

A Survey-Based Study of Wrong-Level Lumbar Spine Surgery: The Scope of the Problem and Current Practices in Place to Help Avoid These Errors

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Key words

- Complication
- Localization
- Lumbar
- Malpractice
- Spine surgery
- Wrong level
- Wrong side

Abbreviations and Acronyms

AANS: American Association of Neurological Surgeons

CNS: Congress of Neurological Surgeons

Joint Commission: The Joint Commission on the Accreditation of Healthcare Organizations

PACS: Picture archiving and communications system

Spine Section: The Joint Section on Disorders of the Spine and Peripheral Nerves



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INTRODUCTION

There has been a growing effort to understand medical error in the context of a systems approach. Contemporary medicine is a very complex environment with many competing priorities at work simultaneously. From this perspective, it has been suggested that when an error occurs it is more useful to correct the system that failed than to assign blame to the individual who committed the last act in the chain of events leading to the error. Systematic study of medical error has been hindered by the lack of a consistently applied understanding of

■ **OBJECTIVE:** To understand better the scope of wrong-level lumbar spine surgery and current practices in place to help avoid such errors.

■ **METHODS:** The Joint Section on Disorders of the Spine and Peripheral Nerves (Spine Section) developed a survey on single-level lumbar spine decompression surgery. Invitations to complete the Web-based survey were sent to all Spine Section members. Respondents were assured of confidentiality.

■ **RESULTS:** There were 569 responses from 1045 requests (54%). Most surgeons either routinely (74%) or sometimes (11%) obtain preoperative imaging for incision planning. Most surgeons indicated that they obtained imaging after the incision was performed for localization either routinely before bone removal (73%) or most frequently before bone removal but occasionally after (16%). Almost 50% of reporting surgeons have performed wrong-level lumbar spine surgery at least once, and >10% have performed wrong-side lumbar spine surgery at least once. Nearly 20% of responding surgeons have been the subject of at least one malpractice case relating to these errors. Only 40% of respondents believed that the site marking/"time out" protocol of The Joint Commission on the Accreditation of Healthcare Organizations has led to a reduction in these errors.

■ **CONCLUSIONS:** There is substantial heterogeneity in approaches used to localize operative levels in the lumbar spine. Existing safety protocols may not be mitigating wrong-level surgery to the extent previously thought.

what constitutes an error. To move our understanding forward, the definition of a medical error should be tied to a standardized process that has failed where that failure has a causal link to an adverse outcome (8).

Wrong-site surgery is an example of an error that has received significant attention. This error is often discussed within a group of errors that includes wrong procedure and wrong patient errors as well (18, 19). The "time out" program as mandated by The Joint Commission on the Accreditation of Healthcare Organizations (Joint Commission) is a program in common usage intended to address these errors. This program standardizes a set of behaviors to prevent the occurrence of surgical error. Adoption of the "time out" program met initial resistance from many who pointed out that the elements suggested were already in place to a large degree. The National Quality

Forum identified a list of "never events" that includes wrong-site operations. The National Quality Forum meaning of "wrong site" includes the performance of an operative procedure on the incorrect side (left vs. right) and on the incorrect body part (e.g., hip vs. knee). It also includes the performance of a spine procedure at the incorrect level (e.g., L3-4 vs. L4-5) and errors including the wrong procedure or the wrong patient (15).

Recognizing that the problem of wrong-site surgery continues to occur despite substantial efforts, the Joint Section on Disorders of the Spine and Peripheral Nerves (Spine Section) of the American Association of Neurological Surgeons (AANS) and the Congress of Neurological Surgeons (CNS) conducted a survey of its membership to understand better the issues surrounding wrong-level surgery in single-level lumbar decompression. The objectives of this study were twofold. First, we

sought to understand better the scope of the problem among practicing surgeons, including the number of surgeons who have experienced this error and the number of surgeons who have been affected by resulting medico-legal action. Second, we sought to understand better the current practices in place to help avoid this error. The findings should serve as a basis for future studies designed to reduce the occurrence of these errors.

METHODS

The AANS/CNS Spine Section Executive Committee assembled a task force to develop a survey to evaluate wrong-level lumbar spine surgery. Questions were designed to elicit information regarding the numbers of relevant cases performed by the surgeon, current techniques used to localize operative levels, and occurrence of wrong-level surgery. A trial performance of the survey was done first on a small test group of 40 spine surgeons for usability. This group represented a wide variety of practice settings, including rural and urban settings and academic and private practice settings. Feedback from the test group was used to improve the clarity of questions posed and standardized answers from which to select. A final survey consisting of 28 questions was developed (Table 1).

Invitations to complete the final survey were sent to all members of the AANS/CNS Spine Section by electronic mail beginning in April 2011. The survey was administered via a Web interface to facilitate data collection and ensure that confidentiality was maintained. Two more requests were sent over the next month. No other attempts were made to solicit response to the survey. Respondents were assured that the Spine Section would not collect the names of the respondents or in any way connect the answers given to the participants.

Frequency distributions and summary statistics were calculated for all questions with categorical answers. An overall response rate for the survey was calculated based on the number of individuals that responded and the total number of requests distributed. The structure of the survey was such that some questions were intentionally not presented based on previous responses. For example, if the respondent indicated that only fluoroscopic imaging is used for localization, follow-up questions

regarding conventional x-ray imaging were not presented. In an effort to encourage a higher response rate to the survey, respondents were offered a “decline to answer” option for a small subset of potentially sensitive questions, and respondents were permitted not to answer any specific question and still progress through the survey.

RESULTS

There were 569 responses from a total of 1045 requests (54% response rate) (Table 1). Lumbar single-level decompression procedures are part of surgical practice for almost all of the surgeons responding to the survey, with most respondents performing 25–74 of these procedures per year (Table 1, Questions 1–2).

Questions 3–9 of the survey (Table 1) relate to immediate preoperative x-ray imaging for level localization and incision planning. Based on this series of questions, most surgeons either routinely (74%) or sometimes (11%) obtain preoperative x-rays for incision planning; only 15% indicated that preoperative imaging is not part of their practice. For surgeons performing such imaging, use of fluoroscopy is more common (71%) than conventional x-rays (29%), and these images are routinely uploaded to a picture archiving and communications system (PACS) by 51% (fluoroscopy images) and 69% (conventional x-rays) of the respondents. Lateral x-ray projections, either alone (82%) or in combination with anteroposterior views (16%), are most commonly obtained. Approximately one-half (56%) of respondents performing preoperative imaging for localization do so with a radiopaque marker, such as a spinal needle or Kirschner wire inserted through the patient’s skin. Other respondents use a radiopaque marker placed at the side of the patient (16%), overlying the planned incision site (14%), or depressed into the patient’s back without violating the skin (19%). Only 11% of surgeons reported that these preoperative images are routinely interpreted by a radiologist, and another 14% indicated that a radiologist provides interpretation only in cases for which imaging is difficult to interpret.

Questions 10–18 of the survey (Table 1) relate to intraoperative x-ray imaging for level confirmation after incision. Most surgeons indicated that intraoperative imaging

is obtained before bone removal (73%). A few surgeons responded that imaging after performing the incision to confirm the level either is not obtained (2%) or is obtained only sometimes (8%). Similar to the responses regarding localization imaging before performing the incision, lateral x-ray views are used preferentially, imaging following the incision was more commonly performed with fluoroscopy (65%) than with conventional x-ray (35%), conventional x-rays were frequently displayed digitally (70%), and fluoroscopic images were uploaded to a PACS for approximately one-half of the surgeons. The most common technique for imaging after the incision was to place a Penfield No. 4 or a similar instrument beneath the lamina (42%). Approximately 10% of surgeons use a towel clamp or similar instrument attached to a spinous process (10%) or place a Penfield No. 4 or similar instrument in the midportion of the incision but not beneath the lamina (10%). The remaining surgeons use a combination of these methods or use other methods. A few surgeons (21%) routinely obtain confirmatory imaging after bone removal with an instrument at the level of the disk space (21%), although a substantially greater percentage (44%) obtain such confirmatory imaging only sometimes. Confirmatory imaging after performing the incision is routinely (18%) or sometimes (14%) interpreted by a radiologist. The radiologist’s interpretation is reviewed before proceeding with the critical portions of the case as a routine required by the institution for 2% of surgeons, as a routine not required by the institution for 7%, and sometimes for 12%; a radiologist’s interpretation is not obtained for 80% of surgeons.

Questions 19–28 of the survey (Table 1) relate to wrong-level and wrong-side surgery. Most surgeons report being very (67%) or somewhat (15%) concerned regarding wrong-level surgery, and only 4% indicate that they are not at all concerned about this issue. Approximately 40% of surgeons think that wrong-level or wrong-side spine surgery occurs at least 1% of the time in the United States, whereas only 10% think that it occurs <1 time per 1000 cases.

Approximately one-half (47%) of responding surgeons have performed wrong-level lumbar spine surgery, either once (33%) or more than once (14%) (Figure 1).

Table 1. Survey Questions and Responses

| Question | Response | Percent (number) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|------------------|
| Demographics | | |
| 1. Do you perform lumbar single-level decompression procedures as part of your practice? | Yes | 96.5 (548) |
| | No | 3.5 (20) |
| 2. Approximately how many single-level lumbar decompression procedures do you perform in a year? | 0–24 | 20.2 (110) |
| | 25–49 | 31.9 (174) |
| | 50–74 | 24.0 (131) |
| | 75–100 | 13.4 (73) |
| | >100 | 10.5 (57) |
| Localization approaches | | |
| 3. Before performing a lumbar single-level decompression procedure such as a disectomy, do you routinely obtain an immediate preoperative x-ray image for incision planning? | Yes | 73.8 (400) |
| | No | 15.1 (82) |
| | Sometimes | 11.1 (60) |
| 4. Is this image obtained through conventional plain x-ray or with fluoroscopy? | Conventional x-ray | 29.3 (135) |
| | Fluoroscopic image | 70.7 (326) |
| 5. Is the conventional x-ray image uploaded and displayed digitally (e.g., through PACS), or is the image printed on film? | Digital image | 68.9 (93) |
| | X-ray film | 31.1 (42) |
| 6. Is the fluoroscopic image uploaded to PACS? | Yes | 50.8 (166) |
| | No | 23.2 (76) |
| | Sometimes | 26.0 (85) |
| 7. What x-ray projection is used to identify the level preoperatively? | Anteroposterior | 2.0 (9) |
| | Lateral | 81.7 (371) |
| | Both | 16.3 (74) |
| 8. Which method do you most frequently use to identify the level on the preoperative x-ray? | Radiopaque instrument or marker held beside patient's body | 15.9 (72) |
| | Radiopaque instrument or marker overlying the planned incision (e.g., placed on the back) | 14.1 (64) |
| | Radiopaque instrument or marker depressed into patient's back (without violating skin) | 18.5 (84) |
| | Radiopaque marker inserted through patient's skin (e.g. spinal needle or Kirschner wire) | 55.9 (254) |
| | Other | 4.2 (19) |
| 9. Is the preoperative image interpreted by a radiologist? | Yes, routinely | 11.2 (51) |
| | Yes, only when interpretation is difficult | 13.7 (62) |
| | No | 75.1 (341) |
| 10. Is an intraoperative x-ray image obtained to confirm the level? | Yes, before bone removal | 72.7 (389) |
| | Yes, after bone removal | 1.3 (7) |
| | Yes, most frequently before bone removal but occasionally after | 16.3 (87) |
| | No | 2.2 (12) |
| | Sometimes | 7.5 (40) |
| 11. Is the intraoperative image obtained through conventional plain x-ray or with fluoroscopy? | Conventional x-ray | 34.6 (181) |
| | Fluoroscopic image | 65.4 (342) |
| Continues | | |

Table 1. Continued

| Question | Response | Percent (number) |
|--------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|------------------|
| 12. Is the intraoperative conventional x-ray image uploaded and displayed digitally (e.g., through PACS), or is the image printed on film? | Digital image | 69.6 (126) |
| | X-ray film | 30.4 (55) |
| 13. Is the fluoroscopic intraoperative image uploaded to PACS? | Yes | 54.1 (185) |
| | No | 20.2 (69) |
| | Sometimes | 25.7 (88) |
| 14. What x-ray projection is used to confirm the level intraoperatively? | Anteroposterior | 1.1 (6) |
| | Lateral | 91.0 (475) |
| | Both | 7.9 (41) |
| 15. Which method do you most frequently use to identify the level on the intraoperative x-ray (before bone removal)? | (A) Towel clamp or similar instrument attached to spinous process | 9.8 (51) |
| | (B) No. 4 Penfield or similar instrument placed in midportion of incision (not beneath lamina) | 10.2 (53) |
| | (C) No. 4 Penfield or similar instrument placed beneath lamina | 41.6 (217) |
| | (D) Marker placed to identify the pedicle | 5.7 (30) |
| | Both (A) and (B) | 5.2 (27) |
| | Both (A) and (C) or (D) | 15.9 (83) |
| | Other | 11.7 (61) |
| 16. Is an intraoperative image obtained after bone removal with an instrument at the level of the disk space? | Yes | 21.2 (110) |
| | No | 35.2 (183) |
| | Sometimes | 43.7 (227) |
| 17. Is the intraoperative image interpreted by a radiologist? | Yes | 17.9 (93) |
| | No | 67.9 (353) |
| | Sometimes | 14.2 (74) |
| 18. Is a radiologist's interpretation reviewed before proceeding with the critical portions of the procedure? | Yes, required by institution | 1.5 (8) |
| | Yes, not required by institution | 6.5 (34) |
| | No | 80.4 (418) |
| | Sometimes | 11.5 (60) |
| Wrong-level, wrong-side surgery | | |
| 19. How concerned are you regarding wrong-level surgery? | Very | 66.5 (352) |
| | Somewhat | 14.7 (78) |
| | A little | 14.9 (79) |
| | Not at all | 3.8 (20) |
| 20. How often do you think wrong-level or wrong-side spine surgery is performed in the United States? | >1 time in 100 | 21.4 (113) |
| | 1 time in 100 | 19.7 (104) |
| | 1 time in 500 | 28.5 (151) |
| | 1 time in 1000 | 20.2 (107) |
| | <1 time in 1000 | 10.2 (54) |
| 21. Have you ever performed a lumbar single-level decompression procedure at the wrong level or on the wrong side? Answer all that apply. | Yes, wrong <i>level</i> once | 33.1 (175) |
| | Yes, wrong <i>level</i> more than once | 13.6 (72) |
| | Yes, wrong <i>side</i> once | 10.0 (53) |
| | Yes, wrong <i>side</i> more than once | 1.1 (6) |
| | No | 50.1 (265) |

Continues

Table 1. Continued

| Question | Response | Percent (number) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|------------------|
| 22. Have you ever had a "close call" regarding wrong level or wrong side surgery? | (A) Yes, wrong level exposed but no bone removal | 65.5 (173) |
| | (B) Yes, wrong side exposed but no bone removal | 3.4 (9) |
| | Both (A) and (B) | 19.7 (52) |
| | No | 11.4 (30) |
| 23. If wrong-level or wrong-side surgery was performed, when was the error discovered? | At the time of surgery; proceeded with correct level or side surgery | 67.8 (179) |
| | At the time of surgery; did not proceed with correct level or side surgery | 0.4 (1) |
| | Immediately following the case | 4.9 (13) |
| | Sometime (>24 hours) after the case | 26.9 (71) |
| 24. Do you know a colleague who has performed a lumbar single-level decompression procedure at the wrong <i>level</i> ? | Yes, just one colleague | 21.8 (115) |
| | Yes, more than one colleague | 60.9 (321) |
| | No | 17.3 (91) |
| 25. Do you know a colleague who has performed a lumbar single-level decompression procedure on the wrong <i>side</i> ? | Yes, just one colleague | 16.9 (89) |
| | Yes, more than one colleague | 17.3 (91) |
| | No | 65.8 (347) |
| 26. Has a medical malpractice case ever been brought against you for wrong-side or wrong-level spine surgery? | Yes, once | 15.2 (80) |
| | Yes, more than once | 3.2 (17) |
| | No | 80.8 (426) |
| | Decline to answer | 0.8 (4) |
| 27. Do you believe that the Joint Commission's universal protocol (site marking/"time out") has led to a reduction in errors regarding level and side? | Yes, personal experience | 14.0 (74) |
| | Yes, no personal experience | 23.9 (126) |
| | No | 43.3 (228) |
| | Not sure | 18.8 (99) |
| 28. Do you believe a standard should be established for radiographic localization? | Yes | 43.3 (228) |
| | No | 34.9 (184) |
| | Not sure | 21.8 (115) |

PACS, picture archiving and communications system; Joint Commission, The Joint Commission on the Accreditation of Healthcare Organizations.

In addition, >1 in 10 (11%) responding surgeons have performed wrong-side lumbar spine surgery, either once (10%) or more than once (1%). In approximately two-thirds (68%) of cases in which wrong-level or wrong-side surgery was performed, this error was discovered at the time of surgery, and the surgeon proceeded with surgery of the correct level or correct side. The error was discovered immediately after the procedure in 5% of cases and sometime >24 hours after the procedure in 27% of cases. In addition, almost 90% of surgeons reported at least one "close call" with regard to wrong-level or wrong-side lumbar spine surgery, including wrong level exposed but no bone removal (65%), wrong side ex-

posed but no bone removal (3%), or both of these events (20%). Nearly one in five responding surgeons has been the subject of a medical malpractice case for wrong-side or wrong-level spine surgery (once for 15% and more than once for 3% of surgeons).

Of responding surgeons, >80% know of at least one colleague who has performed wrong-level surgery, and more than one-third know of at least one colleague who has performed wrong-side surgery. Although this information may be considered hearsay, it does provide a crude assessment of the magnitude of the problem.

Surgeons were divided when asked whether they believed the universal protocol (site marking/"time out") presented by

the Joint Commission has led to a reduction in errors regarding level and side. Approximately 40% believed that it has helped to reduce these errors, and approximately 40% believed that it has not. Almost 20% indicated uncertainty as to whether there had been an associated reduction in these errors. A similar division was observed when surgeons were asked whether a standard should be established for radiographic localization, with 43% indicating yes, 35% indicating no, and 22% indicating not sure.

DISCUSSION

The Spine Section and the parent organizations the AANS and the CNS have a long-

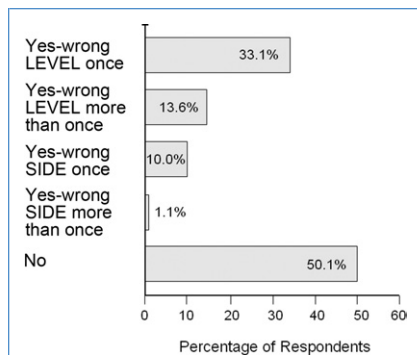


Figure 1. Graphic summary of the responses to the survey question: "Have you ever performed a lumbar single-level decompression procedure at the wrong level or on the wrong side? (Answer all that apply.)"

standing commitment to patient safety and surgical excellence. The report from the Institute of Medicine in 2000 drew national attention to patient safety with the assertion that 44,000–98,000 patient deaths in hospitals each year were attributable to medical errors (13). The Institute of Medicine report has been criticized for presenting "attention to error as a new and different approach to improving care" (8). In addition, the report sheds little light on the definition of a medical error. At the same time, the report has appropriately focused considerable energies on quality improvement in health care. Additionally, the Joint Commission has brought the concept of "preventable harm" to the fore in the quality improvement programs of almost every hospital. The clinicians providing care on the front lines are committed to minimizing harm to all patients, although it is recognized that some adverse outcomes are unavoidable. However, the distinction between preventable harm and inevitable harm remains elusive (17).

Most respondents to our survey are concerned about wrong-level and wrong-side spine surgery. Almost 50% of reporting surgeons have performed wrong-level lumbar spine surgery at least once, and >10% have performed wrong-side lumbar spine surgery at least once. Almost 90% have had at least one "close call" with wrong-level or wrong-side spine surgery. Nearly 20% of responding surgeons have been the subject of at least one medical malpractice case relating to these errors. Collectively, the survey results indicate that wrong-level and wrong-side spine surgery are significant

problems and that further study is warranted. Although the present study was focused on practice patterns in North America, undoubtedly similar issues exist for spinal procedures performed outside of North America.

One of the objectives of the present study was to identify current standard practices that are in place to mitigate wrong-level surgery. Most reporting surgeons use intraoperative radiographic imaging, either fluoroscopy or conventional x-rays, to aid in the localization process, and a relatively small subset review a radiologist's interpretation of these images before proceeding. Various methods for radiographic localization, either immediately before the incision or after bone landmarks have been exposed, were reported, and there does not seem to be a clear single standard. Instead, practitioners seem to have found solutions that work in their own particular situation. Although variation in practice may raise concerns, this study does not present evidence to support a specific protocol over others.

Previous studies have reported incidences of wrong-level lumbar spine surgery with rates ranging from 0.05%–5.3% (2, 4, 12, 14, 16). Although the present study does not permit determination of incidences of wrong-level surgery, the fact that 50% of the surgeons reported having performed surgery at the wrong level at least once suggests that the rate is likely higher than reported in many previous studies; this may be a result of the emphasis on maintaining anonymous responses in our survey. There is a negative stigma associated with this error that undermines free reporting, and it may be that creating an environment that is more conducive to reporting this error would advance understanding of the causes.

In studying wrong-level surgery, the most important goal is to reduce the incidence of this error. Although our survey was not designed to identify new approaches, the survey does illuminate the lack of confidence that respondents have in the current methodologies thought to mitigate wrong-level surgery, including the Joint Commission–endorsed "time out." The suggestion that the "time out" procedure and the process of marking patients preoperatively do not address the issue of wrong level is important and has been noted previously (4, 12). With the increasing recognition that

error prevention is most meaningful at the system level, it is even more important to ensure that the systems implemented are directed at the intended problems. It may be that the system changes needed to impact the incidence of wrong-level surgery have not been completely identified or incorporated into current practice. This is not a reason to deemphasize the systems approach that has been shown to improve the quality of health care (3, 7). However, it does highlight the importance of identifying and implementing the correct systems.

Previous studies have suggested risk factors for the occurrence of wrong-level surgery and have suggested approaches for reducing these errors (1, 9, 10, 20). Ammerman et al. (1) assessed 100 consecutive patients who underwent lumbar discectomy by a single surgeon who was initially asked to identify the level exposed without the use of intraoperative x-ray. Subsequent x-ray imaging showed a 15% rate of wrong-level identification. The findings reported by Ammerman et al. (1) not only provided strong support for the use of intraoperative imaging but also showed that older patient age and pathology above the level of L5-S1 were predictors of exposure of the incorrect level. Irace and Corona (10) reported an incidence of wrong-level lumbar spine microdiscectomy of 0.12% (1 of 818) when they applied a three-step process in which a wire was placed in the cranial spinous process of the target level before skin incision and lateral fluoroscopy was obtained to confirm the level. A verbal confirmation of the target level was obtained before the incision, and additional fluoroscopic imaging as needed was obtained to confirm the level after incision.

Among medical specialties, neurosurgeons have been reported to have the highest rates of malpractice claims, with 19.1% of neurosurgeons facing at least one claim per year, and 99% facing at least one claim by age 65 years (11). In 2003, Goodkin and Laska (6) reported on the medicolegal implications of surgery of the wrong disk space level. They identified 68 cases that were the subjects of lawsuits. Of these cases, 37 (54%) were settled, and plaintiff verdicts were rendered in 18 (26%) and defense verdicts were rendered in 13 (19%) of the cases. Indemnities ranged from \$62,000–\$1,500,000. Among cases decided in favor of the surgeon, intraoperative radiographs for localization were not obtained for two cases and were obtained for four cases; the remain-

ing seven cases lacked adequate reported detail to determine whether intraoperative imaging was performed. In another report, Fager (5) documented 16 cases of wrong-level lumbar spine surgery, despite the “so-called localizing x-rays” that were obtained in the operating room in each of these cases. These studies suggest that use of intraoperative imaging for localization is not infallible and is not protective of medicolegal liability in the event of wrong-level surgery.

Several factors complicate the effective study of wrong-level surgery and methods to reduce the rate at which it occurs. Although it is probably more common than previously thought, wrong-level lumbar surgery is still an uncommon event. Considerable stigma for the operating surgeon and institution is associated with wrong-level surgery. In addition, there is substantial heterogeneity in approaches used by surgeons to localize the desired operative level. These factors are powerful arguments for development of a standardized approach for level confirmation that at least can be used to facilitate a multiinstitutional effort to investigate and mitigate this error further.

The present study has several strengths, including a relatively high response rate and the assurance of participants that there would be confidentiality and nondisclosure and that data would be published only in aggregate. For some of the more sensitive questions, such as questions relating to medical malpractice claims, respondents were offered a “decline to answer” option. In addition, the present study distinguishes between the occurrence of wrong-level and wrong-side surgery, instead of grouping the two together as a single “wrong-site” surgery category, because the two errors likely reflect different underlying issues.

The survey methodology of this study also has several limitations. Recall bias plays a role in the retrospective collection of data. In addition, there is no ability to know the total number of cases that were performed during the time period covered. Any understanding of incidence or prevalence of this error is based on expert opinion only. Another study limitation relates to the differences in work flows for minimally invasive surgery and microscopic open spine cases, with the former relying heavily on fluoroscopic imaging and the later often depending more on x-ray imaging. Because

the survey did not record the identity of the respondents, it is impossible to determine if a particular response was made by a surgeon using a minimally invasive surgery or a microscopic open approach. In addition, the survey approach does not allow determination of how specific practices of localization affect the risk of wrong-level surgery. Another limitation of the study is the modest response rate of 53%, which, although perhaps not unexpected for a survey-based study, is lower than expected from an association with a focus on spine care. Finally, we acknowledge that there may be important differences between the surgeons who chose to respond to the survey and the surgeons who did not respond. Nonetheless, we believe the survey provides unique insight into the current issues affecting wrong-level surgery and should serve as a basis for future study designed to reduce the occurrence of these errors.

CONCLUSIONS

The AANS/CNS Spine Section has undertaken a survey of its membership to understand better the scope of wrong-level and wrong-side lumbar spine surgery and the current practices in place to help avoid these errors. Almost 50% of reporting surgeons have performed wrong-level lumbar spine surgery at least once, and >10% have performed wrong-side lumbar spine surgery at least once. Nearly 20% of responding surgeons have been the subject of a medical malpractice case relating to these errors.

The survey results show substantial heterogeneity in approaches used by surgeons to localize the desired operative level. No universally implemented standard is in place to reduce the incidence of wrong-level surgery, and the existing safety protocols including the “time out” may not be decreasing the occurrence of wrong-level surgery to the extent previously thought. Collectively, the findings of the present study argue for additional study of wrong-level spine surgery, including development of a standardized approach for level confirmation that at least can be used to facilitate a multiinstitutional effort to investigate and mitigate this error further.

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