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Research article

The incidence of proximal deep vein thrombosis after elective hip arthroscopy: a prospective cohort study in low risk patients

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ABSTRACT

Prospectively assess the incidence of deep venous thrombosis (DVT) using Doppler Ultrasound, in patients receiving elective hip arthroscopy without pharmacologic/mechanical prophylaxis. One hundred and fifteen consecutive patients (mean 35.4 years, SD = 10.3) underwent elective hip arthroscopy. Patients with previous major risk factors for DVT were excluded. Signs/symptoms of DVT/pulmonary embolism were assessed at 2-week post-operatively. A bilateral whole leg Duplex color (Doppler) Ultrasonography was scheduled between 10- and 22-day post-op. The primary outcome was frequency of DVT. Secondary outcomes assessed surgical risk factors. One hundred and ten patients (mean = 34.3 years, SD = 10.1) did not get a DVT. Five patients (mean = 43.8 years, SD = 12.1) were diagnosed with a DVT, 2- to 22-day post-operatively. All DVT patients received arthroscopy in the supine position ($n = 76$), versus no patients in the lateral position ($n = 39$). Average traction time was 38 (SD = 4) and 61 (SD = 4) minutes for patients with and without a DVT, respectively. All other a priori defined risk factors were similar. Four out of five patients presented with symptoms of a DVT, confirmed by ultrasound. One patient was without symptoms/clinical findings. Four patients had a DVT restricted to the calf veins; one patient had involvement of the popliteal vein. No patients had proximal extension into the thigh or pelvis. No pulmonary emboli were suspected or occurred. The incidence of deep venous thromboembolism is 4.3%. The majority of patients had symptomatic and distal venous thromboembolic events. This study provides supportive evidence that routine prophylaxis and/or screening may not be necessary in low risk patients undergoing elective hip arthroscopy.

INTRODUCTION

Hip arthroscopy has been used to treat various disorders of the hip including labral pathology, femoro-acetabular impingement and early arthritis. There have been several reports of thromboembolic events in both elective and urgent hip arthroscopy procedures [1–3]. Published reviews of hip arthroscopic procedures have identified deep venous thrombosis (DVT) and pulmonary embolism (PE) as recognized complications [4–7]. Retrospective case series and database studies have reported the incidence of DVT and PE ranging from 0% to 3.7% [8–11]. There has been one retrospective study that specifically attempted to identify DVT and PE as part of a quality assurance protocol [12]. This study examined for DVTs using Doppler

ultrasound in 58% of a cohort of 139 patients. They identified two symptomatic thromboembolic events (one DVT and one PE). However, this study was unable to identify the true incidence of asymptomatic DVT due to an under-reporting bias, since not all patients were investigated [12]. Studies looking at the risk of thrombosis in lower risk procedures, such as knee arthroscopy, show a 0.6–17.9% rate of DVT [13–16]. A comparison of the number needed to treat for a symptomatic thromboembolic event versus the number needed to harm for the routine use of pharmacologic prophylaxis showed more risk than benefit [16]. In a randomized clinical trial, the efficacy of aspirin for postoperative pharmacologic prophylaxis in a low-risk population undergoing knee arthroscopy identified no cases of venous thromboembolism in either the treatment or control groups [17]. This literature demonstrates that routine pharmacologic prophylaxis for lower risk procedures may not be warranted.

The decision whether to provide mechanical or chemical methods of thromboprophylaxis depends on the risk-benefit analysis for individual patients. In order to determine this, one must know the rate of thromboembolic events in the patient population. The primary objective of this study was to determine the rate of deep vein thrombosis in patients with no known risk factors for thromboembolic events, undergoing elective hip arthroscopy. The secondary objectives were to explore whether or not any surgical factors (traction time, peripheral compartment arthroscopy, bony surgery such as for CAM and pincer impingement, microfracture or labral repair) were associated with a higher rate of thromboembolic events.

MATERIALS AND METHODS

This study was approved by the University of Calgary Conjoint Health Research Ethics Board. Subjects for this prospective cohort study were recruited from two surgeons' practices at the University of Calgary Sport Medicine Centre and the Alberta Hip and Knee Clinic in Calgary, Alberta, Canada. Consecutive patients aged over 18 years, undergoing elective hip arthroscopy and willing to participate in the study were recruited. Patients were considered not eligible if they could not effectively communicate in English, were involved in litigation for the injury or were receiving third party compensation, had an acute fracture, dislocation or septic arthritis, prior surgery on the same hip, drug addiction or had underlying risk for thromboembolic events. These risks included a prior thromboembolic event, known genetic/familial thrombophilia, active malignancy and circumstances where the patients had planned extended travel within 2 weeks of the index surgery [16].

Eligible and consenting patients underwent their scheduled procedure as elective day surgery. One surgeon (NGM) performed hip arthroscopy in the supine position and the other (KJ) in the lateral position, both with the same traction device. Information regarding the patient demographics and the specifics of the procedure (Table I) were collected using standardized forms. The subjects were not given any pharmacologic or mechanical thrombo-prophylactic measures, but were encouraged to mobilize as aggressively as possible, given any restrictions imposed by the procedure. No patients were either braced or underwent continuous passive motion (CPM). Weight-bearing status was determined at the discretion of the surgeon. The subjects were informed both verbally and in written format to be vigilant for the signs and symptoms of PE and DVT and were given the appropriate measures to take should they notice any symptoms.

At a 2-week follow-up visit, subjects underwent a standardized history and physical examination, tailored to detect DVTs and PEs in addition to the routine encounter. The physical exam was based on modified Wells criteria and included localized tenderness along the distribution of the deep venous system, entire leg swelling, calf swelling >3 cm compared with the contralateral side as measured 10 cm from the tibial tubercle, pitting edema confined to the affected leg and the presence of collateral non-varicose veins [18].

At 10–22 days after surgery, subjects were scheduled for a bilateral whole leg Duplex color ultrasonography. A radiologist evaluated the ultrasound using a dedicated protocol. All patients underwent 3-month follow-up appointments with their surgeons, where they were asked whether they had been diagnosed with a thromboembolic event since their last follow-up. All thromboembolic events were treated according to the accepted practices.

A formal *a priori* power and sample size calculation was performed for both statistical and practical reasons. There was limited available published data on the incidence of DVT; therefore, it was not possible to complete the calculation with definitive precision or accuracy. The best available evidence was a retrospective study that reported a DVT rate of 3.7% [19], as well as the CHEST guidelines, which reported a DVT rate of $<10\%$ for healthy, mobile patients undergoing minor surgery [11, 20]. Thus, a mid-range DVT rate of 5% was used, along with an alpha of 0.05, and power of 80%. Based on these inputs, it was determined that 98 participants would be required. Given an anticipated dropout rate of 20%, a total of 120 participants were targeted for recruitment.

In order to determine the rate of DVT in patients with no known risk factors for thromboembolic events, frequency count and percentages were computed. Descriptive univariate statistics were calculated to summarize all

Table I. ***Comparison of demographic characteristics for the patients with and without a deep vein thrombosis (DVT) or pulmonary embolism (PE)***

Characteristic	*NO DVT/PE (n=110)*	*DVT/PE (n=5)*	P *values*
Age (years)			0.08
Mean (SD)	34.5 (10.1)	43.8 (12.1)	
95% confidence interval	32.6–36.4	28.8–58.8	
Median	33.0	46.0	
Range	18–59	27–58	
Body mass index (BMI, kg/m^2)			0.41
Mean (SD)	24.8 (3.8)	23.5 (4.0)	
95% confidence interval	24.0–25.5	18.6–28.4	
Median	24.3	22.1	
Range	18.3–38.0	19.4–29.8	
Sex (% patients)			0.54
Female	57 (52%)	3 (60%)	
Male	53 (48%)	2 (40%)	
Affected side (% patients)			0.37
Left	52 (47%)	1 (20%)	
Right	58 (53%)	4 (80%)	
Smoking status (% patients)			0.49
Smokers	15 (14%)	0 (0%)	
Non-smokers	95 (86%)	5 (100%)	
Positioning (# patients)			0.16
Lateral	39	0	
Supine	71	5	
Females on oral birth control or hormone therapy (# patients)			0.17
Yes	14	2	
No	43	1	

variables. In order to determine whether surgical factors were associated with a higher rate of thromboembolic events, Pearson cross-tabulation contingency table analyses were conducted. Specifically, Fisher's exact tests were used to compare patients with and without a DVT on all categorical risk factor variables, while independent samples *t*-tests or one-way ANOVA were computed for all continuous measured risk factor variables. Risk factors included: demographics, family history of DVT or blood dyscrasia, smoking status, surgical traction time and patient positioning, specific surgical procedures, post-operative weight-bearing status, mobilization and use of NSAIDs.

All results were determined to be statistically significant at $P < 0.05$.

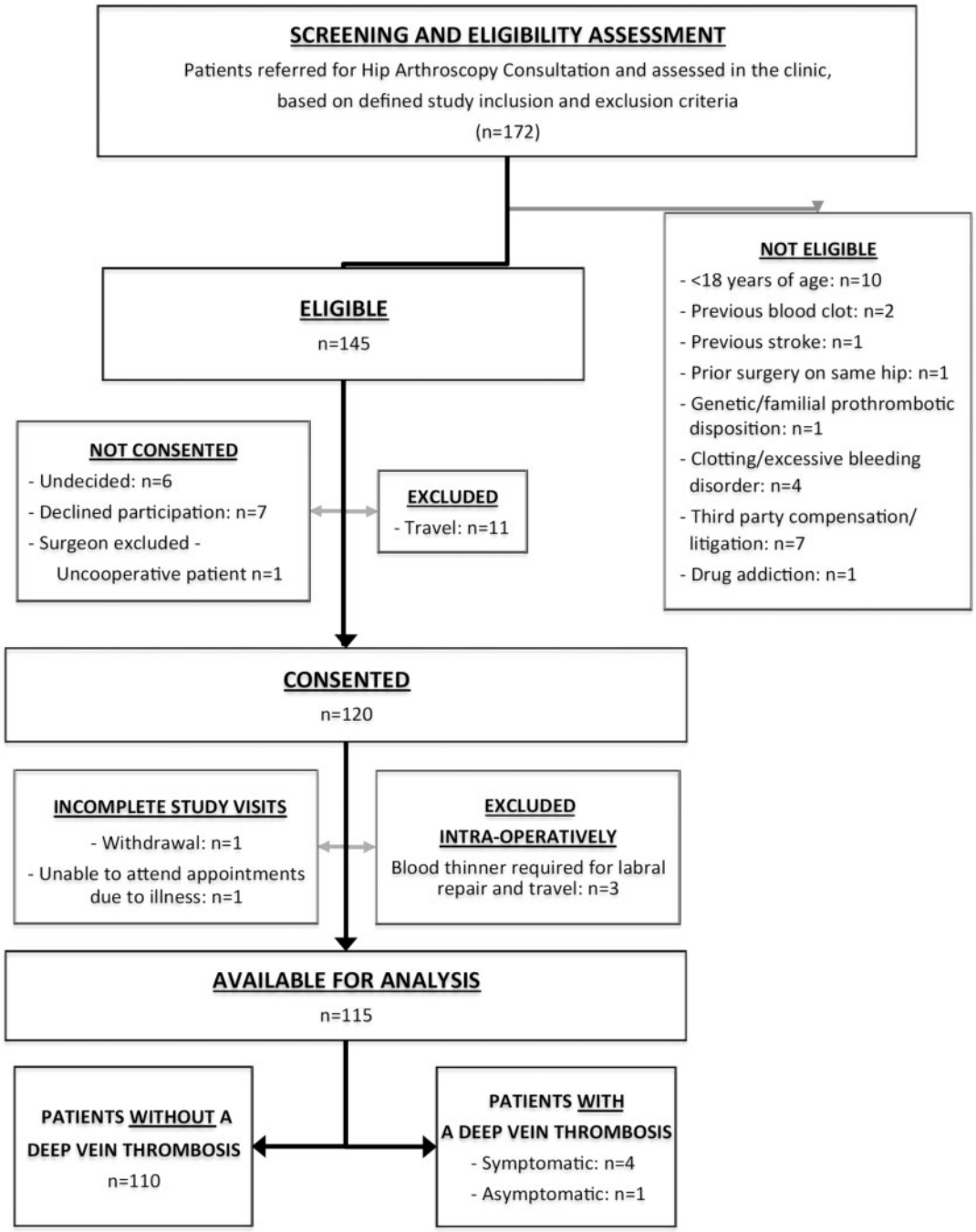

Fig. 1. Flow diagram showing subject recruitment and dropout.

RESULTS

One hundred and twenty subjects were consented, out of 162 eligible patients (see Fig. 1). Of these eligible and consenting patients, there were two patients with incomplete follow-up and three patients who were excluded intra-operatively. These three patients were deemed to have an increase risk of getting a DVT. All three patients had a labral repair and were required to be relatively immobile, in addition to having unanticipated post-operative extended travel. One hundred and fifteen patients were available for

Table II. ***Comparison of surgical details for the patients with and without a deep vein thrombosis (DVT) or pulmonary embolism (PE)***

Variable	*NO DVT/PE (n=110)*	*DVT/PE (n=5)*	P *values*
Peripheral compartment arthroscopy performed (% patients)			0.70
Yes	86 (78%)	4 (80%)	
No	24 (22%)	1 (20%)	
Bony surgery for CAM impingement performed (% patients)			0.48
Yes	74 (67%)	4 (80%)	
No	36 (33%)	1 (20%)	
Bony surgery for pincer impingement performed (% patients)			0.54
Yes	57 (52%)	3 (60%)	
No	53 (48%)	2 (40%)	
Microfracture performed (% patients)			0.24
Yes	20 (18%)	2 (40%)	
No	90 (82%)	3 (60%)	
Labral repair performed (% patients)			0.59
Yes	71 (65%)	3 (60%)	
No	39 (36%)	2 (40%)	
Other surgical procedure(s) performed (% patients)			0.66
Yes	49 (45%)	3 (60%)	
No	61 (55%)	2 (40%)	
Intra-operative complications (% patients)			0.63
Yes	10 (9%)	0 (0%)	
No	100 (91%)	5 (100%)	
Traction time (min)			0.12
Mean (SD)	61 (35)	38 (11)	
95% confidence interval	55–68	24–53	
Median	57	39	
Range	0–145	20–50	

full follow-up. All hip arthroscopy surgeries were performed between October 2011 and May 2014.

Table I shows the comparison of the demographic characteristics for those patients with and without a detected DVT. Table II describes the surgical details between the same two groups. Table III is a comparison of the post-operative weight-bearing status and frequency of NSAID prescription in each group.

Five patients (two males, mean age 47.5 years, SD = 14.8) were diagnosed with a DVT (Table IV). Four out of the five patients (80%) presented with symptoms of a DVT. Three were diagnosed prior to the first scheduled

Table III. ***Comparison of post-operative weight-bearing status and NSAID prescription for the patients with and without a deep vein thrombosis (DVT) or pulmonary embolism (PE)***

Variable	*NO DVT/PE* (n=*110*)	*DVT/PE* (n=*5*)	P *values*
Post-op weight-bearing status (% **patients**)			Not calculable
None	10 (9%)	0 (0%)	
Partial	99 (90%)	5 (100%)	
Full	1 (1%)	0 (0%)	
NSAID prescription (% **patients**)			0.87
Yes	107 (97%)	5 (100%)	
No	3 (3%)	0 (0%)	

post-operative appointment because the symptoms required an urgent clinical assessment and Doppler Ultrasound evaluation. The other patient was suspected of having a DVT at the first post-operative visit, which was confirmed on ultrasound. No subject had extension of the thrombus into the thigh or the pelvis. One patient had involvement of the popliteal vein and the remainder had DVTs restricted to the calf veins (Table IV). The asymptomatic patient had a DVT in the tibial and peroneal veins extending into the inferior popliteal vein. No pulmonary emboli were diagnosed or suspected out to the 3-month follow-up visit.

All patients suffering a DVT had their surgery performed in the supine position. The average age was 43.8 years (SD = 12.1) for patients with DVTs, and 34.5 years (SD = 10.1) for those without a DVT, but this was not statistically significant. The average traction time for patients who had a DVT was 38 min (SD = 4), compared with 61 min (SD = 4) for those without a DVT. All other potential risk factors for thromboembolic events were similar between the two groups (see Tables I and II).

DISCUSSION

The rate of DVT after elective hip arthroscopy as diagnosed by venous Doppler Ultrasound was 4.3%. Four DVTs resulted in patient symptoms; three of these were diagnosed when the patients sought urgent medical care, and the other was diagnosed as part of the study protocol. The last patient with a DVT was asymptomatic, diagnosed solely based on the study ultrasound and extended into the popliteal vein. None extended into the thigh or pelvis and therefore, no patients underwent a CT scan or chest MRI scans to rule out asymptomatic pulmonary emboli. Three out of the five patients were treated with anticoagulation: Warfarin (2) and Rivaroxaban (1). One patient was treated with ASA and compression stockings and the other with homeopathic medicine and over-the-counter NSAIDs (Table IV).

There were no statistically significant patient or surgical factors associated with the occurrence of a DVT.

Our study is the only prospective study specifically designed to determine the rate of thromboembolic disease after hip arthroscopy. The rate of 4.3% in this study is similar to that of 3.7% reported in a published retrospective study [11]. The only other study that has specifically looked for DVT in the hip arthroscopy population was part of a quality-assurance protocol in 139 patients [12]. Although retrospective by design, the intention was to evaluate all patients with Doppler Ultrasound in a similar manner to our study. Only 58% (80/139) of their series of patients completed the ultrasound examination post-operatively [12], suggesting that there may be an underreporting bias and/or and insufficient sample size. All patients who had post-operative DVT prophylaxis were excluded, but it is not clear whether mechanical DVT prophylaxis was employed in any of the patients. Two symptomatic DVTs were identified with an incidence of 1.4% [12]. Sufficient patients were recruited in our study to meet the calculated *a priori* sample size, particularly since the dropout rate was much less than expected. As such, we believe our results accurately express the risk of DVT after hip arthroscopy for patients with no known risk factors for thromboembolic events.

One potential limitation to this study is that Doppler Ultrasound, rather than venography was used to diagnose DVTs [19]. The overall sensitivity for Dopper ultrasound in detecting proximal and distal DVTs in asymptomatic patients is 62% and 53%, respectively [21]. In asymptomatic

Table IV. ***Detailed information on patients with a detected DVT***

Surgical/screening data	*Patient 1*	*Patient 2*	*Patient 3*	*Patient 4*	*Patient 5*
Sex	Female	Female	Female	Male	Male
Age (years)	51	27	46	37	58
Previous PE or DVT	No	No	No	No	No
Family history of DVT/PE	No	No	No	Yes (parent)	Yes (parent)
Patient bleeding disorder	No	No	No	No	No
Family history of bleeding disorder	No	No	No	Yes (sibling)	Yes (grandparent)
Smoker	No	No	No	No	No
Oral birth control pill or hormone replacement therapy	Yes BCP (off 1 cycle prior to surgery)	Yes BCP (off 1 cycle prior to surgery)	No	No	No
History of cancer	Yes (melanoma)	No	No	No	No
Other medical co-morbidity	None	Anemia	Hypo-thyroidism	Celiac disease	Heavy metal toxicity
Body mass index (kg/m^2)	21.7	19.4	22.1	24.6	29.8
Operative side	Right	Right	Right	Right	Left
Performed procedures					
• **Hip arthroscopy**	Yes	Yes	Yes	Yes	Yes
• **Peripheral compartment arthroscopy**	Yes	No	Yes	Yes	Yes
• **Bony surgery for CAM impingement**	Yes	No	Yes	Yes	Yes
• **Bony surgery for pincer impingement**	No	Yes	Yes	Yes	No
• **Microfracture**	Yes	No	No	No	Yes
• **Labral repair**	No	Yes	Yes	Yes	No
• **Other**	No	Chondroplasty actebaulum	No	Debridement cyst in ligamentum teres	Labral debridement
Traction time (min)	20	45	50	38	39
Intra-operative complications	None	None	None	None	None

(continued)

Table IV. (*continued*)

Surgical/screening data	*Patient 1*	*Patient 2*	*Patient 3*	*Patient 4*	*Patient 5*
Post-operative weight-bearing status	Partial	Partial	Partial	Partial	Partial
Prescribed/recommended NSAIDs	Yes	Yes	Yes	Yes	Yes
Diagnosed with DVT (# days post-op)	14 days	22 days	17 days	2 days	7 days
Treatment	Aspirin × 1 month and compression stocking	Warfarin × 3 months	Warfarin × 3 months	Rivaroxaban × 3 months	Homeopathic OTC NSAID
Symptomatic DVT	Yes	No	Yes	Yes	Yes
Diagnosed prior to post-op study visit	No	No	Yes	Yes	Yes

patients after orthopedic surgery, the sensitivity and specificity of ultrasound for the diagnosis of DVT is 62% and 97%, respectively [18, 22]. Venography is considered the gold standard, but it is invasive, and painful for patients; and 'has never been accepted as a systematic screening tool' [23]. In a study using venography to document DVTs after knee arthroscopy, 12% of study participants refused a unilateral venogram despite already having consented to the study [13]. Thus we sought to choose a diagnostic modality that was more acceptable to patients to lessen the potential for complications from the procedure, as well as to have the most complete follow-up possible.

Another limitation is that this study was designed with sufficient power to determine the rate of DVTs in the selected patient population, but not powered to assess specific risk factors. As such, there were no statistically significant differences between the patients with and without DVTs, despite some obvious differences. All patients with a diagnosed DVT occurred in patients who had been operated by the same surgeon using the supine approach. No patients operated in the lateral position were identified with a DVT. This unexpected finding has not previously been reported. There is evidence to support decreased blood flow in the popliteal and femoral veins using Doppler Ultrasound when patients are under traction in the supine position [24]. These findings have not been evaluated in patients undergoing hip arthroscopy in the lateral position. The age of the patients with a DVT was higher than the non-DVT group, and four out of five patients had a past history of a medical co-morbidity (Table IV). None of these patients had active symptomatic disease. In order to examine these potential risk factors, such as patient positioning, a larger sample size would be required. A registry of hip arthroscopy would be well suited to addressing this issue, assuming that a process of surveillance for DVT was part of the registry. The same could be said of other possible risk factors, such as smoking and traction time.

This prospective study demonstrated a DVT rate of 4.3%, including one patient with a proximal/popliteal DVT, and no clinically evident pulmonary emboli. According to this most current evidence, we do not recommend providing routine pharmacologic prophylaxis after elective hip arthroscopy in patients with no pre-existing risk factors for thromboembolic events. The current practice at our institution is to encourage early mobilization, given the modest post-surgical limitations imposed. Mechanical methods of thromboprophylaxis are not currently or routinely being employed. Anti-inflammatory medication is a routine protocol to facilitate pain management, and possible prophylaxis for heterotopic ossification [25, 26].

CONCLUSION

This study demonstrated an incidence of deep venous thromboembolism of 4.3%. The majority of patients had symptomatic and distal venous thromboembolic events. This study provides supportive evidence that routine prophylaxis and or screening may not be necessary in low risk patients undergoing elective hip arthroscopy.

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CONFLICT OF INTEREST STATEMENT

None declared.

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