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ORIGINAL ARTICLE

Incidence and management of pulmonary embolism following spinal surgery occurring while under chemical thromboprophylaxis

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Abstract Patients undergoing spinal surgery are at risk of developing thromboembolic complications even though lower incidences have been reported as compared to joint arthroplasty surgery. Deep vein thrombosis (DVT) has been studied extensively in the context of spinal surgery but symptomatic pulmonary embolism (PE) has engaged less attention. We prospectively followed a consecutive cohort of 270 patients undergoing spinal surgery at a single institution. From these patients, only 26 were simple discectomies, while the largest proportion (226) was fusions. All patients received both low molecular weight heparin (LMWH) initiated after surgery and compressive stockings. PE was diagnosed with spiral chest CT. Six patients developed symptomatic PE, five during their hospital stay. In three of the six patients the embolic event occurred during the first 3 postoperative days. They were managed by the temporary insertion of an inferior vena cava (IVC) filter thus allowing for a delay in full-dose anticoagulation until removal of the filter. None of the PE patients suffered any bleeding complication as a result of the introduction of full anticoagulation. Two patients suffered postoperative haematomas, without development of neurological symptoms or signs, requiring emergency evacuation. The overall incidence of PE was 2.2% rising to 2.5% after exclusion of microdiscectomy cases. The incidence of PE was highest in anterior or combined thoracolumbar/lumbar procedures (4.2%). There is a large variation in the reported incidence of PE in the spinal literature. Results from the only study found in the literature specifically monitoring PE suggest an incidence of PE as high as 2.5%. Our study shows a similar incidence despite the use of LMWH. In the absence of randomized controlled trials (RCT) it is uncertain if this type of prophylaxis lowers the incidence of PE. However, other studies show that the morbidity of LMWH is very low. Since PE can be a life-threatening complication, LMWH may be a worthwhile option to consider for prophylaxis. RCTs are necessary in assessing the efficacy of DVT and PE prophylaxis in spinal patients.

Keywords Deep vein thrombosis · Pulmonary embolism · Spinal surgery · Incidence · Low molecular weight heparin

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Introduction

Deep vein thrombosis (DVT) and pulmonary embolism (PE) are potential complications following major orthopaedic surgical procedures, predominantly total hip arthroplasty (THA) and total knee arthroplasty (TKA). In the absence of prophylaxis, DVTs occur in as much as 84% of elective hip and knee arthroplasty cases with up to 36% being proximal lesions. The incidence of PE has been reported to range from 9 to 30% with fatal events occurring in 0.1–0.7% of the cases [6].

Although lower incidences have been noted, patients undergoing spinal surgery are also at risk of developing thromboembolic complications. DVT incidence has been reported to range from 0% [12] to 15.5% [11] with PE incidence varying from 0% [12] to 13.1% [13]. Although DVT has been studied extensively in the context of spinal

surgery, symptomatic PE, which in itself is life threatening, has been given less attention. Furthermore, the pathophysiology of PE in spinal surgery differs from that in joint arthroplasty were lower limb DVT is the main source of thrombi causing PE [4]. The purpose of the present study was to report on the incidence of PE following spinal surgery and to present the management rationale in our institution.

Materials and methods

A consecutive cohort of 270 patients undergoing spinal surgery by a single surgeon at an academic spinal unit over a 24-month period was prospectively followed. The study included all patients operated during this period except the ones with procedures under local anaesthetic such as discographies and facet joint injections. Principle variable studied was the presence of symptomatic pulmonary embolism confirmed by spiral chest CT while secondary variables were occurrence of postoperative haematomas and the management of patients with symptomatic PE. The average patient age was 44.2 years (15.6–92.4) and the minimum follow up time was 12 months. From the 270 patients, 31 underwent a cervical procedure, 198 with a lumbar procedure, and the remaining 41 had either a thoracic or thoracolumbar junction procedure. Diagnosis was spinal stenosis in 77 cases, acute fractures or posttraumatic deformities in 57 cases, degenerative disc disease in 37 cases, herniated lumbar discs in 26 cases, isthmic spondylolsthesis in 27 cases, degenerative scoliosis with stenosis in 23 cases, tumours in 8 cases, infections in 8 cases, and rheumatoid arthritis in 7 cases. No spinal cord injuries were included in this study. A total of 41 patients had either anterior or combined anterior/posterior procedures, 24 of which were lumbar or thoracolumbar cases. Lumbar discectomies accounted for 26 cases whereas 18 patients underwent purely a decompressive procedure. From the whole cohort, 226 surgeries included spinal fusion of which 222 were instrumented.

Compressive stockings were employed on all patients upon admission. Enoxoparin, a low molecular weight heparin (LMWH), was administered starting from the eighth postoperative hour, once daily, and discontinued upon discharge. Following institutional guidelines established by a multidisciplinary committee, a 20 mg dosage was used during the first 3 postoperative days and 40 mg thereafter. Patients were mobilised on the postoperative day 1 or 2 depending on the amount of postoperative pain. PE diagnoses were made using spiral computer tomography (CT) of the chest. Investigations were directed only when clinical suspicion of PE was present. Postoperative haematomas requiring surgical evacuation were also recorded. Duration of surgery was noted for all PE patients as well as co-morbidities, expressed according to an available index from the literature [3]. Odds ratios (OR) and their 95% confidence intervals (CI) were calculated for PE and diagnosis as well as type of approach. Two-tail Fisher's exact test was performed in the subgroup analysis.

Results

No deaths occurred in this 270 patient cohort; 6 patients did, however, develop symptomatic PE (5 while still at the hospital) with shortness of breath being the main symptom. Clinical suspicion of PE was confirmed using Spiral CT. The overall incidence of PE was 2.2%, raising to 2.5% after the exclusion of simple microdiscectomy cases ($n = 26$) in which no PE was recorded. The incidence of PE was highest (4.2%) in anterior or combined thoracolumbar/lumbar procedures. Details of the PE cases are shown in Table 1.

In three out of the six PE cases, the duration of surgery exceeded the average (243 min) of the posterior fusion subgroup but remained within one standard deviation

Table 1 Details of the symptomatic PE patients and management approach

Case no	Type of surgery	Duration of surgery(min)	Co-morbidity index [3]	Approach	Surgery-PE time interval (days)	Treatment
1	Decompression and non-instrumented fusion	183	3	Posterior	1	IVCF, full-dose anticoagulation from day 10
2	Decompression and instrumented fusion	319	2	Posterior	2	IVCF, full-dose anticoagulation from day 10
3	Decompression and instrumented fusion	213	0	Posterior	3	IVCF, full-dose anticoagulation from day 10
4	ALIF and disc arthroplasty	328	0	Anterior	8	Full-dose anticoagulation
5	Decompression and instrumented fusion	265	1	Posterior	10	Full-dose anticoagulation
6	Thoracic # fixation	210	0	Posterior	30	Full-dose anticoagulation

(71 min). Two patients had a co-morbidity index higher than the average (1.9) of the decompression and fusion subgroups. From the six affected patients, three were managed by temporary insertion of an inferior vena cava filter (IVCF). This approach was taken mainly since the embolic event occurred during the first three postoperative days following a posterior decompressive procedure, and allowed for the delay of full-dose anticoagulation until removal of the filter. No complications related to the use of IVCFs were observed. None of the PE patients suffered any bleeding complication as a result of the introduction of full anticoagulation. Only two patients suffered postoperative haematomas requiring emergency evacuation. Neither of these two patients developed neurological symptoms or signs but instead presented with a tense wound and increasing pain.

Evaluating the association between PE and diagnosis, we found both spinal stenosis (OR = 5.23, 95% CI = 0.94–29.19) and degenerative disc disease (OR = 1.27, 95% CI = 0.14–11.16) to increase the likelihood of PE as compared to the other diagnoses from the rest of our patient population. Only spinal stenosis though reached statistical significance ($P = 0.056$). Although a PE occurred in our fracture group this patient population was less likely to develop PE (OR = 0.74, 95% CI = 0.09–6.49) without reaching statistical significance ($P > 0.1$). In addition, patients undergoing anterior or combined procedures were more likely to suffer a PE (OR = 1.12, 95% CI = 0.13–9.84) as compared to patients having a posterior only approach. This difference was nevertheless not statistically significant ($P > 0.1$).

Discussion

Incidence of symptomatic PE

A great variation in the incidence of PE exists in the literature for spinal surgery. Studies have focused on the incidence of DVT in spinal surgery but often do not comment on the incidence of PE explicitly. Other than the current study, only one other study focuses on reporting PE incidence and postoperative haematomas occurring under LMWH prophylaxis in spinal surgery patients [7]. A summary of the studies looking at PE incidence are summarised in Table 2 and briefly described below.

Ferree reported a 5% DVT incidence [5] using ultrasonography in a group consisting of 60 patients undergoing laminectomy using compressive stockings for prophylaxis. All of the reported thrombi were distal to the knee, which is known to have a lessened risk for PE [10]. No PE was recorded in that study group. In a randomized study looking at the efficacy of different compression devices, including a subgroup of cases receiving coumarine anticoagulation, Rokito et al. [12] found a very low DVT rate (0.3%) and no symptomatic PE. In contrast, Rosner et al. [13], using a retrospective cohort of high-risk patients as a control group to study the routine use of IVCF as a form of thromboembolic prophylaxis, found a much higher rate of PE (13.1%). Nevertheless, their group was not representative of the average spinal practise and for that reason their findings were not included in our statistic describing the average incidence of PE from the literature (see Table 2). In a study by Oda et al. [11] a higher incidence of DVT (15.5%) was found in their patient population without any PEs. Their study used venography which was thought to be better at detecting distal DVTs. The incidence of above knee thrombotic events in their study was only 0.9%. Smith et al. [14], reported on a younger population than in other studies, with a significant proportion of adolescent scoliosis and spondylolisthesis cases. They found a lower incidence of DVT (0.6%) and only one PE (0.3%). Prophylaxis consisted of only mechanical methods without any chemical prophylaxis. Wood et al. [16] found a 0.7% incidence of PE in patients using either compressive stockings or intermittent pneumatic compression in a randomized manner.

Only one study, by Dearborn et al. [4], looked prospectively at the incidence of both asymptomatic DVT and

Table 2 Summary and synthesis of studies from the literature on DVT/PE in spinal surgery

Study	Total No. of patients	Prophylaxis	No. of symptomatic PEs	% PE	No. of DVTs	% DVT
Dearborn JT [4]	318	CS + IPC	8	2.5	1	0.3
Ferree BA [5]	60	CS	0	0	3	5
Oda T [11]	110	None	0	0	17	15.5
Rokito SE [12]	329	CS ± IPC ± coumarine	0	0	1	0.3
Smith MD [14]	317	CS + IPC	1	0.3	2	0.6
West JL [15]	41	None	0	0	6	14.6
Wood KB [16]	136	IPC	1	0.7	1	0.7
Total	1,311		10	0.8	31	2.4

CS compressive stockings and *IPC* intermittent pneumatic compression

asymptomatic PE during spinal surgery. Patients received both compressive stockings and pneumatic compression of the lower limbs. Using perfusion scans, no subclinical PEs were noted, whereas, a 0.3% incidence of asymptomatic DVT was recorded. However, there was a 2.5% incidence of symptomatic PE, including one fatal case. This reported incidence was lower in cases requiring only a posterior approach (0.5%). The authors concluded that both routine ultrasound and perfusion scanning would not be cost effective since no asymptomatic PE was observed, and since the PE patients who had a scan showed no DVT. Their interpretation was that clotting occurs more likely in the iliac vessels and would therefore be missed by ultrasound examination. Patient positioning may in itself play a role in the development of DVT. The knee–chest position has been shown to reduce blood flow in the lower limbs increasing thromboembolic risk [8].

In a large cohort of patients looking at the morbidity of LMWH in spinal surgery Gerlach et al. [7] found a 0% incidence of PE and a 0.05% incidence of DVT using this type of prophylaxis. Although the number of patients in their study was much larger when compared to the aforementioned studies, a significant proportion of their cases were cervical or lumbar disc herniations. Furthermore, the main focus of their study was the incidence of haemorrhagic complications which could result in under reporting of thromboembolic events. On the other hand this is the only study, along with the current study, commenting on the incidence of PE with the use of LMWH in spinal surgery. In the present study, we found the incidence of PE to be 2.2%. Although this appears higher than the average 0.8% finding from the studies presented in Table 2, it compares with the findings reported by Dearborn et al. [4], which is the only other study we found with the primary aim of identifying the true incidence of PE. Under reporting of PE can therefore probably explain this difference. As a final comment concerning the incidence statistics, it should be noted that in all the aforementioned studies as well as in our current study, spinal cord injury patients were excluded. Such patients are known to have the highest risk for thromboembolic events among all hospital admissions [6].

Use of LMWH in spinal surgery

Although there is good evidence that LMWH reduces the incidence of PE and DVT in hip and knee surgery [6] no study has looked into this matter for spinal surgery. Many spinal surgeons are unwilling to use LMWH due to the possibility of epidural haematoma formation in the post operative period. Only one study so far has shown the relative safety of this approach, reporting a very low (0.7%) incidence of postoperative haematomas [7]. This low incidence is also confirmed in our study. In terms of randomized studies, we identified only one study that used some type of chemical prophylaxis (low dose coumadine) [12]. The group of patients receiving this chemical prophylaxis, however, was small ($n = 35$), limiting our ability to draw conclusions on risks and benefits [12]. Owing to the lack of data on chemical prophylaxis in spinal surgery, the accepted methods for prophylaxis have been the use of elastic stockings, intermittent pneumatic compression, or a combination of the two [6].

A difference may also exist in the pathophysiology of PE between spinal surgery and orthopaedic procedures such as THA and TKA. In THA and TKA, PE seems to be occurring in 45 to 80% of patients after they have been discharged from the hospital, at a median of 17 days for THA, and 7 days for TKA [6]. In our series only one patient had a late PE indicating this possible difference in pathophysiology for PE in spinal surgery. Furthermore, unlike with arthroplasty surgery, this finding may suggest that prophylaxis could be discontinued after hospital discharge, although more research will need to be done in order to be conclusive.

Management of symptomatic PE in the postoperative period

Full-dose anticoagulation during the early post operative period in spinal surgery is linked with frequent and severe complications. A retrospective review of management with anticoagulation of nonfatal PE among members of the Scoliosis Research Society revealed a 67% complication rate attributed to heparanization alone [2]. From the nine PE cases identified in the review, two suffered neurological complications due to haematoma formation whereas four developed wound haematomas requiring evacuation. The introduction of IVCF has changed the management of such cases. There is now widespread evidence that IVCF are safe and effective in preventing PE in patients in whom full-dose anticoagulation is contra-indicated [1]. Although their routine use for prophylaxis is not encouraged [6], they have a definitive role to play in the treatment of symptomatic PE during the immediate postoperative period. Furthermore, their routine use has been recommended in high-risk patients [9]. In a relatively recent study [9], Leon et al. used IVCFs in 74 high-risk patients with a contra-indication to anticoagulation. Only one patient developed a PE despite a 30% overall incidence of proximal DVT.

In our patient population, we chose to place a temporary IVCF only if a PE was diagnosed in the first 7 days following surgery. Full anticoagulation was undertaken only after removal of the IVCF, which in our three patients took place one week later. In these three patients, using this approach, no complications related to heparanization were

observed. Full anticoagulation was introduced in patients that had their PE diagnosed from the eigth postoperative day onwards, under regular wound inspection and neurological examination. Although the 8-day waiting period prior to full-dose anticoagulation was somehow arbitrary, we felt that this would be the earliest point prior to which the risk of haematoma formation would be unacceptable. This of course has to be tailored to each individual case. A multilevel cervical decompression, for example, may not carry the same risk as a one level anterior lumbar fusion in terms of neurological risk in the case of haematoma formation.

DVT was not actively sought after in all our patients. In the PE group, only one patient was found to also have a DVT. This further confirms the suspicion noted by others that routine screening for DVT may not be cost effective.

Conclusion

The incidence of symptomatic PE at our institution under LMWH was 2.2%. Although this is higher than the average calculated from our synthesis of the literature (see Table 2), it is equivalent to the statistic reported by the only study prospectively evaluating PE using only mechanical prophylaxis. Our observational prospective study was limited by its relative small sample size given the overall incidence of PE. Additionally, the cohort was operated by a single surgeon at a single unit and therefore its conclusions may not be transferable to other settings. In the absence of randomized trials, we cannot confirm that LMWH is effective in reducing the incidence of PE. Nevertheless, we found the risk of haematoma formation while under LMWH prophylaxis to be very low (0.7%) and therefore felt more comfortable in considering it as an acceptable option. Our PE management in the postoperative period, mainly the use of a temporary IVCF and the delay of full anticoagulation from the eighth postoperative day onwards, proved to be safe in the small series of patients that presented this life-threatening complication. Prospective randomized trials are needed in order to assess the efficacy of LMWH in reducing DVT and above all PE in spinal surgery patients.

References

1. Becker DM, Philbrick JT, Selby JB (1992) Inferior vena cava filters. Indications, safety, effectiveness (review). Arch Intern Med 152:1985–1994 (50 Refs)
2. Cain JE Jr., Major MR, Lauerman WC, West JL, Wood KB, Fueredi GA (1995) The morbidity of heparin therapy after development of pulmonary embolus in patients undergoing thoracolumbar or lumbar spinal fusion. Spine 20:1600–1603
3. Charlson ME, Pompei P, Ales KL, Mackenzie CR (1987) A new method of classifying prognostic co-morbidity in longitudinal-studies—development and validation. J Chronic Dis 40:373–383
4. Dearborn JT, Hu SS, Tribus CB, Bradford DS (1999) Thromboembolic complications after major thoracolumbar spine surgery. Spine 24:1471–1476
5. Ferree BA (1994) Deep venous thrombosis following lumbar laminotomy and laminectomy. Orthopedics 17:35–38
6. Geerts WH, Heit JA, Clagett GP, Pineo GF, Colwell CW, Anderson FA Jr., Wheeler HB (2001) Prevention of venous thromboembolism (Review). Chest 119:132S–175S (630 Refs)
7. Gerlach R, Raabe A, Beck J, Woszczyk A, Seifert V (2004) Postoperative nadroparin administration for prophylaxis of thromboembolic events is not associated with an increased risk of hemorrhage after spinal surgery. Eur Spine J 13:9–13
8. Laakso E, Ahovuo J, Rosenberg PH (1996) Blood flow in the lower limbs in the knee–chest position. Ultrasonographic study in unanaesthetised volunteers. Anaesthesia 51:1113–1116
9. Leon L, Rodriguez H, Tawk RG, Ondra SL, Labropoulos N, Morasch MD (2005) The prophylactic use of inferior vena cava filters in patients undergoing high-risk spinal surgery. Ann Vasc Surg 19:442–447
10. Lotke PA, Ecker ML, Alavi A, Berkowitz H (1984) Indications for the treatment of deep venous thrombosis following total knee replacement. J Bone Joint Surg Am 66:202–208
11. Oda T, Fuji T, Kato Y, Fujita S, Kanemitsu N (2000) Deep venous thrombosis after posterior spinal surgery. Spine 25:2962–2967
12. Rokito SE, Schwartz MC, Neuwirth MG (1996) Deep vein thrombosis after major reconstructive spinal surgery. Spine 21:853–858
13. Rosner MK, Kuklo TR, Tawk R, Moquin R, Ondra SL (2004) Prophylactic placement of an inferior vena cava filter in high-risk patients undergoing spinal reconstruction. Neurosurg Focus 17:E6
14. Smith MD, Bressler EL, Lonstein JE, Winter R, Pinto MR, Denis F (1994) Deep venous thrombosis and pulmonary embolism after major reconstructive operations on the spine. A prospective analysis of three hundred and seventeen patients. J Bone Joint Surg Am 76:980–985
15. West JL III, Anderson LD (1992) Incidence of deep vein thrombosis in major adult spinal surgery. Spine 17:S254–S257
16. Wood KB, Kos PB, Abnet JK, Ista C (1997) Prevention of deep-vein thrombosis after major spinal surgery: a comparison study of external devices. J Spinal Disord 10:209–214