



Symptomatic pulmonary embolism after outpatient arthroscopic procedures of the knee

THE INCIDENCE AND RISK FACTORS IN 418 323 ARTHROSCOPIES

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Pulmonary embolism is a serious complication after arthroscopy of the knee, about which there is limited information. We have identified the incidence and risk factors for symptomatic pulmonary embolism after arthroscopic procedures on outpatients. The New York State Department of Health Statewide Planning and Research Cooperative System database was used to review arthroscopic procedures of the knee performed on outpatients between 1997 and 2006, and identify those admitted within 90 days of surgery with an associated diagnosis of pulmonary embolism. Potential risk factors included age, gender, complexity of surgery, operating time defined as the total time that the patient was actually in the operating room, history of cancer, comorbidities, and the type of anaesthesia. We identified 374 033 patients who underwent 418 323 outpatient arthroscopies of the knee. There were 117 events of pulmonary embolism (2.8 cases for every 10 000 arthroscopies). Logistic regression analysis showed that age and operating time had significant dose-response increases in risk ($p < 0.001$) for a subsequent admission with a pulmonary embolism. Female gender was associated with a 1.5-fold increase in risk ($p = 0.03$), and a history of cancer with a threefold increase ($p = 0.05$).

These risk factors can be used when obtaining informed consent before surgery, to elevate the level of clinical suspicion of pulmonary embolism in patients at risk, and to establish a rationale for prospective studies to test the clinical benefit of thromboprophylaxis in high-risk patients.

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Thromboembolic disease is a frequent and well-studied complication of total knee replacement, with a reported incidence of more than 50% in patients not receiving prophylaxis.^{1,2} Symptomatic cases may range from swelling of the calf and soreness to a post-phlebotic syndrome^{3,4} and in severe cases, thromboembolism. There is, however, limited information about the incidence of pulmonary embolism (PE) and its risk factors after arthroscopy of the knee.

When limbs are screened with venography after arthroscopy of the knee, the incidence of deep-vein thrombosis (DVT) is up to 17.9%.⁵ However, as most of these are distal,⁵ their clinical significance is questionable.⁶ Symptomatic and proximal thromboembolic disease, which may progress to PE, is reported to affect less than 1% of patients who undergo arthroscopy of the knee.⁷⁻¹² Therefore, routine thromboprophylaxis has not usually been recommended, but an individualised approach based on risk factors has been suggested for patients at high risk.^{8,10}

Previous studies which mentioned PE after arthroscopy of the knee were either case

reports or cohort studies with very few cases.¹²⁻¹⁷ None were powered to demonstrate a significant association between potential risk factors and the incidence of clinically symptomatic PE.

As no data on the incidence of symptomatic PE are available, surgeons who perform these procedures may fail to diagnose this rare, but potentially lethal, complication. Another concern is the potential financial burden on healthcare systems if legal action is taken after a fatal PE.

The object of this study, therefore, was to evaluate the incidence and risk factors for symptomatic PE in a very large cohort of patients who had undergone arthroscopy. Based on the limited information available when operating on the knee as an outpatient, we hypothesised that the incidence of PE after these procedures would be $< 1\%$, and that specific risk factors could be identified.

Patients and Methods

The New York State Department of Health Statewide Planning and Research Cooperative

Table I. Demographics of outpatient knee arthroscopies

Variable	With PE*	Without PE	p-value†
Number of knee arthroscopies	117	418 206	
Mean age (range)	50.3 (15 to 79)	45.5 (0 to 100)	0.001
Female gender (%)	67 (57.3)	195 740 (46.8)	0.026
Deyo comorbidity score (%) ¹⁹			
0	108 (92.3)	392 639 (93.9)	0.449
1	8 (6.8)	23 303 (5.6)	
2	1 (0.9)	1822 (0.4)	
3+	0 (0)	422 (0.1)	
History of cancer	3 (2.6)	3040 (0.7)	0.054
Type of surgery (%)			
Meniscectomy	89 (76.1)	304 160 (72.7)	0.468
Meniscal repair	5 (4.3)	10 239 (2.5)	0.215
ACL‡ reconstruction	11 (9.4)	39 902 (9.5)	0.999
ACL reconstruction and meniscus surgery	7 (6.0)	18 943 (4.5)	0.377
Debridement	8 (6.8)	29 456 (7.0)	0.999
Chondroplasty	37 (31.6)	123 528 (29.5)	0.613
Synovectomy	13 (11.1)	64 227 (15.4)	0.248
Type of anaesthesia (%)			
Local	4 (3.4)	18 266 (4.4)	0.821
Regional	14 (12)	53 835 (12.9)	0.890
General	54 (46.2)	194 307 (46.6)	0.999
No specific type of anaesthesia reported	45 (38.5)	151 798 (36.3)	0.632
Mean operating time: minutes (range)	74.9 (12 to 235)	62.4 (5 to 300)	0.002

* PE, pulmonary embolism

† p-values in this table were calculated using bivariate analysis

‡ ACL, anterior cruciate ligament

System database, a census of all hospital admissions and outpatient surgery in New York State, was used to identify all arthroscopic procedures performed on the knee in New York State between 1997 and 2006. Cases were defined as patients who were admitted with a PE within 90 days of the arthroscopic procedure, based on their ICD-9-CM code of diagnosis during discharge (415.1, which refers to 'Pulmonary embolism and infarction', or 415.11, which refers to 'Iatrogenic pulmonary embolism and infarction'). In order to minimise bias associated with readmissions due to PE to hospitals outside New York State, which could underestimate the number of cases of PE as these are not included in our New York State database, we limited our study to patients who were residents of New York State. Potential risk factors that were available on the database included age, female gender, increased operating time, a history of cancer, complexity of the surgery, type of anaesthesia, and comorbidities. Complexity of surgery was assessed by types of procedures performed during the arthroscopy, which were categorised according to their specific CPT-4 (Current Procedural Terminology, 4th edition) code as involving meniscectomy, meniscus repair, anterior cruciate ligament (ACL) reconstruction, synovectomy, chondroplasty and debridement. The types of anaesthesia included general,

regional and local. Comorbidities were defined using the comorbidity scale described by Charlson et al¹⁸ and adjusted for use with administrative data by Deyo, Cherkin and Ciol.¹⁹

Statistical analysis. This included bivariate comparisons for each variable, and then, accordingly, a multiple logistic regression model was built including all potential risk factors. Adjusted odds ratios and 95% confidence intervals (CI) were derived from the model to determine the degree of association between these factors and the risk of symptomatic PE following arthroscopy of the knee. A p-value of 0.05 was considered statistically significant. All analysis was performed with SAS for Windows 9.1 (SAS Institute Inc., Cary, North Carolina).

Results

The demographics and bivariate analyses are provided in Table I. The incidence of PE was 2.8 events for every 10 000 procedures. There was one death in the PE group which occurred following an admission that included the diagnosis of PE, and which may therefore have been a case of fatal PE. None of the patients had more than one admission for PE. Patients who had a PE were on average five years older than patients who did not ($p = 0.001$). Over 57% of

Table II. Logistic regression model of the potential risk factors

Variable	Adjusted odds ratio	Lower 95% CI	Upper 95% CI*	p-value
Age (yrs)				
< 20	Reference	--	--	0.0006
20 to 29	2.14	0.42	11.1	
30 to 39	5.71	1.32	24.6	
≥ 40	6.53	1.57	27.1	
Female gender	1.51	1.04	2.19	0.03
Any comorbidity	1.14	0.57	2.26	0.71
History of cancer	3.02	0.95	9.58	0.06
Type of surgery				
Meniscectomy	Reference	--	--	--
Chondroplasty	1.05	0.71	1.57	0.79
Synovectomy	0.88	0.40	1.27	0.25
ACL [†] reconstruction	0.88	0.44	1.77	0.72
Meniscal repair	2.07	0.81	5.13	0.12
Operating time (mins)				
< 30	Reference	--	--	0.0004
30 to 59	1.22	0.66	2.29	
60 to 89	1.46	0.76	2.80	
≥ 90	2.96	1.52	5.75	

* CI, confidence interval

† ACL, anterior cruciate ligament

patients with PE were women, but only 47% of those without ($p = 0.026$). More than 92% of the procedures were performed in a population with no significant chronic illnesses, which was reflected by a comorbidity index score of zero. A history of cancer was reported in < 1% of the group that did not have a PE, and in > 2.5% of the group with PE ($p = 0.054$). The most frequent procedure was a meniscectomy, which constituted more than 72% of the operations in each group. The type of anaesthesia did not vary substantially by group. The mean operating time was 12 minutes longer for the procedures that were followed by PE (74.9 minutes, 12 to 235) than for the procedures that were not (6.24 minutes, five to 300) ($p = 0.002$). A history of previous thromboembolic events was extremely rare, being reported in only 0.1% of the procedures that were not followed by PE and in only one case of the procedures that were followed by PE ($p = 0.271$).

The multiple logistic regression model provided estimates of the magnitude of association for risk factors of interest (Table II). As the type of anaesthesia was not remotely associated with PE according to the bivariate analyses (p -values between 0.821 and 0.999), this variable was not included in the regression model. In this model, age showed a substantial dose-response relationship, with patients between 20 and 29, 30 and 39 and 40 years or older having a significantly greater likelihood of developing a PE than those under the age of 20 (adjusted odds ratio = 2.14, 5.71, and 6.53, respectively, $p = 0.0006$). The operating time also demonstrated a dose-response relationship for risk of PE ($p = 0.0004$). However, whereas times between

30 minutes and 90 minutes showed a minor increase in risk compared to those < 30 minutes (adjusted odds ratio < 1.5), a time > 90 minutes was associated with a threefold increase in risk compared to that < 30 minutes. The risk was also greater in women, with a 1.5-fold increase over men, and a history of cancer was associated with a threefold increase in risk ($p = 0.06$). No significant increased risk for symptomatic PE was found with any type of surgery, or any comorbidity.

Discussion

The extremely low incidence of symptomatic PE identified in this study supports our hypothesis that this complication affects < 1% of knee arthroscopies performed as an outpatient procedure. This may be related to the relatively limited extent of soft-tissue injury, blood vessel compression and bony trauma in the majority of these procedures, as well as to the relatively short period of post-operative immobilisation. Nevertheless, despite its rarity, this potential complication cannot be overemphasised, because of its seriousness, the potential for requiring hospitalisation with close monitoring and treatment, and finally the risk of death, as demonstrated by at least one fatal case in this study. We therefore believe that this information should be discussed with patients when obtaining informed consent prior to surgery. Both surgeons and patients should be aware that despite the 'simplicity' of outpatient arthroscopy, major complications can still occur.

Age and the operating time were most significantly associated with an increased risk of PE. Previous studies,

which evaluated smaller numbers of arthroscopies, could only identify trends for an increased risk for thromboembolic disease with older patients and longer operating times, but these did not reach statistical significance.^{5,9,17,20,21} In our study, beginning with the 20 to 29 years old age group, there was a more than twofold increased risk compared to patients < 20 years. The risk for PE increased to more than sixfold for patients over the age of 40. This clearly demonstrates that age is a risk factor for symptomatic PE, and that surgeons should suspect a PE after arthroscopic surgery even if their patient is 'only' in their fifth decade of life. The same concern should be shown after procedures taking longer than 90 minutes, which increases the risk of PE by a factor of three compared to those taking less than 30 minutes.

In this study women were at a significantly increased risk of PE compared to men. Previous studies, which were probably underpowered, have not been able to show this. The increased risk may be due to thromboembolic disease,^{5,9,20-22} but we had no information about which patients were on oral contraceptives or hormone replacement therapy, and whether these medications were given in the peri-operative period. The clinical significance of this increase in risk remains doubtful, as the adjusted odds ratio in our study was only 1.5:1.

A history of cancer increased the risk of PE by a factor of three, which was very close to significance ($p = 0.06$). Given the seriousness of PE, and the literature reporting an association between cancer and thromboembolic events,²³ we believe that this factor should be taken to be significant. Although a previous study⁹ found no association between malignancy and thromboembolic disease after arthroscopy of the knee when patients receiving anticoagulation were excluded, we believe that our results raise the concern that a significant association may exist, and that this should be further investigated.

The complexity of the operation, presented in our data as type of surgery, did not increase the risk of PE when the procedure involved ACL reconstruction or meniscal repair. This finding is consistent with a previous study⁹ that did not find a statistically significant difference in the risk of DVT after ligament reconstruction compared to a group of arthroscopic procedures without this procedure. A further study⁶ found no association between prolonged post-operative immobilisation related to meniscal repair, ACL reconstruction or other more complex procedures, and an increased risk of DVT. Therefore, there appears to be no increased risk of DVT or PE after complex arthroscopic procedures. The important surgical variable is the operating time. Indeed, one surgeon's arthroscopy and partial meniscectomy may take longer than another's ACL reconstruction, and may therefore be at higher risk.

Comorbidity scores were not associated with an increased risk of symptomatic PE. However, as more than 92% of the procedures in both groups were performed in patients with no comorbidities, this may simply reflect that we had

excluded patients who had arthroscopy performed as an inpatient, who may have had higher degrees of comorbidity.

In elective hip and knee replacement, regional anaesthesia is associated with a reduced incidence of DVT compared to general anaesthesia.^{24,25} In arthroscopy of the knee, previous reports could not associate the type of anaesthesia with DVT.¹⁷ An association with PE has never been specifically reported for either type of knee surgery. Our results suggest that there was no association between either the type of anaesthesia or thromboembolic events in patients undergoing outpatient arthroscopy.

A history of thromboembolic disease was only reported by one patient in the group that had a symptomatic PE (0.9%), but the incidence was 0.3% in the group without. As no data relating to the administration of thromboprophylaxis were available, we did not include this factor in our regression model, but a positive history would appear to reflect an increased risk, and we view it as such.

The limitations of this study include a lack of data about potential PE-related deaths that may have occurred outside a hospital without readmission, as well as a lack of data about potential cases of symptomatic PE that could have occurred in patients who were then admitted to hospitals outside New York State. Other potential limitations include a lack of information about thromboprophylaxis, and of additional potential risk factors which were not available to us, such as the duration of any tourniquet use, obesity and smoking. Another limitation is the possibility of a coding error in the database. This is likely to be small, as the coding used in this database is validated routinely each year.

In conclusion, we have studied the largest cohort of outpatient arthroscopic procedures on the knee yet evaluated to determine the incidence and risk factors for symptomatic PE. The findings support our hypothesis that symptomatic PE is extremely rare. Despite this, the information presented has practical implications. There should be a higher index of suspicion for clinical symptoms after surgery in cases involving patients in their fifth decade of life and over, and cases requiring an operating time of over 90 minutes. In our opinion, specific attention should be paid to patients with a history of cancer, and to women, particularly if accompanied by other risk factors. In terms of thromboprophylaxis, a recent review of randomised clinical trials recommended anticoagulation only for patients at risk,¹⁰ whereas another showed a reduction in DVT by giving low-molecular-weight heparin for seven days.²⁶ Our study may support the idea of thromboprophylaxis in selected cases where multiple risk factors coexist. It may also improve the accuracy of informed consent prior to surgery. Finally, these data could provide a basis for future prospective studies by focusing on the specific risk factors that have been identified.

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