NON-DEPOLARIZING NEUROMUSCULAR BLOCKERS AND THE EYE: A STUDY OF INTRAOCULAR PRESSURE

Pancuronium versus alcuronium

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SUMMARY

Intraocular pressure remained stable when either pancuronium or alcuronium was used to produce muscle relaxation, suggesting that alcuronium may be a reasonable alternative to pancuronium for routine surgery of the open eye, particularly in elderly patients with limited cardiac reserve.

Premedicant drugs, inhalation anaesthetic agents, systemic arterial and central venous pressure, and arterial oxygen and carbon dioxide tension are known to influence intraocular pressure (i.o.p.) (Duncalf, 1975). Al Abrak and Samuel (1974a) devised a study to minimize the effects of these factors, and compared the i.o.p. changes produced by pancuronium and tubocurarine during nitrous oxide in oxygen anaesthesia (Al Abrak and Samuel, 1974b). Although there was a significant reduction in i.o.p. following the administration of tubocurarine, there was no change with pancuronium.

Alcuronium has been the non-depolarizing muscle relaxant of choice for ophthalmic anaesthesia in our department for several years. The present study compares the effects of pancuronium and alcuronium on i.o.p. The technique of the study is similar to our previous investigation of i.o.p. changes during halothane and enflurane anaesthesia (Runciman et al., 1978) and is based upon that by Al Abrak and Samuel (1974a).

PATIENTS AND METHODS

Informed consent was obtained from 20 healthy, male patients (aged 16–43 yr) requiring surgical treatment for ophthalmic trauma. Ophthalmic abnormalities of the non-traumatized eye excluded the patient from the study. None of the surgical procedures was performed as an emergency, and the patients were in a state of normal hydration. Twelve patients required enucleation, four evisceration of a severely damaged eye, and the remaining four extensive repair to severe eyelid lacerations.

Premedication comprised morphine 10–15 mg i.m. and diazepam 5 mg i.m., 1 h before surgery. In the operating theatre a basal i.o.p. reading was obtained in the normal eye after instillation of a local anaesthetic solution to the conjunctival sac. All i.o.p. measurements were made using a Perkins hand-held applanation tonometer (Perkins, 1965). Measurements of systolic arterial pressure (Riva Rocci method) and heart rate (Mennen–Greatbatch Portoscope) were also obtained before induction of anaesthesia.

Further sedation was produced with droperidol 5 mg i.v. and fentanyl 100–200 μg i.v. After a suitable period of time to allow the sedation to take effect, the oropharynx and laryngeal inlet were sprayed with 2–4 ml of 4% lignocaine solution under direct laryngoscopy. Anaesthesia of the trachea was produced by the direct injection of 2 ml of 4% lignocaine solution through the cricothyroid membrane.

After 5 min of pre-oxygenation via a non-rebreathing anaesthetic circuit, anaesthesia was induced with 2.5% thiopentone 4.5–5.5 mg kg⁻¹. The trachea was intubated with a cuffed endotracheal tube and ventilation controlled using a Manley ventilator delivering a minute volume of 120 ml kg⁻¹ min. The fractional inspired oxygen concentration (FIO₂) was maintained at a constant value of 0.4 by monitoring fresh gas flow with a Beckman OM.11 oxygen analyser, and adjusting the flow rates of oxygen and nitrous oxide appropriately. The fractional end-expired carbon dioxide concentration (FE'CO₂) was monitored continuously using a Beckman LB2 Infrared CO₂ analyser and maintained at approximately 0.05 by the addition of carbon dioxide to the fresh gas supply and adjusting the flow rates of oxygen.
and nitrous oxide appropriately in order to maintain \( P_{\text{A}O_2} \) steady.

A 16-French gauge i.v. catheter was inserted into the right internal jugular vein for the measurement of central venous pressure (c.v.p.) with a saline manometer. The zero reference point was taken as the surface of the operating table and all measurements were made with the patient in the horizontal position.

Heart rate (photoelectric finger transducer) and e.c.g. were monitored continuously using a Mennen-Greatbatch Portoscope. Systolic arterial pressure was measured using a sphygmomanometer.

Measurements of i.o.p., systolic arterial pressure, heart rate and central venous pressure were made at 10, 15 and 20 min after induction of anaesthesia, by which time all the patients were in a stable state. A non-depolarizing muscle relaxant, either pancuronium 0.1 mg kg\(^{-1}\) or alcuronium 0.25 mg kg\(^{-1}\), was administered i.v. on a random basis, 10 patients receiving each drug. The measurements were repeated at 5, 10 and 15 min following injection of the drug and surgery was then commenced. At the conclusion of the operation, residual neuromuscular blockade was antagonized with neostigmine 3.75 mg and atropine 1.2 mg i.v.

Data were analysed using Student's \( t \) test for the significance of the difference between two sample means, computed on a Hewlett-Packard 9815A desktop calculator. Comparisons were made between measurements obtained before induction and those at 20 min after anaesthesia commenced, and again between the latter measurements and those obtained 15 min after injection of the muscle relaxant.

**RESULTS**

The mean age of patients given pancuronium was significantly greater than that of those receiving alcuronium (31.4 yr ± SEM 2.2 v. 24.5 ± 1.9 yr; \( P < 0.05 \)). The mean body mass of the two groups was similar (64.1 ± 3.2 v. 60.1 ± 2.7 kg). The difference in age was considered unimportant in view of the healthy physical status of the subjects studied, together with the fact that each patient acted as his own control.

Mean i.o.p. decreased in both groups of patients 20 min after induction of anaesthesia in comparison with awake control values, but this was only significant in the pancuronium group (fig. 1). Further reductions in i.o.p. following i.v. injection of both the muscle relaxants were statistically insignificant.

Mean systolic arterial pressure 20 min after anaesthesia commenced was significantly reduced in both groups of patients compared with control (pre-induction) values (\( P < 0.001 \)). No further change occurred in either group thereafter (figs 1, 2).

In the alcuronium group there were no significant changes in heart rate throughout the study (fig. 2). However, heart rate increased following the i.v. injection of pancuronium (fig. 1), but this was not statistically significant (0.1 > \( P > 0.05 \)). Mean c.v.p.
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During anaesthesia did not change following injection of either pancuronium or alcuronium. $F{E'}_{CO_2}$ was maintained steady in both groups during the period of study (fig. 3).

**DISCUSSION**

Any increase in ocular vascular congestion during intraocular surgery is undesirable and possibly dangerous, and should be avoided in order to safeguard against the expulsion of vitreous humor from the open eye. Furthermore, it is desirable to achieve a normal or reduced i.o.p. before the eye is opened, to avoid expulsive haemorrhage and ocular disruption at the time of the incision (Duncalf, 1975). Therefore, the ideal anaesthetic technique for intraocular procedures should produce a moderate reduction in i.o.p., or maintain i.o.p. at near normal values, and avoid marked fluctuations during surgery.

The use of a non-depolarizing muscle relaxant allows controlled ventilation with nitrous oxide and oxygen, and this technique tends to maintain a stable intraocular pressure. Pancuronium has been suggested as the relaxant of choice for ophthalmic surgery since it produces little change in i.o.p. (Al Abrak and Samuel, 1974b). In contrast, tubocurarine appeared to produce a marked reduction in i.o.p. in association with significant alterations in cardiovascular haemodynamics.

Alcuronium has been used in our department for several years as the non-depolarizing muscle relaxant of choice. Kalff and Linzen (1969) have shown that alcuronium causes no change in i.o.p. unless the dose is sufficient to produce a concurrent decrease in systolic arterial pressure. Alcuronium, similar to tubocurarine, but not pancuronium, may reduce mean systemic vascular resistance and hence arterial pressure (Coleman et al., 1972). An excessive reduction in arterial pressure would be undesirable in the elderly patient undergoing ophthalmic surgery. However, a moderate decrease in the afterload of the heart, induced by anaesthesia, may be beneficial to the patient with reduced myocardial reserve. In contrast, pancuronium tends to increase the work load of the heart, by increasing heart rate, arterial pressure and cardiac output (Coleman et al., 1972).
In the present study, conducted under standardized conditions of anaesthesia, arterial and central venous pressure and $F_{\text{CO}_2}$, alcuronium produced no change in mean i.o.p., heart rate or arterial pressure—findings similar to those documented by Kalff and Linzen (1969). Similar circumstances prevailed after the administration of pancuronium, with regard to the average i.o.p., heart rate and arterial pressure. The latter results are in accord with those of Al Abrak and Samuel (1974b).

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This study was approved by the Ethical Committee of the Faculty of Medicine, University of Natal and Director of Hospital Services, Natal Provincial Administration.

REFERENCES


AGENTS DE BLOCAGE NEUROMUSCULAIRE NON DEPOLARISANT ET L’ŒIL: ÉTUDE DE LA PRESSION INTRAOCULAIRE

Pancuronium par rapport à alcuronium

RESUME

Lorsqu'on a utilisé le pancuronium ou l'alcuronium pour produire une relaxation du muscle, la pression intraoculaire est restée stable, ce qui laisse penser que l'alcuronium peut être une alternative raisonnable au pancuronium pour les interventions chirurgicales à l’œil ouvert, surtout chez les personnes âgées ayant une réserve cardiaque limitée.

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