INFLUENCE OF HYPOTENSION ON THE INTRA-CAPSULAR CATARACT OPERATION*

BY

K. REED HILL AND G. P. GOODWIN

Maidstone

Of recent years very many changes and advances have been made in ophthalmic surgery, especially in those operations which necessitate opening the eyeball itself in an intra-ocular operation. It used to be axiomatic that the ophthalmic surgeon was allowed one chance and one only; this may not still be strictly true, but it is undeniably of the utmost importance in the precise and meticulously exact technique of the ophthalmologist that everything should go well at the first attempt.

Cataract extraction, one of the commonest major operations on the eye, has undergone as many changes as any, and the rapidly increasing popularity of the intracapsular operation suggests that it is as near the ideal as is at present available. There are undoubtedly more operative risks than in the older extracapsular operation, especially in the hands of relatively inexperienced surgeons or those with limited opportunities for practice, and every step that adds to the margin of safety should be taken. Derangement of the vitreous, or its extrusion from the eye, and haemorrhage from the lips of the incision or occasionally from the iridectomy, with risk of admixture with the vitreous, are two of the outstanding difficulties of the intracapsular operation.

No two surgeons seem to use quite the same technique, nor is there any general agreement upon the best method of reducing intra-ocular pressure; but the fact that some means or other is invariably employed indicates the necessity of it.

General anaesthesia and full doses of curare seem to be favoured in the U.S.A. In Spain moderate doses of curare are relied upon. In Britain the retro-ocular injection of adrenaline and novocaine has been preferred. Curare in safe doses in the conscious patient would seem to be adequate only when reinforced by a rather potent personality in the surgeon.

Retro-ocular injections usually reduce the intra-ocular pressure satisfactorily, but not infrequently the presentation of the lens or of vitreous on opening the globe leaves little doubt of the presence of minor haemorrhages in the cone of muscles; neither immediate pressure on the eyeball following the injection nor Kirby’s method of placing the injection only anteriorly in Tenon’s capsule serves to prevent them.

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General anaesthesia as ordinarily administered tends to create a slight venous congestion of the eyeballs, and gives rise at times to a troublesome ooze of blood.

These two complications affect still more the surgical treatment of acute glaucoma.

It seems desirable therefore to reduce the intra-ocular pressure almost to atmospheric pressure pre-operatively and to lower the blood pressure to a point where bleeding does not occur.

During the last 3 years various hypotensives have been used experimentally by anaesthetists, mainly to prevent haemorrhage from being a source of embarrassment to plastic surgeons operating on the head and neck, to ophthalmologists in rhinostomy, and to aurists performing fenestration operations. The patients have nearly all been in or below middle age. I cannot find that any extensive use has been made of these substances in intra-ocular surgery, though Mr. Rycroft has suggested that in glaucoma a fall in intra-ocular pressure might usefully be achieved. Nor is there any record of their use in the upper (cataractous) age groups, where the vessels are hardening and the kidneys becoming less efficient, and where some degree of hyperglycaemia not infrequently exists. Dr. G. P. Goodwin and I have carried out certain investigations into their use in such cases as these from the respective standpoints of the anaesthetist and the ophthalmologist.

For the past 2 or 3 years practically all intra-ocular operations in my clinic have been carried out under general anaesthesia; and for nearly a year the anaesthesia has included the induction of intra-ocular hypotension.

In all cases of intracapsular extraction of cataract the eye was not opened until the ocular tension had dropped below 10 mm. Hg Schiötz.

Results

The results have been most satisfactory; no case of loss or derangement of the vitreous has been experienced, and no haemorrhage from the incision or the iridectomy has proved troublesome, or has even occurred in any extent greater than an ooze of perhaps a minim or so. Recovery in every case was uneventful and rapid and not associated with vomiting.

The drugs used were "Thiopentone" and "Tubarine" and hexamethonium bromide. Other drugs of the methonium group have not been tried by us as they would appear to be less reliable and less certain in their action and to offer no advantages over hexamethonium.

Tubarine and hexamethonium bromide achieve their effect in preventing the acetyl choline from acting on the ganglion cells by the use of an inactive drug (i.e., "block by competition", Paton, 1951). Hexamethonium bromide influences blood pressure by the relief of automatic tone and not by any direct effect on the blood vessels; it has no other depressive effect even in large doses (Paton, and Zaimis, 1951).

Investigation of the ocular fundi of patients under the influence of
ANAESTHESIA and hexamethonium bromide shows that in the retinal arteries the column of blood is greatly diminished though not beaded and the edges are slightly blurred and indistinct. The appearance of the veins is normal and the optic disk is not appreciably blanched. These changes are more marked in the elderly than in the young.

The fall in ocular tension would appear to be solely due to the cessation of the circulation (Duke-Elder, 1952).

In the group of intracapsular extractions, the ocular tension, usually taken on the unoperated eye, was measured with a weightless Schiötz tonometer:

(i) before the patient reached the theatre,
(ii) when under "Thiopentone" and "Tubarine" but flat,
(iii) when tilted into the reverse Trendelenburg position,
(iv) when still in the reverse Trendelenburg position but 2 minutes after the injection of hexamethonium bromide.

These findings were correlated with changes in the systolic and, where it could be measured, in the diastolic blood pressure.

Generally it was found that a drop in the systolic blood pressure to about 90 mm. Hg was accompanied by a drop of the intra-ocular pressure to about 11 mg. Hg; this was very satisfactory in the matter of the vitreous but did not stop haemorrhage. Adrenaline locally cannot be used to augment this for the clot then formed does not fit the artery as it expands with the resumption of the normal circulation, and late bleeding may occur.

At a systolic blood pressure of 55 the intra-ocular pressure is in the neighbourhood of 8-9 mm. Hg where the Schiötz tonometer becomes unreliable, and no blood flows from an incision.

In those cases in which it was used, hexamethonium bromide produced a semi-dilatation of the pupil and only a single instillation of the smallest quantity of homatropine and cocaine was required an hour before the operation.

Operative Technique.—The reverse Trendelenburg posture was essential in attaining these low pressures in elderly people, but once the low pressures were achieved the patients could be levelled out for operative purposes and no significant change in the intra-ocular or intravascular pressure occurred for 15 to 20 minutes; if any oozing of blood appeared it was found that a resumption of a few degrees of angle in the position of the patient promptly controlled it, and usually all that was necessary was to tilt the patient's chin slightly downward.

In our series this method of using hypotensives was mainly used in intra-capsular cataract extraction in elderly patients.

The incision was made with a Graefe knife very slightly on the corneal side of the limbus. Three corneo-scleral sutures were then inserted, and the loops laid clear of the incision. A peripheral iridectomy was performed, and the lens removed by Duthie's capsule forceps. Eserine was instilled at this stage, and again before bandaging the eye.
In two instances where the lens capsule ruptured in passing through a rigid pupil in an eye that had previously suffered an iritis and in which an iridotomy had not been performed after releasing the synechiae, no difficulty was experienced in removing the lens by Williamson-Noble's methods of two opposing cystotomes and subsequent drawing out of the capsule.

Three cases of acute glaucoma are not included in the statistics. In two the ocular tension was partly reduced by miotics before the operation and the fall of tension due to hexamethonium bromide was from about 32–35 to 18 mm. Hg.

In one case, following a central retinal vein thrombosis, the intra-ocular pressure dropped from 120 to 35 mm. Hg; had it been proposed to open this eye the change in tension might have been very valuable.

Anaesthetic Technique.—This has been evolved by one of us (G. P. G.) for use in patients of advanced years presenting for intracapsular cataract extraction. In such cases intra-ocular surgery demands absolute control of haemorrhage and a low ocular tension. Derangement of the vitreous or its extrusion from the eye, and haemorrhage from the lips of the incision or occasionally from the iridectomy with its risk of mixing in the vitreous, are two of the outstanding difficulties, and an anaesthetic technique capable of lessening these difficulties is beneficial to patient and surgeon alike.

Premedication is by atropine only, morphia being avoided to eliminate the risk of post-operative vomiting.

Induction of anaesthesia is with intravenous thiopentone. Oral intratracheal intubation is carried out on all cases and if necessary a muscle-relaxant drug such as tubarine is used to assist. Prior to intubation the larynx is well sprayed with a local anaesthetic solution and this local laryngeal toilet undoubtedly assists in maintaining relatively light anaesthesia in the presence of an intratracheal tube.

Maintenance of anaesthesia is assisted by occasional doses of thiopentone delivered through a Gordh needle commonly placed on the dorsum of the foot.

Oxygen is administered throughout the operation and a percentage never less than 50 is delivered with nitrous oxide. It cannot be stressed too strongly that a perfect airway is essential in the aged patient and an intratracheal tube is the only method of ensuring this.

This anaesthetic technique produces quiet respiration with no straining on the intratracheal tube, and has proved very successful with delivery of a high percentage of oxygen.

Pre-operative blood pressure readings are taken as a routine and the figures correlated with those found after the patient has been anaesthetized. There is no doubt that thiopentone, assisted by a muscle-relaxant drug, reduces blood pressure, and we observed that most cases showed a fall in intra-ocular pressure also. We therefore felt that, if blood pressure could be lowered still further, there might be a corresponding improvement in operating conditions.
INTRA-CAPSULAR CATARACT OPERATION

Burt and Graham (1950) having already stressed the influence of posture on hypotension, we felt justified in cautiously using this method. The average age of our patients was 65 years, the oldest being 83 and the youngest 47 years old. It will be appreciated that these advanced ages bring particular problems to the anaesthetist. Cautious use of the reverse Trendelenburg position to 30° has proved beyond doubt that low blood pressure levels can be reached with a marked fall in ocular tension. So long as adequate oxygenation was maintained there was no cause for anxiety, and in fact the patient usually looked better under anaesthesia than before.

It would appear that the older the patient, the more readily is a state of hypotension, with the accompanying fall in intra-ocular pressure, obtained with posture. So marked has been the reduction of ocular tension that the description of the 'concave' eye aptly describes the picture.

The following facts have gradually emerged from our results. Postural ischaemia reduces blood pressure and at the same time reduces ocular tension as measured with a weightless Schiötz tonometer. The perfectly slack eye corresponds with a tension less than 10 mm. Hg, which in turn appears to be related to a systolic blood pressure less than 80 mm. Hg. By lowering blood pressure posture also reduces haemorrhage to a minimum, of which there are no visible signs at all in most cases.

When the fall in blood pressure is inadequate with posture the hypotensive drugs are used. Hexamethonium bromide has proved most reliable and has been successful in relatively small doses, 10–20 mg. being all that is required in most cases. From experience it appears that only the more robust patients require hypotensive drugs to assist postural ischaemia. The results obtained in an average case are shown in the Figure.

![Graph](http://bjo.bmj.com)

**Figure.**—Average graph of a typical reaction in a healthy woman aged 66.

Material

Of the 36 patients who have undergone the intracapsular cataract operation, the average age being 65 years, eighteen were operated upon using postural methods only, and eighteen patients received hexamethonium bromide in addition (see Table, overleaf).

Typical Case Reports

**Case 1, female, aged 63 years.**—Pre-operative blood pressure 165/100 mm. Hg, ocular tension 25 mm. Hg. Under anaesthesia and posture these figures fell to 110/75 and 12.5; the addition of 10 mg. hexamethonium bromide produced a further systolic blood pressure fall to 60 and an ocular tension of 9.5. The field of operation was perfect with no haemorrhage and a very low intra-ocular pressure.
K. REED HILL AND G. P. GOODWIN

TABLE

ANALYSIS OF CASES

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>No. of Cases</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Posture alone</td>
</tr>
<tr>
<td>40-50</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>51-60</td>
<td>5</td>
<td>1</td>
</tr>
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<td>61-70</td>
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<tr>
<td>71-80</td>
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<td>6</td>
</tr>
<tr>
<td>80 and over</td>
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<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>18</td>
</tr>
</tbody>
</table>

Case 2, male, aged 66 years.—Pre-operative blood pressure 165/100 mm. Hg, with an intra-ocular pressure of 22 mm. Hg. Posture with the addition of 30 mg. hexamethonium bromide gave a systolic blood pressure of 60 and an intra-ocular of 10, with corresponding benefit to the surgeon.

Case 3, female, aged 65 years.—Pre-operative blood pressure 190/100 mm. Hg, intra-ocular pressure 22 mm. Hg. Under posture and hexamethonium bromide readings of 70 systolic blood pressure and 8 intra-ocular pressure were obtained.

Case 4, female, aged 47 years.—Pre-operative blood pressure 170/110 mm. Hg, intra-ocular pressure 20 mm. Hg. Under posture alone the systolic reading fell to 80 with an intra-ocular pressure of 9, and this produced a perfect operating field.

These cases are taken at random to show the type of result experienced. The post-operative condition of the patient was uniformly excellent and blood pressures quickly returned to normal after normal posture was resumed. The use of hexamethonium bromide in addition caused no prolonged fall as the doses were too small.

Summary

A series of patients presenting for the intracapsular cataract operation were anaesthetized, and the blood and intra-ocular pressures were lowered either by posture alone or with the addition of hexamethonium bromide to facilitate operating conditions.

In the older patients posture alone usually produced the low intra-ocular pressure required. In the younger age groups hexamethonium bromide was required in addition.

Surgical complications during operation were negligible as a result of the low preliminary intra-ocular pressure and the absence of bleeding.

From the beginning to the end of the operation the surgical situation was thoroughly under the surgeon's control.

We acknowledge with gratitude the kind advice of Sir Stewart Duke-Elder and the very valuable work done by Miss Helen Hood of the Kent County Ophthalmic Hospital, Maidstone.

REFERENCES