

# Rates of Deep Vein Thrombosis Occurring After Osteotomy About the Knee

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## Abstract

We conducted a study to determine the rates of symptomatic deep vein thrombosis (DVT) and pulmonary embolism (PE) after high tibial osteotomy (HTO), distal femoral osteotomy (DFO), or tibial tubercle osteotomy (TTO) in patients who did not receive postoperative chemical prophylaxis.

All patients who had HTO, DFO, or TTO performed by a single surgeon between 2009 and 2014 were identified. Charts were reviewed to determine presence or absence of DVT or PE. Patient age, smoking status, oral contraceptive (OC) use, and body mass index (BMI) were recorded. Patients received no chemical or mechanical prophylaxis after surgery.

We identified 141 patients (44% male, 56% female) who underwent HTO, DFO, or TTO.

Mean (SD) age was 34.28 (9.86) years, mean (SD) follow-up was 17.1 (4.1) months, and mean (SD) BMI was 26.88 (5.11) kg/m<sup>2</sup>. Overall, 36.7% of female patients used OCs, and 13.48% of all patients were smokers.

After surgery, 2 patients (1.42%) developed below-knee DVT (unilateral in 1 case, bilateral in the other). The bilateral DVT case progressed to PE. Neither patient smoked, but the bilateral DVT/PE patient was using OCs. DVT patients' mean (SD) age was 48.16 (8.24) years, and their mean (SD) BMI was 23.18 (0.18) kg/m<sup>2</sup>.

HTO, DFO, and TTO patients who did not receive chemical prophylaxis had low rates of DVT (1.42%) and PE (0.71%). Administration of DVT/PE prophylaxis after these osteotomies may not be warranted.

High tibial osteotomy (HTO), distal femoral osteotomy (DFO), and tibial tubercle osteotomy (TTO) are viable treatment options for deformities about the knee and patella maltracking.<sup>1-4</sup> Although TTO can be performed in many ways (eg, anteriorization, anteromedialization, medialization), the basic idea is to move the tibial tubercle to improve patellar tracking or to offload a patellar facet that has sustained trauma or degenerated.<sup>2</sup> DFO is a surgical option for treating a valgus knee deformity (the lateral tibiofemoral compartment is offloaded) or for protecting a knee compartment after cartilage or meniscal restoration (medial closing wedge or lateral opening wedge).<sup>1</sup> Similarly, HTO is an option for treating a varus knee deformity or isolated medial compartment arthritis; the diseased compartment is offloaded, and any malalignment is corrected.

Akin to DFO, HTO is often performed to protect a knee compartment, typically the medial tibiofemoral compartment, after cartilage or meniscal restoration.<sup>2-4</sup>

Compared to most arthroscopic knee surgeries, these osteotomies are much more involved, have longer operative times, and restrict postoperative weight-bearing and range of motion.<sup>2,4</sup> The rates of deep vein thrombosis (DVT) and pulmonary embolism (PE) after these osteotomies are not well documented. In addition, there is no documentation of the risks in patients who smoke, are obese, or are using oral contraceptives (OCs) at time of surgery, despite the increased DVT and PE risks posed by smoking, obesity, and OC use in other surgical procedures.<sup>5-7</sup> Although the American Academy of Orthopaedic Surgeons (AAOS) issued clinical practice guidelines for DVT/PE prophylaxis after hip

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### Take-Home Points

- DVT and PE are uncommon complications following osteotomies about the knee.
- Use of oral contraceptives can increase the risk of a patient sustaining a postoperative DVT and PE following osteotomies about the knee.
- In the absence of significant risk factors, postoperative chemical DVT prophylaxis may be unnecessary in patients undergoing osteotomies about the knee.

and knee arthroplasty, there is no standard prophylaxis guidelines for DVT/PE prevention after HTO, DFO, or TTO.<sup>8,9</sup> Last, rates of DVT after total knee arthroplasty (TKA) are well defined; they range from 2% to 12%.<sup>10,11</sup> These rates may be surrogates for osteotomies about the knee, but this is only conjecture.

We conducted a study to determine the rates of symptomatic DVT and PE after HTO, DFO, or TTO in patients who did not receive postoperative DVT/PE prophylaxis. We also wanted to determine if age, body mass index (BMI), and smoking status have associations with the risk of developing either DVT or PE after HTO, DFO, or TTO. We hypothesized

that the DVT and PE rates would both be <1%.

### Methods

After this study was approved by our university's Institutional Review Board, we searched the surgical database of Dr. Cole, a sports medicine fellowship-trained surgeon, to identify all patients who had HTO, DFO, or TTO performed between September 1, 2009 and September 30, 2014. *Current Procedural Terminology (CPT)* codes were used for the search. The code for HTO was 27457: osteotomy, proximal tibia, including fibular excision or osteotomy (includes correction of genu varus [bowleg] or genu valgus [knock-knee]); after epiphyseal closure). The code for DFO was 27450: osteotomy, femur, shaft or supracondylar; with fixation. Last, the code for TTO was 27418: anterior tibial tubercleplasty (eg, Maquet-type procedure). The 141 patients identified in the search were treated by Dr. Cole at a single institution and were included in the study. Study inclusion did not require a minimum follow-up. Follow-up duration was defined as the time between surgery and the final clinic note in the patient chart. No patient was excluded for lack of follow-up clinic visits, and none was lost to follow-up.

Age, BMI, smoking status, and OC use were recorded for all patients. For each procedure, the surgeon's technique remained the same throughout the study period: HTO, medial opening-wedge osteotomy with plate-and-screw fixation; DFO, lateral opening-wedge osteotomy with plate-and-screw fixation; and TTO, mostly anteromedialization with

screw fixation (though this was dictated by patellar contact pressures). A tourniquet was used in all cases. Each patient's hospital electronic medical record and outpatient office notes were reviewed to determine if symptomatic DVT or PE developed after surgery. The diagnosis of symptomatic DVT was based on clinical symptoms and confirmatory ultrasound, and the PE diagnosis was based on computed tomography. Doppler ultrasound was performed only in symptomatic patients (ie, it was not routinely performed).

Per surgeon protocol, postoperative DVT prophylaxis was not administered. Patients were encouraged to begin dorsiflexion and plantar flexion of the ankle (ankle pumps) immediately and to mobilize as soon as comfortable. Each patient received a cold therapy machine with compression sleeve. Patients were allowed toe-touch weight-bearing for 6 weeks, and then progressed 25% per week for 4 weeks to full weight-bearing by 10 weeks. After surgery, each patient was placed in a brace, which was kept locked in extension for 10 days; when the brace was unlocked, the patient was allowed to range the knee.

Continuous variable data are reported as weighted means and weighted standard deviations. Categorical variable data are reported as frequencies and percentages.

### Results

Our database search identified 141 patients (44% male, 56% female) who underwent HTO (47 patients, 33.3%), DFO (13 patients, 9.2%), or TTO (81 patients, 57.5%). Mean (SD) age was 34.28 (9.86) years, mean (SD) BMI was 26.88 (5.11) kg/m<sup>2</sup>, and mean (SD) follow-up was 17.1 (4.1) months. Of the female patients, 36.7% were using OCs at time of surgery. Of all patients, 13.48% were smokers.

Two patients (1.42%) had clinical symptoms consistent with DVT. In each case, the diagnosis was confirmed with Doppler ultrasound. The below-knee DVT was unilateral in 1 case and bilateral in the other. The bilateral DVT case progressed to PE. Neither patient smoked, but the bilateral DVT/PE patient was using OCs. DVT patients' mean (SD) age was 48.16 (8.24) years, and their mean (SD) BMI was 23.18 (0.18) kg/m<sup>2</sup> (**Table**).

The unilateral DVT occurred in a patient who underwent anteromedialization of the tibial tubercle and osteochondral allograft transfer to the lateral femoral condyle for patellar maltracking and a focal trochlear defect. The DVT was diagnosed 8 days after surgery and was treated with warfarin.

Low-molecular-weight heparin (LMWH) was used as a bridge until the warfarin level was therapeutic (4 days). This male patient had no significant medical history.

The bilateral DVT with PE occurred in a patient who underwent a medial opening-wedge HTO for a varus deformity with right medial compartment osteoarthritis and a meniscal tear. The DVT and PE were diagnosed 48 hours after surgery, when the patient complained of lightheadedness and lost consciousness. She had no medical problems but was using OCs at time of surgery. The patient died 3 days after surgery and subsequently was found to have a maternal-side family history of DVT (the patient and her family physician had been unaware of this history).

### Discussion

As the rates of DVT and PE after osteotomies about the knee have not been well studied, we wanted to determine these rates after HTO, DFO, and TTO in patients who did not receive postoperative DVT prophylaxis. We hypothesized that DVT and PE rates would both be <1%, and this hypothesis was partly confirmed: The rate of PE after HTO, DFO, and TTO was <1%, and the rate of symptomatic DVT was >1%. Similarly, the patients who developed these complications were nonsmokers and had a BMI no higher than that of the patients who did not develop DVT or PE. In addition, only 1 patient developed DVT and PE, and she was using OCs and had a family history of DVT. Last, the patients who developed these complications were on average 14 years older than the patients who did not develop DVT or PE.

Although there is a plethora of reports on the incidence of DVT and PE after TKA, there is little on the incidence after osteotomies about the knee.<sup>8,12</sup> The rate of DVT after TKA varies, but many studies place it between 2% and 12%, and routinely find a PE rate of <0.5%.<sup>10,11,13,14</sup> Although the AAOS issued a clinical practice guideline for postoperative DVT prophylaxis after TKA, and evaluated the best available evidence, it could not reach consensus on a specific type of DVT prophylaxis, though the workgroup did recommend that patients be administered postoperative DVT prophylaxis of some kind.<sup>8,9</sup> Similarly, the American College of Chest Physicians (ACCP) issued clinical practice guidelines for preventing DVT and PE after elective TKA and total hip arthroplasty.<sup>15</sup> According to the ACCP guidelines, patients should receive prophylaxis—LMWH, fondaparinux, apixaban, dabigatran,

**Table. Demographics of Patients Who Developed and Patients Who Did Not Develop DVT or PE**

Demographic	Postoperative DVT/PE	
	No	Yes
Age, y (Mean [SD])	34.28 (9.86)	48.16 (8.24)
BMI, kg/m <sup>2</sup>	26.88 (5.11)	23.18 (0.18)
Male	44%	50%
Smoker	13.48%	0%
Oral contraceptive user	20.60%	50%

Abbreviations: BMI, body mass index; DVT, deep vein thrombosis; PE, pulmonary embolism.

rivaroxaban, low-dose unfractionated heparin, adjusted-dose vitamin K antagonist, aspirin, or an intermittent pneumatic compression device—for a minimum of 14 days. Unfortunately, though there are similarities between TKAs and peri-knee osteotomies, these procedures are markedly different, and it is difficult to extrapolate and adapt recommendations and produce a consensus statement for knee arthroplasties. In addition, guidelines exist for hospitalized patients who are being treated for medical conditions or have undergone surgery, but all the patients in the present study had their osteotomies performed on an outpatient basis.

Martin and colleagues<sup>16</sup> reviewed 323 cases of medial opening-wedge HTO and found a DVT rate of 1.4% in the absence of routine DVT prophylaxis, except in patients with a history of DVT. Their rate is almost identical to ours, but we also included other osteotomies in our study. Miller and colleagues<sup>17</sup> reviewed 46 cases of medial opening-wedge HTO and found a 4.3% DVT rate, despite routine prophylaxis with once-daily 325-mg aspirin and ankle pumps. This finding contrasts with our 1.42% DVT rate in the absence of postoperative chemical DVT prophylaxis. Motycka and colleagues<sup>18</sup> reviewed 65 HTO cases in which DVT prophylaxis (oral anticoagulant) was given for 6 weeks, and they found a DVT rate of 9.7%. Turner and colleagues<sup>19</sup> performed venous ultrasound on 81 consecutive patients who underwent HTO and received DVT prophylaxis (twice-daily subcutaneous heparin), and they found a DVT rate of 41% and a PE rate of 1.2%, though only 8.6% of the DVT cases were symptomatic. Of note, whereas

the lowest postoperative DVT rate was for patients who did not receive postoperative DVT prophylaxis, the rate of symptomatic DVT after these osteotomies ranged from 1.4% to 8.6% in patients who received prophylaxis.<sup>16,19</sup> Given this evidence and our study results, it appears routine chemical DVT prophylaxis after osteotomies about the knee may not be necessary, though higher level evidence is needed in order to make definitive recommendations.

In the present study, the 2 patients who developed symptomatic DVT (1 subsequently developed PE) were nonsmokers in good health. The female patient (DVT plus PE) was using OCs at time of surgery. Studies have shown that patients who smoke and who use OCs are at increased risk for developing DVT or PE after surgery.<sup>5,6,12</sup> Given that only 2 of our patients developed DVT/PE, and neither was a smoker, smoking was not associated with increased DVT or PE risk in this study population, in which 13.48% of patients were smokers at time of surgery. In addition, given that the 1 female patient who developed DVT/PE was using OCs and that 36.7% of all female patients in the study were using OCs, it is difficult to conclude whether OC use increased the female patient's risk for DVT or PE. Furthermore, neither the literature nor the AAOS consensus statement supports discontinuing OCs for this surgical procedure.

Patients in this study did not receive chemical or mechanical DVT prophylaxis after surgery. Regarding various post-TKA DVT prophylaxis regimens, aspirin is as effective as LMWH in preventing DVT, and the risk for postoperative blood loss and wound complications is lower with aspirin than with rivaroxaban.<sup>20,21</sup> Given that the present study's postoperative rates of DVT (1.42%) and PE (0.71%) are equal to or less than rates already reported in the literature, routine DVT prophylaxis after osteotomies about the knee may be unnecessary in the absence of other significant risk factors.<sup>16,19</sup> However, our study considered only symptomatic DVT and PE, so it is possible that the number of asymptomatic DVT cases is higher in this patient population. Definitively answering our study's clinical question will require a multicenter registry study (prospective cohort study).

### Study Limitations

The strengths of this study include the large number of patients treated by a single surgeon using the same postoperative protocol. Limitations of this study include the lack of a control group.

Although we found a DVT rate of 1.42% and a PE rate of 0.71%, the literature on the accepted risks for DVT and PE after HTO, DFO, and TTO is unclear. With our results stratified by procedure, the DVT rate was 2% in the HTO group, 0% in the DFO group, and 1% in the TTO group. However, we were unable to reliably stratify these results by each specific procedure, as the number of patients in each group would be too low. This study involved reviewing charts; as patients were not contacted, it is possible a patient developed DVT or PE, was treated at an outside facility, and then never followed up with the treating surgeon. Patients were identified by CPT codes, so, if a patient underwent HTO, DFO, or TTO that was recorded under a different CPT code, it is possible the patient was missed by our search. All patients were seen after surgery, and we reviewed the outpatient office notes that were taken, so unless the DVT or PE occurred after a patient's final postoperative visit, it would have been recorded. Similarly, the DVT and PE rates reported here cannot be extrapolated to overall risks for DVT and PE after osteotomies about the knee in all patients—only in patients who did not receive DVT prophylaxis after surgery.

### Conclusion

The rates of DVT and PE after HTO, DFO, and TTO in patients who did not receive chemical prophylaxis are low: 1.42% and 0.71%, respectively. After these osteotomies, DVT/PE prophylaxis in the absence of known risk factors may not be warranted.

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