EXTENDED REPORT

Serious complications of local anaesthesia for cataract surgery: a 1 year national survey in the United Kingdom

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Background: The techniques of sub-Tenon's, topical and topical-intracameral local anaesthesia (LA) have become common in routine practice.
Aims: This study aimed (i) to estimate the frequency of various LA techniques used in cataract surgery, (ii) to estimate the incidence of severe adverse events associated with each LA technique, and (iii) to document these adverse events.
Methods: This was a prospective, 13 month observational study of routine practice in the UK in 2002–2003. The British Ophthalmological Surveillance Unit sent a monthly mailing to UK ophthalmologists, asking for reports of ''potentially sight-threatening or life-threatening complications of LA for cataract surgery''. Current LA practice was assessed by questionnaire.
Results: Cataract surgery comprised 4.1% general anaesthesia, 92.1% LA without sedation and 3.9% LA with sedation. Of the estimated 375 000 LAs 30.6% were peribulbar, 3.5% retrobulbar, 42.6% sub-Tenon's, 1.7% sub-conjunctival, 9.9% topical and 11.0% topical-intracameral LA. ''Potentially sight-threatening complications'' were mostly associated with retrobulbar and peribulbar techniques and ''potentially life-threatening'' complications with all techniques except topical/intracameral LA. Eight neurological complications consistent with brainstem anaesthesia were reported: 7 with peribulbar or retrobulbar LA. Poisson regression analysis strongly indicated that rates vary with technique ($p<0.001$ for ''potentially sight-threatening'' complications, $p=0.03$ for ''neurological'' complications). Because of likely under-reporting, further complications probably occurred during the survey period.
Conclusions: This large survey found a lower rate of reported serious complications with sub-Tenon's, topical and topical-intracameral LA compared with retrobulbar and peribulbar techniques. These ''newer'' methods may be preferable for routine cataract surgery.

The introduction of small-incision phacoemulsification has revolutionised the way in which cataract surgery is carried out. Previously, the large incision needed for extra-capsular or intra-capsular cataract extraction carried a significant risk of serious complications at the time of surgery. In particular, contraction of the extra-ocular muscles could squeeze the globe and cause the vitreous and other ocular contents to be extruded through the surgical wound. Safer surgery required either general anaesthesia (GA) or a technique of local anaesthesia (LA) that gave good akinesia of the extra-ocular muscles. The small, self-sealing incision used for modern phacoemulsification has greatly improved control of the wound and anterior chamber, and many surgeons feel that it is no longer necessary to have total akinesia of the globe for safe surgery.

The move towards safer surgical techniques has been accompanied by a desire for safer techniques of anaesthesia. The ideal anaesthetic technique would be totally free of risk to the patient, guarantee total comfort throughout the procedure, and give perfect operating conditions for the surgeon. This ideal still does not exist. Until the 1990s, the standard techniques of LA for cataract surgery were retrobulbar anaesthesia[1 2] and peribulbar anaesthesia.[2 3] These methods give good akinesia and analgesia, but the use of a sharp needle carries the risk of serious complications.[4] For example, the needle inadvertently penetrating the globe or optic nerve can result in blindness. If the needle inadvertently penetrates the dural sheath of the optic nerve, anaesthetic can track back to the brainstem, causing unconsciousness and severe cardio-respiratory collapse with potentially fatal outcome. These complications are rare, with some studies suggesting an incidence of between 0.009% and 0.13% for globe perforation[4–7] and between 0.09% and 0.79% for brain-stem depression.[4 8 9] In recent years, there has been a move away from these ''sharp needle'' techniques in favour of less invasive methods. Sub-Tenon's anaesthesia with a blunt canula should eliminate the risks of the needle, but it still requires dissection and serious complications may occur.[10] Topical or topical-intracameral techniques involve no dissection other than that required for surgery, so one would expect fewer anaesthetic-related complications.[11] However, as there is no akinesia, these techniques are best avoided for large-incision surgery.

When assessing the safety of the various LA techniques, it is necessary to look at large numbers of cases because serious (sight-threatening or life-threatening) adverse events are so rare. The best way to compare LA techniques would be to carry out a prospective randomised controlled trial, collecting information on all outcomes, with tens of thousands of cases in each arm of the trial. However, such a study would be difficult and expensive to perform. Our study design was simpler and less cumbersome. We aimed to collect data on serious complications of LA, prospectively on a national scale, over a 1 year period. This was done through the British Ophthalmological Surveillance Unit (BOSU), a validated means of case ascertainment for studies of rare conditions in ophthalmology.

METHOD

This was a prospective, observational study of routine practice in the United Kingdom (UK). The aims were (i) to estimate the

Abbreviations: BOSU, the British Ophthalmological Surveillance Unit; GA, general anaesthesia; LA, local anaesthesia; NHS, National Health Service

frequency of use of the various LA techniques used in cataract surgery in the UK, (ii) to estimate the incidence of severe adverse events associated with each LA technique, and (iii) to document the types of severe adverse events associated with each LA technique.

Case ascertainment was through BOSU, an organisation which was set up to facilitate case ascertainment for studies of rare ophthalmic conditions.[12] Every month, BOSU mails a postcard to all ophthalmologists (consultant and associate specialist grade) in the UK and Ireland, enquiring whether they have seen any cases (or none) from a small list of specified conditions in the foregoing month. Response rates for BOSU cards are in the region of 80% each month. Validation of previous studies has indicated that the BOSU system identified 62.5% to 95% of potential cases.[12 13] For a period of 13 months (November 2002 to November 2003 inclusive), BOSU cards included a request for cases of ''Potentially life-threatening or sight-threatening complications of local anaesthesia for cataract surgery''. Respondents were sent a brief questionnaire 2–4 months after the adverse event occurred. This case report questionnaire asked what LA technique was used, what happened and what the outcome was. At the mid-point of the survey period (May 2003), another questionnaire was sent to all the ophthalmologists on the BOSU mailing list, in order to assess current usage of GA, LA and the various LA techniques for cataract surgery. Ophthalmologists were asked to estimate the number of cataract operations carried by themselves and their team in an average week (for cases done under the National Health Service, NHS) or month (for private practice), and to estimate the percentage use of GA/LA techniques and sedation for their cataract practice. Respondents were asked to ensure that their estimated percentages summed to 100%. These ''current practice'' questionnaires were anonymous and unmarked in order to encourage full and frank reporting, but this meant that reminders could not be sent to non-respondents. The survey was approved by the BOSU steering committee, and also by a Multi-centre Research Ethics Committee.

We estimated the total number of LAs given by each technique for the entire survey. Exact figures for the total number of NHS cataract operations during the 13 month survey were not available. Therefore, we estimated these data using published government figures for England. The Hospital Episode Statistics section of the Department of Health website (www.dh.gov.uk, accessed 7 February 2005) provides data for NHS patients in England only, and carries a warning that the figures may not be accurate. We looked at reports for the fiscal years 2002–3 and 2003–4, with a primary diagnosis of ''senile cataract'' or ''other cataract''. Totals were used to estimate the number of NHS cataract operations done in England during the survey period, and a proportionate correction was made for the number of UK ophthalmologists on the BOSU database whose address was not in England.

The proportion of operations carried out using GA, and the different LA techniques, was calculated using ophthalmologists' responses to the ''current practice'' questionnaire. In our previous study of LA usage,[14] validation showed that ophthalmologists' estimates for these data were very similar to actual NHS practice. Therefore, we expected the questionnaire to give a reasonably accurate representation of the proportionate usage of GA/LA techniques. In this way, we estimated the total number of cataract operations done during the survey period using each LA technique.

In calculating complication rates, the numerator for each LA technique was the actual number of complications reported. For the denominator, we used the estimated totals, derived from Department of Health figures and our questionnaire, as described above. This method is likely to give an under-estimate of the true complication rates, as discussed below.

RESULTS

Results are presented for practice under the NHS in the United Kingdom. The ''current practice'' questionnaire was returned by 699 of 1058 UK ophthalmologists (66.1%). Five questionnaires were returned uncompleted: two because the respondent had retired and three without explanation. A total of 52 respondents stated that NHS cataract surgery was not done by themselves or any member of their surgical team. Results are presented for the remaining 642 respondents.

Table 1 summarises the responses of the 642 respondents who performed cataract surgery in the UK. For cataract surgery carried out within the NHS, respondents estimated that 4.1% was done using GA, 92.1% using LA without sedation and 3.9% using LA with sedation (table 1A). For those NHS cataract operations done using LA, the reported usage of the different LA techniques can be summarised as 30.6% peribulbar, 3.5% retrobulbar, 42.6% sub-Tenon's, 1.7% sub-conjunctival, 9.9% topical and 11.0% topical-intracameral LA (table 1B). For private practice, there appears to be a slightly higher usage of GA and sedation, and proportionately higher usage of retrobulbar and peribulbar techniques for LA (table 1A,B).

We also looked at whether respondents used a particular anaesthetic technique for most of their cataract surgery, and whether an individual would never use a particular technique. Results appear in table 2A,B. If a respondent entered ''0%'' for a technique, we defined this as ''never used'', and we defined

Table 1 Overall use of anaesthetic techniques for cataract surgery in the United Kingdom in 2003

	NHS	Private practice
A: All cataract surgery		
General anaesthesia (GA)	4.1%	5.5%
Local anaesthesia (LA)	96.0%	93.5%
Without sedation	92.1%	85.8%
With sedation	3.9%	7.7%
No anaesthesia	0%	0%
B: Cataract surgery using LA		
Peribulbar LA	30.6%	34.7%
Without sedation	28.5%	30.5%
With sedation	2.0%	4.2%
Retrobulbar LA	3.5%	4.7%
Without sedation	3.3%	4.4%
With sedation	0.2%	0.3%
Sub-Tenon's LA	42.6%	35.1%
Without sedation	41.1%	33.3%
With sedation	1.5%	1.9%
Sub-conjunctival LA	1.7%	2.5%
Without sedation	1.6%	2.4%
With sedation	0.1%	0.1%
Topical LA	9.9%	9.8%
Without sedation	9.6%	9.2%
With sedation	0.3%	0.6%
Topical-intracameral LA	11.0%	11.9%
Without sedation	10.7%	10.5%
With sedation	0.3%	1.4%

Responses to a postal questionnaire survey of current practice, mailed to UK ophthalmologists. Pooled data from 699 respondents, of whom 642 provided data for practice in the National Health Service and 462 provided data for private practice. Section A: Pooled responses to the question ''[for cataract operations performed by yourself or members of your surgical team], what is the usual frequency of the different types of anaesthesia?''. Section B: Pooled responses to the question ''Of the cataracts that are performed using local anaesthesia, what is the usual frequency of the different techniques?''. Respondents gave an exact percentage estimate for their own usage of each technique. Columns do not all sum to 100% because of incomplete forms from some respondents and rounding of percentages. NHS, National Health Service.

Table 2 Individuals' reported use of anaesthesia techniques for cataract surgery in the United Kingdom in 2003

	National Health Service			Private practice		
	"Always /mostly" (90% to 100% of cases)	"Less often" (0.1% to 89.9%)	"Never used" (0%)	"Always/ mostly" (90% to 100% of cases)	"Less often" (0.1% to 89.9%)	"Never used" (0%)
A: All cataract surgery						
General anaesthesia (GA)	0.5%	76.6%	22.9%	0.6%	63.3%	36.1%
Local anaesthesia (LA)						
Without sedation	84.1%	14.5%	1.4%	74.4%	21.3%	4.3%
With sedation	1.3%	33.0%	65.7%	4.1%	29.2%	66.7%
B: Cataract surgery using LA						
Peribulbar LA						
Without sedation	13.0%	41.4%	45.6%	20.6%	27.5%	51.9%
With sedation	0.5%	14.6%	84.9%	2.2%	15.8%	82.0%
Retrobulbar LA						
Without sedation	2.1%	6.3%	91.6%	3.2%	7.4%	89.4%
With sedation	0%	1.0%	99.0%	0.2%	3.7%	96.1%
Sub-Tenon's LA						
Without sedation	27.1%	45.1%	27.8%	25.1%	29.9%	45.0%
With sedation	0.2%	12.8%	87.0%	0.2%	14.8%	85.0%
Sub-conjunctival LA						
Without sedation	1.0%	1.7%	97.3%	1.7%	3.9%	94.4%
With sedation	0%	0.2%	99.8%	0%	2.6%	97.4%
Topical LA						
Without sedation	5.6%	16.8%	77.6%	5.8%	13.7%	80.5%
With sedation	0%	1.9%	98.1%	0.2%	4.6%	95.2%
Topical-intracameral LA						
Without sedation	7.1%	12.3%	80.6%	8.2%	9.2%	82.6%
With sedation	0.2%	1.7%	98.1%	1.3%	3.7%	95.0%

For method and questions, see legend to table 1. We arbitrarily categorised individuals' use of each technique as "always/mostly" (defined by us as the technique used for 90% to 100% of the individual's cataract cases), "less often" (0.1% to 89.9%) or "never" (0%).

90% to 100% usage of a technique as "always/mostly". For NHS cataract surgery, LA without sedation was "always/mostly" used by 84.1% of respondents (table 2A). Usage of the individual LA techniques is summarised in table 2B.

We estimated that the actual number of NHS cataract operations done in the survey period was in the order of 375 000 and that the total number of LAs given for NHS cataract surgery in the 13 month survey were 115 700 peribulbar, 13 200 retrobulbar, 161 000 sub-Tenon's, 6400 sub-conjunctival, 37 400 topical and 41 600 topical-intracameral LA (table 3).

Reported complications are summarised in table 3. The study identified 74 cases that were definitely eligible for the survey, from a total of 119 responses to the BOSU postcards. Of these 74 eligible cases, 71 were from the NHS (table 3), two were reported from private practice and data were missing for one patient. All complications were reported by ophthalmologists in the UK, with none reported from Ireland. The 74 eligible cases comprised 72 phacoemulsification procedures, one removal of residual soft lens matter, and one intraocular lens exchange.

For the 45 potential cases that were excluded from the study, the reasons were as follows. Four LA complications occurred outside the study period, and five LA complications occurred with operations other than cataract surgery. Information on date and operation was not forthcoming for a further three LA complications, so these were also excluded. Seven respondents could not find the case notes. In two cases, the respondent stated that the event was not considered to be an LA complication after all. In two cases, the adverse event occurred before any LA was given. Six cases appeared to be administrative error, in that the respondents stated that they had not reported any case to BOSU. Two were assumed to be duplicate reports and 14 respondents failed to return the case questionnaire despite reminders.

Reported complications are described in table 3 for each LA technique. This table includes only those 71 cases that were reported to have occurred in NHS patients. The two cases reported for private patients were an orbital haemorrhage (peribulbar LA) and delayed orbital inflammation (sub-Tenon's LA with hyaluronidase). There was no information on one case of central visual loss, presumed to be caused by peribulbar LA, as to whether it was NHS or private.

Outcomes for the 50 "potentially sight-threatening" complications were as follows. Of the 26 cases of globe penetration/perforation with retrobulbar or peribulbar LA, 12 required further surgery for retinal detachment and 16 had a poor visual outcome. One case of "globe penetration/perforation" was described with sub-Tenon's LA. The respondent described "a through and through perforation using a sub-Tenon's cannula. It caused a supra-choroidal haemorrhage … there was no evidence of retinal tear so presumably it was a supra-choroidal passage of the cannula". Insertion of the intraocular lens was delayed and final visual outcome was good; no further details were available for this case. None of the nine cases of retrobulbar/periocular haemorrhage lost vision. The case of retrobulbar/periocular haemorrhage associated with sub-Tenon's LA was associated with diplopia that took "a long time to resolve". Of the five cases of orbital inflammation associated with hyaluronidase, four recovered with no loss of vision. The fifth patient had surgical exploration of the orbit under general anaesthesia, but no cause was found and the eye became "blind".

The 21 "potentially life-threatening" complications and their outcomes are described in table 3. For patients who had retrobulbar or peribulbar anaesthesia, seven reported complications were consistent with brainstem anaesthesia. A neurological event was also reported after sub-Tenon's anaesthesia. Cardiovascular events also occurred in association with sub-Tenon's anaesthesia and topical anaesthesia. There were two reported deaths, as detailed in table 3. In both cases, the reporting ophthalmologist thought that the LA did not contribute to the cause of death.

Sedation was given to three patients who were reported to have complications (table 3). In two cases (apnoea, angina) the

Table 3 Complications of local anaesthesia (LA) for cataract surgery in the National Health Service, as reported to the investigators

LA technique	"Potentially sight-threatening" complications	"Potentially life-threatening" complications
Estimated number of LAs given during 13 month survey	Number of reports Reported incidence (95% CI) Description of events	Number of reports Reported incidence (95% CI) Description of events (patient information, outcome)
Peribulbar LA Estimated 115 700 cases	**34 reports** **2.9 per 10 000** (95% CI 2.0 to 4.1 per 10 000) 22 globe penetrations/perforations (1 with central retinal artery occlusion, 1 had sedation) 7 retrobulbar/periocular haemorrhage 2 orbital inflammation (had hyaluronidase) 2 diplopia (1 had hyaluronidase) 1 choroidal haemorrhage	**8 reports** **0.7 per 10 000** (95% CI 0.3 to 1.4 per 10 000) 1 grand mal fit, 5 min after LA (82 year old with HT, not on AEDs; no long-term effects) 1 grand mal fit, pulse 32/min (timing not stated) (77 year old with IHD, not on AEDs; no long-term effects) 1 apnoea for 10 min, unresponsive to speech for 20 min, pulse 130/min, 2 min after LA (83 year old with angina; transferred to medical ward, no long-term effects) 1 numb legs, variable BP, pulse 50/min, felt "strange", 5 min after LA (70 year old with IHD; no long-term effects) 1 drowsy, reduced oxygen saturation, 1 min after LA (73 year old with osteoarthritis; transferred to medical ward, no long-term effects) *1 angina, 5 min after LA (possibly caused by IV sedation)* (81 year old with IHD and COPD; stayed in hospital an extra 8 days, no long-term effects; respondent thought event not caused by LA) *1 CVA, BP 224/112, pulse 90/min, 15 min after LA; died later* (87 year old with controlled HT; left hemispheric CVA confirmed on MRI scan, patient died 15 days later; respondent thought LA did not contribute to cause of death) *1 nausea, sat up during operation, 20 min after LA* (77 year old with NIDDM, IHD, HT; given sedation and stayed in hospital an extra 3 days, no long-term effects; respondent thought event not caused by LA)
Retrobulbar LA Estimated 13 200 cases	**6 reports** **4.5 per 10 000** (95% CI 1.7 to 9.9 per 10 000) 4 globe penetrations/perforations 2 retrobulbar/periocular haemorrhage (1 had retro/peribulbar LA)	**2 reports** **1.5 per 10 000** (95% CI 0.2 to 5.5 per 10 000) 1 unresponsive to speech for 30 min, irregular breathing with oxygen saturation 85%, pulse 35/min, 5 min after LA; thought to be brainstem anaesthesia (frail patient aged 87, COPD and previous CVA; transferred to emergency department, no long-term effects) 1 grand mal fit, 30 min after LA (retro/peribulbar LA) (76 year old with IHD and cardiac failure, not on AEDs; transferred to medical ward, no long-term effects)
Sub-Tenon's LA Estimated 161 000 cases	**9 reports** **0.6 per 10 000** (95% CI 0.3 to 1.1 per 10 000) 3 orbital inflammation (all had hyaluronidase) 2 choroidal haemorrhage 1 "globe perforation" (doubtful, see text) 1 retrobulbar/periocular haemorrhage 1 inferior rectus palsy 1 inferior rectus laceration	**10 reports** **0.6 per 10 000** (95% CI 0.3 to 1.1 per 10 000) 5 "vaso-vagal" episodes, at 0, 5, 5, 15 and 25 min after LA (58 year old with NIDDM, HT; no long-term effects) (65 year old healthy individual; no long-term effects) (69 year old with HT; no long-term effects) (48 year old healthy individual; no long-term effects) (61 year old with aortic stenosis; no long-term effects) 1 numb arms, slurred speech and drowsy, 5 min after LA (58 year old with HT, hypothyroid, cervical spondylosis; kept in overnight, no long-term effects) 1 fast breathing, 20 min after LA (85 year old with HT; transferred to medical ward, no long-term effects) 1 fast atrial fibrillation 150/min, 5 min after LA (81 year old with HT; transferred to medical ward, no long-term effects) *1 cardiac arrest, 2 min after LA, patient died* (69 year old with IHD, aortic stenosis, previous thrombosis, obesity and type I respiratory failure; patient died in theatres due to myocardial infarction; respondent thought LA did not contribute to cause of death) *1 apnoea, low BP during surgery (after IV sedation)* (82 year old with HT, IHD; apnoea in sedated patient; converted to GA, no long-term effects; respondent thought event not caused by LA)
Sub-conjunctival LA Estimated 6400 cases	**0 reports** **0 per 10 000** (95% CI 0 to 4.7 per 10 000)	**0 reports** **0 per 10 000** (95% CI 0 to 4.7 per 10 000)
Topical LA Estimated 37 400 cases	**0 reports** **0 per 10 000** (95% CI 0 to 0.8 per 10 000)	**1 report** **0.3 per 10 000** (95% CI 0.01 to 1.5 per 10 000) 1 angina, 15–30 min after LA (age not stated, known angina; transferred to medical ward, investigations continuing)
Topical-intracameral LA Estimated 41 600 cases	**0 reports** **0 per 10 000** (95% CI 0 to 0.7 per 10 000)	**0 reports** **0 per 10 000** (95% CI 0 to 0.7 per 10 000)
LA technique not stated	1 report 1 globe penetration/perforation	

For a few reported events, the reporting ophthalmologist thought that the event was not caused by the LA; these events are marked with asterisks (*). Three patients had sedation, as indicated in the description of events. AEDs, anti-epileptic drugs; BP, blood pressure; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; HT, hypertension; IHD, ischaemic heart disease; IV, intravenous; NIDDM, non-insulin dependent diabetes mellitus.

respondent thought that the sedation had contributed to, or caused, the complication. The third case was a globe perforation. All these three cases had intravenous sedation.

Complication rates were estimated for each LA technique by dividing the number of reported adverse events by the estimated number of LAs given. Complication rates are presented in table 3. As expected, complication rates were low for all LA techniques. The complications varied with technique. Sharp-needle LA (retrobulbar and peribulbar) accounted for most or all of the globe penetrations and perforations, as described above. ''Brainstem anaesthesia'' was also seen with peribulbar and retrobulbar LA, although some neurological complications were reported with other LA techniques. There were five reports of vaso-vagal type episodes with sub-Tenon's LA, although this was not reported with any other LA technique. Topical and topical-intracameral LA had only one reported complication, of angina in a patient with previous angina.

We looked for statistical evidence as to whether complication rates varied with LA technique. For ''potentially sight-threatening complications'', Poisson regression gave strong evidence that rates vary with technique ($p<0.001$). For ''potentially life-threatening complications'', Poisson regression provided no evidence of rates varying with technique ($p = 0.16$), when all such reports were considered together regardless of severity or whether the respondent thought the LA had caused the complication. When the more severe, ''neurological'' adverse events are considered separately, Poisson regression analysis indicates a variation in complication rates with technique ($p = 0.03$).

DISCUSSION

This study confirms that the recent trend towards use of local anaesthesia (LA) for cataract surgery is continuing. In the United Kingdom, this is occurring in both the NHS and the private sector. This 2003 survey indicated that over 95% of UK cataract surgery is done using LA and most is performed using phacoemulsification (table 1). Our 1996 survey[14 15] found that around 59% of cataract surgery was done by phacoemulsification, of which 87% was done using LA and 13% using GA. For large-incision extracapsular cataract extraction, the figures in 1996 were 67% LA and 33% GA. The 1990 National Cataract Surgery Survey found that 92% of cataract surgery was done using large-incision extracapsular extraction and less than 4% using phacoemulsification: 46% used LA and 54% GA.[16]

The techniques of LA have also changed significantly in recent years. This 2003 survey indicated that LA use for cataract surgery consisted of 30.6% peribulbar, 3.5% retrobulbar, 42.6% sub-Tenon's, 1.7% sub-conjunctival, 9.9% topical and 11.0% topical-intracameral (table 1). Our 1996 survey[15] indicated the figures for phacoemulsification were 65% peribulbar, 15% retrobulbar, 7% sub-Tenon's, 6% sub-conjunctival, 4% topical and 0.1% topical-intracameral. A 1989 survey of UK ophthalmologists[17] indicated that, for LA cataract surgery, retrobulbar was the preferred technique of 83.5%, peribulbar 8.1%, combined retro/peribulbar 6.9%, and topical LA 1.4%. Thus, there has been a major shift in LA practice away from sharp-needle periocular injections (retrobulbar, peribulbar) and towards less invasive techniques.

Several factors have contributed to this change of practice, with a trend away from GA and towards the less invasive LA techniques of sub-Tenon's, topical, and topical-intracameral anaesthesia. Contributing factors include changes in surgical technique, the move to day-case surgery, efficiency and staffing issues, changing patient expectations, and safety concerns. With the traditional large-incision cataract techniques, contraction of the extraocular muscles was likely to cause vitreous loss or even an expulsive haemorrhage. Because of this risk of sight-threatening complications, most surgeons used GA, sedation or periocular injections to minimise the risk of eye movement during surgery. The small, self-sealing incision used in modern phacoemulsification surgery gives much greater control, such that contraction of the extra-ocular muscles is unlikely to cause sight-threatening complications. Thus, phacoemulsification has reduced the need for GA, sedation and periocular injections for routine cataract surgery.

Numerous authors have suggested that sub-Tenon's and topical/intracameral LA should be safer than retrobulbar or peribulbar injections. A knowledge of anatomy and physiology would support this assertion, although some concerns remain. Because there is no sharp needle, there should be no risk of needle perforation of the globe or optic nerve, and brainstem anaesthesia should not occur with these techniques. However, it has been suggested that these less invasive techniques might possibly have their own risks of complications. For example, concern has been raised regarding a possible increased rate of surgical complications in mobile eyes. Complications have been reported, including globe perforation occurring when dissecting with sharp scissors prior to sub-Tenon's LA.[10 18]

The safety of these less invasive LA techniques has not previously been assessed in any large clinical study. Published series, comprising a few thousand cases each, appear to confirm low complication rates, but case series produced by centres with an interest in LA safety should always be interpreted with caution. For example, the safety profile shown in the initial published series of 16 224 peribulbar LAs[19] has not been replicated in the real world.[4] The early assertion that ''complications of retrobulbar anesthesia … are greatly minimised in peribulbar anesthesia…''[3] has been proved to be incorrect, as the two techniques have similar incidences of globe perforation and brain-stem depression.[4 15] Our 1996 survey did look at large numbers of LAs given for cataract surgery in the real world of routine practice, but at the time there were too few cases using sub-Tenon's, sub-conjunctival, topical or topical-intracameral anaesthesia to assess their safety with any degree of certainty.[15]

The present study is the first to look at safety for large numbers of sub-Tenon's, topical and topical-intracameral LAs, in routine practice and on a national scale. It appears to confirm a low incidence of serious complications for these techniques. Results should be interpreted with caution, because of the method of case ascertainment used. Since we asked for reports of ''potentially life-threatening or sight-threatening complications of LA'', then we would only expect to get reports of ''recognised'' complications for each LA technique. Unrecognised complications (for example, an excess of cardiac problems with a particular LA technique) would not have been identified by this survey. Despite these caveats, our findings of very low complication rates would support the arguments for continued usage of these LA techniques for cataract surgery.

The low complication rates for this survey are likely to be an under-estimate of the true complication rates for each LA technique. Under-reporting of adverse events could occur for numerous reasons, including lack of interest in the study or BOSU, unwillingness to complete further forms, inability to locate patient details, embarrassment at having a complication, failing to recognise a complication when it occurs, or simply forgetting. Validation of previous BOSU studies indicates that 62.5% to 95% of potential cases were identified by the BOSU system.[12 13] To validate the reporting rate for our 1996 national survey of LA safety,[14] we obtained reports of all LAs given for 1 week (whether or not a complication occurred), and thereafter asked for reports of complications only for the remainder of the 3 month study. There were three reports of life-

threatening or sight-threatening complications in the initial week, and a total of 22 such reports in the full 3 months. After correcting for weekly workload, this suggested apparent under-reporting by a factor of 2–3: however, the actual number of reports did fall within the wide range of uncertainty of prediction, based on the first-week returns.[15] In the present survey, the actual degree of under-reporting is not known, and a validation study would be very difficult to do in view of the low complication rates expected, and probable incomplete note-keeping.

The complications reported in this survey may not all be complications of the LA technique itself. Some adverse events, such as needle perforation of the globe, are obviously a direct complication of the LA technique used. Causation can be confirmed if a needle penetration site is seen on examination of the eye itself. The reported globe perforation with sub-Tenon's LA (table 3) had no such confirmed perforation site, so it may have simply been a suprachoroidal haemorrhage, unrelated to anaesthesia technique. For brainstem anaesthesia, cadaver studies have shown that this complication can certainly occur with peribulbar and retrobulbar injections, when the needle inadvertently pierces the dural sheath of the optic nerve prior to LA injection.[20–22] Brainstem depression may also occur for other reasons, most commonly a cerebrovascular accident. In a large cohort of elderly patients undergoing any procedure, it would be no surprise if a few patients had a brainstem cerebrovascular accident as a chance event. Therefore, it may be that some of these neurological events reported to us were not LA complications at all. Alternative explanations include chance events, the stress of surgery, or the side-effects of peri-operative medications such as phenylephrine eye drops. For sub-Tenon's LA, there is no anatomical explanation for neurological complications, so we suspect that the reported case of ''numb arms, slurred speech and drowsy'' (table 3) may have been unrelated to LA technique.

A significant number of sight-threatening and life-threatening complications were reported with peribulbar and retrobulbar injections. The 26 cases of globe penetration/perforation can be directly attributed to the LA technique used; many cases had a poor visual outcome. There were seven neurological events which were likely to represent brainstem anaesthesia due to inadvertent injection of LA around the optic nerve. Because of likely under-reporting, it is probable that the true number of such complications is higher. With the continuing trend away from sharp-needle injection LA, we would expect the incidence of these sight-threatening and life-threatening complications to reduce in the coming years. However, there are also concerns that a move away from retrobulbar and peribulbar injections may lead to a de-skilling of ophthalmologists and anaesthetists, leading to a higher risk of complications for those few injections that such individuals give in the future.

This study shows that we should be prepared for life-threatening adverse events in all patients undergoing cataract surgery. Some, but not all, are related to LA technique and it appears that sub-Tenon's, topical and topical-intracameral LA are ''low risk'' as regards LA complications. A move to using these techniques for cataract surgery is likely to be associated with a lower incidence of sight-threatening and life-threatening adverse events. As discussed above, there is a theoretical risk that other, as yet unrecognised, adverse events could occur with these techniques. Fears regarding possible increased rates of surgical complications with topical/intracameral anaesthesia appear to be unfounded according to a prospective randomised trial[23] and a recent study of routine practice.[24] The question as to the best/safest LA technique could only be answered by a very large, prospective randomised trial, looking at all outcomes for tens of thousands of patients. Such a study could probably never be done. Based on currently available evidence, the current trend away from sharp-needle injections for routine cataract surgery appears to be justified.

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REFERENCES

1 **Hamilton RC**. Anesthesia block technique. *Ophthalmol Clin North Am* 1998;**11**:133–6.
2 **Hamilton RC**. Retrobulbar block revisited and revised. *J Cataract Refract Surg* 1996;**22**:1147–50.
3 **Davis DB 2nd**, Mandel MR. Posterior peribulbar anesthesia: an alternative to retrobulbar anesthesia. *J Cataract Refract Surg* 1986;**12**:182–4.
4 **Hamilton RC**. Complications of ophthalmic regional anaesthesia. In: Kumar CM, Dodds C, Fanning GL, eds. *Ophthalmic anaesthesia*. Lisse, Netherlands: Swets & Zeitlinger, 2002:181–96.
5 **Hamilton RC**. Ocular explosion after peribulbar anesthesia. *Ophthalmology* 1998;**105**:1355.
6 **Edge R**, Navon S. Scleral perforation during retrobulbar and peribulbar anesthesia: risk factors and outcome in 50,000 consecutive injections. *J Cataract Refract Surg* 1999;**25**:1237–44.
7 **Ramsay RC**, Knobloch WH. Ocular perforation following retrobulbar anesthesia for retinal detachment surgery. *Am J Ophthalmol* 1978;**86**:61–4.
8 **Nicoll JM**, Acharya PA, Ahlen K, *et al*. Central nervous system complications after 6000 retrobulbar blocks. *Anesth Analg* 1987;**66**:1298–302.
9 **Wittpenn JR**, Rapoza P, Sternberg P Jr, *et al*. Respiratory arrest following retrobulbar anesthesia. *Ophthalmology* 1986;**93**:867–70.
10 **Kumar CM**, Dodds C. Sub-Tenon's anesthesia. *Ophthalmol Clin North Am* 2006;**19**:209–19.
11 **Irle S**, Luckefahr MH, Tomalla M. [Topical anesthesia as routine procedure in cataract surgery: evaluation of pain and complications in 1010 cases]. *Klin Monatsbl Augenheilkd* 2005;**222**:36–40.
12 **Foot B**, Stanford M, Rahi J, *et al*. The British Ophthalmological Surveillance Unit: an evaluation of the first 3 years. *Eye* 2003;**17**:9–15.
13 **Kamalarajah S**, Silvestri G, Sharma N, *et al*. Surveillance of endophthalmitis following cataract surgery in the UK. *Eye* 2004;**18**:580–7.
14 **Eke T**, Thompson JR. The National Survey of Local Anaesthesia for Ocular Surgery. I. Survey methodology and current practice. *Eye* 1999;**13**:189–95.
15 **Eke T**, Thompson JR. The National Survey of Local Anaesthesia for Ocular Surgery. II. Safety profiles of local anaesthesia techniques. *Eye* 1999;**13**:196–204.
16 **Courtney P**. The National Cataract Surgery Survey: I. Method and descriptive features. *Eye* 1992;**6**:487–92.
17 **Campbell DN**, Spalton DJ. A national survey of the use of local anesthesia for cataract surgery. *Eur J Implant Refract Surg* 1992;**4**:213–17.
18 **Frieman BJ**, Friedberg MA. Globe perforation associated with subtenon's anesthesia. *Am J Ophthalmol* 2001;**131**:520–1.
19 **Davis DB 2nd**, Mandel MR. Efficacy and complication rate of 16,224 consecutive peribulbar blocks. A prospective multicenter study [erratum appears in J Cataract Refract Surg 1994;20: 673], *J Cataract Refract Surg* 1994;**20**:327–37.
20 **Drysdale DB**. Experimental subdural retrobulbar injection of anesthetic. *Ann Ophthalmol* 1984;**16**:716–18.
21 **Unsold R**, Stanley JA, DeGroot J. The CT-topography of retrobulbar anesthesia. Anatomic-clinical correlation of complications and suggestion of a modified technique. *Albrecht Von Graefes Arch Klin Exp Ophthalmol* 1981;**217**:125–36.
22 **Zahl K**, Nassif JM, Meltzer MA, *et al*. Simulated peribulbar injection of anesthetic. *Ann Ophthalmol* 1991;**23**:114–17.
23 **Jacobi PC**, Dietlein TS, Jacobi FK. A comparative study of topical vs retrobulbar anesthesia in complicated cataract surgery. *Arch Ophthalmol* 2000;**118**:1037–43.
24 **Shaw AD**, Ang GS, Eke T. Complication rates for phacoemulsification surgery, in a hospital ophthalmology department where topical-intracameral anaesthesia is the norm (submitted for publication).