The effect of sub-Tenon's anaesthesia on intraocular pressure

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CLINICAL STUDY

Abstract

Purpose **To assess the effect of sub-Tenon's anaesthesia on intraocular pressure (IOP) prior to cataract surgery.**

Methods **Fifty consecutive patients undergoing phacoemulsification of cataract were recruited. Routine sub-Tenon's anaesthesia was administered with 5 ml unpreserved 2% lignocaine. IOPs were measured immediately prior to and at 1, 3, 5 and 10 min after injection. Efficacy was assessed subjectively by the operating surgeon. No ocular compression was used. Pre- and post-injection IOPs were compared using the Wilcoxon signed rank test, whereas all other results were compared with baseline using Student's two-tailed paired *t*-tests.**

Results **All patients achieved good analgesia and akinesis. There was no significant difference between the IOP prior to and 1 min after injection. At all time intervals after 3 min there was a significant reduction in IOP compared with the pre-injection measurement. At 5 min, the mean IOP reduction was 2.72 mmHg and at 10 min IOP was lowered by 2.92 mmHg. Both reductions were statistically significant compared with baseline.**

Conclusions **Sub-Tenon's anaesthesia does not cause any significant rise in IOP, thereby possibly making it the anaesthetic technique of choice when an increase in IOP is undesirable. There is no indication for the use of an ocular pressure-reducing device when sub-Tenon's anaesthesia is employed.**

Key words Cataract surgery, Intraocular pressure, Local anaesthesia, Sub-Tenon's, Tonopen

Sub-Tenon's anaesthesia has been shown to be a safe and effective alternative to peribulbar and retrobulbar regional anaesthesia for intraocular surgery.[1] Injection of a volume of anaesthetic agent into the fixed orbital space may cause globe compression and a concomitant rise in intraocular pressure (IOP). This rise in IOP is undesirable as it may cause compromise of retinal blood flow with possible exacerbation of glaucomatous damage, an elevated vitreous pressure with subsequent risk of complications during intraocular surgery, or problems related to sudden decompression at initial incision.

Peribulbar anaesthesia has been shown to cause an immediate post-injection elevation in IOP.[2–8] This rise is highly individually variable and may be dependent on the volume of agent utilised.

Our study aimed to identify the effect of sub-Tenon's regional anaesthesia on IOP and to discuss the clinical implications of any findings.

Materials and methods

We studied the IOP changes after sub-Tenon's anaesthesia in 50 consecutive patients undergoing clear cornea cataract surgery (one eye per patient). Patients with glaucoma or ocular hypertension were excluded, as were patients with axial lengths outside the range 20–25 mm. Measurements were taken with a Tonopen XL (Biorad), calibrated according to the manufacturer's guidelines at the start of each session. The study complied with and received approval from the Local Research Ethics Committee. All patients gave informed consent to participation.

All patients had their IOP measured immediately before, and at 1 min, 3 min, 5 min and 10 min after administration of routine sub-Tenon's anaesthesia. The anaesthetic agent utilised was 5 ml of 2% unpreserved lignocaine given via a curved 19G blunt sub-Tenon's cannula introduced into the sub-Tenon's space in the inferonasal quadrant. Injection took approximately 10 s. All patients underwent routine phacoemulsification of cataract with intraocular lens implantation. Efficacy of block was assessed subjectively by the operating surgeon with regard to the quality of akinesis and analgesia. No ocular compression was undertaken. Pre- and post-injection IOPs were compared using the Wilcoxon signed rank test while other comparisons were made using Student's two-tailed paired *t*-test.

Results

Complete data were obtained on 50 patients. The mean age for all subjects was 79.71 years (standard deviation = 7.15 years). Thirty-two (64%) patients were female and 18 (36%) were male. All patients achieved full analgesia and good akinesis as assessed by the operating surgeon. No operative or anaesthetic complications were encountered.

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Table 1. *Mean intraocular pressures and standard deviations at each time interval*

	Time after injection				
	Pre-injection	1 min	3 min	5 min	10 min
Mean (mmHg)	21.04	21.40	20.36	18.32	18.12
SD	4.79	5.03	4.90	4.63	4.75

There was no significant difference between the IOP prior to and 1 min after injection ($p = 0.367$) by Wilcoxon signed rank test. Table 1 summarises the IOP readings at each time interval and Table 2 gives statistical data relating to the IOP at each time point compared with baseline by paired *t*-test. Fig. 1 graphically demonstrates the IOP changes over time compared with time zero (pre-injection IOP).

At all time intervals after 3 min there was a significant reduction in IOP compared with the pre-injection measurement. At 5 min the mean IOP reduction was 2.72 mmHg ($p < 0.001$) and at 10 min IOP was lowered by 2.92 mmHg ($p < 0.001$).

Discussion

Since its initial description in 1992 by Stevens, sub-Tenon's anaesthesia for ocular surgery has been increasingly popular.[9] It involves the transconjunctival injection of anaesthetic solution into the potential sub-Tenon's space. It aims to achieve good analgesia and akinesis while avoiding the risks of globe perforation, retrobulbar haemorrhage, optic nerve damage, and inadvertent injection into the subarachnoid space associated with needle techniques. It has been shown to be at least as effective as peribular anaesthesia.[1]

Numerous studies have assessed the effect of retrobulbar and peribulbar anaesthesia on IOP. Although there is great variation in methodology used, in particular in relation to the volume of local anaesthetic injected, the majority confirm a sustained increase in IOP after periocular anaesthesia. To negate the pressure rise, ocular compression, whether digital or with the use of devices such as the Honan's balloon, is commonly employed.

Palay and Stulting[2] measured a mean rise in IOP of 6.20 mmHg after injection of 4 ml retrobulbar anaesthesia that was rapidly reversed by pressure application. Morgan and Chandna,[3] in their study of 70 patients, found a significant rise in IOP at 1 min after 8 ml

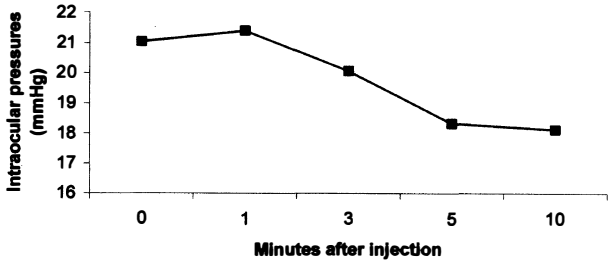

Fig. 1. *Intraocular pressure changes after sub-Tenon's anaesthesia administration. Time zero indicates the measurement taken prior to injection.*

Table 2. *Changes in IOP compared with pre-injection values, with standard deviation, standard error of mean (SEM) and paired* t*-test results*

	Time after injection			
	1 min	3 min	5 min	10 min
IOP change (mmHg)	0.36	–0.68	–2.72	–2.92
SD	1.88	2.57	2.27	2.27
SEM	0.26	0.36	0.32	0.32
Paired *t*-test	0.182	0.068	<0.001	<0.001

peribulbar anaesthesia. They noted a spontaneous subsequent decrease in IOP, reaching baseline/pre-injection levels by 4 min without any ocular compression. After this point there was no further reduction in IOP. Interestingly, 10 of their 70 subjects suffered dramatic IOP increases, reaching values in excess of 50 mmHg. Bowman *et al.*[4] also found a large and individually variable rise in IOP after peribulbar anaesthesia, documenting a mean rise in IOP of 11.44 mmHg with the greatest increase being 31 mmHg.

All the current literature suggests that this pressure rise is secondary to the volume effect of the local anaesthetic agent forcibly placed within the limited confines of the bony orbit. It has been shown that increasing the volume of injectate causes exaggeration of the IOP rises.[5,10] The high variability of response indicates that other factors are likely to be involved such as variation in orbital volume and tightness of extraocular musculature and orbital septum.

We utilised Tonopen measurements because of ease of use, repeatability and its documented accuracy.[11,12] Our findings indicate that there is no significant IOP rise associated with sub-Tenon's anaesthesia. This may be due in part to the lower volumes of anaesthetic agent used compared with peribulbar anaesthesia; however, the technique in itself may contribute to avoidance of a pressure rise. The potential sub-Tenon's space surrounds the globe and when filled with anaesthetic agent leads to more diffuse thin layer of fluid compared with the very localised initial collection associated with needle techniques. Moreover, the transconjunctival/sub-Tenon's passage of the blunt cannula (which is initially delineated by blunt dissection) potentially acts as a pressure valve. This conduit may allow reflux of excess injectate, thereby acting as a release mechanism and preventing development of unwanted compressive forces.

To our knowledge only two other studies have looked at the effect of sub-Tenon's anaesthesia on IOP. Azmon and colleagues[6] directly compared the IOP changes associated with peribulbar and sub-Tenon's anaesthesia. One minute after the injection, IOP increased significantly in the peribulbar group (mean 7.97 mmHg); however, there was no significant increase in the sub-Tenon's injection group. In both their groups, IOP returned to pre-procedure levels by 10 min after injection with no compression. Stevens *et al.*[14] used 3.2 ml for sub-Tenon's anaesthesia compared with 6.4 ml (mean values) for peribulbar anaesthesia, finding that the former produced no significant IOP rise and the latter resulted

in a significant increase in ocular tension. Our study utilised a slightly higher volume of injectate (5 ml), but despite this our findings agree with those of the previous studies in that even with this volume there is no significant effect upon IOP.

Although the great majority of eyes will tolerate short periods of raised IOP, a small proportion may be at risk of serious complication. In particular patients with glaucoma may be particularly susceptible to a sustained or even transient excessive rise in IOP. Indeed in 1994 O'Donoghue *et al*.[8] found that patients with glaucoma having peribulbar or retrobulbar anaesthesia experienced higher and more persistent increases in IOP than non-glaucoma patients. In cases of pre-existing deficient optic nerve head blood supply, the pressure rise associated with peribulbar anaesthesia may potentially precipitate further deleterious compromise of perfusion. Of further concern is the practice of immediate application of the Honan's balloon in order to reduce IOP and 'soften' the eye. It has been shown that in some patients after peribulbar anaesthesia, IOP may rise to values in excess of 50 mmHg.[2,4] The immediate placement of Honan's balloon compression, for example set at 30 mmHg, will give an immediate (albeit transient) summative pressure effect of 80 mmHg. McDonnell *et al*.[13] have demonstrated that IOP may increase to levels sufficient to occlude the central retinal artery immediately following placement of a Honan's IOP reducer.

In contrast to other previously reported data we noted a small but statistically significant reduction in IOP below baseline/pre-operative readings after 5 min with no ocular compression. We are unsure as to the true significance of this finding; however, the size of the statistical significance would indicate a constant reproducible effect. Our study was not designed to look for any reduction in IOP but was specifically tailored to assess any pressure increase, and thus these findings must be interpreted with caution. This reduction in IOP may be due in part to the pharmacological effect of the local anaesthetic agent on ocular blood flow or may be due to an effect on the ciliary ganglion with secondary reduction in aqueous production. The short time from cause to effect would make this latter explanation unlikely.

The likeliest aetiology of this phenomenon would be the reduction in tone of the extraocular musculature causing less resting tension on the globe and consequent IOP reduction. Reduction of IOP back to pre-injection levels has been shown in peribulbar cases without ocular compression,[3] but no reduction below baseline has previously been noted. It is possible that pressure reduction secondary to the aforementioned factors is indeed taking effect; however, because of the larger initial peak associated with this method of anaesthesia, it is not manifesting as below-baseline IOP readings. A further factor that must be considered is that the Tonopen readings themselves are causing a reduction in IOP secondary to a compressive/massage effect. Repeated Tonopen readings have not previously been shown to cause inherent reductions in IOP.[3,11,12]

The results presented here show that IOP does not increase significantly after sub-Tenon's local anaesthetic injection, and we would thus suggest that it is a safer method of regional anaesthesia for use in patients where a rise in IOP may be deleterious. Moreover, the use of ocular compression for pressure reduction is unnecessary in the sub-Tenon's setting. Glaucoma patients were excluded from our study and it is likely that their pressure responses are different from those of our patient group. However, the pattern of significantly smaller IOP changes with sub-Tenon's compared with peribulbar anaesthesia would suggest that any pressure changes would be less profound with this method of anaesthesia. Glaucoma patients, particularly those in whom very little residual visual field is maintained and the risks of further visual loss need to be actively avoided, may benefit from sub-Tenon's rather than peribulbar regional anaesthesia.

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