Published in final edited form as:

Spine (Phila Pa 1976). 2012 January 1; 37(1): 57–66. doi:10.1097/BRS.0b013e318212bb61.

Geographic Variation in the Surgical Treatment of Degenerative Cervical Disc Disease: American Board of Orthopedic Surgery (ABOS) Quality Improvement Initiative; Part II Candidates

Kevin J. McGuire, MD, MS¹, John Harrast, MS², Harry Herkowitz, MD³, and James N. Weinstein, DO, MS⁴

¹Department of Orthopaedics, Beth Israel Deaconess, Boston, MA

²American Board of Orthopaedic Surgeons

³William Beaumont Hospital, Royal Oak, MI

⁴The Dartmouth Institute for Health Policy and Clinical Research, Dartmouth College, Hanover, NH

Abstract

Study Design—Retrospective case series

Objective—To examine and document the change in rates and the geographic variation in procedure type and utilization of plating by orthopaedic surgeons for anterior cervical discectomy--fusion (ACDF).

Summary of Background—Age- and gender-adjusted rates of cervical spine surgery have not increased but the rate of cervical spinal fusion has, accounting for 41% of all fusion procedures in 2004.

Methods—Records were selected from the American Board of Orthopaedic Surgeons Part II examination from 1999–2008. CPT and ICD-9-CM codes were used to determine utilization of structural allograft, autograft/interbody devices, and anterior cervical plating over time and within geographic region. Main outcome measures were physician workforce, and rates and variation of procedure types.

Results—From 1999 to 2008, the number of self-declared orthopaedic spine surgeon candidates increased 24%. Over this period, the annual number of discectomies with fusions for degenerative cervical disc disease increased by 67%, while the number of such operations per surgeon operating on at least one such case increased 48% ($p=0.018$). Interbody device (0% to 31%; $p<0.0001$), anterior cervical plating (39% to 79%; $p<0.0001$), and allograft (14% to 59%; $p<0.0001$) use increased, while autograft use decreased (86% to 10%; $p<0.0001$).

The Southwest and Southeast were more likely than the Midwest to use interbody devices (OR 2.42 and 1.66 respectively). The Southwest and Northeast were more likely than the Midwest to use autograft (OR 1.55 and 1.49). The Southwest, Northeast, and Southeast were less likely to use allograft than the Midwest (OR 0.408, 0.742, and 0.770). The Northeast was less likely and the Southeast more likely than the Midwest to utilize anterior cervical plating (OR 0.67 and 1.33). Surgical complications were more often associated with autograft compared to allograft (OR 1.61).

Conclusions—From 1999–2008, the number of orthopaedic surgeon candidates performing spine surgery has increased. These surgeons are performing more fusions, and utilizing more structural allografts, interbody devices and/or anterior cervical plates. Regional variations also remain in the type of constructs utilized.

INTRODUCTION

Previous longitudinal studies have reported that the overall rate of spine surgery in the United States has increased. (1–3)The rate of spinal fusions increased by 250% between 1990–2003. (3) Specifically for cervical spine surgery, age-and gender-adjusted rates of cervical spine surgery have not increased but the rate of cervical spinal fusions have increased, accounting for 41% of all fusion procedures in 2004.(4–6)Explanations include an increase in the prevalence of disease; patients' changing expectations and preferences; development and application of new technologies; physician workforce; reimbursement patterns; economic forces; and scientific uncertainty. (4, 7)Moreover, the costs for any given procedure have increased; the costs of a primary spinal fusion increased by 111% from 1998–2004. (3)Enigmatic regional variations in the rates of cervical surgery persist. (4)These variations may reflect professional and patient uncertainty regarding the appropriate indications for cervical surgery, resulting in differing thresholds for surgical intervention. (8–10)

Previous studies have examined discectomy with and without fusion. No advantage by fusion type has been described, in particular for anterior cervical plating.(4) The purpose of this study is to examine the change in: rates; geographic variation; types of procedures(utilization of structural autograft, allograft, interbody devices, and/or anterior cervical plating in ACDF for cervical disc disease). This is representative of ongoing quality improvement initiatives by the American Board of Orthopaedic Surgeons(ABOS)to document and inform physicians about current practice and significant changes in practice as part of a reflective effort to improve orthopaedic clinical care.

MATERIALS AND METHODS

Data Source

The American Board of Orthopaedic Surgeons, Inc (ABOS) provides voluntary, time limited, board certifications to orthopaedic surgeons. The process involves both a written examination (Part I) and an oral examination (Part II). In order to sit for Part II of the examination, a surgeon must be a graduate of an accredited 4 year medical school; complete a minimum of a 5 year accredited orthopaedic residency; successfully pass Part I; practice orthopaedic surgery as a full-time staff with hospital privileges for at least 22 months; and submit all surgical cases over a 6 month period. The number and names of the surgical cases are confirmed by the director of medical records at each institution and notarized. Data submitted include ICD-9-CM and CPT codes, as well as some demographic and associated medical information: age; gender; length of follow-up; medical and surgical complications; year of examination; and practitioner specific factors (e.g., region of practice; city and state; specialization (e.g., spine or hand); and fellowship training). Although the board certification process is voluntary, it is deemed necessary in order to practice orthopaedic surgery in the United States.

Case Identification

The ABOS quality improvement database was analyzed for the years 1999–2008. Cases were identified and classified based on types of procedures using CPT codes (Table 1). Once all such cases were identified, analysis was limited to degenerative cervical disc disease

(Table 1). Only anterior procedures were included. Written case descriptions provided by the candidates were then utilized to confirm inclusion into the database.

Definition of Variables

All data was self-reported by the candidate, including whether he/she completed a spine fellowship (one year of training specifically in spine surgery after the completion of an orthopaedic residency), and whether they planned on taking the board exam as a self-identified specialist in spine (>50% of cases submitted were performed on the spine versus other orthopaedic procedures). Reporting of medical and/or surgical complications is also a requirement (bone fracture, hemorrhage, implant failure, implant fracture, infection, nerve palsy/injury, nonunion/delayed union, skin ulcer/blister, spinal cord injury, surgical unspecified, vascular injury, wound dehiscence, wrong side/site). The utilization of structural autograft, structural allograft, interbody cage, and anterior cervical plating was defined by separate, specific CPT codes. (Table 1) Regions of practice were defined by the ABOS.(11)

STATISTICAL METHODS

In testing for differences between groups, several methods were used: Fisher's exact test for two-by-two contingency tables; Chi Square test for larger contingency tables; t-test for comparison of two means; and ANOVA for comparison of more than two means. Scheffe's Least Significant Difference post-hoc tests were performed to determine if the difference between any two groups in ANOVA were significant at $p=0.05$.

Simple linear regression was utilized to look at rates for temporal trends and regional variation. Multiple logistic regression was utilized to analyze the effect of multiple factors on the odds of types of surgical procedures. Year of surgery, region of practice, fellowship training, and declared subspecialty were explanatory variables. This was also done for medical and surgical complications. For all tests, a P-value less than 0.05 was considered statistically significant.

RESULTS

From exam year 1999–2008, a total of 6,609 cases were identified based on CPT codes. Cases were excluded if CPT codes for combined procedures (i.e. anterior/posterior procedures), and/or additional ICD-9-CM codes for diagnoses for trauma, infection, and/or revision were present. Case descriptions were all also reviewed for further clarification. After excluding these cases, 5,229 cases determined to be isolated anterior cervical discectomy and fusions for degenerative cervical disc disease remained.

Forty-eight percent were male with a mean age of 48 years. A herniated disc and/or a degenerated disc encompassed more than 50% of the diagnoses. Candidates reported medical and surgical complications (1.9% and 5.9%, respectively). The most common surgical complication was "surgical unspecified" (2.03%) followed by "nerve palsy/injury" (0.92%). The most common medical complication was "medical unspecified" (1.28%) followed by "pneumonia" (0.36%). (Table 2) Over 87% of cases were performed by a candidate who reported completing a spine fellowship. Over 89% of cases were performed by self-designated orthopaedic spine surgeons. (Table 3)

There was a 24% increase in the absolute number of candidates who self-declared a subspecialty in spine surgery (59 in 1999 to 73 in 2008). No other orthopaedic subspecialty group (i.e. hand, pediatric, foot and ankle) realized a significant change, while the number declaring as general orthopedists decreased 25%. (Figure 1)

Over this period, the absolute number of cervical discectomies with fusions per exam year increased by 67% (341 to 570 operations), and the number of such operations per orthopaedic spine surgeon performing at least one such procedure increased 48% (4.8 to 7.1 operations per spine surgeon; $p < 0.02$). (Figure 2) In the same period there was a marked decrease in the utilization of autograft, from 86% to 10% ($p < 0.0001$). In turn, there was a marked increase in the use of allograft, from 14% to 59% of cases ($p < 0.0001$). Likewise, there was a dramatic increase in the use of interbody devices, from 0% to 31% ($p < 0.0001$). From 2000–2002 autograft was favored but, from 2004 to 2008 allograft or an interbody device became the dominant choice for interbody fusion. (Figure 3)

Exam year was associated with a statistically significant decrease in the utilization of autograft ($p < 0.0001$; OR 0.695), and was less likely to be used in multilevel procedures compared to allograft and/or interbody devices ($p < 0.0001$; OR 0.574). Autograft was more likely to be utilized by surgeons without a declared spine subspecialty ($p = 0.007$; OR 1.39).

The percentage of cases utilizing anterior cervical plating drastically increased (39% to 79%) ($p < 0.0001$). (Figure 4) Based on logistic regression, anterior cervical plating was associated with multiple level surgery ($p < 0.001$; OR=0.64); and a declared spine subspecialty ($p = 0.001$; OR=1.44).

Regional variations exist across time. Controlling for number of levels, year, age, gender, declared subspecialty, and diagnosis, candidates in the Southwest and Southeast were more likely than those in the Midwest to use interbody devices (OR 2.42 and 1.66 respectively). The Southwest and Northeast candidates were more likely than those in the Midwest to use autograft (OR 1.55 and 1.49). The Southwest, Northeast, and Southeast candidates were less likely to use allograft than those in the Midwest (OR 0.408, 0.742, and 0.770). Candidates in the Northeast were less likely and those in the Southeast were more likely than in the Midwest to utilize anterior cervical plating (OR 0.67 and 1.33).

Surgical complications were more often associated the use of autograft compared to allograft ($p = 0.005$; OR 1.61) Declaration of subspecialty in spine was not statistically associated with a difference in the complication rate compared to those candidates that did not declare a subspecialty.

DISCUSSION

Analysis of quality improvement data from the ABOS Part II examination from 1999–2008 showed that the overall percentage of orthopaedic surgeon candidates sitting for their board examination who declared themselves as orthopaedic “spine” surgeons increased compared to other specialties and to “general” orthopaedic surgeons. At the same time the absolute number of ACDF cases/orthopaedic spine surgeon candidates substantially increased; the utilization of allograft and/or an associated interbody device replaced autograft as the interbody graft of choice; and significant regional variation persisted.

Given the relatively small epidemiological change in cervical disc disease(3) one must question the increase in surgical rates among orthopaedic candidates, and continued regional variations in the types of procedures. Some factors impacting rates and variation would be: increase in the prevalence of disease; patients’ changing preferences and expectations; development and application of new technologies; physician workforce density; reimbursement patterns or economic forces; and scientific uncertainty. Each factor likely plays a role; some are more evidence-based than others.

Could an increase in the prevalence of disease account for the increase? The proportion of the total U.S. population that visited a physician for back pain and neck pain has increased

from 1998 to 2004. However the increase for back pain was greater than that for neck pain. A total of 8.5% of the population sought out a physician for back pain in 1998 compared to 10.6% in 2004. A total of 3.3% sought a physician for neck pain compared to 4.4% in 2004. (3) It remains unclear whether or not these differences represent an increase in the prevalence of disease.

Another potential etiology is changing patient preferences and expectations. However, Weinstein et al failed to detect systematic differences in patient preferences, and striking differences in rates between neighboring geographic regions appears to be inconsistent with this explanation. (7) Although Weiner et al has suggested spine patients often defer the decision-making process to their surgeon, formal decision aids may change patient preferences. (9, 10, 12, 13)

The challenge of new technologies and the lack of evidence about comparative effectiveness of one treatment versus another or natural history limit our ability to provide an informed choice to patients facing preference-based decisions. (9, 10, 12) Candidates taking Part II are using more allografts and interbody devices over time. And while allograft has replaced autograft, the difference between the two does not change the clinical indications surgical intervention and therefore the rate of the procedure.

Physician density may play a role. Certainly this study shows an increase in self declared subspecialization and a decrease in percentage of declared general orthopedic surgeons. This may represent an overall increase in surgeons doing spine procedures. However, Weinstein et al. showed no correlation between orthopaedic and neurosurgeon workforce and rates of procedures. (7) Sample size per region limited our ability to evaluate orthopaedic physician workforce by region and its relationship to rates of procedures. Moreover, neurosurgeons and board certified orthopaedic surgeons were not included which limits a true evaluation of national rates.

Reimbursements for physicians may also play a role. To date no clear association with surgical rates has been shown, though not unlike any specialty, doing more procedures incurs greater charges.

However, perhaps the greatest effect on the rate and type of procedure performed stems from a lack of literature comparing medical to surgical treatment and types of procedure performed for degenerative cervical disc disease. (8, 15) Certainly physicians and their patients do recognize that cervical spine fusions, performed for appropriate indications in well-informed patients whose preferences and values are incorporated into the treatment decision, are clinically successful, especially in short-term follow-up. (8, 15–27) However, there remains no clear published evidence that answers the most basic question of whether surgical intervention is warranted compared to the natural history.

The natural history of cervical radiculopathy is documented, with approximately 50% or more of patients improving with conservative care. (28)(29)(30) However, there remains only one randomized controlled trial comparing non-operative versus surgical treatment of cervical radiculopathy. (8, 15, 31) Persson et al. (31) compared a Cloward-type anterior cervical discectomy and fusion (although a limited number of patients underwent a laminectomy or laminoplasty) to physiotherapy or a cervical collar. Patients with cervical spondylosis and radicular pain were included. Soft, acute disc herniations were not part of the study. This study included 81 patients (27 per group). The majority had been out of work for 1 year. At 3 months, pain and sensory loss was markedly improved in the surgical group compared to control groups. However, at 1 year there was no statistical difference. (8, 15)

Beyond the initial question of whether surgery is indicated compared to non-operative care, the evidence for the “best” type of procedure or construct remains unclear. As in this study, cervical fusion constructs certainly vary and many have been compared in randomized controlled trials. (20, 32–34) Despite these important studies, the literature remains unclear as to whether the relatively more “complex” operations provides any better clinical improvement over time compared to “simpler” methods (i.e. discectomy alone). (8)

This data and studies similar to it, however, do document changes in treatment patterns at the procedure level and in doing so provide indirectly current best practices or standards of care. As of 2004, allograft and interbody devices dominated autograft as the graft of choice. With the assumption that surgeons preferences are based on a review of the literature, experience, and clinical outcomes, this study documents an “expert consensus” – that among orthopaedic spine surgeon candidates that an allograft or an interbody device with an anterior cervical plate is the preferred construct.

There are unique aspects of this study as well as significant limitations. Based on the negative consequences to the candidate of inaccurate reporting to a national examination board (ABOS), validation by the director of medical records/notarization, and the ultimate review and questioning by board examiners of the specifics of chosen cases (ABOS is the only board from ABMS who requires an oral practice based exam), the quality and completeness of cases submitted assures that the denominator of cases is valid. Certainly it is possible that more complex cases may be avoided by the candidate and “passed” to more senior surgeons during the board collection period. However, this would lead to an under estimation of the true cases performed and strengthens this studies results. The reporting of complications is problematic. The reporting of complications in ABOS process has not been validated. One could argue that there is incentive to both under-report or over-report these complications since the final selected cases are reviewed in detail during the oral examination. Further study of the complication rate is warranted.

Unlike in previous studies, the ABOS database captured the details of the procedures performed. Most often those taking Part II of the boards have relative inexperience in surgical coding and this may have had effects on the results – in particular “complete” coding is not required and therefore under-coding would be likely. This was certainly found based on the author’s review of the text description of the cases versus the coding of the cases provided. As in all databases, these coding errors can occur. The effect of these errors on a study’s outcome cannot be predicted. (35)

The most significant limitation of this study is that it does not capture information about those procedure performed by neurosurgeons or board certified practicing orthopaedic surgeons. This study is limited only to candidates for board certification in orthopaedic surgery. This study does not provide data on national rates of all spine surgeons or types of constructs. For example, the increase in the rate of cases of orthopedic spine surgeon candidates does not necessarily mean there has been an increase in the total number of cases performed over time in the United States; it is possible that orthopaedic surgeon candidates are performing a greater proportion of these cases compared to neurosurgeons or board certified orthopaedic surgeons. However, given the evidence that the rate of cervical spine fusions has increased over approximately the same time period, this study is consistent with an overall increase rather than a reallocation of spine procedures among providers.(4–6) Moreover, the authors do believe that this data does provide insight into the current practices as these candidates are judged by their senior peers on whether or not they are practicing within acceptable “standards of care” with the peril of failing their board certification.

As a quality improvement initiative, this documents the trends in the treatment of degenerative cervical disc disease by orthopaedic spine surgery candidates. Given the increase in the rate of spinal fusion and the variations in treatment patterns there remains a need for further evidence to validate the need for increasing number of procedures compared to natural history as well as for the best type of procedure.” The American Board of Orthopedics will use this information to continue its quality improvement initiative related to the Part II examinations.

Acknowledgments

The authors would like to acknowledge funding from the following sources:

The American Board of Orthopaedic Surgery; The National Institute of Arthritis and Musculoskeletal and Skin Diseases (U01-AR45444-01A1) and the Office of Research on Women’s Health, the National Institutes of Health, and the National Institute of Occupational Safety and Health, the Centers for Disease Control and Prevention.

References

1. Deyo RA, Gray DT, Kreuter W, Mirza S, Martin BI. United States trends in lumbar fusion surgery for degenerative conditions. *Spine*. 2005 Jun 15; 30(12):1441–5. discussion 6-7. [PubMed: 15959375]
2. Deyo RA, Weinstein JN. Low back pain. *N Engl J Med*. 2001 Feb 1; 344(5):363–70. [PubMed: 11172169]
3. AAOS. AAOS. Burden of Musculoskeletal Disease. Rosemont, IL: AAOS; 2008.
4. Angevine PD, Arons RR, McCormick PC. National and regional rates and variation of cervical discectomy with and without anterior fusion, 1990–1999. *Spine*. 2003 May 1; 28(9):931–9. discussion 40. [PubMed: 12942010]
5. Davis H. Increasing rates of cervical and lumbar spine surgery in the United States, 1979–1990. *Spine*. 1994 May 15; 19(10):1117–23. discussion 23-4. [PubMed: 8059266]
6. Einstadter D, Kent DL, Fihn SD, Deyo RA. Variation in the rate of cervical spine surgery in Washington State. *Med Care*. 1993 Aug; 31(8):711–8. [PubMed: 8336510]
7. Weinstein JN, Lurie JD, Olson PR, Bronner KK, Fisher ES. United States’ trends and regional variations in lumbar spine surgery: 1992–2003. *Spine*. 2006 Nov 1; 31(23):2707–14. [PubMed: 17077740]
8. Carragee EJ, Hurwitz EL, Cheng I, Carroll LJ, Nordin M, Guzman J, et al. Treatment of neck pain: injections and surgical interventions: results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine*. 2008 Feb 15; 33(4 Suppl):S153–69. [PubMed: 18204388]
9. Weinstein JN, Clay K, Morgan TS. Informed patient choice: patient-centered valuing of surgical risks and benefits. *Health Aff (Millwood)*. 2007 May-Jun; 26(3):726–30. [PubMed: 17485750]
10. Wennberg JE, O’Connor AM, Collins ED, Weinstein JN. Extending the P4P agenda, part 1: how Medicare can improve patient decision making and reduce unnecessary care. *Health Aff (Millwood)*. 2007 Nov-Dec; 26(6):1564–74. [PubMed: 17978377]
11. Koval KJ, Harrast JJ, Anglen JO, Weinstein JN. Fractures of the distal part of the radius. The evolution of practice over time. Where’s the evidence? *J Bone Joint Surg Am*. 2008 Sep; 90(9): 1855–61. [PubMed: 18762644]
12. O’Connor AM, Wennberg JE, Legare F, Llewellyn-Thomas HA, Moulton BW, Sepucha KR, et al. Toward the ‘tipping point’: decision aids and informed patient choice. *Health Aff (Millwood)*. 2007 May-Jun; 26(3):716–25. [PubMed: 17485749]
13. Weiner BK, Essis FM. Patient preferences regarding spine surgical decision making. *Spine*. 2006 Nov 15; 31(24):2857–60. discussion 61-2. [PubMed: 17108841]
14. Martin BI, Deyo RA, Mirza SK, Turner JA, Comstock BA, Hollingworth W, et al. Expenditures and health status among adults with back and neck problems. *JAMA*. 2008 Feb 13; 299(6):656–64. [PubMed: 18270354]

15. Fouyas IP, Statham PF, Sandercock PA. Cochrane review on the role of surgery in cervical spondylotic radiculomyelopathy. *Spine*. 2002 Apr 1; 27(7):736–47. [PubMed: 11923667]
16. Aronson N, Filtzer DL, Bagan M. Anterior cervical fusion by the smith-robinson approach. *J Neurosurg*. 1968 Oct; 29(4):396–404. [PubMed: 4235320]
17. Connolly ES, Seymour RJ, Adams JE. Clinical evaluation of anterior cervical fusion for degenerative cervical disc disease. *J Neurosurg*. 1965 Oct; 23(4):431–7. [PubMed: 5852400]
18. DePalma AF, Rothman RH, Lewinnek GE, Canale ST. Anterior interbody fusion for severe cervical disc degeneration. *Surg Gynecol Obstet*. 1972 May; 134(5):755–8. [PubMed: 5031486]
19. Gore DR, Sepic SB. Anterior cervical fusion for degenerated or protruded discs. A review of one hundred forty-six patients. *Spine*. 1984 Oct; 9(7):667–71. [PubMed: 6505833]
20. Hacker RJ, Cauthen JC, Gilbert TJ, Griffith SL. A prospective randomized multicenter clinical evaluation of an anterior cervical fusion cage. *Spine*. 2000 Oct 15; 25(20):2646–54. discussion 55. [PubMed: 11034651]
21. Herkowitz HN, Kurz LT, Overholt DP. Surgical management of cervical soft disc herniation. A comparison between the anterior and posterior approach. *Spine*. 1990 Oct; 15(10):1026–30. [PubMed: 2263967]
22. Robinson R, Walker A, Ferlic D. The results of anterior interbody fusion of the cervical spine. *J Bone Joint Surg Am*. 1962; 44:1569–87.
23. White AA, Southwick WO, DuPont R, Gainor JW, Hardy R. Relief of pain by anterior cervical spine fusion for spondylosis. A report of sixty-five patients. *J Bone Joint Surg Am*. 1973; 55(3): 525–34. [PubMed: 4703205]
24. Baskin DS, Ryan P, Sonntag V, Westmark R, Widmayer MA. A prospective, randomized, controlled cervical fusion study using recombinant human bone morphogenetic protein-2 with the CORNERSTONE-SR allograft ring and the ATLANTIS anterior cervical plate. *Spine*. 2003 Jun 15; 28(12):1219–24. discussion 25. [PubMed: 12811263]
25. Bohlman HH, Emery SE, Goodfellow DB, Jones PK. Robinson anterior cervical discectomy and arthrodesis for cervical radiculopathy. Long-term follow-up of one hundred and twenty-two patients. *J Bone Joint Surg Am*. 1993 Sep; 75(9):1298–307. [PubMed: 8408151]
26. Coric D, Finger F, Boltes P. Prospective randomized controlled study of the Bryan Cervical Disc: early clinical results from a single investigational site. *J Neurosurg Spine*. 2006 Jan; 4(1):31–5. [PubMed: 16506463]
27. Hacker RJ. Cervical disc arthroplasty: a controlled randomized prospective study with intermediate follow-up results. Invited submission from the joint section meeting on disorders of the spine and peripheral nerves, March 2005. *J Neurosurg Spine*. 2005 Dec; 3(6):424–8. [PubMed: 16381203]
28. Lees F, Turner JW. Natural History and Prognosis of Cervical Spondylosis. *Br Med J*. 1963 Dec 28; 2(5373):1607–10. [PubMed: 14066179]
29. Gore DR, Sepic SB, Gardner GM, Murray MP. Neck pain: a long-term follow-up of 205 patients. *Spine*. 1987 Jan-Feb; 12(1):1–5. [PubMed: 3576350]
30. Slappendel R, Crul BJ, Braak GJ, Geurts JW, Booij LH, Voerman VF, et al. The efficacy of radiofrequency lesioning of the cervical spinal dorsal root ganglion in a double blinded randomized study: no difference between 40 degrees C and 67 degrees C treatments. *Pain*. 1997 Nov; 73(2):159–63. [PubMed: 9415501]
31. Persson LC, Moritz U, Brandt L, Carlsson CA. Cervical radiculopathy: pain, muscle weakness and sensory loss in patients with cervical radiculopathy treated with surgery, physiotherapy or cervical collar. A prospective, controlled study. *Eur Spine J*. 1997; 6(4):256–66. [PubMed: 9294750]
32. Peolsson A, Hedlund R, Vavruch L, Oberg B. Predictive factors for the outcome of anterior cervical decompression and fusion. *Eur Spine J*. 2003 Jun; 12(3):274–80. [PubMed: 12687444]
33. Peolsson A, Vavruch L, Hedlund R. Long-term randomised comparison between a carbon fibre cage and the Cloward procedure in the cervical spine. *Eur Spine J*. 2007 Feb; 16(2):173–8. [PubMed: 16463197]
34. Vavruch L, Hedlund R, Javid D, Leszniewski W, Shalabi A. A prospective randomized comparison between the cloward procedure and a carbon fiber cage in the cervical spine: a clinical and radiologic study. *Spine*. 2002 Aug 15; 27(16):1694–701. [PubMed: 12195057]

35. Faciszewski T, Broste SK, Fardon D. Quality of data regarding diagnoses of spinal disorders in administrative databases. A multicenter study. *J Bone Joint Surg Am.* 1997 Oct; 79(10):1481–8. [PubMed: 9378733]

Key Points

- From 1999–2008, the number of orthopaedic surgeon candidates performing spine surgery has increased.
- Orthopaedic surgical candidates are performing more fusions, and utilizing more structural allografts/interbody devices and/or anterior cervical plates.
- Regional variations remain in the type of constructs utilized by orthopaedic surgical candidates.

Figure 1.
ABOS Part II: Percentage Declared Subspecialty by Exam Year

Figure 2.
Mean number of ACDF Cases per surgeon with at least one ACDF case.

Figure 3.
Utilization of Autograft, Allograft and Interbody Device in Cervical Discectomy/Fusion Cases Exam Year

Figure 4.
Cervical Discectomy/Fusion by Exam Year With and Without Anterior Cervical Plating

Table 1

CPT* and ICD**-9-CM Codes for Anterior Cervical Surgery and Degenerative Cervical Disc Disease

CPT Code	Description
63075	Anterior Cervical Discectomy
63076	Anterior Cervical Discectomy Additional Level
22554	Anterior Cervical Arthrodesis
22585	Anterior Cervical Arthrodesis Additional Level
22845	Anterior Instrumentation; 2–3 Vertebral Segments
20938	Structural Autograft for spine surgery only (includes harvesting the graft); structural, bicortical or tricortical (through separate skin or fascial incision)
20931	Structural Allograft: Allograft for spine surgery only; structural
22851	Application of Invertebral Biomechanical device(s) (eg, synthetic cages, threaded bone dowel(s), methylmethacrylate) to vertebral defect or interspace
ICD-9-CM codes	
721.0	Cervical spondylosis without myelopathy
721.1	Cervical spondylotic myelopathy
722.0	Herniated disc without myelopathy
722.2	Herniated Disc site unspecified without myelopathy
722.4	Degeneration of cervical intervertebral disc
722.71	Cervical disc disorder with myelopathy
722.91	Other and unspecified cervical disc disorder
723.0	Spinal stenosis in cervical region
723.1	Cervicalgia; Pain in Neck
723.3	Cervicobrachial syndrome
723.4	Brachia neuritis or radiculitis
724.4	Cervical radiculitis; Brachial neuritis or radiculitis NOS

* CPT = Current Procedural Terminology

** ICD-9-CM =International Classification of Diseases 9th Revision Clinical Modification.

Table 2**Incidence of Specific Complications**

<u>Surgical Complications</u>		
Nerve Palsy/Injury	48	0.92%
Non Union/Delayed Union	44	0.84%
Surgical Procedure Intervention	24	0.46%
Infection	22	0.42%
Hemorrhage	17	0.33%
Implant Failure	17	0.33%
Bone Fracture	11	0.21%
Wound Dehiscence	11	0.21%
Skin Ulcer/Blister	10	0.19%
Spinal Cord Injury	8	0.15%
Wrong Side/Site	5	0.10%
Implant Fracture	4	0.08%
Dislocation	1	0.02%
Vascular Injury	1	0.02%
Surgical Unspecified	106	2.03%
<u>Medical Complications</u>		
Pneumonia	19	0.36%
Patient Expired	8	0.15%
Pulmonary Embolism	5	0.10%
Cerebral Vascular Accident	4	0.08%
Myocardial Infarction	3	0.06%
Congestive Heart Failure	1	0.02%
Renal Failure	1	0.02%
Medical Unspecified	67	1.28%

Table 3
 Characteristics of the Surgical Treatment of Degenerative Cervical Disc Disease from 1999–2008 for Declared Spine Surgeons.

Characteristic	All Cases	Anterior Cervical Plating	Autograft	Allograft	Interbody Cage
N	5,229	4,283	1,295	1,873	703
Male (%)	48%	48%	51%	46%	46%
ICD-9-CM (n)					
Mean age (Yrs)	48	48	47	49	50
721.0	617	540	151	255	65
721.1	416	342	98	163	58
722.0	2,606	2,185	702	1,009	303
722.2	64	55	20	25	5
722.4	1,001	914	225	394	194
722.71	462	360	120	129	93
722.91	6	5	4	2	0
723.0	901	799	172	337	157
723.1	162	149	34	74	35
723.3	1	1	0	1	0
723.4	1,325	1,114	278	555	175
# of Levels Fused					
1 Level	3,275	2,574	783	1,203	431
2 Levels	1,803	1,588	470	635	254
3 Levels	142	115	38	35	17
4 Levels	8	6	4	0	1
5 Levels	1	0	0	0	0
Medical complication (%)	1.9%	1.9%	2.2%	1.7%	1.4%
Surgical complication (%)	5.9%	5.6%	6.9%	4.8%	5.5%
Region (% Cases)					
Northeast (%)	16%	14%	20%	15%	11%
Midwest (%)	22%	22%	18%	27%	19%
Northwest (%)	6%	6%	5%	8%	5%

Characteristic	All Cases	Anterior Cervical Plating	Autograft	Allograft	Interbody Cage
South (%)	21%	21%	21%	22%	20%
Southeast (%)	16%	17%	15%	16%	19%
Southwest (%)	19%	19%	21%	12%	27%
Spine Fellowship Training (% Cases) *	87%	89%	72%	90%	91%
Spine Declared Subspecialty (% Cases)	89%	90%	86%	91%	92%

* Data available only for exam years 2002–2008