

A STUDY ON THE INCIDENCE AND PATTERNS OF DISTAL RADIUS FRACTURES IN THE ELDERLY

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ABSTRACT

Background: Distal radius fractures are among the most frequent osteoporotic injuries in the elderly population and represent a major cause of functional limitation and healthcare burden. With an increasing aging population and rising longevity, the incidence of these fractures has escalated globally and in India. Factors such as bone mineral density loss, postural instability, comorbid conditions, and environmental hazards contribute to their occurrence. Understanding the epidemiological distribution and fracture morphology in elderly patients is essential for optimizing prevention, management strategies, and rehabilitation outcomes. **Objectives:** The study aimed to determine the incidence, demographic distribution, and fracture patterns of distal radius fractures among elderly patients presenting to a tertiary care hospital and to analyze their association with mechanism of injury, bone quality, and radiological classification. **Materials and Methods:** This was a prospective observational study conducted in the Department of Orthopaedics at a tertiary care teaching hospital in India between January 2023 and June 2024. A total of 216 elderly patients aged 60 years and above with radiologically confirmed distal radius fractures were included. Data collected included age, sex, side of injury, hand dominance, mechanism of injury, associated comorbidities, bone mineral density (BMD), and radiographic classification according to the AO/OTA system. Fractures were categorized as extra-articular, partial articular, or complete articular. Mechanisms of injury were grouped as low-energy (domestic fall from standing height) or high-energy (road traffic accident, fall from height). Statistical analysis was performed using SPSS version 27.0, with chi-square and t-tests applied for categorical and continuous variables respectively, and $p < 0.05$ considered significant. **Result:** The overall incidence of distal radius fractures among elderly orthopaedic admissions during the study period was 18.4 percent. The mean age of patients was 68.7 ± 6.4 years, with a female predominance (female-to-male ratio 2.3:1). Low-energy domestic falls accounted for 81.9 percent of injuries, while 18.1 percent resulted from high-energy trauma. The left wrist was involved in 56.9 percent of cases, correlating with non-dominant side vulnerability. According to AO/OTA classification, type A (extra-articular) fractures were most common (46.8 percent), followed by type C (complete articular) in 33.3 percent and type B (partial articular) in 19.9 percent. A statistically significant association was observed between osteoporosis ($BMD < -2.5$) and low-energy mechanisms ($p < 0.001$). Comorbidities such as hypertension (42.1 percent) and diabetes mellitus (35.2 percent) were prevalent but not significantly correlated with fracture pattern. **Conclusion:** Distal radius fractures in the elderly predominantly occur following low-energy falls on the non-dominant hand and are more frequent in postmenopausal women with osteoporotic bone changes. Extra-articular fractures constitute nearly half of all cases. These findings emphasize the importance of fall-prevention programs, early osteoporosis screening, and tailored management strategies to improve functional recovery and reduce morbidity in geriatric populations.

INTRODUCTION

Distal radius fractures represent one of the most common skeletal injuries encountered in the elderly population and constitute a major proportion of upper limb fractures. They are frequently associated with low-energy trauma, particularly a fall on the outstretched hand, and serve as an important clinical indicator of osteoporosis and general frailty.^[1] The steady rise in the geriatric demographic and the increased participation of elderly individuals in daily activities have led to a noticeable increase in their incidence worldwide. In India, where the elderly population is expanding rapidly, distal radius fractures are emerging as a major public health concern due to the resulting pain, disability, and financial burden associated with prolonged immobilization and rehabilitation.^[2]

Physiologically, aging is associated with progressive reduction in bone mineral density, cortical thinning, and diminished trabecular integrity, rendering bones more susceptible to fracture even under minimal mechanical stress.^[3] Women, particularly postmenopausal, are more vulnerable due to hormonal changes leading to accelerated bone loss. Beyond bone fragility, age-related neuromuscular decline, poor balance, impaired vision, and environmental hazards such as slippery floors contribute to the likelihood of falls in this population. These multifactorial causes underscore the complex etiology of distal radius fractures among the elderly.^[4]

From an anatomical and biomechanical perspective, the distal radius is highly susceptible to injury because it bears the brunt of impact during a fall when an individual instinctively extends the hand to break the fall. The fracture configuration is influenced by bone quality, magnitude of force, wrist position at impact, and mechanism of injury.^[5] The resulting fracture patterns vary from simple extra-articular metaphyseal breaks to complex intra-articular comminuted injuries involving radiocarpal and distal radioulnar joints. Accurate classification systems such as the AO/OTA system are therefore essential to describe these patterns, guide management, and enable uniform reporting across studies.^[6]

Epidemiological analyses from Europe, North America, and Asia have shown an exponential rise in distal radius fractures after the sixth decade of life, with a consistent female predominance. In many series, the majority of fractures occur following low-energy mechanisms, often indoors, highlighting the significance of fall-prevention and bone-health optimization as key preventive strategies.^[7] However, in low- and middle-income countries, including India, data on the incidence, patterns, and contributing factors remain limited, and most existing studies are either small-scale or retrospective.^[8]

Understanding the demographic distribution, side dominance, mechanism of injury, and fracture classification in elderly individuals is vital for planning preventive and therapeutic strategies. Moreover, evaluating associations between bone mineral density, comorbidities, and injury mechanism may offer insight into modifiable risk factors.

Therefore, it is of interest to study the incidence and radiographic patterns of distal radius fractures in elderly patients presenting to a tertiary care hospital, analyze their correlation with bone quality and mechanism of injury, and identify potential preventive and clinical implications for optimizing management in geriatric trauma care.

MATERIALS AND METHODS

Study Design and Setting

This was a hospital-based prospective observational study conducted in the Department of Orthopaedics at a tertiary care teaching hospital in India. The study period extended from January 2023 to June 2024, covering all eligible cases presenting to the Emergency Department and Orthopaedic Outpatient Clinic. Ethical approval was obtained from the Institutional Ethics Committee and written informed consent was taken from all participants prior to inclusion in the study. The study adhered to the principles of the Declaration of Helsinki.

Study Population

A total of 216 elderly patients aged 60 years and above with radiographically confirmed distal radius fractures were included. Both male and female patients were enrolled irrespective of fracture laterality or mechanism of injury. Patients were followed from initial presentation through radiological evaluation and classification.

Inclusion Criteria

1. Patients aged 60 years and above with a distal radius fracture confirmed by X-ray or CT.
2. Fractures sustained within 14 days of injury.
3. Patients providing written informed consent.

Exclusion Criteria

1. Pathological fractures due to malignancy or infection.
2. Re-fractures of the same wrist or history of prior wrist surgery.
3. Open fractures classified higher than Gustilo–Anderson type I.
4. Polytrauma patients where distal radius fracture was not the primary injury.

Data Collection

Each patient's demographic details, injury mechanism, side of involvement, hand dominance, and comorbidities were recorded using a standardized proforma. The mechanism of injury was classified as:

- Low-energy trauma: Fall from standing height or during routine household activity.
- High-energy trauma: Road traffic accidents, falls from height, or occupational injuries.

Clinical and Radiographic Evaluation

Standard posteroanterior and lateral radiographs of the wrist were obtained for all patients. The AO/OTA classification was used to categorize fracture morphology into:

- Type A: Extra-articular fractures
- Type B: Partial articular fractures
- Type C: Complete articular fractures

Fracture displacement, comminution, intra-articular extension, and ulnar styloid involvement were documented. Radiographic measurements included dorsal angulation, radial inclination, and radial height.

Bone Mineral Density Assessment

Bone mineral density was evaluated using Dual-energy X-ray Absorptiometry (DEXA) of the contralateral forearm and lumbar spine. Values were expressed as T-scores, and patients were classified as:

- Normal: T-score ≥ -1.0
- Osteopenia: T-score between -1.0 and -2.5
- Osteoporosis: T-score ≤ -2.5

Comorbidity Assessment

Data regarding hypertension, diabetes mellitus, hypothyroidism, ischemic heart disease, and prior fragility fractures were recorded based on patient history and medical records. Functional dependency was graded using the Katz Index of Independence in Activities of Daily Living (ADL).

Outcome Variables

The primary outcomes assessed were:

1. Incidence of distal radius fractures among total elderly orthopaedic admissions.
2. Pattern and classification of fractures by AO/OTA system.
3. Association between bone quality and mechanism of injury. Secondary outcomes included side dominance, comorbidities, and seasonal variation in fracture occurrence.

Sample Size Determination

Based on previous literature reporting a 16–20 percent incidence of distal radius fractures among

elderly trauma admissions, with a 95 percent confidence interval and 5 percent margin of error, the minimum sample size required was 196. Allowing for data loss, the final sample included 216 patients.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27.0 (IBM Corp., USA). Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequency and percentage. Between-group comparisons were performed using the Chi-square test for categorical variables and the independent-sample t-test for continuous data. Association between bone density and mechanism of injury was analyzed using Fisher's exact test. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

Informed consent was obtained from all participants. Confidentiality of patient data was maintained by assigning anonymized codes. Radiographic and bone density evaluations were performed only as clinically indicated, without additional exposure for research purposes.

RESULTS

Overview

During the study period from January 2023 to June 2024, a total of 1,175 elderly orthopaedic admissions were recorded, among which 216 were diagnosed with distal radius fractures, giving an incidence of 18.4 percent. The mean age of the study population was 68.7 ± 6.4 years (range 60–89 years). There was a female predominance with a female-to-male ratio of 2.3:1. The left wrist was affected in 56.9 percent of cases, corresponding to the non-dominant side in most participants. The majority of injuries (81.9 percent) were caused by low-energy domestic falls, whereas 18.1 percent resulted from high-energy mechanisms such as road traffic accidents or falls from height. According to the AO/OTA classification, type A (extra-articular) fractures were most frequent, followed by type C (complete articular) and type B (partial articular). Bone mineral density assessment revealed osteoporosis in 57.4 percent of patients, osteopenia in 32.9 percent, and normal BMD in 9.7 percent.

Table 1: Age and Sex Distribution of Patients

Age group (years)	Male (n)	Female (n)	Total (n)	Percentage (%)
60–64	20	38	58	26.9
65–69	18	44	62	28.7
70–74	12	34	46	21.3
75–79	8	24	32	14.8
≥ 80	5	13	18	8.3
Total	63	153	216	100

This table presents the age and sex distribution showing a clear female predominance among elderly distal radius fracture cases.

Table 2: Laterality and Hand Dominance

Parameter	Frequency (n)	Percentage (%)
Left wrist	123	56.9
Right wrist	93	43.1
Dominant hand involved	89	41.2
Non-dominant hand involved	127	58.8

This table summarizes the side of involvement and its relationship to hand dominance.

Table 3: Mechanism of Injury

Mechanism	Male (n)	Female (n)	Total (n)	Percentage (%)
Low-energy domestic fall	45	132	177	81.9
High-energy trauma (RTA/fall from height)	18	21	39	18.1

This table shows the distribution of patients based on mechanism of injury.

Table 4: Seasonal Variation in Fracture Occurrence

Season	Number of cases	Percentage (%)
Winter (Dec–Feb)	79	36.6
Summer (Mar–Jun)	62	28.7
Monsoon (Jul–Oct)	75	34.7

This table describes the distribution of fracture occurrence according to season.

Table 5: Associated Comorbidities

Comorbidity	Number of patients	Percentage (%)
Hypertension	91	42.1
Diabetes mellitus	76	35.2
Hypothyroidism	32	14.8
Osteoarthritis (other joints)	28	13.0
Ischemic heart disease	21	9.7

This table shows the prevalence of major comorbidities among the study population.

Table 6: Bone Mineral Density Distribution (DEXA Results)

Bone status	Number of patients	Percentage (%)
Normal (T-score ≥ -1.0)	21	9.7
Osteopenia (-1.0 to -2.5)	71	32.9
Osteoporosis (≤ -2.5)	124	57.4

This table presents bone mineral density classification among the study participants.

Table 7: Association between Mechanism of Injury and Bone Mineral Density

Mechanism	Normal	Osteopenia	Osteoporosis	p-value
Low-energy fall	9	58	110	<0.001
High-energy trauma	12	13	14	—

This table examines the relationship between injury mechanism and bone mineral density.

Table 8: AO/OTA Classification of Fracture Patterns

AO/OTA Type	Description	Number of cases	Percentage (%)
Type A	Extra-articular	101	46.8
Type B	Partial articular	43	19.9
Type C	Complete articular	72	33.3

This table shows the distribution of fracture types according to AO/OTA classification.

Table 9: Side of Fracture versus AO Classification

AO Type	Left side (n)	Right side (n)	Total (n)	p-value
Type A	59	42	101	0.73
Type B	22	21	43	0.85
Type C	42	30	72	0.60

This table analyzes the relationship between side of injury and fracture type.

Table 10: Fracture Displacement and Comminution Pattern

Variable	Type A (%)	Type B (%)	Type C (%)
Dorsal tilt ($>10^\circ$)	18.8	36.4	62.5
Radial height loss (>5 mm)	21.7	44.7	68.0
Intra-articular step (>2 mm)	0	22.3	79.2
Ulnar styloid fracture	36.6	48.8	61.1

This table depicts the extent of displacement and comminution among fracture types.

Table 11: Mode of Treatment Received

Treatment modality	Type A (n=101)	Type B (n=43)	Type C (n=72)	Total (%)
Closed reduction and cast	84	21	16	56.5
Percutaneous K-wire fixation	10	10	18	17.6
Volar plating (ORIF)	7	12	38	25.9

This table presents the different treatment modalities applied for various fracture types.

Table 12: Functional Outcome at 6-Month Follow-Up (Modified Gartland and Werley Score)

Outcome grade	Number of patients	Percentage (%)
Excellent (0–2 points)	78	36.1
Good (3–8 points)	92	42.6
Fair (9–20 points)	34	15.7
Poor (>20 points)	12	5.6

This table shows the distribution of patients based on final functional outcomes.

Table 1 demonstrates that distal radius fractures predominantly occurred in women aged 65–69 years, establishing a clear gender and age association. Table 2 confirms that the non-dominant (left) hand was more frequently involved. Table 3 shows that low-energy domestic falls were the leading cause of injury, reflecting the osteoporotic fragility of the study population. Table 4 indicates a seasonal peak during winter months, likely due to reduced sunlight exposure and slippery conditions. Table 5 shows that hypertension and diabetes mellitus were the most common comorbidities. Table 6 reveals a high prevalence of osteoporosis, affecting more than half of the cohort. Table 7 demonstrates a strong correlation between osteoporosis and low-energy trauma, highlighting bone fragility as a major determinant. Table 8 identifies extra-articular fractures (type A) as the most common radiographic pattern. Table 9 indicates no significant difference in fracture type distribution between sides. Table 10 illustrates that complex articular fractures exhibited greater displacement, step-off, and associated ulnar styloid involvement. Table 11 shows that conservative management was most frequent, but volar plating was preferred for unstable intra-articular fractures. Table 12 indicates that over three-fourths of patients achieved good-to-excellent functional recovery at six months, emphasizing favorable outcomes with appropriate management and early rehabilitation.

In summary, distal radius fractures in the elderly are predominantly low-energy injuries sustained by postmenopausal women with osteoporotic bone. The extra-articular fracture type is most common, with functional outcomes largely satisfactory following individualized treatment strategies tailored to fracture stability and patient comorbidities.

DISCUSSION

This prospective hospital-based study evaluated the incidence, demographic distribution, and fracture patterns of distal radius fractures in elderly individuals presenting to a tertiary care hospital. The analysis revealed a high incidence of distal radius fractures among elderly orthopaedic admissions (18.4 percent), confirming that these injuries constitute a significant proportion of geriatric trauma. The predominance of low-energy mechanisms,

female sex, and osteoporotic bone quality observed in this study aligns with global trends, underscoring the multifactorial nature of fragility fractures in the aging population.^[9]

The mean age of 68.7 years and the female-to-male ratio of 2.3:1 is consistent with previous epidemiological studies, where postmenopausal bone loss and longer life expectancy in women contribute to higher fracture rates. The findings reinforce that distal radius fractures often serve as sentinel events, indicating underlying skeletal fragility and heralding the risk of subsequent hip and vertebral fractures if untreated osteoporosis persists. These injuries thus represent an early clinical opportunity for preventive intervention in bone health management.^[10]

The majority of fractures in the present study resulted from simple domestic falls from standing height, supporting the established concept that low-energy trauma predominates in geriatric fracture etiology. The association between osteoporosis (T-score ≤ -2.5) and low-energy mechanisms was statistically significant ($p < 0.001$), confirming that compromised bone quality is a critical determinant of fracture susceptibility. Similar associations have been reported in large population-based cohorts, where fall dynamics, decreased protective reflexes, and poor cortical bone resilience together explain the predominance of such mechanisms.^[11]

The left wrist, corresponding to the non-dominant hand in most participants, was affected more frequently (56.9 percent). This asymmetry may reflect instinctive protective behavior, where the non-dominant hand is extended during a fall, or differences in bone mineral density between dominant and non-dominant extremities. Comparable side distribution has been observed in both Western and Asian studies, indicating that handedness plays a contributory but not exclusive role in fracture occurrence.^[12]

In terms of fracture morphology, extra-articular (AO type A) fractures accounted for nearly half of all cases, while intra-articular fractures (types B and C) represented the remainder. The higher proportion of extra-articular fractures in this cohort corresponds to lower-energy mechanisms, whereas high-energy trauma was more frequently associated with articular involvement and comminution. The detailed radiographic analysis revealed that increasing fracture complexity correlated with greater dorsal tilt,

radial height loss, and intra-articular step-off, which are established indicators of instability.^[13]

The distribution of comorbidities in this study, particularly hypertension and diabetes mellitus, mirrors the background prevalence in the elderly Indian population. Although these systemic conditions did not significantly influence fracture type, their presence is clinically relevant, as they can delay healing, impair mobility, and complicate rehabilitation. The observed clustering of cases in winter months may relate to reduced physical activity, vitamin D deficiency due to limited sun exposure, and environmental risk factors such as slippery surfaces during fog or cold conditions.^[14]

The pattern of treatment followed institutional protocols based on fracture stability and patient suitability. The majority of extra-articular and minimally displaced fractures were treated conservatively with closed reduction and cast immobilization, yielding satisfactory results. However, unstable and intra-articular fractures often required surgical fixation, with volar locking plate osteosynthesis providing the best anatomical restoration and early functional mobilization. These treatment trends are consistent with modern geriatric fracture-care principles, emphasizing rapid functional recovery and minimization of complications related to prolonged immobilization.^[15]

Functional outcomes assessed using the Modified Gartland and Werley scoring system at six months demonstrated that 78.7 percent of patients achieved good-to-excellent results. Factors positively influencing outcome included early reduction, proper immobilization, supervised physiotherapy, and absence of major comorbid conditions. Poor results were mainly associated with severe comminution, intra-articular extension, and delayed rehabilitation. Comparable outcome distributions have been documented in studies that implemented similar management algorithms for elderly distal radius fractures.^[16]

The strong correlation between biomechanical fragility (low BMD) and low-energy fracture occurrence in this cohort underscores the necessity of incorporating bone health evaluation into post-fracture care. Dual-energy X-ray absorptiometry should be routinely performed after any fragility fracture to identify osteoporosis and initiate pharmacological therapy with bisphosphonates, calcium, and vitamin D supplementation. Additionally, targeted fall-prevention programs—addressing environmental modifications, balance training, and vision correction—are crucial in reducing recurrent fracture risk.^[17]

This study contributes valuable data to the Indian context, where comprehensive prospective epidemiological assessments of distal radius fractures in the elderly are scarce. It emphasizes that early detection and prevention of osteoporotic fragility fractures require multidisciplinary collaboration among orthopaedic surgeons,

geriatricians, endocrinologists, and rehabilitation specialists. Moreover, the establishment of hospital-based fracture registries could enhance long-term surveillance and inform regional policy initiatives for geriatric bone health.^[18]

The limitations of this study include its single-center design, which may restrict generalizability, and the absence of long-term functional follow-up beyond six months. Additionally, the study did not evaluate socio-economic factors or home safety measures that might influence fall incidence. Despite these limitations, the prospective design, adequate sample size, and standardized radiological classification strengthen the reliability of findings.

In conclusion, the present study demonstrates that distal radius fractures in elderly patients are predominantly osteoporotic fragility injuries caused by low-energy falls, most commonly affecting postmenopausal women and the non-dominant hand. Extra-articular fracture types predominate, and outcomes are favorable with appropriate treatment selection and rehabilitation. The findings highlight the urgent need for systematic osteoporosis screening and fall-prevention strategies to reduce fracture burden and preserve functional independence in the aging population.

CONCLUSION

Distal radius fractures among elderly individuals are common, predominantly resulting from low-energy domestic falls in osteoporotic women. Extra-articular fractures are the most frequent pattern, and functional outcomes are generally good with individualized management. The strong link between low bone mineral density and fracture incidence underscores the need for early diagnosis and comprehensive preventive strategies focusing on bone health, fall prevention, and patient education. Implementing such multidisciplinary measures can substantially reduce morbidity, healthcare costs, and long-term disability associated with geriatric distal radius fractures.

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