GENERAL ANAESTHESIA IN OPHTHALMIC SURGERY

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Many ophthalmic operations can be performed under local analgesia and this technique is used with satisfaction in all parts of the world today; in fact, many surgeons and consultant anaesthetists are satisfied that the best results are obtained by this method. On the other hand, general anaesthesia is used much more than formerly and in some centres it is used routinely for most operations, including removal of cataracts. There are, in addition, occasions when the future of the eye depends upon surgery which can only be performed under general anaesthesia; but if this is not skilfully administered a functionless eye may result from coughing and vomiting. Having watched the surgeons in this area make a slow but continuous change-over during about five years, I feel that it is opportune to review the value of general anaesthesia in ophthalmic surgery and to discuss ways to produce maximum benefit for patient and surgeon.

The disadvantages of local analgesia

The less desirable aspects of locals must be considered before advantages can be claimed for other techniques. Some of these are:

1. *The co-operation of the patient* is essential for success and so difficulties arise in:
   (a) The young (under 12) and this includes most cases of squint.
   (b) The very old.
   (c) The disabled, deaf, arthritic, etc.
   (d) Those who are temperamentally unfit or very nervous.

2. A *greater strain* falls on the surgeon because he has to bolster the morale of the patient as well as operate. With a difficult patient this strain can affect an apprehensive surgeon to the extent of reducing his skill; these surgeons, and there are many of them, are happier when their patients are unconscious. This may be one of the greatest advantages of general anaesthesia in ophthalmic surgery.

   (a) Facial block.
      (i) If inadequate, “squeezing” may occur with its accompanying dangers.
      (ii) Pain in the temporo-mandibular joint for some weeks afterwards.
      (iii) On rare occasions prolonged facial paralysis.
   (b) Topical analgesia before an operation may upset the patient: there is a slight risk of introducing sepsis to the outer eye.
   (c) Iris anaesthesia (retrobulbar injection into the ocular muscular cone).
      (i) May not give complete analgesia particularly in cases of acute glaucoma.
      (ii) Risk of retrobulbar haemorrhage which necessitates postponing the operation for a week.
      (iii) The inferior rectus muscle may be paralysed by the injection, in which case the patient cannot look down and the operation is made more difficult.
      (iv) Intra-ocular pressure is often lowered excessively and renders operations like trephine, iridectomy ab externo and extra-capsular lens extractions much more difficult.
   (d) Postoperative vomiting, though less common than after general anaesthesia, can occur.

4. *Personal preference.* There is little doubt that most people prefer to be asleep when surgery is being performed on them. I have had a number of patients who have had previous eye operations
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TECHNIQUES

Before describing any techniques for particular operations one must consider two important aspects of this work:

1. The necessity for an almost bloodless field.
2. The control of intra-ocular tension.

BLOODLESS SURGICAL FIELD

The advantages of a bloodless field are greater ease of operating and a less stormy convalescence. It should be possible to have a "white eye" in most cases; obvious exceptions are those which are red, inflamed or congested by the pathological condition for which the surgery is being performed. The following points are thought to be important in preventing the eye from becoming engorged during anaesthesia.

1. Induction. A smooth induction followed by smooth maintenance and recovery are essential for good results in intra-ocular surgery.

2. Agents. It always will be true that it is the anaesthetist who produces results rather than the agents that he uses; nevertheless I do not use gallamine hydrochloride in this work, because not only my own cases but those of others appear to bleed more when relaxants other than those mentioned below are used for a routine technique. Suxamethonium chloride is used for patients who are to breathe spontaneously and tubocurarine hydrochloride when respiration is to be controlled. Bleeding is increased if respiration is not assisted after the administration of the longer acting relaxants.

3. Apparatus. If respiration is to be spontaneous, resistance to air flows should be carefully eliminated. Children have some form of T-piece technique. A lightly loaded valve or Bullough's (1952; 1955) technique is used for adults. If for any reason it is necessary to alter the tension on the expiratory valve of a Magill's assembly, one's hand must pass under the sterile towel in the area where the surgeon's swabs and instruments lie; this inconvenience is avoided if a circle absorber is used. Then not only is the expiratory valve readily accessible but one can easily change from closed to semi-open or T-piece technique.

ADVANTAGES OF GENERAL ANAESTHESIA

Patient's Choice. As has already been stated most people prefer to be asleep during the performance of anything but very minor surgery.

Surgeon's Choice. If a patient is asleep there is no doubt that it is easier for the general management of a theatre. The teaching of surgical techniques can be very disturbing to the conscious patient. Also, as has been mentioned above, many surgeons have an even greater reason for wanting their patients to be asleep.

DISADVANTAGES OF GENERAL ANAESTHESIA

Patient's View. The only patients who have commented adversely on the method are those who have vomited. Whilst this incidence can be kept at about 5 per cent in adults, it is doubtful if it can be eliminated.

Nursing. A conscious patient will almost certainly need less nursing care than one who is, or has been, unconscious. Many patients in the ophthalmic wards are edentulous and must be watched carefully during recovery of consciousness. Consequently these cases do need more care than the local group, but no one has suggested that this created a need for extra staff.

(mainly for cataract) whilst awake; pre-operatively most have stated that they were quite satisfied last time, though later they were loud in their praise of general anaesthesia. One such patient surprised me by giving as her reason for this enthusiasm "that this time I did not feel anything." Some on hearing that they would be asleep have expressed great relief that "they would not have to go through that again." There have been a few who preferred the local and their reason has always been the same—they had vomited after the general but not after the local.

(5) Insufficient experience for the anaesthetist with general anaesthesia for intra-ocular operations will mean that the surgeon will not receive all possible help from him on the occasions when anaesthesia is essential for intra-ocular surgery. Good vision is unlikely to be obtained from a second operation necessitated by failure at the first one. Poor results mean little or no vision in that eye.
(4) **Posture.** A head up tilt of the table helps to produce a bloodless field in three ways:

(a) Improved venous drainage of the eye.

(b) This position, particularly during general anaesthesia, tends to lower the systolic blood pressure and so the volume of blood reaching the eye per minute.

(c) The pressure of the abdominal viscera on the diaphragm is reduced, particularly in obese subjects, which in turn improves pulmonary ventilation and the venous return to the heart. This must assist the venous drainage of the eye.

(5) **Lamellae.** Tablets of adrenaline hydrochloride (0.5 mg) help in the production of a "white eye." These, however, cause discomfort and so should be used after the induction of anaesthesia. Full surgical sterility should be observed when placing these in the eye. Guttae adrenaline 1/1000 are also satisfactory.

**The Intra-ocular Pressure**

The eye may be looked on as a chamber containing fluid enclosed within a feebly distensible envelope formed by the sclera and cornea. The pressure within is maintained at its normal height by two factors—the elasticity of the outer coat and the volume of its contents, which is maintained by the energy derived from the blood pressure.

**Variations of the Intra-ocular Pressure.**

The intra-ocular pressure may be varied from normal by three groups of factors:

(1) **External pressure upon the globe by voluntary muscles.** The total effect exercised upon the intra-ocular pressure by the normal tone of the voluntary muscles is demonstrated by the fact that the pressure of the eye falls to almost half of its original height when the muscles are paralysed by curare, although the blood pressure is maintained at a constant level.

(2) **Alterations in the equilibrium level.** The intra-ocular pressure varies directly with the blood pressure in the capillaries, and therefore can be influenced by the general arterial pressure and the venous pressure only in so far as their influence penetrates to the capillary circulation. When the capillary circulation remains passive, changes in the arterial pressure are reflected directly in the intra-ocular pressure. If the venous pressure is altered, other things being equal, intra-ocular pressure varies very directly with it.

(3) **Variation of the intra-ocular volume.** Since the distensibility of the envelope of the eye is very small, the intra-ocular pressure may be varied by altering the volume occupied by any of its contents. A dilatation of its capillaries brings about a large rise of pressure, and their contraction a corresponding fall.

**The Control of Intra-ocular Tension during Anaesthesia.**

For some operations, e.g. extracapsular extraction of lens, a normal intra-ocular tension is usually desired by the surgeon as this aids expression of the lens. If, however, at any time during any operation there is risk of vitreous loss, this risk is reduced if the tension of the eye is lowered. This risk is always present during any intra-ocular operation and particularly during cataract extractions. When the anaesthetist has a fair measure of control of the intra-ocular tension, he can provide a tension appropriate for the operation and the surgeons are very appreciative of the assistance afforded to them. In the anaesthetized patient this tension can be varied during the operation at the request of the surgeon.

**Anatomy.**

Figures 1 and 2 show the important difference to the anaesthetist between intra- and extracapsular operations. When the cataract has been removed without its capsule (fig. 1), the vitreous face still has this to support it. To coax the lens through the small hole in the anterior capsule it is expressed against the supporting vitreous as shown in figure 3. If the eye has good tone the pressure is effective; if, however, the eye is very soft the counterpressure is lacking and the extraction made more difficult. When the lens is removed within its capsule (fig. 2), there is practically no support for the all important vitreous and it is easily seen how increased intra-ocular tension following anaesthesia can cause the vitreous to follow the encapsulated lens as it is withdrawn.

With full understanding of the foregoing principles the experienced anaesthetist will then use
Cornea
Anterior
chamber

Vitreous Body

FIG. 1
Showing the eye after removal of lens by the extracapsular operation. Vitreous face is protected by the posterior capsule of the lens.

Cornea
Anterior
chamber

Vitreous Body

FIG. 2
Showing the eye after removal of lens by the intracapsular operation. The vitreous face is exposed and will prolapse more readily.

Pressure
by Surgeon

Direction of Lens

FIG. 3
Extracapsular extraction of lens. Lens is expressed between the cornea and the supporting vitreous.

the techniques which he already knows will give the required conditions. The following are the methods which I normally employ.

ANAESTHETIC TECHNIQUES

Children. The youngest (one week to one year old) have usually come for probing of the nasolachrymal duct or for examination of the eye and refraction under anaesthesia. It seems unnecessary to intubate these cases, yet even the smallest face piece (Sandiford, 1953) obstructs the surgical field. A small open mask is satisfactory and that shown in figure 4 is excellent. It was designed by the late Mr. A. Valentine and has been in use for many years. Deep anaesthesia is unnecessary and so contra-indicated, though the eye must be stationary for the examination. Valentine’s curved forceps are often used to position the eye. A very clear airway must be maintained and this is easily done by the nurse who is steadying the head; she should extend the head at the atlanto-occipital joint and an artificial airway is rarely required.

Premedication. Atropine only is given unless the case is likely to return for repeated examinations, e.g. congenital cataract or suspected malignant disease. In these cases some sedation is given
as early as at six months and rectal thiopentone (1 gram for 50 lb (22.5 kg) body weight) is satisfactory.

For any delicate procedure, however brief (e.g. needling of a congenital cataract), an intratracheal tube is always used, as the surgeon should have perfect operative conditions. For intubation intramuscular suxamethonium chloride was tried, but was discontinued as the effect persisted longer than was wished. It is therefore given intravenously when used.

Most of these children are outpatients and can go home very soon after they leave the theatre. Any who have been given rectal thiopentone have usually recovered fully in two to three hours and are then allowed home.

The older children who come as outpatients are usually presented for incision and curettage of chalazion. Here satisfactory if not perfect results can be obtained with nitrous oxide oxygen and trichloroethylene administered through a standard dental nose piece; again the recovery time is very brief. A small dose of intravenous thiopentone is an advantage but, of course, delays recovery.

Operations for strabismus are very numerous. Sedative premedication is always given and frequently is quinalbarbitone sodium (0.6 grain per stone body weight—6 mg/kg approx.) one and a half hours before operation. Patients are then placed on a trolley and atropine 0.6 mg is given half an hour before operation. They are usually asleep on arrival at the theatre and anaesthesia is induced with nitrous oxide and oxygen with a little ether being added before the child is lifted from the trolley; this anaesthetic mixture is used throughout the operation. Intravenous thiopentone (less than 0.05 g per year of age) and possibly a quick acting relaxant are then given slowly to allow a smooth induction and to facilitate intubation. The lungs are inflated to prevent straining at this stage, after which spontaneous respiration is allowed to return. The table is usually tilted. Postoperative vomiting in these cases would appear to be common. One is told that vomiting frequently occurs if analgesia alone is used, and I now think that some central effect follows the disturbance and pull on the extra-ocular muscles, causing the vomiting. I regret to say that I am resigned to an overall incidence of approximately 30 per cent but know that on some days every child is sick.

**Adults.** Premedication for intra-ocular operations is almost always atropine 0.8 mg and pethidine 100

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![Fig. 4](image-url)

**Fig. 4**

Showing Valentine's mask which allows full access to both eyes.
mg one hour before operation. This is because of the tendency for morphia and its closer derivatives to cause vomiting. Young adult males are treated differently, being given papaveretum 20 mg and scopolamine 0.45 mg one and half hours before operation. This is allowed because men of this age group seldom vomit following morphia and because the extra sedation helps to produce the desired pattern of anaesthesia and subsequent recovery. After only pethidine the reflexes may be somewhat brisk when one is trying to minimize the doses of intravenous and inhalational anaesthetics. Half this dose is also given occasionally to older subjects who are very large or alcoholics.

For intracapsular extractions, and in all cases where a reduced intra-ocular tension is desired, tubocurarine hydrochloride is given usually in the dose of 15 mg; this is occasionally increased to 20 mg for the robust and, on rare occasions, to 25 mg for very large adult males and for alcoholics. It is given as a single dose and is followed by thiopentone up to 500 mg which is given in divided doses to the bad risk cases. Inflation of the lungs with oxygen precedes spraying of the trachea and intubation with a No. 10 cuffed tube; to avoid possible straining the cuff is inflated only if there is considerable air leakage. Respiration is controlled throughout on a circle absorber using nitrous oxide 3 litres and oxygen 1½ to 2 litres with a minimal concentration of either chloroform or ether. The former is chosen for all cases except diabetics, because it is the smoothest of all inhalational anaesthetics and is, in my experience, less likely to cause vomiting than ether. It causes some loss of vasomotor tone and so will assist in reducing the blood pressure and intra-ocular tension; only two measured drams are put in the bottle of the Boyle’s machine and usually one dram remains at the finish of the operation. Should the plane of anaesthesia become too light the chloroform vapour is strengthened rather than give additional intravenous drugs. Only rarely is it necessary to add more chloroform to the bottle and then it is always for a large patient and when the operation has continued for more than 30 minutes. At no time should the vapour concentration be suddenly increased as this produces cardiac arrhythmias. Weak ether vapour has always been given to diabetics and no harm has yet been observed to follow this practice. When the patient has been induced, and after a check has been made on the pulse and blood pressure, the head of the table is raised. If this alteration in position follows too rapidly on induction an undesirable fall in blood pressure can occur in the poor risk case.

With this technique a blood pressure of about 100 mm Hg is usual; no attempt is made to reduce it further and if this is the figure after the induction, the table will not be tilted at all. In some hypertensive patients the pressure remains high—even above 200 mm Hg; on these occasions the surgeon is asked if the tension is satisfactory and frequently it is so. This may be explained by reduction in the contents of the orbit from improved venous drainage and some reduction of filling from lowering of the blood pressure. If the tension is unsatisfactory the head up tilt is increased to about 15 degrees. By making the top end of the table horizontal the head can still be kept in a normal position for operating; this extra tilt has never failed to produce a satisfactory tension.

Neostigmine (1 mg with atropine 0.6 mg) is given only if the tidal volume is unsatisfactory some minutes after the operation is finished. Statistics now being collected appear to show that when neostigmine is given vomiting will follow.

**Extracapsular Extractions.**

If a normal intra-ocular tension is required spontaneous respiration is retained; unconsciousness is induced with thiopentone and followed by a short acting relaxant. The trachea and cords are thoroughly sprayed with an analgesic solution, or 2 ml of lignocaine 4 per cent is injected through the cricothyroid membrane. It is desirable that slight coughing should follow the injection to spread the solution throughout the bronchial tree. The remainder of the thiopentone and a relaxant is then given. The lungs are inflated with oxygen prior to intubation with a No. 10 tube. Anaesthesia is maintained with nitrous oxide 6 litres and oxygen 2-3 litres and minimal ether or trichloroethylene; Bullough’s (1952, 1955) circuit is often used. The table remains horizontal throughout the operation. With this technique the blood pressure does not fall, and any lowering of the intra-ocular tension is not appreciable. For extracapsular extractions a small
reduction of tension is sometimes requested with the proviso that the eye must not be too soft. On these occasions the technique as for intracapsular extractions has been used, but without table tilt; little blood pressure drop follows and the operative conditions have satisfied the surgeon.

These techniques have been described in detail as the principles involved cover the requirements for all ophthalmic operations in adults.

COMPPLICATIONS

Postoperative Vomiting. In contrast to the cases of strabismus the vomiting rate following operations for cataract has been very low, below 5 per cent if neostigmine has not been given, but very much higher when it has. If vomiting occurs, the patient is given 50 mg of chlorpromazine intramuscularly immediately, and on the few occasions that it has been given vomiting has ceased quickly. This drug is not given pre-operatively, as the published results when this has been done do not suggest any improvement on our own, and we prefer to avoid the delayed recovery of consciousness which usually follows.

Ocular Complications. Causes of serious complications from the ophthalmological point of view are coughing, vomiting and restlessness, and they have occurred in this series, but they also occur, though less frequently, when analgesia alone is used. The fact remains that the surgeons are emphatic that these complications of general anaesthesia have caused little ocular damage provided that corneoscleral sutures have been used at the operation. No surgeon has published results showing the return of some useful vision in all cases and the figure of only 4 per cent of blind eyes is not always achieved (Stallard, 1946).

Deaths. In the hospital series no deaths have occurred in the first week from any cause. A case was lost in a nursing home and is of interest. The patient was a female, 75 years old and obese; a bad diabetic having 90 units of insulin daily; she had been in cardiac failure. She had already lost one eye following lens extraction elsewhere under local analgesia. The operation was very difficult and continued for 45 minutes. Increased tilt was requested during the operation. Under the conditions it was not possible to check the blood pressure frequently; shortly after completion of the operation there was sudden cardiac arrest. Ether and not chloroform was being used. I feel now that if a 15 degree tilt is to be used in such a patient, and it is doubtful if it should, blood pressure readings must be taken, if necessary by a third individual.

Surgically improved end results have been achieved from the use of general anaesthesia. Better results are obtained at operation and only occasionally is this advantage lost in the postoperative period. As far as the surgeons are concerned there is no dispute as to which is the better method, for let us not forget the patient has come to hospital to obtain improved vision.

THE FUTURE

Experience has led me to believe that the future trend of anaesthesia for ophthalmic surgery will follow that of general surgery, i.e. if the end results are better with anaesthesia than analgesia then the anaesthetists will be asked for assistance. The danger, as I see it, is that, particularly at holiday time, anaesthetists without special experience or training will undertake this work. One such informed me, with laughter, that a patient coughed hard as the lens was being withdrawn!

ACKNOWLEDGMENTS

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REFERENCES


