Incidence of Symptomatic and Asymptomatic Venous Thromboembolism After Elective Knee Arthroscopic Surgery: A Retrospective Study With Routinely Applied Venography

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Purpose: The purpose of this study was to assess the incidence of total venous thromboembolism (VTE) after knee arthroscopy with routinely applied venography. Methods: We reviewed 537 consecutive patients undergoing arthroscopic knee surgery from March 2012 to July 2013. The surgical procedure was categorized as simple anterior cruciate ligament reconstruction (ACLR), posterior cruciate ligament reconstruction (PCLR), or reconstruction of both cruciate ligaments. All patients having arthroscopy in our institution were routinely examined with venography on the third postoperative day. Clinical signs of DVT were checked and recorded before venography. Results: Eighty (14.9%) of 537 patients were diagnosed with VTE by venography. Of the 80 detected cases of VTE, only 20 (3.7%) patients presented with clinical signs of DVT, indicating that there were 60 (11.2%) asymptomatic cases. No patient died or presented with a clinically suspected pulmonary embolism (PE). Sex, body mass index (BMI), operative time, and duration of tourniquet application were not significant risk factors for DVT. Patient age ($P < .0001$) is a strongly significant risk factor for deep venous thrombosis (DVT). Compared with patients who underwent simple arthroscopic procedures, complex procedures—the reconstruction of 1 ($P < .005$) or both knee cruciate ligaments ($P < .0005$)—led to a significantly higher postoperative incidence of DVT. Conclusions: The total incidence of VTE diagnosed with venography after arthroscopic knee surgery was 14.9%, of which only 3.7% of cases were symptomatic, indicating 11.2% cases of silent VTE. Advanced age and complex arthroscopic surgery are strongly associated with VTE. Level of Evidence: Level IV, prognostic case series.

Deep venous thrombosis (DVT) is viewed as a relatively rare complication in knee arthroscopy. Clinically, it is difficult to diagnose and has the potential to develop into pulmonary embolism (PE). However, whether prophylaxis should be used in patients undergoing arthroscopic surgery is still controversial. Reported incidence of DVT after knee arthroscopy with or without anticoagulant medication ranges from 1.5% to 41.2% in the literature. Because of the varied evidence regarding venous thromboembolism (VTE) in patients undergoing knee arthroscopy, this makes clinical decision making difficult. Mauck et al., in their historical cohort study, found a cumulative symptomatic incidence of VTE as low as 0.4% at 35 days after surgery and recommended no prophylaxis. Results from Jameson et al. and Maletis et al. have also shown a very low symptomatic incidence of DVT, ranging from 0.05% to 0.3% using large databases of medical records. However, the exact DVT measurement was not shown. The data collected in these articles implied that the populations comprised mostly symptomatic patients with DVT who needed further treatment. Asymptomatic VTE can be easily neglected without the use of venography or duplex ultrasonography. Although silent VTE has been suggested to be associated with the development of post-thrombotic syndrome, its long-term clinical significance is still unclear. A high prevalence of silent DVT was found in patients with acute illness at admission.

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The authors report that they have no conflicts of interest in the authorship and publication of this article. Supported by grants from the National Natural Sciences of China (no. 30973046) and China National Funds for Distinguished Young Scientists (no. 81125013).

Received September 9, 2013; accepted February 27, 2014.

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© 2014 by the Arthroscopy Association of North America 0749-8063/13662/536.00
http://dx.doi.org/10.1016/j.arthro.2014.02.043

The incidence of asymptomatic VTE was reported to be as high as 9% in patients undergoing anterior cruciate ligament reconstruction (ACLR). The difference in the long-term clinical importance of asymptomatic and symptomatic VTE has not been well investigated.

Based on the established evidence, the purpose of this study was to assess the incidence of DVT in different arthroscopic procedures and identify relevant risk factors. We hypothesized that the incidence of VTE (symptomatic and silent) after arthroscopy, detected with venography, would be high without thromboprophylaxis.

**Methods**

We reviewed 537 consecutive patients undergoing arthroscopic knee surgery from March 2012 to July 2013. The procedures were performed by 2 surgeons. All patients received lumbar or general anesthesia, which was chosen by the patient and the anesthesiologist. The surgical procedure was categorized as simple (e.g., diagnostic only, meniscal repair or meniscectomy, cartilage cleanup, or excision of cyst or lipoma), ACLR, posterior cruciate ligament reconstruction (PCLR), or reconstruction of both cruciate ligaments. No postoperative thromboprophylaxis (e.g., mechanical squeezer, Plexi Pulse, or aspirin) were used. No patient was given nonsteroidal anti-inflammatory drugs for the first 2 weeks after surgery. On average, patients were mobilized and discharged on the fourth postoperative day.

All patients having knee arthroscopic procedures at our institution were routinely examined with chest radiography and venography on the third postoperative day. We have routinely performed venography for nearly 5 years. The scan was performed by a physician who had 5 years of experience in the procedure and whose training started within the radiology department 5 years previously. The venogram was read by this physician and another 2 radiology specialists to get a definitive diagnosis. Clinical signs of DVT were checked and recorded before venography. Clinical signs differ in symptomatic patients with DVT and patients with silent DVT. Common clinical signs of DVT could be a positive Homan test, unilateral leg swelling, local rise of skin temperature, or redness. Common chest radiographic abnormalities in patients with acute PE were cardiac enlargement, pulmonary parenchymal infiltrates, atelectasis, pleural effusion, and pulmonary congestion. Diagnosis of PE in our study was largely based on presentation of respiratory symptoms. Specific details of the venography procedure, clinical management, and outcome measures for VTE were reported in our previous study. Patients did not have associated nerve blocks as anesthesia for postoperative pain relief. None of the patients received any form of preoperative or postoperative thromboprophylaxis against DVT. We included patients 18 years of age and older who had knee arthroscopic surgery. Patients were excluded if they were younger than 18 years, were pregnant, were already taking anticoagulation medication, had a history of DVT or PE, had cancer or a concurrent fracture, or if there was any contraindication to contrast venography (e.g., allergy). This study was approved by the ethics review committee, and written informed consent was obtained from all participants.

**Statistical Analysis**

The proportion of patients with VTE (PE, distal and proximal) was calculated. Thrombosis was classified as proximal if it involved the iliac, superficial femoral, or popliteal veins, with or without calf vein thrombosis, and as distal if it was isolated to the calf veins (e.g., posterior tibial, anterior tibial, or peroneal veins). The outcome measurement and clinical management of diagnosed DVT was reported in our previous study. Clinical characteristics such as age, sex, (body mass index [BMI]), operative time, tourniquet time, surgery operator, and type of arthroscopic procedure were tested for association with VTE by use of multivariate regression analysis. All statistical analysis was performed with IBM SPSS Statistics software, version 19 (SPSS, Chicago, IL).

**Results**

During this 17-month period, 537 patients (304 men) with a mean age (±standard deviation [SD]) of 41.1 ± 14.2 years had arthroscopic knee surgery. The mean duration (± SD) of the operation and tourniquet application were 80.4 ± 36.8 minutes and 60.1 ± 21.9 minutes, respectively. A total of 80 (14.9%) patients were diagnosed with VTE by venography, with 13 (2.4%) distributed in proximal veins and 67 (12.5%) in distal veins. Of the 80 detected cases of VTE, only 20 (3.7%) (9 of which were proximal) presented with clinical signs of DVT, indicating 60 (11.2%) silent cases that would have been missed without venography. No patient died or presented with clinically suspected PE (Table 1). Association between several potential risk factors and DVT were analyzed with multivariable regression analysis (Table 2). There was no significant difference in the incidence of DVT found between the 2 surgeon groups (P = .12) Sex, BMI, operative time, and duration of tourniquet application were not significant risk factors for DVT. In contrast, patient age (P < .0001) and operative type appeared to be significant risk factors for DVT. Compared with patients who underwent simple arthroscopic procedures, complex procedures—the reconstruction of 1 (P < .005) or both knee cruciate ligaments (P < .0005) led to a significantly higher postoperative incidence of DVT (Fig 1).

**Discussion**

Using venography, this study showed a 3.7% incidence of symptomatic DVT, which was close to the result found in a recent prospective study by Struij-
Mulder et al., and an 11.2% incidence of silent DVT in 537 patients undergoing arthroscopic surgery. The incidence of symptomatic DVT was relatively low. These symptomatic cases might be recognized in clinical practice without venography or ultrasonography, in which case thrombolysis and antithrombotic management would catch up to prevent long-term post-thrombotic syndrome or secondary PE. However, our incidence of silent DVT is 11.2%, almost 3-fold that of

Table 2. Association Between Clinical Risk Factors and Venous Thromboembolism

<table>
<thead>
<tr>
<th>Variable</th>
<th>Patients without VTE</th>
<th>Patients with VTE</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>40.4</td>
<td>44.7</td>
<td>.000003</td>
</tr>
<tr>
<td>Operative time, min</td>
<td>78.1</td>
<td>93.8</td>
<td>.20</td>
</tr>
<tr>
<td>Tourniquet time, min</td>
<td>59</td>
<td>66.4</td>
<td>.50</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>24.4</td>
<td>24.2</td>
<td>.98</td>
</tr>
<tr>
<td>Male sex, %</td>
<td>56.7</td>
<td>56.3</td>
<td>.53</td>
</tr>
</tbody>
</table>

Operator

Operator 1 (%) 255 (83.6) 50 (16.4) .12
Operator 2 (%) 202 (87.1) 30 (12.9)
Operative type

Simple 191 (91.0) 19 (9.0)
ACLR 195 (84.4) 36 (15.6) .004
PCLR 55 (78.6) 15 (21.4) .0004
ACLR + PCLR 16 (61.5) 10 (38.5) .0003

ACLR, anterior cruciate ligament reconstruction; BMI, body mass index; PCLR, posterior cruciate ligament reconstruction; VTE, venous thromboembolism.

Fig 1. Incidence data with standard error of venous thromboembolism (VTE) in different arthroscopic procedures are presented. Incidence of VTE after arthroscopic surgery increased with increased severity of knee injury and complexity of arthroscopic procedure. *, P < .05; ***, P < .001. ACLR, anterior cruciate ligament reconstruction; PCLR, posterior cruciate ligament reconstruction.
symptomatic DVT. The high percentage of silent DVT indicated that roughly 75% of DVT cases would have been imperceptible without venography in our study. With unstated long-term clinical importance of silent DVT, clinical preference toward symptomatic VTE could be dangerous because silent DVT is much more likely to be undiagnosed and therefore not managed with antithrombotic treatment in most cases. Distinction between the long-term prognoses of silent and symptomatic VTE has to be further elucidated in the future.

Age and procedure type were shown to be significant risk factors for DVT after arthroscopic surgery in our study. Age is a well-accepted risk factor for DVT. This can be attributed to decreased exercise, increasing immobility, and increasing systemic activation of blood coagulation with aging. The incidence of DVT in patients with injury to both cruciate ligaments was extremely high (38%), which implied that high-energy injury was mostly high-energy trauma, which itself is a risk factor for DVT in the literature.\textsuperscript{19-21} In this case, we could not distinguish postoperative DVT from preoperative DVT. Also, the incidence in this study was identified in patients during hospitalization. DVT might develop after the patient is discharged. Therefore, the true incidence of DVT after arthroscopic surgery is probably higher than that found in this study. Our 4-day hospitalization is quite different from many western practices, in which many of these patients are discharged on the day of surgery. The increased hospitalization in our study could potentially influence the incidence of VTE.\textsuperscript{22} Venography as an invasive examination is not quite acceptable for follow-up. Hence, venography was performed on the third postoperative day. Another limitation of this study is that contraceptive use in the 233 female patients and tobacco use were not identified, and this may have an overall effect on the numbers.

Conclusions

The total incidence of VTE diagnosed with venography after arthroscopic knee surgery was 14.9%, of which only 3.7% were symptomatic cases, indicating 11.2% silent cases of VTE. Advanced age and complex arthroscopic surgery are strongly associated with VTE.

Acknowledgments

Y. Sun and D.Y. Chen were responsible for concept and design, analysis, or interpretation of the data, critical writing or revision of the intellectual content, and final approval of the version to be published. Z.H. Xu and D.Q. Shi were responsible for concept and design and final approval of the version to be published. J. Dai, J.H. Qin, and Q. Jiang were responsible for analysis or interpretation of the data, critical writing or revision of the intellectual content, and final approval of the version to be published.

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