CLINICAL STUDY

Vertical diplopia following local anaesthetic cataract surgery: predominantly a left eye problem?

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Abstract

Purpose **Vertical diplopia is an uncommon but disappointing complication of otherwise successful local anaesthetic cataract surgery. We studied strabismus patterns in a group of such patients to identify the nature and extent of extraocular muscle involvement.**

Methods **A retrospective review identified 15 cases of vertical diplopia following local anaesthetic cataract surgery between July 1994 and January 1998. Peribulbar anaesthesia was used in all cases and given by right-handed professionals.**

Results **All cases had otherwise successful cataract surgery (mean age 80.5 years; median pre-operative VA 6/18; median post-operative VA 6/9). The mean level of vertical diplopia was 7.2 prism dioptres (PD) in the primary position (range 2–25 PD). The left inferior rectus (IR) was paretic in 6 cases and restricted in 5 cases. The left superior rectus (SR) was not affected in any of the cases. The right IR was restricted in a single case. The right SR was paretic in 2 cases and restricted in a single case. None of the cases had clinical involvement of the oblique muscles. Eleven of the cases were managed successfully with prisms. Two of the cases required strabismus surgery.**

Conclusions **The incidence of left eye extraocular muscle involvement was greater than right eye involvement, although this did not reach statistical significance (73% vs 27%; $p = 0.075$). This may be due to the more difficult access of right-handed individuals giving left eye peribulbar injections with the needle tract being directed more closely to the muscle cone. The IR muscle is more commonly affected than the SR (80% vs 20%; $p = 0.019$). An equal incidence of paretic and restricted rectus muscle pathology was found in this study (53% vs 47%; $p = 0.818$). The exact aetiology of muscle injury is unknown but could be due to direct muscle or nerve trauma, anaesthetic toxicity, periocular haemorrhage or a combination of these.**

Key words Cataract surgery, Complications, Diplopia, Local anaesthetic

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Persistent binocular diplopia is an uncommon, but disappointing, adverse outcome of otherwise successful local anaesthetic cataract surgery.[1] Several different aetiological categories have been proposed to account for vertical diplopia in these cases:[2] (1) pre-existing disorders (e.g. thyroid eye disease[3]), (2) sensory deprivation by the cataract (e.g. decompensated heterophorias,[4] central disruption of binocular fusion[5,6]), (3) optical aberrations (e.g. aneisokonia[2]) and (4) surgical/anaesthetic trauma to the extraocular muscles or orbital soft tissue. This last category has received much attention recently as a potentially avoidable cause of vertical diplopia.

Potential mechanisms for either direct or indirect surgical trauma have included bridle suture placement,[4,7,8] subconjunctival antibiotic injections,[9–11] direct needle trauma to the muscles or nerves,[8,12,13] haemorrhage within the muscles[2,7,14] or a myotoxic effect of the local anaesthetic.[7,12,13,15–25]

We identified a group of local anaesthetic cataract surgery cases in which post-operative vertical diplopia was due to surgical/anaesthetic trauma. We describe the strabismus patterns in this group and identify the nature and extent of extraocular muscle involvement and discuss management.

Patients and methods

Cases

We reviewed all cases of vertical diplopia referred to the orthoptic department and/or the ocular motility clinic of our unit following local anaesthetic cataract surgery between July 1994 and December 1998. We included only those cases with diplopia that was noted within the first 4 weeks after cataract surgery and persisted for more than 3 months.

Only those cases identified as being potentially secondary to surgical/anaesthetic trauma were included. Any patients with pre-existing disorders (e.g. thyroid eye disease, neurogenic palsies, myasthenia gravis),

decompensated heterophorias or post-operative optical aberrations (e.g. anisometropia ⩾ 4.5 D) were excluded.

Data collection

Pre-operative and peri-operative data were collected retrospectively from the casenotes. All cases were reviewed post-operatively by at least one of the authors. Pre-operative data included demographic data, pertinent medical and ophthalmic history, corrected Snellen acuity, refraction and detailed ophthalmic slit-lamp examination.

Peri-operative data included mode of local anaesthesia (e.g. retrobulbar vs peribulbar; number and position of injection sites; nature of anaesthetic agents used; complications) and details of surgery (phacoemulsification vs extracapsular; use of bridle sutures; subconjunctival antibiotic injections; complications).

Post-operative review involved a complete ophthalmological examination including corrected Snellen acuity, refraction, slit-lamp evaluation and dilated fundal examination. Ocular motility evaluation involved a prism cover test with a fixation target at 6 m in the nine diagnostic positions of gaze and in the primary position for a near accommodative target at 0.33 m. The Bielschowsky head-tilting test, measurement of torsion, subjective assessment of saccadic velocities, Hess chart assessment and forced duction testing were performed in selected cases.

Post-operative management

The post-operative management of diplopia in these cases was reviewed. Management was categorised as no treatment, occlusion, prisms or surgical correction. The nature, extent and success of each of these treatment modalities were recorded.

Statistical analysis

For continuous data, statistical analysis was by the use of a paired Student's *t*-test for paired samples. For the categorical data of extraocular muscle involvement, statistical analysis was by calculation of the *z*-test statistic for a single proportion assuming the expected proportion to be 50%. A p value of 0.05 or less was considered to be statistically significant.[26]

Results

Patient characteristics

Between July 1994 and January 1998 we identified 15 cases of vertical diplopia following local anaesthetic cataract surgery (5 men, 10 women). The mean age was 80.5 years (range 65–95 years).

The median pre-operative Snellen acuity was 6/18 (range 6/9-Hand Movements). The post-operative Snellen acuity was significantly improved to a median level of 6/9 (range 6/6–6/12; $t = 5.36$; $p = 0.0001$). The mean level of post-operative anisometropia was 1.89 D (range 0.75–4.25 D). Only a single case (case 6) had anisometropia greater than 3.00 D. This case was included in the study as there was good clinical evidence that the diplopia was due to restrictive pathology of the inferior rectus rather than to an effect of anisometropia.

Peri-operative data

Eleven of the patients (73%) had left eye cataract surgery. Fourteen had standard phacoemulsification surgery and posterior chamber intraocular lens implantation (PC-IOL). A single patient had extracapsular cataract extraction and PC-IOL. Fourteen of the patients had uneventful cataract surgery, with a single patient having a posterior capsule rupture managed with limited anterior vitrectomy and sulcus-fixated posterior chamber intraocular lens. None of the patients had bridle sutures for fixation. All patients had a subconjunctival injection of cefuroxime.

All patients had peribulbar local anaesthetic, 14 performed by four different anaesthetists and one by a surgeon. The most popular technique used in our cohort of cases was a two-site peribulbar technique (percutaneous inferolateral and medial; 25 gauge 25 mm needle) using 10 ml of a 50:50 mixture of 0.75% bupivacaine and 2% lignocaine with hyaluronidase. The exact volume of injection was not recorded in all cases. All the local anaesthetics were given by right-handed professionals.

In 3 cases (20%) a peribulbar haemorrhage was noted and recorded at the time of the anaesthetic.

Strabismus patterns

The vertical diplopia in our cohort of post-cataract surgery cases had a mean of 7.2 prism dioptres (PD) in the primary position as measured by a prism cover test (range 2–25 PD). There were 8 cases of ipsilateral hypotropia in the primary position (5 left eyes, 3 right eyes). There were 5 cases of ipsilateral hypertropia in the primary position (4 left eyes, 1 right eye) and a further 2 cases of ipsilateral hypertropia only manifested on downgaze; both of these cases followed left eye cataract surgery (Table 1).

All cases had involvement of the recti muscles; none had clinical involvement of the oblique muscles. In 73% (11/15) of cases the affected extraocular muscles were of left eyes ($p = 0.075$). In 80% (12/15) of cases the inferior rectus muscle was affected. This was statistically significant when compared with superior rectus involvement ($p = 0.019$). Affected extraocular muscles were paretic in 53% (8/15) of cases and restricted in 47% (7/15) of cases ($p = 0.818$).

Management

Eleven of the patients (73%) were managed satisfactorily with the incorporation of prisms into spectacles. A single patient (case 8) had a very limited fusional range

Table 1. *Peri-operative details and post-operative strabismus patterns*

Patient no.	Cataract surgery	Anaesthetic technique	Peri-operative complications	Deviation of surgical eye in primary position	Presumed affected muscle	Management	Outcome
1	L Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	Peribulbar haemorrhage	L hypotropia 10 PD	LIR restriction	Prisms	Diplopia free
2	L Phaco	PB Inferolateral 2% Ligno	Peribulbar haemorrhage	L hypertropia 5 PD	LIR paresis	Prisms	Diplopia free
3	R Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	R hypotropia 25 PD	RIR restriction	RIR recession 5 mm (further 3 mm at adjustment)	Residual 8 PD R hypotropia managed with prism
4	L Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	L hypotropia 2 PD	LIR restriction	Prisms	Diplopia free
5	L Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	PC rupture, anterior vitrectomy, IOL in sulcus	L hypotropia 10 PD	LIR restriction	Prisms	Diplopia free
6	L Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	L hypotropia 8 PD	LIR restriction	Prisms	Diplopia free
7	L Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	L hypotropia 4 PD	LIR restriction	None	Diplopia free
8	R Phaco	PB Inferolateral 2% Ligno	None	R hypotropia 3 PD	RSR paresis	Occlusion	Diplopia free
9	L Phaco	PB Inferolateral 2% Ligno	None	L hypertropia 4 PD in primary 12 PD on downgaze	LIR paresis	RIR recession 2 mm	Diplopia free
10	L ECCE	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	L hypertropia 5 PD in primary 8 PD on downgaze	LIR paresis	Prisms	Diplopia free
11	L Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	L hypertropia only on downgaze 6 PD	LIR paresis	Prisms	Diplopia free
12	R Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	R Hypertropia 2 PD in primary 4 PD on downgaze	RSR restriction (initially RIR paresis)	Prisms	Diplopia free
13	L Phaco	PB Inferolateral 2% Ligno	Peribulbar haemorrhage	L hypertropia only on downgaze 4 PD	LIR paresis	Prisms	Diplopia free
14	R Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	R hypotropia 3 PD	RSR paresis	Prisms	Diplopia free
15	L Phaco	PB Inferolateral + medial 0.75% Bupi + 2% Ligno	None	L hypertropia 2 PD in primary 4 PD on downgaze	LIR paresis	Prisms	Diplopia free

L, left; R, right; Phaco, phacoemulsification; ECCE, extracapsular cataract extraction; PB, peribulbar; Ligno, lignocaine; Bupi, bupivacaine; PD, prism dioptres; LIR, left inferior rectus; RIR, right inferior rectus; RSR, right superior rectus.

and could not be consistently controlled with prisms. In this case we resorted to the use of occlusion using a Blenderm patch on the patient's spectacles. A further patient (case 7) had 4 PD of right hypertropia in the primary position and could manage to control this for much of the time without the need for prismatic correction.

Two further patients were managed with surgical intervention. In case 3, 25 PD of right hypotropia in the primary position was noted following right eye cataract surgery. Forced duction testing (under general anaesthetic with non-depolarising muscle paralysis) demonstrated a restricted right inferior rectus. A 5 mm recession of the right inferior rectus was performed on an adjustable suture. At adjustment a large residual right hypotropia was present. We further recessed the muscle 3 mm. Six months post-operatively a residual 8 PD of right hypotropia remains but this is managed satisfactorily with prisms. In case 9, 4 PD of left hypertropia in the primary position, increasing to 12 PD on downgaze, was noted following left eye cataract surgery. Forced duction testing excluded an ipsilateral restriction. In the absence of restrictive pathology the presumed aetiology for the manifest left hypertropia was a paretic left inferior rectus. A 2 mm adjustable recession of the right inferior rectus was performed under topical anaesthesia. Post-operatively the patient is comfortable with no diplopia.

Discussion

Persistent vertical diplopia following local anaesthetic cataract surgery is an uncommon but increasingly recognised complication of otherwise successful surgery. It would be interesting to know the overall incidence of vertical diplopia following local anaesthetic cataract surgery. However, in such a retrospective series the true incidence is very difficult to ascertain. Despite the obvious limitations of any estimate, we have identified 15 cases in a period when 4600 local anaesthetic cataract operations were performed in our unit. This equates to an approximate incidence rate of 0.3%, assuming we have all the symptomatic cases. During this same period, approximately 500 cataract operations were performed under general anaesthesia. We have not identified any cases of vertical diplopia following general anaesthesia in our own unit. However, previous studies have suggested that post-operative diplopia is not exclusive to local anaesthetic surgery and can occur following general anaesthesia for a number of reasons including bridle suture placement and subconjunctival antibiotic toxicity.[4,10,11]

Our 15 cases of post-operative vertical diplopia following local anaesthetic surgery appear to have been secondary to anaesthetic/surgical trauma to the extraocular muscles. The precise aetiology of this muscle trauma is unknown. In previous studies the placement of bridle sutures[4,8,11,27] and the use of subconjunctival gentamicin injections in rabbit[9] and human studies[10] have been implicated as causal factors. In our study none of the cases had bridle sutures and all had subconjunctival cefuroxime injections placed in the inferolateral/inferomedial quadrants avoiding direct injection over muscle insertions.

Other potential mechanisms for direct or indirect extraocular muscle trauma are direct needle trauma to the muscles or nerves,[8,12,13] haemorrhage within the muscles[2,7,14] or a myotoxic effect of the local anaesthetic.[7,12,13,15–25] We can not be sure which of these possible aetiologies, either alone or in combination, is responsible for the vertical diplopia patterns in our own cohort of cases. It may be important that in 3 of our cases peribulbar haemorrhage was noted at the time of anaesthetic administration. This might imply that there has either been haemorrhage within the muscle or perhaps an indirect muscle insult through local ischaemia. Previous studies have shown MRI evidence for segmental enlargement of the inferior rectus in cases of diplopia following cataract surgery, suggesting local haematoma.[14,20] None of the patients in our retrospective study had orbital imaging.

The myotoxic effect of local anaesthetics has been demonstrated histologically in rat,[23] primate[24,25] and human studies.[24] In clinical studies both bupivacaine (0.75%) and lignocaine (2% and 4%) have been implicated as being myotoxic.[7,12,13,15–22,28] In our own study, the patients received 0.75% bupivacaine and/or 2% lignocaine. Some authors have suggested that the use of a lower concentration of bupivacaine may prevent this potential toxicity.[11,19]

Table 2. *Nature of affected recti muscles*

Nature of affected muscle	% of cases (*n*)
Left inferior rectus	
Paretic	40% (6/15)
Restricted	33% (5/15)
Left superior rectus	
Paretic	0
Restricted	0
Right inferior rectus	
Paretic	0
Restricted	7% (1/15)
Right superior rectus	
Paretic	13% (2/15)
Restricted	7% (1/15)

The most commonly affected extraocular muscle in our study was the inferior rectus (80% of cases). This correlates well with many previously reported studies.[2,7,13–15,17,18,20–22,29] Many of these studies propose the mechanism of inferior rectus contracture syndrome resulting in an ipsilateral restrictive hypotropia.[2,14,20,22,29] This pattern was present in 40% (6/15) of our cases (Table 2). However, a further 40% (6/15) of cases had paresis of the inferior rectus. Although this paretic pattern appears to be less common in the literature it has been reported in several studies.[13,15,19] It is not fully understood why some muscles become restricted and others paretic.[15] It might reflect the extent and nature of trauma, with paresis resulting from either nerve trauma or localised muscle trauma whilst anaesthetic toxicity or diffuse muscle ischaemia may cause muscle contracture.

In our study, 3 patients had involvement of the superior rectus. Although these 3 cases involved the right superior rectus the very low incidence would not suggest that this finding was exclusively unilateral in nature. In one of these cases there was restriction of the superior rectus which followed initial paresis of the ipsilateral inferior rectus. This phenomenon has previously been reported after local anaesthetic.[18] In the further 2 patients the superior rectus was paretic. One of these had a two-site peribulbar anaesthetic technique involving inferolateral and medial injections using a 25-gauge 25 mm needle. In this case the medial injection could inadvertently have caused direct or indirect trauma to the superior rectus or neuromuscular complex. In the remaining patient, a single-site peribulbar technique was used. Although it is difficult to imagine how a correctly placed needle could have affected the superior rectus it is possible that the needle path took more of a retrobulbar course and damaged the superior rectus.

None of our cases of vertical diplopia had clinical involvement of the oblique extraocular muscles, although this phenomenon has been reported.[12] A particularly interesting finding in our study was that 73% of the cases followed left eye surgery. A previous review of the literature by Corboy and Jiang[29] showed that of 132 cases of vertical diplopia after local anaesthetic

cataract surgery, 116 (88%) followed left eye surgery. This left eye predominance has been attributed to the difficulties of access when right-handed professionals give left eye local blocks.[29] All our local anaesthetic blocks were given by right-handed professionals. It has been suggested that if, when right-handed professionals give left eye blocks, they stand on the left-hand side of the patient then there is a tendency for the needle tract of the peribulbar injection to be directed more closely towards the muscle cone.[29] This can be avoided by maintaining extreme dorsiflexion of the wrist whilst giving the inferolateral injection or by standing directly in front of the patient for access. In general, management of these cases of post-operative vertical diplopia in our own cohort has been relatively successful, with 80% of patients managing with prisms or their own fusional reserve. In only 2 cases have we proceeded to surgical intervention. In both these cases an inferior rectus recession has permitted good post-operative functional control. Several authors have advocated the use of adjustable sutures for inferior rectus recessions in cases of this nature.[14,20,22,27]

In conclusion, persistent vertical diplopia is an uncommon but disappointing complication of otherwise successful local anaesthetic cataract surgery. Although the precise aetiological mechanisms of anaesthetic trauma remain unclear the left inferior rectus appears to be particularly vulnerable when local blocks are given by right-handed professionals. To reduce the risk of this potential complication it would be prudent to use the minimum number of sites for local anaesthesia along with the minimum volume and concentration of anaesthetic to achieve adequate anaesthesia. Particular attention should be given to maintaining sufficient wrist dorsiflexion when right-handed professionals are giving left eye inferolateral injection from the left side (and vice versa). Any significant periorbital haemorrhage should be noted and managed with immediate local compression. With increased awareness and appropriate developments in our anaesthetic technique we hope to be able to reduce the incidence of this disappointing complication of cataract surgery.

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