UNPREDICTABILITY OF REGRESSION OF ANALGESIA DURING THE CONTINUOUS POSTOPERATIVE EXTRADURAL INFUSION OF BUPIVACAINE

T. MOGENSEN, N.-C. HJORTSØ, D. BIGLER, C. LUND AND H. KEHLET

Extradural blockade with local anaesthetics, in combination with light general anaesthesia, relieves pain during major abdominal surgery. However, the maintenance of the same degree of sensory analgesia (and pain relief) during the postoperative period is difficult as a result of tachyphylaxis [1-5] or other factors [6,7]. However, in those studies, extradural analgesia was maintained by the administration of “top up” doses, or by continuous infusion using a variable dose rate, thereby hindering the interpretation of those factors important to the maintenance of a defined level of sensory analgesia. The purpose of this study was to investigate the possible correlations between age, sex, weight, height, body surface area, serum albumin concentration, duration of surgery and site of operation and sensory analgesia during a standardized regimen utilizing a continuous extradural infusion of bupivacaine, in order to assess the possible predictive value of these clinical data in relation to the duration of sensory analgesia.

PATIENTS AND METHODS

Twenty-four patients scheduled for elective major abdominal surgery were premedicated with diazepam 0.2 mg kg⁻¹ and general anaesthesia was induced with thiopentone 3-5 mg kg⁻¹; after precurarization with pancuronium 0.01 mg kg⁻¹, suxamethonium 1.5 mg kg⁻¹ was used to facilitate orotracheal intubation. General anaesthesia was maintained with 0.25-0.75% halothane and 67% nitrous oxide in oxygen. Before the induction of general anaesthesia, an extradural catheter was inserted between L2 and L3 or L3 and L4 and 0.5% plain bupivacaine was used to produce a sensory blockade from T4 to S5. Immediately thereafter, 0.5% plain bupivacaine was delivered by an infusion pump at a fixed dose rate (8 ml h⁻¹), and scheduled to continue for 16 h after skin incision. The following clinical data were recorded: age, sex, height, weight, body surface area, serum albumin concentration, duration of surgery and site of operation.

SUMMARY

Twenty-four otherwise healthy patients scheduled for elective major abdominal surgery received general anaesthesia plus lumbar extradural analgesia. A loading dose of 0.5% plain bupivacaine was given to produce sensory analgesia (pin prick) from T4 to S5 and followed by a continuous infusion of 0.5% plain bupivacaine 8 ml h⁻¹. Pain, scored on a 5-point scale, and sensory analgesia were assessed hourly for 16 h after skin incision. If sensory analgesia decreased by more than 5 segments from its preoperative level, or if the pain score reached 2 (moderate pain), the patients were removed from the study, and pain was treated otherwise. Only three patients maintained their initial levels of sensory analgesia and a pain score of less than 2. In the remaining patients sensory analgesia decreased at least 5 segments or pain score reached 2 between 4 and 16 h after skin incision. We found a weak correlation between increasing age and the duration of sensory analgesia (r = 0.46, P < 0.05), but no significant correlations between duration of sensory analgesia and sex, weight, height, body surface area, serum albumin concentration, duration of surgery and site of operation.
surface area, duration of operation and whether surgery was in the upper or lower abdomen. Upper abdominal surgery was defined as a procedure involving an assumed afferent innervation to the coeliac or superior mesenteric plexus, and lower abdominal surgery as a procedure involving innervation to the inferior mesenteric plexus.

Upper procedures were: right hemicolecction (n = 3), exploratory laparotomy (n = 3) antrectomy (n = 3), small bowel resection (n = 2), pancreatico-gastrostomy (n = 1), cholecystectomy (n = 1) and gastrectomy (n = 1).

Procedures involving the lower abdomen were: low anterior resection (n = 5), colo-anal anastomosis (n = 2) abdomino-perineal excision of rectum (n = 1), cystectomy (n = 1) and sigmoid resection (n = 1).

Pain scores on a 5-point scale (no pain, slight pain, moderate pain, severe pain and unbearable pain) and the levels of sensory analgesia (pin prick, bilateral) were assessed hourly after the patients recovered from general anaesthesia. If the rostral level of sensory analgesia decreased by more than 5 segments from the preoperative level, or if the pain score reached 2 (moderate pain), the patient was removed from the study and pain was treated by other methods.

Informed consent was obtained from all patients.

Data were analysed using Student's t test for unpaired data and the method of least squares for calculation of linear regressions. Multiple linear regression was computed by NWA Statpak program. P values less than 0.05 were considered significant.

RESULTS

The preoperative level of sensory analgesia was T3.8 ± 0.5 (mean ± SEM) after a loading dose of 0.5% bupivacaine 24 ± 0.5 ml.

Only three patients maintained a stable level of sensory analgesia and a pain score below 2 during the 16-h observation period (small bowel resection (n = 1), colo-anal anastomosis (n = 1) and sigmoid resection (n = 1)). Regression of sensory analgesia always corresponded with an increase in pain score, and no patient showed a pain score ≥ 2 without a simultaneous decrease in the level of sensory analgesia to below that of the skin incision (figs 1, 2).

The relationships between the duration of sensory analgesia, defined as time until a decay > 5 segments or pain score ≥ 2 from initial level, and age, sex, weight, height, body surface area, serum albumin concentration, duration of surgery and site of surgery are shown in figure 3. There was a weak correlation between age and duration of sensory analgesia (r = 0.46, P < 0.05), but there were no significant correlations between the duration of sensory analgesia and sex, height, weight, body surface area, serum albumin concentration, and duration of surgery or site of operation. By multiple linear regression analysis our results did not suggest that the duration of sensory analgesia could be predicted, since no significant scoring system could be obtained (F = 1.171; P > 0.05.)

There was no difference > 1 segment in bilateral spread of sensory analgesia.
Fig. 3. Relationships between age, weight, height, body surface area (BSA), serum albumin concentration, duration of surgery, sex or site of surgery, and duration of sensory analgesia during the continuous extradural infusion of 0.5% bupivacaine 8 ml h⁻¹ after abdominal surgery.
DISCUSSION

Extradural analgesia with local anaesthetics is effective in preventing intraoperative pain and may be useful in the alleviation of pain in the postoperative period. However, several problems have been described during the maintenance of analgesia using so-called continuous techniques of extradural blockade with local anaesthetics.

Tachyphylaxis has been reported during intermittent extradural injections [1], as well as during continuous extradural infusion [2,3,5], but the explanation of the tachyphylaxis remains unknown [7]. Furthermore, an unpredictable instability of sensory blockade, which could not be explained by tachyphylaxis, has been reported during the prolonged but intermittent extradural administration of local anaesthetics in the postoperative period [6,8]. The explanation of the variability in sensory analgesia in these latter studies may be changes in the compliance of the extradural space or in the position of the catheter.

In our study we found a weak correlation between age and time before regression of sensory analgesia in the postoperative period. Bromage, Pettigrew and Corwell [1] demonstrated a correlation between age and segment-minute analgesia to the initial dose of local anaesthetic, but others have failed to demonstrate any relationship between dose and maximum extent of analgesia [9]. No comparative studies are available between intermittent and continuous extradural analgesia using a constant administration regimen.

Renck and colleagues [2] used a continuous low-volume administration of 1% bupivacaine and found no relationship between the segmental spread of analgesia and dose, or between dose per segment blocked and age, sex, height or weight of the patient in thoracic extradural analgesia. However, in that study “top up” doses were administered when the patients complained of pain, thereby hindering interpretation. Ross, Clarke and Armitage [10] used a high volume–low concentration of bupivacaine (0.125%, 20 ml h⁻¹), but adjusted the infusion rate when necessary, again hindering any interpretation of those factors of possible significance in regard to the maintenance of sensory analgesia. It may be argued that the infusion of bupivacaine to the lumbar extradural space in a rather low volume (8 ml h⁻¹) will, not surprisingly, result in regression of analgesia when the initial level of sensory analgesia is as high as T3.8—as in the present study. However, despite its relevance, this argument does not explain away our main findings of a pronounced and unpredictable variability of regression of analgesia during a constant infusion regimen.

We have described an enhancing effect of systemic morphine on the extent of sensory analgesia during the continuous extradural infusion of bupivacaine in the postoperative period [11]. This study may suggest that the local anaesthetic solution is apparently present at higher levels, but that other factors may reduce its effect with time. Since morphine may re-establish the extent of the sensory block, changes in the distribution of local anaesthetics in the extradural space are probably not of any or are of only minor importance as far as the regression of sensory analgesia is concerned. This is further supported by a recent study in which the addition of morphine to the extradural space prevented any decay of postoperative sensory analgesia during a continuous extradural infusion of bupivacaine [12].

The explanation of the decrease in sensory analgesia and the augmenting effect of extradural or systemic morphine on sensory analgesia during the continuous extradural infusion of bupivacaine may be found in recent studies on the anatomy and physiology of afferent nociceptive traffic. Thus the decrease in sensory analgesia, as seen in this study, may be explained by a relative increase in afferent input, since an experimental study has demonstrated an increase in nociceptor excitability both peripherally and in the spinal cord, following peripheral trauma [13]. Unfortunately, no information is available on the duration of sensory analgesia during the continuous extradural infusion of bupivacaine in patients without trauma. However, another explanation for the regression of analgesia may be that changes occur in the concentration of bupivacaine as a result of alterations in systemic uptake from the extradural space. This point requires further evaluation.

In conclusion, the difficulties in maintaining a high and constant level of sensory analgesia and total postoperative pain relief during the continuous infusion of a fixed dose of bupivacaine remain unexplained. Our results suggest that sex, weight, height, body surface area, serum albumin concentration and the duration and site of the operation are unimportant in this context. Old age may, to a minor degree, facilitate the maintenance
of sensory analgesia, at least during the infusion regimen described in this study.

REFERENCES


