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The preferability of internal fixation in comparison to external fixation in geriatric patients after distal radial fracture in terms of functional and clinical outcomes – a systematic review

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Abstract
Background: Distal radial fractures (DRFs) are common in the elderly, particularly among those over 65, due to factors such as osteoporosis, falls, and comorbidities. Treatment options, including external fixation (ExFix) and internal fixation (IF) with volar locking plates (VLPs), offer different benefits and drawbacks, making the optimal approach for elderly patients a topic of ongoing debate.
Objective: This systematic review aims to evaluate the effectiveness and safety of different treatment modalities for DRFs in elderly patients, focusing on functional outcomes, radiographic parameters, and complication rates.
Methods: A comprehensive search was conducted on PubMed, focusing on studies comparing ExFix and IF in elderly patients. Studies were screened based on predefined inclusion criteria, and data on functional outcomes, radiographic alignment, and complications were extracted and analyzed.

Results: Two studies met the inclusion criteria. Huang et al. demonstrated that VLPs offered better functional outcomes, with improved supination and fewer complications, compared to ExFix. In contrast, the systematic review by Diaz-Garcia et al. suggested that while VLPs generally provided good outcomes, Non-Bridging External Fixation (Non-BrEF) showed superior grip strength in some analyses. Radiographic outcomes varied, with VLPs typically providing better volar tilt and radial inclination, though the clinical significance of these differences remains uncertain. Complication rates were lower with VLPs in Huang et al.'s study, but Diaz-Garcia et al. noted a higher incidence of major complications requiring surgery with VLPs.

Conclusion: The findings suggest that VLPs may offer superior functional outcomes and lower complication rates compared to ExFix in elderly patients with DRFs. However, variations in grip strength and radiographic outcomes across studies highlight the need for individualized treatment decisions. Further research is needed to clarify the clinical significance of these differences and optimize treatment strategies for this vulnerable population.

Introduction

Adults over the age of 50 are among the two most common age groups for distal radial fractures (DRFs), the other being children under the age of 18.[1] The peak amongst this older age group occurs most typically in caucasian women over 65 years old.[2] In patients over 65, DRFs are the second most common cause of fracture, and roughly 50% of all DRFs occur in this cohort of patients.[3] Elderly patients are often burdened with numerous comorbidities, including fragility, prior falls, prior fractures, corticosteroid use, dementia, and diabetes, all of which increase the risk of DRF.[2] Moreover, women in this age group with diabetes are more than twice as likely to suffer a fracture extending into the joint space.[4] Intra-articular fractures are often more difficult to treat using conservative methods.[5] Over 80% of DRFs in elderly patients are related to falls, such as falls from standing heights onto an outstretched hand.[6] Currently, casting is often recommended over surgical intervention, due to the fact that in comparisons between the two interventions, similar long-term outcomes were achieved with lower risks found in casting.[7] In the short-term, however, surgical interventions such as volar locking plates (VLPs) allow for a faster return to activity and better patient-reported outcomes during recovery.[8] DRFs accounts for 18% of fractures in the elderly population who maintain an active lifestyle.[9] Given the fact that the proportion of geriatric patients remaining active into their old age is increasing, an approach to treatment optimizing return to functionality may be warranted.[10]

This systematic review aims to explore and evaluate the effectiveness and safety of different treatment modalities for DRF in elderly patients. By examining the available evidence, this review seeks to provide insights into optimizing treatment strategies to improve outcomes for this vulnerable population.

Indications for and benefits of external fixation

External fixation is particularly indicated in cases of severe soft tissue injury or open fractures where internal fixation may increase the risk of wound complications and infection. By minimizing soft tissue dissection, external fixation can provide temporary stabilization while allowing for soft tissue healing and subsequent definitive management.[11]

In patients with polytrauma or concomitant injuries, external fixation offers a rapid and minimally invasive method of stabilizing distal radial fractures. Historically this has been the method of choice, as methods of fixation in such patients can be limited. This approach can facilitate early mobilization and rehabilitation while addressing more critical injuries in a timely manner.[12]

Geriatric patients with osteoporosis or poor bone quality may benefit from external fixation due to the challenges associated with achieving adequate fixation with internal devices. External fixation provides an alternative method of stabilizing fractures in osteoporotic bone, reducing the risk of fixation failure and secondary displacement. Moreover, external fixation causes less disruption to the blood supply, periosteum, as well as to soft tissue.[13] In patients suffering from compromised skin quality with a decreased capacity to heal, including patients suffering from comorbidities such as rheumatoid disease, peripheral vascular disease, or diabetes, this additional attribute of external fixation can be of significant clinical importance.[13] Patients suffering from recurring osteomyelitis may likewise benefit more from external fixation over internal fixation, as the introduction of more permanent implants can make the eradication of infection more difficult.[13]

External fixation is indicated in cases of highly comminuted or unstable distal radial fractures where internal fixation may be technically challenging.[13] External fixation carries the attribute of being able to stabilize bone from multiple planes, and for stabilization to be adjusted externally during the recovery process.[13] By providing external stability, this approach allows for indirect reduction of fracture fragments and preservation of soft tissue vascularity.[13]

These attributes of external fixation may potentially represent a significant benefit to geriatric patients, who are more likely to suffer from comorbidities that hinder the healing process, and to suffer from more complex, difficult fractures as a result of their age and clinical history.

Drawbacks of external fixation

Complications of external fixation may include pin site infection, transient neuropathies, early sympathetic dystrophy, malunion, and loss of motion.[14] The incidence of pin site infection has a wide range of estimates, from 9% to 100%.[15] Patients may likewise experience both mental and physical discomfort at increased rates postoperatively when compared to patients treated with internal fixation.[16]

With external fixation, patients are forced to endure living with an injured, immobilized limb with the additional discomfort of protruding screws and wires. This, coupled with the regular care and maintenance needed to prevent and/or treat infection, make it understandable that to some, postoperatively, this treatment methodology might pose itself a source of both physical and psychological distress.

Types of external fixation

Uniplanar external fixators consist of pins or wires inserted into the bone and connected to external rods or bars. These devices provide stability in a single plane and are often used for simple or minimally displaced distal radial fractures.[17]

Circular external fixators consist of rings connected by threaded rods, allowing for multiplanar stabilization and adjustable fixation points. These devices offer greater versatility and control over fracture reduction compared to uniplanar fixators.[13,17]

Hybrid external fixation combines elements of both uniplanar and circular fixators, allowing for customized fixation strategies based on fracture characteristics and patient factors. This approach may involve the use of both pins and rings to achieve optimal stability and alignment.[17]

The choice of external fixation device depends on various factors, including fracture severity, patient comorbidity, and surgeon preference. Uniplanar external fixation is suitable for simple fractures with minimal soft tissue injury, while circular and hybrid fixators are preferred for complex or highly comminuted fractures requiring multiplanar stabilization.

Techniques for external fixation involve careful preoperative planning, precise pin or wire placement, and postoperative monitoring for complications such as pin tract infections or loss of reduction. Close collaboration between orthopedic surgeons, radiologists, and rehabilitation specialists is essential to optimize outcomes and minimize complications.

Indications for and benefits of internal fixation

Internal fixation allows for precise anatomical reduction of fracture fragments and rigid stabilization, minimizing the risk of malunion or nonunion. By maintaining alignment and stability at the fracture site, internal fixation promotes optimal healing and facilitates early mobilization.[18]

Internal fixation enables early mobilization and rehabilitation, leading to quicker restoration of function and return to activities of daily living. The rigid fixation provided by internal implants allows patients to engage in range of motion exercises and functional activities sooner, promoting muscle strength and joint flexibility.[19]

Internal fixation techniques have been shown to result in lower complication rates compared to external fixation methods.[20] By minimizing soft tissue disruption and reducing the risk of pin tract infections or hardware prominence, internal fixation contributes to improved patient comfort and satisfaction. Moreover, patients often prefer internal fixation due to improved comfort, a quicker return to functionality, a desire for better pain management, and due to its better aesthetic qualities.[21]

Types of internal fixation

Volar locking plates are commonly used for the management of distal radial fractures, particularly those with dorsal displacement or comminution. These plates are placed on the volar aspect of the radius and secured with locking screws, providing stable fixation and allowing early mobilization.[22]

Dorsal locking plates are utilized for fractures with volar displacement or dorsal comminution. These plates are placed on the dorsal aspect of the radius and offer rigid stabilization, particularly in cases where traditional volar plating may be challenging.[23]

Intramedullary fixation involves the placement of a nail or screw within the medullary canal of the radius, providing stable fixation while preserving the periosteal blood supply.[24]

Drawbacks of internal fixation

Internal fixation procedures often involve significant soft tissue dissection to access the fracture site and place implants. This disruption of the soft tissue envelope can lead to complications such as wound healing delays, infection, and tendon irritation.[25,26]

Internal fixation implants, such as plates, screws, and intramedullary devices, can cause hardware-related complications, including loosening, breakage, and irritation. These complications may necessitate revision surgery and can impact patient satisfaction and long-term outcomes.

Despite meticulous reduction and fixation, distal radial fractures treated with internal fixation may still result in nonunion or malunion, leading to functional impairment and pain.[25,26] Factors such as poor bone quality, inadequate reduction, and delayed healing can contribute to these outcomes.

Anatomy of the distal radius

The distal radius is a complex structure that forms the majority of the wrist joint. It consists of several key anatomical features. The distal end of the radius articulates with the carpal bones of the wrist, forming the radiocarpal joint. The articular surface is divided into the distal ulnar (ulnar notch) and distal radial (lunate fossa) facets, which accommodate the ulna and lunate bone, respectively.[27]

The ulnar styloid process is a bony prominence located on the medial aspect of the distal radius. It serves as an attachment site for ligaments that stabilize the wrist joint, including the triangular fibrocartilage complex (TFCC).[27]

The radial styloid process is a bony prominence located on the lateral aspect of the distal radius. It serves as an attachment site for ligaments and provides stability to the wrist joint.[27]

The distal metaphysis of the radius refers to the region just above the articular surface. Fractures in this area often involve intra-articular displacement and can impact joint function.[27]

The dorsal and volar cortices of the distal radius provide structural support and stability to the wrist joint. Fractures may occur through these cortices, resulting in dorsal or volar displacement of fracture fragments.[27]

Mechanisms of injury to the distal radius

Distal radial fractures typically result from a fall onto an outstretched hand, with the wrist in extension or flexion. The force of impact can cause the distal radius to fracture in various patterns, depending on the direction and magnitude of the force.[5]

Colles' fractures are the most common type of distal radial fracture and typically involve dorsal displacement of the distal fragment. This injury pattern is often seen in falls onto the palm with the wrist extended.[28]

Smith's fractures, also known as reverse Colles' fractures, involve volar displacement of the distal fragment. This injury pattern is less common and typically occurs with falls onto the dorsum of the hand with the wrist flexed.[29]

Intra-articular fractures involve disruption of the articular surface of the distal radius and may result in incongruity of the wrist joint. These fractures often require careful reduction and stabilization to restore joint function, and are more common in younger patients with high-energy falls.[5]

Methodology

We searched PubMed using the search key "(((geriatric) AND (distal radial fracture)) AND (external fixation)) AND (internal fixation)," with no constraints placed on date of publication. Only articles written in English were to be admitted. Only retrospective studies, randomized control trials, and systematic reviews with or without meta-analysis were to be included. At all stages of the screening process, articles were analyzed by two separate authors who independently decided on each article's inclusion or exclusion based on previously agreed upon criteria. After each individual process, the two would convene to share their results, and make a decision about the final inclusion or exclusion of an article. Any disagreements between the two authors were mediated by a third author, and then final decisions regarding the inclusion or exclusion of studies were made via consensus.

First abstracts were screened by two separate authors for relevance. Studies were deemed sufficiently relevant at this stage if they primarily focused on distal radial fractures and their surgical treatments. After the first stage of qualification, abstracts were screened for relevance. At this stage, studies were included if they mentioned elderly patients, as defined as those above the chronological age of 60. Finally, articles were analyzed, and included if they did in fact contain data on the surgical treatment, meaning both internal and external fixation, of distal radial fractures in patients over 60.

Results

The initial search yielded 7 articles. After examining abstracts, 2 were excluded, and 5 remained. After the examination of the articles themselves, only two met all the inclusion criteria, while 3 were excluded.

Huang et al. restrospectively analyzed patients above the age of 80 with dorsally displaced distal radial fractures treated with external fixation or open reduction and internal fixation with volar locking plates. Patients with open fractures, concomitant injuries, and those needing extra procedures were excluded. Of the 74 patients who met these criteria, two were lost to follow up and 3 passed away during the follow up period. 69 patients were therefore included in the final analysis for this study.

The patients were followed up 2 weeks, 6 weeks, 3 months, 6 months, 1 year, and 2 years postoperatively. At final follow-up, patients in the internal fixation group were found to have better range-of motion than the external fixation group, with a significant difference in supination (74.7 ± 6.6 ° EF vs 80 ± 7.2 ° VLP, $p = 0.002$).

Significantly fewer complications were recorded in the volar plate group. 22 patients with external fixators presented with one or more complications, while only 5 patients in the internal fixation group experienced complications. 11 patients in the external fixator group experienced a pin site infection, while only one patient in the internal fixator group experienced an infection at the surgical site. 6 patients in the external group and 2 patients in the internal group experienced wrist stiffness requiring prolonged treatment. 5 patients in the external group and 2 patients in the internal group had tendonitis. One patient from each group experienced neuropathy. In the external group, 2 patients experienced regional pain syndrome and 2 patients experienced pin tract loosening.[30]

Diaz-Garcia et al published a systematic review, wherein the authors conducted a comprehensive search of English-language literature published between January 1980 and July 2009 using databases like MEDLINE, Embase, and CINAHL Plus. They used specific MeSH (Medical Subject Headings) terms related to distal radius fractures and various treatment methods to identify relevant studies. The studies were selected based on predetermined criteria. Inclusion criteria required studies to involve human subjects, be published in English, include patients with a mean age of 60 or older, and provide data on at least one of the specified treatment methods (e.g., volar locking plate system, external fixation, percutaneous Kirschner wire fixation, or cast immobilization). Studies also needed to report on functional outcomes, radiographic parameters, or complications. Studies were excluded if they involved fewer than 10 patients, lacked follow-up data, did not report complications, or involved non-standard treatments or fractures associated with other severe injuries. Their initial search identified 2,039 citations, which were narrowed down to 21 articles that met all inclusion criteria, which included 1025 patients total. The authors also conducted a secondary literature search using MeSH terms "fracture fixation OR orthopedic fixation devices" and reviewed titles and abstracts based on pre-established criteria. They also manually checked the references of the retrieved articles to find any relevant sources missed in the original search. This secondary search included 8 articles covering 12 patient groups. Among these, 3 were level I randomized controlled trials, 1 was a level II prospective cohort study, and the remaining 4 were case series.[31]

The study found that the range of wrist flexion-extension motion at final follow-up was similar across most treatment methods, with the Volar Locking Plate System (VLPS) and Non-Bridging External Fixation (Non-BrEF) both showing a mean arc of 118°, Bridging External Fixation (BrEF) showing 116°, and Percutaneous K-wire Fixation (PKF) showing 112°. Cast Immobilization (CI) had the highest mean arc of 130°. However, these differences were not statistically significant ($P = .68$).

For forearm rotation, the mean arc was highest for Cast Immobilization (CI) at 175°, followed by the Volar Locking Plate System (VLPS) and Non-Bridging External Fixation (Non-BrEF) at 168°, Bridging External Fixation (BrEF) at 153°, and Percutaneous K-wire Fixation (PKF) at 140°. Again, these variations were not statistically significant ($P = .15$). Overall, the data suggest that while Cast Immobilization (CI) provided the highest range of motion, the differences in outcomes across the various treatment methods were not significant.[31]

The study assessed grip strength at final follow-up by comparing it to the uninjured side. In the primary literature review, Cast Immobilization (CI) had the highest mean grip strength at 85%, followed closely by Bridging External Fixation (BrEF) at 84%. The Volar Locking Plate System (VLPS) showed a grip strength of 81%, Percutaneous K-wire Fixation (PKF) had 74%, and Non-Bridging External Fixation (Non-BrEF) had the lowest grip strength at 69%. However, these differences in grip strength between the treatment methods were not statistically significant, with a P value of .707.[31]

In contrast, the secondary literature review revealed that Non-BrEF showed a higher mean grip strength of 83%, BrEF remained at 84%, while VLPS had a lower grip strength of 76%. In this review, the differences were statistically significant, with a P value of .001, indicating that some treatment methods might result in better grip strength outcomes than others.[31]

The study also reported results on radiographic findings. For **volar tilt** in the primary literature review, the mean values were 3.9° for VLPS (n=235), 6.5° for Non-BrEF (n=81), -0.8° for BrEF (n=169), 3.7° for PKF (n=52), and -11° for CI (n=220), with a p-value of .018. In the secondary literature review, the means were 3.1° for VLPS (n=94), 0.3° for Non-BrEF (n=35), 0.5° for BrEF (n=49), and -11° for CI (n=168), with a p-value of .001.[31]

For **radial inclination**, the primary literature review showed mean values of 13.4° for VLPS (n=149), 13.7° for Non-BrEF (n=53), 13.9° for BrEF (n=113), 21° for PKF (n=52), and 14.8° for CI (n=137), with a p-value of .182. The secondary literature review presented means of 22.8° for VLPS (n=94), 19.5° for Non-BrEF (n=35), 21° for BrEF (n=49), and 18.0° for CI (n=168), with a p-value of .001.[31]

For **ulnar variance**, the primary literature review revealed means of 1.5 mm for VLPS (n=53), 1.0 mm for Non-BrEF (n=53), 1.1 mm for BrEF (n=81), 3.0 mm for PKF (n=27), and 3.6 mm for CI (n=143), with a p-value of .001. In the secondary literature review, the means were 1.5 mm for VLPS (n=53), 2.4 mm for Non-BrEF (n=35), 3.0 mm for BrEF (n=49), and 3.6 mm for CI (n=143), with a p-value of .001.[31]

The study reported notably different complication rates among interventions. For **minor complications**, the VLPS group had a total of 2 cases (1%), Non-BrEF had 25 cases (31%), BrEF had 39 cases (16%), PKF had 11 cases (8%), and CI had none. The overall p-value for minor complications was .001, indicating significant variation between the groups. In terms of **major complications not requiring surgery**, VLPS experienced 18 cases (6%), Non-BrEF had only 1 case (1%), BrEF had 34 cases (14%), PKF had 9 cases (7%), and CI had 15 cases (7%). The p-value for this category was .001, showing a significant difference among the groups. For **major complications requiring surgery**, VLPS reported 32 cases (11%), Non-BrEF had 2 cases (3%), BrEF had 5 cases (2%), PKF had 3 cases (2%), and CI had 3 cases (1%). The p-value for major complications requiring surgery was .001, indicating significant differences across the groups.[31]

Discussion

This systematic review aimed to compare the efficacy and safety of different treatment methods for distal radial fractures in elderly patients, focusing on outcomes like range of motion, grip strength, radiographic alignment, and complication rates. The review included two studies, Huang et al. and Diaz-Garcia et al., which provided valuable but varied insights into these treatment modalities.

The findings from Huang et al. suggest that open reduction and internal fixation (ORIF) with volar locking plates (VLPs) may offer better functional outcomes and a lower rate of complications compared to external fixation. Specifically, patients treated with VLPs showed a significantly greater range of supination and fewer complications, including lower rates of infection, wrist stiffness, and tendonitis. These results align with the conclusions of other studies that emphasize the advantages of VLPs, particularly in terms of allowing early mobilization and reducing complication risks.[18]

In contrast, the systematic review by Diaz-Garcia et al. provided a broader perspective, analyzing multiple treatment methods, including VLPs, external fixation, percutaneous Kirschner wire fixation (PKF), and cast immobilization (CI). This review found that while there were some differences in range of motion and grip strength between these methods, most were not statistically significant. However, the secondary analysis within this review highlighted that Non-Bridging External Fixation (Non-BrEF) showed significantly higher grip strength compared to VLPs and other methods, which contrasts with Huang et al.'s findings that favor VLPs for functional outcomes.

Radiographic outcomes, such as volar tilt, radial inclination, and ulnar variance, showed some variability between the studies included in Diaz-Garcia et al.'s review. VLPs generally provided satisfactory radiographic results, though Non-BrEF and other methods occasionally showed superior outcomes in specific parameters. Despite these variations, the overall clinical significance of these radiographic differences remains unclear, as they did not consistently translate into better functional outcomes.

Complication rates varied significantly across the different treatment methods. Huang et al. reported notably fewer complications in the VLP group compared to the external fixation group, reinforcing the idea that internal fixation may be a safer option for elderly patients. Diaz-Garcia et al. also noted significant differences in complication rates, with VLPs associated with lower rates of minor complications but higher rates of major complications requiring surgery. This finding suggests that while VLPs may reduce some risks, they are not without their own set of challenges, particularly in the context of more severe complications.

Limitations and Implications for Clinical Practice

This review is limited by the small number of studies that met the inclusion criteria, with only two studies ultimately being included. The heterogeneity of the patient populations, treatment protocols, and outcome measures further complicates direct comparisons between the studies. Additionally, the methodology and the exclusion of certain patient groups (e.g., those with open fractures or concomitant injuries) limit the generalizability of the findings.

Despite these limitations, the review provides important insights into the management of dorsally displaced distal radial fractures in elderly patients. The findings suggest that ORIF with VLPs may offer advantages in terms of functional outcomes and complication rates, particularly when compared to external fixation. However, the variability in outcomes across different studies underscores the need for individualized treatment planning, taking into account patient-specific factors such as bone quality, comorbidities, and functional demands.

Future research should focus on larger, prospective studies that compare these treatment methods in more diverse patient populations. Additionally, further investigation into the long-term outcomes, particularly regarding quality of life and functional independence, will be crucial in guiding clinical decision-making for this growing patient demographic.

Conclusion

This systematic review highlights the complexity and variability in treating distal radial fractures (DRFs) in elderly patients. The comparison between internal fixation with volar locking plates (VLPs) and external fixation reveals both benefits and drawbacks associated with each method. VLPs are associated with better functional outcomes, including improved range of motion and lower complication rates, particularly regarding infection and wrist stiffness, as demonstrated in Huang et al.'s study. However, findings from Diaz-Garcia et al.'s broader review suggest that while VLPs generally offer satisfactory radiographic outcomes, they may not always result in superior grip strength or reduced major complications when compared to other treatment methods like Non-Bridging External Fixation (Non-BrEF).

The significant variability in outcomes underscores the need for a tailored approach to treatment, considering patient-specific factors such as bone quality, fracture severity, and comorbidities. While internal fixation with VLPs may be advantageous for achieving early mobilization and reducing certain risks, external fixation remains a viable option, particularly in cases involving severe soft tissue injury or poor bone quality.

Given the limited number of high-quality studies and the heterogeneity of the patient populations studied, further research is needed to refine the criteria for selecting the most appropriate treatment for elderly patients with DRFs. Future studies should aim to provide more robust data on long-term functional outcomes, complication rates, and patient quality of life, enabling clinicians to make more informed decisions in managing this increasingly common injury.

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