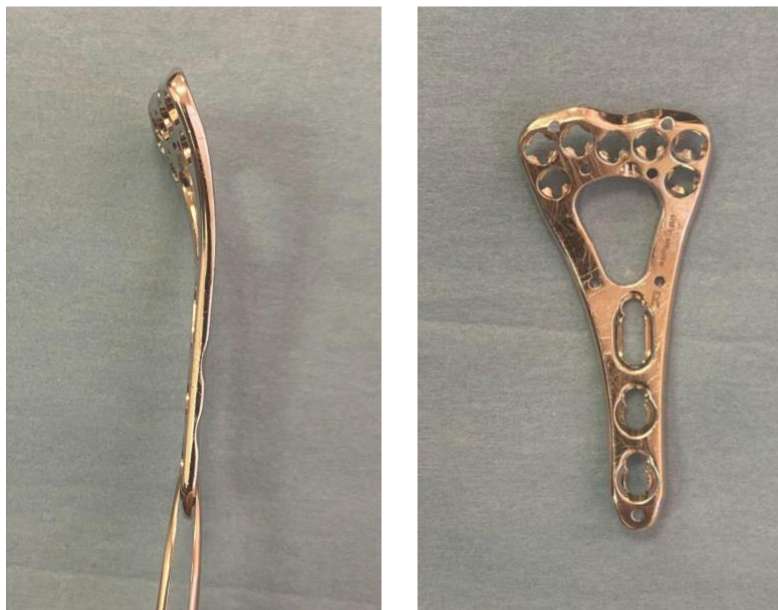

Fig. 4

Left: The plate is anatomically pre-contoured to follow the natural curvature of the distal radius, providing accurate cortical fit while reducing the risk of irritation to the surrounding tendons. Right: in the LCP system, the threaded holes allow the locking screws to engage the plate at a fixed angle, forming a stable angular-locked construct. In the VA version of this plate, the same holes let the surgeon fine-tune the screw trajectory within an approximate range of 0–15°, giving some flexibility in screw direction while still maintaining the locking effect.

In a retrospective study of 46 patients, treatment outcomes after distal radius fractures were compared depending on the use of non-locked or locked volar plates. The patients were divided into two groups. The first one contained 20 patients under 50 years of age with high-energy injuries. In half of them, internal stabilization of the fracture was applied in the form of non-locked plates, and in the remaining 10 cases - in the form of locked plates. The second group consisted of 26 patients over 50 years of age whose injuries were caused by a fall at the same level. In this case, similarly to the first group, half of the patients were treated with non-locking plates and the remaining ones with locked plates. Both groups of patients were examined in terms of range of motion and strength of the operated limb, as well as functional assessment using the MAYO scale and the DASH questionnaire. Most results showed no significant differences between the use of non-locked and locked plates, however, more favorable treatment results were observed when using non-locked plates. The results in both age groups were similar [19].

The Colles' fracture is the most common type of fracture. A large percentage of such fractures can be left in a Charnley splint or plaster cast after bone reduction. However, older people are an exception to this rule when the angular position of the distal epiphysis of the radius exceeds 20°. In such a clinical situation, surgical fixation is performed to maintain appropriate reduction, which involves ulnar deviation but without wrist flexion and the use of traction. The goal should be to prevent restriction of the MCP joints [20].

In 2014, the results of a study were published on the impact of selected applications of elastic bands on the effects of physiotherapy in patients treated conservatively after Colles' fracture. The author's intention was

to check whether the use of a given technique could improve the effectiveness of physiotherapy in patients, which would result in, among other things, better passive and active mobility and the overall quality of movement. The study involved 38 patients who were randomly divided into a research and control group. The research group consisted of 20 people (16 women and 4 men). The therapeutic procedure included the use of the so-called Hand Tutor System (hand rehabilitation system with biofeedback) and selected applications of elastic therapeutic tape, such as a muscle tape - used to firm the wrist flexor, or a ligament or corrective tape for the wrist area. The control group included 18 people (15 women and 3 men), and their therapy was based solely on the use of the Hand Tutor System. According to the comparative analysis conducted before the start of the study, the research and control groups did not differ significantly in the analyzed parameters. The analysis of the results showed that patients belonging to the research group showed a significantly higher frequency of active movements compared to the initial results. However, in both groups there was a significantly greater improvement in wrist mobility, both passive and active [21].

The opposite of a Colles' fracture is a Smith's fracture, which occurs when a person falls backwards onto the flexed wrist. The fracture concerns the distal epiphysis of the radius with a palmar displacement, and is divided into transverse, oblique and extension fractures. The second and third types of fractures do not remain stable in a plaster cast, therefore surgical treatment should be performed, which involves the use of a plate placed on the palmar surface [20].

In 2018, a comparative evaluation of the results was in Surgical treatment of Smith-Colles type fractures of the distal end of the radius after open reduction and fixation with an angle-stable plate. The authors analyzed 25 patients with Colles' fractures and 25 with Smith's fractures. The quickDASH and Mayo scales were used to analyze the results. The following parameters were assessed: radial inclination, depression of the articular surface, volar inclination and height of the articular surface of the radius. Among the assessed radiological parameters, a significant difference was found only in the case of palmar tilt, which was normal only in the group of people with Smith's fractures and amounted to 11°, in Colles' type fractures this value was equal to 5°. On this basis, it was concluded that in fractures with dorsal displacement of fragments, it is more difficult to restore the correct volar inclination with a volar approach. The lack of significant differences in the analysis of other parameters allowed us to conclude that in fractures of the distal end of the radius, the type of displacement does not have a significant impact on the final result of surgical plate stabilization [22].

In Barton's fracture, i.e. a shear fracture that may involve both the palmar part and the dorsal part of the joint edge as well as the styloid process or the lunate surface, in order to avoid subluxation of the wrist, care should be taken to permanently position the elements axially. The most effective method of treatment is open reduction internal fixation with plates and screws [20,23].

A chauffeur's fracture (fracture of the styloid process) is most often unstable and accompanied by ligament damage to the wrist.. Most patients with this type of fracture require open reduction [20].

One of the most difficult types of fractures to treat is the die punch fracture. It is an indication for open reduction and stabilization with Kirschner wires. Surgical treatment involving external stabilization is a solution often used for comminuted fractures. Reduction may require supporting the existing defect with a graft [20,23].

The last stage of treatment of distal radius fractures is rehabilitation, which must be appropriately matched to the previous type of treatment. The most important goal of the rehabilitation process when placing the upper limb in a cast is to prevent loss of muscle strength and to prevent limitation of joint mobility. After removing the plaster cast, rehabilitation aims to restore full mobility in all joints, as well as coordination, stability, dexterity and muscle strength. Correctly carried out rehabilitation should also lead to the possibility of full load on all structures, as well as to the elasticity and smoothness of the scar. An attempt to restore full mobility of the joint is made through traction, which involves pulling the joint surfaces away from each other and preliminary preparation for restoring on joint play, in order to later perform glides: palmar, dorsal, radial and cubital, which serve to improve the movement: extension, flexion, ulnar deviation, radial deviation. Once full joint mobility is achieved, it is possible to use active exercises with resistance, during which the work of both eccentric and concentric muscles should be used. To improve blood circulation and muscle tension and reduce pain, physical therapy can be used, including: cryotherapy, whirlpool massage, low-frequency magnetic field, ultrasound and calcium iontophoresis [20].

Table 1. Summarizes the major fractures along with their recommended surgical treatment.

Fracture Type	Mechanism	Description	Indications for Surgical Management	Surgical Treatment
Colles' Fracture	FOOSH (fall on outstretched hand) with the wrist in extension.	Distal radius fracture with dorsal angulation and dorsal displacement of the distal fragment.	Surgical intervention is indicated if significant deformity or instability remains after reduction. Unstable features include >20° of dorsal angulation, >5 mm of radial shortening, severe comminution, or >2 mm of intra-articular step/gap.	K wires are indicated for extraarticular fracture. ORIF with a volar locking plate allows anatomical reduction and stable fixation of unstable fracture patterns.
Smith's Fracture	A fall onto the back of the hand (wrist in flexion) or a direct blow to the dorsum of the wrist, causing forced volar flexion.	An extra-articular fracture of the distal radius with volar angulation of the distal fragment.	Any Smith's fracture with appreciable volar angulation or any intra-articular involvement (Smith's Type II or III) is generally an indication for surgical management..	Closed reduction with percutaneous pinning Kirschners for 2 or 3-segment fractures gives a good functional outcome. ORIF with a volar locking plate for unstable or irreducible Smith fracture.
Barton's Fracture (dorsal type)	An intra-articular fracture of the distal radius involving the dorsal rim, with dorsal subluxation or dislocation of the radiocarpal joint.	By high-energy forced wrist extension (hyperextension) with forearm pronation, which shears off the dorsal lip of the radius and allows the carpus to displace dorsally.	Surgical stabilization is indicated in virtually all cases.	ORIF with dorsal locking plate or dorsal buttress plate is used to stabilize the fracture and maintain articular congruity.
Chauffeur's Fracture (radial styloid)	Impaction force on the wrist causing the scaphoid to drive into the radial styloid and fracture it.	An intra-articular fracture of the distal radius involving the radial styloid process.	>2 mm articular step or a large fragment. Even a small styloid avulsion may warrant surgery if accompanied by carpal instability.	Fixation can often be achieved with one or two percutaneous Kirschner wires or a cannulated lag screw. For larger or highly displaced fragments, open reduction is performed with a radial styloid buttress plate.
Die Punch Fracture	Axial wrist loading drives the lunate into the distal radius, creating a depressed articular fragment.	An intra-articular impaction fracture of the lunate fossa occurs.	Any intra-articular depression >2 mm or gap that persists after closed reduction is an indication for surgical elevation and fixation of the fragment.	Typically using a volar approach with a locking plate and, when needed, a dorsal approach for direct elevation and bone grafting.

Discussion

The most common type of fracture of the distal radius is a Colles fracture. In the treatment of fractures of the distal radius, closed reduction and external stabilization or open reduction and internal stabilization are used. The most popular method is closed reduction of bone fragments. Then, taking into account the type of fracture and the method of treatment, the limb is immobilized in a forearm or arm plaster cast [6,7,8]. The last stage of treatment is rehabilitation, which must be appropriately selected for the previous type of treatment. The most important goal of the rehabilitation process when placing the upper limb in a cast is to prevent a decline in muscle strength and to prevent limited mobility in the joints [20].

Conclusions

Distal radius fractures (DRF) constitute a significant percentage of orthopedic injuries, representing 17.5% of cases, mainly caused by falls from a height. Treatment modalities for DRF include a variety of approaches, including closed reduction and casting treatment for stable fractures, and percutaneous fixation with Kirschner wires for unstable cases.

The high cost of surgical treatment for DRF, ranging from $4,548 to $5,261, highlights the need for more effective and cost-effective treatments.

The use of modern technologies in the treatment of DRF includes surgical plates made of titanium or stainless steel, but studies have not shown significant differences in surgical complications resulting from the material used.

Rehabilitation after distal radius fractures is a key step that requires an individualized approach and includes a number of techniques such as traction, physiotherapy exercises and various therapeutic methods to restore full function of the limb.

Funding: No financial support was received for the study

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Writing- review and editing: Barbara Bicka and Aleksandra Mazurek
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Project Administration: Damian Machaj, Daniel Grobecki, Wojciech Nowicki
Receiving funding: Not applicable - no specific funding.

All authors have read and agreed with the published version of the manuscript.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors Institutional Review Board Statement: Not applicable.

Institutional Review Board Statement: This study did not require Institutional Review Board approval because it involved no identifiable human data and was based solely on publicly available sources.

Data Availability Statement: Data sharing is not applicable in this article as no new data were created or analyzed in this article.

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

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