

Early incidence of deep venous thrombosis and its early marker after knee arthroscopy: A retrospective study with routinely applied ultrasonography

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Abstract

Background: To (1) investigate the early incidence of deep venous thrombosis (DVT) after knee arthroscopy at a single institution and (2) determine the early marker for DVT in these patients.

Methods: The records of patients who underwent knee arthroscopy in our department between January 2018 and October 2019 were reviewed. Ultrasonography was performed for each patient at 24h preoperative and 72h postoperative. The low-molecular-weight-heparin (LMWH) was routinely used as thromboprophylaxis on the first day postoperative after 1st January 2019. Preoperative and perioperative data were collected with respect to demographic data, medical history, medications, and surgical and anesthesia data. Chi-square test or Student t test was used to preliminarily screen out suspected risk factors. Then, multiple logistic regression analysis was utilized to further determine the risk factors of DVT after knee arthroscopy.

Results: During the study period, 272 patients were reviewed. Among these patients, 21 cases of DVT occurred, resulting in an incidence of 7.7%, two (0.74%) of which were identified as symptomatic thrombosis. The incidence of DVT in the anticoagulant group was 7.9%, and 7.4% in the non-anticoagulant group, respectively. The use of low molecular weight heparin postoperative did not reduce the incidence of DVT after knee arthroscopy. An increased D-dimer level could be an early marker for an elevated risk of postoperative DVT. No association between different arthroscopic procedures and thrombotic events. And the tourniquet time are not related risk factor.

Conclusions: In this study, the early incidence of DVT after knee arthroscopy was 7.7%. Symptomatic DVT was rare and occurred infrequently. The incidence of DVT within three days could not be reduced by using LMWH, and a high D-dimer level was an early marker for DVT after knee arthroscopy.

Background

Knee arthroscopy is commonly considered to be at low to moderate risk of venous thromboembolic events (VTE). Nevertheless, the incidence of deep vein thrombosis (DVT) after knee arthroscopy has increased due to the improved accuracy of thrombosis diagnosis. The incidence has been reported between 1.8% to 41.2%(1), which has caused concerns of orthopedic surgeons. The study of Bohensky et al. showed that DVT had become the most common complication after arthroscopic surgery(2). Even worse, DVT has the potential to develop into pulmonary embolism (PE)(3, 4).

Currently, anticoagulation treatment is not usually prescribed by clinicians after arthroscopic surgery. There is still a big debate about whether pharmacologic thromboprophylaxis should be a criterion after arthroscopic surgery. For instance, the 8th American College of Chest Physicians Evidence-Based Clinical Practice Guidelines for Antithrombotic Therapy and Prevention of Thrombosis suggested against the routine use of pharmacologic thromboprophylaxis, and recommended the use of low-molecular-weight heparin (LMWH) only in patients at high VTE risk (complicated procedures, tourniquet time \geq 60 minutes

[min], etc)(5). Several studies suggested that gender, age, BMI, and other factors may be the potential risk factors of DVT(6-8).

Ultrasonography has been widely recognized as a primary modality for diagnosis and exclusion of acute DVT in recent years because of its safety and noninvasiveness. Besides, the diagnostic accuracy is almost equal to that of venography(7), which making it appropriate as a first choice for diagnosing DVT.

We didn't routinely use chemoprophylaxis after knee arthroscopy before 2019. Conversely, a randomized trial of chemoprophylaxis after arthroscopic knee surgery showed that LMWH can lower the incidence of postoperative DVT compared to a placebo, which indicated chemoprophylaxis is indispensable for patients after knee arthroscopy(9). Therefore, the prophylaxis protocol significantly changed in our institution, routine VTE prophylaxis with LMWH is standard practice after 1st January 2019. Based on evidence existed, a retrospective study was conducted at our institution to assess and analyze the incidence of DVT in the two groups of anticoagulation and non-anticoagulation patients, as well as investigate an early marker for an elevated risk of postoperative DVT, thereby enriching the literature regarding the knowledge of DVT and related prophylaxis and thrombolysis therapy. The study was conducted according to principles contained in the Declaration of Helsinki. Institutional review board approval was obtained.

Materials And Methods

Patients

A retrospective analysis was performed on the patients who have undergone knee arthroscopy in our department from January 2018 to October 2019. Surgeries were divided into two categories, simple (including meniscectomy, meniscus suture, loose body removal, cartilage cleanup, or cystectomy) and ligament reconstruction [anterior cruciate ligament reconstruction (ACLR), posterior cruciate ligament reconstruction (PCLR), or ACLR combined with PCLR]. The rationale for including knee arthroscopy and arthroscopy-assisted procedures such as ACLR is that the reported rates of DVT in ACLR versus simple knee arthroscopy are not significantly different. Exclusion criteria were: pregnancy, with DVT, previous history of DVT, varicose veins or blood system diseases, taking anticoagulant drugs within half a year, or with complicated periarticular fractures. Patients were also excluded from the study if they were younger than 18 years at the time of surgery or had undergone surgery in the 3 months before knee arthroscopy.

Each patient underwent a routine preoperative examination after admission and the following factors were recorded: gender, age, body mass index (BMI), preoperative platelet and D-dimer level, D-dimer level 72h postoperative, anesthetic method, tourniquet time, whether to use LMWH after surgery and type of surgical procedures. Written informed consents were obtained from all participants.

Operative Procedure

All patients received either spinal or general anesthesia in the supine position during the surgery, a thigh tourniquet was used on the operated leg, which was deflated for procedures lasting longer than 120 min, and re-inflated 10 min later if necessary. All the procedure was performed by two experienced surgeons.

After the operation, ice was applied with a compressive wrap for 20 min every 3-4 h for the first 24-48h after the surgery to reduce swelling. Isotonic, progressively restrictive exercises for the quadriceps and hamstrings were begun 24h after the operation. Routine VTE prophylaxis with LMWH was given to each patient underwent knee arthroscopy after 1st January 2019.

Diagnosis of DVT

DVT was ruled in by means of whole-leg color-coded Doppler ultrasonography. All patients underwent ultrasonography of the lower extremities within 24h preoperative. Patients who developed symptoms suggestive of VTE while on treatment underwent ultrasonography as soon as possible. The presence of symptoms or signs of DVT defined as: calf pain or tenderness; calf or whole-leg swelling; pitting edema; discoloration; collateral superficial non-varicose veins. PE defined as syncope; chest pain; sudden shortness of breath; palpitations; hemoptysis. The finding of just one of the above mentioned labelled the patient as "symptomatic".

All other patients underwent clinical examination and bilateral ultrasonography at 72h postoperative to determine whether thrombosis existed, and all patients were operated and diagnosed by the same ultrasound doctor.

The specific diagnostic criteria are as follows: hypoechoic masses appear in venous vein, or venous vein cannot be compressed, or venous blood flow was absent(10). DVT was classified as proximal (occurred in the proximal venous system: common, superficial and deep femoral veins, and popliteal vein to the trifurcation) and distal (occurred in tibioperoneal and muscular veins).

Statistical analysis

SPSS 22.0 (IBM Corp. Released 2013. IBM SPSS Statistics for Windows. Armonk, NY: IBM Corp) software was used for statistical analysis. Using the Chi-square test or Student t test for the comparison of data, to preliminarily screen out suspected risk factors. Then multiple logistic regression analysis was utilized to further determine the risk factors ($P < 0.05$ was considered statistically significant).

Results

A total of 272 patients underwent knee arthroscopy were reviewed in this study, and postoperative ultrasonography examination of lower extremity veins showed that 21 (7.7%) of them had DVT during their stay at the hospital, two of which (9.5%) were identified as symptomatic thrombosis, and none showed symptoms of PE. The incidence of DVT in the anti-coagulant group was 7.9% [14/177], which in the non-anticoagulant group was 7.4% [7/95]. DVT mainly occurred in the distal extremity of the lower

limbs (90.5%, 19/21), among which the thrombosis in the muscular vein was the most common (Table 1). During the study period no patients died or had suspected PE. No major bleeding events were observed during the study period.

The patients were divided into two groups according to whether postoperative DVT occurred. The distribution of DVT occurred in each observation factor is shown in Table 2. There was no statistically significant difference between the two groups in age, gender, BMI, preoperative D-dimer and platelet counts, anesthetic method and whether LMWH was used after surgery ($p>0.05$), but duration of tourniquet application and surgical procedures, which were considered as potential risk factors ($p<0.05$). Moreover, the D-dimer level 72h postoperative was increased significantly in the patients with DVT.

The results of the multivariate regression analysis of the DVT group and non-DVT group patients are shown in Table 3. The results indicated that only postoperative D-dimer was an independent risk factor for predicting early DVT formation after knee arthroscopy (OR=3.773, 95 % CI: 1.775-8.023, $\chi^2=11.906$, $P=0.001$). We found no association between different arthroscopic procedures and thrombotic events. And the tourniquet time are not related risk factor.

Discussion

Knee arthroscopy is the most common orthopaedic operation worldwide. Current guidelines do not recommend thromboprophylaxis in patients undergoing knee arthroscopy, due to uncertainty about the risk-to-benefit ration in this setting. Although symptomatic or fatal VTE is uncommon in this setting, the ever-increasing volume of surgery has the potential to substantially increase the overall burden of VTE in patients.

The present results demonstrated that the incidence of DVT in patients undergoing knee arthroscopy was 7.7%, which indicated DVT with subsequent PE cannot be discounted as a potentially life-threatening complication associated with this surgery. A number of studies have investigated the risk of DVT after knee arthroscopy(2, 11-13).

Our study showed that for knee arthroscopy, the incidence of DVT in patients without anticoagulation was 7.4%, which is very close to the result of Delis et al.(14). The incidence of non-symptomatic DVT is very high (19/21, 90.5%), which was similar to those of sun et al.(15), so adequate attention should be paid to the latent DVT, and it is not reliable to diagnose the occurrence of DVT solely by clinical symptoms.

In contrast, the incidence of DVT in the anticoagulation group was 7.9%, which indicated that the use of LMWH may not reduce the probability of DVT in patients within three days after knee arthroscopy. In some previous studies, it was shown that thromboprophylaxis was not recommended after arthroscopic surgery. A recent systematic review suggested that they against routine use of thromboprophylaxis even after anterior cruciate ligament reconstruction surgery(16). Among patients undergoing knee arthroscopy, short-term use of LMWH is not recommended to prevent the formation of DVT in patients without risk

factors according to our study. Kessler noted that it is suitable to use LMWH for five to seven days after knee arthroscopy(17). Another randomized controlled trial has revealed that prophylaxis should last seven to ten days(18), as other studies have shown poor results for short-term preventive treatment of only three to six days(19, 20). Although LMWH did not increase the risk of perioperative bleeding, it was not a protective factor to prevent the formation of postoperative DVT in three days.

Different types of surgery are associated with varying degrees of DVT risk. In general, the complexity of arthroscopic surgery, especially when combined with arthroscopic assisted ligament reconstruction, has been considered as a risk factor for the development of DVT(15). In addition, the early immobilization of the affected limb after ligament reconstruction may have an effect on the overall probability of DVT. In this study, however, there was no detectable difference in the incidence of DVT between simple knee surgery and ligament reconstruction, which is consistent with the results reported by Maletis et al.(21). Interestingly, the odds ratio (OR) of DVT in patients with ACL reconstruction accompanied by PCL reconstruction (OR=1) was smaller than that in patients with simple ACL reconstruction (OR=1.8) or PCL reconstruction (OR=1.3) in our study. We analyzed the reason is that the patients underwent ACL reconstruction combined with PCL reconstruction may seek more NSAIDs postoperatively. NSAIDs can not only relieve postoperative pain, thus enabling patients to start functional exercise earlier, but also it has been shown to inhibit platelet aggregation, which may be an important reason to explain this result. However, more prospective studies are needed to further clarify the effect of NSAIDs on DVT formation.

Tourniquet times >60 minutes was identified as another procedure-related risk factor for the development of VTE. The stasis induced by tourniquet, combined with the non-occlusive vascular damage that the patients may experience during the operation, could lead to VTE. Although tourniquet duration was longer than 90 minutes in almost all patients (95.2%, 20/21) with DVT, a longer tourniquet duration was not found as an independent factor for DVT in our study. Likewise, Camporese et al.(22) did not found the relationship between VTE and tourniquet time. We suspect that a longer tourniquet time may only be representative of a more complicated case, and the complexity of the operation is the real risk factor for VTE.

The increased density of D-dimers and fibrinogen degradation products, which aggravate hypercoagulation states and enhance secondary fibrinolysis activity. D-dimer generally assumed to tend to decline to a normal level within three to ten days after tissue injury, and has a high sensitivity for predicting the formation of postoperative DVT. Although D-dimer is affected by pregnancy, trauma, tumor, and surgery, our study excluded possible influencing factors except for surgery, we tried our best to minimize its effects. D-dimer is a sensitive but non-specific marker of DVT, so the positive result of D-dimer cannot be used for diagnosis, on the contrary, the possibility of thrombosis can be excluded when D-dimer is negative(23). Our results also demonstrated that for every unit increase in D-dimer, the probability of patients suffering from DVT increased by 3.7 times, so anticoagulation is necessary for patients with high D-dimer after knee arthroscopy. Meanwhile, D-dimer provides a characteristic of quick and convenient. It can also be used as a routine examination to screen the formation of DVT in hospitals

without ultrasound or venography, and unnecessary examination can be avoided for some low-risk patients.

Limitations

Our research still has some limitations. First of all, because the study population was limited to patients who remained in the hospital after the surgery, which probably underestimates the incidence of DVT, since patients who left the hospital likely did not develop DVT but were excluded from the study population. Secondly, although ultrasonography has been used as the main monitoring method for DVT, it has low sensitivity in patients without symptoms of DVT, especially during the early period postoperative, which may also reduce the incidence of DVT in this study. Thus, ultrasonography alone is not sufficient to provide a reliable assessment for assessing the presence of DVT, even though it is considered as having sensitivity and specificity equivalent to venography. Furthermore, this study was a retrospective study with a limited sample size, which cannot fully incorporate the risk factors that may affect the formation of DVT. Therefore, the conclusions of this study need to be further verified by a larger sample size and multi-center randomized controlled study.

Conclusions

In this study, the early incidence of DVT after knee arthroscopy was 7.7%. Symptomatic DVT was rare and occurred infrequently. The incidence of DVT within three days could not be reduced by using LMWH, and a high D-dimer level was an early marker for DVT after knee arthroscopy. Therefore, surgeons and clinicians should thus be more vigilant and individualized anticoagulant therapy should be given appropriately.

Abbreviations

ACLR: anterior cruciate ligament reconstruction

BMI: Body Mass Index

CI: confidence interval

DVT: deep venous thrombosis

DD: D-dimer

LMWH: low molecular weight heparin

OR: odds ratio

PE: pulmonary embolism

PCLR: posterior cruciate ligament reconstruction

VTE: venous thromboembolic

Declarations

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Ethics approval and consent to participate

The Ethics Committee of Wuhan University Affiliated Zhongnan Hospital concluded that no approval is necessary for study based on its retrospective design. All patients agreed to the use of data in the study by oral consent. The oral consent approval was documented in the patients' files, which was approved by the Ethics Committee of Wuhan University Affiliated Zhongnan Hospital. All clinical investigations were conducted in accordance with the guidelines of the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

All data are included in the manuscript.

Competing interests

The authors declare no competing interests associated with this manuscript.

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Authors' contributions

This study was projected by CLB and YX. The first draft of the manuscript was written by SL. All authors (SL, NQB, CB, HHY, CLB, YX) contributed to interpretation of the results and revision of the manuscript. All authors have approved the manuscript before submission.

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Tables

Table 1 Distribution of DVT

Location	Number
Proximal DVT	3
Iliac	0
Femoral	0
Popliteal	3
Distal DVT	18
Muscular	9
Peroneal	1
Anterior tibial	1
Posterior tibial	5
Muscular + Peroneal	1
Muscular + Anterior tibial	0
Muscular + Posterior tibial	1
Anterior tibial + Posterior tibial + Peroneal	0
Total	21

DVT, deep venous thrombosis.

Table 2 Clinical risk factors associated with DVT

Parameters	DVT (-)	DVT (+)	t/ χ^2	P
Age (year)	40.2±17.4	40.0±14.5	t=-0.043	.966
Sex (male/female)	143/108	13/8	$\chi^2=0.019$.661
BMI (Kg/m ²)	23.7±3.7	24.0±4.2	t=-0.342	.732
DD (mg/L) preoperative	0.1±0.2	0.2±0.3	t=-1.542	.124
DD (mg/L) postoperative	0.3±0.4	0.8±0.8	t=-2.752	.012
PLT (×10 ⁹ /L) preoperative	220.9±57.9	196.8±47.3	t=1.859	.064
Anesthesia type (general/spinel)	52/199	5/16	$\chi^2=0.112$.738
Use of LMWH	163/88	14/7	$\chi^2=0.025$.873
Tourniquet time (min)	123.9±59.6	158.1±64.3	t=-2.511	.013
Surgery type (simple/ligament reconstruction)	160/91	7/14	$\chi^2=7.562$.006

DVT, deep venous thrombosis; BMI, Body Mass Index; DD, D-dimer; PLT, platelet; LMWH, low molecular weight heparin.

Table 3 The results of multivariate regression analysis of risk factors in DVT

Risk factors	OR	95% CI	χ^2	<i>P</i>
DD(mg/L) postoperative	3.7	1.8-8.0	11.906	.001
Tourniquet time(min)				
≤60*				
60-120	>10000	-	0.000	.998
≥120	>10000	-	0.000	.998
Surgery type[simple/ligament reconstruction]				
Simple*				
ACLR	1.8	0.4-7.5	0.707	.401
PCLR	1.3	0.1-15.2	0.400	.842
ACLR+PCLR	1.0	0.1-7.3	0.000	.985

DVT, deep venous thrombosis; OR, odds ratio; CI, confidence interval; DD, D-dimer; ACLR, anterior cruciate ligament reconstruction; PCLR, posterior cruciate ligament reconstruction.

* Reference group