Interdisciplinary Neurosurgery 14 (2018) 18–23

Contents lists available at ScienceDirect

Interdisciplinary Neurosurgery

journal homepage: www.elsevier.com/locate/inat

Neuroanatomical Studies

Risk factors and clinical impact of perioperative neurological deficits following thoracolumbar arthrodesis☆

Enyinna L. Nwachuku*, Amol Mehta, Nima Alan, Nitin Agarwal, David O. Okonkwo, David K. Hamilton, Adam S. Kanter, Parthasarathy D. Thirumala

Department of Neurological Surgery, University of Pittsburgh Medical Center, Pittsburgh, PA, USA

ARTICLE INFO

Keywords:
Thoracolumbar fusion
Arthrodesis
Spine
Neurological deficits
Mortality
National Inpatient Sample
Outcomes
Complications

ABSTRACT

Objectives: The rates of arthrodesis performed in the United States and globally have increased tremendously in the last 10–15 years. Amongst the most devastating complications are neurological deficits including spinal cord injury, nerve root irritation, and cauda equine syndrome. The primary purpose of this study is to understand the risk factors for perioperative neurological deficits in patients undergoing thoracolumbar fusion.

Patients and methods: Data from the Nationwide Inpatient Sample between the years of 1999–2011 was analyzed. Patients were between the ages of 18 and 80 who had thoracolumbar fusion. Excluded were patients who underwent the procedure as a result of trauma or a malignancy. A list of covariates, including demographic variables, preoperative and postoperative variables that are known to increase the risk of perioperative neurological deficits were compiled. Statistical analysis utilized univariate and multivariate logistic regression for comparisons between these covariates and the proposed outcomes.

Results: The analysis of 37,899 patients yielded an overall rate of perioperative neurological deficits and mortality of 1.20% and 0.27%, respectively. Risk factors for perioperative neurological deficits included increasing age (OR 1.023 95% CI 1.018–1.029), Van Walraven 5–14 (OR 1.535 95% CI 1.054–2.235), and preoperative paralysis (OR 2.551 95% CI 1.674–3.886). Furthermore, the data showed that being 65 years old or older doubled the risk for perioperative deficit (OR 1.655, CI 1.248–2.194, $p < 0.001$).

Conclusions: This population based study found that increasing age, higher comorbid burden, and preoperative paralysis increased the risk of perioperative neurological deficits while female gender and hypertension were found to be protective.

1. Introduction

Arthrodesis remains one of the most viable options for the treatment of a variety of spinal pathologies that have proved refractory to conservative management [1]. Since the earliest reports of spine fusion in the early 20th century by Hibbs and Albee, fusions have revolutionized the way in which patients with back pain, radiculopathy, and deformities are managed [2]. Due to a number of technological advancements, the rates of arthrodesis performed in the United States and globally have increased tremendously in the last 10–15 years, with a 220% increase in the 1990's and a subsequent 135% increase in the early 2000's [1,3,4]. Additionally, the proportion of health resources allocated to these procedures has increased substantially from $10 billion in 2001 to $46.8 billion in 2010 [5]. The indications for this technically evolving operation include but are not limited to trauma, congenital or idiopathic spinal deformity, degenerative spine disease, vascular malformations, and malignancy [6]. However, these procedures are not without their risks [7–9]; previous studies have yielded complication rates ranging from 2 to 3%. Amongst the most devastating complications following spinal fusion are perioperative neurological deficits [10]. Injuries most commonly include spinal cord injury (contusion and/or transection), nerve root irritation or damage, and cauda equine syndrome [11,12].

These injuries can be debilitating for any patient, especially for those who were functionally independent prior to the procedure. There is an abundance of literature detailing the impact of spinal cord injury, nerve irritation, and cauda equine syndrome on mortality, morbidity, decreased quality of life, and increased cost of healthcare [13–18]. However, the literature lacks data on what characteristics put patients at risk for these deficits and it also lacks information on the effect of these deficits on in-hospital outcomes (i.e., mortality). These are important data points, as in-hospital outcomes occur in a time period

☆ Disclosure: The authors have no conflict of interest to disclosure pertaining to the manuscript.

* Corresponding author at: Department of Neurological Surgery, UPMC Presbyterian-Suite B-400, 200 Lothrop Street, Pittsburgh, PA 15213, USA.
E-mail address: Nwachukuel@upmc.edu (E.L. Nwachuku).

https://doi.org/10.1016/j.inat.2018.04.006
Received 15 November 2017; Received in revised form 17 February 2018; Accepted 7 April 2018

during which intervention is possible and are metrics of the quality of hospital care [19]. It is important to understand the outcomes associated with perioperative neurological deficits, as increased length of stay has been associated with significantly increased health care costs, and an increased risk of hospital acquired infections, which are subsequently associated with their own increase risk of in-patient mortality, and increased cost of hospitalization [20–23].

With the advancement of neuromonitoring with somatosensory evoked potentials and motor evoked potentials it is possible to identify intraoperative signal changes indicative of possible injury. The identification of patients who have either suffered a neurological deficit or are at a high risk for suffering one will allow providers to adopt more aggressive rehabilitative strategies after the event, and offers the opportunity to develop and employ intraoperative neuroprotective therapies.

The primary and secondary aims of our study are to investigate the risk factors for perioperative neurological deficits in patients undergoing thoracolumbar arthrodesis and to understand the effects of these deficits on in-hospital mortality and morbidity, respectively. Although, based on data, approximately 95–97% of patient who undergo thoracolumbar fusion do not develop neurological deficits postoperatively [7–9], it is still paramount to understand why the small subset of patients do in fact experience neurological deficits. We will also evaluate trends of procedure utilization based on patient characteristics, as well as trends in the early outcomes of thoracolumbar fusion.

2. Patient and methods

2.1. Data source

The investigational data was procured from the National Inpatient Sample (NIS) Health Cost Utilization Project (HCUP) between the years 1999 to 2011 as it related to the particular patient subset we were interested in. The NIS represents a 20% stratified sample of discharges from community hospitals. Unweighted, the NIS contains between 7 and 8 million hospital stays each year, and when weighted, provides an estimate of > 35 million hospitalizations each year, which makes it the biggest all-payer health care database that is publically available [24]. We extracted the data using the International Classification of Diseases, Ninth Revision-Clinical Modification (ICD-9-CM) procedure codes and diagnosis codes. This study did not require IRB approval, as no identifying information is included in the database.

2.2. Patient population

The study included patients who underwent thoracolumbar fusion as their primary procedure (ICD-9). However, excluded were patients below the age of 18 and above the age of 80. Additionally, excluded were patients who underwent the operation as a result of trauma or malignancy.

2.3. Covariates

An extensive list of covariates, including demographic variables such as age and gender, pre-operative and post-operative variables that are known to increase the risk of perioperative neurological deficits were analyzed. We additionally used the van Walraven score, a weighted numerical surrogate for the Elixhauser comorbidity index as a covariate to assess comorbidities that have been associated with in-hospital mortality after thoracolumbar fusion. Table 1 depicts the van Walraven (VWR) score stratified into patient risk categories, illustrated as low risk (VWR < 5), medium risk [5–14], and high-risk categories (14+). Studies have shown the van Walraven score to be equally effective at predicting mortality as other established methods (Charlson-Deyo index) [22]. Also, the van Walraven score has been shown to be superior than using purely comorbidity counts [23]. We performed univariate comparisons between covariates and our primary and secondary outcome. We also ran a multivariable logistic regression, adjusting for many of the aforementioned covariates. Finally, we conducted trend analyses via univariate logistic regression.

Table 1
Patient demographics.

Variables	% of patients (n = 37,899)
Average age (± SD)	33.32
Age group	
18 to 44	32.20%
45 to 54	18.35%
55 to 64	21.90%
65 to 74	19.38%
75+	8.17%
Gender	
Female	65.14%
Male	34.86%
Race/ethnicity	
White	75.77%
Black	9.91%
Hispanic	8.15%
Asian	1.91%
Native American	0.50%
Other/missing	3.76%
Admission status	
Emergent	3.36%
Urgent	5.71%
Elective	90.89%
Risk factors and comorbidities	
Average Van Walraven score	1.65
Risk category	
Low risk (VWR < 5)	79.64%
Moderate risk (VWR 5 to 14)	18.78%
High risk (VWR > 14)	1.58%
Comorbidities	
1. Congestive heart failure	1.21%
2. Valvular disease	2.68%
3. Pulmonary circulation disorders	0.58%
4. Peripheral vascular disease	0.85%
5. Hypertension	20.96%
6. Paralysis	8.75%
7. Other neurological disorders	6.27%
8. Chronic pulmonary disease	12.20%
9. Diabetes without chronic complications	5.30%
10. Diabetes with chronic complications	0.69%
11. Hypothyroidism	5.45%
12. Renal failure	0.90%
13. Liver disease	0.51%
14. Chronic peptic ulcer disease	0.10%
15. HIV/AIDS	0.02%
16. Lymphoma	0.01%
17. Metastatic cancer	0%
18. Solid tumor without metastases	0.27%
19. Rheumatoid arthritis/collagen vascular diseases	1.91%
20. Coagulation deficiency	4.09%
21. Obesity	5.36%
22. Weight loss	1.12%
23. Fluid and electrolyte disorders	11.80%
24. Blood loss anemia	1.07%
25. Deficiency anemias	9.35%
26. Alcohol abuse	0.63%
27. Drug abuse	0.90%
28. Psychoses	1.57%
29. Depression	7.14%
Other risk factors	
Cardiac Arrhythmias	7.11%
Delirium	0.79%
Perioperative neurological deficits	1.20%