Original Article

Orthopedic surgery versus neurosurgery: Prevalence and surgical detail assessment of adult spinal fusion procedures

ABSTRACT

Background: A significant procedural overlap exists between orthopedic and neurosurgeons with both subspecialties performing adult spinal fusion procedures. However, the prevalence of varying adult spinal fusion procedures performed by orthopedic surgeons, relative to neurosurgeons, is unknown. This study sought to compare the prevalence of spinal fusion procedures among orthopedic and neurosurgeons.

Materials and Methods: The American College of Surgeons National Surgical Quality Improvement Program database was queried for adult spinal fusion procedures from 2008 to 2016. Procedure prevalence, operative time, and hospital length of stay (LOS) were recorded and analyzed by surgical subspecialty. Spinal fusion cases investigated include all fusions, 2–3-level lumbar fusion, 4-level lumbar fusion, anterior cervical discectomy and fusion (ACDF), 3–6-level posterior cervical fusion, and 6-level posterior cervical fusion.

Results: 67,775 spinal fusions were identified, of which 44,879 (66.2%) were performed by neurosurgeons and 22,896 (33.7%) were performed by orthopedic surgeons. Procedures that involved the lumbar spine were more likely to be performed by orthopedic surgeons while cervical fusions like ACDF were more likely to be performed by neurosurgeons. Orthopedic surgeons had significantly shorter operative times (124.0 vs. 134.0 min, $P < 0.001$) for 2–3-level lumbar fusions while having a similar patient LOS (4.3 vs. 4.2 days, $P = 0.196$). The remaining procedures saw no significant difference in operative time and patient LOS between orthopedic and neurosurgeons.

Conclusions: Neurosurgeons performed nearly double the amount of spinal fusion cases compared to orthopedic surgeons, with an even greater disparity seen in ACDFs, while orthopedic surgeons performed significantly more fusions of the lumbar spine. Orthopedic surgeons had shorter operative times for 2–3-level lumbar fusions.

Keywords: Neurosurgery, orthopedic surgery, outcomes, spinal fusion

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INTRODUCTION

Pathology of the spine continues to affect a substantial portion of the population, with some studies showing a prevalence of lower back pain, alone, of up to 80%. Spine-related disorders can range in presentation from mildly disabling to a complete loss of functional status. Although patients may benefit from noninvasive measures, such as physical therapy, some cases involving severe disease and pain may warrant surgical intervention.[1-3] With a growing number and proportion of elderly individuals, the rates of spine-related procedures have also substantially

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increased over the past few decades, bringing with it vast advancements in surgical technique, surgical options, and surgical instrumentation.[4-6]

When patients are referred for surgical care, both orthopedic and neurosurgeons have the expertise to manage their spine disease. Despite surgical subspecialty differences in residency and postresidency training, including general scope of practice and surgical volume, both types of subspecialists are well-qualified to provide surgical interventions to treat diseases of the spine.[7,8] The existing literature contrasting differences between the two surgical subspecialties has focused on specific spinal procedures that include single-level anterior cervical discectomy and fusion (ACDF) versus multi-level lumbar fusion and different outcome measures such as costs, postoperative course, and surgical details.[7,9] However, few studies provide a comprehensive overview of the difference in case volumes between orthopedic and neurosurgeons. In particular, these studies do not compare the differences in the volume of cervical (both anterior and posterior approaches discretely) and lumbar fusions, as well as differences in case complexity (e.g., number of levels fused) in each of these segments of the spine.

The primary objective of this study was to investigate potential differences in the case volume of surgical fusion by spinal region and degree (by levels) between orthopedic and neurosurgeons. Operative times and patient lengths of stay between the two subspecialties were compared for each spinal region and fusion degree as well.[4] The hypothesis was that the rates of fusions performed would vary between orthopedic and neurosurgeons.

MATERIALS AND METHODS

Data source

This is a retrospective cohort study of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) 2005–2016 database. The ACS-NSQIP database is an initiative to record risk-adjusted outcomes of surgical patients. ACS-NSQIP collects and tracks patient demographics, preoperative risk factors, Current Procedural Terminology (CPT) coding, International Classification of Diseases, 9th Revision (ICD-9) coding, surgical information, and 30-day perioperative outcomes from patients at participating hospitals. More information about the ACS-NSQIP program can be accessed at https://www.facs.org/quality-programs/acs-nsqip/about. Given the de-identified nature of the data, this study was deemed exempt by the Institutional Review Board (IRB). The NSQIP IRB study number is 1285453-1.

Patient identification

ACS-NSQIP was used to identify patients who underwent spinal fusion procedures between 2008 and 2016 using CPT codes for all spinal fusions (22532, 22533, 22548, 22554–22558, 22590, 22595, 22600, 22610, 22612, 22630, and 22633), 2–3-level lumbar fusion (22808), ≥4-level lumbar fusion (22810, 22812), ACDF (22551), 3–6-level posterior cervical fusion (22600), and ≥ 6-level posterior cervical fusion (22600). Patient cases were assigned into two separate cohorts depending on the case surgeon's subspecialty: orthopedic or neurosurgery. The primary outcomes of the study were volume of cases, operative time (minutes), and length of stay (LOS) (days).

Statistical analysis

IBM SPSS Statistics for Windows version 28.0 (IBM Corp., Armonk, NY, USA) was utilized to perform statistical analyses. Case volumes were assessed and stratified by subspecialty. Univariate analyses employing the Wilcoxon signed-ranks test interrogated for significant differences in continuous variable outcomes. $P < 0.05$ was considered statistically significant.

RESULTS

During the study period, 67,775 adult spinal fusions were performed. Among the procedures performed during the study period, the surgical volume was 44,879 (66.2%) and 22,896 (33.7%) for neuro and orthopedic surgeons, respectively.

2–3-level lumbar fusions

The number of 2–3-level lumbar fusions detected was 5821 (8.6% of all spinal fusions). The surgical case volume of 2–3-level lumbar fusions was significantly different between neuro (2641, 45.1%) and orthopedic (3210, 54.9%) surgeons ($P < 0.001$). Compared to neurosurgeons, orthopedic surgeons saw significantly shorter operative times (134.0 min vs. 124.0 min, respectively) ($P < 0.001$). There was no significant difference in patient LOS between neuro and orthopedic surgeons (4.2 vs. 4.3 days, respectively; $P = 0.196$) [Table 1].

≥4-level lumbar fusions

The number of ≥4-level lumbar fusions detected was 363 (0.5% of all spinal fusions). The surgical case volume of ≥4-level lumbar fusions was significantly different between neuro (151, 41.6%) and orthopedic (212, 58.4%) surgeons ($P < 0.001$). There were no significant differences in operative time (189.2 vs. 176.1 min; $P = 0.930$) and patient LOS (6.3 vs. 5.8 days; $P = 0.446$) between neuro and orthopedic surgeons, respectively [Table 1].

Table 1: Prevalence, operative time, and length of stay of adult spinal fusions compared among orthopedic surgeons and neurosurgeons

Spinal fusion	Orthopedic surgeon	Neurosurgeon	*P*
2–3-level lumbar fusion (*n*)	3210	2641	<0.001
Operative time (min)	124	134	<0.001
LOS (days)	4.3	4.2	0.196
≥4-level lumbar fusions (*n*)	212	151	<0.001
Operative time (min)	176	189	0.930
LOS (days)	5.8	6.3	0.446
ACDF (*n*)	7128	20,620	<0.001
Operative time (min)	77	71	0.560
LOS (days)	5.7	4.6	0.789
3–6-level posterior cervical fusion (*n*)	67	128	0.865
Operative time (min)	138	157	0.175
LOS (days)	4.5	6.5	0.219
≥6-level posterior cervical fusion (*n*)	21	41	0.988
Operative time (min)	182	144	0.586
LOS (days)	7.1	9.9	0.253

ACDF - Anterior cervical discectomy and fusion; LOS - Length of stay

Anterior cervical discectomy and fusion

The number of ACDFs detected was 27,748 (40.9% of all spinal fusions). The surgical case volume of ACDFs was significantly different between neuro (20,620, 74%) and orthopedic (7128, 25.7%) surgeons ($P < 0.001$). There were no significant differences in operative time (71.1 vs. 77.0 min; $P = 0.560$) and patient LOS (4.6 vs. 5.7 days; $P = 0.789$) between neuro and orthopedic surgeons, respectively [Table 1].

3–6-level posterior cervical fusion

The number of 3–6-level posterior cervical fusions detected was 195 (0.3% of all spinal fusions). The differences between neuro and orthopedic surgeons in case volume (128, 65.6% vs. 67, 34.4%; $P = 0.865$), operative time (157.2 vs. 138.1 min; $P = 0.175$), and patient LOS (6.5 vs. 4.5 days; $P = 0.219$) were not significantly different [Table 1].

≥6-level posterior cervical fusion

The number of ≥6-level posterior cervical fusions detected was 62 (0.1% of all spinal fusions). The differences between neuro and orthopedic surgeons in case volume (41, 66.1% vs. 21, 33.9%; $P = 0.988$), operative time (143.8 vs. 181.8 min; $P = 0.586$), and patient LOS (9.9 vs. 7.5 days; $P = 0.253$) were not significantly different [Table 1].

DISCUSSION

When spinal pathology poses an inherent risk to a patient's long-term function, or when functional status is persistently impaired despite conservative disease management, specialists may employ instrumented spinal fusion to restore spinal form and function. Although these two subspecialties adhere to the same guidelines for successful management of spinal pathology, outcomes between neuro and orthopedic surgeons may differ.[7,10,11] Numerous studies attribute residency training pathway curricula (orthopedic or neurosurgical) as a possible source of variation.[8] In a study assessing the number of spine surgeries performed during residency, authors found orthopedic surgery residents performed an average of 160 versus the 375 spine surgeries that neurosurgeons performed. Of note, the orthopedic pathway to gain qualification in spine surgery involves mandatory subspecialty fellowship training which helps to close the gap in experience, and, thus, patient outcomes for both cervical and lumbar fusion procedures, when compared to neurosurgeons.[12-15] Differences in patient outcomes following spinal fusion may involve factors external to the difference in surgical subspecialty training like geography which can lead to differences in the types of fusions, surgical techniques utilized, and classification systems used to reach the desired degree of correction.[8,16,17]

This retrospective cohort study investigated the case volume of spinal fusion of orthopedic and neurosurgeons. The current body of literature has compared important clinical factors such as postoperative course and complications between these two surgical subspecialties.[7,9] This study provides a different perspective in comparing the two subspecialty types by assessing case volumes of spinal fusion procedures at different regions and degrees. The procedures evaluated are 2–3-level lumbar fusion, ≥4-level lumbar fusion, ACDF, 3–6-level posterior cervical fusion, and ≥6-level posterior cervical fusion. Furthermore, this study compared the operative times and patient lengths of stay between the two surgical subspecialties for each procedure. This study found significant differences in the amount of shorter (2–3 level) and longer (>4 level) lumbar fusions with orthopedic surgeons performing the majority of these cases. The difference in case volume for ACDF was also significant with neurosurgeons performing nearly three-quarters (74%) of these cases. The case volumes for the remaining procedures of 3–6-level and >6-level posterior fusions were found to mostly be performed by neurosurgeons, but these differences were not statistically significant. These results indicate that procedures involving the lumbar spine are more likely to be performed by orthopedic surgeons while procedures involving the cervical spine are more likely to be performed by neurosurgeons. Of note, Moore *et al*.[18] report a similar population of neurosurgeons (53.27%, $n = 2259$) and orthopedic spine surgeons (46.73, $n = 1982$) in the USA with

orthopedic spine surgeons seeing a slightly higher rate of growth (11.4% vs. 8.6%).

In this study, it was found that orthopedic surgeons performed a greater percentage of both 2–3-level lumbar fusions, as well as ≥4-level lumbar fusions with shorter operative times for 2–3-level fusions and comparable patient LOS. Another study found that operative time for multi-level fusion was shorter as well (221 vs. 239 min) for orthopedic surgeons; however, the authors found a longer LOS for orthopedic patients (96 vs. 89 h), in contrast to this study. There were no significant differences in operative time or patient LOS among ≥4-level lumbar fusions. Of note, McNeil *et al*.[19] found that, in an otherwise comparable cohort, orthopedic surgeons were more likely to use a pedicle subtraction osteotomy (PSO) compared to a neurosurgeon and patient LOS was comparable. In another study, McCutcheon *et al*.[20] found a longer LOS in patients treated with PSO in analysis between specialties.[4,20,21] All of these are factors to consider when assessing similarities and differences among these subspecialties.

In this study, approximately 26% of ACDFs were performed by orthopedic surgeons and 74% by neurosurgeons, with comparable operative times and patient LOS. This study's findings are consistent with those of Alomari *et al*.,[5] which described a case volume that was three times higher for neurosurgeons. In contrast to the results regarding operative time, Hijji *et al*.[22] found orthopedic surgeons performed ACDF in 81.9 min versus 96.0 min in an otherwise comparable cohort while patient LOS showed no differences between specialties.

An important point authors raised in other studies when utilizing the NSQIP database is that the large academic facilities that contribute to the database may have a higher proportion of neurosurgeons performing cervical procedures.[20,23] Interestingly, a recent study that evaluated primary care physician referral rates found that patients were more likely to be referred to orthopedic surgeons for lumbar radiculopathy and neurosurgeons for cervical radiculopathy.[24] Despite the study's limitations, assessing for factors that contribute to differences in referral practices may help to better elucidate potential motivations for referral to one particular subspecialty versus the other.[24]

Nonetheless, the body of literature suggests that additional studies that take into consideration variables that characterize surgical technique and the associated postoperative course may help mitigate differences in perioperative metrics, standardize care, reduce resource utilization, and optimize outcomes.[4,22,25-27]

Consistent with other studies, this one also has limitations. First, this study used ICD-9 and CPT codes to identify patients who underwent elective spine surgery which introduced the possibility of bias due to coding variation or error. The ACS-NSQIP which predominantly receives data from larger or academic hospitals also does not publish information on hospital location, hospital volume, surgeon volume, or surgeon experience, which may contribute not only to referral patterns (which affect case volume) between surgical subspecialties but also surgical technique employed for treatment. Moreover, disease subtype or severity may play a role in referral choice. The lack of data granularity impairs the ability to adjust for important potential confounders. Future studies that take these into account may continue to provide valuable insight into spinal fusion.

CONCLUSIONS

Neurosurgeons had a higher overall volume of spinal fusion cases; however, the proportion of 2–3- and ≥4-level lumbar fusion cases was higher for orthopedic surgeons while neurosurgeons performed a supermajority of cervical procedure volumes. In addition, the operative time for 2–3-level lumbar fusion was shorter for orthopedic surgeons when compared to neurosurgeons though patient LOS was comparable. There was no difference in operative time and patient LOS between the two subspecialties for all the other procedures adding to the body of evidence that show similarities in spinal fusion metrics between the two subspecialties.

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Conflicts of interest
There are no conflicts of interest.

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