RECOVERY OF BOWEL MOTILITY AFTER SURGERY

Detection of Time of First Flatus From Carbon Dioxide Concentration and Patient Estimate after Nalbuphine and Placebo

H. YUKIOKA, D. G. BOGOD AND M. ROSEN

An indication of the return of co-ordinated bowel motility following surgery is the passage of flatus. Previously, we have used this event to test the influence of drugs, especially opioids, on the re-establishment of bowel activity (Shah, Rosen and Vickers, 1984). However, there remains doubt as to how well the patient can note accurately the time at which flatus is first passed, especially if still recovering from the effects of sedative drugs. As flatus contains carbon dioxide (5–80% (Calloway, 1968)), we have compared the time to first flatus as noted by the patient, and as recorded by a carbon dioxide analyser.

PATIENTS, MATERIALS AND METHODS

Patients, Materials and Methods

Materials: Test of sensitivity

A Datex Normocap infra-red carbon dioxide analyser was linked to a Chessel 304 chart recorder. The sampling tip of the analyser was fixed 2 cm from a rubber membrane pierced by a hole through which various oxygen–carbon dioxide mixtures were injected with a gas-tight syringe. The minimum volume of gas required to produce a deflection equivalent to 0.5% carbon dioxide was noted, this concentration being arbitrarily selected as measurable easily and reproducibly.

A volume of 1 ml of gas gave a positive result, even at the lowest concentration of carbon dioxide (5%) in flatus (Calloway, 1968). The volumes of different carbon dioxide–oxygen mixtures needed to produce a deflection equivalent to 0.5% carbon dioxide are shown in figure 1.

Patients

Ethical approval for the trial was granted by the District Ethical Committee. All patients gave informed consent, and agreed to the administration of either a single dose of nalbuphine or placebo after surgery. Patients were free to withdraw from the trial at any time, and alternative oral analgesia was available.

Patients in ASA groups I and II, older than 60 years of age, undergoing minor procedures under general anaesthesia, were studied. Only moderate discomfort after surgery was expected.

SUMMARY

Co-ordinated bowel motility has been studied after surgery. The time to first flatus (TFF) was noted by 20 patients aged 60 yr or older and measured simultaneously using a carbon dioxide analyser. After cystoscopy under general anaesthesia, 10 patients received nalbuphine 20 mg i.v., and 10 patients had placebo (normal saline). In 16 patients (80%) the two observed times coincided and there were no false reports. Two patients were asleep, and did not report TFF. In two others the sampling tube became obstructed. Therefore, both methods are of value; the carbon dioxide analyser, however, is a sensitive and accurate monitor of the initial passage of flatus which does not require patient co-operation. In the i.v. nalbuphine group, the median TFF was more than three times as long (212 min) as that in the placebo group (64 min) (P < 0.01).
No patient had taken any analgesic drug in the 24 h before admission to the study.

Following an evening meal, patients fasted from midnight. Their procedures were scheduled for the following morning. No premedication was given. Anaesthesia was induced with thiopentone 3–4 mg kg\(^{-1}\) and maintained with either halothane or enflurane and nitrous oxide in oxygen. No opioids, neuromuscular blocking agents or vago-lytics were administered.

Immediately on the patient's return to the ward, the carbon dioxide analyser was attached to the patient by a 200-cm fine plastic tube (outer diameter 2 mm), taped no more than 2 cm from the anus. Each patient then received (double-blind) either nalbuphine 20 mg or 0.9% sodium chloride in 2 ml i.v. according to a pre-randomized list. The patient was asked to note the time at which he was first aware of the passage of flatus. Each patient was observed continuously for 15 min and then visited hourly until he and the carbon dioxide analyser had recorded an episode of flatus.

Duration of anaesthesia, time from anaesthesia to the administration of the test drug (recovery time) and time from drug administration to passage of first flatus (TFF) were recorded by both methods. The incidence of drowsiness, nausea, vomiting and other side effects was noted. Results were analysed by the Mann–Whitney \(U\) test for non-parametric data.

RESULTS

Ten patients in each group underwent cystoscopy. All 10 patients in the placebo group were male, and in the nalbuphine group eight were male and two were female. The two groups are similar with respect to age and weight (table I).

The duration of anaesthesia and the recovery time were similar (table II). The TFF in table II is that recorded by the carbon dioxide analyser, except in two patients, both in the placebo group, in whom the sampling tube became obstructed, and the patients' estimates were used. Two other patients in the placebo group were excluded when they asked to withdraw from the trial at 110 and 210 min, respectively (before passing flatus), as they wished to get out of bed. These were replaced by two further patients. The median TFF in the nalbuphine group was 212 min, compared with 64 min in the control group \(P < 0.01\). (If the two patients had not been excluded, and their TFF

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**Table I.** Sex distribution and mean (SD) age and weight of patients

<table>
<thead>
<tr>
<th></th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nalbuphine</td>
<td>70.7 (6.2)</td>
<td>72.8 (12.7)</td>
</tr>
<tr>
<td>Placebo</td>
<td>70.0 (5.9)</td>
<td>77.4 (16.5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sex</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>F</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
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**Table II.** Mean (SD) of anaesthetic time and recovery time and median (inter-quartile range) of TFF.

*Significant difference \(P < 0.01\)

<table>
<thead>
<tr>
<th></th>
<th>Duration of anaesthesia (min)</th>
<th>Time from anaesthesia to drug administration (min)</th>
<th>Time from drug administration to first flatus (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nalbuphine</td>
<td>17.8 (7.9)</td>
<td>53.5 (12.9)</td>
<td>212.0 (152.5)*</td>
</tr>
<tr>
<td>Placebo</td>
<td>13.9 (4.2)</td>
<td>51.9 (8.0)</td>
<td>64.0 (102.5)*</td>
</tr>
</tbody>
</table>
FIG. 2. Correlation between time to first flatus (TFF) as estimated by the patient and the carbon dioxide analyser.

\( r = 0.999, P < 0.001 \)

\( \text{O} = \text{Patients in the control group; } \bullet = \text{patients in the nalbuphine group. The asterisk represents two patients with the same results.} \)

In 16 patients (80%) TFF was recorded both by the patient and the carbon dioxide analyser (fig. 2). A very close correlation was seen between the time to first flatus as estimated by both methods \((r = 0.999; P < 0.001)\).

Patients who received nalbuphine experienced some drowsiness immediately after the injection. Two were asleep when flatus was recorded. Three patients complained of slight nausea after nalbuphine.

**DISCUSSION**

The passage of flatus is widely regarded as a good clinical indication of the return of co-ordinated bowel motility following surgery, and is probably more reliable than the onset of bowel sounds—which do not necessarily indicate a recovery of true propulsive peristaltic activity. In a previous trial Shah, Rosen and Vickers (1984) used this indicator to investigate the effects of premedication with morphine, nalbuphine and diazepam upon recovery of bowel function following minor surgery. That study showed a prolonged TFF in all groups when compared with placebo, but demonstrated that the effect of nalbuphine was less marked than that of morphine in delaying recovery. Shah and his colleagues had to remind the patients frequently to record their time to first flatus, because of drowsiness. In our study, two initial measurements (20%) in the nalbuphine group would have been missed as a result of the patients being asleep. This would reduce the sensitivity of TFF, and necessitate using larger groups in a trial using patient assessment of time to first flatus. However, when the patients did report an episode of flatus, it invariably agreed well with the TFF as recorded by the carbon dioxide analyser. This suggests that reliance on reporting by the patient is acceptable.

This trial assessed also the feasibility of using a carbon dioxide monitor as an objective measurement of the passage of flatus; this proved effective and practicable. The carbon dioxide content of human flatus is between 5 and 80%, a high concentration being especially associated with a diet rich in vegetables (Calloway, 1968). The concentration registered by the analyser was considerably lower than this as a result of dilution of the sample by air. Tracings showed little background noise and, invariably, the first deflection registered agreed very closely with the patient’s own estimate of first passage of flatus. The technique would be sensitive enough to detect 1 ml of flatus, even with the lowest reported carbon dioxide concentration (5%), so that it is unlikely, with the sampling tip close to the anus, that flatus would be missed. Although the technique failed in two early patients in the placebo group because of kinking of the sampling tube, this was corrected easily by using a more rigid catheter for the rest of the trial. Interpretation was easy and this apparatus could be useful for both research and clinical purposes. For instance, it could be valuable to have an automatic, recorded indication when enteral nutrition may be started following surgery in neonates and infants, and in the ITU in sedated, paralysed or comatose patients, all of whom would be unable to report the passage of flatus. This potential application deserves further study.

Morphine depresses co-ordinated bowel function in both the small intestine and colon in man. This effect appears to be dose-dependent and is seen at doses greater than 8 mg of i.m. morphine...
Other opioid agonists and agonist–antagonists, such as pethidine and pentazocine, also produce qualitatively similar effects upon bowel motility, although there are quantitative differences (Vaughan Williams, 1954; Danhof, 1967). In the previous study (Shah, Rosen and Vickers, 1984), i.m. morphine and nalbuphine both produced a marked delay in TFF, although the effect of morphine was greater. This study has demonstrated that an i.v. bolus of nalbuphine significantly prolongs TFF in a group of elderly patients who had undergone minor surgery. Adding the recovery time (table I) to the time to first flatus shows that nalbuphine resulted in flatus appearing after about 4.5 h, compared with at 2 h for the placebo. In the study by Shah, Rosen and Vickers (1984), a similar dose of nalbuphine given i.m. resulted in a similar delay (5.65 h) whereas i.m. morphine delayed passage of first flatus by 11.84 h. This suggests that nalbuphine, especially when given i.v., will have considerably less adverse effect on recovery of bowel function than morphine.

The effect of drugs on recovery of bowel function is obviously important when choosing an analgesic for use after abdominal surgery. Further investigations of other drugs will provide useful information, and the technique described enables simple, non-invasive monitoring of bowel motility to assist these studies.

ACKNOWLEDGEMENTS

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REFERENCES