

Intra-Articular Versus Extra-Articular Distal Radius Fractures: Management Strategies and Outcomes

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DOI: <https://doi.org/10.52403/ijrr.20250637>

ABSTRACT

Introduction: Distal radius fractures (DRFs) are among the most common orthopedic injuries, particularly in older adults and individuals with low bone mineral density. These fractures can be broadly categorized as intra-articular or extra-articular, with the involvement of the radiocarpal joint being a critical determinant of treatment complexity and prognosis. Intra-articular fractures are generally associated with worse functional outcomes due to articular surface disruption and higher rates of post-traumatic arthritis. This literature review aims to compare intra-articular and extra-articular distal radius fractures in terms of treatment modalities and clinical outcomes.

Methods: A comprehensive search was conducted across databases including PubMed, Scopus, and Cochrane Library for studies published from 2014 to 2025. The inclusion criteria focused on randomized controlled trials, observational studies, systematic reviews, and meta-analyses that evaluated treatment modalities (operative or non-operative) and reported on at least one clinical outcome. Data on surgical versus conservative treatment, complication rates, functional recovery, and radiographic outcomes were extracted and analyzed.

Results: Intra-articular DRFs are more frequently managed surgically due to the

need for anatomical joint surface restoration, often utilizing volar locking plate fixation. While both fracture types can yield good outcomes with appropriate management, intra-articular fractures tend to have higher complication rates, including joint stiffness, loss of reduction, and arthritis. Extra-articular fractures, particularly stable ones, may be effectively treated conservatively with closed reduction and plaster cast immobilization. However, the treatment choice is influenced by the patient's age, activity level, and fracture stability. Operative management is indicated in significant displacement, instability, open fractures, and neurovascular deficit, preferably using volar locking plates.

Discussion: Meta-analyses found no significant differences in postoperative visual analog score (VAS) or Oswestry Disability Index (ODI) between PLF and interbody fusion groups. Variations in intraoperative blood loss between interbody and lateral fusion procedures are noted, potentially impacting surgical outcomes and complication rates, including neurological deficits and infections associated with interbody fusion techniques.

Conclusion: Management of distal radius fractures must be individualized based on fracture pattern, patient-specific factors, and surgeon expertise. Intra-articular fractures demand precise reduction and fixation to

preserve joint congruity and function, while extra-articular fractures often allow for conservative treatment with favorable outcomes. Future research should focus on long-term functional comparisons and cost-effectiveness of surgical interventions for both fracture types.

Keywords: distal radius fracture, intra-articular, extra-articular, casting, surgery.

INTRODUCTION

Distal radius fractures represent one of the most common orthopaedic injuries, accounting for approximately one-sixth of all fractures treated in emergency departments, with a bimodal distribution affecting both younger individuals exposed to high-energy trauma and older adults with osteoporotic bone sustaining low-energy falls. These fractures are broadly categorized based on their involvement of the wrist joint into intra-articular and extra-articular types. This distinction carries significant clinical importance, as intra-articular fractures involve disruption of the joint surface, posing a greater risk for long-term complications such as post-traumatic arthritis, joint stiffness, and chronic pain if not managed appropriately (1,2).

The anatomical and biomechanical integrity of the distal radius plays a pivotal role in wrist function, forearm rotation, and load transmission across the upper extremity. Intra-articular fractures, by definition, compromise the congruity of the radiocarpal and/or distal radioulnar joints, often requiring surgical intervention to restore joint alignment and prevent degenerative changes. Conversely, extra-articular fractures occur proximal to the joint surface. While they may seem less complex, malalignment of the metaphyseal fragments can significantly affect wrist biomechanics and lead to impaired function if inadequately treated (3,4).

Management strategies for distal radius fractures vary widely based on fracture pattern, degree of displacement, bone quality, patient age, and functional demands.

Treatment may range from conservative measures such as closed reduction and immobilization for stable or minimally displaced fractures, to operative techniques including open reduction and internal fixation (ORIF), external fixation, or percutaneous pinning for unstable or displaced patterns. Intra-articular fractures more frequently necessitate surgical intervention to achieve anatomic restoration of the joint surface, whereas extra-articular fractures may be amenable to non-operative management if key radiographic parameters are preserved (5).

Despite advances in surgical techniques and implant technology—particularly the widespread use of volar locking plates—clinical outcomes remain variable and depend on multiple patient-specific and fracture-related factors. Functional recovery, return to daily activities, complication rates, and long-term wrist function can differ substantially between intra-articular and extra-articular fracture types. Therefore, understanding the nuances of each fracture category and the appropriate application of evidence-based management strategies is critical to optimizing outcomes (6). This review aims to compare intra-articular and extra-articular distal radius fractures in terms of treatment and outcomes.

METHODS

This literature review was conducted to compare the management strategies and clinical outcomes of intra-articular versus extra-articular distal radius fractures. A structured search of peer-reviewed literature was performed using electronic databases, including PubMed, Scopus, and the Cochrane Library, for articles published between January 2014 and March 2025. The search strategy employed combinations of relevant keywords and Medical Subject Headings (MeSH), including: “distal radius fracture”, “intra-articular”, “extra-articular”, “management”, “surgical treatment”, “functional outcomes”, “volar plate”, “non-operative treatment”, and “complications”.

Boolean operators (AND/OR) were used to optimize search sensitivity.

The inclusion criteria were: (1) original research articles, including randomized controlled trials (RCTs), observational studies, case series, systematic reviews, and meta-analysis; (2) studies that explicitly distinguished between intra-articular and extra-articular distal radius fractures; (3) studies that evaluated treatment modalities (operative or non-operative) and reported on at least one clinical outcome, such as radiographic alignment, range of motion, grip strength, patient-reported outcome measures (PROMs), or complication rates; and (4) studies published in English. Exclusion criteria included animal studies, cadaveric or biomechanical-only studies, isolated case reports, editorials, and non-peer-reviewed articles.

RESULTS AND DISCUSSION

Management of Intra-articular Distal Radius Fractures

Intra-articular distal radius fractures are complex injuries that involve the articular surface of the distal radius and often extend into the radiocarpal and/or distal radioulnar joint (DRUJ). These fractures disrupt the congruity of the wrist joint and can significantly impair function if not managed correctly. They account for a substantial portion of distal radius injuries, particularly in older adults with osteoporotic bone and in younger individuals following high-energy trauma such as falls, sports injuries, or vehicular accidents. The goals of treatment are to restore the anatomic alignment of the articular surface, maintain joint stability, preserve range of motion, and minimize the risk of long-term complications such as post-traumatic arthritis or chronic wrist dysfunction (5).

Diagnosis begins with a thorough clinical examination, noting swelling, deformity, crepitus, neurovascular integrity, and range of motion. Pain may be localized to the wrist, and in intra-articular involvement, subtle changes in joint mechanics can result in marked disability. Standard imaging with

posteroanterior and lateral radiographs is essential to assess fracture displacement, comminution, and involvement of the articular surface. However, due to the limitations of plain radiographs in visualizing complex joint anatomy, computed tomography (CT) scans are often used to evaluate the extent of intra-articular involvement, step-offs, and gaps in the joint surface. This is especially critical for preoperative planning and for classification according to the AO/OTA system, where Type C fractures represent complete articular involvement with metaphyseal disruption (7).

Management strategies are broadly divided into non-operative and operative approaches, depending on the degree of displacement, congruity of the articular surface, stability of the fracture, patient age, functional demands, and bone quality. Non-operative treatment may be considered in cases where the intra-articular step-off is less than 2 mm, the fracture is stable following closed reduction, and the patient's general condition favours conservative management. This typically involves closed manipulation followed by immobilization in a cast or splint for 4 to 6 weeks. During this period, patients must be closely monitored with weekly or biweekly radiographs to ensure that alignment is maintained, especially during the early phases of healing when secondary displacement is most likely (8).

Operative management is indicated in displaced intra-articular fractures, particularly when there is a step-off or gap in the joint surface greater than 2 mm, significant metaphyseal comminution, loss of radial length (>3 mm), dorsal angulation (>10°), or instability that cannot be maintained with casting. Open reduction and internal fixation (ORIF) using volar locking plates has become the gold standard in many cases, as it allows for rigid fixation, direct visualization and reduction of the articular surface, and early mobilization. The volar approach also reduces the risk of extensor tendon irritation and rupture, which can occur with dorsal plating. In cases where

ORIF is not feasible—such as in extensive comminution, open fractures with significant soft tissue injury, or in resource-limited settings—external fixation (bridging or non-bridging) may be used. This method relies on ligamentotaxis to realign fragments and can be combined with percutaneous K-wires or limited internal fixation. Arthroscopic-assisted reduction is a more advanced option that allows direct visualization of the joint surface and is useful for removing loose fragments, confirming reduction, and addressing concomitant soft tissue injuries such as scapholunate ligament tears (5).

Postoperative care is crucial for achieving optimal outcomes. Early controlled wrist mobilization is encouraged, typically within 1–2 weeks after surgery, once soft tissues are stabilized and pain is controlled. Delayed mobilization may lead to stiffness and poor functional outcomes. A structured rehabilitation program supervised by a physiotherapist is often necessary to restore range of motion, strength, and proprioception. Recovery timelines vary based on patient age, comorbidities, and injury severity, but most regain acceptable function within 3–6 months (9).

Cevetello et al. (2025) conducted a comprehensive literature review analyzing different immobilization strategies—splinting in various forearm positions, removable wrist braces, and soft dressings—and their impact on functional outcomes in adult patients with both intra-articular and extra-articular DRFs. The review found that removable braces and soft dressings offered outcomes comparable to, and sometimes

better than, traditional plaster splints, particularly in terms of range of motion (ROM), pain scores, and patient-reported outcomes. Several randomized trials cited in the review demonstrated that early mobilization—defined as starting wrist movement within 1–2 weeks postoperatively—was associated with faster improvement in ROM and strength in the short term, though long-term outcomes tended to converge with those who had longer immobilization. Notably, the use of soft dressings was linked with significantly improved wrist flexion, extension, and supination by final follow-up, without increasing the risk of reduction loss. Despite these findings, no definitive consensus exists, and the decision on immobilization method often remains influenced by surgeon preference, patient comorbidities, and the specific fracture type (10).

Complications of intra-articular distal radius fractures may include malunion, loss of reduction, infection (especially in open fractures or surgical wounds), hardware-related irritation, median nerve compression (especially in cases with significant swelling or volar hematoma), and complex regional pain syndrome (CRPS). One of the most serious long-term complications is post-traumatic osteoarthritis, often resulting from residual articular incongruity. This can lead to chronic pain, limited motion, and reduced grip strength. Therefore, anatomical restoration of the joint surface is critical, and intraoperative fluoroscopy or arthroscopy is often used to ensure accurate reduction (11).

Table 1. Management and Outcome of Intra-articular Distal Radius Fractures

Reference	Study Design	Management	Outcome
(12)	Retrospective cohort study	Operative (volar plate ORIF) vs. Non-operative (casting)	Operative treatment resulted in significantly better upper extremity function based on lower QuickDASH scores (mean 10.53 vs. 23.29; $p = 0.012$). Operatively treated patients were 1.5 times more likely to have normal function (QuickDASH ≤ 20)
(13)	Prospective observational study	External fixation using principle of ligamentotaxis in comminuted intra-articular distal radius fractures	Among 30 patients, 46.6% achieved excellent, 40% good, 10% fair, and 3.3% poor outcomes based on the modified Gartland and Werley score. 86.66% achieved excellent or good results, supporting

			ligamentotaxis as an effective treatment option
(14)	Prospective case series	Dorsal wrist plating using low-profile double plating for intra-articular distal radius fractures with dorsal rim fragments	At 12-month follow-up of 17 patients, 92% of wrist motion was recovered compared to the contralateral side; mean grip strength was 24.6 kg. The mean Mayo Wrist Score was 89.7, and the DASH score was 4.5. No infections, tendon ruptures, or CRPS were reported
(15)	Prospective observational study	Open reduction and internal fixation (ORIF) using volar locking compression plates for comminuted intra-articular distal radius fractures (Melone type 3–5)	Among 56 patients, 75% had excellent to good outcomes, 17.9% fair, and 7.1% poor, based on the Gartland and Werley scoring system. The overall complication rate was 17.86%, with carpal tunnel syndrome and RSD as most common
(16)	Prospective comparative study	Conservative (POP cast) vs. Surgical (ORIF with volar plate, K-wire, or external fixation) in intra-articular distal radius fractures	Surgical group showed superior functional outcomes with 45% excellent and 32.5% good results, compared to 30% and 15% in the conservative group. Surgical management led to better union rates, reduced pain and motion loss, and fewer complications such as malunion and osteodystrophy
(17)	Cross-sectional observational study	Ligamentotaxis using external fixation for comminuted intra-articular distal radius fractures	Among 60 patients, 84% had good to excellent outcomes based on Mayo Wrist Score. Mean difference in score between operated and normal side was 7.2, which was not statistically significant, suggesting ligamentotaxis is safe, effective, and functionally comparable to other treatments
(18)	Prospective case series	Open reduction and internal fixation (ORIF) with volar multi-axial locked plates in intra-articular distal radius fractures	Among 20 patients, at 6-month follow-up: 60% had excellent, 30% good, 5% fair, and 5% poor outcomes based on Modified Mayo Wrist Score. Mean DASH score improved from 20.5 (3 months) to 7.25 (6 months). Early range of motion was achieved in most patients within 2–3 weeks postoperatively

Management of Extra-articular Distal Radius Fractures

Extra-articular distal radius fractures are those in which the fracture line does not extend into the radiocarpal or distal radioulnar joint, thereby preserving the articular surfaces. These injuries are commonly seen in older adults with osteoporotic bones, often resulting from low-energy falls, such as slipping and landing on an outstretched hand. In younger patients, these fractures may result from higher-energy trauma. Although these injuries do not involve the joint surface, failure to properly manage alignment, stability, or soft tissue integrity can lead to long-term functional impairment (6).

Initial clinical evaluation includes a detailed history and physical examination, focusing

on the mechanism of injury, pain location, swelling, wrist deformity, skin condition, and neurovascular status. Radiographic assessment with standard posteroanterior and lateral wrist views is essential to evaluate the degree of displacement, angulation, comminution, and the integrity of the radiocarpal and distal radioulnar joints. Extra-articular fractures are classified as AO/OTA type A, with further subtypes depending on the presence of metaphyseal comminution or fracture orientation. Though less complex than intra-articular fractures, proper management is essential to avoid complications such as malunion, functional limitations, and secondary arthritis due to altered wrist biomechanics (19).

Non-operative management is the mainstay treatment for most stable, minimally

displaced extra-articular distal radius fractures, especially in older adults with low functional demands. Treatment involves closed reduction under hematoma block or conscious sedation, followed by immobilization in a short arm cast or splint, typically for 4 to 6 weeks. The cast should be moulded to maintain alignment in three radiographic planes: volar tilt (11°), radial inclination (22°), and radial height (~11 mm). Regular radiographic follow-up during the first 2–3 weeks is crucial to detect any secondary displacement, particularly in unstable patterns or osteoporotic bone (6).

Operative management is indicated for significant displacement, instability, open fractures and neurovascular deficit (20). Surgery is also indicated for fractures exhibiting unacceptable displacement or instability following closed reduction. Surgical indications include dorsal angulation greater than 10°, volar angulation greater than 15°, radial shortening greater than 3 mm, and loss of radial inclination, especially in active individuals (21). Open reduction and internal fixation (ORIF) with a volar locking plate is the preferred approach, even in extra-articular fractures, because it allows for accurate restoration of anatomy, early mobilization, and reliable fixation even in osteoporotic bone. In some cases, particularly with simple transverse fractures and minimal comminution, closed reduction with percutaneous K-wire fixation or external fixation may be appropriate, though less commonly used now due to the superior biomechanical stability offered by locking plates (20,22).

A meta-analysis comprising 109 studies and a total of 6,707 patients evaluated five primary treatment modalities for extra-articular distal radius fractures: plaster cast immobilization, K-wire fixation, volar plate fixation, external fixation, or intramedullary fixation. The overall complication rates varied significantly across treatment types, with plaster casting associated with the lowest rate (9%), and K-wire fixation the highest (18.5%). Volar plate fixation, while yielding superior radiographic and short-

term functional outcomes, was also linked to a higher incidence of carpal tunnel syndrome (3.5%) and tendon-related complications. Notably, K-wire fixation had the highest incidence of superficial infections (4.7%) and implant failure (6.1%). In terms of radiographic outcomes, volar plating consistently demonstrated superior results across multiple parameters, including volar tilt, radial inclination, radial height, and ulnar variance, particularly at follow-up beyond 12 months. Radiological redisplacement was most frequent in the plaster cast group (9.3%) compared to only 1.0% in the volar plate group, supporting the mechanical advantage of internal fixation methods for maintaining alignment. Functionally, early grip strength and range of motion favored operative interventions, especially volar plate and intramedullary fixation, both of which allowed faster return to near-normal pronation and grip strength within the first three months post-treatment. However, long-term outcomes—assessed by range of motion, DASH score, VAS for pain, and Gartland and Werley score—showed minimal differences between operative and non-operative groups, suggesting that the initial advantage of surgical treatment may diminish over time. Despite advancements in surgical techniques and the increasing popularity of volar plating, the authors concluded that no single treatment method demonstrated clear superiority in long-term functional outcomes or complication profiles. This supports the ongoing debate in orthopedic trauma regarding the optimal approach to managing extra-articular distal radius fractures and underscores the need for individualized treatment planning based on fracture characteristics, patient comorbidities, and functional demands (6). Rehabilitation plays a critical role in functional recovery following both conservative and operative treatment. After cast removal or surgical wound healing, early wrist mobilization is initiated to restore range of motion, prevent stiffness, and strengthen the forearm and hand musculature. Formal physical therapy may be needed in patients

with persistent stiffness or functional deficits. Most patients can resume light activities within 6–8 weeks and full function by 3–6 months, depending on age, bone healing, and adherence to rehabilitation protocols (23,24).

The nationwide survey conducted by Meijer et al. (2023) provided valuable insights into the current rehabilitation practices for distal radius fractures, with particular emphasis on the types of exercises prescribed, home-based exercise strategies, and support tools used by physiotherapists. Among the 92 respondents, joint mobilization (90.2%), grip strength training (73.9%), stretching (68.5%), and coordination exercises (65.2%) were the most commonly employed techniques during clinical sessions. Correspondingly, for home-based rehabilitation, active range of motion exercises (91.3%) and grip strength exercises (79.3%) were most frequently prescribed, followed by passive mobilization or stretching exercises (67.4%). Despite the diversity in exercise strategies, only a minority of therapists adhered to a standardized protocol; most developed individualized regimens based on patient needs. To support adherence and continuity of care at home, 40.2% of therapists provided informational leaflets, 25% used mobile applications, and 17.4% utilized visual aids such as photos or videos taken on the patient's smartphone. An additional 10.8% directed patients to online webpages, while 18.4% reported not using any support tools at all. These findings reveal a lack of standardization in exercise prescription and underscore the growing but underutilized role of technology in enhancing patient self-management and treatment adherence during rehabilitation (25).

Complications in extra-articular distal radius fractures, while generally less severe than

those in intra-articular types, still occur. Malunion is a frequent issue in conservatively treated fractures, particularly if radiographic monitoring is insufficient. Dorsal angulation and radial shortening can alter wrist kinematics, reduce grip strength, and increase the risk of ulnocarpal impaction or distal radioulnar joint dysfunction. Other complications include infection, stiffness, complex regional pain syndrome (CRPS), tendon irritation or rupture, and, in rare cases, nonunion—particularly in patients with poor bone quality or smoking history (11).

Seigerman et al. (2019) provided an extensive review of common complications associated with both operative and non-operative management of DRFs, emphasizing the importance of surgical technique, implant selection, and anatomical awareness. Among the most significant tendon-related complications were extensor pollicis longus (EPL) ruptures, which may occur even in non-displaced fractures treated conservatively. In surgical cases, extensor tendon irritation is more frequent with dorsal plating, although recent advances in low-profile plate designs have reduced such risks. Flexor tendon complications—particularly involving the flexor pollicis longus (FPL)—were often attributed to excessively distal placement of volar locking plates. Improper plate positioning, as classified by the Soong system, was strongly correlated with increased tendon irritation and rupture risk. Furthermore, intraoperative detection of dorsal screw prominence was emphasized as a preventive measure for extensor tendon injury. The review also highlighted nerve complications, particularly acute carpal tunnel syndrome from fracture-related swelling or surgical over-distraction, and stressed the need for prompt recognition and decompression (26).

Table 2. Management and Outcome of Extra-articular Distal Radius Fractures

Reference	Study Design	Management	Outcome
(6)	Systematic review and meta-analysis	Comparison of five treatment modalities for extra-articular distal radius fractures: plaster cast, K-wire fixation, volar plating,	From 109 studies (6,707 patients), volar plating had better short-term grip strength and radiographic outcomes. Plaster cast had the lowest complication rate (9%), K-wires the highest (18.5%). Volar plating had more

		external fixation, and intramedullary fixation	carpal tunnel syndrome (3.5%) but fewer redislocations (1%) compared to casting (9.3%). No method showed clear long-term superiority in functional outcomes
(27)	Literature review and comparative analysis	Plaster immobilization vs. percutaneous K-wire pinning in extra-articular distal radius fractures	Literature analysis of 11 studies showed that percutaneous pinning resulted in better functional and radiological outcomes, with improved range of motion and less stiffness compared to plaster immobilization
(28)	Retrospective observational study	Conservative vs. surgical (plate osteosynthesis, ligamentotaxis, K-wire with Kapandji method) for extra-articular and partial articular distal radius fractures	Among 92 patients, there was no significant difference in overall functional outcomes between conservative and surgical groups. However, better anatomical reduction (dorsal angulation <10°, radial inclination <9°, loss of radial height <6 mm) was significantly associated with improved functional outcomes (P < 0.001)
(29)	Case series (n=144)	Mini-invasive anterior approach (15–16 mm incision), volar plate fixation under regional anesthesia for extra-articular (Type A) and intra-articular (Type C) DRFs	Mean follow-up 4.1 months; QuickDASH avg. 25; ROM >85% of contralateral; 9 cases CRPS I, 2 secondary displacements, 9 tenosynovitis cases, no tendon ruptures; anatomical alignment maintained radiographically

CONCLUSION

Management of distal radius fractures must be individualized based on fracture pattern, patient-specific factors, and surgeon expertise. Intra-articular fractures demand precise reduction and fixation to preserve joint congruity and function, while extra-articular fractures often allow for conservative treatment with favorable outcomes. Future research should focus on long-term functional comparisons and cost-effectiveness of surgical interventions for both fracture types.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

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

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How to cite this article: Kenny Yulian, Stedi Adnyana Christian. Intra-Articular versus extra-articular distal radius fractures: management strategies and outcomes. *International Journal of Research and Review.* 2025; 12(6): 311-319. DOI: <https://doi.org/10.52403/ijrr.20250637>
