British Journal of Anaesthesia **98 (5):** 682–6 (2007)
doi:10.1093/bja/aem058 Advance Access publication March 19, 2007
BJA

REGIONAL ANAESTHESIA

Laparoscopic cholecystectomy under segmental thoracic spinal anaesthesia: a feasibility study

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Background. Laparoscopic surgery is normally performed under general anaesthesia, but regional techniques have been found beneficial, usually in the management of patients with major medical problems. Encouraged by such experience, we performed a feasibility study of segmental spinal anaesthesia in healthy patients.

Methods. Twenty ASA I or II patients undergoing elective laparoscopic cholecystectomy received a segmental (T10 injection) spinal anaesthetic using 1 ml of bupivacaine 5 mg ml^{-1} mixed with 0.5 ml of sufentanil 5 $\mu g\ ml^{-1}$. Other drugs were only given (systemically) to manage patient anxiety, pain, nausea, hypotension, or pruritus during or after surgery. The patients were reviewed 3 days postoperatively by telephone.

Results. The spinal anaesthetic was performed easily in all patients, although one complained of paraesthesiae which responded to slight needle withdrawal. The block was effective for surgery in all 20 patients, six experiencing some discomfort which was readily treated with small doses of fentanyl, but none requiring conversion to general anaesthesia. Two patients required midazolam for anxiety and two ephedrine for hypotension. Recovery was uneventful and without sequelae, only three patients (all for surgical reasons) not being discharged home on the day of operation.

Conclusions. This preliminary study has shown that segmental spinal anaesthesia can be used successfully and effectively for laparoscopic surgery in healthy patients. However, the use of an anaesthetic technique involving needle insertion into the vertebral canal above the level of termination of the spinal cord requires great caution and should be restricted in application until much larger numbers of patients have been studied.

Br J Anaesth 2007; **98**: 682–6

Keywords: anaesthesia, day-case; anaesthetic techniques, regional, spinal; anaesthetics local, bupivacaine; analgesics opioid, sufentanil; surgery, laparoscopic cholecystectomy

Accepted for publication: January 24, 2007

Laparoscopic cholecystectomy is normally performed under general anaesthesia, but regional techniques, such as low thoracic epidural[1] and lumbar spinal,[2] have been used, usually to manage patients with significant medical problems. Thus, the aim has been the avoidance of general anaesthesia rather than the provision of the benefits of regional, although Hamad and Ibrahim El-Khattary[2] concluded that spinal anaesthesia does seem better matched to laparoscopic cholecystectomy, citing reduced sequelae as the primary reason. Encouraged by both that conclusion and our experience of segmental spinal anaesthesia in a patient with end-stage respiratory disease,[3] we decided to study the feasibility of a segmental technique for routine surgery.

Methods

The Catharina Hospital Medical Ethical Review Board approved a feasibility study in 20 patients who gave written informed consent for the procedure and study. Patients were to undergo elective surgery for cholelithiasis

with inclusion criteria of ASA physical status classification groups I or II and ages 18–75, and exclusion criteria of body mass index >32 kg m^{-2}, active cholecystitis, and the presence of any condition contra-indicating elective surgery or spinal anaesthesia. During the preoperative visit, it was made very clear to the patient that any pain, discomfort, or anxiety would be dealt with by the administration, on their request, of systemic medication or, if they preferred, conversion to general anaesthesia. Similarly, the surgeons were prepared to ask for general anaesthesia if they felt that the anaesthetic technique was adding to the technical difficulty of the procedure.

Oral diazepam 10 mg was given 1 h before induction and routine, non-invasive monitoring, and a peripheral venous infusion were started before anaesthesia. Patients were placed in the left lateral position and, under full aseptic precautions, a combined spinal epidural (CSE) block system (CSE cure^{TM}, SIMS, Hythe, Kent, UK) was placed at the 10th thoracic interspace using a 16 swg Tuohy needle and a mid-line approach. The epidural space was identified using the 'loss of resistance' to air method, the distance from skin to epidural space being calculated from the length of needle protruding from the skin. A 27 swg pencil point spinal needle was advanced through the first needle until the resistance of the dura mater was felt, allowing the measurement of its distance from the tip of the Tuohy needle. The dura was then pierced and the two needles secured together by a locking device which ensures that the spinal needle does not move any further forward and allows it to project no more than 14 mm beyond the tip of the Tuohy needle.

Once flow of clear CSF had confirmed correct placement, 1 ml of plain bupivacaine 5 mg ml^{-1} mixed with 0.5 ml of sufentanil 5 μg ml^{-1} was injected before the spinal needle was removed. The epidural catheter was then threaded into place, the Tuohy needle removed, and the catheter taped in place, leaving 4 cm in the space. Finally, the patient was turned to the supine horizontal position for the operation and nasal oxygen 4 litre min^{-1} started. The number of attempts at each phase of the procedure and the occurrence of any paraesthesiae were recorded. No epidural injections were to be made unless low doses of systemic analgesic drugs were ineffective in controlling pain.

Heart rate, blood pressure, and Sp_{O_2} were recorded every minute for 15 min, and every 5 min thereafter. Upper and lower levels of sensory (pinprick), and motor (modified Bromage scale: 0, able to lift extended legs; 1, just able to flex knees, full ankle movement; 2, no knee movement, some ankle movement; 3, complete paralysis), block were assessed and recorded every 5 min until the start of surgery, and every 15 min postoperatively. Once the block was considered adequate (minimum block T4–T12 as assessed by pinprick), surgery commenced using carbon dioxide insufflation and a pressure limit of 12 mm Hg. Patients were allowed to follow the procedure on a monitor screen if they wished, and reminded of the possibility of conversion to general anaesthesia if they expressed any dissatisfaction with the anaesthetic. Anxiety was treated with midazolam 2 mg, pain with fentanyl 50 μg, and hypotension with ephedrine 5 mg, all as i.v. boluses as required. Drug consumption and fluid balance were recorded. During and after the procedure, the patients were encouraged to report any discomfort, abdominal or shoulder pain, nausea, vomiting, or pruritus. If they occurred, these symptoms were scored (0, nil; 1, mild; 2, moderate; 3, severe) every 5 min during surgery, and every 15 min postoperatively. The epidural catheters were removed once the block had regressed completely and before patient transfer from recovery area to ward. The patients were allowed to leave hospital once they had passed urine and had been assessed by the surgeon as being free from any complications. An overall procedure satisfaction score (0–10) was obtained 3 days later by an independent individual using a telephone interview. Specific enquiry was made about post-dural puncture headache.

Results

Twenty typical cholecystectomy patients (Table 1) were recruited in 4 months, the segmental CSE technique being successful in all. Four patients needed a second attempt at epidural puncture, but the first pass of the spinal needle was always successful. One patient experienced paraesthesiae in the right leg on insertion (8 mm beyond the tip of the Tuohy) of the spinal needle. This episode was too brief to identify the precise dermatomal distribution, the occurrence causing immediate, if slight, withdrawal of the needle with good effect. No patient experienced problems during injection of the anaesthetic solution or insertion of

Table 1 Patient details, anaesthetic technique and outcome indicators. Data are mean (range), mean (SD) or numbers of patients. ASA, American Society of Anaesthesiologists

Demographics	
Sex (M:F) (*n*)	6:14
Age (yr)	45 (21–74)
Weight (kg)	76 (12.9)
Height (cm)	171 (11.0)
BMI (kg m^{-2})	26 (19–31)
ASA Grade (I:II:III:IV) (*n*)	15:5:0:0
CSE technique	
Epidural attempts (1:2:>2) (*n*)	16:4:0
Depth epidural space (mm)	54 (30–73)
Distance Tuohy tip to dura mater (mm)	8 (4–12)
Paresthesiae from spinal needle (no:yes) (*n*)	19:1
Paresthesiae during injection (*n*)	0
Epidural catheter (easy:blood) (*n*)	19:1
Outcome	
Duration of surgery (min)	60 (32–101)
Interval: spinal injection to end operation (min)	78 (43–116)
Time to full block regression (min)	176 (135–210)
Intraoperative fluid volume (ml)	2135 (1500–3200)
Conversion to open surgery (*n*)	0
Conversion to general anaesthesia (*n*)	0
Discharge (same day:day 1:day 2) (*n*)	17:3:0
Postoperative time in hospital (h) (*n*)	7 (4–22)
Patient Satisfaction Score (10:9:8:7) (*n*)	12:6:2:0

the epidural catheter, except blood entered the catheter in one. This cleared on slight withdrawal of the catheter.

An effective sensory block [median levels: upper T3 (range T2–T4); lower L3 (range L1–L5)] developed within 15 min in every patient. The cardiovascular changes were minimal, two patients requiring ephedrine (Table 2, Fig. 1), although a mean of 2135 (SD 414) ml of crystalloid/colloid was given in the first hour. Modest amounts of lower limb motor block developed before the start of surgery in half the patients, with only one unable to move unaided at the end of the operation. Five patients described some shoulder, and one some abdominal, discomfort late in the procedure, all responding to modest doses of fentanyl. Two received midazolam 2 mg for anxiety and two described some mild itching not requiring treatment. No patient required an epidural injection, experienced nausea/vomiting or showed overt evidence of respiratory depression (Table 2), oxygen saturation being >97% throughout.

Surgery took an average of 60 (SD 21) min, and was completed 78 (SD 20) min after spinal injection. The first indication of regression of sensory block was observed 75 min after injection, with the median upper level decreasing by two segments at 105 min, and complete recovery occurring at 176 (SD 23) min (Fig. 2). Postoperatively, there were minor degrees of abdominal pain, shoulder pain, or itching in small numbers of patients, all readily treatable with standard oral medication, but no nausea/vomiting, all patients resuming oral intake on the day of surgery. Seventeen patients were discharged home on the same day, with three detained for surgical reasons. All gave an overall satisfaction score of 8 or above (out of 10), none developed a post-dural puncture headache, and all resumed normal activities within a few days.

Table 2 Anaesthetic outcome. Data are median (range) or numbers of patients. T, thoracic; L, lumbar

Sensory block	
Upper level (dermatome) at	
15 min	T3 (T2–T4)
60 min	T3 (T2–T4)
75 min	T3 (T2–T5)
105 min	T5 (T3–T9)
Lower level (dermatome) at	
15 min	L3 (L1–L5)
60 min	L3 (L1–L5)
75 min	L3 (L1–L5)
105 min	L2 (T12–L4)
Motor block	
Bromage Grade (0:1:2:3), *n*	
Before surgery	10:5:5:0
End of surgery	19:0:1:0
Able to move unaided at end (Yes:No) (*n*)	19:1
Side-effects	
Peroperative abdominal pain (Yes: No) (*n*)	1:19
Shoulder pain	
Preoperative (Yes:No) (*n*)	5:15
Postoperative (Yes:No) (*n*)	2:18
Itching (Yes: No) (*n*)	2:18
Nausea/vomiting (Yes:No) (*n*)	0:20
Respiratory rate $<10\ min^{-1}$ (Yes:No) (*n*)	0:20
Use of peroperative medication	
Midazolam (0:2 mg) (*n*)	18:2
Fentanyl (0:50:100 μg) (*n*)	14:4:2
Ephedrine (0:5:10 mg) (*n*)	18:1:1

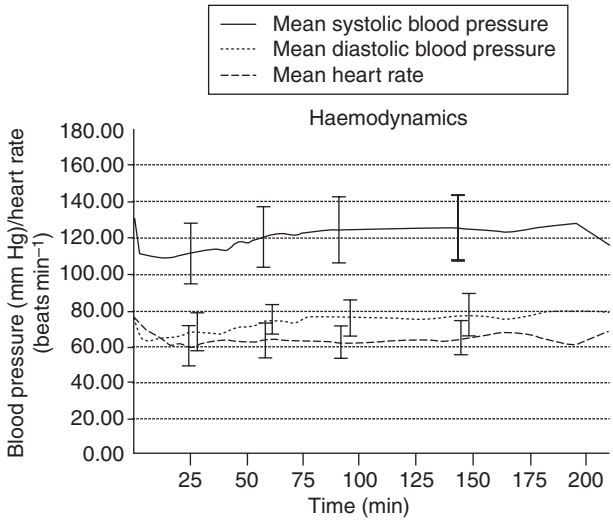

Fig 1 Mean systolic and diastolic blood pressures and heart rate plotted against time. Lines indicate means and the error bars range.

Discussion

This study has provided some preliminary indication of the feasibility of segmental spinal anaesthesia in patients undergoing routine laparoscopic cholecystectomy, and is certainly supportive of wider evaluation. The CSE technique was performed at the low thoracic level without any great difficulty, the 10th interspace being chosen as lying in the 'centre' of the surgical field, although further work on the ideal space may be needed. One patient did experience some paraesthesiae during initial insertion of the spinal needle, these symptoms responding to needle withdrawal and not leading to any postoperative sequela. Paraesthesiae can occur with any technique of spinal anaesthesia, but are of potentially greater significance when the needle is inserted above the termination of the

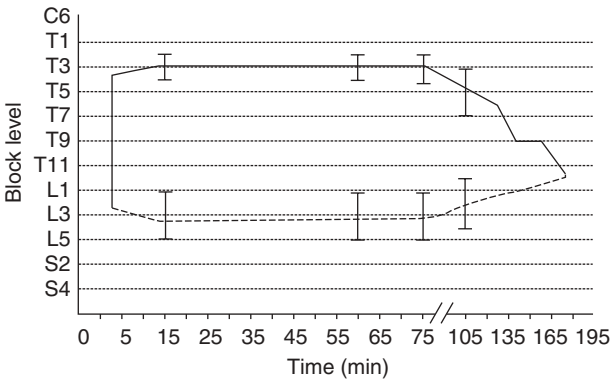

Fig 2 Upper and lower levels of sensory block plotted against time. Lines indicate means and the error bars range.

spinal cord. General consideration of the low potential for cord damage with this technique was given in the earlier case report,[3] where it was noted that the thoracic segment of the cord lies anteriorly, albeit an observation made in the supine, extended position. In this study, lumbar puncture was performed in the lateral flexed position, but it seems unlikely that canal flexion would change the situation, a view supported by a recent MRI study showing that the position of the conus medullaris changes little in moving from the anatomical to the flexed lateral position.[4] Further, a review of cervical myelography found that complications were more associated with needle insertion with the neck in the extended, not flexed position.[5]

Use, as here, of a CSE system which limits the length of needle which can project beyond the tip of the epidural needle should, we hope, minimize the risk of contact with neural tissue. The measurements of the distance from the tip of the needle to the point of contact with the dura were made in an attempt to identify the safety margin available, but it must be recognized that this is an imprecise measurement. It is inevitable that there will be some degree of 'tenting' of the dura before it is punctured, and the occurrence of paraesthesiae in one patient implies that this can be significant. These symptoms warned of needle contact with neural tissue, although we could not identify if this was spinal cord or nerve root. However, serious damage could occur if contact was made with nervous tissue not involved with the transmission of sensations reaching conscious perception. Thus, we recommend that this technique is reserved for experienced clinicians working in defined and approved evaluation programmes, and that it must not yet be used in routine clinical practice.

Another potential concern discussed in the earlier case report was the consequence of paralysing the primary expiratory muscles, those of the anterior abdominal wall. In a group of patients without respiratory disease, this would be expected to have little consequence, and there were no concerns about respiratory status at any time in the group described here. In particular, no patient experienced dyspnoea during abdominal insufflation, perhaps, because of the use of the horizontal position and low gas pressure. It is possible that the low dose of bupivacaine used was a factor which minimized the degree of thoracic motor block. The generally minor and transient degree of lower limb motor block was more likely to have been due to minimal physical spread of solution to the lumbo-sacral nerve roots. Cardiovascular changes were also minimal (Fig. 1), even though the local anaesthetic, as judged by sensory block (Fig. 2), spread to affect most of the spinal cord segments responsible for sympathetic outflow. Again, the differential blocking effects of bupivacaine may have been relevant, but fluid therapy was liberal, the patients all remained conscious, so avoiding significant central depression of circulation or respiration, and there was little cardiovascular disease in the group.

Other side-effects (Table 2) were both infrequent and easily managed (all graded as 0 or 1), the most surprising of these perhaps being the low incidence, and ease of treatment, of shoulder tip pain, a common problem after laparoscopic surgery. It occurred peroperatively in 25% of patients, and postoperatively in 10%. The former figure is comparable with that from a report of laparoscopic surgery under epidural block,[1] but both figures are at odds with the incidence (30–50%) reported after laparoscopic surgery under general anaesthesia.[6] Avoidance of extreme degrees of head-down tilt, so that blood and other irritant fluids did not run onto the diaphragm, may have been relevant, but the low incidence of all side-effects might relate to this being a group of patients who had been approached very carefully and who were, to some extent, self-selected and thus well motivated, most choosing to observe their surgery on a monitor screen. Abdominal discomfort and patient anxiety were also infrequent and easily managed, both responding well to small doses of standard drugs (Table 2). Abdominal discomfort occurred in one patient (whose operation was the longest in the group) 91 min after spinal injection, and in retrospect, it might have been wiser to have administered an epidural top-up before that time, although the discomfort responded well to two 50 μg doses of fentanyl i.v. In future studies, it may appropriate to administer an epidural top-up after a fixed interval (possibly 75–80 min).

The infrequent postoperative sequelae and ease of mobilization may also have been related to the patient motivational issues mentioned earlier, but another factor could have been relevant. Injection at the thoracic level would have ensured that the opioid, and the local anaesthetic, produced its highest concentrations in the surgically relevant segmental levels. Recently, McLeod and colleagues[7] have drawn attention to the importance of achieving high-quality analgesia in the early postoperative period if there is to be an ongoing, effective analgesic benefit from regional block techniques. Achieving an appropriate segmental block is a vital pre-requisite for this.

In conclusion, this small study has provided preliminary evidence that segmental spinal anaesthesia can be an effective anaesthetic technique for routine laparoscopic surgery. In a group of 20 healthy patients, side-effects were minimal and patient satisfaction scores were high, although cardiovascular changes might be greater in older patients and those with intercurrent disease. No comparison has yet been made with other regional or general anaesthetic technique for such surgery, but further careful evaluation of the method is appropriate.

Acknowledgement

We thank Ir. Rutger Stultiëns, Technical University Eindhoven, The Netherlands, for analysing our data.

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