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Nerve Injury Associated with Anesthesia

Donald A. Kroll, M.D., Ph.D., Robert A. Caplan, M.D.,† Karen Posner, Ph.D.,‡ Richard J. Ward, M.D., M.Ed.,§ Frederick W. Cheney, M.D.¶*

The authors examined the American Society of Anesthesiologists Closed Claims Study database to define the role of nerve damage in the overall spectrum of anesthesia-related injury that leads to litigation. Of 1,541 claims reviewed, 227 (15%) were for anesthesia-related nerve injury. Ulnar neuropathy represented one-third of all nerve injuries and was the most frequent nerve injury. Less-frequent sites of nerve injury were the brachial plexus (23%) and the lumbosacral nerve roots (16%). In a large proportion of cases, the exact mechanism of injury was unclear despite evidence of intensive investigation in the claim files. Median payment for nerve damage claims involving disabling injury was $56,000, which was significantly lower than the $225,000 median payment for claims for disabling injury not involving nerve damage ($P < 0.01$). The closed claims reviewers judged that the standard of care had been met significantly more often in claims involving nerve damage than in claims not involving nerve damage. The authors conclude that nerve damage is a significant source of anesthesia-related claims but that the exact mechanism of nerve injury is often unclear. In particular, ulnar nerve injuries seemed to occur without identifiable mechanism. (Key words: Complications, nerve injury: brachial plexus, ulnar. Medicolegal: professional liability.)

PERIOPERATIVE NERVE injuries have long been recognized as a complication of anesthesia.[1–3] Although purported etiologic factors have been well described,[4–6] these injuries continue to be reported and result in malpractice claims for pain, suffering, and economic damage. For the past 4 yr the Committee on Professional Liability of the American Society of Anesthesiologists (ASA) has been conducting a study of closed malpractice claims related to anesthetic care.[7] This study affords a new opportunity to examine the spectrum of peripheral nerve injuries from the standpoint of predisposing factors, severity of injury, outcome, cost, and role of substandard care. The present report is based on 227 cases of nerve injury for which a claim of malpractice was filed against the anesthesia care provider.

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Methods

The ASA Closed Claims Study is a structured evaluation of anesthetic injuries obtained from professional liability insurance company closed claims files. Cases were collected from 20 insurance organizations throughout the United States and the data were retrieved by practicing anesthesiologists who reviewed the claims according to a detailed set of instructions. Twenty-four anesthesiologists, of whom 23 were board certified, participated in the claims review. Five came from private practice, ten from academic practice, and the remainder were in private practice with teaching responsibilities. This report uses the total database of 1,541 claims accrued as of May 1989. Ninety-two percent of cases occurred between 1975 and 1985. Details of the methods have been reported elsewhere[7] but are summarized here.

To collect data, one or more anesthesiologists visited each insurance company office to review all files for claims against anesthesiologists. Each claim was reviewed by one anesthesiologist on site. Claims for dental injury were excluded. A standardized data collection instrument was completed for claims in which there was enough information to reconstruct the sequence of events, the nature of the injury, and how the actions of the caretakers were linked to the damage that occurred. Typically, a closed claim file consists of the hospital record, the anesthesia record, narrative statements of the involved health care personnel, expert and peer reviews, deposition summaries, outcome reports, and the cost of settlement or jury award. The case summaries included detailed information on pa-

* Assistant Professor, Department of Anesthesiology, UCLA School of Medicine.

† Clinical Associate Professor, Department of Anesthesiology, Virginia Mason Medical Center.

‡ Health Systems Analyst, Department of Anesthesiology, University of Washington School of Medicine.

§ Professor, Department of Anesthesiology, University of Washington School of Medicine.

¶ Professor, Department of Anesthesiology, University of Washington School of Medicine; Chairman, Committee on Professional Liability, American Society of Anesthesiologists.

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Address reprint requests to Dr. Cheney: Department of Anesthesiology, RN-10, University of Washington School of Medicine, Seattle, Washington 98195.

tient characteristics (age, sex, weight, and physical status), date of incident, surgical procedure, personnel involved, anesthetic records, consent, monitors employed, anesthetic techniques and agents, critical incidents, clinical clues, complications (outcomes), whether a lawsuit was filed, and the amount of award or settlement. Each claim was assigned a severity of injury score (SIS) by the on-site reviewer using the insurance industry's ten-point scale (table 1).[8] Reviewers wrote a brief summary of each case that summarized the sequence of events and provided additional details. Each reviewer also assessed the overall appropriateness of anesthetic care and its contribution to the adverse outcome. Care was rated by the on-site reviewer as standard (appropriate), substandard (inappropriate), or impossible to judge based upon reasonable and prudent practices at the time of the event. The Closed Claims Study Committee consisting of three practicing anesthesiologists reviewed and approved the on-site reviewer's assessment of the standard of care.[7] Reviewers' judgments were overruled by the Committee in 3% of the cases.

The term "nerve damage" was used to describe injuries in which there were clinical, anatomic, or laboratory findings consistent with damage to discrete elements of the spinal cord or peripheral nervous system. Typical findings included sensory and motor changes following recognized neuroanatomic distributions, electrophysiologic data from nerve conduction studies or electromyography, and surgical descriptions of adhesion or entrapment of nerve structures. Nonspecific pain syndromes (*e.g.*, low back pain, muscle aches, jaw soreness) that could not be linked with specific neuroanatomic lesions were not included in the category of nerve damage. Brain damage and vocal cord palsies were coded separately.

TABLE 1. Severity of Injury Scoring System (SIS)

Severity Scale	Examples
0 No obvious injury	
1 Emotional only	Fright, awake during anesthetic, pain during anesthetic
Temporary	
2 Insignificant	Lacerations, contusions, no delay in recovery
3 Minor	Fall in hospital, recovery delayed (extra time in recovery room or hospital)
4 Major	Brain damage, nerve damage, unable to work, prolonged hospitalization
Permanent	
5 Minor	Damage to organs, nondisabling injuries
6 Significant	Loss of eye, deafness, loss of one kidney or lung
7 Major	Paraplegia, loss of use of limb, blindness, brain damage
8 Grave	Severe brain damage, quadraplegia, lifelong care or fatal prognosis
9 Death	

TABLE 2. Claims for Nerve Injury

Nerve	Number of Claims	Percent of 227
Ulnar	77	34
Brachial plexus	53	23
Lumbosacral nerve root	36	16
Spinal cord	13	6
Sciatic	11	5
Median	9	4
Radial	6	3
Femoral	6	3
Multiple Nerves*	5	2
Other Nerves*	11	5
Total	227	100%

* Includes phrenic, pudendal, perineal, seventh cranial nerve, long thoracic, optic nerves, and unspecified other nerves, each with a frequency of <1%.

The proportion of nerve damage claims and claims for specific nerve injuries having a particular characteristic (*e.g.*, regional anesthesia, substandard care) were compared to the proportion of non-nerve damage claims with that characteristic by calculation of confidence intervals according to the method suggested by Fleiss.[9] Comparisons of severity of injury and payment data were made using the Kolmogorov-Smirnov test. The two-sample median test was used to compare payments between nerve damage and non-nerve damage claims within specific severity of injury groups as the samples were too small for the Kolmogorov-Smirnov test. Two-tailed tests and a significance level of 0.05 were used throughout.

Results

Nerve injury occurred in 227 patients (15%) of the total 1,541 claims. There were 232 nerve injuries in these 227 patients. The distribution of these claims is shown in table 2. Ulnar neuropathies were the most frequent, followed by injuries to the brachial plexus and lumbosacral nerve roots (table 2). Spinal cord injuries and isolated median and radial nerve injuries were much less common, as were injuries to the femoral and sciatic nerves. A wide variety of injuries, each with a frequency of 1% or less, accounted for another 7% of claims for nerve injury.

Nerve damage claims were filed in equal proportions by men (48%) and women (49%) (table 3). This differs from non-nerve damage claims, which were filed predominantly by females (60%, $P < 0.05$). Claims for ulnar nerve damage were more often filed by males (69%) compared with claims for non-nerve damage ($P < 0.01$). Claims for brachial plexus and lumbosacral nerve root injuries were filed mostly by females (table 3).

General anesthesia was the primary technique used in patients filing in 138 (61%) of the 227 nerve damage claims, while regional anesthesia was used in 82 (36%) of

TABLE 3. Distribution of Injury by Gender

	Male	Female	Unknown
Nerve damage (n = 227)	108 (48%)*	112 (49%)*	7 (3%)
Non-nerve damage (n = 1,314)	504 (38%)	790 (60%)	20 (2%)
Ulnar (n = 77)	53 (69%)†	19 (25%)†	5 (6%)
Brachial plexus (n = 53)	19 (36%)	32 (60%)	2 (4%)
Lumbosacral nerve root (n = 36)	10 (28%)	26 (72%)	0
Other nerves (n = 61)	26 (43%)	35 (57%)	0

* $P < 0.05$ compared with non-nerve damage.
† $P < 0.01$ compared with non-nerve damage.

TABLE 4. Percent Claims Where Mechanism of Injury was Noted in the Claim File

	Total Claims Where Mechanism Was Noted in File	Claims Where Mechanism Was Anesthesia-Related
All nerve damage claims (n = 227)	47 (21%)	33 (15%)
Ulnar (n = 77)	5 (6%)	4 (5%)
Brachial plexus (n = 53)	15 (28%)	14 (26%)
Lumbosacral nerve root (n = 36)	13 (36%)	10 (28%)
Other nerves (n = 61)	14 (23%)	5 (8%)

the patients (fig. 1). In seven patients the anesthetic technique was not recorded in the file. The use of regional anesthesia was significantly more frequent in claims involving nerve damage compared with the incidence of regional anesthesia related to claims not involving nerve damage ($P < 0.01$) (fig. 1). Ulnar nerve injuries were associated predominantly with cases involving general anesthesia, whereas lumbosacral nerve root injuries were associated predominantly with regional anesthesia.

The mechanism of nerve injury was not apparent in the file in the majority of claims for nerve injury (table 4). Of the three major nerve injury categories, the mechanism of injury was least often apparent with ulnar nerve injuries (table 4). The mechanism of injury was noted in about one-quarter of the claims for brachial plexus injury and about one-third of the claims for lumbosacral nerve root injury (table 4). Anesthetic-related causes of brachial plexus injury included the use of shoulder braces and head-down position (three claims), suspension of the patient's arm on a bar (two claims), other obvious malpositions (four claims), and regional anesthesia technique (two claims). All lumbosacral nerve root injuries having identifiable anesthetic etiology were attributed to the administration of regional anesthesia and included technique-related mechanisms such as paresthesia or pain during placement of spinal or epidural needle or pain during injection of a local anesthetic.

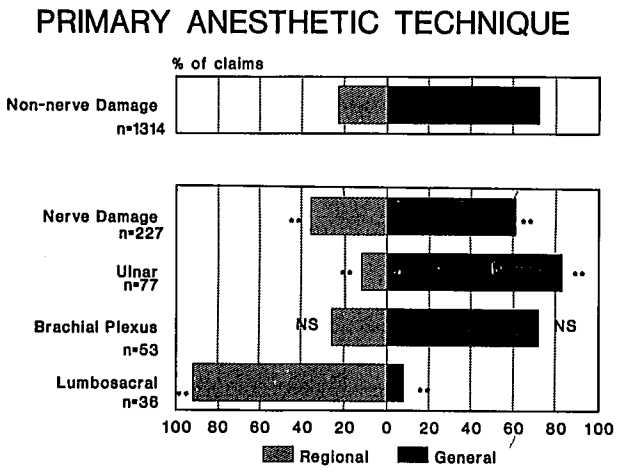

FIG. 1. Incidence of regional and general anesthesia in each category of injury. (**$P < 0.01$ compared with non-nerve damage.)

In 14 of the 77 cases of ulnar nerve injury (18%), the file contained information that the arm was padded over the affected nerve. The time of onset of symptoms was noted in the claim file in 22 of the ulnar nerve injuries. Symptoms were noted by five patients on emergence from anesthesia, three others first noted symptoms on the first postoperative day, ten noticed symptoms by 1 week postoperatively, and in four patients symptoms were first noted 2 weeks to 1 month postoperatively.

Of the 82 regional anesthetics, the most frequent techniques were subarachnoid block (35%), epidural block (20% lumbar, 6% caudal), and axillary block (20%). No obvious patterns were observed that would suggest an association between nerve injury and surgical procedure. Of the various common surgical positions, only the prone position was associated with claims for nerve damage. The proportion of nerve injury claims associated with the prone position (11%) was twice that of non-nerve injuries (6%, $P < 0.01$).

Anesthetic care was judged as "standard" in 63% of all nerve injury cases compared with only 36% of cases not involving nerve damage ($P < 0.01$) (fig. 2). Care was less frequently judged as substandard in the nerve damage group (12%) compared with the cases not involving nerve damage (51%) ($P < 0.01$) (fig. 2). This difference was significant regardless of the severity of injury. These overall patterns were also observed for each of the three largest groups of nerve injury (ulnar nerve, brachial plexus, and lumbosacral nerve roots). Care was described as "impossible to judge" in 25% of nerve damage and 13% of non-nerve damage claims ($P < 0.01$).

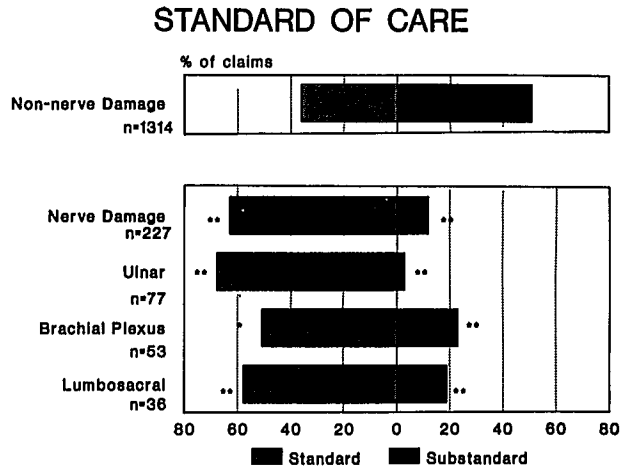

FIG. 2. Incidence of standard and substandard care in each category of injury. Incidence of "impossible to judge" is not shown. (**$P < 0.01$; *$P < 0.05$ compared with non-nerve damage.)

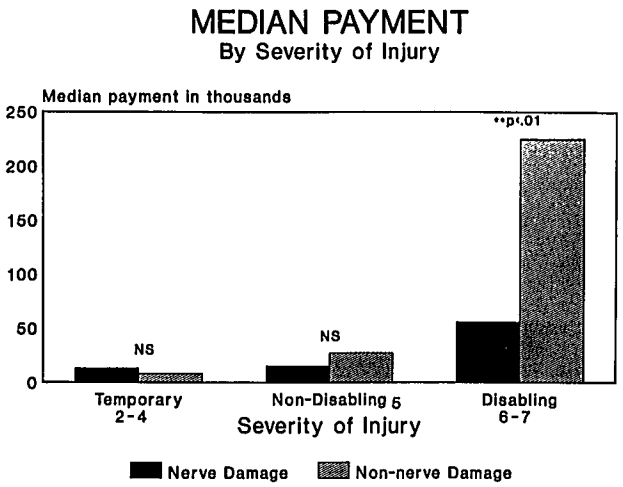

FIG. 3. Median payments categorized by severity of injury in claims involving and those not involving nerve damage.

The severity of injury tended to be lower in claims for nerve damage than in claims not involving nerve damage. The median Severity of Injury score (SIS) was 5 (permanent, minor, nondisabling) (table 1) for nerve damage claims compared with 7 (permanent, major, disabling) for claims not involving nerve damage ($P < 0.01$). The median SIS score for ulnar nerve, brachial plexus, and lumbosacral nerve root injuries was 5.

Payment of claims for nerve damage was lower than for claims for non-nerve damage ($P < 0.01$) (table 5). When broken down into groups by severity of injury, however, differences in magnitude of payments between nerve injury and non-nerve injury claims were only observed when disabling injuries occurred (fig. 3). The median payment for disabling nerve injuries (SIS 6–7) was $56,000 while the median payment for disabling non-nerve injuries was $225,000 ($P < 0.01$) (fig. 3). There was no difference in magnitude of payment between nerve damage claims and non-nerve damage claims when the injury was temporary (SIS 2–4) or permanent but non-disabling (SIS 5) (fig. 3).

Payment was made in 47% of claims for nerve damage, which is significantly less than the 60% payment rate for claims not involving nerve damage ($P < 0.01$) (table 6). The frequency of payment for ulnar nerve injuries did not differ significantly from the payment frequency for non-nerve damage claims (table 6). Claims for brachial plexus and lumbosacral nerve root injuries were less likely to receive payment as compared with claims not involving nerve damage ($P < 0.05$) (table 6). The likelihood of payment for a claim of nerve damage was essentially the same regardless of whether the care was judged as having met the "standard" (table 6). This was in contrast to non-nerve damage claims in which the payment rate was 60% overall and only 38% when care was judged as standard.

TABLE 5. Magnitude of Payments for Nerve Damage and Non-Nerve Damage Claims

	Median	Range
Nerve damage (n = 106)	$18,000*	$188–$2.1 million
Non-nerve damage (n = 788)	$100,000	$15–$6 million
Ulnar (n = 42)	$15,000†	$2,000–$330,000
Brachial plexus (n = 24)	$30,000†	$368–$550,000
Lumbosacral nerve root (n = 15)	$30,000†	$1,000–$500,000

* $P < 0.01$ compared with non-nerve damage.
† No significant difference between payments for the three types of injury.

Discussion

We have previously described the limitations of closed claims analysis.[7] These include the retrospective nature of the study, the lack of data on the total population at risk for anesthetic injury, the lack of geographic balance in the source of claims, and the issue of interrater variability in judging the standard of care. This last issue has been tested in a separate study that demonstrated significant agreement across a broad spectrum of the practicing anesthesia community.[10]

Nerve damage is a common anesthesia-related patient injury and a major source of professional liability in anesthetic practice. While the severity of injury, the likelihood of payment, and the amount of payment are all less for nerve injury than for injuries not involving nerve

TABLE 6. Payment Frequency in All Claims and Claims that Met Standards

All Claims			Claims Where Anesthesia Met Standards		
	Number of Payments	Percent Payments		Number of Payments	Percent Payments*
Nerve damage (n = 227)	106	47%‡	Nerve damage (n = 143)	65	45%
Non-nerve damage (n = 1314)	788	60%	Non-nerve damage (n = 468)	176	38%
Ulnar (n = 77)	42	55%	Ulnar (n = 52)	30	58%‡
Brachial plexus (n = 53)	24	45%†	Brachial plexus (n = 27)	13	48%
Lumbosacral nerve root (n = 36)	15	42%†	Lumbosacral nerve root (n = 21)	8	38%

* Percentages based on number of claims with this injury and care that met standards (claims with substandard care or care impossible to judge excluded).

† $P < 0.05$ compared with non-nerve damage.
‡ $P < 0.01$ compared with non-nerve damage.

damage, claims for nerve damage represent 15% of the total 1,541 claims reviewed. Ulnar, brachial plexus, and lumbosacral nerve root injuries were the most frequent source of claims.

It was notable how rarely the mechanism of injury was explicitly stated in the claim file in spite of extensive medicolegal investigation. Some of the mechanisms of nerve injury during anesthesia that have been extensively described[4–6] were observed in the claim files of cases involving brachial plexus and lumbosacral nerve root injuries. For claims involving ulnar nerve injury, the mechanism was apparent in only 6% of the files. Perhaps no one noticed (or admitted noticing) the affected arm in contact with a sharp edge of the operating table during surgery which is a commonly described mechanism of ulnar nerve injury.[5] However, the extensive questioning and documentation that routinely accompanies such cases makes this explanation seem unlikely. Padding of the arm has been recommended as a maneuver that should prevent compression of the ulnar nerve.[3,5] However, the affected arm was padded over the ulnar nerve in 14 of the cases of injury to that nerve.

What then were the mechanisms of ulnar nerve injury? One clue provided by the present study is the male predominance of ulnar nerve injury. In our study there was a three-to-one male predominance among ulnar nerve claims that is similar to the five-to-one male predominance in 35 postoperative ulnar nerve injuries reported by Cameron and Stewart.[3] Because our study is of claims, not of all injuries, comparison with other studies must be made with caution. However, the male predominance observed in our study does not seem to be due to a male predominance in claims filing, as there is a female predominance in the entire database of closed claims (table 3). The male predominance of perioperative ulnar nerve injuries suggests an anatomic predisposition associated with the male body habitus.[11] Another notable finding in the ulnar nerve injury group was the late appearance of symptoms of nerve damage. Of the 22 cases in which the onset of symptoms was noted in the claim file, only eight were noted by the first postoperative day, with the remainder noted from 2 days to 1 month after surgery. These late developing symptoms suggest that some of the ulnar nerve injuries may be occurring during the postoperative period rather than during the intraoperative period.

It may be that some of the nerve injuries for which claims were filed occurred spontaneously without any causal relationship to anesthesia or surgery. Ulnar nerve injuries can occur without apparent etiology in the general population,[3] although the rate of such injury is not known. In certain susceptible patients nerve injury may occur despite conventionally accepted methods of positioning and padding. We agree with the conclusions of Dawson and Krarup[11] who recently reviewed the literature on perioperative nerve injuries from the neurologist's perspective. They stated that the precise mechanism of perioperative nerve injury is usually unknown and concluded that more and careful clinical and electrophysiologic studies are needed.[11] Although prospective studies of low-incidence injuries are difficult to do, this may be required in order to improve our understanding of mechanisms and effective preventive strategies.

The standard of care was more often met in the nerve damage claims than in non-nerve damage claims (fig. 2). The explanation for this finding can be related to multiple factors. Nearly half the non-nerve damage claims were for respiratory-related injuries where the median SIS (9–death) was higher than the median SIS of 5 for nerve damage claims ($P < 0.01$). We have previously noted[7] that the reviewers are more apt to judge the care as substandard as the severity of injury increases. Another factor

is that despite extensive data in many of the files, no departures from the standard could be identified by the reviewer in most of the nerve injury claims.

As found in the overall database,[7] the payment data for nerve injury illustrates that factors other than standard of care, as judged by peers, are involved in whether or not payment is made for nerve injury. Although substandard care was identified in only 3% of cases of ulnar nerve injury (fig. 2), payment was made in 55% of these cases (table 6). Looked at another way, 58% of the claims for ulnar nerve damage in which care was considered adequate nonetheless resulted in payment (table 6). This is substantially higher than the 38% payment rate for nonnerve damage claims involving standard care (table 6). We speculate that the unclear mechanism of ulnar nerve injury may represent a liability itself, as it leads to the presumption that the anesthesiologist must have done something wrong if the injury occurred in temporal proximity to anesthetic care.

In conclusion, an important finding in this study was that the mechanisms of nerve injury during anesthesia commonly described in the literature[4–6] were usually not apparent in the claim file. For the most common nerve injuries the mechanism of injury was apparent in the file in one-third or less of the claims for brachial plexus and lumbosacral nerve root injuries and in only five of the 77 claims for ulnar nerve injury. The lack of identifiable mechanism suggests either methodologic shortcoming in the medicolegal investigative process or the existence of other mechanisms of nerve injury, especially of the ulnar nerve, which are not yet understood.

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