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Correlation of higher preoperative American Society of Anesthesiology grade and increased morbidity and mortality rates in patients undergoing spine surgery

Clinical article

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Object. Patients with varied medical comorbidities often present with spinal pathology for which operative intervention is potentially indicated, but few studies have examined risk stratification in determining morbidity and mortality rates associated with the operative treatment of spinal disorders. This study provides an analysis of morbidity and mortality data associated with 22,857 cases reported in the multicenter, multisurgeon Scoliosis Research Society Morbidity and Mortality database stratified by American Society of Anesthesiologists (ASA) physical status classification, a commonly used system to describe preoperative physical status and to predict operative morbidity.

Methods. The Scoliosis Research Society Morbidity and Mortality database was queried for the year 2007, the year in which ASA data were collected. Inclusion criterion was a reported ASA grade. Cases were categorized by operation type and disease process. Details on the surgical approach and type of instrumentation were recorded. Major perioperative complications and deaths were evaluated. Two large subgroups—patients with adult degenerative lumbar disease and patients with major deformity—were also analyzed separately. Statistical analyses were performed with the chi-square test.

Results. The population studied comprised 22,857 patients. Spinal disease included degenerative disease (9409 cases), scoliosis (6782 cases), spondylolisthesis (2144 cases), trauma (1314 cases), kyphosis (831 cases), and other (2377 cases). The overall complication rate was 8.4%. Complication rates for ASA Grades 1 through 5 were 5.4%, 9.0%, 14.4%, 20.3%, and 50.0%, respectively ($p = 0.001$). In patients undergoing surgery for degenerative lumbar diseases and major adult deformity, similarly increasing rates of morbidity were found in higher-grade patients. The mortality rate was also higher in higher-grade patients. The incidence of major complications, including wound infections, hematomas, respiratory problems, and thromboembolic events, was also greater in patients with higher ASA grades.

Conclusions. Patients with higher ASA grades undergoing spinal surgery had significantly higher rates of morbidity than those with lower ASA grades. Given the common application of the ASA system to surgical patients, this grade may prove helpful for surgical decision making and preoperative counseling with regard to risks of morbidity and mortality. *(DOI: 10.3171/2010.12.SPINE10486)*

Key Words • **American Society of Anesthesiologists grade** • **complication** • **morbidity** • **mortality** • **spinal surgery**

Patients seeking treatment from spine surgeons may present with complex medical comorbidities, which can complicate surgical decision making.[8] Often, surgeons approach with caution patients with significant medical comorbidities, but there are few reports that specifically evaluate risk stratification mechanisms for spine surgery. In other surgical disciplines, several different risk stratification schemes, such as APACHE II (Acute Physiology and Chronic Health Evaluation II) and POSSUM (Physiological and Operative Severity Score for the Enumeration of Mortality and Morbidity), have been evaluated, but most of these tools are potentially cumbersome and of varied utility.[3,15] The ASA classification system,[4] in use for many years, has the benefit of being relatively simple and is typically applied to every surgical patient. The grades range from 1 to 5; a description of each grade is provided in Table 1. This system has historically been demonstrated to predict morbidity and

Abbreviations used in this paper: ASA = American Society of Anesthesiologists; SRS = Scoliosis Research Society.

TABLE 1: Summary of the ASA physical status classification

Grade	Definition
1	normal healthy
2	mild systemic disease
3	severe systemic disease
4	severe systemic disease that is a constant threat to life
5	moribund & not expected to survive w/o the op

mortality in general surgical procedures and has more recently been shown to predict mortality in trauma patients and those being treated for adult spinal deformity.[5,6,11,12,16]

To examine whether ASA classification correlates with increased rates of morbidity and mortality for operative spine treatment, we analyzed complication-related data from the SRS Morbidity and Mortality database, with reference to the reported ASA classification. The use of this multicenter database allows for analysis of a large sample of spine cases, with varied complexity, age, and pathology. In addition, correlations between ASA grade and morbidity and mortality were performed for 2 specific subgroups of patients—those treated for adult degenerative lumbar disease and adult patients treated for spinal deformity.

Methods

To assess the rates of morbidity and mortality associated with spinal surgery based on ASA grade, all surgical cases reported from the year 2007 were extracted from the SRS Morbidity and Mortality database. This was the only year in which ASA data were collected as part of the case submission process. Inclusion criteria for this study included a reported ASA grade, and entries missing this information were excluded. The database on which this project was based was determined to be exempt from internal review board approval based on the use of de-identified data (internal review board no. 29045).

Prior to application for active membership in the SRS, surgeons must complete a 5-year period of candidate membership. During the time interval over which the data used in this study were collected, candidate members were required to collect and submit data on all treated spine cases, including all associated instances of morbidity and mortality. Active members were also encouraged to submit their cases.[1,2,7,13,14] Data are gathered using a questionnaire developed by the SRS Morbidity and Mortality Committee in the early 1990s and updated to a secure internet-based data entry form in 2001. The SRS has invested substantial resources in this database and emphasizes to its membership the importance of accurate and consistent reporting. In addition, during the time interval over which the data used in this study were collected, data submission included a process in which members formally attested that submitted data are true and complete. All data are de-identified upon entry into the database, with regard to patient, surgeon, and institution identifiers. Reported complications do not influence whether a candidate is offered membership, given that the SRS Membership Committee is provided only with an indication of whether each candidate member has completed the required case submission process, and not the number or types of complications for each candidate.

For each case included in the present study, age, procedure type, and the presence or absence of complications, including death, were extracted from the database. In cases in which a complication occurred, the complications were classified into categories (for example, pulmonary embolus, deep venous thrombosis, and wound infection). Not consistently included in the database was information on comorbidities, long-term follow-up, and objective outcome measures; therefore, analyses related to these parameters were not performed in the present study.

Statistical comparisons between subgroups were performed using Fisher exact or Pearson chi-square tests. A p value of less than 0.05 was considered statistically significant. All statistical analyses were 2 sided. Subgroup analysis was performed on data obtained in adult patients with spinal deformity (age ≥ 21 years with a diagnosis of scoliosis or kyphosis and those patients undergoing a spinal osteotomy) and in adult patients with degenerative lumbar disease (age > 35 years). In addition, logistic regression analyses were performed to adjust for the effects of case complexity (whether instrumentation was implanted was used as a surrogate for case complexity) and patient age on the relationship between ASA grade and morbidity and mortality. Mean values are presented ± SD.

Results

After excluding 3972 patients (15% of 26,829) for whom an ASA grade was not reported, the study group was formed by 22,857 patients who met inclusion criteria. The mean age of patients was 42.6 ± 22.9 years. Degenerative diseases were treated in 9409 of these patients. Patients with deformity were treated for scoliosis (6782 cases), spondylolisthesis (2144), and kyphosis (831). Trauma was listed as the diagnosis in 1314 cases. A total of 2377 patients were treated for other causes, including infection and tumor. Overall, instrumentation was used in 16,272 patients (71%).

All ASA grades were represented in the database. The majority of cases were lower grade, including 11,101 Grade 1 and 7408 Grade 2 cases. Three thousand eight hundred seventy-nine were Grade 3. Higher-grade patients were not as well represented; there were 463 patients with Grade 4 and 6 patients with Grade 5 status. The morbidity rates and mortality rates differed significantly based on ASA grade ($p = 0.001$). Tables 2 and 3, respectively, present the morbidity and mortality data stratified by ASA grade. Patients had an increasing likelihood of both morbidity and mortality if they had a higher grade classification. These differences remained statistically significant when the small number of Grade 5 patients was excluded from the analysis ($p < 0.001$).

Rates for several specific complications were greater in patients with higher ASA grades. Table 4 illustrates the rates for common complications such as infections, hematomas, respiratory complications, and thromboembolic events. For each of these complications, the rates were

TABLE 2: Morbidity rates for spinal surgery based on ASA grade in 22,857 patients

ASA Grade	No. of Patients	No. of Complications	Complication Rate (%)*
1	11,101	599	5.4
2	7408	668	9.0
3	3879	557	14.4
4	463	94	20.3
5	6	3	50.0
overall	22,857	1921	8.4

* p = 0.001.

significantly different in the ASA groups ($p < 0.05$), with higher-grade patients generally showing an increased propensity for developing a complication. For infections, there was a nearly 7-fold increase in the rate when a patient with Grade 4 status was compared with a patient with Grade 1 status. Respiratory complications demonstrated an 8-fold increase, from Grade 1 to 4. Hematomas were nearly 9 times as likely to occur in Grade 4 patients than in Grade 1 patients.

For ASA Grades 1–5, the mean ages were 36 ± 20, 51 ± 21, 47 ± 27, 40 ± 29, and 46 ± 30 years, respectively. Logistic regression analysis was performed to assess for potential differences in patient age based on ASA grade. After adjusting for the potential effects of age (continuous variable), overall morbidity and mortality rates remained significantly different among the ASA grades ($p = 0.001$ and $p = 0.001$, respectively).

Logistic regression analysis was also used to adjust for potential differences in the levels of case complexity across the ASA grades. Whether the case included spinal instrumentation was used as a surrogate for case complexity. While this is a potentially imperfect surrogate, since it cannot distinguish between short and long constructs, other potential surrogates, such as blood loss or operative time, were not recorded in the database. The proportions of cases with instrumentation did not differ based on ASA grade ($p = 0.78$), with the percentage of cases including instrumentation for Grades 1–5 being 71%, 72%, 73%, 73%, and 83%, respectively. After adjusting for the potential effects of case complexity based on the use of instrumentation, morbidity and mortality rates remained significantly different among the ASA grades ($p = 0.001$ and $p = 0.001$, respectively).

Data obtained in adults, over age 35 years, with degenerative lumbar disease were also analyzed as a separate subgroup, for which 5811 patients, with a mean age of 56 years, met inclusion criteria. Approximately one-half (53%) of the population was male. The secondary diagnoses were lumbar stenosis (2425 cases), disc herniation (1959 cases), degenerative disc disease (1117 cases), and other (310 cases). Patients assigned higher ASA grades had higher rates of complication, with the distribution as follows: Grade 1 (2564 patients), 5% rate of complications; Grade 2 (2413 patients), 7.5% rate of complications; Grade 3 (721 patients), 15% rate of complications; and Grade 4 (22 patients), 18% rate of complications ($p = 0.001$). There were 5 reported deaths: 3 in Grade 2 patients and 1 each in Grade 1 and 3 patients. The mortality rates did not differ significantly based on ASA grade ($p = 0.71$).

TABLE 3: Mortality rates for spinal surgery based on ASA grade in 22,857 patients

ASA Grade	No. of Patients	No. of Deaths	Mortality Rate (%)*
1	11,101	3	0.03
2	7408	8	0.1
3	3879	13	0.3
4	463	10	2.2
5	6	2	33.3
overall	22,857	36	0.16

* p = 0.001.

Data obtained in adults (> 21 years of age) with spinal deformity were also analyzed separately. There were 1954 patients with a mean age of 53 years. Patients assigned higher ASA grades had higher rates of complication ($p < 0.001$) and mortality ($p < 0.001$) as shown in Table 5. Again, as for the lumbar degenerative subset, the trend of higher complication rates in higher-grade patients was present. Grade 1 patients had a 10% complication rate with no deaths reported. Grade 2 patients had a 16% morbidity rate with a 0.2% mortality rate. Grade 3 and 4 patients had higher rates of both morbidity (22% and 31%, respectively) and mortality (0.7% and 4%, respectively).

Discussion

The present analysis of the SRS Morbidity and Mortality database demonstrates that patients with higher ASA grades undergoing spinal surgery have higher rates of complications. This trend in the general overall spinal surgery group was also evident in subgroups of patients undergoing treatment for adult degenerative lumbar disease and adult spinal deformity. The mortality rate was also higher in patients with higher ASA grades, in the overall group, and in the subgroup of patients with major adult deformity. In the subgroup of patients being treated for adult degenerative lumbar disease, mortality rates did not differ significantly, likely because the incidences of mortality were relatively low.

TABLE 4: Specific complication rates for spinal surgery based on ASA grade in 22,857 patients*

ASA Grade	No. of Patients	Incidence (%)†			
		Infection	Respiratory	Hematoma	PE/DVT
1	11,101	1.3	0.3	0.13	0.09
2	7408	2.5	0.61	0.32	0.18
3	3879	4.5	0.93	0.9	0.34
4	463	8.2	3.2	0.9	1.1
5	6	0	16.7	0	0
overall	22,857	2.4	0.55	0.34	0.18

* DVT = deep vein thrombosis; PE = pulmonary embolism.
† $p < 0.05$.

TABLE 5: Morbidity and mortality rates for spinal surgery based on ASA grade in 1954 adult patients with spinal deformity

Grade ASA	No. of Patients	Rate (%)*	
		Morbidity	Mortality
1	662	10	0
2	866	16	0.2
3	401	22	0.7
4	25	31	4

* p = 0.001.

Although no grading system can substitute for clinical judgment and the patient's overall clinical status, the results of the present study suggest that a patient's ASA grade may be helpful in counseling individuals on risks of morbidity and morbidity. An ASA grade is typically given to each patient prior to surgery and is therefore typically readily available. Other grading systems are more complex and may not be easy to obtain.[3]

Aside from historical studies,[5,6,10,16] the ASA classification system has been shown recently to be effective in predicting risk of mortality in operations performed by other surgical specialties, ranging from abdominal surgery to otolaryngology.[3,9,15] Recently, a prospective trauma study found pretrauma ASA status to be an independent indicator of posttraumatic mortality. The effect was robust, with the risk of death effectively doubling with each increase in ASA grade. This effect was reportedly present across different injury severity scores and revised trauma scores.[12]

Several smaller studies have evaluated preoperative ASA status as a predictor of postoperative mortality in various aspects of spine surgery. Recently, Pateder et al.[11] evaluated mortality rates in 407 patients undergoing surgical correction of adult spinal deformity. They reported a 2.4% mortality rate, with a significant ASA difference of 3 versus 2.3 for patients who survived versus those who did not, respectively. This finding, coupled with the ASA data presented here, strongly suggests that a 1-point difference in ASA status may represent a clinically significant higher risk of both morbidity and mortality in patients undergoing spine surgery.

There are several limitations of this study. The SRS database relies on the accurate submission of data by members but is unable to audit them for accuracy. It is possible that all complications were not thoroughly documented, which could result in the underestimation of complication rates. No method currently exists to evaluate the completeness and accuracy of the input data, instead relying on the good faith of reporting surgeons. It is likely that major complications and death are more accurately reported, but this cannot be verified.[1] Although data are reported prospectively, our study was retrospective and, as such, is subject to the weaknesses inherent to such investigations, including confounding variables and reporting bias. In addition, because the SRS Morbidity and Mortality database is not designed to capture long-term outcomes, it is impossible to assess the potential clinical impact of complications. Also, the ASA classifications cannot be verified by independent analysis of comorbidities, as these are not reported. Finally, we cannot comment on how a patient's ASA grade affected the decision of operative versus nonoperative treatment because the database does not record nonoperative cases.

Conclusions

Spinal surgery patients with higher ASA grades had significantly higher morbidity rates than those with lower ASA grades. Given the common application of ASA grading to surgical patients, this grade may prove helpful for surgical decision making and preoperative patient counseling with regard to risks of morbidity and mortality.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Shaffrey, Fu, Smith, Polly. Acquisition of data: Shaffrey, Smith, Perra. Analysis and interpretation of data: Shaffrey, Fu, Smith. Drafting the article: Fu. Critically revising the article: all authors. Reviewed final version of the manuscript and approved it for submission: all authors. Statistical analysis: Smith.

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