The use of patient-controlled epidural fentanyl in elderly patients

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Summary
We studied whether delivering postoperative analgesia, using a patient-controlled epidural analgesia (PCEA) device was effective and safe in elderly patients. We enrolled 40 patients aged > 65 years (elderly group) and 40 patients aged 20–64 years (young group) scheduled for elective major abdominal surgery. PCEA infusion was started following completion of surgery. Mean (SD) fentanyl consumption (10.7 (3.7) compared with 10.5 (2.7) µg.kg\(^{-1}\), \(p = 0.76\)) and number of times patients pressed the bolus switch (32 (36) compared with 44 (38), \(p = 0.16\)) during the first 24 h postoperatively were similar in the two groups. Pain scores, which were similar in both groups at rest, were significantly lower in the elderly on coughing (at 24 h, \(p < 0.05\)). In addition, average pain scores were similar at the time of PCEA bolus demands in the two groups. Elderly and young adult patients therefore required similar amounts of patient-controlled epidural fentanyl to produce satisfactory pain relief.

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Adequate postoperative pain control can sometimes be difficult in elderly patients. Postoperative opioid requirements decrease with increasing age, due to age-related changes in the metabolism and clearance of these analgesics [1, 2]. In addition, elderly patients may be less willing to express their pain [3], and anticipate less intense postoperative pain than younger patients [4]. Therefore, medical personnel are reluctant to prescribe them and elderly patients are reluctant to use sufficient opioids postoperatively. This situation may lead to inadequate postoperative pain relief in the elderly.

Patient-controlled epidural analgesia (PCEA) has been reported to provide effective and safe postoperative analgesia [5, 6]. However, few studies of this technique have focused on the analgesic requirements, analgesic effects, and side-effects in older patients. Furthermore, elderly patients using PCEA may not adequately medicate themselves due to fear of adverse effects, or fear of the PCEA device itself [7]. We therefore sought to determine whether delivering postoperative analgesia using patient-controlled epidural analgesia (PCEA) was effective and safe in elderly patients.

Methods
The Ethics Committee of the Faculty of Medicine, University of Yamanashi, approved this study, and all patients gave written informed consent. We enrolled 40 patients, aged 65 years or older (elderly group), and 40 patients, aged 20–64 years (young group), who were scheduled to undergo major elective open abdominal surgery under standardised general anaesthesia combined
with epidural analgesia. Not included in the study were patients with contraindication to epidural analgesia, who took opioids daily, who were unable to use the PCEA device, who had clinically important mental disorders, or who had a known allergy or adverse reaction to ropivacaine or fentanyl.

Pre-operatively, patients were informed of the concept of PCEA and were taught how to use the PCEA device. Thirty minutes before arrival in the operating room, patients received intramuscular midazolam, 0.05 mg.kg\(^{-1}\), and atropine, 0.01 mg.kg\(^{-1}\). On arrival in the operating room, routine monitors were applied for recording heart rate, blood pressure, and oxygen saturation. Before induction of general anaesthesia, an epidural catheter was positioned at a vertebral level corresponding to the dermatomal level of the anticipated surgical incision. The epidural space was identified by using loss of resistance with a glass syringe filled with 1.5% mepivacaine [8]. The epidural catheter was inserted 5 cm into the epidural space. Correct placement of the catheter was confirmed by using an injection of 5 ml 1.5% mepivacaine without adrenaline.

Intra-operatively, all patients were given a continuous epidural infusion of 1.5% mepivacaine at a rate of 5 ml.h\(^{-1}\). General anaesthesia was induced using 2 mg.kg\(^{-1}\) propofol and 0.1 mg.kg\(^{-1}\) vecuronium. Following tracheal intubation, end-tidal carbon dioxide partial pressure and end-tidal sevoflurane concentration were also monitored. General anaesthesia was maintained using 67% nitrous oxide and 1–2% sevoflurane in oxygen. Immediately prior to completion of surgery, the epidural catheter was connected to a PCEA pump (Baxter 6060 multitherapy pump, Baxter, Tokyo, Japan) that was programmed to provide an initial bolus of 8 ml, 4 ml.h\(^{-1}\) basal infusion rate, 2-ml bolus dose, and with a 10-min lockout interval. The epidural solution of 0.05% ropivacaine with 4 μg.ml\(^{-1}\) fentanyl was prepared by the hospital pharmacy as previously described by Hodgson and Liu [9].

Data were collected at the following times: 4 h after the patient arrived on the ward, on the first postoperative morning, and 24 h following completion of surgery. Visual analogue scale (VAS; 0–100 mm) pain scores (0 mm = no pain, 100 mm = the worst pain imaginable) at rest and on coughing were recorded, as was a VAS score of each patient’s satisfaction (0 mm = not satisfied at all, 100 mm = very satisfied) with their pain management. Patients also recorded VAS scores for pain at the time of PCEA bolus demands, i.e. when they pressed the bolus button. A four-point scale (0 = none, 1 = mild, 2 = moderate, 3 = severe) was used to assess pruritus, nausea (3 = severe with vomiting), and drowsiness. Respiratory depression was defined as a respiratory rate slower than 8 breaths.min\(^{-1}\), and hypotension was defined as a systolic blood pressure decrease of > 30% from the baseline value. The consumption of fentanyl per kg of body weight was also recorded.

Data are presented as mean (SD), number, or median and quartiles (25th and 75th percentiles). A power analysis revealed that an estimated minimal sample size of 35 patients per group was required to detect a 15-mm difference in VAS scores for pain between groups with an α of 0.05 and a power of 0.8 based on a SD of 22 mm. Unpaired t-tests were used to compare continuous variables: age, height, weight, duration of surgery and anaesthesia, dose of fentanyl, and number of times the bolus button was pressed. VAS scores were analysed using the Mann–Whitney U-test. VAS score were averaged in each patient and the averages were used to compute the median for the group. Four-point scale scores were compared using a Chi-squared test. A p value of < 0.05 was considered significant.

**Results**

There was on average a 19-year age difference between the two groups. Patients in the elderly group were significantly shorter and weighed less than those in the younger age group. However, the two age groups were similar with regard to sex distribution, duration of anaesthesia and surgery, and surgical site (Table 1).

Fentanyl consumption (μg.kg\(^{-1}\)) for the 24-h period following surgery was similar in older and younger patients (Fig. 1). The number of times patients in the two groups pressed the bolus button during the 24-h postoperative period was also comparable between groups (Table 1).

Median VAS scores for pain at rest were < 20 mm in both groups. The VAS score at 24 h following completion of surgery in the elderly group was significantly less

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Patients’ characteristics and frequency of pressing bolus switch.</th>
<th>Elderly group</th>
<th>Young group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age; year</td>
<td>72 (5)*</td>
<td>53 (9)</td>
<td></td>
</tr>
<tr>
<td>Gender; Female/Male</td>
<td>15 / 25</td>
<td>16 / 24</td>
<td></td>
</tr>
<tr>
<td>Height; cm</td>
<td>156 (10)†</td>
<td>163 (8)</td>
<td></td>
</tr>
<tr>
<td>Weight; kg</td>
<td>56 (11)*</td>
<td>62 (11)</td>
<td></td>
</tr>
<tr>
<td>Duration of operation; min</td>
<td>284 (152)</td>
<td>239 (123)</td>
<td></td>
</tr>
<tr>
<td>Duration of anaesthesia; min</td>
<td>352 (166)</td>
<td>294 (132)</td>
<td></td>
</tr>
<tr>
<td>Surgical site; UA/LA</td>
<td>27 / 13</td>
<td>26 / 14</td>
<td></td>
</tr>
<tr>
<td>Pushing bolus switch; times per 24 h</td>
<td>32 (35)</td>
<td>44 (38)</td>
<td></td>
</tr>
</tbody>
</table>

*p < 0.0001, †p < 0.0005, ‡p < 0.05 compared with the young group. UA, upper abdomen; LA, lower abdomen.
than that in the younger group ($p < 0.05$); however, the difference may not be clinically significant (Fig. 2). However, VAS scores on coughing the morning following surgery and at 24 h were significantly lower in the elderly group than in the younger group ($p < 0.05$) (Fig. 3). There were no significant differences between groups in VAS scores for pain at the time of PCEA bolus demand or in the patients’ overall satisfaction (Fig. 4).

Pruritus was seen in 50% of elderly patients and in 45% of younger patients ($p = 0.93$). The incidence of nausea and drowsiness was slightly greater in the elderly group; however, these differences were not statistically significant (Table 2). No patients in either the elderly group or the young group suffered from respiratory depression or hypotension (Table 2).

**Discussion**

The major findings of this study were as follows:

- the elderly and young patients used similar amounts of epidural fentanyl in the 24 h following surgery;
- postoperative analgesia was comparable in the elderly and young patients at rest; however, it was superior in the elderly patients during coughing;
- self-reported pain was high in both elderly and young patients when pressing the bolus-request button;
- both elderly and younger patients had a low incidence of serious adverse events;
- both groups were highly satisfied with PCEA.

**Table 2** Adverse events. Values are absolute numbers. A four-point scale (0 = none, 1 = mild, 2 = moderate, 3 = severe) was used to assess pruritus, nausea (3 = severe with vomiting), and drowsiness.

<table>
<thead>
<tr>
<th>Event</th>
<th>Elderly group ($n = 40$)</th>
<th>Young group ($n = 40$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pruritus; 0/1/2/3</td>
<td>20/17/2/1</td>
<td>22/16/1/1</td>
</tr>
<tr>
<td>Nausea; 0/1/2/3</td>
<td>31/7/0/2</td>
<td>36/3/0/1</td>
</tr>
<tr>
<td>Drowsiness; 0/1/2/3</td>
<td>34/3/1/2</td>
<td>38/2/0/0</td>
</tr>
<tr>
<td>Respiratory depression</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hypotension</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Postoperative opioid requirements, including those for morphine [10], fentanyl and alfentanil [11] have been shown to be decreased in the elderly, probably due to an age-related reduction in pain perception [12] and changes in the metabolism and clearance of these analgesic drugs [1, 2]. However, elderly patients may develop an increased response to high intensity noxious stimuli, decreased pain tolerance, and decreased descending modulation [12–14]. In addition, the pharmacokinetic properties of fentanyl, such as the elimination half-life, total plasma clearance, and mean residence time are similar in elderly and young adult patients [15]. These factors may explain our finding that the consumption of fentanyl was similar in both the elderly and the young patients, and that both age groups achieved satisfactory pain relief at rest. This result is consistent with Pickering et al. [16] who reported that thermal pain thresholds are not modified with age. Because thermal perception relates to somatic pain, and pain intensity should be severe in the first 24 h after surgery, the threshold of postoperative somatic pain perception may be comparable in elderly and young patients.

Patients experience greater pain while coughing [17], moving [18], and walking [9] than at rest. Our findings confirmed that pain on coughing was greater than at rest in both the elderly and young patients. However, the effect of ageing on pain relief during coughing has not been evaluated. In the present study the reported pain scores on coughing were lower in elderly than in young patients. This suggests that epidural fentanyl provides more effective analgesia for pain on coughing in the elderly. However, an equally plausible explanation is simply that the elderly did not cough as hard as the young patients, and therefore provoked less pain.

As we had explained the theoretical basis for PCEA therapy and the operational aspects of the PCEA pump to each patient in detail, we expected that patients would press the bolus switch when their pain scores were low (< 30 mm on the VAS). However, patients in both groups reported pain scores > 40 mm when pressing the bolus switch. This means that patients experienced postoperative pain at times, even though they had the ability to treat the pain. Our results agree with those of Karci [19] which showed that patients using PCA rarely medicate themselves sufficiently to achieve complete pain relief. However, patients’ satisfaction with their analgesic control was high in both groups. Both elderly and young patients apparently accepted some pain rather than risk suffering side-effects, or they may have been concerned with overmedicating themselves.

We speculated that elderly patients were more stoical in relation to postoperative pain control and were reluctant to use the PCEA device [20]. However, not only were the pain scores comparable in both of the patient groups when they activated the bolus-request button, but there was no difference in the number of times the two groups pressed the button during the 24 h following surgery. Our results suggest therefore that elderly and young patients are equally willing to treat their pain.

Whether a patient suffers adverse effects significantly impacts a patient’s satisfaction with their postoperative analgesia [19]. Elderly and young patients consumed a comparable amount of fentanyl and, consequently, had similar incidences of side-effects such as pruritus, nausea, and drowsiness. Furthermore, neither elderly nor young patients experienced any serious adverse effects such as respiratory depression or hypotension (however, our sample size was too small to reliably estimate the incidence of such rare complications). The low incidence of adverse effects may in part have been responsible for the high level of the patients’ satisfaction with the PCEA.

Although the number of times patients in the two groups pressed the bolus switch during the 24-h postoperative period was comparable, the mean number in the elderly patients was lower. In this study, there is a risk of making a type 2 error in claiming that there was no difference between the two groups. A larger sample size would be required to determine a difference in the frequency of bolus button pushes.

Our patients were given fentanyl and ropivacaine as a postoperative analgesic regimen. We have previously compared 0.1%, 0.075%, and 0.05% ropivacaine for patient-controlled epidural analgesia, and found that those concentrations of ropivacaine produced equivalent analgesia [21]. We therefore used a single concentration of ropivacaine and focused on fentanyl in this study.

In conclusion, we found that both elderly and young adult patients self-administered similar amounts of fentanyl using PCEA in the 24 h following surgery. Analgesia at rest was comparable in both groups; however, analgesia was superior in the elderly patients on coughing. The number of serious adverse events in both elderly and younger patients was low, and both groups reported high levels of satisfaction with PCEA. One concern is that the patients in both age groups may have hesitated to use PCEA, suggesting that anaesthetists should educate patients about when to push the bolus button and to reassure patients of the safety of this technique.

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Conflict of interest

There are no financial relationships between any authors and any commercial interest.

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