LAPAROSCOPY: BLOOD-GAS VALUES AND MINOR SEQUELAE ASSOCIATED WITH THREE TECHNIQUES BASED ON ISOFLURANE

J. P. KENEFICK, A. LEADER, J. R. MALTBY AND P. J. TAYLOR

Gynaecological laparoscopy is a common outpatient procedure. The anaesthetic technique should be safe, and ensure rapid recovery with as few after-effects as possible. Two recent studies comparing different anaesthetic agents have reported a high incidence of post-operative complications such as sore throat, muscle pains, nausea and headache (Dhamee et al., 1982; Tracey, Holland and Unger, 1982). In these studies all patients received succinylcholine and tracheal intubation was performed.

A minority of anaesthetists, including one of the present authors (J.R.M.), allow patients undergoing laparoscopy to breathe spontaneously via an anaesthetic face mask (Scott and Julian, 1972; Kurer and Welch, 1984). However, one of the criticisms of this technique is that hypercarbia, especially in combination with halothane, may produce dangerous arrhythmias.

Isoflurane is not arrhythmogenic at PaCO₂ values as high as 9.31 kPa (Cromwell et al., 1971) and may be a safer agent for laparoscopy. This study was designed to compare three different anaesthetic techniques (using isoflurane) with respect to respiratory status and cardiac arrhythmias during laparoscopy, and to evaluate postoperative morbidity.

PATIENTS AND METHODS

Approval for the study was obtained from the University of Calgary Joint Ethics Committee.

SUMMARY

Three anaesthetic techniques based on isoflurane were compared in outpatients undergoing laparoscopy. Sixty healthy patients were randomly allocated to receive isoflurane via mask (spontaneous respiration), via tracheal tube (spontaneous respiration) or via tracheal tube with controlled ventilation. Moderate hypercarbia occurred in the group breathing from a mask, although there was no further increase during carbon dioxide insufflation and laparoscopy. No arrhythmias were seen during insufflation and surgical conditions in all groups were good. Spontaneous respiration via a face mask did not lead to significant hypercarbia, acidosis or cardiac arrhythmia. A high incidence of minor morbidity was found in all groups. Sore throat was much less frequent in the mask group, whereas the incidence of other after-effects, including muscle pains, did not differ significantly among the groups.

Sixty women (all ASA class I or II) undergoing outpatient laparoscopy for investigation of infertility were studied. All gave informed consent for the insertion of a radial artery cannula to permit sampling for blood-gas analyses (Allen's test was performed on all patients). The patients were randomly allocated to one of three anaesthetic regimens.

Anaesthetic regimens (table I)

No premedication was given. The anaesthetics were all given by a consultant anaesthetist (J.P.K. or J.R.M.) and the laparoscopies performed by a consultant gynaecologist (A.L. or P.J.T.). All patients received thiopentone 6 mg kg⁻¹ for induction of anaesthesia and this was followed by 65% nitrous oxide and 2–3% isoflurane in oxygen.
administered via a circle system with carbon dioxide absorption. Patients in group I breathed spontaneously via a face mask; patients in groups II and III received tubocurarine 3 mg 3 min before suxamethonium 1.5 mg kg\(^{-1}\) and the trachea was intubated. Patients in group III received, in addition, an infusion of suxamethonium 1 mg ml\(^{-1}\), and their lungs were ventilated with a tidal volume of 10 ml kg\(^{-1}\) at a rate of 10 b.p.m. Cuffed plastic 8.0-mm orotracheal tubes (National Catheter Corporation) without lubricant were used. Pharyngeal suction was performed on all patients in groups II and III before extubation, and on one patient in group I.

A 10° head-down tilt was used in all patients and the peritoneal cavity was distended with carbon dioxide using a Veress needle. The transmitted inflation pressure was recorded with the insufflating machine in the automatic mode. The duration of insufflation was similar in all groups (range 7-12 min).

Analgesics were not given routinely after the procedure and the requirements of the different groups were similar: 40-45% of patients received pentazocine 0.5-1 mg kg\(^{-1}\) in the recovery room, 22-30% received two 292 tablets (acetyl salicylic acid 375 mg, caffeine citrate 30 mg, codeine phosphate 30 mg) before leaving the hospital; 27-36% did not require any analgesic.

Assessment

The electrocardiogram was monitored from before the induction of anaesthesia until surgery was complete. After induction of anaesthesia a radial artery cannula was inserted and blood samples taken at the following times:

1. with the patient in lithotomy position, but before insertion of the Veress needle;
2. after maximum carbon dioxide insufflation;
3. immediately before deflation, and
4. 10 min after arrival in the recovery room.

Analysis of variance and Tukey’s \(F\) test were used to analyse the arterial blood-gas results.

Morbidity after operation was assessed by means of a questionnaire. Patients completed this at the time of discharge from hospital—about 4 h after completion of surgery, and on the first and second days after operation. The results were analysed using the \(\chi^2\)-test.

RESULTS

The three groups were similar in age, weight, volume of carbon dioxide insufflated and intra-abdominal pressure at maintenance of insufflation (table II).

After the induction of anaesthesia, five patients from group I and six patients from group II were slow to settle. Periods of breath holding were often observed before spontaneous respiration became regular. The administration of a further dose of thiopentone was necessary in some cases. Once stable anaesthesia had been established, conditions for laparoscopy were uniformly good in all groups.

No cardiac arrhythmia was observed in any group during the period of carbon dioxide pneumoperitoneum. However, in group III four patients showed transient ventricular bigeminy immediately following orotracheal intubation and before the insertion of the Verre needle. In each case the arrhythmia reverted spontaneously to sinus rhythm within 1 min.

Arterial blood-gas tensions are shown in table III. There was good oxygenation in all groups at all times. Moderate hypercarbia (6.38 kPa± 1.06; 5.99 kPa± 1.06) and moderate respiratory acidosis

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**Table I. Anaesthetic techniques and agents. \(F_{1,0.9} = 0.35\) in all groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>Technique</th>
<th>Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Mask, spontaneous respiration</td>
<td>Thiopentone, (N_2O, O_2, isoflurane)</td>
</tr>
<tr>
<td>II</td>
<td>Intubation, spontaneous respiration</td>
<td>Tubocurarine, thiopentone, suxamethonium, (N_2O, O_2, isoflurane)</td>
</tr>
<tr>
<td>III</td>
<td>Intubation controlled ventilation (V_t = 10) ml kg(^{-1}); (f = 10)</td>
<td>Tubocurarine, thiopentone, suxamethonium, (N_2O, O_2, isoflurane)</td>
</tr>
</tbody>
</table>
TABLE II. Comparison of age, weight, carbon dioxide volume and transmitted intra-abdominal pressure reading in each group (mean ± SD). * Baseline pressure, with Veress needle open to air, 8-10 mm Hg

<table>
<thead>
<tr>
<th>Group</th>
<th>Technique</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Volume of CO₂ insufflated (litre)</th>
<th>Transmitted insufflation pressure (mm Hg)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Mask, spont. resp.</td>
<td>28.2±3.8</td>
<td>60.5±8.1</td>
<td>3.05±0.72</td>
<td>14.7±2.6</td>
</tr>
<tr>
<td>II</td>
<td>Intubated, spont. resp.</td>
<td>29.0±4.1</td>
<td>59.0±9.2</td>
<td>3.10±0.74</td>
<td>15.0±3.5</td>
</tr>
<tr>
<td>III</td>
<td>Intubated, IPPV</td>
<td>29.8±3.5</td>
<td>59.4±6.6</td>
<td>3.02±0.52</td>
<td>14.8±3.1</td>
</tr>
</tbody>
</table>

TABLE III. Blood-gas values (± SD). (1) = With patients in lithotomy position before insertion of Veress needle; (2) = after maximal insufflation of carbon dioxide; (3) = at completion of laparoscopy before deflation; (4) = 10 min after arrival in recovery room

<table>
<thead>
<tr>
<th>Group</th>
<th>(1) Baseline</th>
<th>(2) Max insufflation</th>
<th>(3) Before deflation</th>
<th>(4) Recovery Room</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pH</td>
<td>CO₂ (kPa)</td>
<td>O₂ (kPa)</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>7.30±0.05</td>
<td>6.12±0.67</td>
<td>17.42±4.92</td>
<td>7.37±0.03</td>
</tr>
<tr>
<td>II</td>
<td>7.38±0.05</td>
<td>4.65±0.67</td>
<td>4.65±4.52</td>
<td>7.37±0.02</td>
</tr>
<tr>
<td>III</td>
<td>7.43±0.05</td>
<td>4.12±0.53</td>
<td>4.52±4.40</td>
<td>7.38±0.02</td>
</tr>
</tbody>
</table>

(pH 7.28±0.06; 7.29±0.06) were noted in groups I and II immediately before deflation of the pneumoperitoneum. However, these figures did not differ significantly from the baseline values for group I patients in the lithotomy position before the creation of the pneumoperitoneum. The baseline values for group II, which were similar to those for group III, reflect the effects of the manual ventilation required before spontaneous breathing was resumed. Patients in group III demonstrated moderate hypocarbia (4.26 kPa ± 1.06) and no acidosis (pH 7.40±0.05) immediately before the deflation of pneumoperitoneum.

One patient in group I, who was moderately obese and smoked 40 cigarettes per day, had a stormy induction. She salivated, coughed repeatedly, and developed laryngospasm. She took several minutes to settle into smooth anaesthesia. The baseline arterial blood-gas sample, taken during this episode, showed a pH of 7.16. Smooth anaesthesia was eventually achieved and the laparoscopy completed. pH values during the pneumoperitoneum showed steady improvement. The problems in this patient were attributed to the irritant isoflurane vapour in an unpremedi-}

ated heavy smoker. One patient (group I) and one in group II had pH values of 7.19 and 7.16, respectively, immediately before deflation of the pneumoperitoneum, but their clinical condition gave no cause for concern. The acid–base status of all patients in the recovery room was satisfactory.

The symptoms reported after the procedure are shown in table IV. At the time of discharge from hospital the most common symptoms were general weakness (68%), drowsiness (45%), shoulder pain (50%) and muscle ache (48%). Sore throat was present in 10% of the mask group and 28% of the intubated groups; however, this difference was not significant (P>0.05).

Twenty-four hours later, the most frequent complaint was pain in the shoulder area (65%) and general muscle ache (55%). There were no significant differences between the groups. Sore throat was present in 65% of intubated patients, and in 10% of the non-intubated patients; this difference was significant (P<0.0005).

By the 2nd day after operation all symptoms were less frequent, although some minor discomfort still persisted, especially aching in the shoulder and muscles.
TABLE IV. Postoperative morbidity in three groups of 20 patients. Number (% of group) with each symptom. * P < 0.0005 group I v. group II v. group III on 1st day

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Group:</th>
<th>Discharge from hospital</th>
<th>1st day after op.</th>
<th>2nd day after op.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>Drowsiness</td>
<td>10 (50)</td>
<td>9 (45)</td>
<td>8 (40)</td>
<td>5 (25)</td>
</tr>
<tr>
<td>Dizziness</td>
<td>5 (25)</td>
<td>9 (45)</td>
<td>7 (35)</td>
<td>2 (10)</td>
</tr>
<tr>
<td>Headache</td>
<td>9 (45)</td>
<td>4 (20)</td>
<td>4 (20)</td>
<td>4 (20)</td>
</tr>
<tr>
<td>Sore throat</td>
<td>2 (10)</td>
<td>6 (30)</td>
<td>5 (25)</td>
<td>2 (10)*</td>
</tr>
<tr>
<td>Weakness</td>
<td>15 (75)</td>
<td>15 (75)</td>
<td>11 (55)</td>
<td>9 (45)</td>
</tr>
<tr>
<td>Nausea</td>
<td>4 (20)</td>
<td>5 (25)</td>
<td>3 (15)</td>
<td>3 (15)</td>
</tr>
<tr>
<td>Vomiting</td>
<td>1 (5)</td>
<td>1 (5)</td>
<td>1 (5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Pain in shoulder</td>
<td>9 (45)</td>
<td>14 (70)</td>
<td>9 (45)</td>
<td>13 (65)</td>
</tr>
<tr>
<td>Muscle ache</td>
<td>7 (35)</td>
<td>13 (65)</td>
<td>9 (45)</td>
<td>8 (40)</td>
</tr>
</tbody>
</table>

DISCUSSION

Early reports of anaesthesia for laparoscopy using halothane emphasized the dangers of hypercarbia if patients were allowed to breathe spontaneously (Desmond and Gordon, 1970; Calverley and Jenkins, 1973). These authors condemned the practice of spontaneous respiration via a face mask, but others disagreed (Lewis et al., 1972; Scott and Julian, 1972). More recently, Kurer and Welch (1984) found no significant differences in intraoperative anaesthetic or surgical complications between patients breathing halothane via a face mask and those in whom ventilation was controlled via a tracheal tube. Both techniques are equally popular in their hospital. The duration of insufflation was usually less than 5 min. The authors concluded that the safety of the procedure probably depends less on the particular technique than on a short operative time, close intraoperative monitoring, and the experience of both anaesthetist and surgeon.

Stability of cardiac rhythm is a feature of isoflurane anaesthesia. A study of three anaesthetic techniques using this newer agent was felt to be justified. The first objective was to determine whether spontaneous respiration using isoflurane during laparoscopy caused hypercarbia, acidosis or cardiac arrhythmia. A second objective was to assess postoperative morbidity and to determine whether postoperative symptoms were influenced by the different anaesthetic techniques.

Oxygenation in all patients was good throughout the period of study. Hypercarbia (6.38 kPa ± 1.06) was present, as expected, in group I during carbon dioxide pneumoperitoneum. However, this was only minimally greater than the baseline value in the same patients in the lithotomy position before the insertion of the Veress needle (6.12 kPa ± 0.67). In healthy young patients, and in the absence of other problems, this is unlikely to be dangerous. The baseline figures in group II reflect manual ventilation before patients resumed spontaneous respiration. There was no significant increase in \( P_{\text{aCO}_2} \) in any group during the laparoscopy itself while the pneumoperitoneum was maintained. Ten minutes after arrival in the recovery room, all three groups had virtually identical blood-gas tensions.

In the two groups of patients who breathed spontaneously, moderate acidosis developed during the carbon dioxide pneumoperitoneum. During insufflation there was no concern about the clinical condition of any of these patients. However, they were almost all healthy, young, non-obese women and the duration of the procedure was brief. Spontaneous respiration, whether via mask or tracheal tube cannot be recommended for obese or less healthy patients, nor when the laparoscopy may be prolonged, as for oocyte retrieval for in vitro fertilization.

The risk of arrhythmias during spontaneous respiration and carbon dioxide pneumoperitoneum was not confirmed in this study. No arrhythmia was recorded in any group during peritoneal insufflation. Immediately following orotracheal intubation, four patients in group III showed transient ventricular bigeminy which disappeared spontaneously within 1 min. It is known that such arrhythmias may be related to the stimulus of intubation and usually do not require specific treatment (Atkinson, Rushman and Lee, 1982).

It has been shown that both inpatients and
outpatients undergoing general anaesthesia are at theoretical risk of regurgitation and aspiration of acid stomach contents (Ong, Palahniuk and Cumming, 1978; Miller, Wishart and Nimmo, 1983). Passive regurgitation of gastric contents into the pharynx may occur in any patient, but inhalation of foreign material deep into the bronchial tree can only occur if laryngeal and cough reflexes are abolished by the use of neuromuscular blocking drugs or deep inhalation anaesthesia. Patients breathing spontaneously under light general anaesthesia, without a tracheal tube, usually maintain the cough reflex and the integrity of the crico-pharyngeal sphincter (Davies, 1979). Scott (1980) has pointed out that, in a series of 50000 patients undergoing laparoscopy studied prospectively in the United Kingdom, of whom approximately 5000 were not intubated, there was no case of inhalation of gastric contents. An even larger series would be needed to show that intubation provides safer conditions, and no such study has yet been reported.

The pungent nature of isoflurane vapour makes it a more difficult agent than halothane to use with spontaneous respiration (Corall, 1983). In the present study some patients were slow to settle although, once smooth anaesthesia was established, surgical conditions were excellent.

The study confirmed that there is a high incidence of morbidity after laparoscopy no matter which agent or technique is used. Dhamee and colleagues (1982) compared fentanyl, halothane and enflurane and found that drowsiness, dizziness, headache and weakness were more frequent than in the present study. In the fentanyl group vomiting occurred in 43% of patients and persisted into the first day after operation in 28% of patients. Tracey, Holland and Unger (1982) compared halothane, enflurane and isoflurane. Their observations for halothane and enflurane were similar but, of patients who received isoflurane, 40% could still smell the anaesthetic and (44%) complained of headache the next day. In view of the low solubility of isoflurane, these results are rather surprising.

In the present study it was expected that there would be a much lower incidence of sore throat and muscle pains when orotracheal intubation using suxamethonium was avoided. This was true for sore throats in the non-intubated patients (10% v. 65%) on the first day. However, there was no significant difference in the incidence of muscle pains between the groups and this suggests that muscle pains are related more to the surgical procedure than to the anaesthetic agents or technique. The incidence of other symptoms did not show statistically significant differences between the groups.

This study has confirmed the high incidence of minor morbidity following laparoscopy. Spontaneous respiration with a mask using isoflurane produced good operative conditions without dangerous hypercarbia, acidosis or cardiac arrhythmias, and the decreased frequency of postoperative sore throat appeared to be a major advantage.

ACKNOWLEDGEMENTS
The authors thank Kalene Nix and Dr A. W. Rademaker for statistical analysis and advice, and Caroline Nelson and Kalene Nix for secretarial assistance.

REFERENCES

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