Deep vein thrombosis (DVT) is a serious and common complication after major orthopedic surgery. The risk period for postoperative development of DVT begins at the time of total knee arthroplasty (TKA). Without prophylactic anticoagulation, the prevalence of DVT is as high as 84%, with proximal occurrence as high as 20%.1 Clinically significant portions of thrombi may be present beginning 24-48 hours postoperatively, peaking at 5-10 days, and continuing for up to several weeks.2 The prevalence of DVT is uncertain because of the nonspecific nature of clinical signs and symptoms. In the majority of patients with DVT, classical clinical findings, such as leg pain and swelling, shortness of breath, and chest pain, are absent and 30% of those who die of a pulmonary embolism have negative venous studies for DVT.3

Low-molecular-weight heparin has been studied extensively establishing it as safe and effective prophylaxis after TKA. Low molecular weight heparin is derived from unfractionated heparin and is formed by individual depolymerization procedures. With highly predictable pharmacokinetic properties and high bioavailability, it can be administered subcutaneously in fixed doses without requiring laboratory monitoring.4,5 A meta-analysis of studies suggests that the overall prevalence of DVT using low-molecular-weight heparin prophylaxis after TKA has a range of 29%-33%.1 Our previous research demonstrates that enoxaparin (Lovenox, Aventis, Bridgewater, NJ) 30 mg given subcutaneously every 12 hours following TKA resulted in an overall DVT prevalence of 24.6% (56/228), with a proximal rate of 2.2% (5/228) and a distal rate of 22.4% (51/228).6 Other clinical trials have indicated that enoxaparin 40 mg, given once preoperatively and as a single daily dose, is effective, safe, and well tolerated.4,7

This outcomes study evaluated the efficacy of DVT prophylaxis, using enoxaparin 40 mg administered once daily subcutaneously for 7 days following TKA. Presence of DVT, both asymptomatic and symptomatic, was assessed using bilateral lower extremity duplex ultrasound upon hospital discharge and on postoperative day 21 (±2). In 60 extremities, duplex ultrasound demonstrated a DVT prevalence of 16.7% (10) on the day of discharge and of 11.7% (7) on postoperative day 21. No new DVT or propagation of distal to proximal DVT were noted. For this small cohort, enoxaparin 40 mg daily demonstrates effective prophylaxis for DVT in TKA patients.

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symptomatic, was documented using bilateral lower extremity duplex ultrasonography screening. Our orthopedic research group routinely assesses practice management procedures performing outcomes studies to evaluate quality of care and system efficacies. An emphasis was placed on this study to refine our routine techniques and protocols.

**MATERIALS AND METHODS**

Patients scheduled for elective TKA were sequentially entered into this prospective outcomes study. No control group was included. Before enrollment in the study, a written informed consent, approved by the Scripps Human Subjects Committee, was obtained from each patient.

Patient inclusion criteria consisted of 1) signed informed consent prior to participation, 2) at least age 21 years, 3) clinically qualified for TKA, 4) physically and mentally willing and able to comply with the postoperative duplex ultrasound diagnostic testing, and 5) willing to receive enoxaparin 40 mg for 7 days postoperatively. Patients were excluded if unable or unwilling to comply with the outcomes protocol. Patients reflected Scripps Clinic population, which is 91% white, 6% Hispanic, 3% Asian, and 1% other ethnic backgrounds.

This study included 54 patients (25 men and 29 women) with 60 operated limbs. Average patient age was 68 years (range: 31-83 years). The left knee was operated on in 37 cases and the right knee in 23 cases, including 6 bilateral TKAs.

Patients who were enrolled in the study received enoxaparin 40 mg once daily by subcutaneous injection starting within 12-24 hours postoperatively and continuing for 7 days. Patients underwent bilateral ultrasound examination prior to hospital discharge (postoperative day 3 or 4), and returned on day 21 for clinical examination and repeat duplex ultrasound examination. Scripps Clinic ultrasound has been found to have 100% sensitivity, specificity, and accuracy for proximal DVT and 88% sensitivity, 98% specificity, and 98% accuracy for detection of distal DVT compared to venography.8

**RESULTS**

Duplex ultrasound demonstrated overall DVT prevalence of 16.7% (10/60) on the day of discharge. Three proximal DVTs accounted for 5% (3/60) and 7 distal DVT accounted for 11.7% (7/60) (Figure 1). Two proximal and 2 distal DVTs were treated with low-molecular weight-heparin and coumadin; the remainder was observed with repeated ultrasounds. On postoperative day 21,
a new finding of thrombi in the posterior tibial veins. Treatment regime of low-molecular-weight heparin and coumadin was implemented. Duplex ultrasound examination on postoperative day 21 demonstrated no change. No patient developed pulmonary symptoms during the study.

**DISCUSSION**

Using enoxaparin 40 mg given subcutaneously for 7 days is a safe and effective prophylaxis in reducing the occurrence of DVT. Patients undergoing TKA are routinely discharged from the hospital on or around postoperative day 3. The Division of Orthopedic Surgery has a successful history of using twice-daily dosing of enoxaparin 30 mg subcutaneously, ranging from 5-7 days after surgery following total joint arthroplasty.

Two European studies reported that use of a single preoperative dose of enoxaparin 40 mg and then once daily postoperatively was effective DVT prophylaxis. Planes et al9 evaluated the efficacy and safety of subcutaneous enoxaparin 40 mg administered once daily during hospitalization of 13-15 days. The prevalence of DVT at hospital discharge was 13%. This study provides evidence that enoxaparin 40 mg daily is effective, relatively safe, and well tolerated following total hip arthroplasty (THA).

In a study by Bergqvist et al,10 a single dose of enoxaparin 40 mg given subcutaneously before elective THA and during hospitalization, followed by randomization to enoxaparin 40 mg or placebo daily for 21 days after discharge, resulted in significantly fewer venous thromboembolic complications in patients in the enoxaparin group. None of the patients in Bergqvist et al’s10 study experienced clinical symptoms of DVT or pulmonary embolism during the active treatment phase during hospitalization. The incidence of adverse events leading to discontinuation of study medication, except for those related to venous thromboembolism disease, was similar in the two study groups.

In our study, the enoxaparin 40 mg once daily regime for 7 days postoperatively demonstrated effective prophylaxis against DVT in TKA patients. Enoxaparin 40 mg administered once daily in 60 TKA extremities resulted in an overall DVT prevalence of 16.7%, with 5% proximal prevalence and 11.7% distal prevalence. The findings compared favorably with an overall prevalence of 24.6% with proximal of 2.2% (5/228) and distal 22.4% (51/228) using enoxaparin 30 mg given subcutaneously every 12 hours following TKA in a previous study.6 Future studies with a larger cohort of patients would corroborate these findings.

**REFERENCES**


**What is already known on this topic**

- Total knee arthroplasty patients have a high incidence of deep vein thrombosis without prophylaxis.
- Prophylaxis with a pharmacologic agent is recommended by consensus conferences.

**What this article adds**

- Use of enoxaparin 40 mg once daily provides similar deep vein thrombosis outcomes to 30 mg twice daily after total knee arthroplasty.