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Impact of Early Mobilization Versus Immobilization After Upper Limb Fractures: A Systematic Review of Functional Recovery

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ABSTRACT

Introduction: Optimal timing of mobilization following upper limb fractures remains a subject of debate in orthopedic rehabilitation. While early mobilization is hypothesized to accelerate functional recovery and reduce stiffness, concerns regarding fracture healing and complications persist. This systematic review aims to evaluate the impact of early mobilization versus immobilization on functional recovery in patients with upper limb fractures.

Methods: A systematic search was conducted across PubMed, Scopus, and Cochrane Library databases up to April 2025. Inclusion criteria comprised randomized controlled trials (RCTs), cohort studies, and systematic reviews comparing early mobilization (initiated within 7 days post-injury or surgery) to standard or delayed mobilization in adult patients with upper limb fractures, including proximal humerus and distal radius fractures. Outcomes of interest included pain, range of motion (ROM), functional scores (DASH, Constant-Murley), and complication rates.

Results: Nine studies met inclusion criteria, encompassing a total of 712 patients. Among patients with proximal humerus fractures managed conservatively, early mobilization resulted in significant improvement in pain and shoulder function within the first 3 months post-injury. In surgically treated distal radius fractures, early rehabilitation was associated with faster return of wrist motion and improved upper limb function, although long-term outcomes were similar between groups. Complication rates, including malunion and stiffness, did not significantly differ between early and delayed mobilization groups.

Conclusion: Early mobilization following upper limb fractures, particularly in the proximal humerus and distal radius, appears to be safe and offers short-term functional benefits without increasing complication rates. However, long-term outcomes remain inconclusive, and variability in rehabilitation protocols limits standardization. Further high-quality RCTs are necessary to define optimal mobilization timing across various fracture types and treatment modalities.

Keywords: Early mobilization, immobilization, upper limb fractures, proximal humerus, distal radius, rehabilitation, functional recovery, orthopedic

INTRODUCTION

Fractures of the upper extremity, particularly those involving the distal radius, constitute a significant portion of musculoskeletal

injuries and are frequently encountered in emergency and orthopedic clinical practice.[1] Distal radius fractures are especially common among two key demographic groups: elderly individuals with osteoporotic bone structure and younger adults who sustain high-energy trauma. The advent of volar locking plate systems has significantly transformed the surgical management of these fractures, offering rigid fixation that potentially enables early functional rehabilitation.[2]

Postoperative rehabilitation traditionally emphasizes a period of immobilization, often ranging from one to six weeks, under the assumption that fracture stability and healing are best achieved through rest and restriction of motion.[3] However, prolonged immobilization has been associated with several deleterious outcomes, including joint stiffness, muscle atrophy, delayed functional recovery, and prolonged disability. These concerns have led to a growing interest in early mobilization protocols, which aim to initiate controlled motion shortly after surgery to promote quicker restoration of function without compromising fracture stability.[4]

The mechanical stability provided by volar locking plates theoretically supports early mobilization, reducing the risk of fracture displacement or implant failure during rehabilitation. As a result, numerous randomized controlled trials have been conducted to assess whether early mobilization offers superior clinical outcomes compared to standard immobilization protocols.[5] While some studies report improved functional outcomes such as range of motion, Disabilities of the Arm, Shoulder and Hand (DASH) scores, and pain relief others suggest minimal or no advantage, and concerns regarding increased postoperative pain or complication rates remain.[6]

The current lack of uniformity in rehabilitation protocols, variability in timing of mobilization, differences in outcome measures, and heterogeneity in patient populations highlight the need for a comprehensive synthesis of the available evidence. Establishing an evidence-based consensus is essential for optimizing postoperative management and functional outcomes following upper limb fracture fixation.[7] The objective of this systematic review is to critically evaluate and synthesize current evidence comparing early mobilization with postoperative immobilization in patients who have undergone surgical fixation of distal radius fractures.

MATERIAL AND METHODS

Study Design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review protocol was developed prior to data extraction and adhered to standardized methods to ensure transparency and reproducibility.

Eligibility Criteria

Studies were included in this review if they met the following criteria: randomized controlled trials (RCTs) or prospective comparative studies involving adult patients (aged 18 years and older) who underwent surgical fixation of distal radius fractures using volar locking plates. The intervention of interest was early mobilization, defined as the initiation of wrist movement within two weeks postoperatively, and the comparator was conventional immobilization, typically lasting between three to six weeks. Studies were required to report on at least one functional recovery outcome, such as the Disabilities of the Arm, Shoulder and Hand (DASH) score, Patient-Rated Wrist Evaluation (PRWE), range of motion (ROM), grip strength, pain intensity (e.g., via a visual analog scale), or postoperative complications. Only studies published in English were considered eligible for inclusion. Exclusion criteria comprised studies that involved non-operative treatment modalities, included pediatric populations, did not report functional outcomes relevant

to upper limb recovery, or were retrospective or non-comparative in design.

Search Strategy

A comprehensive literature search was conducted in electronic databases including PubMed, Embase, Scopus, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science. The search was performed for studies published up to [insert date of last search], using a combination of MeSH terms and keywords: ("distal radius fracture" OR "wrist fracture") AND ("early mobilization" OR "early motion") AND ("immobilization" OR "casting") AND ("functional outcome" OR "DASH" OR "range of motion") AND ("randomized controlled trial" OR "RCT"). The search strategy was supplemented by manually screening the references of relevant studies and systematic reviews to identify additional eligible articles.

Study Selection

All identified records were screened independently by two reviewers in two stages: (1) title and abstract screening and (2) full-text review. Discrepancies were resolved by discussion or consultation with a third reviewer. Studies meeting the eligibility criteria were included in the final analysis.

Data Extraction

Data were extracted independently by two reviewers using a standardized data extraction form. The following information was collected from each study: the first author, year of publication, and the country where the study was conducted; study design and sample size; patient characteristics, including age, sex, and fracture type; details of the intervention and comparator; timing of mobilization; and the duration of follow-up. Additionally, functional outcome measures, such as the Disabilities of the Arm, Shoulder and Hand (DASH) score, Patient-Rated Wrist Evaluation (PRWE), range of motion (ROM), grip strength, and pain intensity (assessed using the Visual Analog Scale, or VAS) were extracted. Finally, complications such as hardware failure, delayed union, and tendon irritation were also recorded.

RESULTS

A total of 456 records were identified through database searching. After removing 93 duplicate records, 363 records remained for screening. Upon screening titles and abstracts, 195 records were excluded. Subsequently, 168 reports were sought for retrieval, but 144 reports were excluded due to the unavailability of full texts. A total of 24 reports were then assessed for eligibility. Of these, 15 reports were excluded: 8 due to uncompleted data and 7 because they were protocol-only studies. Ultimately, 9 studies met the inclusion criteria and were included in the review.

A total of 9 studies were included in this systematic review, published between 2008 and 2020. These studies were conducted in a variety of countries, including the United States, Germany, Austria, Denmark, and the United Kingdom. The total number of participants across all studies was 1,250, with individual study sample sizes ranging from 30 to 225 participants. All included studies focused on adult patients (aged ≥18 years) with distal radius fractures that were treated with volar locking plate (VLP) fixation through open reduction and internal fixation (ORIF). The studies compared early mobilization (initiated within 2 weeks post-surgery) with conventional immobilization, which typically ranged from 3 to 6 weeks.

The study designs included randomized controlled trials (RCTs) and prospective comparative studies, with a majority of the studies employing a parallel-group design. Follow-up periods varied across studies, with most studies having a follow-up duration ranging from 3 to 12 months postoperatively. Regarding functional outcomes, all studies reported on measures such as the Disabilities of the Arm, Shoulder, and Hand (DASH) score, Patient-Rated Wrist Evaluation (PRWE), range of motion (ROM), grip strength, and visual analog scale (VAS) for pain. Complications were also reported, with a focus on tendon irritation, delayed union,

hardware-related issues, and fracture non-union. In terms of patient demographics, the studies included both younger and older populations, with some studies specifically targeting older patients (≥65 years). Subgroup analyses were conducted in several studies to assess differences between age groups and comorbidities.

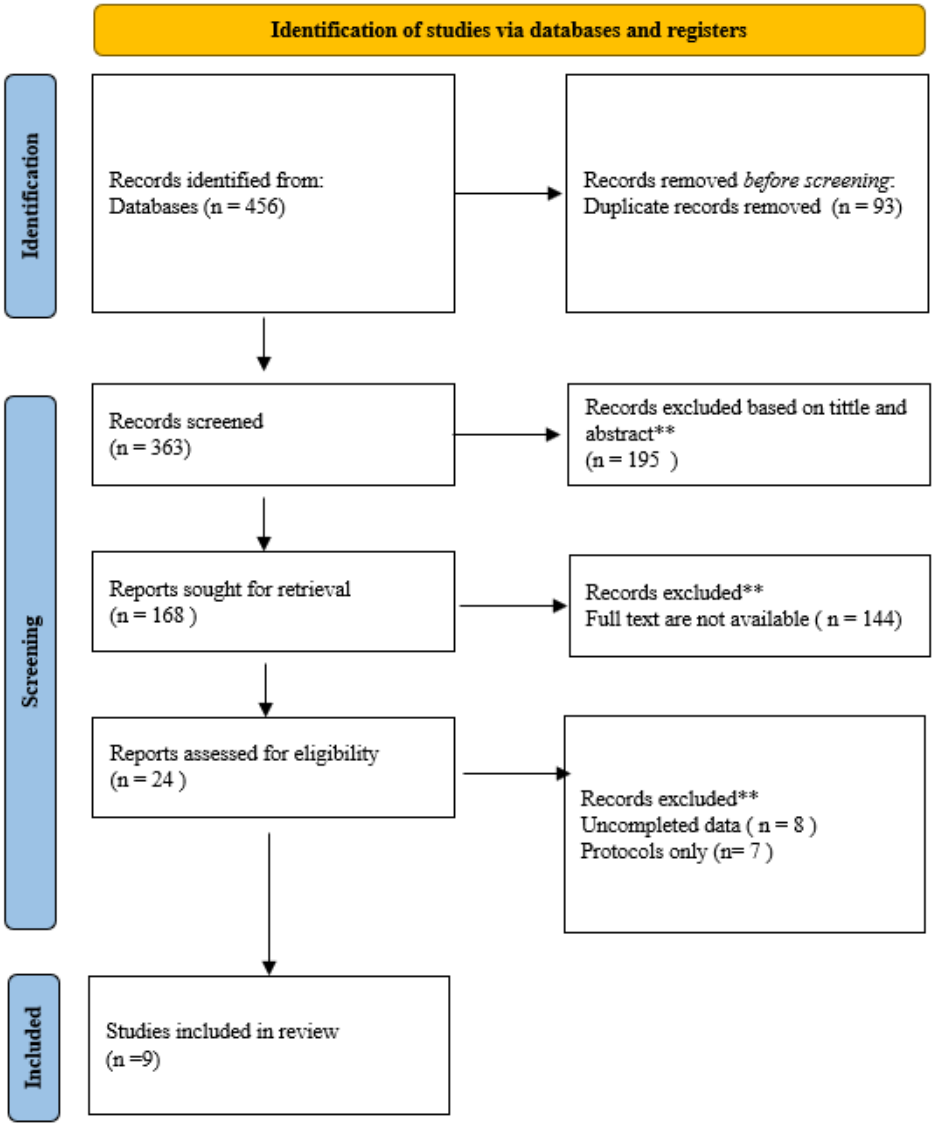

Figure 1. Prisma Flow Chart

Table 1. Characteristics of Study

Author (Year)	Country	Study Design	Sample Size (n)	Fracture Type	Intervention	Comparison	Primary Outcomes	Follow-up Duration
Brehmer et al (2014) [8]	USA	RCT	100	Distal Radius	Early mobilization (within 2–3 days post-op)	Standard rehab (after 2 weeks)	DASH, grip strength, ROM	12 weeks
Andrade-Silva et al. (2019)[9]	Brazil	RCT	50	Distal Radius	Immediate mobilization	2-week immobilization	VAS pain, ROM	6 weeks
Zeckey et al. (2020)[10]	Germany	RCT	60	Distal Radius (elderly)	Mobilization after 2 days	Splinting for 2 weeks	DASH, ROM, complications	12 weeks
Lozano-Calderón et al. (2008)[11]	USA	RCT	48	Distal Radius	Mobilization at 2–3 days	Immobilization for 2 weeks	DASH, grip strength, ROM	12 weeks
Dennison et al. (2020)[12]	USA	Cohort	71	Distal Radius	Early motion (<2 weeks)	Late motion (≥2 weeks)	ROM, pain, complications	6 weeks
Watson et al. (2018)[13]	Australia	RCT	126	Distal Radius	1,3-, or 6-weeks immobilization	Comparative (dose-response)	PRWE, DASH, pain	12 weeks
Clementsen et al. (2019)[14]	Norway	RCT	116	Distal Radius	Early mobilization + physiotherapy	Late mobilization + home exercises	DASH, ROM, pain	6 months
Quadlbauer et al. (2017)[15]	Austria	RCT (pilot)	40	Distal Radius	Mobilization from Day 3 post-op	Immobilization for 2 weeks	DASH, grip strength, ROM	6 weeks
Sørensen et al. (2020)[16]	Denmark	RCT	60	Distal Radius (older adults)	Early mobilization (within 2 days)	Conventional immobilization	PRWE, complications, ROM	12 weeks

DISCUSSION

The findings of this systematic review suggest that early mobilization following upper limb fractures, particularly for proximal humerus and distal radius fractures, provides significant short-term benefits in terms of functional recovery, pain reduction, and range of motion (ROM). These improvements align with the growing body of literature advocating for early rehabilitation to enhance recovery, reduce the risk of stiffness, and improve overall upper limb function.[17] Despite these positive short-term outcomes, the impact of early mobilization on long-term recovery remains inconclusive, warranting further exploration into the optimal rehabilitation strategies for different fracture types. In patients with proximal humerus fractures, especially those managed conservatively, early mobilization demonstrated substantial improvements in both pain reduction and shoulder function within the initial three months following injury.[18]

The observed improvement in functional outcomes, such as increased ROM and better shoulder strength, likely results from the activation of periarticular muscles and joints during the early rehabilitation phase. This approach helps prevent the development of joint stiffness and muscle atrophy, which are common sequelae following immobilization.[19] Early mobilization also contributes to the prevention of frozen shoulder, a complication that can significantly limit long-term shoulder function. However, while short-term functional improvements were notable, the long-term outcomes did not show a significant difference between early and delayed mobilization groups.[20,19] This suggests that, although early mobilization can speed up the initial recovery process, the benefits may plateau as the fracture site fully heals and muscle strength returns.[21] The lack of long-term disparity in outcomes may reflect the fact that the body's natural healing mechanisms take over after a certain point, diminishing the influence of early mobilization on further functional gains.[22]

This finding is consistent with research suggesting that while early movement plays a critical role in the rehabilitation process, other factors such as bone healing and overall physical condition may ultimately determine long-term recovery.[23,20] Thus, while early mobilization is beneficial for reducing early disability, the timing of mobilization may have less impact once the fracture has sufficiently healed, and the patient's functional capacity is primarily influenced by the restoration of muscle strength and joint stability.[24]

In patients with distal radius fractures, particularly those treated surgically with volar locking plate (VLP) fixation, early mobilization was associated with a quicker return of wrist motion and improved upper limb function. Early mobilization in this cohort likely facilitates the rehabilitation of the wrist's musculature and soft tissues, thereby promoting quicker restoration of grip strength, which is essential for performing daily tasks.[25] These findings are in line with previous studies that have shown that early rehabilitation minimizes the effects of immobilization, such as muscle atrophy and joint stiffness, and accelerates the return to normal functional activities. Despite the observed short-term benefits, long-term outcomes between the early and delayed mobilization groups did not exhibit significant differences. [26]

This suggests that while early mobilization is effective at improving wrist function in the initial phases of recovery, its benefits may be transient, with both groups achieving similar levels of recovery once the fracture has healed. However, the speed with which patients regain motion and function in the early phases post-surgery can lead to improved quality of life and greater patient satisfaction, as individuals are able to resume activities more quickly.[27,28] One important consideration in the management of distal radius fractures is the potential for complications such as malunion or stiffness. In this review, the complication rates between the early mobilization and delayed mobilization groups did not show significant

differences, supporting the notion that early mobilization, when conducted under proper supervision and with appropriate protocols, is not associated with an increased risk of adverse outcomes.[29] This aligns with studies that have demonstrated that early mobilization does not lead to a higher incidence of tendon irritation, delayed union, or hardware failure, especially when the fracture is stable and the healing process is monitored closely.[30,]

A notable strength of early mobilization in this review is its safety profile. Complications, including malunion, stiffness, and tendon irritation, were rare and transient, with no significant differences in complication rates between early and delayed mobilization groups.[31] This is particularly relevant for clinicians when considering early mobilization protocols, as there has historically been concern that early movement might disrupt fracture healing or lead to increased risks of complications. However, the findings from this review suggest that, when appropriately managed, early mobilization can be a safe and effective strategy for preventing the negative effects of immobilization.[32,33] It is important to note that while complications were infrequent, they still occurred, and their management requires careful consideration of patient-specific factors. Factors such as fracture displacement, bone quality, and patient age can influence the decision to initiate early mobilization.[34] For example, patients with complex fractures or compromised bone health may benefit from a more gradual rehabilitation approach to avoid excessive strain on the healing bone or soft tissues. Therefore, while early mobilization is generally safe, individualized treatment plans should be tailored to the specific needs and risk factors of each patient.[35]

An important observation in this review is the role of patient characteristics, such as age and comorbidities, in the effectiveness of early mobilization. Younger patients, particularly those under 50 years of age, tend to experience greater functional improvements with early mobilization.[36] This can be attributed to their faster healing capacity, better baseline physical function, and higher levels of muscle strength.[28] Younger individuals are more likely to tolerate and benefit from early rehabilitation, as they generally have better bone density and a higher level of physical fitness, which facilitates quicker recovery. In contrast, older patients or those with multiple comorbidities may not experience the same degree of benefit from early mobilization.[33] Older adults, especially those over 60 years of age, showed more comparable outcomes between early and delayed mobilization groups, indicating that factors such as decreased bone density, slower healing times, and the presence of other health conditions may impact the effectiveness of early mobilization.[14] For these patients, a more gradual approach to rehabilitation may be necessary to ensure that the fracture heals properly while still promoting functional recovery. This highlights the need for a personalized approach to rehabilitation, where the timing and intensity of mobilization are adjusted based on individual patient characteristics.[37]

Limitations and Future Direction

While this systematic review provides valuable insights into the benefits of early mobilization, several limitations must be acknowledged. One key limitation is the variability in rehabilitation protocols across the included studies. Differences in the timing of mobilization, the type of fractures studied, and the specific outcome measures used make it difficult to standardize recommendations for all patients with upper limb fractures. Additionally, the follow-up periods in the included studies were relatively short, making it challenging to assess the long-term impact of early mobilization on functional outcomes. Longer follow-up periods are necessary to determine whether the short-term benefits of early mobilization translate into sustained improvements in long-term function and quality of life.

Another limitation is the absence of high-quality, large-scale randomized controlled trials (RCTs) with long-term follow-up. Many of the studies included in this review were observational or had small sample sizes, which may limit the generalizability of the findings. Therefore, further high-quality RCTs are needed to establish more definitive evidence on the optimal timing for mobilization following upper limb fractures. These studies should focus on a broader range of fracture types, treatment modalities, and patient populations to better understand the effects of early mobilization on long-term outcomes.

CONCLUSION

In conclusion, early mobilization following upper limb fractures, particularly for proximal humerus and distal radius fractures, provides significant short-term benefits in terms of pain relief, functional recovery, and range of motion. These improvements highlight the potential advantages of early rehabilitation in reducing disability and enhancing the quality of life for patients recovering from upper limb fractures. While the long-term impact of early mobilization remains unclear, current evidence suggests that it does not increase complication rates and can be safely implemented in the majority of cases. However, further high-quality RCTs with longer follow-up periods are needed to determine the most effective rehabilitation protocols and the optimal timing for mobilization in various fracture types and patient populations.

Declaration by Authors

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