EFFECTS OF ATRACURIUM ON INTRAOCULAR PRESSURE

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SUMMARY

The effects of atracurium on intraocular pressure (IOP) were compared with those of pancuronium in 20 patients less than 45 years-of-age requiring surgery for trauma of one eye. After a standard premedication and the application of topical analgesia to the upper airway, anaesthesia was induced with thiopentone i.v. and the trachea was intubated without the use of neuromuscular blockade. Following 20 min of steady state anaesthesia during which measurements of IOP, arterial pressure, heart rate, \( F_{\text{O}_2} \), \( F_{\text{CO}_2} \) and CVP were recorded, one group of patients received atracurium 0.45 mg kg\(^{-1}\) and the other pancuronium 0.1 mg kg\(^{-1}\). The observations were repeated for a further 15 min before surgery commenced. Neither atracurium nor pancuronium produced any change in IOP. Atracurium was associated with greater cardiovascular stability than pancuronium.

Atracurium, a non-depolarizing neuromuscular blocking drug, has been introduced recently to clinical practice (Miller, 1982). This study examines the effects of this drug on intraocular pressure (IOP) using methods whereby other variables likely to influence IOP were controlled (Al-Abrak and Samuel, 1974).

PATIENTS AND METHODS

Twenty healthy patients aged between 18 and 36 years-of-age and undergoing elective surgery for ocular trauma were studied with their consent. The study was approved by the Ethics and Standards Sub-Committee of the Faculty of Medicine, University of Natal. Patients with abnormalities of the non-traumatized eye were excluded from the study. Fifteen patients required enucleation, two repair to severe eyelid lacerations, two corneal repairs and one a plastic repair of the socket following enucleation.

Premedication consisted of morphine 10–15 mg i.m. and diazepam 10 mg by mouth 1 h before surgery.

A central venous catheter was inserted under local analgesia. The route chosen was either the right internal jugular (Bardicath) or a forearm vein (Drum catheter, Abbott Laboratories), depending on the preference of the investigator. The catheter was connected to a saline manometer. A swing in the meniscus of the fluid with ventilation was regarded as confirmatory evidence of the correct placement of the catheter. The manometer was used for readings of central venous pressure (CVP), the zero reference point being taken as the surface of the operating table. All measurements of CVP were obtained with the patient in the horizontal position.

When the patient arrived in the operating theatre, a baseline measurement of IOP was obtained in the normal eye after the application of a local anaesthetic solution to the conjunctival sac. All IOP measurements were made using a Perkins hand-held application tonometer (Perkins, 1965). Readings of systolic, diastolic and mean arterial pressure were obtained non-invasively using an automated microprocessor-based oscillometric pressure recording device (Sentry, Automated Screening Devices Incorporated). The accuracy of the readings was assessed by comparing the values obtained for systolic and diastolic arterial pressure with those obtained by the standard Riva Rocci method. Cardiac rate and rhythm were monitored continuously on an oscilloscope (Mennen–Greatbatch Portoscope).

Once baseline readings had been obtained, further sedation was produced with droperidol 5 mg and fentanyl 100–200 \( \mu \)g i.v. The opharynx and the laryngeal inlet were sprayed with 4% lignocaine solution 2–4 ml under direct laryngoscopy. Anaesthesia of the trachea was produced by direct injection of 4% lignocaine 2 ml through the vocal cords or transtracheally.
After pre-oxygenation for 5 min (administered through an A.D.E. anaesthetic breathing system (Mapleson A mode) (Humphrey, 1983) anaesthesia was induced with 2.5% thiopentone 4.5–5.5 mg kg\(^{-1}\). The trachea was intubated with a cuffed tracheal tube, without prior use of a neuromuscular blocking drug. Ventilation was controlled using a Penlon Nuffield series 100 ventilator, delivering a minute volume of 120 ml kg\(^{-1}\) min\(^{-1}\) with the A.D.E. anaesthetic system in the Mapleson D mode (Humphrey, 1983). The fractional inspired oxygen concentration (\(F_{\text{IO}}\)) was maintained at a constant value of 0.4 by monitoring the fresh gas flow with a Beckman O.M. 11 oxygen analyser and adjusting the flow rates of oxygen and nitrous oxide appropriately. The fractional end-expired carbon dioxide concentration (\(F_{\text{ECO}}\)) was measured continuously using a Beckman LB2 Infrared CO\(_2\) analyser and maintained at approximately 0.05 by changing the fresh gas flow rates.

Measurements of IOP, systolic and diastolic arterial pressures, heart rate, and end-expired carbon dioxide concentration were recorded 5, 10, 15 and 20 min after the induction of anaesthesia, by which time all the patients were considered to be stable. At this stage, a non-depolarizing muscular blocking drug, either atracurium 0.45 mg kg\(^{-1}\) (group I) or pancuronium 0.1 mg kg\(^{-1}\) (group II) was administered i.v. on a cohort basis, 10 patients receiving each drug. The above measurements were repeated at 5, 10 and 15 min following injection of the drug, and thereafter surgery was commenced. At the conclusion of the operation residual neuromuscular blockade was antagonized with neostigmine 3.75 mg and glycopyrrolate 0.8 mg i.v.

Data were analysed using the paired Student's \(t\) test for the significance of the difference between two means, computed on a Hewlett-Packard 9815A desk-top calculator. Comparisons were made between measurements obtained before the induction of anaesthesia and those measured after 20 min of anaesthesia, immediately before the administration of the myoneural blocker, and again between the latter measurements and those obtained 15 min after the injection of the test drugs. Thus, each patient acted as his own control.

RESULTS

The mean ages of the patients in groups I and II were 24.4 yr ± 2.2 (SEM) and 27.6 yr ± 1.9, respectively and their mean body weights 62.4 kg ± 3.2 and 60.1 kg ± 2.4.

Mean intraocular pressures decreased in both groups of patients 20 min after induction of anaesthesia (fig. 1). No further changes in the IOP were observed following the injection i.v. of either pancuronium or atracurium. The steady state end-expired carbon dioxide concentration (fig. 2) was similar in both groups of patients.

Mean systolic arterial pressure (fig. 3) was greater in the group receiving pancuronium than in the atracurium group, both before the induction of anaesthesia and 20 min thereafter. Following the administration of atracurium (group I) i.v., systolic

![Fig. 1. Mean (±SEM) intraocular pressure (mm Hg) after atracurium (group I) or pancuronium (group II). A = Before induction of anaesthesia; B = 20 min after induction of anaesthesia; C = 15 min after neuromuscular blocker.](image1)

![Fig. 2. Mean end expired carbon dioxide concentration (units: \(\times 100\)) after atracurium (group I) or pancuronium (group II). A = Following tracheal intubation; B = 20 min after induction of anaesthesia; C = 15 min after neuromuscular blocker.](image2)
arterial pressure remained unchanged. There was an increase in mean systolic pressure in group II (pancuronium). While both groups of patients had mean heart rates that were comparable before induction and 20 min later, in group II heart rates increased significantly following the administration of the neuromuscular blocking drug \((P < 0.001)\) and remained higher during the 15 min period of observation (fig. 4). In contrast, no change in mean heart rate followed the administration of atracurium.

Mean CVP remained constant during anaesthesia in both groups after the administration of the neuromuscular blocking drugs.

**DISCUSSION**

The main advantages of atracurium over other neuromuscular blocking agents are a shorter duration of action, minimal cumulative potential and little or no effect on the cardiovascular system (Payne and Hughes, 1981; Basta et al., 1982). Animal studies (Hughes and Chapple, 1981) have shown a wide (approximately 15-fold) separation of the dose–response curves for neuromuscular blockade and haemodynamic changes.

General anaesthesia for intraocular ophthalmic procedures necessitates the use of an anaesthetic technique which will provide stable intraocular con-
ditions (Holloway, 1980) and such techniques frequently include the use of a non-depolarizing neuromuscular blocking drug. Pancuronium and alcuronium have both been shown to be acceptable from the point of view of intraocular stability since they produce little change in IOP (George et al., 1979). However, both possess significant haemodynamic side-effects (Coleman et al., 1972). While these side-effects are well tolerated by healthy patients, those with limited cardiopulmonary reserve or with established cardiovascular disease may be placed at greater risk by the administration of these drugs.

Since many patients undergoing ophthalmic surgery fall into the latter category on account of age (Adams and Jones, 1980) or co-existing disease, the use of a neuromuscular blocking drug without cardiovascular side-effects would appear advantageous. Atracurium appears to fulfil these criteria (Payne and Hughes, 1981; Basta et al., 1982). However, to be acceptable, atracurium should not produce any deleterious effects on intraocular pressure. The results of this study indicate that this drug does meet this criterion also, as there was no change in the mean intraocular pressure after its administration. In addition, the increases in heart rate and systolic arterial pressure (the latter statistically insignificant) demonstrated in patients in group II were not evident in the patients given pancuronium.

Atracurium appears to offer a favourable alternative to pancuronium in patients requiring ophthalmic surgery, particularly in those who have cardiovascular disease where hypertension or tachycardia may be undesirable.

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REFERENCES


WIRKUNGEN VON ATRACURIUM AUF DEN INTRAOKULÄREN DRUCK

ZUSAMMENFASSUNG

Bei 20 bis zu 45 Jahre alten Patienten, die wegen Verletzung eines Auges operiert werden mußten, wurden die Wirkungen von Atracurium auf den intraokulären Druck (IOP) mit denen von Pancuronium verglichen. Nach Standardprämedikation und Lokalanästhesierung der oberen Luftwege wurde die Narkose mit Thiopental i.v. eingeleitet und die Trachea ohne vorherige neuromuskuläre Blockade intubiert. Nach 20 Minuten Steady-state-Anästhesie mit Messung von IOP, Arterieller Druck, Herzfrequenz, Pco2, Po2 und CVP erhielt eine Patientengruppe Atracurium 0,45 mg kg⁻¹, die andere Pancuronium 0,1 mg kg⁻¹. Die Messungen wurden weitere 15 Minuten bis zum Operationsbeginn fortgesetzt. Weder Atracurium noch Pancuronium führten zu Veränderungen von IOP. Atracurium ging mit größerer kardiovaskulärer Stabilität einher als Pancuronium.
EFECTOS DEL ATRACURIO SOBRE LA PRESIÓN INTRA-OCULAR

SUMARIO
En 20 pacientes de menos de 45 años de edad que necesitaban una operación por trauma de un ojo, se compararon los efectos del atracurio sobre la presión intra-ocular (IOP) con los del pancuronio. Después de una premedicación normal y la aplicación de analgesia tópica en las vías respiratorias altas, se indujo la anestesia mediante tiopentona i.v. y se intubó la tráquea sin proceder al bloqueo neuromuscular previo. A los 20 min de la anestesia en estado estable durante los cuales se tomaron mediciones de la IOP, de la presión arterial, del ritmo cardíaco, del \( P_{102} \), del \( FE_{CO_2} \) y de la CVP, se administró a un grupo de pacientes 0,45 mg kg\(^{-1}\) de atracurio y al otro 0,1 mg kg\(^{-1}\) de pancuronio. Se repitieron las observaciones durante unos 15 min más antes de iniciar la cirugía. Ni el atracurio ni el pancuronio modificaron de cualquier manera la IOP. El atracurio se encontró asociado con una estabilidad cardiovascular mayor que la del pancuronio.