EFFECT OF VECURONIUM ON INTRACRANIAL PRESSURE, MEAN ARTERIAL PRESSURE AND HEART RATE IN CATS

J. P. GIFFIN, J. HARTUNG, J. E. COTTRELL, C. CAPUANO AND B. SHWIRY

Vecuronium is challenging the propriety of pancuronium as the most widely used non-depolarizing neuromuscular blocking drug (Agoston et al., 1983). It has a considerably shorter onset of action (Agoston et al., 1980; Fahey et al., 1981; Leinhart et al., 1983) and maintains haemodynamic stability at doses producing complete muscle paralysis (Krieg, Crul and Booij, 1980; Basta and Savarese, 1983; Robertson et al., 1983). If, like pancuronium (McLeskey, Cullen and Kennedy, 1974), but unlike suxamethonium (Cottrell et al., 1983) and tubocurarine (Tarkkanen, Laitinen and Johansson, 1974), vecuronium does not increase intracranial pressure (ICP), it may be especially appropriate for use during neurosurgical procedures.

Using doses adequate in cats to cause complete ablation of twitch response within 70 s, we tested the effect of vecuronium on both normal and artificially increased ICP.

MATERIALS AND METHODS

After approval had been obtained from our institution's Animal Care Committee, six semi-conditioned male cats weighing 4-5 kg were anaesthetized with pentobarbitone 33 mg kg\(^{-1}\) i.p and acepromazine 0.6 mg kg\(^{-1}\) i.p. The trachea was intubated, and the lungs ventilated with nitrous oxide in oxygen. Mean arterial pressure (MAP), heart rate (HR), twitch response and ICP were recorded continuously. After the effect of vecuronium had been ascertained under the condition of normal ICP, and after full recovery of twitch response, pH-adjusted Ringer's lactate solution was infused to the cisterna magna until an ICP baseline of 26±2 mm Hg was established, and had stabilized. Vecuronium was administered again to determine its effect under the condition of increased ICP. Complete ablation of twitch response was obtained in 68±15 s with vecuronium 80 μg kg\(^{-1}\), and there was no significant change in ICP, MAP, HR or cerebral perfusion pressure (CPP) under either ICP condition.

SUMMARY

The effect of vecuronium on intracranial pressure (ICP) was investigated in six cats with normal and increased ICP. Cats were anaesthetized with pentobarbitone 33 mg kg\(^{-1}\) i.p and acepromazine 0.6 mg kg\(^{-1}\) i.p., the trachea was intubated, and the lungs ventilated with nitrous oxide in oxygen. Mean arterial pressure (MAP), heart rate (HR), twitch response and ICP were recorded continuously. After the effect of vecuronium had been ascertained under the condition of normal ICP, and after full recovery of twitch response, pH-adjusted Ringer's lactate solution was infused to the cisterna magna until an ICP baseline of 26±2 mm Hg was established, and had stabilized. Vecuronium was administered again to determine its effect under the condition of increased ICP. Complete ablation of twitch response was obtained in 68±15 s with vecuronium 80 μg kg\(^{-1}\), and there was no significant change in ICP, MAP, HR or cerebral perfusion pressure (CPP) under either ICP condition.

PacO\(_2\) at 4.8±0.53 kPa. Temperature was kept at 36±0.5 °C with a heating blanket. A femoral artery catheter was inserted and blood sampled, as necessary, for measurement of blood-gas tensions. MAP and HR were recorded continuously. Dextrose 5% in physiological saline 4–5 ml kg\(^{-1}\) h\(^{-1}\) and drugs were administered through a catheter placed in the cephalic vein. The response of the sciatic nerve to twitch stimulation was recorded continuously with a Grass Instruments force-displacement transducer.

A single 19-gauge curved needle was inserted to the cisterna magna and secured with cyanoacrylate tissue adhesive (Krazy Glue). Intracranial pressure was monitored continuously and readings were

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TABLE I. The effect of vecuronium on intracranial pressure (ICP), mean arterial pressure (MAP), heart rate (HR), and cerebral perfusion pressure (CPP) in cats with normal and increased ICP. All values are mean ± SEM. *Maximum change subsequent to administration of neuromuscular blocker and before recovery of twitch response

<table>
<thead>
<tr>
<th>Normal ICP</th>
<th>Increased ICP</th>
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<tbody>
<tr>
<td></td>
<td>Control</td>
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<tr>
<td>ICP (mm Hg)</td>
<td>14.8 ± 0.6</td>
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<tr>
<td>MAP (mm Hg)</td>
<td>98 ± 8</td>
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<tr>
<td>HR (beat min⁻¹)</td>
<td>169 ± 17</td>
</tr>
<tr>
<td>CPP (mm Hg)</td>
<td>83 ± 8</td>
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accepted if the pressure tracing changed 1-3 mm Hg with respiration.

With haemodynamic values stabilized and ICP within the physiological range, a bolus of vecuronium 80 µg kg⁻¹ was administered i.v. After the recovery of the twitch response and the re-establishment of control haemodynamic values, pH-adjusted Ringer’s lactate solution was infused, over a 10-20 min period, to the cisterna magna. Pulsation of ICP with respiration was not disturbed by the infusion. (Our method for increasing ICP has been more fully explained elsewhere (Cottrell, Hartung and Giffin, 1984).) With ICP stabilized at an increased baseline value of 26 ± 2 mm Hg, the same dose of vecuronium was administered again to each cat.

For each experimental condition in each animal (normal or increased ICP), control values for MAP, ICP, HR and cerebral perfusion pressure (CPP = MAP - ICP) were compared with their values at the point of maximum change subsequent to the administration of the muscle relaxant and before the recovery of the twitch response. Each animal served as its own control and the maximum changes for all variables were analysed for statistical significance by the two-tail paired t test. All intervals reported are mean values ± SEM.

RESULTS

Complete ablation of twitch response was obtained in 68 ± 15 s and this onset of action was unaffected by the baseline value of ICP. There were no significant changes in ICP, MAP, HR or CPP under either initial ICP condition (table I).

DISCUSSION

The ideal neuromuscular blocking drug should be non-depolarizing, reversible, and should not affect systemic or central variables (Savarese and Kitz, 1975). Vecuronium seems to offer improvement over pancuronium, and our investigation indicates that, unlike suxamethonium (Cottrell et al., 1983) and tubocurarine (Tarkkanen, Laitinen and Johansson, 1974), vecuronium does not increase ICP. Our observed change in ICP was so slight that the 95% confidence interval implies that vecuronium did not increase ICP by more than 0.6 mm Hg. We also found that vecuronium failed to produce a statistically or clinically significant change in either MAP or HR.

In conclusion, we found vecuronium to be capable of inducing neuromuscular blockade rapidly in cats without causing the increase in MAP that often characterizes high-dose tubocurarine and metubine (Basta and Savarese, 1983). As might be expected, we also failed to detect changes in HR that would indicate the ablation of the vagolytic response which sometimes accompanies blockade induced with pancuronium (Stoelting, 1972). In addition, we did not detect any evidence of increased ICP whether ICP was normal before blockade or had been increased artificially. Since cats are an especially sensitive animal model for detecting effects on ICP, our observed stability of ICP marks a significant improvement over suxamethonium and tubocurarine. When considered together with the observed haemodynamic stability at doses adequate to induce blockade rapidly, our results suggest that vecuronium is an especially appropriate neuromuscular blocker for use during neurosurgical procedures.

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REFERENCES


