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Research Article

Oral versus Injectable Anticoagulants- a Prospective Study Evaluating Apixaban as a Patient-Friendly Alternative to Enoxaparin for DVT Prevention in Orthopaedic Trauma

Dr. Bekkem Mani Dinakar Reddy[1], Dr. Suriyan A M[2], Dr. M.Md.Saqlain[3], Dr. Alan Roy J[4], Dr. Girish Rao Suryakari[5], Dr. Nagakiran K V[6]

[1]Post Graduate Resident, Department of Orthopaedics, PESIMSR, Kuppam, A.P, India.
[2]Post Graduate Resident, Department of Orthopaedics, PESIMSR, Kuppam, A.P, India.
[3]Post Graduate Resident, Department of Orthopaedics, PESIMSR, Kuppam, A.P, India.
[4]Post Graduate Resident, Department of Orthopaedics, PESIMSR, Kuppam, A.P, India.
[5]Post Graduate Resident, Department of Orthopaedics, PESIMSR, Kuppam, A.P, India
[6]Professor and HOD, Department of Orthopaedics, Kuppam, A.P, India.
Email: [1]mdmsdinakar@gmail.com, [2]suriyananbu@gmail.com, [3]saqlainmmd@gmail.com, [4]anjacalan@yahoo.com, [5]girishrajput0472@gmail.com, drnagakiran@gmail.com[6]
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ABSTRACT

Background: Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE), is a major cause of morbidity and mortality in hospitalized orthopaedic and trauma patients. Its multifactorial pathogenesis—venous stasis, endothelial injury, and hypercoagulability (Virchow's triad)[1]—necessitates timely prophylaxis. Low molecular weight heparins (LMWH) have been standard, but limitations such as injection-site issues and bleeding risks have led to increased use of direct oral anticoagulants (DOACs) like apixaban[2,4]. Apixaban offers oral administration, predictable pharmacokinetics, and minimal monitoring[2]. Evidence suggests it is as effective as LMWH with potentially lower bleeding risk[3,5]. In trauma patients, anticoagulation must be tailored due to variable bleeding risk[5]. This study compares apixaban and enoxaparin in hip fracture patients to assess safety and effectiveness.

Methods: A prospective comparative study was conducted over 18 months at a tertiary orthopaedic centre. A total of 120 patients aged >45 years with fractures around the hip joint were enrolled and divided into two equal groups receiving either apixaban (2.5 mg orally twice daily) or enoxaparin (40 mg subcutaneously once daily) for DVT prophylaxis. Pre and post-intervention assessments included coagulation profile (PT, aPTT, INR) and Doppler studies. Safety was assessed through patient-reported bleeding and side effects; effectiveness was assessed through Doppler-confirmed absence of DVT.

Results: There were no statistically significant changes in PT, aPTT, or INR in either group post-intervention ($p > 0.05$). No episodes of DVT or major bleeding were reported in either group during the early postoperative period (~11th postoperative day). Patients in the apixaban group preferred oral administration over subcutaneous injection. Both groups demonstrated comparable safety and effectiveness profiles for DVT prophylaxis in the early postoperative period.

Conclusion: Apixaban was found to be as effective and safe as enoxaparin for DVT prophylaxis in patients undergoing orthopedic procedures for hip fractures. The convenience of oral administration favored patient preference, supporting apixaban's role as a viable alternative to enoxaparin. Larger randomized controlled trials with longer follow-up are recommended to confirm these findings and evaluate long-term outcomes.

INTRODUCTION

Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE), is a significant cause of morbidity and mortality, especially among hospitalized orthopaedic patients and trauma victims. The multifactorial pathogenesis—venous stasis, endothelial injury, and hypercoagulability (Virchow's triad)[1]—makes prophylaxis essential. While low molecular weight heparins (LMWH) have long been the standard for prevention, their need for subcutaneous administration and bleeding risks have driven the adoption of direct oral anticoagulants (DOACs) like apixaban, which offer oral dosing, predictable pharmacokinetics, and reduced monitoring[2,4].

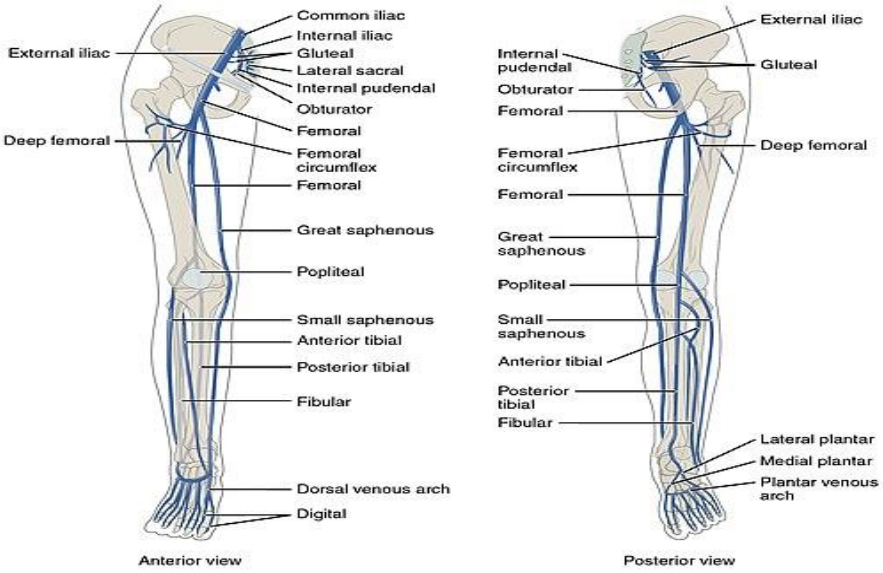
Recent studies show apixaban to be as effective as LMWH in preventing postoperative DVT, with a potentially lower bleeding risk[3,5]—particularly important in elderly patients. In trauma cases, however, anticoagulation strategies must be individualized due to complex coagulopathy and bleeding risks[5]. This thesis aims to compare enoxaparin and apixaban in orthopaedic trauma patients, evaluating efficacy, safety, and outcomes to guide evidence-based prophylaxis protocols that improve patient care and minimize complications.

History

The Sushruta Samhita (600–900 BC) contains the earliest known reference to deep vein thrombosis (DVT).[7] In 1271, a French manuscript described a 20-year-old male with leg DVT symptoms, marking an early Western account.[7,8] In 1856, Rudolf Virchow's experiments on embolism led to the identification of three thrombus-forming factors: hypercoagulability, stasis, and endothelial injury—later termed "Virchow's triad" in 1950.[9,10] Diagnostic progress began in the 1960s with ultrasound,[11] and by 1986, compression ultrasound became the preferred method, although plethysmography and venography remained common into the 1990s.[12] Anticoagulant treatment advanced from oral agents in the 1940s to subcutaneous low-dose heparin in 1962 and LMWH in 1982. The link between vascular inflammation and venous thrombosis was proposed in 1974.[13] Warfarin remained the standard for decades despite monitoring and injection drawbacks. Direct oral anticoagulants (DOACs) like rivaroxaban, apixaban, and dabigatran emerged in the late 2000s–early 2010s, offering greater convenience and prompting industry competition.[14,15]

Anatomy

Understanding venous anatomy is crucial for identifying underlying pathophysiological processes. The legs are drained by two parallel venous systems—the superficial and deep veins—which are interconnected through perforating veins that maintain continuity between the systems. In 2002, the terminology for the veins of the lower limb was updated[16], establishing standardized nomenclature from the common femoral vein proximally through the popliteal, tibial, and plantar systems to the pedal veins distally. Throughout the lower limb, perforating veins form connections between the superficial and deep venous systems at multiple locations, including the foot, medial and lateral aspects of the calf, and the thigh. The number and arrangement of these perforators are highly variable. In the foot, perforating veins are often valveless or may contain valves that allow blood to flow from the deep venous system toward the superficial veins[17].



Anatomy of lower limb Venous system

Deep Vein Thrombosis

Deep vein thrombosis (DVT) is a blood clot in a deep vein, most commonly in the lower limbs[18'19]. Symptoms include pain, swelling, warmth, and redness. A major complication is pulmonary embolism (PE), and together they

are called venous thromboembolism (VTE)[20]. Post-thrombotic syndrome (PTS) can cause chronic pain, swelling, and ulcers. Annual DVT incidence is ~1 in 1,000 adults, increasing with age. Roughly 50% of individuals with DVT exhibit symptoms, though these are not definitive for diagnosis as many patients have other conditions like cellulitis, Baker's cyst, muscle injuries, or lymphedema. A rare and severe manifestation is Phlegmasia cerulea dolens, which occurs in critically ill patients with almost complete venous obstruction, leading to an acutely painful, swollen, and cyanotic limb.

Pathophysiology and Risk Factors: Virchow's triad—stasis, hypercoagulability, and endothelial injury—explains DVT pathogenesis, with inflammation now considered a fourth thrombotic factor. DVT often begins in calf veins and may extend upward to femoral, iliac veins, or inferior vena cava. Unlike arterial thrombosis involving vessel wall injury, venous thrombi form without clear damage, initiated by tissue factor and dominated by fibrin and red blood cells. Clots often originate at venous valves due to stasis and hypoxemia, where hypoxia triggers HIF-1, EGR-1, ROS, and NF-κB pathways that promote monocyte adhesion and tissue factor release. Risk factors include acquired factors (old age, major surgery, cancer, immobilization, trauma, previous VTE, oral contraceptives, obesity), inherited factors (antithrombin deficiency, protein C/S deficiencies, Factor V Leiden, prothrombin G20210A), and mixed factors (low free protein S, activated protein C resistance, elevated factor levels).

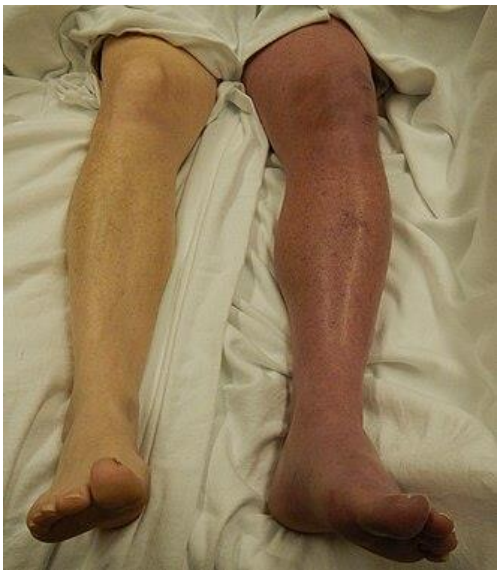


Image showing phlegmasia cerulea dolens in the left leg

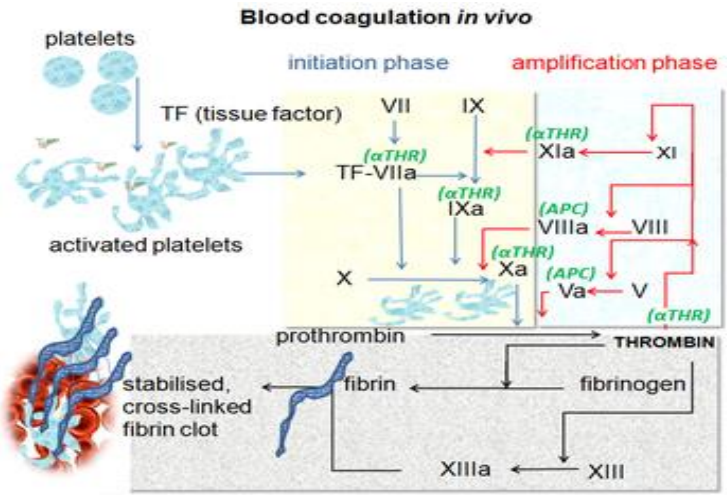
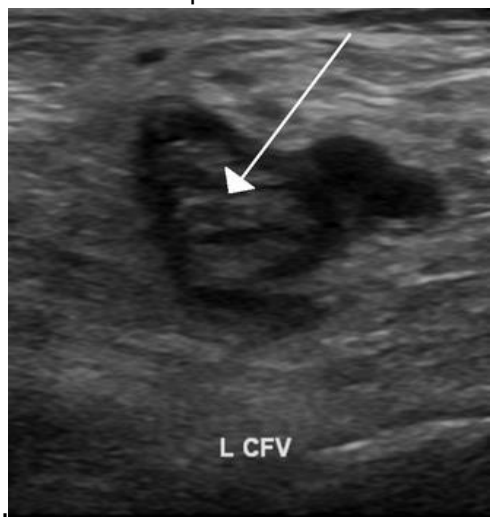
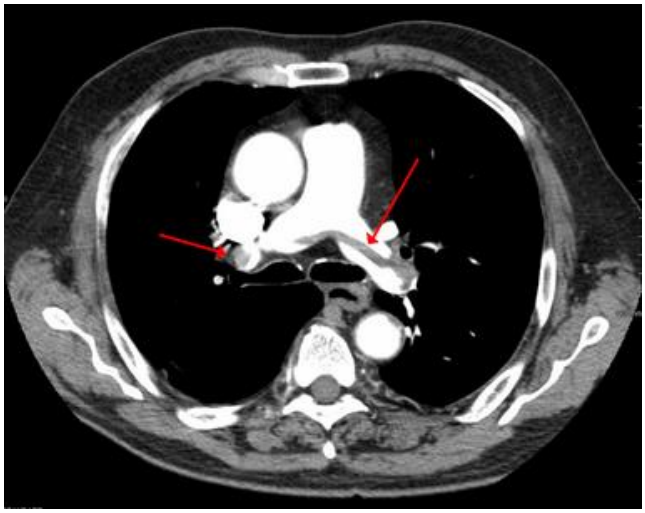


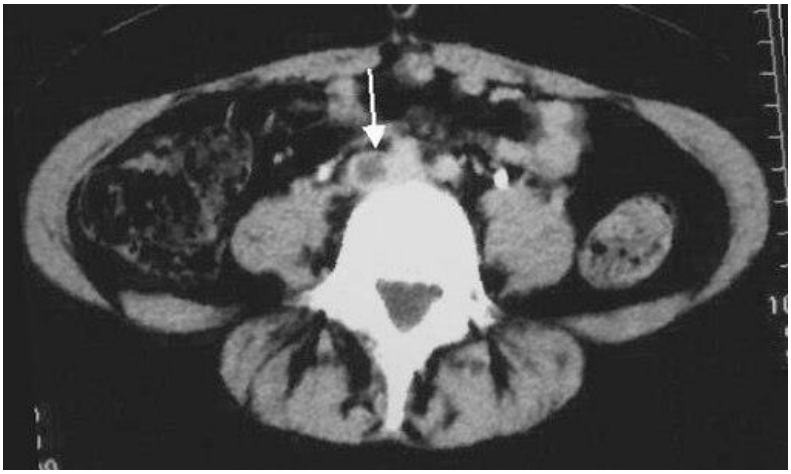
Image showing coagulation cascade in vivo



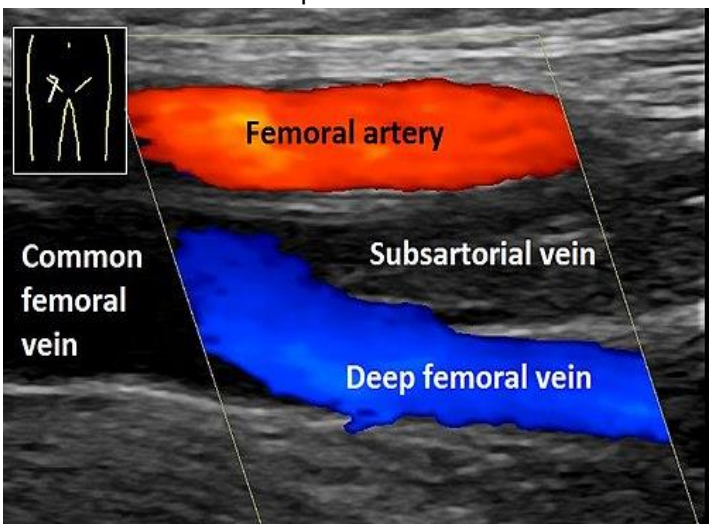
Ultrasound image showing blood clot in the left common femoral vein



CT image with red arrows showing PE (grey) in the pulmonary arteries (white)



Abdominal CT scan showing clot in the right common iliac vein of the pelvis. The arrow indicates filling defect in the vein visualized using radio contrast.



Doppler ultrasonography showing absence of flow and hyperechogenic content in a clotted femoral vein (labelled subsartorial) distal to the branching point of deep femoral vein.

Probability

A clinical probability assessment using the **Wells score** (see column in the table below) to determine if a potential DVT is "likely" or "unlikely" is typically the first step of the diagnostic process.

Wells score or criteria for DVT: (possible score −2 to 9)

1. Active cancer (treatment within last 6 months or palliative)	+1 point
2. Calf swelling ≥ 3 cm compared to asymptomatic calf (measured 10 cm below tibial tuberosity)	+1 point
3. Swollen unilateral superficial veins (non-varicose, in symptomatic leg)	+1 point
4. Unilateral pitting edema (in symptomatic leg)	+1 point
5. Previous documented DVT	+1 point
6. Swelling of entire leg	+1 point
7. Localized tenderness along the deep venous system	+1 point
8. Paralysis, paresis, or recent cast immobilization of lower extremities	+1 point
9. Recently bedridden ≥ 3 days, or major surgery requiring regional or general anesthetic in the past 12 weeks	+1 point
10. Alternative diagnosis to DVT as likely or more likely	−2 points

A Wells score can be interpreted in a binary (likely vs. unlikely) or ternary (low, moderate, or high probability) fashion. For a binary interpretation, scores of two or above are categorized as likely, while one and below means unlikely. For a ternary interpretation, scores of one and two are of moderate probability, while scores below or above are low and high probability, respectively. When people are segregated into binary groups, DVT prevalence is about 6% versus 28%. Ternary groups stratify prevalences into groups of about 5%, 17%, and 53%.

Diagnosis and Management: In clinical practice, imaging is typically used when D-dimer results are elevated or when patients present with high pre-test probability. The most widely used technique is venous ultrasound, including proximal compression ultrasound (focuses on veins above the knee but may miss distal DVT) and whole-leg ultrasound (covers both proximal and distal veins but may result in overdiagnosis of clinically insignificant distal clots). Other imaging modalities include Doppler ultrasound, CT venography, MRI venography, and direct MRI of the thrombus. Although rarely used, contrast venography remains the gold standard despite its invasive nature, high cost, and potential side effects.

Prevention and Treatment: DVT prevention includes regular exercise, leg movements during prolonged sitting, healthy weight maintenance, and avoiding smoking. In hospitalized patients, anticoagulants may help, especially in critically ill individuals. After major orthopedic surgery, combining anticoagulants

or aspirin with pneumatic compression devices is recommended. Treatment for DVT is typically required when clots are proximal, symptomatic distal, or symptomatic upper extremity. Anticoagulation is the standard approach when bleeding risk is low. For isolated distal DVT with mild symptoms and low recurrence risk, ultrasound monitoring may be used; otherwise, anticoagulation is given as for proximal DVT. Proximal DVT generally requires at least three months of anticoagulation. Anticoagulants include oral agents like warfarin (vitamin K antagonist), rivaroxaban, apixaban, and edoxaban (factor Xa inhibitors), and dabigatran (a direct thrombin inhibitor), as well as parenteral options.

Apixaban (Pharmacodynamics and pharmacokinetics)[1]

Apixaban is a direct factor Xa inhibitor that works independently of antithrombin, blocking the conversion of prothrombin to thrombin and thereby reducing thrombin-mediated clot formation. It also prolongs PT, INR, and aPTT, though these are not reliable for monitoring its effect. Pharmacokinetically, it has ~50% oral bioavailability and reaches peak plasma levels in 3–4 hours. It follows a linear dose-response up to 10 mg, has a 12-hour half-life, and is highly protein-bound, making dialysis ineffective. Apixaban is metabolized mainly by CYP3A4 and is a substrate for P-glycoprotein and BCRP. Elimination occurs via renal (27%) and fecal routes, with prolonged half-life in renal impairment.

Apixaban pharmacokinetics and pharmacodynamics

Mechanism of action	**Factor Xa inhibitor**
Bioavailability	50%, gastrointestinal
T (max)	3–4 hours
Distribution	87% protein bound
Half-life	8–13 hours (prolonged in renal impairment)
Monitoring	None required. Anti-Xa assay useful in determining if anticoagulant effect present
Dosing	Nonvalvular atrial fibrillation: 5 mg twice daily
	THR prophylaxis: 2.5 mg twice daily for 35 days
	TKR prophylaxis: 2.5 mg twice daily for 12 days
	VTE treatment: 10 mg twice daily for 7 days, then 5 mg twice daily
	Prophylaxis of recurrent VTE: 2.5 mg twice daily after at least 6 months of treatment
Dose adjustments	In patients with nonvalvular atrial fibrillation and at least two of the following: Age ≥80 years, body weight ≤60 kg, or serum creatinine ≥1.5 mg/dL, recommended dose is 2.5 mg twice daily
Metabolism	Hepatic CYP3A4 system
Elimination	25% renal, 75% biliary
Drug interactions	Potent P-gp and CYP3A4 inhibitors or inducers

Currently, apixaban is US FDA-approved to decrease the risk of stroke and systemic embolism in patients with nonvalvular atrial fibrillation, for DVT prophylaxis, which may lead to PE, in patients who have undergone knee or hip replacement surgery, for the treatment of DVT and PE, and for risk reduction of recurrent DVT and PE following initial therapy.[1]

Parenteral anticoagulants include:

- **Low-molecular-weight heparin (LMWH) –** examples**: Enoxaparin, Dalteparin**
- **Fondaparinux**
- **Unfractionated heparin**

Enoxaparin

Enoxaparin is a low molecular weight heparin (LMWH) derived from heparin, first approved for medical use in 1993, with a mean molecular weight of 4,000–5,000 Daltons. It acts as an indirect anticoagulant by binding to antithrombin III (ATIII) via a specific pentasaccharide sequence, enhancing ATIII's inhibition of factor Xa. Due to its shorter chain length, enoxaparin shows greater anti-Xa activity and reduced anti-IIa activity, with an anti-Xa:IIa ratio of 2:1 to 4:1, compared to 1:1 for unfractionated heparin. Peak anti-Xa activity occurs ~4 hours post-administration with ~90% subcutaneous bioavailability. Standard VTE prophylaxis dosing is 40mg subcutaneously daily. Elimination occurs

renally with 3-4.5 hour half-life for single doses, requiring dose adjustment when creatinine clearance <30 mL/min. Common adverse effects include bleeding, heparin-induced thrombocytopenia (HIT), and injection site reactions. Protamine sulfate partially reverses effects, neutralizing about 60% of LMWH anticoagulant activity.

Treatment Duration and Management: Among oral anticoagulants, rivaroxaban (once daily) and apixaban (twice daily) can be initiated without prior injectable therapy, while warfarin, dabigatran, and edoxaban require initial parenteral anticoagulation. For warfarin, this includes a minimum 5-day overlap until INR stabilizes between 2.0–3.0. DOACs like apixaban and rivaroxaban offer the advantage of not requiring regular INR monitoring. DVT anticoagulation duration depends on cause and recurrence risk—typically 3 months for surgery-related cases, longer for unprovoked events. High-risk patients may require indefinite therapy, guided by D-dimer levels. Thrombolysis, catheter-directed thrombolysis, and mechanical thrombectomy are used selectively in severe cases but carry bleeding risks. DVT has a 6% 30-day mortality, with PE and post-thrombotic syndrome being major complications. Recurrence occurs in 30% over 10 years, especially after unprovoked or cancer-related events.

Aim and Objective of the Study

To assess effectiveness and safety of apixaban vs enoxaparin as prophylactic agents in deep vein thrombosis (DVT) prophylaxis following orthopaedic procedures in patients with fractures around hip joint.

MATERIALS AND METHODS

Study Design: A prospective comparative study was conducted over 18 months at the Department of Orthopedics, PESIMSR Hospital, Kuppam, using purposive sampling technique with a sample size of 120 patients (60 per group, calculated based on Hui Jiang et al[5]).

Participants: Patients aged >45 years with fractures around the hip joint at high risk of developing DVT were included. Exclusion criteria comprised patients with previous DVT/PE, existing anticoagulant therapy, coagulation disorders, hepatic/renal diseases, known drug allergies, or bleeding complications.

Intervention: After ethical approval and informed consent, patients were divided into two groups: Group A received apixaban (2.5mg orally twice daily) and Group B received enoxaparin (40mg subcutaneously once daily). Both treatments were initiated 12-24 hours post-surgery. The treating consultant decided drug allocation after patient counseling.

Assessment: Wells criteria were used for DVT risk stratification, with moderate and high-risk patients receiving prophylaxis. Preoperative coagulation profile and Doppler scanning excluded existing DVT. Safety assessment included daily questionnaires for bleeding symptoms (gum bleeds, subconjunctival hemorrhages, black stools, hematemesis) and stool occult blood testing when indicated. Effectiveness was assessed by repeating coagulation profile and Doppler studies prior to discharge (~11th postoperative day) to confirm DVT absence. Additional investigations included complete blood count, serum electrolytes, liver/kidney function tests, ECG, chest X-ray, and D-dimer/2D-ECHO when clinically indicated.

RESULTS AND OBSERVATIONS

Demographic Characteristics

Age Distribution: The study enrolled 120 patients with hip fractures, with the majority being elderly (46.67% >71 years, 25.83% aged 61-70 years). Only 11.67% were <50 years, reflecting the typical age-related fracture pattern.

Gender: Males comprised 55.83% (n=67) of the cohort, while females represented 44.17% (n=53).

Injury Mechanism: Low-energy trauma predominated, with 85.83% (n=103) resulting from slip and fall accidents, while only 14.17% (n=17) were due to road traffic accidents.

Pre-injury Mobility: Most patients (58.33%, n=70) were community ambulators, while 41.67% (n=50) were household ambulators, indicating a relatively functional baseline population.

Clinical Characteristics

Comorbidities: 55% (n=66) had no comorbidities. Among those with comorbidities, diabetes mellitus was most common (15%, n=18), followed by hypertension (12.5%, n=15), and combined diabetes-hypertension (10%, n=12).

Presentation Timing: 79.17% (n=95) presented within 0-3 days post-injury, 15.83% (n=19) within 4-7 days, and only 5% (n=6) after >7 days, reflecting prompt medical attention.

Fracture Types: Intertrochanteric fractures were most prevalent (53.33%, n=64), followed by neck of femur fractures (37.5%, n=45), and subtrochanteric fractures (9.17%, n=11). Laterality was nearly equal (53.33% right, 46.67% left).

Surgical Procedures: CRIF with PFN was performed in 60.83% (n=73), bipolar hemiarthroplasty in 36.67% (n=44), and ORIF with DHS in 2.5% (n=3).

Intervention and Coagulation Analysis

DVT Prophylaxis: Patients were equally divided between apixaban (50%, n=60) and enoxaparin (50%, n=60) groups.

Coagulation Parameters:

Overall Changes (Pre vs Post-intervention, n=120):

- **PT**: 13.16±2.12 vs 13.20±1.79 seconds (p=0.893)
- **aPTT**: 29.89±3.65 vs 30.30±3.81 seconds (p=0.368)
- **INR**: 1.0045±0.0230 vs 1.005±0.0242 (p=0.761)

Between-Group Comparisons

Pre-intervention (no significant differences):

- **PT**: Apixaban 13.17±2.13 vs Enoxaparin 13.16±2.14 sec (p=0.9625)
- **aPTT**: Apixaban 29.46±3.63 vs Enoxaparin 30.31±3.66 sec (p=0.2031)
- **INR**: Apixaban 1.01±0.32 vs Enoxaparin 1.00±0.004 (p=0.0952)

Post-intervention (no significant differences):

- **PT**: Apixaban 13.01±2.13 vs Enoxaparin 13.39±1.35 sec (p=0.2414)
- **aPTT**: Apixaban 30.03±3.99 vs Enoxaparin 30.57±3.63 sec (p=0.4340)
- **INR**: Apixaban 1.01±0.27 vs Enoxaparin 1.00±0.20 (p=0.1132)

Key Findings

1. Coagulation Stability: Neither apixaban nor enoxaparin significantly altered coagulation parameters (PT, aPTT, INR) from baseline, indicating hemostatic stability.
2. Group Comparability: No significant differences in coagulation parameters between treatment groups at baseline or post-intervention, suggesting equivalent effects on hemostasis.
3. Patient Population: The cohort represented typical hip fracture demographics with predominantly elderly patients suffering low-energy trauma, with a substantial proportion having minimal comorbidities.
4. Clinical Practice Patterns: Preference for minimally invasive fixation methods (CRIF with PFN) and prompt medical attention-seeking behavior were observed.

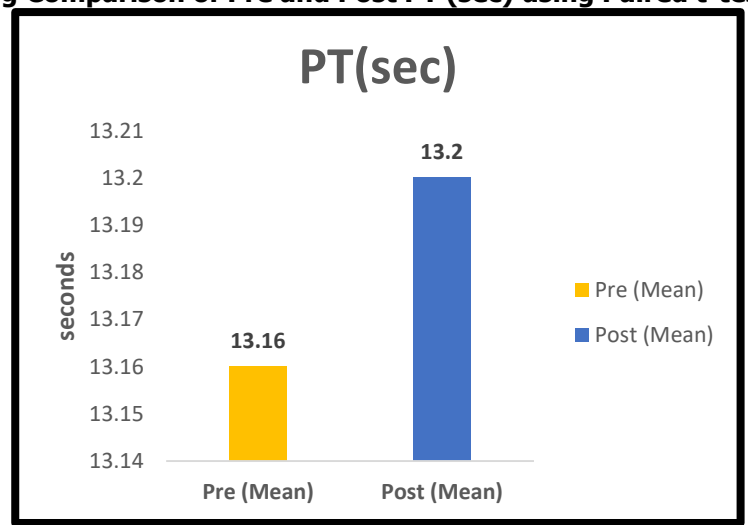
The results demonstrate that both anticoagulants maintained stable coagulation profiles without significant inter-group differences, supporting their comparable safety from a hemostatic perspective.

Interpretation of Coagulation Profile Parameters (PT, aPTT, INR) Pre and Post Intervention (DVT prophylaxis) using paired t-tests among 120 participants.

Comparison of Pre and Post PT (sec)using Paired t-test (n = 120)

Parameter	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t-value	p-value
PT(sec)	13.16 ± 2.12	13.20 ± 1.79	-0.13	0.893

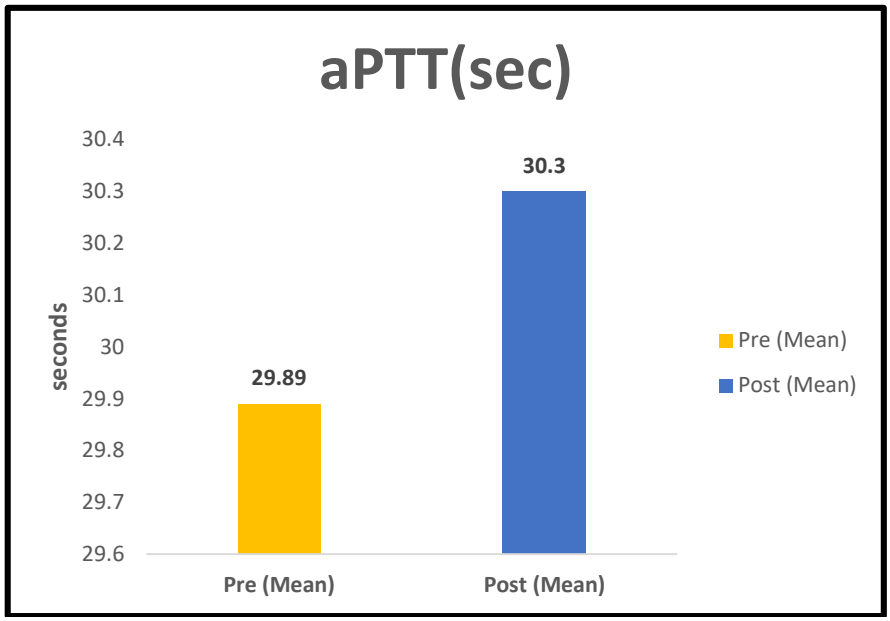
Bar chart showing Comparison of Pre and Post PT (sec) using Paired t-test



Comparison of Pre and Post aPTT (sec)using Paired t-test (n = 120)

Parameter	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t-value	p-value
aPTT(sec)	29.89 ± 3.65	30.30 ± 3.81	-0.90	0.368

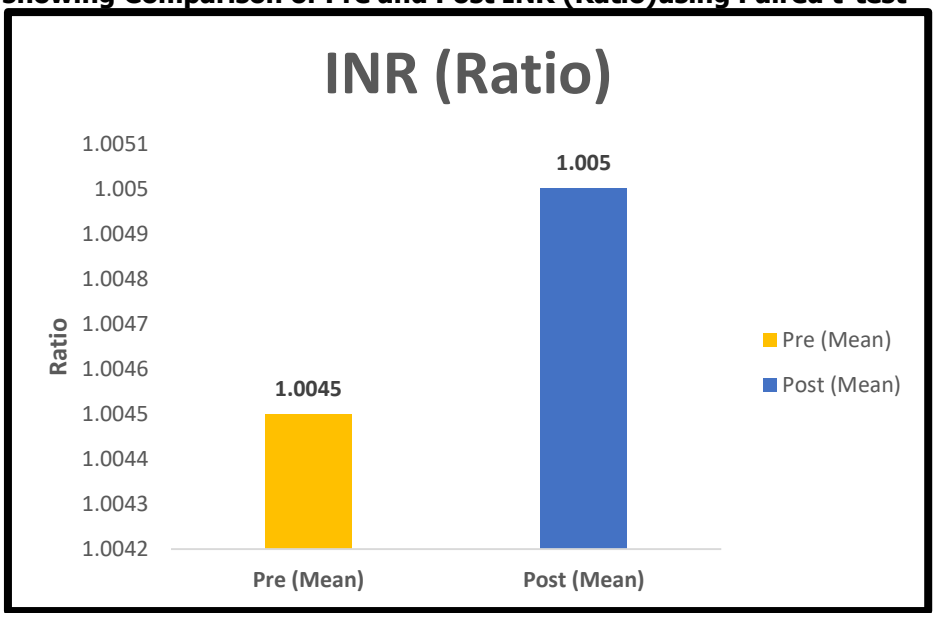
Bar chart showing Comparison of Pre and Post aPTT (sec)using Paired t-test



Comparison of Pre and Post INR (Ratio)using Paired t-test (n = 120)

Parameter	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t-value	p-value
INR (Ratio)	1.0045 ± 0.0230	1.005 ± 0.0242	-0.30	0.761

Bar chart showing Comparison of Pre and Post INR (Ratio)using Paired t-test



Interpretation of coagulation parameters between Apixaban and Enoxaparin groups using independent (Student's) t-tests:

Comparison of Pre PT (sec) by DVT Prophylaxis Drug (n = 60 per group) using Student's t-test

DVT Prophylaxis Drug	Pre-PT (Mean ± SD)	t-value	p-value
APIXABAN	13.17 ± 2.13	0.0471	0.9625
ENOXAPARIN	13.16 ± 2.14		

Comparison of Post PT (sec) by DVT Prophylaxis Drug (n = 60 per group) using Student's t-test

DVT Prophylaxis Drug	Post-PT (Mean ± SD)	t-value	p-value
APIXABAN	13.01 ± 2.13	-1.1775	0.2414
ENOXAPARIN	13.39 ±1.35		

Comparison of Pre aPTT (sec) by DVT Prophylaxis Drug (n = 60 per group) using Student's t-test

DVT Prophylaxis Drug	Pre-aPTT (Mean ± SD)	t-value	p-value
APIXABAN	29.46 ± 3.63	-1.2800	0.2031
ENOXAPARIN	30.31 ± 3.66		

Comparison of Post aPTT(sec) by DVT Prophylaxis Drug (n = 60 per group) using Student's t-test

DVT Prophylaxis Drug	Post-aPTT (Mean ± SD)	t-value	p-value
APIXABAN	30.03 ± 3.99	-0.7850	0.4340
ENOXAPARIN	30.57 ± 3.63		

Comparison of Pre INR (Ratio) by DVT Prophylaxis Drug (n = 60 per group) using Student's t-test

DVT Prophylaxis Drug	Pre-INR (Mean ± SD)	t-value	p-value
APIXABAN	1.01 ± 0.32	1.6822	0.0952
ENOXAPARIN	1.00 ± 0.004		

Comparison of Post INR (Ratio) by DVT Prophylaxis Drug (n = 60 per group) using Student's t-test

DVT Prophylaxis Drug	Post-INR (Mean ± SD)	t-value	p-value
APIXABAN	1.01 ± 0.27	1.5956	0.1132
ENOXAPARIN	1.00 ± 0.20		

Note on PT and INR Relationship:
Although INR is derived from PT and is generally expected to follow a proportional trend, minor discrepancies between PT and INR changes observed in this study are likely due to rounding, limited variability in PT values, or the influence of lab-calculated INR reference ranges. These variations do not reflect a true inverse relationship but are within the acceptable range of clinical and analytical variability.

DISCUSSION

This prospective comparative study compared the effectiveness and safety of Apixaban and Enoxaparin as prophylactic agents for Deep Vein Thrombosis (DVT) during the early post operative period (till post operative day- 11) in patients undergoing orthopaedic procedures for fractures around the hip joint. After following the Inclusion and Exclusion criteria, a total of 120 patients were enrolled and evenly divided between the two intervention arms. All the patients were mobilized and started on physiotherapy in the immediate post-operative period from post-operative day - 1 and were encouraged to do so even post-discharge.

Demographic and Clinical Characteristics

The majority of patients were over 70 years old (46.67%), consistent with known epidemiological data highlighting advanced age as a significant risk factor for both hip fractures and venous thromboembolism (VTE)【Afzal et al., 2019】[6]. Most injuries were due to low-energy mechanisms such as slip and fall (85.83%), reinforcing the vulnerability of the elderly to minor trauma.

Comparison of Coagulation Parameters Pre and Post Intervention

Across all patients, there were no statistically significant changes in coagulation parameters (PT, aPTT, INR) post-intervention, either within or between the Apixaban and Enoxaparin groups (Tables 15–23). This stability in coagulation profile suggests that both drugs are safe from a haemostatic standpoint in the context of routine DVT

prophylaxis in orthopaedic patients with fractures around hip joint.

Apixaban group showed a subtle decrease in PT post-intervention (13.17 to 13.01 seconds), whereas Enoxaparin showed a subtle increase (13.16 to 13.39 seconds) but these subtle changes were within the reference range; however, neither was statistically significant. This is consistent with existing literature which reports that Apixaban, being a direct factor Xa inhibitor, typically has minimal effect on traditional coagulation parameters like PT and INR due to assay variability【Mandernach et al., 2015】[1].

The aPTT and INR values in both groups remained within the normal range post-operatively, reinforcing findings from studies like Jiang et al. (2019)[5], where Apixaban was found to provide effective anticoagulation with minimal alteration in routine clotting tests.

Effectiveness Assessment

In our study, prior to discharge (on ~11th post operative day), patients in both groups were checked for the presence of DVT by repeating lower limb venous Doppler scan along with Coagulation profile. None of the participants in both groups had evidence of DVT following the intervention as suggested by Doppler scan results and Coagulation profile parameters indicating that both Apixaban and Enoxaparin are comparably effective as DVT prophylactic agents yielding desirable results in real-world settings.

Safety Assessment

Importantly, no major bleeding and minor bleeding (e.g., gum bleeds or subconjunctival hemorrhages) events were recorded in either group. The once-daily administration of Enoxaparin and twice-daily oral dosing of Apixaban were both well tolerated with no side-effects like nausea/vomiting noted following oral intake in Apixaban group and no local side-effects noted at injection site in Enoxaparin group indicating that both drugs are equally safe for DVT prophylaxis administration (i.e., both the drugs have a comparable safety profile).

The oral route of Apixaban offered greater convenience and patient satisfaction, in agreement with studies by Afzal et al. (2019)[6], which emphasized better compliance and quality of life associated with DOACs. Also, when asked if given a choice among the two drugs which one would they prefer, all participants in the study chose to prefer Apixaban over Enoxaparin due to its ease of oral intake on contrary to Enoxaparin's painful subcutaneous administration using syringe.

Comparative Literature Support

Kapoor et al. (2017)[3] concluded that Apixaban has equivalent efficacy and a better safety profile than Enoxaparin in elective orthopaedic surgeries. While most of the literature focuses on elective joint replacements, our study adds valuable data in a trauma-specific cohort — a population historically underrepresented in randomized trials【Paydar et al., 2016】[2].

Flevas et al. (2018)[4] noted the growing shift toward DOACs in orthopaedic practice due to ease of administration and reduced monitoring needs. The findings in our study support this trend, particularly highlighting the practicality of Apixaban in the post-trauma context.

Strengths of the Study

- Prospective design with standardized administration of prophylaxis.
- Direct comparison of two widely used agents with thorough safety monitoring.
- Inclusion of real-world orthopaedic trauma patients rather than elective cases.

Limitations

- Absence of long-term follow-up for late-onset DVT or post-thrombotic syndrome.
- Small sample size may limit the detection of rare events.
- Non-randomized allocation may introduce selection bias.

Clinical Implications

This study supports the safe and effective use of Apixaban as an alternative to Enoxaparin in orthopaedic trauma patients. Given its convenience of oral administration, it may enhance patient compliance avoiding injection-related discomfort or complications (e.g., bruising, pain, hematomas) and reduce hospitalization costs. However, larger randomized studies are needed to generalize these findings to broader trauma populations.

CONCLUSION

This prospective comparative study involved 120 participants undergoing orthopaedic procedures for fractures around the hip joint. Effectiveness and safety of Apixaban and Enoxaparin as prophylactic agents for Deep Vein Thrombosis (DVT) were compared during the early post operative period. There were no variations in the baseline demographic

variables between Apixaban and Enoxaparin groups and on analysis of coagulation parameters in pre-operative and early post-operative periods, both Apixaban and Enoxaparin did not alter the values as evidenced by independent t-tests and paired t-tests.

Subsequently, when patients' feedback was taken with respect to oral versus parenteral medications for DVT prophylaxis, all the patients preferred the usage of oral medications for DVT prophylaxis. In addition, the Apixaban group did not show any adverse events documented in the literature. So, we would like to conclude mentioning Apixaban as effective and safe as Enoxaparin with an added preference by the patient as an oral anticoagulant. Thus, the clinician is justified in selecting oral Apixaban over injectable Enoxaparin for DVT prophylaxis as per patients' preference and convenience.

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