Incidence of Deep Venous Thrombosis After Tibial Tubercle Osteotomy

A Single Case Series Study

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Background: Tibial tubercle osteotomy (TTO) is performed in a predominantly young and often female population due to the prevalence of patellofemoral disorders in this group. While considered a procedure that falls within the realm of sports surgeries, the procedure can carry significant morbidity, including infection, fracture, and deep vein thrombosis (DVT). The incidence of postoperative DVT in this population has not been described in the literature, although it has been mentioned anecdotally, and current guidelines do not address the issue of DVT prophylaxis in postoperative TTO patients.

Purpose: To describe the incidence of DVT after TTO and identify any predisposing factors.

Study Design: Case series; Level of evidence, 4.

Methods: Subjects who had undergone TTO by the senior author from 2002 to 2013 were identified, and a retrospective chart review was performed. Those who presented with symptomatic DVT confirmed with ultrasonography were reported. Demographic data, as well as potential risk factors such as body mass index, family history of bleeding/clotting disorders, duration of the nonweightbearing period, total tourniquet time, use of contraceptive medication, smoking status, and use of anticoagulants, were collected from the chart and analyzed for correlation with development of DVT.

Results: A total of 156 patients were included in this study. Six patients were found to have developed symptomatic DVT during the first 6 weeks after surgery. The mean age at the time of surgery in the DVT group was 34.94 ± 6.57 years, compared with 26.26 ± 10.20 years in the non-DVT group ($P = .04$). Due to the small number of patients with positive findings, there was no statistically significant correlation between the development of DVT and factors such as nonweightbearing duration, tourniquet time, or the use of contraceptives.

Conclusion: The incidence of postoperative DVT in arthroscopic and sports procedures has been thought to be low. This case series reported a rate of 3.8% with symptomatic DVT after TTO, and patients diagnosed with DVT were significantly older than unaffected patients. It is anticipated that the actual rate including asymptomatic DVT would be higher, as only 60% of patients with DVT are symptomatic. More studies are needed to define the actual incidence in this population. Given the number of common risk factors in this population, including nonweightbearing duration and the use of oral contraceptive pills, future studies may show the advantage of chemical prophylaxis for DVT in this group.

Keywords: tibial tubercle osteotomy; patellofemoral instability; deep vein thrombosis; age

Tibial tubercle osteotomy (TTO) is an accepted treatment for patients with patellofemoral disorders. It is performed to treat symptomatic and refractory patellar instability and patellofemoral overload, specifically in the setting of bony malalignment and patella alta. A variety of TTO techniques exist, ranging from direct medial transfers for isolated instability (Elmslie-Trillat) to direct anterior transfers for isolated distal patellar arthritis (Maquet) to an anteromedialization for the combined purpose of treating instability and simultaneously unloading the distal and lateral patella for overload syndromes of chondral lesions.[8,19,25,33]

Tibial tubercle osteotomy is performed in a predominantly young and often female population because of the prevalence of patellofemoral disorders in this group. While

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considered a procedure that falls in the realm of sports surgeries, the procedure can carry significant morbidity, including infection, arthrofibrosis, fracture, and painful hardware.[2,3,5,9,14,18,31,32] The incidence of postoperative deep vein thrombosis (DVT) in this population has not been described in the literature, although it has been mentioned anecdotally, and current guidelines do not address the issue of DVT prophylaxis in postoperative TTO patients.

Several features in this population make this group susceptible to the development of DVT. The use of a tourniquet during the procedure, in addition to the weightbearing restrictions that patients are given for approximately 6 weeks, can increase this risk. This particular patient population is composed predominantly of young women who are often taking contraceptive medication, which can also increase one's risk for developing DVT. In patients who develop DVT, the risk of pulmonary embolism (PE) is increased and can have fatal complications. Long-term risks of DVT, such as postthrombotic syndrome, can have more marked effects in these patients because of the younger age of onset.

The incidence of DVT after sports surgeries is reported to be 1.2%,[24] and the numbers specifically in anterior cruciate ligament reconstructions range from 0.3% to 1.78%.[1,13] However, the overall incidence of DVT in lower extremity surgery ranges from 0.1% in unicompartmental knee replacements[4] to as high as 80% in a population undergoing total knee replacement without prophylaxis.[35] In patients undergoing high tibial osteotomy, the reported numbers range from 4.3%[23] to as high as 41% in a venographic study.[34]

To date, the postoperative incidence and characteristics of symptomatic DVT in patients who have undergone tibial tubercle transfer have not been described. In this study, we aim to determine how many patients who underwent TTO by a single surgeon developed symptomatic DVT within 6 weeks of surgery. We also aim to describe the characteristics of this population that may put them at risk for developing DVT. Our hypothesis is that there is a higher incidence of symptomatic DVT in our population undergoing TTO than would be expected based on the literature surrounding arthroscopic procedures.

METHODS

A retrospective chart review was performed to determine the incidence of symptomatic DVT in a single-surgeon cohort. This study is the precursor to a larger prospective study with screening ultrasound to determine the "true" incidence of DVT in patients undergoing TTO, both symptomatic and asymptomatic. Inclusion criteria for our current study were those patients who underwent a TTO between 2002 and 2011 by the senior author. Patients of all ages were included in the study and included patients younger than 18 years, as patellar instability is common in the adolescent period. Exclusion criteria were patients who had concomitant injuries or procedures that altered their standard perioperative protocol.

TABLE 1
Recorded Variables[a]

Age
Height
Weight
BMI
Sex
Contraceptive (birth control) use
Family risk factors of bleeding or clotting disorders
Smoking status
Type of surgery
Length of tourniquet time
Duration of nonweightbearing (in weeks)
Development of symptomatic DVT (calf pain or swelling with ultrasound confirmation)
Ultrasound results (location and extent of clot)
Length of time from DVT from surgery
Type of treatment for DVT
Length of treatment for DVT
Subjective symptoms after treatment was completed
Posttreatment ultrasound (yes or no, and if yes, results)

[a]BMI, body mass index; DVT, deep vein thrombosis.

Approval for this study was obtained from the institutional review board at our institution. A search of the electronic database by procedure name was performed to identify all subjects who had undergone TTO by the primary investigator from 2002 to 2013. Additional CPT (Current Procedural Terminology) codes were used to search and filter the senior author's case log and identify patients who fit the inclusion criteria. A retrospective chart analysis was then performed to obtain demographic data, as well as the presence of hypothesized risk factors such as body mass index (BMI), family history of bleeding/clotting disorders, duration of nonweightbearing period, total tourniquet time, use of oral contraceptives, smoking status, and use of anticoagulants (Table 1). All data points were collected and recorded in a secure electronic database.

Descriptive statistics were collected in the form of means and standard deviations for continuous variables and frequencies and percentages for discreet variables. No formal power analysis was performed, as this was a retrospective case series. The differences in potential risk factors between patients who developed DVT and those who did not were calculated utilizing independent-samples t tests for continuous variables and chi-square/Fisher exact tests for categorical variables for independent associations with the outcome of development of DVT.

RESULTS

A total of 156 cases in 138 patients who had undergone TTO from 2002 to 2011 by the senior author were identified. Eighteen patients had undergone bilateral, staged procedures, and 133 cases involved female patients. The mean age at surgery was 26.59 years (range, 13.5-57.8 years; SD, ±10.21 years). The mean BMI was 23.17 kg/m^2 (range, 14.63-39.48 kg/m^2; SD, ±4.24 kg/m^2), and it was less than 25 in the majority (78.3%). Nine patients (6.5%) reported

TABLE 2
Caption[a]

Variable	No DVT Group		DVT Group		*P* Value
	n	Mean ± SD or n (%)	n	Mean ± SD or n (%)	
Age at surgery	150	26.260 ± 10.20	6	34.93 ± 6.57	.041
Female sex	150	127 (84.7)	6	6 (100.0)	.593
BMI, kg/m^2	146	23.17 ± 4.24	6	23.40 ± 4.58	.893
TTT, min	142	62.15 ± 23.74	6	56.83 ± 21.00	.590
Duration of NWB, wk	133	6.21 ± 0.82	5	6.00 ± 0.00	.560
Prophylactic anticoagulation	149	43 (28.9)	6	3 (50.0)	.363
Aspirin	94	29 (30.9)	6	3 (50.0)	.381
Family history of bleeding/clotting	150	11 (7.3)	6	0 (0.0)	>.999
History of smoking	147	5 (3.4)	6	0 (0.0)	>.999
OCP use	149	41 (27.5)	6	3 (50.0)	.353

[a]BMI, body mass index; NWB, nonweightbearing; OCP, oral contraceptive pill; TTT, total tourniquet time.

having a family history of bleeding or clotting disorders; 4.3% reported a smoking history, and 31.9% reported a history of oral contraceptive pill (OCP) use, with a wide range of formularies, including Alesse, Loestrin, Depo Provera, Mirena, NuvaRing, Orthotrycyclin, Ovcon, Premarin, Recipliser, Seasonique, Triphasil, Trinessa, Velivet, Yasmin, or unknown brands.

At the time of surgery, 55 cases underwent concurrent medial patellofemoral ligament reconstruction (35.2%), and 13 cases (8.3%) underwent microfracture. The mean total tourniquet time for the procedures was 61.94 minutes (range, 20-126 minutes; SD, ±23.60 minutes). All patients wore sequential compression devices during their hospital stay: a compressive wrap around the operative foot was utilized in conjunction with the hinged knee brace, and a calf wrap was worn on the opposite lower extremity. The duration of postoperative nonweightbearing status averaged 6.21 weeks (range, 5-12 weeks; SD, ±0.80 weeks). Forty-five surgeries (28.8%) were followed by prophylactic anticoagulation with aspirin (19.8%), coumadin (2.6%), lovenox (1.9%), fondoparinux (0.6%), or a combination of medications (3.2%).

Six patients (3.8% of surgeries) developed a DVT in the operative limb within the 6-week postoperative period. All were diagnosed within 3 days to 3 weeks of the postoperative period. The results are summarized in Table 2. We discovered DVTs in the deep peroneal vein and an intramuscular branch of the soleal vein in 1 patient; in another patient, the DVT was in the deep peroneal vein alone; in 2 patients, DVTs were found in the posterior tibial vein; 1 patient's thrombus was noted in the soleal vein; and 1 patient's outside hospital venogram was unavailable for review. No patients in this cohort suffered pulmonary emboli or postthrombotic syndrome.

Due to the small number of DVT cases, only 1 variable reached statistical significance: The patients diagnosed with DVT were significantly older than their counterparts. The patients' ages at the time of surgery were a mean 34.93 years (SD, ±6.57 years) in the group with DVT, compared with 26.26 years (SD, ±10.20 years) in the group without DVT ($P = .04$). No patient younger than 25 years developed postoperative DVT. All 6 patients who developed DVT were female. Three of the 6 DVT cases had been treated prophylactically with aspirin. None of the DVT cases had a family history of bleeding or clotting disorders or a history of smoking. There was no difference in the mean BMI in the DVT group versus no DVT (23.17 kg/m^2; SD, 4.24 kg/m^2 vs 23.40 kg/m^2; SD, 4.58 kg/m^2) ($P = .893$). The OCP use was higher in the DVT group (50% vs 27.5%), without reaching statistical significance ($P = .353$).

DISCUSSION

In our case series, we noted a 3.8% incidence of symptomatic DVT within the immediate postoperative period. The incidence of postoperative DVT in arthroscopic and sports procedures has been thought to be low, although the reported rates in the orthopaedic literature vary from 0.1 to as high as 41.2%.[1,6,12,13,20,22,37] The group of patients suffering a DVT was composed of significantly older individuals, and no patient younger than 25 years was diagnosed with a DVT. This finding is in agreement with the large review by Hetsroni et al,[11] which determined that patients older than 20 years were at significantly higher risk of DVT following knee arthroscopy, and the risk increased steadily with each decade of age.

Delis et al[6] studied 102 consecutive patients undergoing unilateral knee arthroscopy without DVT prophylaxis, in which 8 patients (7.84%) developed a DVT in the operative leg. Half of these were symptomatic with calf tenderness, and 1 had a positive Homan sign. The authors noted that the incidence of DVT was higher among those with 2 or more risk factors and in those with previous thrombosis. The risk factors considered in their study included age greater than 65 years, BMI >30 kg/m^2, smoking, contraceptive usage or hormone replacement, chronic venous insufficiency, or previous DVT. In their study, they found the relative risk of postoperative DVT to be 3.444 in patients using contraceptive agents or hormone replacement, 2.46 in BMI >30 kg/m^2, and 2.302 in tourniquet time greater than 30 minutes.

The characteristic patient in our TTO population meets several of these criteria, in large part based on the

demographic population of young women using contraceptive agents. Three of the 6 patients diagnosed with DVT in our study were taking oral contraceptives, and all 3 patients were taking the specific agent Yasmin (Bayer). Yasmin contains drospirenone, a synthetic progestin that has been linked to a higher risk of blood clots than other oral contraceptives in some studies.[30] As a result, in 2012, the US Food and Drug Administration required Bayer and other pharmaceutical companies making high-risk contraceptive medications to strengthen the warnings on their labeling.

Adding to the DVT risk in the setting of TTO is the fact that the procedure generally takes longer than a standard knee arthroscopy or meniscectomy. A longer tourniquet time has been reported as a risk factor for development of DVT.[7,22] Delis et al[6] noted a relative risk of 2.3 in those with tourniquet time greater than 30 minutes, and Demers[7] noted DVT was significantly more common in those with a tourniquet time greater than 60 minutes (46.7%) versus less than 60 minutes (15.4%). The average tourniquet time in our series was 61.94 minutes. Postoperative immobility due to nonweightbearing restrictions further increases the risk. Additionally, as noted in other studies,[6,28] the presence of multiple risk factors can further increase the likelihood of developing DVT.

As this was a retrospective review, the patients who developed DVT were identified by symptomatic findings, which were subsequently confirmed or ruled out by ultrasound studies. The development of asymptomatic DVT is assumed to be higher. Delis et al[6] noted that only 60.6% of patients with postoperative DVT after knee arthroscopy had symptomatic DVT, indicating that clinical evaluation alone was insufficient for the diagnosis. Furthermore, 16.6% of patients had clinical symptoms suggestive of DVT without actually having a confirmed DVT. According to their study, the positive predictive value of symptoms was 44.4% and the negative predictive value 90.6%. Williams et al[36] also found in a series of 85 patients who underwent arthroscopic knee surgery that the incidence of "silent" asymptomatic DVT was 3.5%. The study used compression ultrasound to determine this, and suggested that the clinical examination was not as sensitive to detect DVT.

Standardized recommendations regarding DVT prophylaxis in outpatient orthopaedic surgeries do not currently exist; however, most studies have found the incidence of postoperative DVT to be low enough to justify withholding chemical prophylaxis in this setting. Hoppener et al[12] performed a prospective study to assess the rate of venous thromboembolism events in 335 patients who underwent outpatient knee arthroscopy. Of these 335 patients, 19 (5.7%) showed the development of venous thromboembolism on postoperative ultrasound at 2 weeks postoperatively, and only 2 patients were symptomatic. One patient developed a nonfatal PE over the next 8 weeks. The study did not identify any risk factors that correlated with the development of DVT, including the period of postoperative immobilization.

The lack of clinical warning signs suggests that in the setting of DVT risk, with its serious complications and lack of appropriate screening measures, we should perhaps consider treating certain patient groups with prophylaxis instead of waiting for symptoms that may or may not have clinical relevance. DVT from arthroscopic surgeries can lead to other serious complications. Symptomatic pulmonary emboli have been reported to occur in up to 1.7% of patients with DVT in the calf.[10] Hetsroni et al[11] found in a review of the New York State Department of Health database that the rate of PE was 2.8 for every 10,000 arthroscopies. The authors found that age and operating time had dose-related increases in risk for development of PE. In this study, female sex was associated with a 1.5-fold increase as well, although sex was not found to be a risk factor in other studies.[7]

In following their patients with thromboses, Delis et al[6] also noted that 50% of the DVTs resorbed, but that venous reflux developed in 75%. Postthrombotic syndrome (PTS) is the major chronic sequela of DVT and is a debilitating condition characterized by edema, venous ectasia, hyperpigmentation, varicose veins, venous ulceration, and pain. PTS develops because of residual venous obstruction or valvular reflux, leading to increases in venous pressure in the microcirculation. More than one third of patients with DVT develop PTS.[15,16,21,26,27,29] The long-term sequelae of DVT have particular significance in the younger population, who may suffer from these complications during their active years.[17]

Some authors have noted the efficacy of postoperative prophylaxis in patients after arthroscopic knee procedures, without any adverse events. A study by Michot et al[22] found, in a randomized clinical trial of 218 patients who had arthroscopic knee surgery, that the incidence of DVT in the control group was 15.6% versus 1.5% in the group that had received prophylaxis for 4 weeks with low–molecular weight heparin, based on compression ultrasound at 12 and 31 days after surgery. Marlovits et al[20] reported an even higher rate of DVT (41.2%) in a group of patients who underwent anterior cruciate ligament reconstruction and received only 3 to 8 days of chemical prophylaxis versus the treatment group, who received 20 days of prophylaxis using low–molecular weight heparin.

The limitations of this study include the nature of the case series in its retrospective design. Assessment for DVT relied on clinical evaluation of the symptomatic patient who was then sent for further studies to confirm the diagnosis. As Turner et al[34] noted, the venographic incidence of DVT can be much higher and much more accurate than that of symptomatic DVT. Therefore, the true incidence of DVT in this series of patients is unknown and potentially higher than our reported number.

As our study spanned the course of 11 years of the senior author's practice, the protocol surrounding DVT prophylaxis varied between patients, as the author modified her protocol over the course of the years. In our current series, 3 of 6 patients who developed symptomatic DVT had been treated with aspirin during the nonweightbearing period. The retrospective study design also does not account for variations in the types of contraceptives that were taken by patients, as the formulations and subsequent risk factors for DVTs may have changed over the past 10 years. On noting a trend in the patient population regarding DVT in postoperative TTO surgery, most study

patients who underwent TTO after 2006 were routinely advised to stop taking oral contraceptive medication 1 month prior to surgery. In addition, they received DVT prophylaxis with aspirin postoperatively.

CONCLUSION

The incidence of postoperative DVT in arthroscopic and sports procedures has been thought to be low. In our case series, we report a rate of 3.8% with symptomatic DVT after TTO. We anticipate the actual rate including asymptomatic DVT would be higher, as only 60% of DVTs are symptomatic. Patient age proved to be a significant risk factor: patients who suffered DVTs were significantly older, and no patient younger than 25 years developed a DVT. More studies are needed to define the actual incidence in this population. Given the number of common risk factors in this population, including nonweightbearing duration and the use of OCPs, future studies may show the advantage of chemical prophylaxis for DVT in this group.

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