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Original research article

Evaluation of five-pin fixation for distal radius fractures in postmenopausal women: A prospective cohort study

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Abstract

Introduction: Distal radius fractures are prevalent in adults, accounting for 17–21% of all fractures, with a significant proportion occurring in postmenopausal women. These women are particularly at risk due to osteoporosis, which weakens bones and increases fracture susceptibility. Traditional treatments, such as closed reduction and cast immobilization, often lead to complications like malunion and stiffness. More recently, minimally invasive techniques like the five-pin method have emerged as effective alternatives that provide stability while allowing early mobilization.

Aims and Objectives: The primary aim of this study is to assess the functional outcome of the five K-wire fixation technique in treating distal radius fractures in postmenopausal women. The objectives are to evaluate the effectiveness of less invasive surgical methods and to determine the feasibility of using the five-pin technique as a daycare procedure.

Methods: This prospective cohort study was conducted on 40 postmenopausal women aged 45 to 65, admitted with distal radius fractures to Guntur Medical College Hospital from March 2022 to March 2024. The Modified Mayo Wrist Score was used to assess functional outcomes. Patients were divided into those receiving conservative treatment or surgical intervention with the five-pin technique. Radiological evaluations and clinical outcomes were recorded, including range of motion, pain, and grip strength.

Discussion: Distal radius fractures in postmenopausal women are often caused by low-energy trauma. The five-pin technique has shown to be effective in providing stability and promoting early mobilization. Comparisons with previous studies indicate that this method yields superior functional outcomes when compared to traditional techniques, and the use of the Modified Mayo Wrist Score enables a standardized assessment of these outcomes.

Conclusion: The five-pin technique offers a minimally invasive solution for distal radius fractures, delivering functional results comparable to volar plating and superior to traditional K-wire fixation. Given the positive outcomes, further studies with larger cohorts are recommended to validate these findings and guide future treatment strategies.

Keywords: Distal radius fracture, postmenopausal women, five-pin technique, modified mayo wrist score, osteoporosis, fracture fixation.

Introduction

Distal radius fractures are among the most common fractures in adults, accounting for 17 to 21% of all adult fractures. These fractures are particularly prevalent in postmenopausal women, with approximately 20% of distal radius fractures occurring in this demographic. The distal radius is a key structural component of the wrist, which plays an essential role in the wide range of movements necessary for daily activities. However, the intricate anatomy of this region, combined with the effects of aging and menopause, makes it especially vulnerable to fractures. Postmenopausal women are at a heightened risk due to osteoporosis, which weakens bones and increases susceptibility to fractures from even low-energy trauma [1, 2].

The incidence of distal radius fractures in postmenopausal women rises significantly between the ages of 50 and 75, with a peak between 55 and 65 years. Women in this age group are five to six times more likely than men to experience these fractures. Several factors contribute to this increased risk, including decreased bone mineral density (BMD), increased osteoclastic and osteoblastic activity, and other

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systemic conditions that can weaken bones. The distal end of the radius has more trabecular bone than cortical bone, making it particularly prone to fractures in osteoporotic patients.
Treating distal radius fractures in postmenopausal women can be challenging due to the poor bone quality associated with osteoporosis. Traditional methods such as closed reduction and cast immobilization may not provide sufficient stability, often resulting in late fracture collapse, malunion, and significant stiffness. As a result, more invasive techniques, such as open reduction and internal fixation (ORIF), are often employed to achieve better anatomical reduction and earlier mobilization. However, ORIF is associated with a higher risk of complications, including infections and hardware-related issues. In recent years, the five-pin technique has emerged as a minimally invasive and effective alternative for treating distal radius fractures. This technique provides sufficient stability while allowing for early mobilization, reducing the risk of postoperative stiffness and improving functional outcomes [3, 4].

Scoring systems in distal radius fracture outcomes
Functional outcomes following distal radius fractures are often evaluated using validated scoring systems. One widely used system is the Modified Mayo Wrist Score, which assesses various aspects of wrist function, including pain, range of motion, grip strength, and the ability to perform daily activities. This scoring system provides a comprehensive measure of both clinical and patient-reported outcomes, making it a valuable tool for evaluating the success of different treatment modalities [5, 6].
The Modified Mayo Wrist Score is based on four key parameters:

1. **Pain:** This component evaluates the level of discomfort the patient experiences during activities.
2. **Range of Motion:** This includes the functional arc of supination and pronation, as well as flexion and extension movements.
3. **Grip Strength:** This assesses the patient's ability to apply force and hold objects, which is critical for daily activities.
4. **Functional Status:** This measures the patient's ability to return to work or engage in daily activities without significant limitations.

Each parameter is assigned a point value, and the total score is used to classify the functional outcome into one of four categories

- **Excellent:** 90 to 100 points.
- **Good:** 80 to 89 points.
- **Fair:** 65 to 79 points.
- **Poor:** Less than 64 points.

The use of the Modified Mayo Wrist Score allows for a standardized evaluation of patient outcomes, enabling clinicians to compare the efficacy of different treatment techniques objectively. Studies have shown that functional outcomes after distal radius fractures improve significantly with early mobilization and stable fixation, which aligns with the goals of the five-pin technique [8, 9].
In addition to the Mayo Wrist Score, other scoring systems such as the Disabilities of the Arm, Shoulder, and Hand (DASH) score and Cooney's modification of the Green and O'Brien scoring system are sometimes used to assess the impact of distal radius fractures on overall upper extremity function. However, the Mayo Wrist Score remains a preferred tool for evaluating wrist-specific outcomes [10-12].
In this study, we employed the Modified Mayo Wrist Score to assess the functional outcomes of postmenopausal women treated for distal radius fractures using the five-pin technique. This scoring system helped us evaluate the effectiveness of the technique in terms of pain relief, restoration of movement, and overall patient satisfaction.

Aim

1. The primary aim of this prospective study is to determine the functional outcome of the five K-wire technique for distal end radius fractures in postmenopausal women.

Objectives

1. To analyze the effectiveness of less invasive surgical methods in treating distal radius fractures in postmenopausal women.
2. To evaluate the role of 5 K-wire fixation as a viable daycare procedure for managing distal radius fractures.

Methods & Materials
A prospective cohort study titled "Functional Outcome of Distal Radius Fractures with Five K-Wire Fixation in Postmenopausal Women" was conducted at Guntur Medical College Hospital, Guntur. This study included 40 patients, admitted between March 2022 and March 2024, who were diagnosed with a distal radius fracture. Each patient provided written informed consent before participating in the study.

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This observational study followed a prospective cohort design, focusing on postmenopausal women aged 45 to 65 years. The inclusion and exclusion criteria were strictly adhered to, ensuring a well-defined patient group for accurate results.

Inclusion criteria

1. Postmenopausal women, aged 45 to 65 years.
2. Patients with isolated extra-articular and intra-articular distal radius fractures within one week of injury.
3. Patients with closed distal radius fractures suitable for closed reduction, with or without ulnar involvement.

Exclusion criteria

1. Pre-menopausal women.
2. Children and men.
3. Patients with chronic comorbidities.
4. Patients with Barton's fracture.
5. Patients with open fractures (classified using Gustilo-Anderson).
6. Patients with ipsilateral upper limb trauma.
7. Patients who did not consent or were unfit for surgery.

The Modified Mayo Wrist Score was used to assess the functional outcomes

- **Excellent:** 90 to 100
- **Good:** 80 to 89
- **Fair:** 65 to 79
- **Poor:** Less than 64

The study excluded patients with chronic conditions like diabetes, hypertension, and heart disease. A thorough clinical examination and medical history were taken for all patients admitted to Guntur Government Hospital. Preoperative radiographs (lateral and anterior views) were obtained and reviewed to determine the fracture pattern using the AO classification. In some cases, CT scans were performed to assess the extent of articular surface involvement. Intraoperative observations confirmed the fracture classification, and the mechanism of injury, AO grading, and patient details were carefully recorded.
Postoperative radiographs were evaluated for signs such as radial length, dorsal tilt, radial inclination, and comminution. This data was entered into a Microsoft Excel database for statistical analysis.

Instrumentation and Implants

1. 1.8 mm K-wires
2. Power drill
3. K-wire bender
4. K-wire cutter

These instruments and techniques were employed to achieve optimal fixation and stabilization in the management of distal radius fractures.

Operative Procedure

Anesthesia: Supraclavicular block.
Position: Supine, with the arm placed on the arm table.

Step 1: Fracture Reduction

The initial stage focuses on achieving near-anatomical reduction of the fracture fragments. Traction and countertraction techniques are used to reduce impaction, align distal fragments, and correct angulation. C-arm control is used to ensure proper alignment and position, maintaining radial length and inclination [32].

Step 2: K-Wire Application [30-33]

- **First K-Wire (Ulno-radial distal wire):** Inserted from the distal ulna to the radial styloid or through the inferior radio-ulnar joint, parallel to the wrist joint line. This wire prevents supination and maintains radial length.
- **Second K-Wire (Volar styloid wire):** Passed at a 45-degree angle, targeting the radial cortex and crossing to the opposite proximal radius. It stabilizes the radial column and aids in medial displacement of the radial fragment.
- **Third K-Wire (Lister's tubercle wire):** Positioned radially to Lister's tubercle, securing the volar cortex of the proximal radius and preventing dorsal tilt of the distal fragment.

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- **Fourth K-Wire (Ulnar corner wire):** Extends from the dorsal ulnar corner of the distal radius to the lateral cortex of the proximal radius. It stabilizes the intermediate column.
- **Fifth K-Wire (Proximal ulno-radial wire):** Inserts from the ulnar shaft into the proximal radius, ensuring radial length and controlling forearm rotation. Paired with the distal ulno-radial wire, it acts like an external fixator to provide additional stability.

This five-pin technique offers stability across different columns of the distal radius and allows for early mobilization.

Post-operative protocol [34, 35]

At our hospital, patients are routinely monitored at two, four, and six weeks post-surgery to check for any signs of infection or pin site loosening until the pins are removed. X-rays are taken at two-week intervals to assess the progress of radiological union. During these check-ups, wrist mobility, radiological measurements, and clinical signs of fracture union are also evaluated.

Typically, after six weeks of immobilization, the percutaneous K-wires are removed under strict aseptic conditions. Following pin removal, patients begin rehabilitation, focusing on both active and passive movements. Physical therapy continues until the patient regains full use of their hand, including functional grip strength, enabling them to resume normal daily activities.

Generally, plaster immobilization is removed after the six-week period. For additional protection, most patients are advised to wear a splint, primarily as a precautionary measure.

Results

In order to analyze the functional outcome of both intra & extra-articular distal end radius fractures, observational prospective cohort study was conducted on 30 postmenopausal patients at Guntur Medical College Hospital over the course of two years, from March 2022 to March 2024. The postmenopausal women in study had a mean age of 58.6 years. Six months was the average follow-up duration.

Following a thorough analysis of our study's data in conjunction with earlier, comparable observational research, the following hypotheses were put forth.

Table 1: Age distribution

Age Range (Years)	Number of Patients	Percentage of Participants
50-55	10	25%
56-60	16	40%
61-65	10	25%
66+	4	10%

The age distribution shows that 25% of patients were between 50-55 years, indicating an increased fracture risk shortly after menopause. The highest incidence, at 40%, occurred in the 56-60 age group, suggesting that fracture risk peaks during this period, likely due to declining bone density and increased fall risk. The 61-65 age group also accounted for 25% of cases, showing that while the incidence slightly decreases after 60, the risk remains significant. Only 10% of patients were over 66, possibly reflecting a smaller population or reduced activity levels in this age group.

Table 2: Side involved

Involved side of injury	Number of patients	Percentage of participants
Right Dominant side	16	41%
Left Non-dominant side	24	59%

Predominantly Affected Side: Most patients sustained injuries on the non-dominant left side (60%), which corresponds to 24 patients. The remaining 16 patients (40%) had injuries on the dominant right side.

Table 3: Mode of Injury

Mode of injury	Number of patients	Percentage of Participants
Low-velocity household self-fall	33	82%
High-velocity road traffic accidents	8	20%

Mode of Injury

- Low-velocity self-falls during household activities were responsible for the majority (80%, 32 patients) of the fractures, while high-velocity road traffic accidents accounted for 20% (8 patients).

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Table 4: Fracture pattern

Fracture pattern	Total cases	Percentage of participants
A2	22	54%
A3	11	27%
B1	5	14%
C1	3	7%

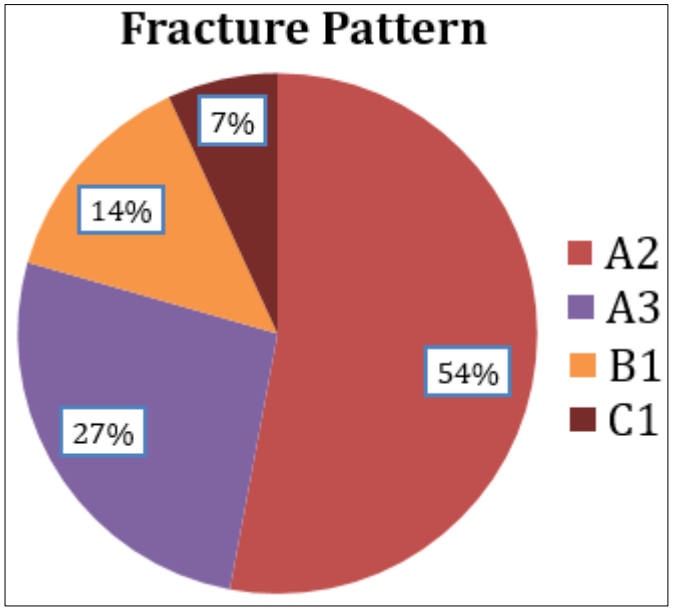

Fig 1: Fracture pattern

Fracture classification

- The A2 fracture pattern was the most common (53%, 21 patients), followed by A3 (27%, 11 patients). Less frequent were B1 (13%, 5 patients) and C1 (7%, 3 patients).

Table 5: Articular surface involvement

Fracture pattern	Number of cases	Percentage of Participants
Extra-articular	29	71%
Intra-articular	12	29%

Articular Surface Involvement

- 70% (28 patients) of the fractures were extra-articular, while 30% (12 patients) were intra-articular.

Table 6: Waiting period

Waiting period	Number of cases	Percentage of participants
Less than 24 hours	30	75%
24 to 48 hours	10	26%

Waiting Period for Surgery

- Most surgeries were performed within 24 hours (73%, 29 patients). Eight patients (27%) had their surgeries between 24 to 48 hours after injury.

Table 7: Functional range of motion

Functional Range of motion	No. of cases	Percentage of Participants
Flexion	29	29%
Extension	29	29%
Radial deviation	29	29%
Ulnar deviation	30	30%
Supination	29	29%
Pronation	29	29%

Functional Range of Motion

- The majority of patients showed normal range of motion for flexion, extension, radial deviation, supination, and pronation, with just two patients exhibiting a reduced range of motion.

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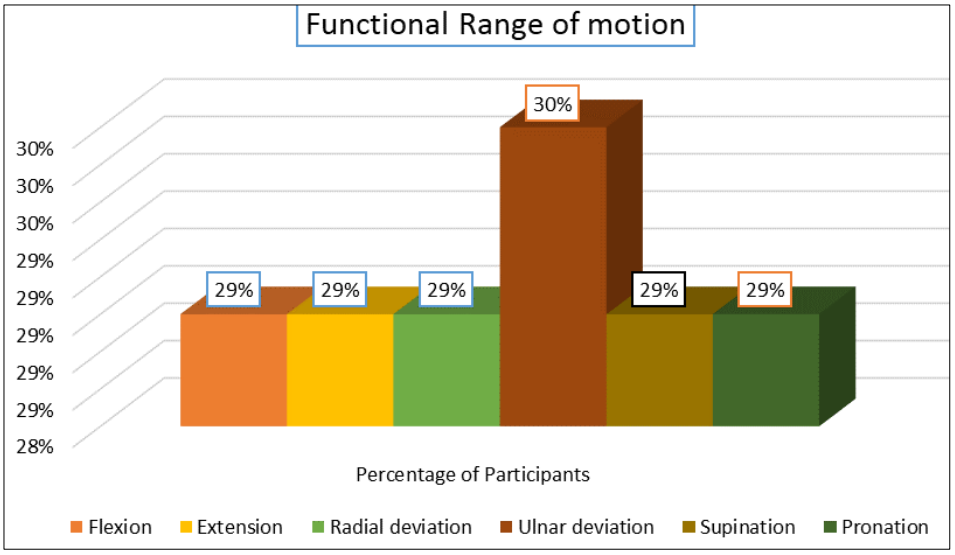

Fig 2: Functional Range of motion

Table 8: Complications

Complications	Number of cases	Percentage of participants
Reduced functional range of movements	3	7%

Complications

- Two patients (7%) experienced complications, mainly in the form of a reduced functional range of movement.

Table 9: Functional Outcome

Functional outcome	Number of cases	Percentage of participants
Excellent	24	61%
Good	14	34%
Fair	1	3%
Poor	1	3%

Functional Outcome (Mayo Score)

- Excellent outcomes were achieved in 61% (24 patients), good outcomes in 34% (14 patients), and 3% (1 patient) each for fair and poor outcomes.

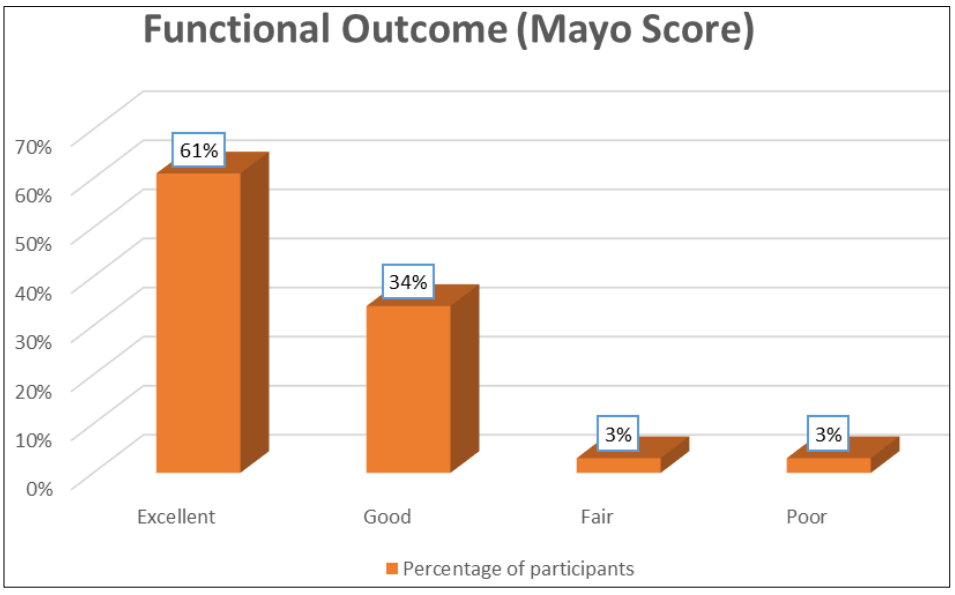

Fig 3: Functional Outcome (Mayo Score)

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Table 10: Treatment Type, Bone Mineral Density (BMD), Complications by Fracture Type DATA table

Category	Number of Patients	Percentage of Participants
Treatment Type		
Treatment Type: Conservative	10	25%
Treatment Type: Surgical	30	75%
Bone Mineral Density (BMD)		
BMD: Normal	8	20%
BMD: Osteopenia	20	50%
BMD: Osteoporosis	12	30%
Hand Dominance and Functional Outcome		
Hand Dominance: Right	24	75%
Hand Dominance: Left	8	25%
Complications by Fracture Type		
Complications (A2)	1	4.76%
Complications (A3)	0	0%
Complications (B1)	1	20%
Complications (C1)	0	0%

- **Treatment Type:** 75% of the patients (30) underwent surgical treatment, while 25% (10 patients) were treated conservatively with casting. This indicates a preference for surgical intervention, likely due to the fracture patterns and patient requirements.
- **Bone Mineral Density (BMD):** Half of the patients (50%, 20 patients) were classified as having osteopenia, while 30% (12 patients) had osteoporosis. Only 20% (8 patients) had normal BMD. This reinforces the relationship between lower BMD scores and an increased likelihood of fractures in postmenopausal women.
- **Hand Dominance and Functional Outcome:** Among the patients, 75% (24) were right-hand dominant and showed excellent or good functional outcomes. The remaining 25% (8) were left-hand dominant. This might suggest that functional recovery was better in patients with injuries to their non-dominant hand.
- **Complications by Fracture Type:** Only 1 patient with an A2 fracture and 1 patient with a B1 fracture experienced complications, representing 4.76% and 20% of these respective fracture categories. No complications were observed in patients with A3 or C1 fracture patterns.

Table 11: Surgical techniques, postoperative rehabilitation, and pain management

Category	Number of Patients	Percentage of Participants
Surgical Techniques		
Surgical Technique: ORIF	25	62.5%
Surgical Technique: External Fixation	5	12.5%
Postoperative Rehabilitation		
Rehabilitation: Physiotherapy	30	75%
Rehabilitation: Self-managed	10	25%
Pain Management		
Pain Management: Oral Analgesics	35	87.5%
Pain Management: Physiotherapy	5	12.5%

- **Surgical Techniques:** The majority of patients (62.5%, 25 patients) underwent Open Reduction Internal Fixation (ORIF), while a smaller proportion (12.5%, 5 patients) received external fixation. This indicates ORIF as the preferred method of surgical treatment for distal radius fractures.
- **Postoperative Rehabilitation:** Physiotherapy was the primary method of rehabilitation for 75% (30 patients) of the study group, while 25% (10 patients) managed their rehabilitation independently. This highlights the importance of guided physiotherapy in the recovery process.
- **Pain Management:** Oral analgesics were widely used for pain relief, with 87.5% (35 patients) relying on them. Physiotherapy for pain management was less common, utilized by only 12.5% (5 patients). This shows a significant reliance on medication for pain control in the early postoperative phase.

Discussion

The wrist is a remarkable biomechanical structure that enables a wide range of complex movements essential for daily activities. As the critical connection between the hand and forearm, its delicate framework also makes it vulnerable to injury, with distal radius fractures being a common example. These fractures highlight the brittleness of this anatomical region. Deciding on the optimal treatment for distal radius fractures remains a topic of debate, with options ranging from column-specific plating to traditional cast immobilization. The best approach varies depending on the patient's condition and fracture characteristics.

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The majority of distal radius fractures occur in postmenopausal women engaged in routine household or leisure activities. For older women, these fractures often result in significant functional decline, making daily tasks such as cooking, cleaning, shopping, or getting in and out of a vehicle more difficult. Gender differences are pronounced, with women over 40 experiencing a sharp rise in distal radius fractures. A prospective study of 15, 293 adults found that women between the ages of 60 and 94 were six times more likely than men to sustain these fractures.

Patients with low bone mineral density (BMD) are more susceptible to fractures following low-energy trauma, and this risk increases with age, particularly after menopause. The age-related decline in bone structure complicates fracture management, as older bones take longer to heal and are more prone to displacement during the healing process. Osteoporotic fractures frequently affect the wrist, hip, and spine.

Complications from distal radius fractures can be severe, including wrist dysfunction and malunion. Although closed reduction and cast immobilization are straightforward and effective in some cases, this method often leads to late fracture collapse, significant stiffness, and suboptimal functional outcomes. On the other hand, open reduction and plating provide better anatomical reduction but carry increased risks of infection and postoperative complications. The key objectives in treating distal radius fractures include anatomical reduction, fracture stability, early mobilization, pain-free range of motion, and minimizing complications.

While external fixators can maintain radial length and inclination through ligamentotaxis, they are less effective in preserving palmar tilt. Studies have reported complications in up to 60% of cases involving external fixators, including radial sensory neuritis, reflex sympathetic dystrophy, pin tract infection, pin loosening, and delayed union. Therefore, external fixators are not ideal for non-comminuted extra-articular distal radius fractures. Instead, internal fixation, open reduction, and arthroscopic techniques are preferred for complex or partial intra-articular fractures.

Numerous clinical studies and laboratory evaluations have emphasized the importance of precise anatomical reduction in achieving favorable outcomes. Poor results are often seen in cases where there is more than 2 mm of articular displacement, more than 5 mm of radial shortening, or over 20° of dorsal angulation. Achieving accurate fracture reduction is a critical step in treating distal radius fractures.

The five-pin technique offers several advantages, including early mobilization. The pins provide sufficient stability across the fracture site and the distal radioulnar joint, allowing for early movement and reducing postoperative stiffness. Another benefit of this technique is its versatility, as distal radius fractures occur in various patterns. The five-pin method enables fragment-specific fixation, addressing the specific needs of each fracture pattern. Conventional pinning methods have limitations, as they may not provide sufficient stability to withstand the forces exerted during fracture healing. However, the new five-pin technique improves stability by using crossed k-wires at different points, with at least one k-wire providing interfragmentary fixation, preventing pin migration and loosening.

Age

In our study, the postmenopausal women had a mean age of 57 years. This finding aligns with the fact that all patients in our study were postmenopausal females, making the association of age with distal radius fractures statistically not significant.

Table 12: Age comparison

Study	Mean Age
Patil *et al.* [13]	46
Bhasme *et al.* [14]	45
Brogren *et al.* [12]	65
Vipin *et al.* [15]	47
Sandeep *et al.* [16]	39
Our Study	57

Side involved

In our study, 59% of patients had fractures on the left side, and 41% had fractures on the right side, reflecting a predominant involvement of the non-dominant side. This trend is in contrast with studies such as Patil *et al.*, where right-sided fractures were more common. The variations across studies may be due to different activity levels or hand dominance among participants.

Table 13: Side comparison

Study	Left	Right
Patil *et al.* [13]	34%	66%
Vipin *et al.* [15]	45%	55%
Sandeep *et al.* [16]	57%	43%
Brogren *et al.* [12]	51%	49%
Our study	59%	41%

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Mode of injury
In our study, the majority of fractures resulted from falls on outstretched hands (FOOSH), with road traffic accidents (RTA) being a secondary cause. This aligns with studies such as Sandeep *et al*., [16] where FOOSH was the leading cause of fractures. However, studies like Vipin *et al*. [15] report RTA as the primary mode of injury. The difference may be attributed to lifestyle or regional differences in trauma mechanisms.

Fracture classification
The AO classification was used in our study, with the A2 fracture pattern being the most common. Comparatively, other studies have used different classification systems, such as Frykman in the study by Vipin *et al*., [15] where type 6 fractures were most frequent. The variation in fracture classification across studies may reflect the differing severities of trauma or velocity of injuries.

Involvement of articular surface
In our group, 29% (12 patients) had intra-articular fractures, while 71% (28 patients) had extra-articular fractures. This differs from the study by Bhasme *et al*., [14] where intra-articular fractures were more prevalent. Our patients may have experienced less severe trauma, leading to a higher proportion of extra-articular fractures.

Waiting period for surgery
Most patients (75%) were operated on within 24 hours, with only 25% waiting up to 48 hours for surgery. This is significantly quicker compared to Bhasme *et al*.'s study [14], where surgeries were performed up to two to three weeks after injury. Early intervention in our study likely contributed to better outcomes by reducing the risk of complications.

Range of motion
In our study, 93% of patients regained normal functional movements, including flexion, extension, radial deviation, supination, and pronation, with only 7% exhibiting a reduced range of motion. This compares favorably to other studies, such as Anilkumar Vidhyadharan *et al*., [49] where a similarly high percentage of patients regained full range of motion.

Functional outcomes
Our study, using the Mayo Wrist Score, showed excellent outcomes in 61% of cases, good outcomes in 34%, and fair or poor outcomes in only 3% of cases each. This is consistent with other studies, such as Sandeep *et al*., [16] where functional outcomes improved significantly over time. Our shorter follow-up period may explain the relatively lower proportion of excellent outcomes compared to longer-term studies.

Complications
In our study, the primary complications were reduced range of motion, seen in 7% of patients. In comparison, studies such as Anilkumar *et al*. [49] reported complications like pin loosening and migration, particularly in osteoporotic patients. Pin track infections and complex regional pain syndrome (CRPS) were observed in other studies, such as those by Vipin *et al*. [15] and Sandeep *et al*., [16] but were less common in our cohort.

Table 14: Comparison of complications

Study	Complications
Patil *et al*. [13]	Dorsal angulation
Bhasme *et al*. [14]	Late fracture collapse, malunion
Anilkumar *et al*. [49]	Pin loosening and migration in osteoporotic pts
Vipin *et al*. [15]	Superficial pin tract infection, CRPS
Sandeep *et al*. [16]	CRPS
Our study	Reduced range of motion

Limitations of the research
- The sample size of only 40 patients is relatively small, making it difficult to draw definitive conclusions about the functional outcomes of the five-pin technique.
- Ideally, all fractures should have been treated by a single surgeon to minimize bias, but this was not feasible in our situation.

Conclusion
As age increases and postmenopausal hormonal changes take effect, bone quality declines significantly, leading to osteoporosis. In postmenopausal women with displaced intra- and extra-articular distal radius

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fractures, but without severe articular and metaphyseal comminution, the five-pin technique offers a minimally invasive and effective treatment option.

Our findings suggest that the five-pin technique provides functional outcomes comparable to volar locking plate fixation and superior to traditional K-wire fixation. However, further studies with larger sample sizes are necessary to reinforce these findings and guide future treatment strategies.

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