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Injuries Associated with Regional Anesthesia in the 1980s and 1990s

A Closed Claims Analysis

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Background: **The authors used the American Society of Anesthesiologists Closed Claims Project database to identify specific patterns of injury and legal liability associated with regional anesthesia. Because obstetrics represents a unique subset of patients, claims with neuraxial blockade were divided into obstetric and nonobstetric groups for comparison.**

Methods: **The American Society of Anesthesiologists Closed Claims Project is a structured evaluation of adverse anesthetic outcomes collected from closed anesthesia malpractice insurance claims of professional liability companies. An in-depth analysis of 1980–1999 regional anesthesia claims was performed with a subset comparison between obstetric and nonobstetric neuraxial anesthesia claims.**

Results: **Of the total 1,005 regional anesthesia claims, neuraxial blockade was used in 368 obstetric claims and 453 of 637 nonobstetric claims (71%). Damaging events in 51% of obstetric and 41% of nonobstetric neuraxial anesthesia claims were block related. Obstetrics had a higher proportion of neuraxial anesthesia claims with temporary and low-severity injuries (71%) compared with the nonobstetric group (38%; $P \leq 0.01$) and a lower proportion of claims with death or brain damage and permanent nerve injury compared with the nonobstetric group ($P \leq 0.01$). Cardiac arrest associated with neuraxial block was the primary damaging event in 32% of obstetric and 38% of nonobstetric neuraxial anesthesia claims involving death or brain damage. Eye blocks accounted for 5% of regional anesthesia claims.**

Conclusion: **Obstetric claims were predominately associated with minor injuries. Permanent injury from eye blocks increased in the 1990s. Neuraxial cardiac arrest and neuraxial hematomas associated with coagulopathy remain sources of high-severity injury.**

BOTH prospective and retrospective studies have reported major injuries associated with regional anesthesia.[1–3] Cardiac arrest occurring during spinal blockade has been reported to be as high as 6.4 per 10,000 patients, with many of these arrests attributed partially or completely to the spinal anesthetic.[2,4] Paraplegia, cauda equina syndrome, and seizures resulting from unintentional intravenous injections of local anesthetic are other serious complications that have resulted from regional anesthesia. In addition to these major complications, less severe injuries such as post–dural puncture headache and back pain are frequent sequelae of regional anesthesia.[5] Obstetric patients represent a unique group of patients of similar age, American Society of Anesthesiologists (ASA) physical status, and physiology who routinely receive regional anesthetics. Predominately minor complications such as back pain and post–dural puncture headache from neuraxial blockade have been reported in obstetric patients.[6] We used the database of the ASA Closed Claims Project to identify specific patterns of injury and legal liability associated with regional anesthesia, with a subset comparison between obstetric and nonobstetric neuraxial anesthesia claims. A detailed analysis was performed to examine factors associated with high-severity injuries such as death or brain damage, nerve injuries, and neuraxial complications.

Materials and Methods

The ASA Closed Claims Project is a structured evaluation of adverse anesthetic outcomes collected from the closed anesthesia malpractice insurance claim files of more than 35 professional liability companies throughout the United States. A detailed description of the data collection process has been previously reported.[7,8] In brief, anesthesiologist–reviewers completed a detailed data form plus narrative summary for each claim in which the sequence of events and nature of injury could be determined from the information available in the file. Claims for damage to teeth and dentures were excluded from data collection. Claims with inadequate information were also excluded and resulted in an approximate 27% file rejection rate of available claims for review before data collection. Severity of injury was assigned by the on-site reviewer using the insurance industry's 10-point scale, ranging from 0 (no apparent injury) to 9 (death). Severity scores were grouped into three broad categories for analysis: temporary injuries (score 0–4), permanent injuries (5–8), and death (9). Appropriateness of care was rated as standard (appropriate), substandard, or impossible to judge based on reasonable and prudent practice at the time of the event. The reliability of reviewer assessments of appropriateness of care has been found to be acceptable.[9] Amount of payment was

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adjusted to 1999 dollars using the Consumer Price Index.#

Claims in the ASA Closed Claims Project database are categorized according to damaging events and complications. The damaging event is the mechanism by which the complication (injury) occurs. Each claim is assigned a primary damaging event. Damaging events are grouped into broad categories based on the physiologic system or anesthesia technique implicated in the injury: respiratory system events, cardiovascular system events, regional block–related events, equipment problems, drug administration errors, other anesthesia events, surgical events or patient condition, and none or unknown. For this analysis, the following events were grouped as regional block–related damaging events: unintentional intravascular injection or absorption of local anesthetic, shearing or breaking of an epidural catheter, high block, inadequate analgesia from block, dural puncture, block needle trauma, block technique, and neuraxial cardiac arrest. *Neuraxial cardiac arrest* was defined as the sudden onset of severe bradycardia or cardiac arrest during neuraxial block with relatively stable hemodynamics preceding the event. Claims for injuries that could be reasonably attributed to a regional block (*e.g.*, epidural hematoma, epidural abscess, increased pain at the site of block administration) were grouped as block-related without further specification of the particular damaging event. Claims were categorized as dural puncture if there was descriptive evidence of dural puncture in the records or if the patient experienced a positional headache after a regional block. Nonspecific headache after an uneventful block with no return of cerebrospinal fluid was categorized as no damaging event, rather than dural puncture or block related. Claims with no obvious adverse occurrence during the anesthetic course were classified as no damaging event (*e.g.*, nerve injury unrelated to block administration or positioning/padding). Claims with a complicated anesthetic course in which the specific event leading to the complication could not be identified were classified as unknown damaging event.

Complications were defined as the physical or psychological injuries for which the patient (plaintiff) was seeking compensation. A claim could have multiple complications. In cases of brain damage followed by death, death was considered the complication. Nerve damage was assigned to injuries in which there were clinical, anatomical, or laboratory findings consistent with damage to discrete elements of the spinal cord or peripheral nervous system.[10] Pain syndromes such as low back pain or muscle aches that could not be linked to specific neuroanatomical lesions were not included as nerve injury but rather were grouped as other complications. Neuraxial complications were defined as temporary or permanent insults to the spinal cord or neuraxis, with or without nerve injury as defined above. For example, an epidural hematoma with paralysis was categorized as a neuraxial complication and nerve injury, whereas an epidural hematoma without any neurologic impairment was categorized as a neuraxial complication only. Permanent neurologic deficits for neuraxial complications included chronic back and leg pain, difficulty walking/lower extremity weakness, or complete paralysis.

Data for this report were derived from the current ASA Closed Claims Project database of 5,802 claims, with dates of claim occurrence from 1980 to 1999. Claims for unknown years of event (n = 88) and 1970s claims (n = 667) were excluded from analysis, leaving 5,047 claims for events that occurred in the 1980s and 1990s. For purposes of analysis and comparison, the inclusion criterion was any claim that involved regional anesthesia used for obstetric or nonobstetric procedures. Claims involving administration of both regional and general anesthesia were included in the regional anesthesia group if the complication resulted from administration of regional anesthesia (*e.g.*, postblock headache, epidural hematoma) but were excluded from the analysis if the complication resulted from the administration of general anesthesia (*e.g.*, difficult intubation, esophageal intubation). Claims involving eye blocks for ophthalmic surgery were included in the nonobstetric regional anesthesia group if the block was administered by an anesthesiologist. Claims resulting from eye blocks administered by surgeons (with monitored anesthesia care by the anesthesia personnel) were excluded from the analysis.

Exclusion criteria were (1) any claim which involved general anesthesia or monitored anesthesia care for obstetric or nonobstetric procedures, (2) claims for chronic and postoperative pain management (n = 360), and (3) obstetric claims involving only injuries to the infant (n = 131). Claims involving complications from regional blocks for treatment of pain in the immediate postoperative period were included in the regional anesthesia group if the regional block was placed preoperatively or intraoperatively but were excluded if the block was administered postoperatively. Obstetric claims involving only injuries to the infant were excluded to focus on complications directly affecting the patient receiving the regional anesthetic. Because obstetrics comprised such a significant percentage of regional anesthesia claims, neuraxial anesthesia claims were divided into obstetric and nonobstetric groups for purposes of comparison. The final analysis included a total of 1,005 regional anesthesia claims. Of the neuraxial anesthesia claims, 368 obstetric claims were compared to 453 nonobstetric claims. Obstetric claims with injury to the newborn were excluded from analysis of payment amounts.

Consumer Price Index Inflation Calculator. U.S. Department of Labor, Bureau of Labor Statistics. Available at: http://data.bls.gov/cgi-bin/cpicalc.pl. Accessed November 5, 2003.

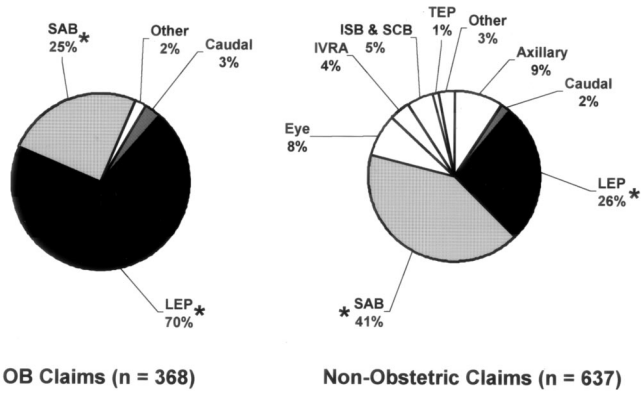

Fig. 1. Type of technique for regional anesthesia claims, 1980–1999: obstetric (OB) *versus* nonobstetric. Obstetric claims were associated with significantly more lumbar epidural blocks (LEPs) compared with nonobstetric claims ($P \leq 0.01$) and significantly fewer subarachnoid blocks (SABs) compared with nonobstetric claims ($P \leq 0.01$). ISB = interscalene block; IVRA = intravenous regional anesthesia; SCB = supraclavicular block; TEP = thoracic epidural block.

Statistical Analysis

For comparison of obstetric to nonobstetric regional anesthesia claims, differences in proportions were tested for statistical significance using the Z test.[11] Age differences and differences between hematoma symptom and diagnosis times were analyzed by t test. Differences in payment amounts were analyzed using the Kolmogorov-Smirnov test.

Results

Neuraxial Anesthesia Claims: Obstetric (n = 368) versus Nonobstetric (n = 453) Procedures

Obstetrics was associated with 368 (37%) of 1,005 regional anesthesia claims and significantly influenced the type of block associated with regional anesthesia claims (fig. 1). The obstetric group contained a higher proportion of obese, female patients with ASA physical status of I and II who were undergoing emergency surgery compared with the nonobstetric neuraxial anesthesia group (table 1; $P \leq 0.05$ for obesity, $P \leq 0.01$ for other demographics). Obstetric claims were associated with lumbar epidural anesthetics significantly more often (70% *vs.* 37%) and with subarachnoid blockade significantly less often (25% *vs.* 57%) than nonobstetric neuraxial claims ($P \leq 0.01$). Nearly half of the damaging events for both obstetric and nonobstetric neuraxial anesthesia claims were block related (table 2).

Death or Permanent Brain Damage in Neuraxial Anesthesia Claims: Obstetric (n = 57) *versus* Nonobstetric (n = 143). The proportion of neuraxial anesthesia claims with death or brain damage was significantly lower in the obstetric neuraxial anesthesia group compared with the nonobstetric group ($P \leq 0.01$; fig. 2). The most common damaging event for these high severity injuries in obstetric and nonobstetric groups was neuraxial cardiac arrest (n = 18, 32% and n = 55, 38%, respectively; fig. 3). Unintentional intravascular injection (n = 9, 16%) was the second most common damaging event in obstetric claims but accounted for only 2% (n = 3) of nonobstetric claims with high-severity outcome ($P \leq 0.05$). Other block-related damaging events in the obstetric and nonobstetric groups included high spinal–epidural blockade and regional block technique (5% *vs.* 6%, respectively; fig. 3). Non–block-related damaging events for obstetric (n = 27, 47%) and nonobstetric (n = 76, 53%) groups with death or brain damage included cardiovascular events, respiratory events, wrong drug or dose, surgical events/error or patient condition, and allergic reaction. Claims for death or brain damage in the

Table 1. Demographics of Neuraxial Anesthesia Claims: Obstetric *vs.* Nonobstetric, 1980–1999

	Obstetric Anesthesia (n = 368)		Nonobstetric Anesthesia (n = 453)
Age, yr			
Mean (SD)	28 (6)	*	53 (19)
Range	15–44		0.25–94
	[No. (% of 368)]		[No. (% of 453)]
ASA physical status			
I, II	225 (61%)	*	217 (48%)
III–V	19 (5%)	*	112 (25%)
Sex			
Female	368 (100%)	*	231 (51%)
Male	0	*	221 (49%)
Obesity	94 (26%)	†	84 (19%)
Emergency	126 (34%)	*	47 (10%)

ASA = American Society of Anesthesiologists.

* $P \leq 0.01$ and † $P \leq 0.05$ between obstetric and nonobstetric regional anesthesia groups. Percentages do not sum to 100% because of missing data (not shown).

Table 2. Primary Damaging Events in Obstetric *vs.* Nonobstetric Neuraxial Anesthesia Claims, 1980–1999

	Obstetric (n = 368), No. (%)		Nonobstetric (n = 453), No. (%)
Block related	187 (51%)	*	186 (41%)
Block technique	62 (17%)		84 (19%)
Neuraxial cardiac arrest	20 (5%)	*	61 (13%)
Inadequate anesthesia/analgesia	40 (11%)	*	7 (2%)
High spinal–epidural	21 (6%)		19 (4%)
Epidural–spinal catheter	27 (7%)	*	8 (2%)
Unintentional intravenous injection	17 (5%)		7 (2%)
Other anesthetic event	58 (16%)		51 (11%)
No event	55 (15%)		75 (17%)
Unknown	25 (7%)		33 (7%)
Surgical event	14 (4%)		19 (4%)
Cardiovascular event	9 (2%)	*	36 (8%)
Respiratory event	9 (2%)	*	30 (7%)
Wrong drug or dose	8 (2%)		15 (3%)
Equipment	3 (1%)		5 (1%)
Multiple events	0		3 (1%)

* $P \leq 0.01$ between obstetric and nonobstetric regional anesthesia groups. Surgical events include complications of surgical technique or patient condition, with no anesthetic contribution to the complication.

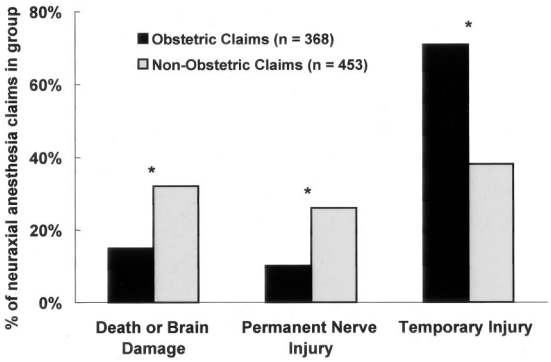

Fig. 2. Outcomes in neuraxial anesthesia: obstetric *versus* nonobstetric claims, 1980–1999. Claims for obstetric and nonobstetric neuraxial anesthesia were grouped according to severity of injury: temporary, permanent nerve injury, and death or brain damage. The proportion of death or brain damage (15% *vs.* 32%) and the proportion of permanent nerve injury claims (10% *vs.* 26%) were lower in the obstetric neuraxial claims compared with the nonobstetric group, respectively. The proportion of temporary injury claims was higher in the obstetric neuraxial group compared with the nonobstetric group (71% *vs.* 38%, respectively). Other permanent injuries accounted for 4% (n = 13) of obstetric neuraxial claims and 4% (n = 20) of nonobstetric claims (data not shown). * $P \leq 0.01$.

obstetric neuraxial anesthesia group involved lumbar epidural blocks in a higher proportion of claims compared with the nonobstetric group (n = 37, 65% *vs.* n = 44, 31%, respectively; $P \leq 0.01$).

Neuraxial cardiac arrest claims comprised the largest single category of obstetric and nonobstetric regional anesthesia claims with death or brain damage. Fifty claims associated with neuraxial cardiac arrest were from the 1980s, and 31 claims were from the 1990s. The mean age for all neuraxial cardiac arrest claims was 42 yr, and approximately half of the claims were of ASA physical status I or II. No significant difference existed between decades for age or ASA status. Obstetrics was associated with 18% of the 1980s claims compared with 35% of the 1990s claims. The majority of nonobstetric neuraxial cardiac arrest claims in both the 1980s and the 1990s were associated with surgical procedures in the lower extremity or the pelvis.

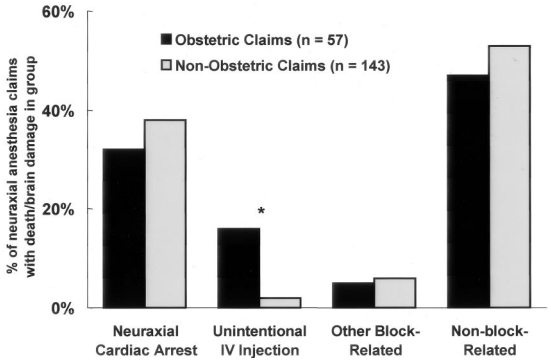

Fig. 3. Obstetric *versus* nonobstetric neuraxial anesthesia death or brain damage, 1980s and 1990s: primary damaging events. Other block/anesthesia-related events included high spinal/epidural block and regional block technique. Non–block-related events for obstetric (n = 27) and nonobstetric (n = 76) neuraxial anesthesia claims associated with death or brain damage included cardiovascular event (such as pulmonary/air/amniotic embolus, stroke, hypotension, myocardial infarction), n = 7 (obstetric) *versus* n = 29 (nonobstetric); respiratory event (such as inadequate ventilation, airway obstruction, bronchospasm, aspiration), n = 8 (obstetric) *versus* n = 27 (nonobstetric); wrong drug or dose, n = 2 (obstetric) *versus* n = 5 (nonobstetric); surgical event/error or patient condition, n = 6 (obstetric) *versus* n = 3 (nonobstetric); allergic reaction, n = 2 (obstetric) *versus* n = 3 (nonobstetric); and miscellaneous causes, n = 2 (obstetric) *versus* n = 9 (nonobstetric). * $P \leq 0.05$.

Ninety percent (n = 73) of claims for neuraxial cardiac arrest resulted in death or permanent brain damage, with no significant differences in severity of injury between decades or between obstetric and nonobstetric groups. Regional technique in all neuraxial cardiac arrest claims was predominately associated with subarachnoid blockade (n = 57, 70%). Lumbar epidural (n = 20, 25%), caudal epidural (n = 2, 2%), thoracic epidural (n = 1, 1%), and combined subarachnoid–epidural (n = 1, 1%) accounted for the remainder of regional techniques. Of the 21 neuraxial cardiac arrest claims involving lumbar or thoracic epidurals, 11 (52%) were associated with an unintentional subarachnoid block. Therefore, a total of 68 of 81 neuraxial cardiac arrest claims (84%) had either intentional or unintentional subarachnoid block.

Associated factors for neuraxial cardiac arrest claims were examined for the 1990s (n = 31) when both capnography and pulse oximetry monitoring were included in the ASA standards for intraoperative monitoring. Pulse oximetry was used in 45% of the 11 obstetric neuraxial cardiac arrest claims compared with 90% of the 20 nonobstetric claims ($P \leq 0.05$), and capnography was used in 36% of obstetric claims compared with 35% of nonobstetric claims. Sedation was not administered in any obstetric claims but was given in 80% of the nonobstetric claims ($P \leq 0.01$). Eighty-two percent (n = 9) of obstetric cases occurred outside the operating room compared with 10% (n = 2) of nonobstetric cases ($P \leq 0.01$). Recognition of neuraxial cardiac arrest was delayed in 55% of obstetric claims (n = 6) and 10% of nonobstetric claims (n = 2; $P \leq 0.05$). Of these 8 cases of late recognition, 4 were associated with an unintentional subarachnoid block. Resuscitation was delayed in 91% (n = 10) of obstetrics claims compared with 45% of nonobstetric claims (n = 9; $P \leq 0.01$), as judged by two or more ASA Closed Claims Project Committee reviewers.

The other major category of neuraxial anesthesia claims resulting in death or brain damage was unintentional intravenous injection. Of these 12 cases, 11 occurred in the 1980s, and only 1 occurred in the 1990s. The anesthetics involved were all epidural blocks (9 lumbar and 3 caudal), and the majority of claims (75%) were associated with obstetrics. Nine of these 12 cases resulted in cardiac arrest. Test doses were used in 83% of these blocks, and only 30% of the test doses contained epinephrine.

Table 3. Standard of Care and Payment Factors: Regional Anesthesia Claims, 1980–1999*

Claim Group (n)	% Less than Appropriate Care	% Claims with Payment	Median Payment (Range), $
Neuraxial anesthesia			
Death/brain damage			
Obstetric (42)	48	81	912,597 (10,370–6,405,000)
Nonobstetric (143)	45	58	381,000 (8,400–6,360,000)
Permanent nerve injury			
Obstetric (36)	25	56	183,500 (617–1,246,400)
Nonobstetric (117)	31	56	143,250 (627–2,043,500)
Temporary injury			
Obstetric (256)	16	29	20,145 (955–558,333)
Nonobstetric (172)	23	29	19,505 (245–1,238,250)
Eye blocks			
Permanent injury (37)	19	78	127,500 (13,352–595,000)
Temporary injury (8)	0	38	30,500 (11,200–30,500)
Peripheral nerve blocks			
Death/brain damage (15)	67	80	393,750 (54,900–2,380,000)
Permanent nerve injury (39)	23	38	113,900 (6,929–359,375)
Temporary (78)	14	31	13,243 (630–127,300)

* Claims with injury to the newborn (n = 22) were excluded from the obstetric group. Payments were adjusted to 1999 dollars. No significant differences between obstetric and nonobstetric groups were found for standard of care, percent of claims with payment, or payment amounts.

There was no significant difference between the proportion of obstetric and nonobstetric death or brain damage claims in standard of care or payment to the plaintiff (table 3). When neuraxial anesthesia claims with newborn injury were excluded, the median payment for obstetric claims was not significantly different than that for nonobstetric claims.

Permanent Nerve Injuries in Neuraxial Anesthesia Claims: Obstetric (n = 37) *versus* Nonobstetric (n = 117). Permanent nerve injuries (paraplegia, quadriplegia, peripheral nerve injuries) were significantly less common in the obstetric group (10%, n = 37) compared with the nonobstetric group (26%, n = 117; $P \leq 0.01$; fig. 2 and table 4). Lumbosacral nerve root damage and paraplegia were the most common injuries encountered in both groups. Ulnar nerve and femoral/sciatic nerve damage were the next most common injuries in nonobstetric claims.

Injuries of the Neuraxis. Hematoma accounted for 43% of the 84 complications of the neuraxis in regional anesthesia claims and resulted in permanent neurologic deficit in 89% of these cases (table 5). Other types of neuraxial injury with poor recovery of function were anterior spinal artery syndrome, spinal cord infarct, and other/unknown causes. Neuraxial injuries from epidural abscess or herniated disc resulted in permanent neurologic deficit less frequently. Hematoma cases (n = 36) were associated with vascular (56%), orthopedic (22%), general surgery (11%), obstetrics (8%), and urologic procedures (3%). Neuraxial injuries that were not associated with hematoma (n = 48) occurred in obstetrics (48%), orthopedic (19%), urologic (15%), vascular (13%), and general surgical (6%) procedures. Hematoma accounted for a significantly smaller proportion ($P \leq 0.01$) and epidural abscess accounted for a greater proportion ($P \leq 0.05$) of obstetric neuraxial complications compared with nonobstetric claims. If epidural abscess and meningitis claims were combined, infection was the leading cause of obstetric neuraxial complications (46%).

Combined analysis of obstetric and nonobstetric neuraxial claims associated with hematoma (n = 36) revealed that almost three fourths of these claims (n = 26) had evidence of either an intrinsic (one obstetric claim with severe preeclampsia) or iatrogenic coagulopathy (table 6). Six of the remaining 10 cases, including 2 obstetric cases, without a coagulopathy showed signs of trauma in the cord above L1. Increased motor block was present in a higher proportion of hematoma claims (83%) compared with back pain (25%). The mean number of days for diagnosis (postoperative day 2) was longer than the mean number of days for appearance of initial symptoms (postoperative day 1; $P \leq 0.05$). No significant differences were found in standard of care, proportion of payment, or payment amount between the proportion of obstetric and nonobstetric neuraxial anesthesia claims with permanent nerve injury (table 3).

Table 4. Permanent Nerve Injuries in Obstetric *vs.* Nonobstetric Neuraxial Anesthesia Claims, 1980–1999

	Obstetric (n = 37), No. (%)	Nonobstetric (n = 117), No. (%)
Lumbosacral nerve root	19 (51)	47 (40)
Paraplegia	8 (22)	41 (35)
Brachial plexus	2 (5)	1 (1)
Ulnar nerve	1 (3)	10 (9)
Femoral/sciatic nerves	1 (3)	12 (10)
Radial nerve	0	1 (1)
Other	6 (16)	5 (4)

No significant differences were found between obstetric and nonobstetric neuraxial anesthesia groups.

Table 5. Injuries to the Neuraxis in Regional Anesthesia Claims, 1980–1999 (n = 84)

	Obstetric (n = 26), No. (% Cases)		Nonobstetric (n = 58), No. (% Cases)	No. Cases Permanent Neurologic Deficit/Total (OB + Non-OB) (% Cases‡)
Hematoma	3 (12)	*	33 (57)	32/36 (89)
Unknown	4 (15)		9 (16)	12/13 (92)
Anterior spinal artery syndrome	2 (8)		3 (5)	4/5 (80)
Meningitis	6 (23)	†	2 (3)§	1/8 (13)
Spinal cord infarct	2 (8)		3 (5)	5/5 (100)
Abscess	6 (23)	†	2 (3)	2/8 (25)
Herniated disc	2 (8)		3 (5)	1/5 (20)
Other causes‖	1 (4)		4 (7)	4/5 (80)

* $P \leq 0.01$ and † $P \leq 0.05$ for obstetric *vs.* nonobstetric regional claims. ‡ % cases refers to percent of cases for each type of neuraxial complication. § In one patient with meningitis and permanent nerve injury, osteomyelitis and abscess developed. ‖ Other causes include cervical fracture after fall from table, arachnoiditis, transverse myelitis, intrathecal catheter, and direct needle trauma without hematoma.

Non-OB = nonobstetric; OB = obstetric.

Temporary Injuries in Neuraxial Anesthesia Claims: Obstetric (n = 260) *versus* Nonobstetric (n = 172). Temporary injury (headache, back pain, temporary nerve damage, and others) was associated with a higher proportion of obstetric neuraxial anesthesia claims (71%) compared with nonobstetric claims (38%; $P \leq 0.01$; fig. 2). The most common temporary injuries in obstetric patients were headache (32%), back pain (22%), nerve damage (17%), inadequate analgesia (17%), and emotional distress (13%). The most common temporary injuries in nonobstetric patients were nerve damage (30%), headache (22%), back pain (18%), emotional distress (10%), and inadequate analgesia (3%). A significantly greater proportion of obstetric claims were associated with inadequate analgesia ($P \leq 0.01$) and headache ($P \leq 0.05$) compared with nonobstetric claims. A significantly smaller proportion of obstetric claims were associated with nerve damage compared with nonobstetric claims ($P \leq 0.01$). Standard of care, proportion of payment, and payment amount were not different between the obstetric and nonobstetric groups (table 3).

Eye Injuries Associated with Regional Anesthesia Claims (n = 48)

Eye injuries after regional anesthesia performed by anesthesiologists accounted for 5% of all regional anesthesia claims. Thirty-nine of these 48 claims (81%) were for cataract extraction with or without intraocular lens implant; 6 claims (13%) were for other or unknown eye surgery, and 3 claims (6%) were for nonocular procedures involving the use of lumbar epidurals (2 claims for visual deficits after epinephrine administration causing malignant hypertension and resultant visual deficits during lumbar epidural anesthesia and 1 claim for a cerebrovascular accident causing visual deficits with postoperative lumbar epidural analgesia). Ten claims from the 1980s and 35 claims from the 1990s were associated with eye surgery ($P \leq 0.01$). Among the 45 eye surgery claims with regional anesthesia, 29 (64%) were performed with retrobulbar blocks, 12 (27%) were performed with peribulbar blocks, and 4 (9%) were performed with other or unspecified eye blocks. Injuries were permanent in 37 claims (82%) and temporary in 8 claims (18%). Blindness occurred in 28 claims (62%). The damaging events for eye surgery claims were primarily from regional block technique (n = 40, 89%), rather than patient movement (n = 3, 7%). There was no identifiable damaging event in 2 claims (4%). Payment to the plaintiff occurred in claims associated with permanent injury more often than claims with temporary injury. Claims judged with less than standard care were all associated with permanent injury (table 3).

Regional Anesthesia Claims Associated with Peripheral Nerve Blocks (n = 134)

Peripheral nerve blocks accounted for 13% of all regional anesthesia claims, and 21% of nonobstetric regional anesthesia claims. Axillary blocks were used in

Table 6. Associated Factors for Epidural/Spinal Hematoma in Regional Anesthesia Claims, 1980–1999 (n = 36)*

Factor	No. (% of 36)
Any coagulopathy	26 (72)
Intraoperative heparin	20 (56)
Preoperative anticoagulant therapy	8 (22)
Postoperative anticoagulant therapy	8 (22)
Antiplatelet therapy ± subcutaneous heparin	3 (8)
Low-molecular/weight heparin	2 (6)
Intrinsic coagulopathy	2 (6)
Catheter removed on anticoagulation	6 (17)
Needle trauma above L1	6 (17)
Symptoms	
Increased motor block	30 (83)
Increased sensory block	21 (53)
Back pain	9 (25)
Symptom onset, mean	Postoperative day 1 (range, 0–3)
Time of diagnosis, mean†	Postoperative day 2 (range, 0–5)

* Three of 36 hematoma cases were from the obstetrics group: 1 case with severe preeclampsia and 2 cases with evidence of needle trauma above L1.
† $P \leq 0.05$ for symptom onset *vs.* time of diagnosis (*t* test).

the majority of peripheral blocks (44%), followed by intravenous regional blocks (21%), interscalene blocks (19%), and supraclavicular blocks (7%). The damaging event was block related in 51% of peripheral block claims (47% block technique, 2% unintentional intravenous injection, 1% delayed absorption of local anesthetic, 1% high block from inadvertent intrathecal injection, and 1% inadequate analgesia).

Death or brain damage was associated with 11% (n = 15) of peripheral block claims and included 5 interscalene blocks, 3 axillary blocks, 3 intravenous regional blocks, and 4 miscellaneous blocks. Damaging events in these high severity injury claims were block technique (n = 3), wrong drug or dose (n = 3), allergic reaction (n = 2), inadequate ventilation (n = 2), high block (n = 1), delayed absorption of local anesthetic (n = 1), difficult intubation (n = 1), no event (n = 1), and unknown (n = 1).

Permanent nerve damage was associated with 29% (n = 39) of peripheral block claims (14% brachial plexus damage, 10% median nerve, 4% ulnar nerve, 1% radial nerve, and 1% femoral/sciatic nerves) and temporary injury with 58% of claims (30% nerve damage, 10% pneumothorax, 2% emotional distress, 2% inflammatory skin reaction, and 14% miscellaneous causes). Three claims of unintentional intravenous injection resulted in temporary or low-severity injury. Claims with an outcome of death or permanent brain damage had the highest percentage of less than appropriate care, the highest percentage of claims with payment made to the plaintiff, and the highest median payment (table 3).

Discussion

The damaging events in almost half of obstetric and nonobstetric neuraxial anesthesia cases in the ASA Closed Claims database were block related. Obstetric neuraxial anesthesia claims had a significantly greater proportion of claims associated with temporary and low-severity injuries compared with nonobstetric claims. Approximately half of high-severity claims in both groups were block-related complications predominately from neuraxial cardiac arrest and unintentional intravenous injection. Permanent nerve injuries such as lumbosacral nerve root injuries and paraplegia accounted for a significantly lower proportion of obstetric neuraxial anesthesia claims compared with nonobstetric claims. Eye injuries, which were predominately block related, comprised 5% of the regional anesthesia claims and usually resulted in permanent injury.

Limitations of the ASA Closed Claims Database

The analysis of data collected from the ASA Closed Claims Project has several limitations that have been described previously.[7,12] The database does not contain claims on all adverse anesthetic events, nor does it have any denominator data on how many anesthetics are performed per year. Consequently, estimates of risk for specific regional anesthesia procedures or populations cannot be made. Other limitations include the nonrandom, retrospective collection of data provided partially by direct participants instead of impartial observers; the bias toward substandard care designations for poor outcomes; and changing anesthetic practice and standards during the 20-yr time span for this data. Despite these limitations, the ASA Closed Claims database provides useful information on large numbers of rare adverse events that are not amenable to prospective study from single centers.

Neuraxial Anesthesia Claims

Death and Permanent Brain Damage Claims. In the overall database of the Closed Claims Project, non–block-related damaging events accounted for almost half of claims associated with death or brain damage. Cardiovascular and respiratory damaging events accounted for the majority of these high-severity non–block-related events during obstetric and nonobstetric neuraxial anesthesia. Cardiovascular events include emboli, myocardial infarction, hypotension, and stroke. Respiratory events in the high-severity regional anesthesia claims were predominately a result of inadequate ventilation that was not caused by the block.

Neuraxial Cardiac Arrest. Neuraxial cardiac arrest accounted for approximately one third of obstetric and nonobstetric neuraxial anesthesia claims associated with death or brain damage. Outcomes for this complication in the ASA Closed Claims database were poor, with 90% of all cases resulting in death or brain damage. Twenty percent of these cases from the 1980s (10 of 50 claims) were reported in the 1988 article of Caplan *et al.*[13] describing the first series of 14 neuraxial cardiac arrest cases from the ASA Closed Claims Database. Only one of these 14 patients recovered neurologic function sufficiently to provide independent self-care. Cyanosis was noted as the first sign of cardiac arrest in six of seven patients who were sedated to a level of verbal nonresponsiveness and prompted the recommendation that pulse oximetry should be used routinely when sedation is administered with neuraxial anesthesia. Other recommendations from this article included early use of epinephrine in the treatment of sudden severe bradycardia with neuraxial anesthesia, and immediate administration of a full resuscitation dose of epinephrine if cardiac arrest ensued.

Despite these recommendations and the widespread availability of capnography and pulse oximetry in the 1990s, outcome for neuraxial cardiac arrest was not significantly different between the 1980s and 1990s claims in our database. This result may reflect the lack of denominator data for all neuraxial cardiac arrest cases

and the bias for poorer outcome cases to result in claims. Pulse oximetry was used in less than half of obstetric claims in the 1990s associated with neuraxial cardiac arrest and almost all nonobstetric claims. However, no difference in severity of injury was detected between groups (death or brain damage occurred in 91% of 1990s obstetric claims *vs.* 85% of nonobstetric claims). Capnography was used in approximately one third of obstetric and nonobstetric claims. Lack of prevention of this complication with monitoring is most likely a result of at least two factors. First, delays in recognition of neuraxial cardiac arrest and implementation of resuscitation still occur. Second, the rapid and sudden onset of bradycardia/asystole without preceding arterial desaturation in many patients may not allow sufficient time for appropriate treatment before full cardiac arrest ensues.[14,15] Most of the cases that were not monitored occurred outside the operating room (*e.g.*, obstetric ward) where pulse oximetry is not routinely used in a continuous fashion, capnography is rarely used, and resuscitation equipment and drugs may not be readily available.

Recovery from neuraxial cardiac arrest without sequelae has been reported in many case studies when therapy is promptly instituted.[14,16] However, patients may be refractory to treatment, even when it is initiated in a timely manner, because of the local anesthetic–induced intense sympathetic blockade, which reduces circulating blood volume and may also cause a defective neuroendocrine response to stress.[17,18] In the 1990s neuraxial arrest claims, 39% of cases had appropriate treatment with epinephrine but sustained a poor outcome. These results indicate that even early administration of epinephrine may not guarantee a good outcome during neuraxial cardiac arrest.

Unintentional Intravenous Injections. Unintentional intravenous injections were the second largest category of neuraxial anesthesia claims that were block related and associated with death or brain damage. The anesthetics involved were predominately lumbar or caudal epidural blockade for obstetrics. No cases of direct intravascular injection during peripheral blockade were identified for claims associated with death or brain damage. Although the prospective studies of complications associated with regional anesthesia in France demonstrated a higher frequency of unintentional intravenous injections during peripheral blockade compared with neuraxial anesthetics, these complications were associated with seizures only, not death or permanent brain damage.[1,2] Transient seizures without significant sequelae would be less likely to result in claims and may partially explain why there are only three peripheral nerve blocks with unintentional intravenous injection in the database. It is likely that obstetric patients are less able to recover from the hemodynamic consequences of unintentional intravenous injection than nonobstetric patients, thus resulting in more claims for death or permanent brain damage associated with this complication. Alternatively, obstetric patients may have a greater likelihood of sustaining an unintentional intravenous injection compared with nonobstetric patients because of dilated epidural veins during labor. The relatively infrequent use of epinephrine in test doses in these claims (25%) is striking, but its utility in obstetrics continues to be controversial.[19,20]

Permanent Nerve Injuries.

Injuries to the Neuraxis. The majority of neuraxial complications associated with regional anesthesia claims resulted in permanent neurologic deficits (table 5). However, complications caused by meningitis, abscesses, or herniated discs usually demonstrated good recovery. Hematoma was the most common cause of neuraxial injuries, and the majority (72%) of these cases were associated with either intrinsic or iatrogenic coagulopathy. These results are consistent with the review of the literature by Vandermeulen *et al.*[21] in which they found that 42 of 61 neuraxial hematomas (68%) were associated with impaired coagulation. Intraoperative anticoagulation for vascular surgery was used in more than half of the neuraxial hematoma claims and was combined with other medications that can impair coagulation (aspirin, urokinase, ketorolac, dextran, coumadin, and subcutaneous heparin) either preoperatively or postoperatively in three claims. Low-molecular-weight heparin was used in only 2 cases of neuraxial hematoma, but this small number of cases may reflect the 3- to 5-yr time lag for claims to be settled and entered into the ASA Closed Claims database. Intrinsic coagulopathy was present in only 2 cases.

The benefits of regional anesthesia, particularly for peripheral vascular surgery with reduced graft thrombosis and improved graft blood flow, have been described in several reports.[22–24] In addition, the low frequency of epidural hematomas in regional anesthesia for vascular surgery with anticoagulation has also been demonstrated in three studies with no epidural hematomas reported in approximately 6,000 patients cumulatively.[25–27] A risk–benefit assessment of neuraxial anesthesia in an anticoagulated patient should be made preoperatively with appropriate informed consent. Although many studies and texts state that back pain is the cardinal symptom of an epidural hematoma, our data and several other studies demonstrate that an increased motor block out of proportion to the infused local anesthetic is the most common presenting symptom.[21,28] Back pain may be less prominent in the presence of a local anesthetic, opiate infusion, or both. Other symptoms include increased sensory block and bowel and bladder dysfunction. The critical factor for a favorable outcome with epidural hematoma is time to treatment with decompression of the spinal cord. Improved surveillance for this complication, especially in patients who were anticoagulated at any time during a neuraxial anesthetic, and emergent

diagnostic workup and treatment may decrease the number of epidural hematoma cases with permanent neurologic injury.

Four cases of epidural/spinal hematoma after subarachnoid block had evidence of needle trauma in the thoracic region, and one case of thoracic epidural hematoma resulted after a labor epidural. Studies demonstrating considerable anatomical variability between patients in the location of the end of the spinal cord (T12–L3),[29] as well as the variability in the iliac crest alignment with lumbar interspaces (L3–L4 to L5–S1),[29,30] may partially explain some of these injuries. Body habitus may further complicate correct identification of lumbar interspaces. Given these limitations, placement of spinal anesthetics at the lowest interspace possible might decrease the number of spinal cord injuries caused by direct needle trauma.

Temporary Injuries. The majority of claims in the obstetric neuraxial anesthesia group were associated with temporary injuries. A higher proportion of minor injuries for headache, back pain, inadequate analgesia, and emotional distress were present in obstetric patients compared with nonobstetric patients. In contrast, a lower proportion of claims were associated with nerve damage in the obstetric group (17%) compared with the nonobstetric group (36%). These differences in the types of claims between obstetric and nonobstetric groups may partially be explained by the physiology of young laboring women who are at high risk for post–dural puncture headache and back pain.[31,32] Moreover, the higher proportion of claims for inadequate analgesia may partially result from the limitations in administering supplemental systemic anesthesia in the obstetric population. The relatively high proportion of claims for minor injuries in the obstetric group may also reflect an "idealized" and unrealistic expectation of the pregnant patient that childbirth is a beautiful experience, compared with the group of nonobstetric patients who primarily receive anesthesia for surgery for pathologic conditions.

Eye Injuries

The proportion of regional anesthesia claims associated with eye blocks increased from 2% in the 1980s to 7% in the 1990s. These injuries were usually permanent and related to the block technique, and more than half of the claims resulted in blindness. Almost all of these claims involved retrobulbar or peribulbar blocks performed by anesthesiologists. Topical anesthesia as the sole anesthetic for cataract removal is becoming more common and may make these complications less frequent.

Conclusions

In summary, almost half of all regional anesthesia claims are block related, but the majority of obstetric claims are associated with temporary or low-severity injury. Eye blocks emerged as a new source of permanent injury in the 1990s. Block-related complications such as neuraxial cardiac arrest and neuraxial hematomas associated with coagulopathy continue to result in serious morbidity and mortality. Significant delays from symptom onset to diagnosis contributed to poor neurologic outcome for neuraxial hematomas. These data highlight the importance of perioperative vigilance and monitoring of patients undergoing regional anesthesia.

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