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RESEARCH ARTICLE
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DELAY IN FRACTURE CARE AND POPULATION-BASED OUTCOMES IN RURAL KERALA: A MULTI-CENTRIC ORTHOPAEDIC ANALYSIS.

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ABSTRACT:
Background: Timely fracture care is critical in preventing complications and ensuring optimal recovery. However, in rural India, especially in states like Kerala with a rapidly aging population, access to early orthopaedic intervention remains inconsistent.
Aim of the Study: To evaluate the factors that delay in fracture management and their outcomes across multiple rural centres in Kerala.
Methods: A multicentre cross-sectional study was conducted in three rural tertiary hospitals across northern, central, and southern districts of Kerala between January and December 2023. Data from 216 patients with fresh fractures were analyzed for time to care, reasons for delay, treatment modality, and functional outcome at 6 months using the Modified Harris Hip Score (for lower limb fractures) and DASH (Disabilities of the Arm, Shoulder, and Hand) score for upper limb fractures.
Results: Among 604 patients, 55.09% reported delays exceeding 48 hours post-injury. Major causes included transportation difficulty (36.57%), referral delays from primary centres (31.48%), and financial constraints (18.05%). Patients with delayed intervention had significantly lower functional recovery scores at 6 months ($p<0.01$). Open fractures, elderly patients (>60 years), and those with co-morbidities were particularly vulnerable to poor outcomes.
Conclusion: Delay in fracture management in rural Kerala is substantial and significantly impacts patient recovery. Strengthening referral networks, ambulance availability, and early orthopaedic triaging at primary health levels is essential to improve fracture care outcomes.

Keywords: fracture delay, rural health, Kerala, orthopaedic outcomes, multicentre study

INTRODUCTION

Fractures are a leading cause of morbidity globally, but timely access to orthopaedic care remains a challenge in many low- and middle-income countries, including India. While Kerala boasts one of the best public health indices in the country, healthcare access in its rural areas still presents challenges, particularly in time-sensitive trauma cases (1). India's burden of musculoskeletal injuries

has been increasing, attributed to rising road traffic accidents, falls in elderly populations, and work-related injuries (2). Studies from North India have shown that delays beyond 24–48 hours significantly worsen long-term outcomes and increase complications such as malunion, non-union, infection, and disability (3). Despite this, regional data on fracture care timelines and outcomes in rural southern India, particularly Kerala, remain scarce. Kerala's aging population presents a unique orthopaedic challenge. As per Census 2011, nearly 13% of the state's population is aged 60 and above, projected to rise to over 20% by 2031 (4). With osteoporosis and fall-related injuries on the rise, fractures are becoming increasingly common in rural elderly populations. However, the triage and referral systems from primary care centres to tertiary orthopaedic units are often delayed due to infrastructure limitations, lack of trained personnel, and inadequate transportation (5). This study aims to assess the extent and impact of delays in fracture care through a multicentre orthopaedic evaluation in rural Kerala. It further examines the reasons for delays and their association with clinical and functional outcomes, contributing to region-specific evidence for policy-level orthopaedic service improvement.

MATERIALS

This multicentre cross-sectional study was conducted over a period of 12 months from January to December 2023 in three rural tertiary care hospitals located in geographically diverse zones of Kerala: Kannur Medical College, Anjarakandy, Kannur (North Kerala), Palakkad District Hospital (Central Kerala), Malappuram and Kozhikode Rural health centres. These centres were selected based on their patient load, rural catchment area, and availability of orthopaedic services. The study adhered to the Indian Council of Medical Research (ICMR) National Ethical Guidelines for Biomedical Research involving human participants (6). The study population included adult patients (≥18 years) presenting with fresh fractures of the upper or lower limbs within 14 days of trauma. Both closed and open fractures were considered. The inclusion criteria were: (a) fractures managed conservatively or surgically at the participating centres, (b) patients residing in rural areas within a 30 km radius of the hospital, and (c) those providing informed written consent. Exclusion criteria were: pathological fractures, spinal fractures, poly-trauma, and patients with cognitive impairment precluding valid consent. Delay in fracture care was operationally defined as the time interval exceeding 48 hours from the moment of injury to the initiation of definitive orthopaedic treatment (either surgical or conservative). This definition aligns with World Health Organization guidelines and the recommendations of the Indian Orthopaedic Association, which advocate early stabilization of fractures to prevent complications and optimize outcomes (7, 8). A structured case record form was used to capture demographic characteristics, injury mechanism, fracture type and site, time to first healthcare contact, referral pathway, mode of transport, healthcare facility accessibility, and time to initiation of definitive fracture care. Delays were categorized based on causative domains: transport-related, health-system related, financial constraints and personal delay (e.g., denial, fear, traditional healing). Functional outcome assessment was performed at six months post-treatment using validated tools. For lower limb fractures, the Modified Harris Hip Score (MHHS) was applied. For upper limb fractures, the Disabilities of the Arm, Shoulder, and Hand (DASH) score were used. Both tools are widely validated for functional recovery assessment in orthopaedic outcomes research and were administered either during follow-up visits or via telephonic interviews by trained physiotherapists blinded to the delay status.

Statistical Analysis: Data entry and cleaning were done using Microsoft Excel and analysis was carried out with IBM SPSS version 26. Descriptive statistics were calculated for all variables. Chi-square tests and independent t-tests were applied for bivariate analysis. Multivariate logistic regression was used to determine predictors of poor functional outcome, adjusting for age, co-morbidities, fracture type, and treatment delay. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 604 patients from three rural centres in Kerala were included in the final analysis. The mean age of participants was 52.6 ± 16.2 years, with 66.20% being male and 33.76% female. The majority of fractures were lower limb injuries (58.4%), and 41.20% involved upper limbs. Overall, 58.33% of the patients experienced delays greater than 48 hours before receiving definitive orthopaedic care. **(Table 1 and Fig 1)**

Variable	Category	Frequency (n)	Percentage (%)
Age group	18–39	044	20.37
	40–59	071	32.87
	≥60	101	46.75
Sex	Male	136	62.96
	Female	080	37.03
Fracture site	Lower limb	115	53.24
	Upper limb	101	46.75
Co-morbidities	Present	081	37.50
	Absent	135	62.50

Table 1: Socio-demographic and clinical characteristics of patients (n=216)

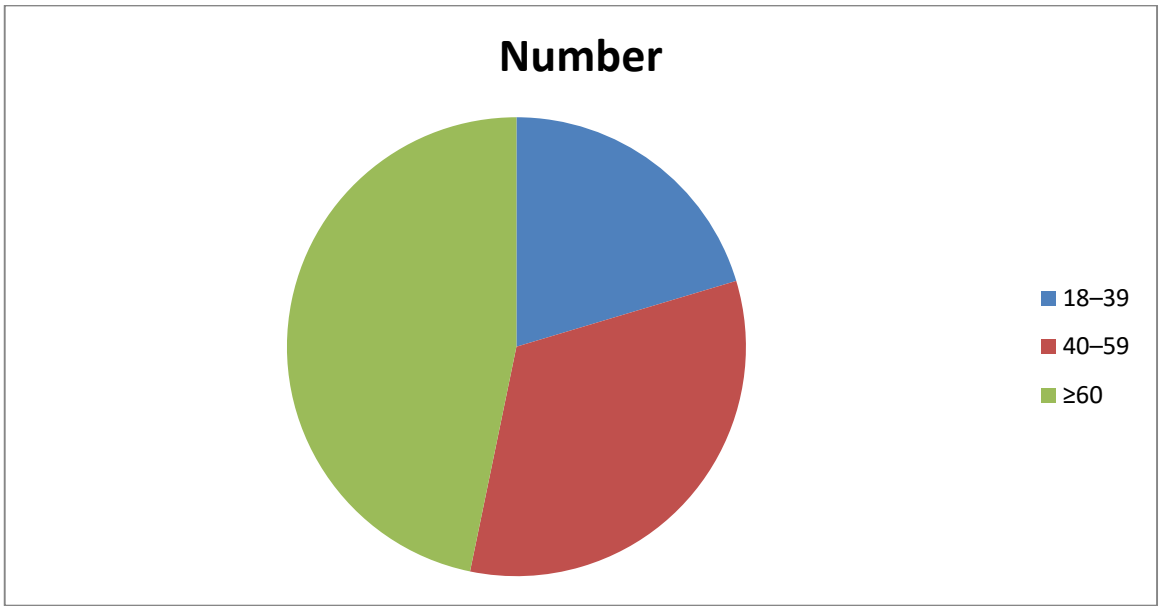

Figure 1: Distribution of Fracture Sites by Age Group (n-216)

The various reasons for the delay in treatment were studied and found that Transportation issues accounted for the large number of patients that is in 38.88%, followed by delay in referral system from rural health centres to the referral hospitals in 25.46%, followed by financial constraints in 17.59% and personal reluctance in the patients was observed in 09.72% of the patients **(Table 2)**

Reason for Delay	Frequency (n)	Percentage (%)
Transportation issues	084	38.88
Referral system delay	055	25.46
Financial constraints	038	17.59
Personal reluctance/traditional healing	021	09.72
Others	18	08.33

Table 2: Delay in care and contributing factors Reason for Delay Frequency (n-216).

The MHHS score and DASH scores were related to the two groups in the study namely the group where delay occurred for less than 48 hours and another group where the delay occurred for more than 48 hours. It was found that the mean values for both the groups was statistically significant with p value 0.001 (p taken as significant at <0.05, **(Table 3)**

Outcome Tool	Delay ≤ 48 hrs (Mean ± SD)	Delay > 48 hrs (Mean ± SD)	p-value
MHHS (Lower limb)	79.2 ± 08.25	63.5 ± 11.56	<0.01
DASH (Upper limb)	20.9 ± 6.6	29.8 ± 5.15	<0.01

Table 3: Showed the MHHS score and DASH score, in the groups: less than and more than 48 hours lapse for treatment in the study (n-216).

The final functional outcomes was observed in all the patients and found that the predictor Table 4:

The predictor values for assessing the Functional outcome of treatment of fractures of survey the present for fracture treatment in northern districts of Kerala were, age above 60 years, (with p value 0.002), presence of Co-morbidities present like High BMI, lack of exercise, and site of fracture (with p value 0.019), lower limb fractures (with p value 0.045) and delayed availability of treatment for more than 48 hours in less than (0.001). All the predictors were statistically significant. **(Table 4)**

Predictor Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Age ≥60 years	2.3	1.1–3.5	0.002
Co-morbidities present	2.2	1.1–2.3	0.019
Lower limb fracture	1.2	1.0–2.1	0.045
Delay > 48 hrs	2.3	1.3–3.7	<0.001

Table 4: Multivariate logistic regression for predictors of poor functional outcome

DISCUSSION

This multicentre study from rural Kerala provides valuable insights into the burden and determinants of delay in fracture care and its implications on patient outcomes. The observed delay in more than half of the patients (more than 48 hours) is consistent with previous reports from rural India, where infrastructural limitations and systemic gaps continue to hinder timely orthopaedic intervention (9). Our findings highlighted that transportation-related difficulties, referral pathway inefficiencies, and financial constraints were the predominant causes of treatment delays. A study conducted by Reddy et al. in (10) Telangana similarly noted that referral delays from peripheral health centres and poor road connectivity were major barriers to prompt treatment in trauma care, in rural districts (11). Despite Kerala's better health infrastructure, such delay persisted, especially in hilly and tribal belts, necessitating region-specific strategies. The association between treatment delay and poorer functional outcomes was significant in both upper and lower limb fractures. Patients with delays exceeding 48 hours demonstrated lower Modified Harris Hip Scores (MHHS) and higher DASH scores at 6-month follow-up. These findings aligned with an orthopaedic outcome study in rural Maharashtra by Sharma et al., (12) where early intervention was linked to better rehabilitation outcomes and fewer post-fracture complications. The results from multivariate regression reaffirm the significance of timely intervention. Treatment delayed for more than 48 hours, age ≥60 years, and the presence of co-morbidities were strong predictors of poor outcome. Older patients often have compromised healing capacity and are at higher risk for adverse events. Similar observations were made by Rajagopal et al. (13) in Tamil Nadu, where elderly rural patients with co-morbidities and delayed treatment showed higher rates of non-union and disability. From a public health perspective, these findings necessitate a multi-pronged strategy to improve

orthopaedic care access. First, strengthening the referral linkages between primary health centres and tertiary orthopaedic units is vital. Second, introducing district- level trauma care coordination centres could facilitate triage and transport. Third, the incorporation of trained community health workers for early detection and guidance may accelerate the treatment-seeking process, as proposed in the National Programme for Prevention and Control of Non-Communicable Diseases (NP-NCD) (11). A major strength of our study lies in its multicentre design covering three districts of northern Kerala, enhancing the generalization of the findings. Additionally, the use of validated functional outcome tools such as DASH and MHHS provided robust evidence linking care delay to recovery trajectories. However, the study had certain limitations. First, reliance on patient recall for reporting time to first contact and delays might introduce bias. Second, absence of radiographic progression data restricted anatomical outcome comparisons. In conclusion, this study emphasized the critical role of timely fracture care in determining orthopaedic recovery in rural Indian settings. It calls for system-level improvements in transport, triage, and decentralized fracture management. Addressing these delays is crucial for achieving better musculoskeletal outcomes, particularly for the elderly and economically vulnerable populations.

CONCLUSION

Fracture care in rural Kerala remains hampered by preventable delays, leading to adverse outcomes. Systemic reforms are essential—strengthening ambulance networks, integrating fracture triage protocols at PHCs, and mobilizing community health workers for early orthopaedic referrals. These interventions, aligned with the objectives of national programs like the NP-NCD, can significantly reduce disability burden and improve the quality of life in underserved populations.