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Hospital-acquired COVID-19 and deep vein thrombosis in orthopaedic inpatients: a retrospective cohort study in a resource-constrained setting

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ABSTRACT

Background: Hospital-acquired COVID-19 presents a distinct challenge in orthopaedic care within low- and middle-income country (LMIC) settings, where prolonged isolation, delayed mobilization and system constraints increase immobilization-related morbidity. Unlike high-income settings that emphasize respiratory outcomes, LMIC orthopaedic inpatients appear to face a disproportionate burden of thromboembolic complications, particularly deep vein thrombosis (DVT).
Methods: A retrospective cohort study was conducted at a South Indian teaching hospital between January 2020 and December 2025. Orthopaedic inpatients with RT-PCR–confirmed COVID-19 were categorized as having nosocomial or community-acquired infection based on timing of diagnosis. Demographic data, injury and treatment characteristics, immobilization duration, comorbidity burden, thromboprophylaxis use and vitamin D status were analysed. DVT was diagnosed using duplex ultrasonography and multivariable logistic regression identified independent predictors.
Results: Of 217 patients (median age 48 years; 68.2% male), 68 developed nosocomial COVID-19. Hospital-acquired infection was associated with significantly longer hospital stay and immobilization. Overall DVT incidence was 11.1%, with a higher prevalence in nosocomial compared with community-acquired cases (19.1% vs. 7.4%). Nosocomial infection, immobilization exceeding seven days and vitamin D deficiency independently predicted DVT. In-hospital mortality did not differ between groups.
Conclusion: Hospital-acquired COVID-19 significantly increases DVT risk among orthopaedic inpatients in LMIC settings, driven primarily by prolonged immobilization. Preventive strategies should prioritize early mobilization, optimized isolation workflows and correction of modifiable risk factors to reduce avoidable thromboembolic morbidity.

Keywords: Hospital-acquired COVID-19, Deep vein thrombosis, Orthopaedic trauma, Immobilization, Vitamin D deficiency, LMIC

INTRODUCTION

Hospital-acquired COVID-19 infections represent an important yet underreported challenge in orthopaedic care within LMIC settings, where prolonged isolation protocols and health system constraints amplify immobilization-related morbidity.[1] Unlike reports from high-income countries that primarily focus on respiratory failure and mortality, orthopaedic wards in LMICs, particularly Indian teaching hospitals, experienced a distinct morbidity pattern dominated by thromboembolic complications such as DVT.[1,2] Factors contributing to this pattern include prolonged bed rest due to high bed occupancy, delayed

physiotherapy and inconsistent access to thromboprophylaxis.[2,3]

This retrospective study from South Indian teaching hospitals aimed to evaluate the incidence of duplex-confirmed DVT among orthopaedic patients with hospital-acquired COVID-19 compared with those presenting with community-acquired infection. Additionally, the study sought to examine the relationship between duration of immobilization and thromboembolic risk after accounting for injury characteristics, surgical management and comorbidities, assess vitamin D deficiency as a potentially modifiable risk factor and propose context-specific preventive strategies relevant to orthopaedic practice in resource-constrained settings.

METHODS

This study is a retrospective cohort analysis conducted at the Department of Orthopaedics, M.S. Ramaiah Memorial Hospital, Bengaluru, Karnataka, India, over a six-year period from January 2020 to December 2025. The study evaluated orthopaedic inpatients with reverse transcriptase polymerase chain reaction (RT-PCR) confirmed COVID-19 infection diagnosed during hospital admission. Ethical approval was obtained from the institutional review board prior to initiation of the study.

A total of 235 consecutive orthopaedic admissions with confirmed COVID-19 infection were initially identified. After exclusion of patients younger than 18 years, those discharged within 72 hours of admission and cases with incomplete medical records, 217 patients were included in the final analysis. Patients were stratified based on timing of COVID-19 diagnosis into nosocomial infection, defined as RT-PCR positivity occurring more than 48 hours after admission and community-acquired infection, defined as positivity at or within 48 hours of admission. Patient data were obtained from electronic medical records and included demographic variables (age and sex), injury characteristics (fracture type and anatomical location classified using the AO/OTA system, operative versus non-operative management), duration of immobilization (defined as the interval from admission to first documented ambulation) and comorbidity burden assessed using the Charlson comorbidity index. Details of thromboprophylaxis, including low-molecular-weight heparin use, duration and documented adherence, were recorded. Serum 25-hydroxyvitamin D levels were noted where available, with deficiency defined as <20 ng/ml. Duplex ultrasonography was performed routinely in patients immobilized for more than seven days and selectively in symptomatic patients to confirm proximal deep vein thrombosis.

Statistical analysis was performed using SPSS version 26. Continuous variables were summarized as medians with interquartile ranges and analyzed using the Mann–Whitney U test. Categorical variables were expressed as frequencies and percentages and compared using chi-square or Fisher's exact tests, as appropriate. Multivariable logistic regression analysis was used to identify independent predictors of deep vein thrombosis, including nosocomial infection status, duration of immobilization and vitamin D deficiency. Statistical significance was set at $p<0.05$.

RESULTS

Of the 217 patients included in the analysis (median age 48 years, interquartile range (IQR) 34 to 62; 68.2% male), 68 patients developed nosocomial COVID-19 infection, while 149 presented with community-acquired infection. Patients with nosocomial infection demonstrated a significantly longer median hospital stay and prolonged immobilization compared with those with community-acquired infection (both $p<0.001$). Overall, duplex-confirmed DVT was identified in 24 patients (11.1%). The incidence of DVT was significantly higher among patients with nosocomial COVID-19 compared with those with community-acquired infection (19.1% vs. 7.4%; $p=0.012$), as shown in Table 1. On multivariable logistic regression analysis, nosocomial infection status, immobilization exceeding seven days and vitamin D deficiency emerged as independent predictors of DVT after adjustment for potential confounders (Table 2). There was no statistically significant difference in in-hospital mortality between the nosocomial and community-acquired infection groups.

Table 1: Baseline characteristics and clinical outcomes stratified by COVID-19 acquisition.

Parameters		Nosocomial (N=68)	Community (n=149)	P value
Age (median, interquartile range-IQR) (in years)		50 (36–64)	(47.33–61)	0.21
Gender	Male	48 (70.6%)	100 (67.1%)	0.62
	Female	20 (29.4%)	49 (22.9%)	
Lower limb fractures		52 (76.5%)	108 (72.5%)	0.54
Operative management		38 (55.9%)	92 (61.7%)	0.41
Charlson index (median, IQR)		2 (1-3)	2 (1-3)	0.88
Thromboprophylaxis use (n %)		45 (66.2%)	112 (75.2%)	0.13
Vitamin D deficiency (n %)		50 (73.5%)	102 (68.5%)	0.47
Hospital stay (median, IQR, in days)		14 (9-21)	5 (3-8)	<0.001
Immobilization (median, IQR, in days)		10 (7-16)	4 (2-7)	<0.001
Deep vein thrombosis (n %)		13 (19.1%)	11 (7.4%)	0.012

Table 2: Multivariable logistic regression analysis identifying predictors of deep vein thrombosis.

Predictors	Adjusted OR	95% CI	P value
Nosocomial COVID - 19	2.8	1.1–7.1	0.028
Immobilization >7 days	4.1	1.6–10.5	0.003
Vitamin D deficiency	3.2	1.3–7.9	0.012
Operative management	1.4	0.6–3.4	0.41
Charlson index >/=3	1.6	0.7–3.8	0.27

DISCUSSION

Orthopaedic cohorts affected by COVID-19 have consistently demonstrated a predominance of middle-aged male patients, reflecting the demographic profile of trauma admissions during the pandemic. Prior studies have reported median ages ranging from the mid-40s to mid-50s with male representation between 60% and 75%, findings that closely align with our cohort, which demonstrated a median age of 48 years and a male predominance of 68.2%.[2,4] In contrast to several European series that reported a younger trauma demographic during lockdown periods, attributed to reduced vehicular traffic and high-energy injuries, The South Indian teaching hospital population reflects fracture epidemiology typical of low- and middle-income country settings, where occupational injuries, domestic falls and delayed presentations remained prevalent throughout the pandemic.[2,3] Importantly, age and sex distributions were comparable between patients with nosocomial and community-acquired COVID-19 infection, indicating a demographically balanced cohort. This similarity minimizes confounding related to baseline thromboembolic risk and strengthens the validity of subsequent comparisons in deep vein thrombosis incidence between groups, allowing observed differences to be more confidently attributed to infection timing, immobilization duration, and system-level factors rather than demographic variation of comparisons in thromboembolic outcomes between groups.

Orthopaedic trauma patterns during the COVID-19 pandemic have consistently demonstrated a predominance of lower limb injuries across both high-income and low- and middle-income country settings, reflecting a combination of traffic-related trauma and fragility fractures.[2,4,5] Existing literature reports lower extremity involvement in approximately two-thirds to four-fifths of cases, a distribution that was closely replicated in the present cohort.[5,6] Lower limb fractures constituted the majority of injuries in both nosocomial and community-acquired infection groups, with no significant intergroup difference, and fracture morphology conformed to commonly reported AO/OTA patterns involving the femur, tibia, and distal tibial plafond.[1,6] Importantly, unlike reports from several Western countries describing a reduction in high-energy trauma during lockdown periods, fracture patterns in Indian teaching hospitals remained largely unchanged, likely reflecting sustained occupational exposure, domestic injuries, and delayed healthcare access during the pandemic. The comparable anatomical distribution and injury severity between infection groups in the study minimize the potential for fracture-related confounding and support the interpretation that differences in thromboembolic outcomes were primarily driven by system-level factors such as prolonged immobilization associated with nosocomial COVID-19 infection rather than injury characteristics themselves.

Operative management rates in orthopaedic patients with COVID-19 have varied widely across published series, with reported surgical intervention ranging from approximately half to two-thirds of cases.[2,4,5] Early reports from high-income countries described a shift toward conservative treatment during the initial pandemic phases, largely driven by concerns regarding viral transmission, perioperative risk and resource reallocation. In contrast, many LMIC centers were compelled to maintain standard fixation protocols due to higher trauma volumes, limited feasibility of prolonged immobilization and differing healthcare delivery constraints.[1,6] In the present cohort, operative intervention rates were comparable between patients with nosocomial and community-acquired infection, reflecting the capacity of Indian teaching hospitals to sustain essential surgical services despite pandemic-related pressures. This parity in surgical management minimizes treatment-related confounding and suggests that differences in thromboembolic outcomes cannot be attributed to variations in operative decision-making or delay. Unlike several European series in which nosocomial cases experienced disproportionate postponement of surgery, the consistency of operative care in our setting isolates prolonged immobilization associated with hospital-acquired infection as the principal driver of increased deep vein thrombosis risk.[3]

Comorbidity burden among orthopaedic trauma patients with COVID-19 has been reported to be modest across international cohorts, with median Charlson comorbidity index scores typically ranging from 1 to 3, reflecting a predominance of working-age patients with controlled chronic illnesses.[2,4,5] This pattern was replicated in our cohort, where comorbidity profiles were comparable between nosocomial and community-acquired infection groups, with no significant intergroup difference in Charlson scores. The comorbidity spectrum was dominated by diabetes mellitus and hypertension, consistent with epidemiological patterns observed in urban

Indian fracture populations.[7,8] The similarity in baseline health status between groups minimizes the likelihood of chronic disease acting as a confounder for thromboembolic outcomes in our analysis. This contrasts with several North American series in which higher cardiovascular comorbidity burdens have been shown to influence both COVID-19 severity and thrombosis risk.[3,7,9] The observed parity in comorbidity profiles in our cohort therefore strengthens the inference that differences in deep vein thrombosis incidence are more plausibly attributable to infection timing and immobilization-related factors rather than underlying systemic disease.

Adherence to pharmacological thromboprophylaxis in orthopaedic patients with COVID-19 has demonstrated wide variability across published cohorts, with reported utilization rates ranging from 55% to 85% globally.8,9 Lower adherence has been consistently observed in LMIC settings, largely attributable to medication supply constraints, staffing shortages and competing clinical demands during pandemic surges.[5,8,9] In the present cohort, low-molecular-weight heparin was administered in 66.2% of nosocomial cases and 75.2% of community-acquired cases, a difference that was not statistically significant, reflecting real-world gaps despite guideline recommendations.

Importantly, this non-significant disparity in thromboprophylaxis exposure was accompanied by a persistently higher incidence of deep vein thrombosis among nosocomial patients, indicating that standard pharmacological prophylaxis alone was insufficient to mitigate the thrombotic risk associated with isolation-mandated immobilization. This contrasts with reports from high-income settings, where prophylaxis compliance exceeding 90%, combined with structured early mobilization protocols, has been associated with lower thromboembolic rates.[2,4,10] Collectively, these findings suggest that in resource-constrained orthopaedic settings, pharmacological thromboprophylaxis must be complemented by system-level strategies aimed at minimizing immobilization to effectively reduce venous thromboembolism risk. Hospital-acquired COVID-19 has been consistently associated with a marked prolongation of hospital stay in orthopaedic cohorts, with multiple international studies reporting median lengths of stay ranging from 12 to 16 days compared with 4 to 6 days for community-acquired infection.[1,10,11] This disparity is largely attributed to mandatory isolation and cohorting protocols implemented during the pandemic. The findings corroborate this pattern, with patients acquiring COVID-19 during hospitalization demonstrating a significantly longer median length of stay compared with those presenting with community-acquired infection.

In the context of a South Indian teaching hospital, this prolonged hospitalization reflects system-level pressures, including bed occupancy exceeding 90% during pandemic surges, which necessitated extended isolation and delayed patient turnover. Importantly, prolonged hospital stays in this setting likely compounded venous stasis beyond injury-related immobilization alone, distinguishing LMIC care environments from high-income settings where early discharge pathways and step-down isolation facilities mitigated hospitalization duration.[3,5,10] These differences underscore the role of health system constraints in amplifying thromboembolic risk among orthopaedic patients with nosocomial COVID-19.

Prolonged immobilization represents the central pathophysiological link between nosocomial COVID-19 infection and increased thromboembolic risk in orthopaedic patients, with international cohorts consistently reporting two- to threefold increases in bed rest duration among hospital-acquired cases.[8,10,11] This effect was clearly demonstrated in our cohort, where patients with nosocomial infection experienced significantly longer immobilization compared with those with community-acquired COVID-19. In the setting of Indian teaching hospitals, this disparity was directly driven by prolonged isolation mandates during periods of bed occupancy exceeding 90%, which delayed physiotherapy initiation and mobilization.[2,10,12]

Importantly, the magnitude of immobilization observed in the cohort exceeds that reported in high-income settings, where structured rehabilitation pathways and early discharge protocols mitigated prolonged bed rest. Reflecting this, multivariable analysis identified immobilization exceeding seven days as the strongest independent predictor of deep vein thrombosis (OR 4.1), underscoring the dominant contribution of immobilization to thromboembolic risk in resource-constrained orthopaedic care environments. The reported incidence of deep vein thrombosis among orthopaedic inpatients with COVID-19 varies widely in the literature, ranging from 7% to 40%, with several prospective cohorts demonstrating a two- to threefold higher risk in patients with hospital-acquired infection compared with those presenting from the community.[1,12,13]

In the present cohort, the prevalence of duplex-confirmed DVT was significantly higher among nosocomial cases than community-acquired cases, aligning closely with systematic reviews reporting DVT rates of 15% to 25% in LMIC trauma populations undergoing routine screening.[2,3] The implementation of a structured duplex ultrasonography protocol in the study, performed routinely in patients immobilized for more than seven days and selectively in symptomatic individuals likely enhanced case ascertainment compared with earlier reports relying on symptom-driven screening alone.[5] This methodological rigor strengthens the observed association between nosocomial COVID-19 and thromboembolic events and supports isolation-related immobilization as the dominant trigger for thrombosis in orthopaedic inpatients, rather than injury severity or baseline demographic factors. Multivariable analyses across COVID-19 orthopaedic cohorts have consistently identified prolonged immobilization, markers of hypercoagulability and

baseline comorbidity burden as the principal predictors of deep vein thrombosis, with reported odds ratios typically ranging from 2 to 5 in international studies.[8,13,15] In the present analysis, nosocomial COVID-19 status (OR 2.8, 95% CI 1.1 to 7.1), immobilization exceeding seven days (OR 4.1, 95% CI 1.6 to 10.5) and vitamin D deficiency (OR 3.2, 95% CI 1.3 to 7.9) emerged as independent predictors of DVT after adjustment for potential confounders. Notably, these factors demonstrated stronger predictive value than traditional risk stratification tools such as the PADUA score.[1,2] In contrast to high-income country models that emphasize laboratory-driven predictors such as escalating D-dimer levels, the risk factors identified in our cohort underscore system-level and potentially modifiable determinants of thrombosis.[3] These findings are particularly relevant to LMIC settings, where prolonged isolation protocols, delayed mobilization, and uncorrected vitamin D deficiency may represent actionable targets for reducing thromboembolic complications in orthopaedic inpatients with COVID-19.

Vitamin D deficiency is highly prevalent among Indian orthopaedic trauma populations, with reported rates ranging from 70% to 95%, substantially exceeding those observed in high-income country cohorts, where prevalence typically ranges between 15% and 35%.[7,16,17] Emerging evidence has linked hypovitaminosis D to endothelial dysfunction, impaired fibrinolysis and a prothrombotic state. In the cohort, vitamin D deficiency was common in both nosocomial and community-acquired COVID-19 groups (73.5% vs. 68.5%; p=0.47) and was independently associated with an increased risk of deep vein thrombosis on multivariable analysis (OR 3.2, 95% CI 1.3 to 7.9).[18] Importantly, vitamin D deficiency represents a modifiable risk factor that is particularly relevant in resource-constrained settings. Low-cost cholecalciferol supplementation, widely available in India at minimal expense, offers a pragmatic adjunct to conventional thromboprophylaxis strategies. This potentially impactful intervention is rarely emphasized in Western literature, underscoring the need for context-specific preventive frameworks tailored to LMIC orthopaedic practice.[1,2]

This study has several limitations inherent to its retrospective design. Selection bias cannot be entirely excluded despite consecutive sampling, as the exclusion of patients with incomplete medical records may have omitted individuals at higher risk. Residual confounding from unmeasured variables such as baseline mobility status, adherence to thromboprophylaxis, and underlying prothrombotic conditions remains possible despite multivariable adjustment. The use of routine duplex ultrasonography in immobilized patients, rather than symptom-driven screening alone, may have led to higher detection rates compared with other studies. Finally, the findings reflect the experience of an urban South Indian teaching hospital and may not be fully generalizable to other settings, although similar resource constraints are common across many low- and middle-income healthcare systems.

CONCLUSION

Hospital-acquired COVID-19 infection in orthopaedic in-patients is associated with a substantially increased risk of DVT compared with community-acquired infection in a resource-constrained setting. This elevated risk appears to be driven predominantly by prolonged immobilization resulting from isolation protocols and health system constraints, rather than differences in injury patterns, operative management, comorbidity burden or thromboprophylaxis exposure. Despite comparable functional care pathways, immobilization exceeding seven days and vitamin D deficiency emerged as key independent and potentially modifiable predictors of thromboembolic events.

These findings highlight a critical disconnect between standard pharmacological prophylaxis and real-world effectiveness in LMIC orthopaedic wards and underscore the need for context-specific preventive strategies that prioritize early mobilization, optimized isolation workflows, and correction of reversible risk factors. Tailoring thromboprophylaxis protocols to the realities of LMIC healthcare systems may be essential to reducing preventable morbidity associated with hospital-acquired COVID-19 in orthopaedic practice.

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