
Reports of Investigation

Litigation in Canada against anesthesiologists practicing regional anes- thesia. A review of closed claims

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Purpose: To review the pattern of malpractice litigation related to regional anesthesia in Canada.

Source: The Canadian Medical Protective Association (CMPA) provided with information about all anesthesia claims that closed in the years 1990-1997.

Principal Findings: In the period 1990-97 there were 7,909 closed legal actions involving all CMPA members (56,000). Of these, there were 310 cases involving anesthesiologists, of which 61 cases (approximately 20%) were related to regional anesthesia. Forty-two involved neuraxial blocks, and the legal outcome was favourable (dismissed or judgement in favour of the defendant doctor) in 37 claims. Nineteen claims involved peripheral nerve blocks. All these had favourable legal outcomes. Overall, 10% of regional anesthesia claims have unfavourable outcomes, compared with 28% of all anesthesia related claims and 30% of all CMPA members' claims. The degree of disability in the regional anesthesia claims were: none 10%; minor 49%; major 36%; catastrophic 5%. There were no deaths in the malpractice claims involving regional anesthesia, compared with 17% in the all anesthesia group and 11% in all members' claims.

Conclusion: Twenty percent of all anesthesia claims in Canada are related to regional anesthesia. The legal outcome of these claims is favourable in 90%. Unfavourable clinical outcome is associated with catastrophic or major injury. There were no deaths in the regional anesthesia claims.

Objectif : Revoir les accusations pour faute professionnelle concernant l'anesthésie régionale au Canada.

Source : L'Association canadienne de protection médicale (ACPM) a fourni les renseignements au sujet de toutes les réclamations réglées de 1990 à 1997 qui concernaient l'anesthésie.

Constatations principales : De 1990 à 1997 il y a eu 7 909 poursuites judiciaires réglées qui impliquaient des membres de l'ACPM (56 000). De ce nombre, 61 cas étaient liés à l'anesthésie régionale, donc environ 20 % des 310 cas touchant des anesthésiologistes. Dans 42 cas, il s'agissait de blocs neuraxiaux et l'issue de la poursuite a été favorable (action rejetée ou jugement en faveur du médecin accusé) dans 37 cas. Dans 19 cas, c'était des blocs nerveux périphériques. Toutes ces poursuites ont été favorables aux médecins. Globalement, 10 % des réclamations liées à l'anesthésie régionale ont été défavorables contre 28 % de toutes les réclamations anesthésiques et 30 % de celles des membres de l'ACPM. Le degré d'invalidité concernant l'anesthésie régionale ont été : aucun, 10 %; mineur, 49 %; majeur, 36 %; catastrophique, 5 %. Aucun décès n'est lié aux poursuites pour faute professionnelle dans des cas d'anesthésie régionale, à comparer à 17 % dans tous les groupes d'anesthésie et 11 % des réclamations parmi tous les membres.

Conclusion : De toutes les réclamations concernant l'anesthésie au Canada, 20 % sont reliées à l'anesthésie régionale. L'issue de ces poursuites est favorable aux médecins dans 90 % des cas. Des résultats cliniques défavorables sont liés à des lésions catastrophiques ou majeures. Aucun décès n'était associé aux poursuites dans des cas d'anesthésie régionale.

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REGIONAL anesthesia and analgesia are commonly used for surgical and obstetrical procedures. Blocks are gaining popularity in day surgery because one can avoid complications from general anesthesia, and the recovery is faster.^{1,2} Regional anesthesia is generally the technique of choice for obstetrical operative delivery because maternal mortality associated with general anesthesia can be avoided.³ With increasing evidence of improved outcome, neuraxial blockade is now commonly used for postoperative pain control following various surgical procedures.⁴⁻⁶ Complications resulting from various regional techniques have been well described.⁷⁻¹¹ Complications can result in patient suffering, malpractice claims and economic hardships. Studies of insurance claims related to anesthesia practice in the USA and Finland have been published.¹²⁻¹⁴ Similar information regarding Canadian practice is lacking, and the pattern of litigation specifically related to regional anesthesia has not been published before. We describe closed malpractice claims related to the practice of regional anesthesia between 1982-1996, as documented by the Canadian Medical Protective Association (CMPA). These were all the claims that closed from 1990-1997.

Over 95% of Canada's medical practitioners are members of the CMPA, a non-profit mutual medical defence organization which protects its 56,000 members' professional integrity by providing services of the highest quality including legal defence, indemnification, risk identification, educational programmes and general advice. When faced with medical legal difficulties, Canadian doctors contact a colleague at the CMPA. Table I describes the types of cases which are dealt with by the CMPA.¹⁵

Methods

The CMPA files of malpractice claims that closed between 1990-1997 were reviewed. The actual claims dated from 1982-1996. The majority of the anesthetics giving rise to the claims took place from 1986-1995. Four claims arose from action in 1982-1985, and two from 1996. The research and education department of the CMPA prepared case summaries and typically included detailed information such as patients' characteristics (age, sex), date of incident, surgical procedure, location (OR, clinic, recovery room etc.), anesthesia (type, technique), consent, critical incident, complication/outcome and legal outcome.

The regional anesthetic malpractice claims were classified according to whether a neuraxial technique or peripheral nerve block had been performed. They were further subclassified according to the anesthesia

practice - perioperative, obstetric and chronic pain. Physical disabilities or outcomes of patients were classified as minor, major, catastrophic and death (Table II). The legal outcome can be one of the following - dismissal, settlement, judgment by the court for the defendant or the plaintiff (Table III). In the present article, both dismissal and judgment by the court for the defendant are grouped as a favourable outcome while settlement and judgment by the court for the plaintiff are grouped as an unfavourable outcome.

Results

Between January 1990 - December 1997, there were 1,819 actual case contacts with the CMPA involving an anesthesiologist. The types of contacts involving anesthesiologists and all CMPA members are listed in Table IV. Most of these did not progress to legal action. The incidence of legal action against an anesthesiologist compared with all CMPA members during the period 1990-1997 is illustrated in the Figure. In 1997, the number of legal actions per 1000 anesthesiologist members was 20.6 (i.e. 1 in 49) compared with 24.6 for all CMPA members (i.e. 1 in 41). This calculation assumes two members involved per legal action. In contrast there were 13 actions per 1000 for all CMPA members including anesthesiologists in 1980. Within the same period from 1990-1997, 7909 legal actions were closed from all CMPA members. Anesthesiologists were the defendant in 310 cases, of which 61 cases were related to regional anesthesia that was given from 1982-1996.

The types of regional anesthesia involved in the closed claims are shown in Table V. Approximately two-thirds of the cases were associated with neuraxial block.

Risk of a Legal Action



FIGURE Risk of a legal action

TABLE I Legal and general services provided by CMPA

1. LEGAL	Civil legal action
2. ADVICE	General advice to members
3. THREAT	Help and advice when under the threat of a legal action
4. COLLEGE	Help with complaints or other matters before a Provincial/Territory Medical Licensing Body
5. HOSPITAL	Help and advice regarding hospital privilege matters
6. INQUESTS	Legal help with inquests
7. OTHER MATTERS	

TABLE II Physical disabilities of patients

1. minor- pain, scarring
2. major- disabilities that interfere with the activities of daily living
3. catastrophe- severe neurological impairment
4. death

TABLE III Legal outcomes

1. consent dismissal - plaintiff(s) withdraws or abandons the legal action prior to trial
2. settlement - legal action is resolved by the way of a payment by CMPA on behalf of the defendant member prior to trial. This is done in circumstances where CMPA is unable to find peer support for the clinical care
3. judgment for the defendant - the court decides in favour of the defendant at trial
4. judgment for the plaintiff - the court decides in favour of the plaintiff at trial

Of these 42 cases, 34 involved either perioperative or obstetrical settings (Table V). Of the remaining eight cases, all but one (spinal cord stimulator insertion) involved the administration of epidural steroids for chronic pain. Almost all of these cases are related to complications that occurred during the procedure. The reasons for the claims are shown in Table VI.

Eleven of 19 claims involving peripheral nerve block techniques took place in the perioperative setting. Seven cases arose from eye blocks for surgery (Table VII). Four of these cases were the direct result of retrobulbar blocks. Two patients suffered from perforations, one from retinal detachment and one from intraocular hemorrhage.

Four claims were filed when patients suffered pneumothorax, two after stellate ganglion block and two after supraclavicular brachial plexus block. One case of celiac plexus block that resulted in paraplegia was settled on behalf of the hospital, since the block was performed by a Fellow (hospital employed) who had

TABLE IV Types of contacts with CMPA during the period from Jan 1990 - Dec 1997

	<i>Anesthesiologists</i> <i>n = 1,819</i>	<i>All CMPA members</i> <i>n = 98,283</i>
Advice	52%	68%
Legal	19%	10%
Threat	11%	5%
College	10%	13%
Hospital	5%	2%
Inquests	2%	1%
Others	1%	1%

TABLE V Type of regional anesthesia involved in closed claims (1990-1997) N=61

<i>Total</i>	<i>Perioperative</i>			<i>Chronic Pain</i>
	<i>n=32</i>	<i>n=13</i>	<i>n=16</i>	
Neuraxial block		21	13	8
epidural	31			
spinal	11			
Peripheral nerve block		11		8
retrobulbar/ peribulbar block	7			
brachial plexus block	3			
stellate ganglion block	3			
lumbar sympathetic block	2			
celiac plexus	1			
other peripheral nerves	3			

previously been supervised by the anesthesiologist who in this case was let out of the action.

Patient outcome associated with closed claims from regional anesthesia, all anesthesia and all CMPA members are summarized in Table VIII. There were no deaths in the malpractice claims involving regional anesthesia, compared with 17% in the all anesthesia group and 11% in the all CMPA group. Otherwise, the pattern of patient outcome in the three groups was very similar, with minor or no disability ranging from 50-60%, major disability ranging from 25-34% and catastrophic complications under 8%.

The legal outcomes of the claims associated with regional anesthesia, all anesthesia types and all CMPA members are listed in Table IX. Favourable outcomes are defined as those outcomes categorized as 'dismissal', or 'judgment for the defendant'. Regional anesthesia was associated with a greater chance of a favourable outcome. Complications associated with increased risk of unfavourable outcome are paraplegia and globe perforation. Since the number of malpractice claims associated with regional anesthesia is small, identification of risk factors by statistical analysis of different subgroups will not be meaningful.

TABLE VI Complication and outcome associated with neuraxial block (n=42)

Complication	No.	Outcome	
		Favourable	Unfavourable
nerve injury†	3	3	0
cauda equina	1	1	0
cardiorespiratory arrest	1	1	0
lipolysis	1	1	0
PDPH	1	1	0
viral hepatitis	1	1	0

*7 cases are related to epidural steroid administration, 1 case related to placement of spinal cord stimulator; PDPH- postdural puncture headache; †one case related to spinal cord stimulator placement, resulting in persistent numbness in left arm and leg

2. Obstetrical

Complication	No.	Outcome	
		Favourable	Unfavourable
PDPH	5	5	0
CRA	2	1	1
paraplegia	1	0	1
pain	2	1	1
catheter shear	1	1	0
viral meningitis	1	1	0
poor baby outcome	1	1	0

PDPH- postdural puncture headache; CRA- cardiorespiratory arrest

3. Perioperative

Complication	No.	Outcome	
		Favourable	Unfavourable
nerve injury	9	9	0
paraplegia	3	1	2
cauda equina	2	2	0
pain	1	1	0
seizure	1	1	0
CRA	1	1	0
PDPH	2	2	0
hearing loss	1	1	0
meningitis	1	1	0

Discussion

The objective of this article was to review the litigation pattern against anesthesiologists practicing regional anesthesia in Canada. Similar insurance or closed claims studies have been published in other jurisdictions. There, however, the focus was on either nerve injuries^{1,2} or neuraxial blockade.¹³ The former reflected claims from both general and regional anesthesia where the latter excluded the claims related to peripheral nerve blocks. As with other closed claim analyses, we acknowledge limitations in our paper.^{13,15} Firstly, there is no denominator. The total number of patients receiving regional anesthesia during the same time period (1982-1996) is unknown. Thus, this study does not

TABLE VII Complication and outcome associated with peripheral nerve block

Complication	No.	Outcome	
		Favourable	Unfavourable
globe perforation	7	5	2
pneumothorax	4	4	0
neurological deficit	2	2	0
paraplegia	1	1	0
septicemia	1	1	0
pain	2	2	0
wrong side	1	0	1
no consent	1	1	0

TABLE VIII Patients outcome from malpractice claims related to anesthesia (1990-1997)

Outcome	Regional anesthesia (%)	All anesthesia (%)	All CMPA members (%)
No disability	10%	8%	13%
Minor	49%	42%	47%
Major	36%	25%	26%
Catastrophic	5%	8%	3%
Death	0%	17%	11%

provide an estimate of incidence of the risk of litigation. Secondly, there is no control group from another, similar set of patients who do not sue. One could argue that the data are biased because the reports are derived from one source, the CMPA, rather than impartial observers or court files. However, since Canadian anesthesiologists, almost without exception, are members of the CMPA, all regional anesthesia claims in the country are captured in our data for the study period.

Neuraxial blocks

Neurological complications following neuraxial blocks are the most frequent reasons for malpractice claims related to regional anesthesia in Canada. Although the incidence of such complications is not reflected in this study, neurological injury is extremely rare.¹⁶⁻¹⁷ According to several large studies published at least 20 yr ago, the reported frequency of persistent sensory and motor deficits following spinal anesthesia in approximately 50,000 patients ranged from 0.005% to 0.7%.¹⁸⁻²⁰ Over the years, this safety record of spinal anesthesia has not changed, with reported incidences of 0.08% to 0.12% according to three recent large studies involving more than 50,000 patients.^{8,10,11} Similarly, neurological complications following epidural anesthesia, as reviewed by Dawkins three decades ago, are uncommon.²¹ In that series, of 32,718 cases, transient paralysis was reported in 48 cases (0.1%), whereas seven

TABLE IX Legal outcome from malpractice claims related to anesthesia (1990-1997)

<i>Outcome</i>	<i>Regional anesthesia (%)</i>	<i>All anesthesia (%)</i>	<i>All CMPA members (%)</i>
Dismissal	79%	62%	64%
Settlement	11%	28%	28%
Judgment for defendant	8%	8%	6%
Judgment for plaintiff	2%	2%	2%

TABLE X Possible risk factors associated with neurological complication following regional anesthesia

<i>Risk factors</i>	<i>No. of cases</i>
Intraoperative hypotension	3
History of hypertension or diabetes	3
Obesity	3
Preexisting back deformity or spinal fusion	3
paresthesia during needle placement/pain during injection	2
Anticoagulation	1
Multiple attempts (>4)	1

patients suffered permanent paralysis (0.02%). This complication rate remains low, ranging from 0.04% to 0.11%, judging from the studies published in the last few years.^{8,10} In our series, 22 claims (34%) were due to neurological injury, with 19 cases following neuraxial block. An unfavourable outcome occurred in three cases, all suffering paraplegia following neuraxial blocks, reflecting the severe nature of this complication.

In one case, a woman developed complete paraplegia following delivery of her baby by Cesarean section. The cause was alleged to be hypotension during the procedure. However, the record keeping by the anesthesiologist was poor, therefore adequate monitoring could not be proved in court. Another case of paraplegia involved insertion of a thoracic epidural catheter for postoperative pain relief in a patient under general anesthesia without discussion or consent. The third case concerned an older man undergoing radical prostatectomy under epidural and general anesthesia using controlled hypotension. Only systolic blood pressure was monitored using a cuff. The man developed permanent paralysis below T₁₀ due to spinal cord infarction.

Several risk factors have been described in various studies in association with neurological complications following regional anesthesia, including paresthesia during needle placement or pain during injection of local anesthetic, hypotension, anticoagulation, use of lidocaine,^{8,10,11} preexisting neurological condition and arteriosclerosis.²¹ In our claims, a similar pattern of

risk factors was found (Table X). Neurological complications associated with neuraxial block may be divided into two categories; those which are related to the technique of the block, and those that are unrelated but coincide temporally. Direct needle trauma is often implicated in minor neurological problems. In the study by Auroy *et al.*,⁹ two-thirds of cases of radiculopathy after spinal anesthesia (12 of 19 cases) and all cases with radiculopathy after epidural and peripheral block, needle punctures were associated either with paresthesia during puncture or pain during injection. In a recent large retrospective study, Horlocker reported similar findings.¹⁰ Pain on injection resulted in one patient with permanent foot drop and in another with persistent pain in a toe for almost one year in our claims. The anesthesiologist who performs neuraxial block should be cognizant of the signs of needle trauma. It is advisable that those patients who experience paresthesia during needle placement or pain on injection should be followed up in view of the medical legal implications.

Chronic pain management

In our series, seven out of eight claims associated with neuraxial block in chronic pain management were related to epidural steroid injections. Complications range from minor, lipolysis in the skin over the injection site, to major such as cauda equina syndrome. None resulted in an unfavourable legal outcome. Complications of epidural steroids have recently been reviewed.²² They can be subdivided into major categories: neurological dysfunction including arachnoiditis and aseptic meningitis; infectious complications including epidural abscess and bacterial meningitis; steroid related side effects; local anesthetic related complications, and technical complications including post dural puncture headache (PDPH). It has been suggested that intrathecal administration of steroid may result in adhesive arachnoiditis, although no data in animals have confirmed the relationship between subarachnoid steroid injection and arachnoiditis. None of our three claims for neurological problems after epidural steroids were due to arachnoiditis. One patient developed cauda equina syndrome eight hours after the administration of steroid. Laminectomy was performed, but no hematoma was present and the medication was found in the epidural space. The etiology of the cauda equina syndrome was not established, and all experts were supportive of the anesthesiologist's technique. The other two cases had minor neurological impairment, thought to be due to preexisting conditions. Careful documentation of neurological findings before treatment may prevent such claims.

Globe perforations

Perforation of the globe is a well described but uncommon complication of ocular anesthesia. The incidence of globe perforation following peribulbar block has been estimated to be 0.006 - 0.024%.^{2,3} The most common complications resulting from globe perforation are retinal detachment and severe intraocular hemorrhage. Some cases require only observation with no further care, whereas others may require vitrectomy, cryotherapy or laser therapy, or retinal detachment surgery with or without intravitreal gas injection. The predisposing factors for globe perforation were uncooperative patients during injection, increased axial length of the globe as seen with high myopia or with previously placed scleral buckle, and performance of the block by a non-ophthalmologist.²⁴⁻²⁷

In our series, seven claims were related to globe perforation, in which four resulted from retrobulbar blocks and three related to peribulbar blocks. The operation involved in all cases was cataract surgery. All resulted in sight-threatening complications such as vitreous hemorrhage or retinal detachment. One patient was known to have a 'large eyeball' as a result of high myopia. Unfavourable outcomes occurred in two cases, both suffered globe perforations, one from a retrobulbar block and the other from a peribulbar block. In the latter case a double injection technique was used to provide anesthesia for cataract surgery, and the patient complained of pain on injection. The surgery was uneventful but the patient's vision deteriorated. Later, two ocular perforations were found.

Current ophthalmology literature suggests that ocular anesthetic injection performed by an anesthesiologist is one of the predisposing factors for the complication of globe perforation.^{2,6} Although these articles did not directly compare the incidence of complication by anesthesiologist *vs* ophthalmologist, anesthesiologists should be aware of any limitation there may be in their training. Before practising ocular anesthesia, anesthesiologists should have good knowledge of the anatomy and physiology of the eye, as well as be aware of the serious nature of potential complications. Appreciation of the patient's anatomy, particularly the size of the globe, is important before initiating a block since increased axial length is one of the risk factors for needle penetration of the globe. With the increased use of phacoemulsification technique in cataract surgery, topical (eye-drop) anesthesia is becoming popular as the anesthetic technique of choice since the incision is smaller and the duration of surgery is shorter.²⁷

Conclusions

What can we learn from this review? Two questions come to mind: why do people sue their doctors, and how do we prevent an unfavourable outcome of these suits?

A high proportion of malpractice claims both in general, and in regional anesthesia, are associated with unexpected catastrophic outcomes. Patients who have sustained serious injury as a result of a procedure are likely to sue. However, the outcome of the suit depends on a number of factors. It is often cheaper for an insurer to settle a claim for a negotiable sum rather than take the case to court. The CMPA will not settle a suit for financial expediency. If expert peer review determines that the standard of care was not breached, and the case is defensible, the case will be defended up to and including trial. As a result, Canada probably sees fewer malpractice suits than other jurisdictions. In order to defend a suit, there must be adequate documentation to prove what in fact happened. Therefore, anesthesiologists can protect themselves by always documenting assessments, consent discussions, pre-existing conditions, details of procedures and monitoring, as well as vital signs. When performing blocks, well recognized complications and material risks should be discussed before obtaining a written or verbal consent. Should any untoward reactions occur, it is wise to write a detailed contemporaneous note in the chart outlining your findings and treatment. It may be many years after the clinical event that you will be called upon to defend your care, long after the procedure itself is forgotten.

If it is not possible to defend a case, either because the standard of care was inferior, or because the documentation was poor and the standard cannot be ascertained, the CMPA will negotiate a settlement with the plaintiff. This happens in less than 30% of cases. The CMPA takes 8% of its cases to trial. Of these, 6% are judged in favour of the defendant doctor, and 2% in favour of the plaintiff. In other jurisdictions, where medical malpractice is defended by insurers, the settlements are more frequent and favourable court judgments fewer.

Some patients sue because they believe that something went wrong during the procedure. We cannot prevent patients from seeking redress for real or perceived harm resulting from our treatment. However, good communication before, during and after the procedure may prevent a malpractice claim.

Summary

We have reviewed all regional anesthesia related malpractice claims that closed in the years 1990-1997. The actual medical care or procedures that gave rise to these

claims happened during 1982-1996. The average claim can take 2-4 years to process and complete. Some of the more difficult and contentious cases may last much longer and the clinical care may have been provided many years earlier. Approximately 20% of all anesthesia related malpractice claims in Canada reported were associated with regional anesthesia. Of these, 69% were neuraxial blocks. However, unfavourable legal outcomes were uncommon (10%), compared with all anesthesia related claims (28%) and all CMPA members' claims (30%).

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References

- 1 *Mulroy MF*. Regional anesthetic techniques. *Int Anesthesiol Clin* 1994; 32: 81-98.
- 2 *Peng PWH, Chan VWS, Chung FFT*. Regional anaesthesia in ambulatory surgery. *Ambulatory Surgery* 1997; 5: 133-43.
- 3 *Hibbard BM, Anderson MM, Drife JO, et al*. Deaths associated with anaesthesia. In: Report on Confidential Enquiries into Maternal Deaths in the United Kingdom 1991-1993. London: HMSO Her Majesty's Stationary Office. 87-102.
- 4 *Steinbrook RA*. Epidural anesthesia and gastrointestinal motility. *Anesth Analg* 1998; 86: 837-44.
- 5 *Ballantyne JC, Carr DB, deFerranti S, et al*. The comparative effects of postoperative analgesic therapies on pulmonary outcome: cumulative meta-analyses of randomized, controlled trials. *Anesth Analg* 1998; 86: 598-612.
- 6 *Vandam LD, Dripps RD*. Long-term follow-up of patients who received 10,098 spinal anesthetics. *JAMA* 1960; 172: 1483-7.
- 7 *Dahlgren N, Tornebrandt K*. Neurological complications after anaesthesia. A follow-up of 18 000 spinal and epidural anaesthetics performed over three years. *Acta Anaesthesiol Scand* 1995; 39: 872-80.
- 8 *Scott DB, Hibbard BM*. Serious non-fatal complications associated with extradural block in obstetric practice. *Br J Anaesth* 1990; 64: 537-41.
- 9 *Auroy Y, Narchl P, Messiah A, Litt L, Rouvier B, Samii K*. Serious complications related to regional anesthesia. Results of a prospective survey in France. *Anesthesiology* 1997; 87: 479-86.
- 10 *Horlocker TT, McGregor DG, Matsushige DK, Schroeder DR, Besse JA*. A retrospective review of 4767 consecutive spinal anesthetics: central nervous system complications. *Anesth Analg* 1997; 84: 578-84.
- 11 *Kroll DA, Caplan RA, Posner K, Ward RJ, Cheney FW*. Nerve injury associated with anesthesia. *Anesthesiology* 1990; 73: 202-7.
- 12 *Caplan RA, Ward RJ, Posner K, Cheney FW*. Unexpected cardiac arrest during spinal anesthesia: a closed claims analysis of predisposing factors. *Anesthesiology* 1988; 68: 5-11.
- 13 *Aromaa U, Lahdensuu M, Cozanitis DA*. Severe complications associated with epidural and spinal anaesthetics in Finland 1987-1993. A study based on patient insurance claims. *Acta Anaesthesiol Scand* 1997; 41: 445-52.
- 14 *Caplan RA, Posner KL, Ward RJ, Cheney FW*. Adverse respiratory events in anesthesia: a closed claims analysis. *Anesthesiology* 1990; 72: 828-33.
- 15 *Duranceau A*. The Canadian Medical Protective Association. *Bulletin of The American College of Surgeons* 1998; 83: 23-8.
- 16 *Renck H*. Neurological complications of central nerve blocks. *Acta Anaesthesiol Scand* 1995; 39: 859-68.
- 17 *Dripps RD, Vandam LD*. Long-term follow-up of patients who received 10,098 spinal anesthetics. *JAMA* 1954; 156: 1486-91.
- 18 *Sadove MS, Levin MJ, Rant-Sejdinaj I*. Neurological complications of spinal anaesthesia. *Can Anaesth Soc J* 1961; 8: 405-16.
- 19 *Moore DC, Bridenbaugh LD*. Spinal (subarachnoid) block. A review of 11,574 cases. *JAMA* 1966; 195: 123-8.
- 20 *Phillips OC, Ebner H, Nelson AT, Black MH*. Neurologic complications following spinal anesthesia with lidocaine: a prospective review of 10,440 cases. *Anesthesiology* 1969; 30: 284-9.
- 21 *Dawkins CJM*. An analysis of the complications of extradural and caudal block. *Anaesthesia* 1969; 24: 554-63.
- 22 *Abram SE, O'Connor TC*. Complications associated with epidural steroid injections. *Reg Anesth* 1996; 21: 149-62.
- 23 *Kimble JA, Morris RE, Witherspoon CD, Feist RM*. Globe perforation from peribulbar injection (Case Report). *Arch Ophthalmol* 1987; 105: 749.
- 24 *Hay A, Flynn HW Jr, Hoffman JI, Rivera AH*. Needle penetration of the globe during retrobulbar and peribulbar injections. *Ophthalmology* 1991; 98: 1017-24.
- 25 *Grizzard WS, Kirk NM, Pavan PR, Antworth MV, Hammer ME, Roseman RL*. Perforating ocular injuries

- caused by anesthesia personnel. *Ophthalmology* 1991; 98: 1011–6.
- 26 *Ramsay RC, Knobloch WH.* Ocular perforation following retrobulbar anesthesia for retinal detachment surgery. *Am J Ophthalmol* 1978; 86: 61–4.
- 27 *Johnston RL, Whitefield LA, Giralt J, et al.* Topical versus peribulbar anesthesia, without sedation, for clear corneal phacoemulsification. *J Cataract Refract Surg* 1998; 24: 407–10.