

On the Incidence of Pulmonary Embolism in Spinal Arthrodesis and the Need for Better Evidence and Prevention Guidelines

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Introduction

Pulmonary Embolism (PE) is a rare but serious event that may occur after spinal surgery. Vascular endothelial damage during surgery and immobilization of the patient after surgery contribute to a higher risk of thrombosis and subsequent PE.⁶ Prophylaxis including intermittent pneumatic compression stockings, heparin, and other interventions is often employed by the treatment team to lower the risk of thromboembolic complications. In orthopedic, trauma, burn and other high-risk surgical patients, the incidence of PE has been thoroughly studied, and this knowledge has been used to establish prophylaxis guidelines specifically for these patients.⁷ The incidence of PE in spinal fusion patients, however, is less well studied, and definitive prophylaxis guidelines are lacking. The aim of this article is to review what is known about the incidence of PE in spinal arthrodesis patients, and describe the need for better medical evidence and prevention guidelines on this issue.

Literature Review

Smith et al,¹⁷ in the largest published study, reported on 108,419 patients undergoing lumbar microdiscectomy, anterior cervical discectomy and fusion, and lumbar stenosis decompression procedures. They reported a PE incidence of 0.14%. Only one other study, a meta analysis, achieved a sample size greater than 1,000 (Table 1). This study by Sansone et al¹⁵ reported a PE incidence of 0.06% in elective spinal fusion patients. In a study by Schizas et al,¹⁶ 270 spinal fusion patients were given heparin prophylaxis and 2.2% developed PE.

Although other studies had limited sample sizes, they address more specific sub-groups of spinal arthrodesis patients. Platzer et al¹⁴ studied 978 patients that were admitted to a level-1 trauma center and subsequently underwent spinal fusion for traumatic indications and noted a PE incidence of 0.92%. McKinley et al¹⁰ further studied 779 spinal cord injury (SCI) patients and reported the highest incidence of PE at 2.0%. In a group of patients determined to be at high risk for PE, Leon et al⁹ placed prophylactic inferior vena cava filters after spinal fusion surgery and reported a subsequent PE incidence of 1.4% in these patients.

Several studies have identified an association between spinal surgical approach and the incidence of PE. Pateder et al¹² followed 407 spinal patients and noted a PE incidence of 0.65% with posterior approach and 4.5% with anterior or combined anterior-posterior approach. Kim et al⁸ studied 119 patients and reported an incidence of 1.6% with posterior approach and 7.5% with combined anterior-posterior approach. Dearborn et al³ studied 116 patients and reported an incidence of 0.5% with posterior approach and 6.0% with combined anterior-posterior approach. Epstein et al⁴ reported an incidence of 1.5% with anterior approach, Cho et al¹ reported an incidence of 2.1% with posterior approach, and Piasecki et al¹³ reported an incidence of 7.6% with combined anterior-posterior approach, although these studies did not directly compare different approaches.

Other studies examined the incidence of PE after spinal fusion in specific surgical regions. Oskouian et al¹¹ studied 207 patients and reported a PE incidence of 0.48% in thoracolumbar fusions, while Wood et al¹⁹ studied 136 patients and reported an incidence of 0.70% with thoracolumbar fusions. Neither study directly compared the PE incidence in different spinal regions.

Discussion

The incidence of PE in spinal fusion patients is reported in the range of 0.06% – 7.6%. This confirms that PE is a rare event in these patients, but occurs often enough to warrant attention from the medical team. The range of reported incidences, however, is wide. The only large-scale study¹⁷ reported an incidence of 0.14%, but studied a specific group of low risk patients. Other studies that report much

higher incidences are underpowered and focus only on high-risk patients. These discrepancies in the literature highlight the need for larger-scale studies inclusive of patients of all risk stratifications in order to accurately determine the overall incidence of PE after spinal fusion.

Studies that focus on spinal fusion indicated for trauma generally report a higher incidence of PE than studies focused on elective or non-trauma spinal fusions.^{10,14,15,17} No study directly compares trauma versus non-trauma groups, however. A study directly comparing the incidence of PE in non-trauma and trauma spinal fusion patients would be useful to confirm that trauma patients do in fact have higher risks for PE, and might encourage additional prophylaxis and stricter observation in this population.

Likewise, studies that focus on PE incidence depending on the approach to spinal fusion surgery report a higher incidence in combined anterior/posterior approach than in anterior or posterior approaches alone.^{3,8,12} This link, however, is not well established in the literature because few studies compare approaches accurately and those that do are underpowered. To establish a link between surgical approach and a higher incidence of PE, larger studies are necessary. Furthermore, PE incidence also may vary depending on the region of spinal fusion, but too few studies have been published to suggest a relationship.

Over the past decades, several guidelines concerning the management of venous thromboembolism and PE prophylaxis have been produced, such that at present, many spinal fusion patients receive postoperative anticoagulation, compression devices, and elastic stockings.^{2,5,7,18} However it is unclear in the literature how these advancements in prophylactic guidelines and treatments have affected the incidence of PE in spinal fusion patients over time. At present there is little published longitudinal data assessing these effects. A recent analysis at our institution using the Nationwide Inpatient Sample showed that despite these medical advancements, the incidence of PE in spinal fusion patients has steadily remained about 0.2% since 1988.²⁰

Table 1. Studies of Pulmonary Embolism Incidence in Spinal Arthrodesis Patients

Author	Number of Patients	Procedure/indication	Incidence %
JS Smith, et al.	108,419	Lumbar microdiscectomy, anterior cervical discectomy and fusion, lumbar stenosis decompression	0.14%
JM Sansone, et al.	4,383	Elective spinal fusion	0.06%
P Platzer, et al.	978	Spinal fusion after trauma	0.92%
W McKinley, et al.	779	Spinal fusion after spinal cord injury	2.00%
DB Pateder, et al.	407	Reconstructive spinal fusion	2.40%
		Posterior approach	0.65%
		Anterior and Anterior/Posterior approach	4.50%
MD Smith, et al.	317	Reconstructive spinal fusion	0.32%
C Schizas, et al.	270	All fusions	2.20%
		Anterior and Anterior/Posterior lumbar or thoracolumbar fusion	4.20%
RJ Oskouian Jr., et al.	207	Anterior thoracolumbar spinal fusion	0.48%
NE Epstein, et al.	200	Anterior approach	1.50%
KB Wood, et al.	136	Thoracolumbar reconstruction	0.70%
HJ Kim, et al.	119	Posterior Approach	1.60%
		Anterior/Posterior approach	7.50%
JT Dearborn, et al.	116	All fusions	2.20%
		Posterior approach	0.50%
		Anterior/Posterior approach	6.00%
L Leon, et al.	74	"High-risk" spinal fusion	1.40%
DP Piasecki, et al.	66	Anterior/Posterior approach	7.60%
KJ Cho, et al.	47	Posterior approach	2.10%

Further analysis is necessary to determine if the current prophylaxis guidelines and treatments are adequate.

Conclusion

Pulmonary embolism (PE) is a rare and dreaded event that may occur after spinal fusions, the incidence of which is reported in the literature between 0.06%-7.6%. Though some studies report a higher incidence of PE in trauma patients and those undergoing a combined anterior/posterior procedure, more complete and higher powered investigations are necessary to confirm these findings. Longitudinal studies are lacking, and will be necessary to determine if PE prophylaxis in spinal fusion patients has been effective in the long term.

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CONTEMPORARY NEUROSCIENCE

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At Jefferson Hospital for Neuroscience, neurologist Michael M. Mousavi, MD, and nurse Lauren Dougherty use the Jefferson Expert Teleconsulting (JET) system to consult with Robert H. Rosenwasser, MD, FACS, Chair, Department of Neurological Surgery (pictured on monitor), who is at another location.

Pioneering Leading-Edge Treatments

Jefferson Hospital for Neuroscience staff have helped to develop and/or have introduced to the region leading-edge treatments and technologies that reduce the need for open brain surgery for stroke, brain aneurysms and AVMs. Among them:

- Intra-arterial thrombolysis with tPA – pharmacological blood clot-dissolving
- Mechanical thrombectomy devices – e.g., Merci Retrieval System®
- Wingspan stent – FDA-approved mesh tube to open blocked arteries in the brain after clot-dissolving drugs have failed
- Coiling, gluing and stenting of brain aneurysms – reduces need for open brain surgery

Announcing Jefferson's Teleconsulting (JET) Robotic System for Help with Diagnosis and Treatment of Time-Sensitive Neurovascular Diseases

"Time is brain" is the credo among healthcare professionals for diagnosing and treating time-sensitive neurovascular diseases, including arteriovenous malformations (AVMs), brain aneurysms and, especially, stroke. The blood-clot busting medication tissue plasminogen activator (tPA), for example, must be administered to a patient having a stroke within 4.5 hours for best chance of functional recovery. Timely performance of neurosurgical procedures to remove AVMs and aneurysms are similarly urgent. Yet many community hospitals have limited experienced staff and technology to diagnose and treat patients quickly and accurately.

Now, to provide sophisticated care and expertise to patients at hospital emergency rooms in small community hospitals in distant areas of eastern Pennsylvania, south and central New Jersey, and Delaware, Jefferson Hospital for Neuroscience (JHN) in Philadelphia is launching Jefferson Expert Teleconsulting (JET), the region's first university-based high-tech mobile robotic system for neuroscience.

"JET places all of our resources – among them, dual-trained neurosurgeons, advanced technology, and leading-edge clinical trials in which we partner with the National Institutes of Health – at the disposal of patients, their families and physicians in need of a second, expert opinion," says Robert H. Rosenwasser, MD, FACS, Professor and Chair, Department of Neurological Surgery, JHN and Jefferson Medical College of Thomas Jefferson University. "Its greatest value is for timely diagnosis and application of treatment for time-sensitive neurovascular diseases, especially stroke."

Enhancing level of care

"We want to partner with hospitals in other communities to help advance stroke care throughout

the region. As the leading provider of stroke care in the region, we have an obligation to do that," adds Pamela Kolb, Vice President, Neuroscience Service, JHN.

Supported by Thomas Jefferson University, a leading academic center, JHN is the region's only dedicated hospital for neuroscience and leading, most experienced and comprehensive center for diagnosis and treatment of stroke and cerebrovascular disease. JHN's Acute Stroke Center is the largest such facility, with more board-certified neurocritical care physicians than most, in the greater Delaware Valley. It is also a Joint Commission-accredited primary stroke center.

"Stroke is the third-leading cause of death in the United States but the leading cause of disability, by a factor of five over any other disease," Dr. Rosenwasser notes. "Given its prevalence and time-sensitive nature, it is alarming how few people receive treatment in the appropriate amount of time. With JET, even hospitals in remote areas can provide patients with expert consultation and disposition of appropriate care from an experienced neurologist or neurological surgeon immediately in cases where every minute can make a critical difference. It's a very cost-effective approach to providing 24/7 onsite coverage and expertise."

How JET works

Each participating hospital is supplied with a mobile robotic platform, manufactured by InTouch Health® of Santa Barbara, CA, that enables the JHN Network physician to be remotely present. JET's panoramic visualization system and easy-to-use control interface afford physicians, patients and hospital staff a safe and effective interactive experience.

InTouch's remote presence devices are the first and only with FDA approval. The robots allow direct connection to medical devices such as electronic stethoscopes, otoscopes and ultrasound to transmit medical data to the remote physician.

"Should a patient arrive in the ER of a hospital that's located, say, three hours away from Jefferson and either doesn't have a neurologist or neurosurgeon available or has a neurologist who needs to consult with a neurosurgeon," Dr. Rosenwasser, explains, "the attending physician contacts JHN. The JHN Network specialist on call then uses a laptop to connect to the remote hospital via the robot, obtain a medical history by speaking directly with the patient and/or family members, examine the patient and determine what therapy is immediately needed, in real time, without delay. Finally, a decision is made either to admit the patient to the local hospital's Critical Care Unit or transfer him or her to the Jefferson Acute Stroke Center, by JeffSTAT, Jefferson's transport service, or the hospital's own service."

"Patients may not need to be transferred – they can stay in their own community and be treated very successfully there, thanks to this program," says Ms. Kolb. "And most patients want to stay close to home. JET enables them to receive sophisticated medical care without having to travel long distances."

"It also serves as an educational program," adds Dr. Rosenwasser. "As a teaching center, JHN will use JET to share our clinical protocols with participating hospitals so that they can enhance stroke care within their communities. On the other hand, should the patient need an advanced neurosurgical procedure [See sidebar], we can arrange for prompt transfer."

JHN continues to set the standard worldwide for state-of-the-art care for time-sensitive neurovascular diseases. For more information about these and other treatments, visit www.JeffersonHospital.org/neuroscience.



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