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Survey of anesthesia practice in spine surgery patients in the United States

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Abstract
Purpose. There is a wide range of anesthetic practice in spine surgery with respect to anesthetic choice, blood conservation, and monitoring. There is no ideal technique with respect to each of these choices. This study was designed to determine the usual practice for members of the Society of Neurosurgical Anesthesia and Critical Care (SNACC), with regard to the use of anesthetic technique, the type of monitoring used (and the person responsible for its application and interpretation), and the blood conservation strategies most often utilized for the management of patients undergoing spinal surgery.
Methods. A total of 415 questionnaires were mailed to all current members of the SNACC. Of these, 85 (23%) were completed and returned.
Results. The majority of the respondents administer general anesthesia for lumbar laminectomy. Somatosensory evoked potential (SSEP) monitoring is available at most of the institutions (94%) but only utilized in 75% of patients undergoing a Harrington rod placement. Motor evoked potential monitoring is available at 50% of the institutions, but utilized 25% of the time for these surgeries. The two most frequent blood conservation strategies utilized are intraoperative salvage and autologous donation.
Conclusion. The most frequent monitoring utilized for major spinal surgeries is SSEP. Autologous donation and intraoperative salvage are the most frequent blood conservation methods utilized.

Key words Spine Surgery · Neurological anesthesia · Monitoring

Introduction

We surveyed current members of the Society of Neurosurgical Anesthesia and Critical Care (SNACC) to determine the common anesthetic techniques, electrophysiological monitoring practices, and strategies employed to minimize allogenic blood transfusion for the complete spectrum of spinal surgery.

There is a variety of practice regarding the anesthetic technique chosen for laminectomy. Recent studies have suggested the benefit of spinal anesthesia compared with general anesthesia in laminectomy patients [1]. Despite evidence that shows a benefit of spinal compared with general anesthesia, it was our impression that general anesthesia is the more common anesthetic technique.

Electrophysiological monitoring of the central nervous system may be a valuable adjunct for surgical procedures at risk for neural injury [2]. Spinal surgery varies in level and degree of complexity; laminectomy and discectomy are probably the most common spine surgeries. However, correction of spinal deformities, spinal fusion, and stabilization are not uncommon procedures, and involve complicated anesthetic management. Routine spinal cord monitoring during these complex surgical procedures is still controversial; several studies have shown that monitoring can predict and improve neural outcome [3].

Increasing concern regarding the risks associated with homologous blood transfusion has resulted in the development and use of techniques to reduce blood loss (e.g., deliberate hypotension, isovolemic hemodilution, epidural anesthesia) and to reduce homologous blood transfusion (e.g., perioperative blood salvage, banked autologous transfusion). We surveyed the anesthetic technique, monitoring, and blood conservation strategies for spinal surgery in the United States.

Methods

Prior to initiating the survey, Institutional Review Board approval was obtained. A two-page survey was

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sent to all current members of the SNACC. These surveys were e-mailed to members with an e-mail address, and sent by conventional mail to those without an e-mail address. If a member failed to answer the e-mail survey, a survey was sent by conventional mail. Fax return of the questionnaire was offered to participants. No identifying characteristics were requested regarding the respondents themselves, and the questionnaire was designed to be answered anonymously.

The survey consisted of questions designed to address several aspects of anesthesia management for spine surgery, including:

1. Lumbar laminectomy
   a. Use of general vs. regional anesthesia
   b. Percentage of lumbar laminectomies performed by neurosurgeons vs. orthopedic surgeons
2. Complex spine surgery (multisegment fusions or instrumentation surgery)
   a. Availability of neuromonitors
   b. Modality of monitoring available for each procedure
   c. Personnel responsible for monitoring and interpreting procedures
   d. Blood salvage techniques used for multilevel instrumentation procedures
   e. The anesthetic method by which hypotension was induced
   f. Overnight postoperative care disposition

Results

A total of 415 questionnaires were sent; 44 of these were sent by e-mail. Of those 415 questionnaires, a total of 85 completed forms were returned (10 by e-mail), indicating a total response rate of 23%.

Respondents identified lumbar laminectomy as the most common spine procedure (81%). The anesthetic technique used for laminectomy is summarized in Table 1.

The neurophysiological monitoring available at the institutions surveyed is shown in Table 2. The type of monitoring used for various procedures is shown in Table 3. Application and interpretation of monitoring practices and displayed in Table 4. Blood conservation strategies are shown in Table 5. The agents used to achieve hypotensive anesthesia are shown in Table 6. For the overnight postoperative care of patients undergoing posterior fusion for scoliosis correction, 53% were sent to an intensive care unit, 18% were sent to a "step down" unit, and 34% were sent to a ward bed.

Discussion

General anesthesia was the most common anesthetic technique used by our respondents. Significant benefits (i.e., reduced blood loss, lowered incidence of thromboembolism) have been shown when utilizing neuraxial blockade in patients undergoing major hip surgery [4]. Spinal anesthesia was shown to offer benefits in a study comparing spinal and general anesthesia in patients undergoing laminectomy surgery. The benefits included

Table 1. Anesthetic techniques for laminectomy

Anesthetic technique	*n*	%
General anesthesia	75	79
Epidural anesthesia	7	7
Spinal anesthesia	13	14

Table 2. Types of neuromonitoring available at institution

Type of neuromonitoring	*n*	%
No monitoring	2	2
Electroencephalogram (EEG)	80	96
Somatosensory evoked potential (SSEP)	78	94
Motor evoked potential (MEP)	41	49
Transcranial Doppler (TCD)	45	54

Table 3. Monitoring used for various procedures

	Somatosensory evoked potential (SSEP)		Motor evoked potential (MEP)		Electroence-phalogram (EEG)		Wake-up test	
Procedure	*n*	%	*n*	%	*n*	%	*n*	%
Anterior cervical disc	16	19	7	8	4	5	1	1
Posterior cervical disc	27	32	10	12	0	0	1	1
Spinal stenosis	24	28	11	13	0	0	2	2
Lumbar laminectomy	5	6	1	1	2	2	1	1
Lumbar fusion	27	32	4	5	2	2	3	4
Scoliosis/Harrington rods	64	75	21	25	2	2	41	48
Spine tumors	63	74	21	25	0	0	10	12

Table 4. Persons responsible for technical application and interpretation of available monitors

	Somatosensory evoked potential (SSEP)		Motor evoked potential (MEP)		Electroencephalogram (EEG)		Transcranial Doppler (TCD)	
	Apply	Interpret	Apply	Interpret	Apply	Interpret	Apply	Interpret
Neurosurgeon	5%	9%	4%	8%	1%	7%	13%	11%
Neurologist/other	79%	81%	85%	79%	80%	70%	58%	55%
Anesthesiologist	16%	10%	11%	13%	19%	23%	29%	34%

Table 5. Blood salvage strategies used during spinal fusion for scoliosis surgery

Blood salvage strategies	*n*	%
Preoperative autologous donation	64	84
Intraoperative blood salvage	66	87
Acute normovolemic hemodilution	28	37
Induced hypotension	46	61
None	9	11

Table 6. Hypotensive agents used

Hypotensive agent	*n*	%
Halogenated anesthetics	45	53
Trimethaphan	9	11
Morphine	1	1
Sodium nitroprusside	49	58
Labetalol	42	49
Curare	2	2
Other	19	22

shorter anesthetic and surgical times, lower incidence of intraoperative hypertension, lower blood loss, lower postoperative tachycardia, lower postoperative nausea, and decreased postoperative pain [1]. Although spinal anesthesia may be superior to general anesthesia, most laminectomies are performed via general anesthesia. The reasons for this perhaps include both physician bias and patient preference. It is also interesting to note that the vast majority of laminectomy operations are performed by neurosurgeons; this is probably due to patient referral patterns at hospitals where SNACC members practice.

Application and interpretation of neuromonitoring requires a team approach. Monitoring personnel need to be thoroughly familiar with the effects of anesthetic agents and other potentially confounding factors. Monitoring teams who had less monitoring experience (100 or fewer cases) had a neurologic deficit rate more than twice the rate of teams with greater experience (over 300 cases) [3]. In our survey, respondents verified that neurologists and other technicians did most of the application and interpretation of somatosensory evoked potential (SSEP), motor evoked potential (MEP), and electroencephalogram (EEG) monitors. This result was not surprising because they are the most trained in the field of neuromonitoring, and because application, monitoring, and interpretation can distract the anesthesiologist and the neurosurgeon from clinical care.

EEG is a useful monitor for detecting cortical ischemia and it is mainly advocated during procedures involving the vascular supply of the brain. Not surprisingly, it was rarely used by respondents to our survey for spine surgery. In fact, it was utilized by only 2% of the respondents. On the other hand, although SSEP monitoring was available to 94% of respondents, only 75% used it for major spine surgery. This is despite the fact that several studies have shown that SSEP monitoring is predictive of neural outcome and can reduce neural morbidity in patients undergoing stabilization in spinal trauma [5]. A drawback of SSEP monitoring is that it only assesses sensory pathways and does not monitor the motor pathway [6,7]. MEP, as a more specific monitor for the motor tract, may actually be an earlier and better predictor of impending damage to the spinal cord than SSEP [8]. Despite the availability of MEP to 50% of the respondents, only half of those to whom it was available used this monitor in major spinal surgery. In the absence of MEP, a reasonable method of evaluating spinal cord function is to combine both SSEP (to assess posterior spinal cord function) in conjunction with the wake-up test (to assess anterior function).

Another disadvantage of these monitoring devices is the cost of the device (approximately $40000) and the training and salary of technicians. Often, these costs are not reimbursed by insurance. As evidenced by our survey, the majority of these advanced monitoring devices are applied and interpreted by someone other than an anesthesiologist (either a neurologist or other technicians).

Various methods (altering the anesthetic technique and the use of deliberate hypotension) are used to reduce the need for allogenic blood transfusion during spine surgery by reducing blood loss. Sodium nitroprusside (SNP), halogenated agents, and labetalol are most commonly used by the respondents to induce hypotension; these agents are presumably chosen for their ease of use. The most commonly used agent, SNP, was used

by approximately 60% of our respondents. Although it is known to rapidly reduce blood pressure (BP) it is also known for its side effects and toxicity (especially during lengthy procedures). Studies comparing SNP with nicardipine during spinal surgery showed that nicardipine offered a significant advantage over SNP in reducing blood loss [9]. This result may have been due to a longer time to restoration of baseline BP in the nicardipine group.

Hypotensive practice varies between institutions. There are specific risks that are associated with spine surgery as a result of the prone position and the combined effect of hemodilution and hypotension (e.g., visual complications) [10,11]. Because most adolescents have normal cardiovascular systems, they tolerate extreme ranges of hemodilution better than their adult counterparts do. The safe lower limit of hematocrit and blood pressure, however, are not well defined.

Our results indicate that, of all techniques available to homologous blood transfusion, the two most widely used are intraoperative blood salvage (87%) and preoperative autologous donation. In 1987 Bailey and Mahoney demonstrated the benefit of preoperative autologous blood donation in a cohort of 52 spine surgery patients, 85% of whom were able to avoid allogenic transfusion completely [12]. Although the cost efficacy of this technique has been questioned for various surgical procedures [13], its usefulness has been confirmed for adolescent scoliosis surgery. It has been reported that approximately 90% of children undergoing scoliosis surgery who were autologous donors were able to avoid allogenic blood transfusion [14,15]. Thus, although the safety of allogenic blood is improving, and the per-unit cost of preoperative autologous donation is high, our survey demonstrates that preoperative autologous donation continues to be widely used for corrective scoliosis surgery.

As noted, the use of intraoperative blood salvage was the most commonly used blood conservation strategy among our respondents. Widespread support of this technique has been reported in the surgical literature [16]. In patients undergoing spinal surgery, intraoperative blood salvage was only shown to be of benefit to patients with large blood loss (>2000 ml) when added to a program of preoperative donation [17,18]. This amount of blood loss is unusual, although not rare, for posterior lumbar fusions as well as for scoliosis corrective surgery, and one could similarly question the cost effectiveness of this technique. In addition, several reports of coagulopathy complicating intraoperative blood salvage have emerged in recent years, further strengthening the argument against using this technique [19–21]. Thus, although not without risk or expense, intraoperative blood salvage is frequently used as a means of reducing blood transfusion.

Despite a relatively low response rate, our survey was able to discern a number of interesting findings. Our survey of anesthetic practice reveals that the majority of lumbar laminectomies are performed with a general anesthetic. Neuromonitoring is commonly used for spinal instrumentation surgeries; SSEPs are the most common monitoring device. Despite availability of MEP at 50% of the surveyed institutions, only one-half used them for major spinal procedures. The most common blood conservation techniques are preoperative autologous donation and intraoperative blood salvage. Induced hypotension, which is used less frequently, is most often achieved with sodium nitroprusside. As evidence accumulates to reveal the risks and benefits of current practices, we can expect further refinement and development of current monitoring and blood conservation techniques.

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