Clinical Outcomes of Pharmacological Venous Thromboembolism Prophylaxis Following Arthroplasty and Hip Fracture Surgery: A Prospective Study

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Abstract

Background: Major orthopaedic procedures, including total knee replacement (TKR), total hip replacement (THR), and hip fracture surgery, are associated with an increased risk of postoperative venous thromboembolism (VTE). Pharmacological thromboprophylaxis is widely used to reduce the incidence of deep vein thrombosis (DVT) and pulmonary embolism (PE), although anticoagulant therapy may be associated with bleeding and wound-related complications.

Aim: To evaluate the clinical outcomes of pharmacological VTE prophylaxis among patients undergoing arthroplasty and hip fracture surgery.

Materials and Methods: A prospective observational study was conducted in the Department of Orthopaedics, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, from March 2025 to February 2026. A total of 78 patients undergoing TKR, THR, or hip fracture surgery were included after obtaining informed consent. Patients with preoperative VTE, pregnancy, GFR <30 mL/min, cirrhosis, thrombocytopenia, and major pre-existing risk factors for thromboembolism were excluded. All participants received pharmacological prophylaxis with enoxaparin. Patients were followed postoperatively for the development of DVT, PE, bleeding complications, wound hematoma, lower-limb oedema, and mortality. Data were analysed using appropriate descriptive and inferential statistical methods, with $p<0.05$ considered statistically significant.

Results: Among the 78 patients, 66.7% were females and 33.3% were males. Osteoarthritis of the knee was the most common diagnosis (78.2%), followed by NOF fracture (15.4%). Bilateral TKR was performed in 39.7% and unilateral TKR in 38.5% of patients. Cemented arthroplasty was performed in 83.3%, while 16.7% underwent uncemented procedures. All patients received enoxaparin prophylaxis. Wound hematoma and bilateral lower-limb oedema were observed in 3.8% of patients. No proximal or distal DVT was detected. Pulmonary embolism occurred in 1.3% of patients, with the affected patient dying on the fifth postoperative day.

Conclusion: Pharmacological VTE prophylaxis with enoxaparin was associated with a low incidence of clinically evident thromboembolic and bleeding complications in patients undergoing major orthopaedic surgery. However, the occurrence of fatal PE despite prophylaxis highlights the need for continued postoperative vigilance and individualized assessment of thromboembolic risk. Larger prospective studies with longer follow-up are required to further establish the effectiveness and safety of pharmacological thromboprophylaxis in orthopaedic patients.

Keywords: Venous thromboembolism; Deep vein thrombosis; Pulmonary embolism; Enoxaparin; Thromboprophylaxis; Total knee replacement; Total hip replacement; Hip fracture.

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Introduction

Orthopaedic surgery is associated with a substantial risk of postoperative venous thromboembolism (VTE), particularly following major procedures involving the hip and knee.[1] VTE comprises deep vein thrombosis (DVT) and pulmonary embolism (PE), and remains an important cause of postoperative morbidity and mortality. Patients undergoing total hip arthroplasty (THA), total knee arthroplasty (TKA), and surgical treatment of hip fractures are particularly vulnerable because of the combination of advanced age, trauma, major surgery, postoperative immobilisation, and systemic activation of coagulation.[1,2]

The pathogenesis of postoperative VTE is classically explained by Virchow's triad, which consists of venous stasis, endothelial injury, and hypercoagulability. Orthopaedic procedures can contribute to all three components. Surgical manipulation and tissue injury activate coagulation pathways, while prolonged immobilisation and reduced lower-limb muscle-pump activity promote venous stasis. In addition, the inflammatory and hypercoagulable state associated with trauma and surgery further increases thrombus formation. DVT commonly originates in the deep veins of the calf and may remain confined to the distal veins or propagate proximally. Proximal thrombi are clinically important because they have a greater potential to embolise to the pulmonary circulation and produce PE.[3]

The clinical presentation of DVT is variable. Patients may remain completely asymptomatic or develop limb swelling, pain, tenderness, erythema, or increased limb circumference. Similarly, PE may be clinically silent or present with dyspnoea, chest pain, hypoxaemia, haemodynamic instability, or sudden death. The severity of clinical manifestations depends on the extent and location of thrombosis, the adequacy of collateral circulation, and the degree of vascular obstruction and inflammation. Importantly, the absence of symptoms does not exclude clinically relevant thrombosis.[3,4]

The incidence of postoperative VTE varies according to the surgical procedure, diagnostic method, patient population, and use of thromboprophylaxis. Venographic studies have demonstrated substantially higher rates of asymptomatic DVT than clinically apparent VTE following THA and TKA, highlighting the substantial burden of subclinical thrombosis.[4] In a prospective Japanese study involving major hip procedures, VTE was detected in 13.1% of patients undergoing primary THA and 18.1% of those undergoing surgery for hip fracture, demonstrating the particularly high thrombotic risk associated with hip fracture surgery.[5] Among patients receiving thromboprophylaxis after hip fracture, symptomatic VTE remains clinically relevant; a large UK study of 5,300 patients reported symptomatic VTE in 2.2%, with most events occurring within five weeks of the fracture.[6]

Evidence from large international studies further demonstrates that VTE remains an important postoperative complication in hip fracture patients despite contemporary surgical management and thromboprophylaxis. Analysis of patients enrolled in the FAITH and HEALTH trials reported symptomatic VTE in 2.5% of 2,520 hip fracture patients, including DVT in 1.4% and PE in 1.1%.[7] These findings emphasize the importance of identifying patients at increased risk and implementing appropriate preventive strategies.

Because postoperative VTE can result in prolonged hospitalisation, chronic venous complications, PE, and death, prevention is a major component of perioperative orthopaedic care. Current evidence-based guidelines support pharmacological prophylaxis, mechanical prophylaxis, or a combination of both according to the patient's individual risk of thrombosis and bleeding. For patients undergoing THA or TKA, aspirin or anticoagulants may be considered, while pharmacological prophylaxis is recommended for patients undergoing hip fracture repair.[1] Therefore, understanding the incidence, risk factors, clinical characteristics, and outcomes of VTE in orthopaedic surgical patients is essential for improving perioperative care and reducing potentially preventable thromboembolic complications.

Aim

To evaluate the clinical outcomes of pharmacological venous thromboembolism (VTE) prophylaxis in patients undergoing arthroplasty and hip fracture surgery, with particular emphasis on the effectiveness and safety of prophylactic therapy.

Objectives

To determine the incidence of symptomatic venous thromboembolism, including deep vein thrombosis (DVT) and pulmonary embolism (PE), following pharmacological VTE prophylaxis in patients undergoing arthroplasty and hip fracture surgery.

To assess the incidence of bleeding complications associated with pharmacological VTE prophylaxis.

To evaluate the occurrence of wound-related complications, including postoperative hematoma and wound bleeding.

Materials and Methods

This prospective observational study was conducted in the Department of Orthopaedics, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, over a period of 12 months from March 2025 to February 2026. The study was undertaken to evaluate the clinical outcomes of pharmacological venous thromboembolism (VTE) prophylaxis among patients undergoing total hip replacement (THR), total knee replacement (TKR), and hip fracture surgery. Prior to enrolment, the nature and purpose of the study were explained to all eligible participants, and written informed consent was obtained. The study participants were included according to predefined inclusion and exclusion criteria.

The sample size was calculated based on an alpha error of 11% and a prevalence of 43.2% reported in a previous study, resulting in a minimum calculated sample size of 78 patients. All patients presenting to the Department of Orthopaedics on Mondays, Wednesdays, and Fridays for THR, TKR, or hip fracture surgery constituted the sampling frame. Eligible patients who provided informed consent were consecutively enrolled until the required sample size was achieved. Patients were included if they consented to participate and were undergoing THR, TKR, or hip fracture surgery at the study institution. Patients who were unwilling to participate, had evidence of preoperative VTE, were pregnant, or had glomerular filtration rate (GFR) <30 mL/min, cirrhosis of the liver, or thrombocytopenia were excluded. Patients with pre-existing conditions or risk factors considered likely to independently predispose to thromboembolism, including smoking, alcohol consumption, chronic venous insufficiency, previous stroke, varicose veins, renal insufficiency, recent myocardial infarction, heart failure, and other significant thromboembolic risk factors, were also excluded.

Baseline demographic and clinical characteristics were recorded using a structured data collection proforma. Relevant perioperative details, type of orthopaedic procedure, pharmacological VTE prophylaxis administered, duration of prophylaxis, and postoperative clinical outcomes were documented. Participants were monitored for the development of clinically evident DVT or PE and for complications related to pharmacological prophylaxis, particularly bleeding and wound-related complications. The postoperative course, requirement for treatment modification, readmission, and mortality, where applicable, were also recorded.

Statistical Analysis

The collected data were entered into Microsoft Excel and subsequently analysed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation (SD) for normally distributed data and as median with interquartile range (IQR) for non-normally distributed data. Categorical variables were presented as frequencies and percentages. The distribution of continuous variables was assessed for normality before applying statistical tests. Comparisons between categorical variables were performed using the Chi-square test or Fisher's exact test, as appropriate. For comparison of continuous variables between two groups, the independent-samples t-test was used for normally distributed data, while the Mann–Whitney U test was used for non-normally distributed data. Where more than two groups were compared, one-way ANOVA or the Kruskal–Wallis test was applied as appropriate. The association between potential clinical risk factors and postoperative VTE or bleeding complications was assessed using appropriate inferential statistical tests. A two-sided p-value <0.05 was considered statistically significant.

Result:

A total of 78 patients were included in the study and data was analysed. It was found that 66.7% of patients were females and 33.3% of patients were males (Graph and Table 1). About 78.2% of patients were diagnosed with OA knee and 15.4% were diagnosed with NOF Fracture (Graph and Table 2). OA knee was bilateral in 39.7% of patients while in 25.6% of patients it was right sided. NOF fracture was seen more on the left side in 10.3% of patients while OA hip was seen on left side in 2.6% of patients. All the patients underwent recommended pre-operative procedures (PTT/aPTT and venous doppler).

About 39.7% of patients underwent Bilateral Total knee replacement followed by unilateral Total Knee Replacement that was performed in 38.5% of patients. Bilateral Total Hip Replacement was performed in 1.3% of patients. About 83.3% of patients had cemented and 16.7% of patients had uncemented.

In addition, all the participants received Injection Enoxaparin while its complication in the form of wound hematoma and bilateral lower limb oedema were observed only in 3.8% of patients (Graph and Table 7). None of the patients developed proximal or distal DVT, however, pulmonary embolism was observed in 1.3% of patients who died on 5th POD.

Tables and Graphs

Graph 1: Distribution of participants according to gender

Table 1: Distribution of participants according to gender

	Males		Females		Total	
	N	%	N	%	N	%
Gender	26	33.3	52	66.7	78	100

N-Number; %-Percentage

Graph 2: Distribution of participants according to diagnosis

Table 2: Distribution of participants according to diagnosis

Diagnosis	N	%
OA Hip	3	3.8
OA Knee	61	78.2
NOF Fracture	12	15.4
AVN HIP	1	1.3
Post Traumatic	1	1.3

N-Number; %-Percentage

Discussion

The present prospective study evaluated the clinical outcomes of pharmacological venous thromboembolism (VTE) prophylaxis among patients undergoing major orthopaedic procedures, including total knee replacement, total hip replacement, and hip fracture surgery. The study included 78 patients, of whom 66.7% were females and 33.3% were males. The predominance of female participants may be related to the relatively high proportion of patients with osteoarthritis knee in the study population, a condition that commonly affects older women. Osteoarthritis knee accounted for 78.2% of the diagnoses, while neck of femur (NOF) fracture accounted for 15.4%. Bilateral knee involvement was observed in 39.7%, whereas right-sided OA knee was present in 25.6%. These findings indicate that the study population predominantly represented patients undergoing elective arthroplasty for degenerative joint disease, with a smaller but clinically important group undergoing surgery for hip fracture.

All participants underwent the recommended preoperative evaluation, including coagulation assessment and venous Doppler examination. This approach was particularly relevant because the presence of preoperative VTE could influence postoperative thromboembolic outcomes. Patients with pre-existing VTE and several major thromboembolic or bleeding risk factors were excluded, thereby allowing the postoperative outcomes to be evaluated in a relatively selected population.

In the present study, bilateral total knee replacement was the most frequently performed procedure (39.7%), followed by unilateral total knee replacement (38.5%). Cemented arthroplasty was performed in 83.3% of patients, whereas 16.7% underwent uncemented procedures. Irrespective of the type of procedure, all patients received enoxaparin for pharmacological VTE prophylaxis. The absence of distal or proximal DVT in this cohort suggests a favourable prophylactic effect of the regimen. This finding is consistent with evidence supporting low-molecular-weight heparin (LMWH) as an effective pharmacological strategy for prevention of VTE following major orthopaedic surgery.[8] The American College of Chest Physicians (ACCP) recommends pharmacological prophylaxis for patients undergoing total hip arthroplasty, total knee arthroplasty, and hip fracture surgery, with LMWH being among the preferred options.[8]

The low incidence of bleeding-related complications in the present study is also noteworthy. Wound hematoma and bilateral lower-limb oedema were reported in only 3.8% of patients. Importantly, no major bleeding complication was reported. This suggests that enoxaparin was generally well tolerated in the selected study population. Nevertheless, the risk of bleeding remains an important consideration when prescribing anticoagulant prophylaxis, and current guidelines emphasize balancing thrombotic risk against bleeding risk.[9]

Despite the absence of DVT, pulmonary embolism occurred in 1.3% of patients, with the affected patient dying on the fifth postoperative day. This finding highlights that pharmacological prophylaxis substantially reduces, but does not completely eliminate, the risk of postoperative VTE. The occurrence of fatal PE despite prophylaxis reinforces the importance of early recognition of respiratory symptoms and continued vigilance during the postoperative period. The ACCP guidelines recommend prophylaxis for a minimum of 10–14 days following major orthopaedic surgery and consider extended prophylaxis in selected patients.[8] Similarly, the American Society of Hematology recommends pharmacological prophylaxis in patients undergoing hip fracture repair and recognizes the importance of individualized assessment of thrombosis and bleeding risks.[9]

Overall, the present findings suggest that enoxaparin prophylaxis was associated with a low incidence of clinically evident VTE and few bleeding complications in this study population. However, the occurrence of one fatal PE demonstrates that prophylaxis cannot completely prevent thromboembolic events. The relatively small sample

size and exclusion of patients with several pre-existing risk factors may have contributed to the low observed incidence of VTE. Larger prospective studies with longer postoperative follow-up and systematic surveillance for asymptomatic DVT would provide more robust estimates of the effectiveness and safety of pharmacological thromboprophylaxis.

Conclusion

The present prospective study demonstrates that pharmacological venous thromboembolism prophylaxis with enoxaparin was associated with favourable clinical outcomes in patients undergoing total knee replacement, total hip replacement, and hip fracture surgery. No cases of proximal or distal deep vein thrombosis were observed during the study period, while pulmonary embolism occurred in only 1.3% of patients and resulted in mortality on the fifth postoperative day. Bleeding-related complications, including wound hematoma and bilateral lower-limb oedema, were observed in only 3.8% of patients, with no major bleeding events documented. These findings suggest that enoxaparin provides effective VTE prophylaxis with a relatively low rate of complications in appropriately selected orthopaedic surgical patients. However, the occurrence of a fatal pulmonary embolism despite prophylaxis highlights that thromboembolic risk cannot be completely eliminated. Larger studies with longer follow-up and systematic screening for asymptomatic VTE are warranted to further establish the effectiveness and safety of pharmacological thromboprophylaxis in different orthopaedic surgical populations.

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