Does rectus sheath infusion of bupivacaine reduce postoperative opioid requirement?

J PADMANABHAN¹, A ROHATGI¹, A NIAZ¹, E CHOJNOWSKA², K BAIG¹, WGA WOODS¹

Departments of ¹Surgery and ²Anaesthesia, Worthing Hospital, West Sussex, UK

ABSTRACT

INTRODUCTION The aim of this work was to assess the effect of intermittent bupivacaine infusion into rectus sheath space on postoperative opioid requirement, postoperative pain score and peak expiratory flow rate.

PATIENTS AND METHODS A prospective, randomised study involving patients undergoing midline laparotomy. Patients were randomised to receive either intermittent infusion of bupivacaine 0.25% or normal saline via catheters placed in the rectus sheath for 48 h after operation. All patients received intravenous morphine infusion on demand with a patient-controlled analgesic device (PCAD).

RESULTS Forty ASA I–III patients were studied. Nineteen were randomised to receive bupivacaine and 21 patients received normal saline. Patient characteristics and surgical variables were comparable in the two groups. The mean wound lengths were similar. There was no statistically significant difference in postoperative opioid requirement, postoperative pain score and peak expiratory flow rate between the two groups.

CONCLUSIONS Intermittent bupivacaine infusion into the rectus sheath space after midline laparotomy does not reduce postoperative opioid requirement nor does it affect postoperative pain score or peak expiratory flow rate.

KEYWORDS

Midline laparotomy – Rectus sheath space – Bupivacaine – Patient-controlled analgesia – Morphine – Pain score

CORRESPONDENCE TO

J Padmanabhan, Department of Surgery, Neath Port Talbot Hospital, Port Talbot SA12 7BX, UK
T: +44 (0)163 986 2000 bleep 2806; M: +44 (0)7800 850061; E: padlu@hotmail.com

The efficacy of bupivacaine wound perfusion for the relief of postoperative pain is uncertain. Some studies suggest that wound perfusion with bupivacaine reduces postoperative opioid requirement and results in a reduction in postoperative pain scores^{4–9} while others report saline wound perfusion to be equally effective.^{1–3} However, no study has yet specifically addressed the effect of bupivacaine infusion on postoperative pain and postoperative opioid requirements in the midline wound. The objective of this study was to assess the efficacy of bupivacaine on postoperative opioid requirements and postoperative pain, when infused via a catheter in the rectus sheath space, *i.e.* anterior to the posterior sheath (Fig. 1), as the intercostal nerves T7–11 in the abdominal wall lie between the internal oblique and transverses abdominis and pass medially behind the rectus which they pierce to supply the overlying skin.

Patients and Methods

Forty ASA I–III patients who underwent midline laparotomy were recruited for this randomised study. Nineteen patients were randomised to receive an intermittent infusion of bupivacaine 0.25% for 48 h after operation and 21 patients received normal saline as placebo. Solutions (20 ml) were infused every 8 h through each of two epidural catheters placed deep to the rectus muscle on either side of the midline incision. All patients were given intravenous morphine infusion on demand using a patient-controlled analgesic device (PCAD). No other postoperative analgesia was used. The total amount of morphine used every 24 h was recorded and the subjective pain scores were assessed with a 10-cm Visual Analogue Scale (VAS)¹² 2 h after infusion of each dose of the randomised solution. A score of zero on the scale represented no pain and 10 was the worst

pain imaginable. The mean scores for every 24 h were compared between the groups. Peak expiratory flow rates (PEFRs) were also recorded before operation and 1 h after infusion of the randomised solution on Day 1 and Day 2 after operation.

Anaesthetic technique

Anaesthesia was induced intravenously with propofol, fentanyl and morphine. It was maintained with a balanced technique incorporating nitrous oxide, isoflurane and oxygen with vecuronium or rocuronium providing muscle relaxation. Patients were intubated and ventilated to normocapnia throughout the surgical procedure.

Surgical technique

All operations were performed through a midline incision. At the end of the procedure before closure, a fine epidural catheter (Portex 16-G; Portex Inc., Keene, USA) was placed on either side of the midline into the rectus sheath space under direct vision through a separate puncture away from the midline incision. The catheter was connected to a bacterial filter (Fig. 2). The randomised solution (20 ml) was perfused through each catheter to check for any blockage or leak by digital palpation. When the catheter positions were satisfactory, they were secured with a stay suture, the abdomen was closed by mass closure and the catheters were covered with a sterile dressing. Intermittent perfusion was continued every 8 h for 48 h after operation. All patients had a final wound examination at 6 weeks.

Statistical methods

Based on a power of 90% and to obtain a statistical significance of $P < 0.05$ for a difference of 10 mg of morphine, the minimum number of patients needed was 20 in each limb. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) program. Statistical comparisons were made using the Mann-Whitney U-test except for mean expiratory flow rates which were analysed using Student's t -test. A P -value of < 0.05 was regarded as significant.

Randomisation was performed prior to the trial from tables of random numbers. The patients and observers were blinded to the randomised solution used. This study was approved by the Hospital Research and Ethics Committee.

Results

Patient characteristics and surgical variables in the two groups were closely comparable (Table 1). The mean total amounts of morphine used by the bupivacaine and the normal saline groups in the first 24 h were 19.4 mg and 21.4 mg, respectively (Mann-Whitney $U = 179$), and during the second 24 h were 30.5 mg and 25.3 mg (Mann-Whitney $U = 177$) (Table 2). Mean subjective pain scores as recorded by the VAS in the bupivacaine and saline groups during the first 24 h were 2.2 and 1.8 and during the second 24 h were 2.2 and 1.8 (Table 3). The pre-operative mean peak expiratory flow rate between the groups were similar and there was a

Table 1 Comparison of patient characteristics

Patient characteristics	Bupivacaine ($n = 19$)	Normal saline ($n = 21$)	P -value
Sex M:F	7:12	8:13	n.s.
Mean age in years ($\pm$ SEM)	69 (± 2.0)	75 (± 1.7)	n.s.
Mean incision length in cm ($\pm$ SEM)	22 (± 1.2)	21 (± 1.0)	n.s.
Smokers	6	4	n.s.
Stoma	4	4	n.s.
Drain	8	8	n.s.

SEM, standard error of the mean; n.s., not significant.

Table 2 Mean amount of morphine required by the 2 groups

	Time after operation	
	1st 24 h	2nd 24 h
Bupivacaine (mg)	19.4	30.5
Normal saline (mg)	21.4	25.3
Mann-Whitney U value	179	177
P-value	0.535, n.s.	0.464, n.s.
n.s., not significant		

reduction of 40% in the bupivacaine group and 44% in the saline group during the first 24 h and 35% and 34% in the second 24 h (Table 4). None of these differences reached statistical significance. There was no wound infection or any other complications associated with this procedure.

Discussion

Effective management of postoperative pain after abdominal surgery contributes to a patient's recovery.¹¹ Intravenous morphine administration on demand by a patient-controlled analgesic device (PCAD) is widely used but the side effects of morphine, particularly the sedative effect, may cause problems. In an effort to improve pain control while minimising undesirable side effects, direct perfusion of surgical wounds with local anaesthetics was reported as long ago as 1953 by Lewis and Thompson.¹⁰ Since the early 1970s, there has been renewed interest in wound perfusion with local anaesthetics for postoperative pain control. There are many reports of this technique using different incisions – right paramedian,¹ subcostal,²⁻⁶ loin incision,⁷ left iliac fossa incision⁸ and Pfannenstiell incision.⁹ The site of placement of the perfusion catheter have been variously between peritoneum and muscle,^{1,2,5,6} intermuscular,⁷ subcutaneous⁸ and beneath the rectus sheath.⁹ Midline incision is one of the most commonly used for abdominal surgery. However, no study has yet specifically addressed the effect of bupivacaine infusion on postoperative pain and postoperative opioid requirements in the midline wound. In our study, we used midline incision and the perfusion catheter was placed within the rectus sheath space.

Postoperative pain scores

We have not shown any significant difference between the groups in the postoperative pain scores as measured on a visual analogue scale during the first 48 h after operation. Gibbs *et al.*,¹ Russell *et al.*,³ and Cheong *et al.*⁸ found no

Table 3 Mean pain score recorded in the 2 groups

	Time after operation	
	Day 1	Day 2
Bupivacaine	2.24	2.22
Normal saline	1.89	1.85
P-value	0.669, n.s.	0.558, n.s.
n.s., not significant		

Table 4 Mean peak expiratory flow rate

Time	Bupivacaine (± SEM)	Normal saline (± SEM)	P- value
Pre-operative	302 (± 31.0)	297 (± 26.3)	n.s.
Day 1 postoperative	181 (± 20.0)	168 (± 18.0)	n.s.
Day 2 postoperative	195 (± 20.8)	196 (± 19.5)	n.s.

Values in l/min.

SEM, standard error of the mean; n.s., not significant

significant difference in the severity of postoperative pain in their study when local anaesthetic was perfused between peritoneum and muscle layer or in the subcutaneous layer. There are several possible reasons why most studies fail to show a difference. Some have suggested it may be possible that irrigation of the wound dilutes or removes certain humoral agents such as histamine or vaso-active polypeptides which are implicated in the genesis of postoperative pain; thus, normal saline may act as a therapeutic agent rather than simply as a placebo.² Even if the local anaesthetic infusion were effective, one might expect pain scores to be similar with any short-fall in pain relief in the control group being compensated by an increased use of PCA.

Morphine requirements

If the above were the case and the local anaesthetic was effective, then one would expect a reduction in the amount of morphine used via PCAD in the treatment group. However, we found no difference in the mean amount of morphine used during the first 48 h of the postoperative period by each group. Gibbs *et al.*¹ showed no significant difference in the mean amount of morphine used by the two groups after surgery reflecting our findings; however, others⁵⁻⁹ have shown that patients whose wounds were perfused with bupivacaine used significantly less opioid after

surgery. The main difference between the studies of Gibbs *et al.*,¹ ourselves and those giving positive results⁵⁻⁹ is the type of incision used. Whilst we studied vertical incisions, other authors used oblique or horizontal incisions. It may be that the innervation of vertical incisions makes them more difficult to anaesthetise with local anaesthetics. The conclusion of Eugene and Bonica,¹¹ in their review of physiopathology and control of postoperative pain, that incisions that involve cutting or damaging more nerves produce more pain than those that involve a few may be relevant in this regard. Finally, it is possible that uneven perfusion or pooling of infusate in the rectus sheath space may provide the explanation for the failure to observe any benefit from this approach. Injection of contrast medium into the epidural catheters may help to check the uniform perfusion of infusate in the rectus sheath space.

Peak expiratory flow rate (PEFR)

Upper abdominal incisions cause a significant reduction in lung volume due to spasm of the anterior abdominal wall, splinting of the diaphragm and absence of deep breaths and sighs. Our study showed a reduction in PEFR in the first 48 h after surgery but no significant difference in the reduction between the control and study groups. It may be possible that peritoneal irritation of the under-surface of the diaphragm with resultant spasm and limitation of excursion is a more important factor because patients who were comfortable after surgery had reduced PEFR. Therefore, even if bupivacaine perfusion were effective in pain relief, the PEFR may remain restricted.

Conclusions

Bupivacaine infusion via a catheter into the rectus sheath is a theoretically attractive adjunctive to postoperative pain management. In practice, it confers no benefit when assessed by measurement of opiate requirement. Unsurprisingly, the technique did not affect either pain

scores or peak expiratory flow rate.

References

1. Gibbs P, Puroshotham A, Auld C, Cuschieri RJ. Continuous wound perfusion with bupivacaine for postoperative wound pain. *Br J Surg* 1988; **75**: 923-4.
2. Thomas DFM, Lambert WG, Lloyd-Williams K. The direct perfusion of surgical wounds with local anaesthetic solution: an approach to postoperative pain? *Ann R Coll Surg Engl* 1983; **65**: 226-9.
3. Russel WC, Ramsay AH, Fletcher DR. The effect of incisional infiltration of bupivacaine upon pain and respiratory function following open cholecystectomy. *Aust NZ J Surg* 1993; **63**: 756-9.
4. Patel JM, Lanzafame RJ, Williams JS, Mullen BV, Hinshaw JR. The effect of incisional infiltration of bupivacaine hydrochloride on pulmonary function, atelectasis and narcotic needs following elective cholecystectomy. *Surg Gynecol Obstet* 1983; **157**: 338-40.
5. Chester JF, Ravindranath K, White BD, Shanahan D, Taylor RS, Lloyd-Williams K. Wound perfusion with bupivacaine: objective evidence for efficacy in postoperative pain relief. *Ann R Coll Surg Engl* 1989; **71**: 394-6.
6. Levack ID, Holmes JD, Robertson GS. Abdominal wound perfusion for the relief of postoperative pain. *Br J Anaesth* 1986; **58**: 615-9.
7. Chen TF, Clarke N, Bowen R, Harper NJ, Payne SR. Intermuscular bupivacaine infusion for control of pain after renal surgery: a preliminary report. *Br J Urol* 1994; **74**: 155-9.
8. Cheong WK, Seow-Choen F, Eu KW, Tang C, Heah SM. Randomized clinical trial of local bupivacaine perfusion versus parenteral morphine infusion for pain relief after laparotomy. *Br J Surg* 2001; **88**: 357-9.
9. Mecklem DWJ, Humphrey MD, Hicks RW. Efficacy of bupivacaine delivered by wound catheter for post caesarean section analgesia. *Aust NZ J Obstet Gynaecol* 1995; **35**: 416-21.
10. Lewis DL, Thompson WAL. Reduction of postoperative pain. *BMJ* 1953; **1**: 973-4.
11. Pflug EA, Bonica JJ. Physiopathology and control of postoperative pain. *Arch Surg* 1977; **112**: 773-81.
12. DeLoach LJ, Higgins MS, Caplan AB, Stiff JL. The Visual Analog Scale in the immediate postoperative period: intrasubject variability and correlation with a numeric scale. *Anesth Analg* 1998; **86**: 102-6.