OBSERVATIONS ON DENTAL ANAESTHESIA INTRODUCED WITH METHOHEXITONE

III: BLOOD PRESSURE CHANGES

BY

J. G. WHITWAM AND DOUGLAS S. YOUNG

The General Infirmary at Leeds, the Leeds Dental Hospital, and the Regional Thoracic Surgical Centre, Killingbeck Hospital, Leeds, England

SUMMARY

Changes in systolic blood pressure have been measured in ninety-eight patients undergoing dental extraction under general anaesthesia introduced with methohexitone—mean dose: male 12.2 mg/stone (1.91 mg/kg); female 8.7 mg/stone (1.36 mg/kg)—and continued with nitrous oxide and oxygen, with the addition of halothane as a supplement (concentration 1 per cent) in forty-eight patients. The most consistent trends were a reduction in pressure associated with loss of consciousness, the extent of which was related to the initial reading, and a subsequent rise in pressure in response to surgical stimulus. Halothane exerted no influence on the blood pressure changes. The problem of fainting associated with venepuncture is discussed. It was concluded that in terms of the effect on the systolic blood pressure, methohexitone is acceptable for use in patients in the dental chair. When relatively large doses of this drug are used it is recommended that the injection speed should not exceed 2.5 mg/sec.

Cerebral and cardiac hypoxia will occur either if the flow of blood through these organs is impaired or if the arterial blood is not adequately oxygenated, the position being made worse if the oxygen-carrying capacity of the blood is reduced. Prolonged respiratory depression and hypotension in the systemic circulation represent two potential causes of hypoxia which may follow intravenous administration of the barbiturates.

The use of artificial ventilation to overcome respiratory depression following the administration of methohexitone to patients in the dental chair has been discussed in a previous publication (Young and Whitwam, 1964). The present report summarizes the results of a study of changes in systolic blood pressure in patients undergoing extraction of teeth under general anaesthesia in the sitting position. All patients were between the ages of 18 and 72 years.

METHODS

Anaesthetic technique.

This was similar to that described previously (Young and Whitwam, 1964). The dose range, mean dose, injection time and rate of injection of methohexitone are shown in table I.

<table>
<thead>
<tr>
<th>Table I</th>
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<tr>
<td>Dose and speed of injection of methohexitone.</td>
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</table>

<table>
<thead>
<tr>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Range</td>
</tr>
<tr>
<td>Total dose (mg)</td>
<td>144</td>
</tr>
<tr>
<td>Dose (mg/stone)</td>
<td>12.2</td>
</tr>
<tr>
<td>Dose (mg/kg)</td>
<td>1.91</td>
</tr>
<tr>
<td>Injection time (sec)</td>
<td>53.2</td>
</tr>
<tr>
<td>Rate of injection (mg/sec)</td>
<td>2.77</td>
</tr>
</tbody>
</table>

Systolic blood pressure.

This was measured as the point of return of the radial pulse, detected by palpation, during deflation of a sphygmomanometer cuff placed on the left arm and connected to an aneroid manometer. While the patients were in the dental chair the systolic pressure was recorded frequently, and a final measurement was made in the recovery room 15 minutes later.

Ninety-eight patients were studied, three of whom were rejected for the purposes of comparison. The first of these three fainted during induction; in the second, extravenous injection occurred
Halothane was used as a supplement in 22 men and 26 women. It was introduced before extraction commenced in 9 men and 12 women. The vertical lines represent the range in pressure and the short horizontal lines the mean systolic blood pressure at each of ten stages: (1) pre-anaesthetic; (2) injection of methohexitone completed; (3) nosepiece applied; (4) end of period of positive pressure ventilation; (5) mouth opened; (6) extractions commenced; (7) extractions completed; (8) final point while still asleep in chair; (9) awake in chair; (10) recovery room, 15 minutes after leaving chair.

M = Minimum pressure recorded following injection of methohexitone.

A-R = "Augmented Respiration", i.e. period of positive pressure ventilation whether controlled or assisted.

First arrow, mouth opened. Second arrow, extraction commenced.

Fig. 1. Blood pressure changes. Total number of patients: male 46; female 49.
after the administration of a small amount of methohexitone; the third developed complete laryngospasm during extractions, and following the administration of 100 per cent oxygen a fall in blood pressure occurred. This may have been due to the phenomenon of the "oxygen paradox" (Latham, 1951). In addition venous blood gas analyses and electroencephalography have been performed on a further group of patients. All anaesthetics were administered by one of us (D.S.Y.) and all blood pressure measurements were made by the other (J.G.W.).

RESULTS

Pattern of blood pressure changes.

Figure 1 summarizes the results in forty-six male and forty-nine female patients. The initial mean systolic blood pressure was approximately 160 mm Hg, for both male and female groups. The blood pressure changes in sixty-six of the patients (approximately 70 per cent) followed a typical pattern. As the injection of methohexitone took effect the systolic blood pressure started to fall, reaching the lowest reading either just before or shortly after the nosepiece was applied; following this it rose slightly to a steady state, so that at the completion of induction, the blood pressure was either the same or higher than when the nosepiece was first applied. As soon as the mouth was opened by a dental gag there was a sharp rise in the systolic reading to a new steady level (mean value approximately 150 mm Hg). This rise in pressure was associated with a perceptible increase in muscle tone. The onset of extraction of teeth produced a second but slower increase to a mean maximum value above 170 mm Hg. The stimulus producing this second rise appeared to be the application of forceps and the process of extraction. Whenever the extractions were interrupted the pressure decreased. Other procedures, such as incision of the gums, the use of bone chisels or suturing of sockets, did not seem to produce enough response to sustain the "extraction pressure", which was re-attained with the removal of further teeth. Following completion of the extractions there was a gradual reduction in systolic blood pressure to a new mean value of approximately 138 mm Hg. As each patient started to move in the chair during recovery of consciousness there was a sharp rise to a mean value of approximately 150 mm Hg. Like the elevation of the pressure recorded when the mouth was opened this final increment also appeared to be related to an increase in muscle tone, and it is of interest that the mean pressures were approximately the same in each instance. The final record of the systolic blood pressure taken in the recovery room (mean value approximately 143 mm Hg) usually lay between the previous two readings (fig. 1).

The blood pressure responses not conforming to this pattern exhibited quantitative rather than qualitative differences. The two most consistent trends were an initial reduction in pressure associated with loss of consciousness and a subsequent rise in pressure in response to surgical stimulus.

Effect of methohexitone on systolic blood pressure.

The principal differences between male and female patients in terms of the initial fall in systolic blood pressure are summarized in Table II. Unless there is a sex difference in response to methohexitone, the greater overall effect in the male patients is presumably the result of the larger dose and faster rate of injection in that group.

<table>
<thead>
<tr>
<th>TABLE II</th>
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<tbody>
<tr>
<td>The principal differences in changes in systolic blood pressure between male and female patients following injection of methohexitone.</td>
</tr>
<tr>
<td>Mean initial systolic blood pressure (mm Hg)</td>
</tr>
<tr>
<td>Percentage reduction in systolic blood pressure</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>Range</td>
</tr>
<tr>
<td>Mean minimum blood pressure (mm Hg)</td>
</tr>
<tr>
<td>Number of patients with a fall in pressure below 110 mm Hg</td>
</tr>
<tr>
<td>Number of patients with a fall in pressure below 100 mm Hg</td>
</tr>
</tbody>
</table>

In this study the extent of the initial fall in blood pressure associated with loss of consciousness was related to the height of the pre-operative reading (fig. 2).

Effect of halothane on blood pressure changes.

The pattern of the blood pressure changes was the same in the various groups of patients irrespective of whether halothane was used or not (fig. 1).
Reduction in systolic blood pressure following injection of methohexitone. (Numbers refer to repetition of readings.) The patient with the largest fall in blood pressure was a woman aged 73 years, who weighed 14 stones (89.1 kg). 56 mg of methohexitone was administered in 37 sec, representing 4 mg/stone (0.63 mg/kg) at 1.5 mg/sec. Of the two patients who showed no fall in blood pressure the female received 80 mg of methohexitone representing 9 mg/stone (1.4 mg/kg) at 1.5 mg/sec, and the male 128 mg, representing 11.1 mg/stone (1.74 mg/kg) at 1.6 mg/sec.

The average duration of administration of halothane (used as a supplement in a concentration of approximately 1 per cent) was 5 minutes in the female group and 6 minutes in the male; the longest period of supplementation was 7 minutes for both sexes and on each occasion the agent was introduced late during a surgical procedure lasting 14 minutes. In these two patients halothane appeared to produce no effect on the systolic blood pressure. It was concluded that halothane administered in a concentration of approximately 1 per cent and for periods up to 7 minutes produced no appreciable reduction of the systolic blood pressure.

Effect of positive pressure ventilation on systolic blood pressure.

Following the administration of methohexitone a variable period of respiratory depression occurred in all patients. During this time effective ventilation was ensured by intermittently closing the valve on the nosepiece and squeezing the reservoir bag (induction being carried out with the patient's mouth closed). In some patients apnoea did not occur and ventilation was merely assisted, while in others apnoea was present for part of the induction period. The pressure in the nosepiece was measured by inserting a wide-bore needle, connected to a manometer, through the wall of the nosepiece. The inflation pressures recorded were found to reach a peak of between 5 and 15 cm H$_2$O.

The systolic blood pressure measured at the end of the period of positive pressure ventilation was never less than at the beginning. In a number of patients there was a rise in pressure; the largest increase was 20 mm Hg, and the mean value rose from 130 to 134 mm Hg over the whole series. This rise was not significant (t=0.2; P>0.80). The mean duration of application of positive pressure ventilation was 60 sec in the men (range 15 sec to 2 min 5 sec) and 53 sec in women (range 20 sec to 1 min 25 sec). It was concluded that the practice of overcoming the transient respiratory depression produced by methohexitone by applying positive pressure ventilation, in the manner described, did not reduce the systolic blood pressure.

DISCUSSION

In this study no direct correlation was observed between the dose and speed of injection of methohexitone and the initial fall in blood pressure. It was found that the level of the first pressure recorded, which would be expected to be elevated in anxious individuals, determined to a large extent the subsequent reduction in blood pressure following administration of the barbiturate (fig. 2). Green and Jolly (1960), using methohexitone in a dose of 5 mg/stone (0.8 mg/kg), also noted that the largest
reductions in blood pressure occurred in patients with high initial pressures. The occurrence of abnormal muscle movements following the administration of methohexitone might be expected to reduce the extent of the ensuing fall in blood pressure.

Fainting or syncope in association with venepuncture, by producing acute hypotension, represents a particularly dangerous hazard for the patient in the dental chair. One of the authors (D.S.Y.) has experience of administration of an intravenous barbiturate to over 10,000 patients in the dental chair, and the incidence of fainting was found to be approximately 1 in 500. The sight of the needle before venepuncture may cause a susceptible individual to faint, in which situation the syndrome is easily recognized. Bourne (1960) has discussed the dangers of the undetected faint occurring at the beginning of a "dental gas". Venepuncture, especially if difficult, may initiate the faint syndrome, but hypotension from this cause may not develop until 2 or 3 ml of the intravenous agent have been injected. In these circumstances it may be assumed that loss of consciousness is due to a rapid effect of the drug, and if the anaesthetist is unobservant the occurrence of severe hypotension may remain unnoticed. One patient on whom an electroencephalogram was being recorded provided a convincing demonstration of this possibility (fig. 3). This was the only instance in which an electroencephalographic record was obtained showing evidence of cerebral hypoxia. After the administration of only 32 mg of methohexitone the patient suddenly and unexpectedly became unconscious. It was realized that the patient had fainted and appropriate treatment was instituted.

Driscoll (1962), using thiopentone as the induction agent, noted consistent rises in blood pressure during dental extractions. In almost 1,000 operations he found that the stimulation pattern was the same, the blood pressure rising at the initiation of surgery. The results of the present study tend to confirm these findings. Gas analyses have been performed on venous blood obtained from five patients, without application of a tourniquet, at the period of maximum blood pressure rise in response to surgical stimulus. The results (table III) suggest that the rise in systolic blood pressure in these patients was not the result of hypoxia or hypercarbia. Smith (1963) has shown that spontaneous respiration against a resistance of the order of 15 cm H₂O can cause a rise in blood pressure. In the present series of patients, during maintenance of anaesthesia, the valve on the nosepiece was under minimal tension, and pressures at the nosepiece fluctuated around zero, ranging from a maxi-

Fig. 3
Electroencephalogram recorded in a male aged 19 years, who fainted during the administration of the first 2 ml (32 mg) of methohexitone. Cerebral hypoxia resulted in bursts of high voltage delta waves on a background of relative electrographic suppression. At the arrow the injection was stopped and resuscitation commenced.
TABLE III

Venous blood gas analysis in patients undergoing dental extraction under general anaesthesia. At the time of each sample the blood pressure had risen in response to surgical stimulus.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Site of sample</th>
<th>Time from starting extractions (min)</th>
<th>Carbon dioxide tension† (mm Hg)</th>
<th>Oxygen saturation‡ (per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mid forearm</td>
<td>2</td>
<td>45</td>
<td>91.5</td>
</tr>
<tr>
<td>2*</td>
<td>Dorsum of wrist</td>
<td>2</td>
<td>41</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>Dorsum of wrist</td>
<td>1</td>
<td>30</td>
<td>97</td>
</tr>
<tr>
<td>4*</td>
<td>Dorsum of hand</td>
<td>7</td>
<td>33</td>
<td>97</td>
</tr>
<tr>
<td>5*</td>
<td>Dorsum of hand</td>
<td>3</td>
<td>37</td>
<td>97</td>
</tr>
</tbody>
</table>

*Halothane used to supplement nitrous oxide.
†Measured with Astrup micro-equipment.
‡Measured with a Kipp haemoreflector.

mum of +2 cm H₂O to a minimum of −1 cm H₂O (recorded from a wide-bore needle inserted through the wall of the nosepiece). The authors formed the opinion that the rise in blood pressure which occurred during the extraction of teeth was the result of the surgical stimulus and not due to other factors.

Goldman and Harris (1963) noted that halothane, used as a supplement, exerted little effect on the blood pressure during dental extractions and the results of the present study are in agreement with this observation.

In terms of the effect on the systolic blood pressure, the method of administration of methohexitone described in this report appears to be acceptable. The authors are of the opinion that in experienced hands, apart from fainting, dangerous falls in blood pressure are unlikely to occur when methohexitone is employed in the dental chair. When large doses are used, it would seem desirable that this intravenous agent should be given slowly, and a maximum injection speed of 2.5 mg/sec is suggested. This is an arbitrary figure, but was found to represent the maximum speed at which it was possible to assess the response of the patient to the drug during injection.

ACKNOWLEDGMENTS

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To Mr. G. W. Wooler, Director, Department of Thoracic Surgery in the United Leeds Hospitals, in whose laboratories the blood gas analyses were performed.

To Dr. J. D. Kinnell for assistance with this work.

REFERENCES


OBSERVATIONS CONCERNANT L’ANESTHESIE DENTAIRE AVEC PRE-ANESTHESIE PAR METHOHEXITONE

III: ALTERATION DE LA TENSION ARTERIELLE

SOMMAIRE

Les modifications de la tension systolique ont été mesurées chez 98 patients au cours d’avulsions dentaires sous anesthésie générale initiée au méthohexitone. — Les doses moyennes furent de 1.91 mg/kg pour les hommes et de 1.36 mg/kg pour les femmes. On continua l’anesthésie au protoxyde d’azote et à l’oxygène, — chez 48 patients avec complément d’halothane à 1%. Le fait le plus répandu fut une réduction de tension associée à la perte de connaissance — dont l’étendue était en rapport avec la quantité initiale de méthohexitone et l’augmentation consécutive de la tension par suite de la “stimulation” chirurgicale. L’halothane n’exerça aucune influence sur les modifications de la tension artérielle. Les auteurs discutent le problème de l’évanouissement provoqué par la “piqûre” intra-veineuse. Ils parviennent à la conclusion que, en ce qui concerne son effet sur la systolique, le méthohexitone peut
être accepté pour le patient assis dans un fauteuil de dentiste. Les auteurs recommandent lors de l'emploi de doses relativement fortes de méthohexitone de régler la vitesse d'injection à un maximum ne dépassant pas 2,5 mg par seconde.

**ZUSAMMENFASSUNG**

Veränderungen des systolischen Blutdruckes wurden an 98 Patienten, bei denen eine Zahnextraktion unter Allgemeinanästhesie, die mit Methohexitone [mittlere Dosis: beim Mann 12,2 mg/Stone (1,91 mg/kg); bei der Frau 8,7 mg/Stone (1,36 mg/kg)] eingeleitet und mit Lachgas und Sauerstoff fortgesetzt wurde mit dem Zusatz von Halothane (Konzentration 1 Prozent) bei 48 Patienten, bestimmt. Im allgemeinen kam es zu einem Blutdruckabfall bei Eintritt der Bewusstlosigkeit bezogen auf den anfänglichen Wert und einem nachfolgenden Blutdruckanstieg als Reaktion auf den chirurgischen Eingriff. Halothane hatte keinen Einfluß auf die Veränderungen des Blutdruckes. Das Problem einer Ohnmacht bei einer Venenpunktion wird besprochen. Aus den Ergebnissen wurde geschlossen, daß Methohexitone für die Anwendung bei im Dentalstuhl sitzenden Patienten in bezug auf die Wirkung auf den systolischen Blutdruck brauchbar ist. Bei Verwendung von relativ hohen Dosen dieser Droge wird empfohlen, daß die Injektionsgeschwindigkeit 2,5 mg pro Sekunde nicht übersteigt.