PERIOPERATIVE CONTINUOUS MONITORING OF ST-SEGMENT CHANGES IN PATIENTS UNDERGOING ELECTIVE CAESAREAN SECTION

T. N. TROTTER, J. A. LANGTON, P. BARKER AND D. J. ROWBOTHAM

SUMMARY
Using continuous ambulatory electrocardiography, we have investigated the incidence of ST-segment changes occurring in patients undergoing elective Caesarean section under extradural, spinal or general anaesthesia. There was no evidence of significant perioperative ST-segment changes. The findings contrast with the results of other work published recently.

KEY WORDS

A high incidence of electrocardiographic changes during Caesarean section under regional anaesthesia has been reported [1]. This study found also a statistically significant correlation between symptoms of chest pain, pressure or dyspnoea and ECG changes during surgery. If the cause of these changes were myocardial ischaemia, this would have important implications for the anaesthetic management of patients undergoing Caesarean section. However, this study did not include preoperative ECG assessment, monitoring of perioperative ECG changes was intermittent and there was no control group receiving general anaesthesia. Therefore, we have investigated the incidence of ST-segment abnormalities during Caesarean section under regional and general anaesthesia using a computerized ambulatory ECG surveillance system.

PATIENTS AND METHODS
We studied 29 patients (ASA I) undergoing elective Caesarean section. The study was approved by the local Ethics Committee and patients gave informed, written consent. Patients with essential hypertension, pregnancy-induced hypertension or diabetes mellitus were excluded. Extradural, spinal or general anaesthesia was performed according to the preference of the patient after discussion with the anaesthetist.

Anaesthetic technique
Ranitidine 150 mg was administered orally the night before, and on the morning of, surgery. In addition, 0.3-mol litre⁻¹ sodium citrate 30 ml was given 15 min before anaesthesia. All patients were transported to the operating theatre in the left lateral position and 15° left lateral tilt was maintained on the operating table until delivery of the infant.

Patients receiving extradural anaesthesia were given Ringer's lactate solution 1 litre and an extradural catheter was inserted in the 2nd or 3rd lumbar intervertebral space via a 16-gauge Tuohy needle. A test dose of 2% lignocaine 3 ml was administered, followed by two 10-ml aliquots of 2% lignocaine with 1:200 000 adrenaline.

Patients receiving spinal anaesthesia were given Ringer's lactate solution 1 litre and Haemaccel 500 ml. A 26- or 27-gauge spinal needle was inserted in the 3rd lumbar interspace with the patient in the sitting position. Hyperbaric 0.5% bupivacaine 2.5 ml was injected, and the patient placed in the supine position with 15° left lateral tilt. In addition, ephedrine 6 mg i.v. was given on injection of bupivacaine.

All patients receiving regional anaesthesia had sensory anaesthesia to at least the T6 dermatomal level before surgery commenced. Arterial pressure was measured non-invasively every 3 min (Cardiocap, Datex). Ephedrine 3 mg was administered i.v. as required to maintain systolic arterial pressure greater than 90-100 mm Hg. Oxygen was given continuously via a Hudson mask (4 litre min⁻¹) until delivery and then discontinued. All patients received oxytocin 10 i.u. after delivery. Extradural catheters were removed at the end of the operation.

Patients receiving general anaesthesia were not given i.v. fluids before induction of anaesthesia. After preoxygenation for 3 min, anaesthesia was induced with thiopentone 5 mg kg⁻¹ followed by suxamethonium 1.5 mg kg⁻¹ to facilitate tracheal intubation. Cricoid pressure was applied from the start of the induction sequence until tracheal intubation was completed successfully. Anaesthesia was maintained with 1% enfurane and 50% nitrous oxide in oxygen and atracurium 0.5 mg kg⁻¹. The lungs were ventilated to normocapnia (Cardiocap, Datex). After delivery of the infant, papaveretum
0.3 mg kg\(^{-1}\) was administered i.v. and nitrous oxide increased to 66%. Residual neuromuscular block was antagonized with neostigmine 2.5 mg and atropine 1.2 mg.

ECG and haemoglobin oxygen saturation (Cardiocap, Datex) were recorded in all patients during surgery.

Postoperative analgesia was provided in all groups by papaveretum 0.3 mg kg\(^{-1}\) i.m., given by the nursing staff at the request of the patient.

**ECG monitoring**

Continuous ambulatory ECG monitoring was used to record ECG abnormalities during the perioperative period using the Compas computerized ambulatory ECG surveillance system (Cardiac Care Units Inc.). The units are programmed to detect, record and analyse ECG abnormalities using three standard leads (V2, V5 and AVF). In particular, ST-segment changes lasting more than 30 s and the time of these events are recorded. Stored data are transferred to a dedicated printer and a report generated. The computer printout includes a baseline ECG, numerical and graphical recordings of ST-segment changes, atypical beats and arrhythmias. ST-segment depression of 1 mm or greater and ST elevation of 2 mm or greater for a minimum of 1 min were considered significant in this study.

A patient marker button allows the precise time of significant events to be recorded and this was used to record the times of induction of anaesthesia, use of ephedrine, delivery of the infant, patient discomfort and end of surgery. This enabled correlation between ECG abnormalities and specific events.

During surgery, any spontaneous complaints by patients receiving extradural or spinal anaesthesia were recorded. After surgery, patients were asked directly if they suffered any pain or about discomfort in any part of the body during the procedure.

Data were analysed using analysis of variance and chi-square test as appropriate.

**RESULTS**

The groups were similar in age, preoperative arterial pressure and heart rate (table I). There were no significant differences in perioperative changes in heart rate and mean arterial pressure in each group (figs 1, 2).

Median (range) duration of Compas monitoring is shown in table II and the total cumulative duration of Compas monitoring and duration of ST-segment changes in table III. Three episodes of ST-segment depression were detected during the study. One patient in the general anaesthesia group experienced 1 min of ST depression 2 h before surgery. The second episode was of 6 min duration and occurred in the extradural group, 5 min before the i.v. infusion was commenced. A single 1-min episode of ST-

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**TABLE I.** Patient age, heart rate and mean arterial pressure (MAP) (mean (range)) before surgery. No significant differences between groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (yr)</th>
<th>Heart rate (beat min(^{-1}))</th>
<th>MAP (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>30.8 (22-42)</td>
<td>75 (60-105)</td>
<td>102 (86-121)</td>
</tr>
<tr>
<td>Extradural</td>
<td>29.3 (22-34)</td>
<td>80 (65-100)</td>
<td>100 (78-123)</td>
</tr>
<tr>
<td>Spinal</td>
<td>31.3 (26-39)</td>
<td>82 (71-90)</td>
<td>94 (86-113)</td>
</tr>
</tbody>
</table>

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**TABLE II.** Median (range) duration of patient monitoring with Compas monitor (min).

<table>
<thead>
<tr>
<th>Group</th>
<th>Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preoperative</td>
</tr>
<tr>
<td>General</td>
<td>150 (135-300)</td>
</tr>
<tr>
<td>Extradural</td>
<td>135 (60-1020)</td>
</tr>
<tr>
<td>Spinal</td>
<td>214 (45-264)</td>
</tr>
</tbody>
</table>

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**Fig. 1.** Mean arterial pressure (MAP) (mean (SEM)). I = Incision; H = hysterotomy; D = delivery; D + 4, D + 8, D + 16 = times (min) after delivery; C = closure. ⋄ = General anaesthesia; ▽ = extradural; ▼ = spinal anaesthesia.
segment depression occurred in a patient in the spinal group 2 h after surgery. No symptoms were associated with any of these episodes.

No ST-segment changes were detected during surgery. One patient in the extradural group complained of chest pain and another in the spinal group of a feeling of heaviness on the chest. These symptoms were not associated with ST-segment changes.

There were no episodes of ST segment elevation in any patient during the study.

DISCUSSION

We have found no significant evidence of perioperative ST-segment changes suggestive of myocardial ischaemia in healthy patients undergoing Caesarean delivery under general or regional anaesthesia. One patient in the extradural group reported symptoms of chest discomfort and another in the spinal group described a feeling of heaviness on the chest, but these symptoms were not associated with ST-segment changes. Three brief and probably insignificant periods of ST-segment change were recorded, one episode in each of the three patient groups, two occurring before and one after surgery. It is not likely that these brief episodes represented myocardial ischaemia.

A much greater incidence of ECG changes occurring during Caesarean section under regional anaesthesia has been reported by Palmer and colleagues [1]. ECG changes described as compatible with myocardial ischaemia were recorded in 44 of 93 patients (47.3%) and in 35 of these (37.6%) the changes were considered to be characteristic of myocardial ischaemia. Furthermore, 15 patients reported symptoms of chest pain, pressure or dyspnoea and, in every case, these symptoms were associated with ECG changes. These findings are remarkable and the present study has reached significantly different conclusions. If, as suggested by Palmer and colleagues, the incidence of myocardial ischaemia in this group of patients is 37.6%, the power of our study is high, despite the relatively small number of patients. Under these circumstances, the likelihood of not detecting changes consecutively in 19 patients under regional anaesthesia is extremely small.

Differences in methodology between the two studies might have led to these discrepancies. In the present study, three standard anaesthetic techniques were used, whereas in the earlier study, a variety of agents were used in the extradural group and 0.75% bupivacaine in the spinal group. In the latter study, all patients achieved a level of sensory anaesthesia to at least T4, whereas the minimum level in this study was T6. A higher level of sensory anaesthesia would be more likely to block the cardiac sympathetic innervation, affecting myocardial performance deleteriously.

Sudden hypervolaemia in the presence of sympathetic block increases myocardial work and oxygen requirements [2]. Different volumes of fluid were
used before surgery in the two studies: in our study, the extradural group received 1 litre and the spinal group 1.5 litre; in the earlier study, all patients received 2 litre i.v. The effect of uterine autotransfusion at delivery, combined with prehydration, could lead to excessive demands on the myocardium and cause ST-segment changes. However, this would be more likely to occur with the use of larger volumes and it is difficult to envisage how a difference of 0.5–1.0 litre would have such a profoundly greater effect on myocardial work and oxygen requirements, causing widespread ST-segment changes.

The Compas continuous ambulatory ECG monitoring system was used in our study. This has been found to be a sensitive system for the detection of ST-segment changes in the perioperative period [3, 4]. Our definition of significant ST-segment changes, which is that accepted generally, was a depression of 1 mm or greater and elevation of 2 mm or greater that lasted longer than 1 min. The ST-segment changes detected in the earlier study were from intermittent ECG recordings and these might detect ST-segment changes of very short and insignificant duration. It is probable that the different methods used to record ECG were a major factor in the incongruous findings.

There are several factors in addition to myocardial ischaemia that may cause ST segment changes, including ventricular hypertrophy, electrolyte imbalance, drugs and conduction disturbances. However, it is most unlikely that any of these factors was present to a significant extent in the two studies.

In the present study, only two of 29 patients complained of chest symptoms and these were not associated with ST-segment changes. A high incidence of chest discomfort was described by Palmer and colleagues in association with ST-segment changes [1]. Malinow and others have described similar symptoms associated with ultrasonic evidence of venous air emboli during Caesarean section under regional anaesthesia [5]. In this last study, chest pain was reported in 24 of the 46 women with Doppler change, whereas only two of the 43 women without Doppler change reported chest pain. These changes were also associated with dyspnoea in nine of 46 women. ECG changes were not reported in this study. The overall incidence of chest pain (26/89) was again much greater than in our study. The two episodes of chest pain in our study occurred during surgery and may have been related to venous air emboli, but were not associated with ST-segment changes.

In conclusion, we have found no ECG evidence of significant intraoperative myocardial ischaemia in patients undergoing Caesarean section under either regional or general anaesthesia. Further investigation is required to explain the major differences between the findings of this study and the work of Palmer and colleagues, but we believe that significant myocardial ischaemia is very infrequent in healthy patients undergoing elective Caesarean section.

REFERENCES