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Comparison of Intravenous or Epidural Patient-controlled Analgesia in the Elderly after Major Abdominal Surgery

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Background: **Patient-controlled analgesia (PCA) with intravenous morphine and patient-controlled epidural analgesia (PCEA), using an opioid either alone or in combination with a local anesthetic, are two major advances in the management of pain after major surgery. However, these techniques have been evaluated poorly in elderly people. This prospective, randomized study compared the effectiveness on postoperative pain and safety of PCEA and PCA after major abdominal surgery in the elderly patient.**

Methods: **Seventy patients older than 70 yr of age and undergoing major abdominal surgery were assigned randomly to receive either combined epidural analgesia and general anesthesia followed by postoperative PCEA, using a mixture of 0.125% bupivacaine and sufentanil (PCEA group), or general anesthesia followed by PCA with intravenous morphine (PCA group). Pain intensity was tested three times daily using a visual analog scale. Postoperative evaluation included mental status, cardiorespiratory and gastrointestinal functions, and patient satisfaction scores.**

Results: **Pain relief was better at rest ($P = 0.001$) and after coughing ($P = 0.002$) in the PCEA group during the 5 postoperative days. Satisfaction scores were better in the PCEA group. Although incidence of delirium was comparable in the PCA and PCEA groups (24% *vs.* 26%, respectively), mental status was improved on the fourth and fifth postoperative days in the PCEA group. The PCEA group recovered bowel function more quickly than did the PCA group. Cardiopulmonary complications were similar in the two groups.**

Conclusion: **After major abdominal surgery in the elderly patient, patient-controlled analgesia, regardless of the route (epidural or parenteral), is effective. The epidural route using local anesthetics and an opioid provides better pain relief and improves mental status and bowel activity. (Key words: Epidural analgesia; outcome; postoperative cognitive dysfunction.)**

PATIENT-CONTROLLED analgesia (PCA) with intravenous morphine and patient-controlled epidural analgesia (PCEA), using an opioid either alone or in combination with a local anesthetic, are two major advances in the management of pain after major surgery.[1-3] Patient-controlled techniques allow patients to self-administer small boluses of analgesic, providing better titration and enhancing responsiveness in analgesic requirements.[2-4] Although theoretically useful, these techniques have been evaluated poorly in the elderly person. PCA has been proposed as a safe and effective technique for postoperative analgesia and is considered to be the "gold standard" for pain relief after major surgery.[2,3] Previous studies that compared PCA and intramuscular morphine administrations in the elderly patient showed that PCA improved analgesia and resulted in fewer opioid toxic reactions, pulmonary complications, and confusional episodes.[2] In comparison with opioid analgesia by either intravenous or epidural routes, epidural administration of a local anesthetic and opioid mixture improved pain relief.[1,5] Moreover, in healthy patients undergoing colonic surgery, thoracic epidural analgesia with bupivacaine and morphine could result in earlier recovery of

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Table 1. Abbreviated Mental Test*

Age
Time (to nearest hours)
Address of hospital for recall at end of test (Ask patient to repeat the adress to ensure it has been heard correctly.)
Year
Name of hospital
Recognition of two persons (*e.g.*, doctor, nurse)
Date of birth
Year of the start of first world war
Name of the President
Count backward from 20 to 1

* Patients were asked to answer the 10 questions. Each correct answer scores one point.

bowel activity and fulfillment of discharge criteria, with a low incidence of adverse effects.[1,6]

Cognitive dysfunction, commonly reported in the postoperative period, would appear to be associated with an increased incidence of various complications and prolonged hospital stay.[7,8] It has been suggested that the quality of postoperative analgesia could decrease delirium incidence and, in turn, reduce duration and cost of hospital stay in the elderly patient.[6,9] However, no study has evaluated the comparative effects of the different perioperative analgesia techniques on overall recovery in older patients.

We therefore performed a prospective randomized study in elderly patients undergoing major abdominal surgery to compare the effectiveness on pain and safety of two techniques of anesthesia and analgesia: combined epidural analgesia and general anesthesia followed by postoperative PCEA, using a mixture of bupivacaine and sufentanil, or general anesthesia followed by PCA with intravenous morphine. Second, we evaluated the effect of these techniques on mental status and complications, including gastrointestinal, respiratory, and hemodynamic functions.

Materials and Methods

Patient Selection and Protocol

This prospective study was carried out for 18 months after approval from the Montpellier Hospital Ethical Committee. Inclusion criteria were age older than 70 yr, American Society of Anesthesiologists status I or II (age criterion being taken away), normal preoperative mental status defined by a modified Abbreviated Mental Test score[10] (AMT, defined in table 1) $\geq$ 8, elective major abdominal surgery for cancer *via* midline or bisubcostal incision, absence of contraindications to epidural anesthesia (*e.g.*, preoperative coagulopathy, localized infection), and absence of extreme malnutrition or cerebral vascular insufficiency. The day before surgery and after obtaining written informed consent, all subjects received written and verbal instructions for use of PCA or PCEA and were instructed to balance analgesia against sedation. Then, the patients were assigned to receive, as determined by a table of random numbers, either general anesthesia and postoperative morphine (PCA group) or general anesthesia combined with epidural bupivacaine-sufentanil anesthesia (PCEA group).

In both groups, after oral premedication with 100 mg hydroxyzine, general anesthesia was induced with 3-5 mg/kg thiopental and 0.2-0.4 μg/kg sufentanil. Tracheal intubation was facilitated by 0.5 mg/kg atracurium. All patients underwent mechanical ventilation with an equal mixture of oxygen and nitrous oxide. Anesthesia was maintained with isoflurane, and muscle relaxation was provided by an injection of atracurium using train-of-four monitoring.

In the PCA group, analgesia was provided by 0.5 μg/kg sufentanil before skin incision and subsequent injections of 0.2-0.4 μg/kg as necessary. In the postoperative care unit, analgesia was begun after an initial loading dose of up to 5 mg intravenous morphine. Then, the PCA pump (Graseby 3300; Graseby Medical, Vitry, France) was programmed to deliver a 1.5-mg intravenous morphine bolus with a lockout interval of 8 min. In the PCEA group, an epidural catheter was placed at the T7-T9 level before surgery of the upper abdomen or at the T9-T11 level before colonic surgery. Xylocaine, 2%, with epinephrine (5 μg/ml) was injected into the epidural catheter to achieve a bilateral T4 sensory level. General anesthesia thereafter was induced using the same procedure used in the PCA group. Epidural analgesia was obtained by continuous intraoperative infusion of a 0.25% bupivacaine and 1-μg/ml sufentanil mixture, followed by postoperative administration of a 0.125% bupivacaine and 0.5-μg/ml sufentanil mixture provided with a PCEA pump (APM; Abbott Laboratories, Paris, France) programmed to deliver a 2- or 3-ml bolus with a lockout interval of 12 min and a background infusion of 3-5 ml/h. Tracheal extubation was performed when weaning criteria were satisfied: effective cough, coordinated thoracoabdominal movement, absence of sternocleidomastoid muscle participation, a respiratory frequency less than 35 cycles/min, a tidal volume more than 5 ml/kg, a pulse oxygen saturation more than 90%, absence of hemodynamic instability, agitation, excessive

sedation, and hypothermia (< 36°C). All patients received the same postoperative physiotherapy. The day after surgery, the patients sat in an armchair with the help of the nurses. The nasogastric tube was removed when gastric suction provided less than 500 ml/day. From the third postoperative day, PCA or PCEA was discontinued when a dose was not necessary for at least 4 h. Before attempting to walk, patients were assessed for evidence of motor blockade or orthostatic hypotension.

Postoperative Pain, Side Effects, and Satisfaction Assessment

To quantify the intensity of postoperative pain, the patients were asked to use a 100-mm visual analog scale (VAS) grade from 0 mm (no pain) to 100 mm (the worst possible pain). VAS scores were recorded at rest and after coughing at 8 AM, 12 AM, and 8 PM daily. To optimize analgesia while minimizing sedation and hemodynamic instability, the patient-controlled setting could be further adjusted during the twice-daily visits of the physicians. Nurses also received extensive training regarding the studied techniques. Intravenous 2 g propacetamol or 100 mg ketoprofene were infused on request when pain relief was inadequate (VAS score > 30 mm). No other sedative, analgesic, or central nervous system-acting agents were permitted, except haloperidol and metoclopramide as necessary for postoperative delirium with agitation and nausea, respectively. An overall satisfaction score according to postoperative analgesia (nil = 0; mild = 1; good = 2; excellent = 3) was recorded on the fifth postoperative day.

Patients were assessed using a sedation scale (wide awake = 0; mildly sleepy and responsive to verbal command = 1; moderately sleepy and responsive to nociceptive stimulation = 2; extremely sleepy and unresponsive to nociceptive stimulation = 3). The patients were asked whether they had pruritus (yes or no) and nausea and vomiting (yes or no). These parameters were recorded daily at 8 AM, 12 AM, and 8 PM during the first 5 postoperative days.

Postoperative Delirium and Gastrointestinal Assessment

Patients were assessed by an experienced physician not involved in the patients' care using AMT (table 1) and criteria of postoperative delirium in the Diagnostic and Statistical Manual of Mental Disorders (DSM III; table 2)[11] the day before surgery, twice a day during the first 5 postoperative days, and every day until discharge.

Table 2. Diagnostic and Statistical Manual of Mental Disorders (DSM III) Criteria[11]

Reduced ability to maintain attention to external stimuli (questions must be repeated as attention wanders) and to appropriately shift attention to new external stimuli.
Disordered thinking as indicated by rambling or incoherent speech.
At least two of the following:
(1) Reduced level of consciousness, *e.g.*, difficulty keeping awake during examination.
(2) Perceptual disturbance: misinterpretations, illusions, or hallucinations.
(3) Disturbance of sleep–wake cycle with insomnia or daytime sleepiness.
(4) Disorientation to time, place, or person.
(5) Increased or decreased psychomotor activity.
(6) Memory impairement, *e.g.*, inability to learn new material, past events, or names of unrelated objects.
Clinical features develop over a short period of time (hours to days) and trend to fluctuate over the course of a day.
Either (1) or (2)
(1) Evidence from history, physical examination, or laboratory tests of a specific organic factor judged to be etiologically related to the disturbance.
(2) In the absence of such evidence, an etiologic factor can be presumed if the disturbance cannot be accounted for by any nonorganic mental disorder.

Diagnosis of postoperative delirium required fulfillment of DSM III manual criteria and a decrease in the AMT score of 2 or more points.[12]

Patients were assessed for return of gastrointestinal function two times a day by a physician who systematically questioned the patients and consulted nurse observations until the return of flatus, feces, and eating without nausea.

Respiratory, Hemodynamic, and Motor Blockage Assessments

A clinical examination was performed the day before surgery and each morning of the first 7 postoperative days for each patient. Clinical pulmonary complications were graded as described by Jayr *et al.*[13]: cough = 1; purulent sputum = 2; ronchi = 3; localized consolidation on physical examination = 2; fever = 1. A score greater than or equal to 3 on 2 consecutive days was defined as a clinical complication, which was classified as a "minor" complication when resolved spontaneously, a "moderate" complication when treatment for resolution was necessary, and a "severe" complication when significant intervention, such as mechanical ventilation or intensive care, was necessary. Chest radiographs, obtained preoperatively and on the first, third, and fifth postoperative days, were interpreted at the end of the

study by the same radiologist who was not aware of the patient's clinical status. Radiographic chest abnormalities were classified into two groups: segmental atelectasis, or large infiltrates, and pleural effusion.[13]

Oxygen saturation (Sp_{O_2}), arterial blood pressure, and heart rate were recorded every 5 min intraoperatively, every 20 min during early recovery, and, thereafter, every 2 h for 5 days. When systolic arterial blood pressure decreased to less than 90 mmHg, the patient first received 500 ml hydroxyethylstarch, and, if that did not correct the hypotension, the patient received incremental 3-mg doses of ephedrine.

Motor function of the lower limbs was assessed daily by the patient's ability to flex the knees and ankles. Motor blockade was evaluated in terms of a modified four-grade Bromage scale[14]: 0 = no paralysis; 1 = inability to increase extended leg (just able to move knee and feet); 2 = inability to flex knee (able to move feet or first digit only); 3 = inability to move any joint in legs.

Statistical Analysis

Based on retrospective data from our institution in the same surgical population, a power analysis was performed using postoperative pain during cough as the primary outcome variable. We calculated a sample size so that a between-group mean difference in VAS of 20 mm, with reduced pain scores in the PCEA group, would permit a type 1 error rate of one-tailed $\alpha = 0.05$ and, with the alternate hypothesis, the null hypothesis would be retained with a type error of $\beta = 0.20$. This analysis indicates that a sample size of 31 patients/group was necessary.

Continuous variables are presented as the mean ± SD or median (twenty-fifth to seventy-fifth percentile) when data were not normally distributed, and categoric variables are presented as frequencies (percentage of patients).

Preoperative patient characteristics, intraoperative, and postoperative data in the two groups were compared using the chi-square test for categoric variables and the Wilcoxon rank sum test for continuous variables.

Postoperative assessment for all variables measured over time were evaluated using repeated-measures analysis (the Friedman two-way nonparametric analysis of variance) using Statistical Analysis Software (SAS Institute Inc., Cary, NC). Statistical significance was inferred for $P \geq 0.05$.

Table 3. Comparison of the Two Treatment Groups for Preoperative Factors

	PCA Group (n = 35)	PCEA Group (n = 35)
Age (yr)	76.8 ± 4.7	76.1 ± 5.6
Weight (kg)	69.3 ± 15.5	66.5 ± 14.2
Sex	17F/18M	15F/20M
Diseases		
Chronic obstructive pulmonary disease	4 (11%)	3 (9%)
Coronary artery disease	2 (6%)	5 (15%)
Diabetes	6 (17%)	6 (17%)
Hypertension	12 (34%)	14 (40%)
Depression	5 (14%)	3 (9%)

Values are mean ± SD or median (twenty-fifth percentile to seventy-fifth percentile) or actual numbers (%).

PCA = patient-controlled analgesia; PCEA = patient-controlled epidural analgesia.

Results

A total of 108 elderly patients underwent scheduled major abdominal surgery at the Centre Hospitalier Universitaire Montpellier over a period of 18 months. Among them, 38 (35%) were not included in the study because of patient refusal (4 patients [4%]), or severe cardiopulmonary dysfunction or AMT score < 8 (26 patients [24%]), neurologic dysfunction (2 patients [2%]), or other reasons (6 patients [6%]). Seventy patients were assigned randomly to one of the two groups. Six patients did not complete the postoperative study and were excluded from postoperative data analysis because of absence of surgical resection (two in each group) or refusal to use the patient-controlled device with requirement of conventional analgesia (two in the PCEA group and none in the PCA group).

The two groups of patients were similar with respect to weight, age, sex, preoperative diseases (table 3), and AMT and American Society of Anesthesiologists scores. During surgery, no difference was observed in intravenous fluid requirements or the duration and type of surgery (table 4). Patients in the PCEA group received less isoflurane ($P = 0.0001$) and intravenous sufentanil ($P = 0.0001$) but required significantly ($P = 0.0001$) more ephedrine than patients in the PCA group (table 4; $P = 0.0001$). At the end of the surgery, body temperature and duration of postoperative mechanical ventilation were similar in both groups, but extubation time occurred significantly earlier in the PCEA group than in the PCA group (table 4; $P = 0.015$).

Duration of PCA was comparable between the PCA group and the PCEA group (70 ± 20 h and 79 ± 22 h,

Table 4. Comparison of the Two Treatment Groups during Anesthesia

	PCA Group (n = 35)	PCEA Group (n = 35)
Surgery		
Colectomy	26 (74%)	20 (57%)
Gastrectomy	2 (6%)	6 (17%)
Cephalic pancreatectomy	5 (14%)	7 (20%)
Absence of resection	2 (6%)	2 (6%)
Duration of surgery (min)	242 (172–295)	230 (180–305)
Mean isoflurane (%)	0.8 (0.8–1)	0.5 (0.4–0.6)*
Intravenous sufentanil (μg/kg)	1.7 (1.3–2.2)	0.3 (0.3–0.4)*
Crystalloids (l)	5 (4–6)	5 (4–6)
hydroxy ethyl starch (l)	0.5 (0–1)	1.0 (0.5–1.0)
Blood transfusion (l)	0 (0–0)	0 (0–0)
Blood loss (l)	0 (0–0)	0 (0–0)
Incidence of systolic hypotension (< 90 mmHg)	21 (60%)	26 (74%)
Duration of systolic hypotension (min)	5 (0–20)	15 (5–30)
Intravenous ephedrine (mg)	0 (0–0)	12 (6–36)*
Temperature at the end of surgery (°C)	35.8 ± 0.7	37 ± 0.7
Postoperative extubation time (min)	60 (32–90)	30 (17–57)*
Duration of postoperative mechanical ventilation (min)	27 (10–65)	27 (12–45)

Values are mean ± SD or median (twenty-fifth percentile–seventy-fifth percentile) or actual numbers (%).

* $P < 0.05$ between the two treatment groups.

respectively). The daily number of boluses was similar in both groups. Postoperative patient-controlled analgesic consumption is displayed in table 5. PCEA provided significantly better pain relief than did PCA at rest ($P = 0.001$) and after coughing ($P = 0.002$), regardless of the group during the 5 postoperative days (figs. 1 and 2). The satisfaction scores were significantly greater in the PCEA group than in the PCA group (table 6; $P = 0.012$). On the first postoperative day, fewer patients required intravenous administration of ketoprofene in the PCEA group than in the PCA group (table 7; $P = 0.001$).

Preoperative AMT scores were comparable between the two groups. Postoperative delirium developed in 16 (25%) patients, with a mean duration of episodes of 73 ± 31 h. The frequency of postoperative delirium was similar in the PCA group and the PCEA group: 8 patients (24%) and 8 patients (26%), respectively. The patients with delirium had neither different pain scores nor different analgesic consumption than those without delirium. During the episodes of delirium, PCA was not discontinued. AMT scores were lower in the PCA group on the fourth and fifth postoperative days (table 8; $P = 0.03$). Four patients (three in the PCA group and one in the PCEA group) required haloperidol to treat postoperative delirium with agitation.

Table 5. Postoperative Patient-controlled Analgesic Consumption in the Two Groups

Postoperative Day	Intravenous Morphine Sulfate (mg/day)	Epidural Bupivacaine (mg/day)	Epidural Sufentanil (μg/day)
	PCA Group	PCEA Group	PCEA Group
1	25 (24–44)	169 (150–236)	68 (57–94.5)
2	19 (8–32)	158 (120–216)	63 (48–87)
3	10 (0–21)	127 (94–153)	51 (37–61)
4	0 (0–0)	50 (0–120)	20 (0–48)
5	0 (0–0)	0 (0–0)	0 (0–0)

Values are median (twenty-fifth percentile–seventy-fifth percentile).

The first feces ($P = 0.005$) and oral intake without nausea ($P = 0.019$) occurred significantly more quickly in the PCEA group than in the PCA group (table 6). Daily oxygenation values up to the fifth postoperative day and the number of minor asymptomatic hypoxia episodes detected by pulse oximetry were not significantly different between the two groups. No patient required administration of naloxone. Three patients in the PCA group and two in the PCEA group had at least one episode of Sp_{O_2} between 90 and 95%. One patient in both groups

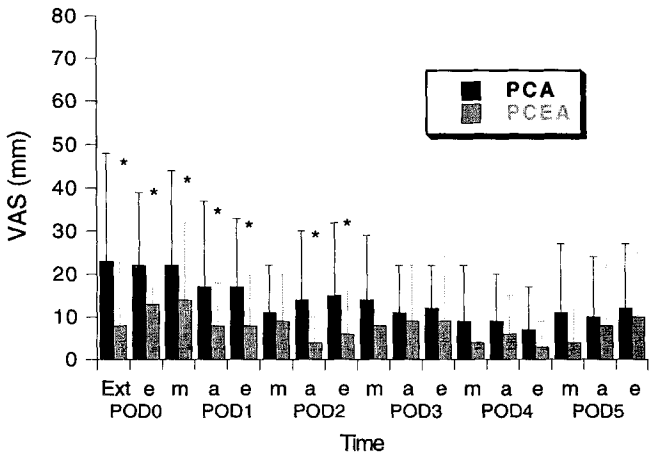

Fig. 1. For postoperative pain intensity (visual analog scale) at rest, patient-controlled epidural analgesia (PCEA) provided significantly better pain relief than did patient-controlled analgesia (PCA; by repeated-measures analysis of variance; $P = 0.001$). Values are the mean ± SD. *$P < 0.05$ compared with PCA (Wilcoxon rank sum test). a = afternoon; e = evening; ext = extubation; m = morning; POD = postoperative day.

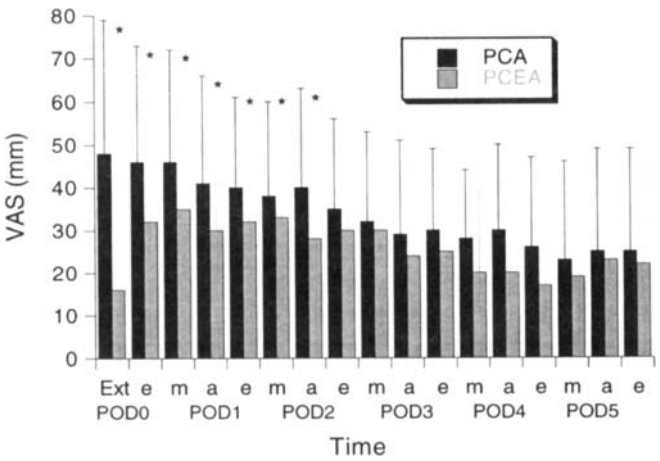

Fig. 2. For postoperative pain intensity (visual analog scale) during cough patient-controlled epidural analgesia (PCEA) provided significantly better pain relief than did patient-controlled analgesia (PCA; by repeated-measures analysis of variance; P = 0.002). Values are the mean ± SD. * $P < 0.05$ compared with PCA (Wilcoxon rank sum test). a = afternoon; e = evening; ext = extubation; m = morning; POD = postoperative day.

had at least one episode of Sp_{O_2} between 85 and 90%. The two groups had similar clinical and radiologic abnormality rates (table 6). The frequency and type of major and moderate pulmonary complications were not significantly different between groups (table 6). Two subjects experienced atelectasis, pneumonia, and hypoventilation and required intensive therapy with bronchoscopy, but not mechanical ventilation.

Five episodes of postoperative hypotension occurred in the PCEA group *versus* none in the PCA group (P = 0.01). The patients were treated by simple fluid loading. No severe hypotension (minimum systolic pressure = 78 mmHg) was recorded in either group (table 6). No motor blockade occurred in either group. Subcutaneous abscess or neurologic complications related to the epidural catheter did not develop in any patient. One patient in each group experienced pruritus. The incidence of anastomosis leak and urinary sepsis and the duration of hospital stay were similar in both groups (table 6).

Discussion

The main finding of this study is that in elderly patients, PCA techniques using either intravenous or epidural routes provide effective management of postoperative pain. However, the epidural route with a combination of local anesthetics and a liposoluble opioid resulted in better postoperative pain relief at rest and during cough without increasing complications compared with the intravenous route. Improved mental status and a quicker gastrointestinal recovery also were observed with PCEA.

In the elderly patient, mismanaging patient-controlled techniques can be related to various factors, such as cardiorespiratory deficiencies or difficulties in handling or learning to use the device. Therefore, it has been suggested that in the elderly patient, close observation and frequent dose titration are needed to use intravenous PCA.[2] In contrast, in our healthy elderly patients, adjustment of patient-controlled setting rarely was necessary. In the PCA group, the initial setting was not modified because no sign of overdosing was detected. In the PCEA group, only five (16%) patients required a change in the initial bolus dose or background infusion to adapt to sensory level or minimize hemodynamic disturbances.

Learning and acceptance of the patient-controlled con-

Table 6. Postoperative Outcome, Side Effects, Hospital Stay, and Patient Satisfaction Scores in the Two Groups

	PCA Group (n = 33)	PCEA Group (n = 31)
Flatus (h)	72 (48–96)	70 (36–72)
Feces (h)	115 (90–144)	80 (60–120)*
Duration of nasogastric tube (h)	58 (38–72)	61 (49–73)
Oral nutrition without nausea (h)	182 (140–240)	142 (120–164)*
Deambulation (h)	98 (84–144)	98 (72–120)
Nausea, vomiting	10 (30%)	10 (32%)
Systolic hypotension (< 90 mm Hg)	0 (0%)	5 (16%)*
Saturation < 95%	5 (15%)	3 (10%)
Postoperative delirium	8 (24%)	8 (26%)
Anastomosis leak	3 (9%)	1 (3%)
Segmental or lobar atelectasis	6 (18%)	7 (23%)
Moderate pulmonary complications	2 (6%)	3 (10%)
Major pulmonary complications	1 (3%)	1 (3%)
Urinary sepsis	5 (15%)	1 (3%)
Duration of hospital stay (days)	11.5 (8–16%)	10.5 (8.5–15%)
Patient satisfaction score (No. of patients with scores of 0/1/2/3)	0/3/19/11	0/1/9/21*

Values are median (twenty-fifth percentile–seventy-fifth percentile) or actual numbers (%).

Patient satisfaction scores as follows: nil = 0; mild = 1; good = 2; excellent = 3.

* $P < 0.05$ between the two treatment groups.

Table 7. Postoperative Analgesic Rescue Consumptions in the Two Groups

Postoperative Day	No. of Patients Having Received Propacetamol Intravenous		No. of Patients Having Received Ketoprofene Intravenous	
	PCA Group	PCEA Group	PCA Group	PCEA Group
	No. (%)	No. (%)	No. (%)	No. (%)
1	18 (54)	11 (35)	15 (45)	5 (16)*
2	18 (54)	15 (48)	6 (18)	3 (10)
3	19 (58)	17 (55)	3 (9)	3 (10)
4	15 (45)	17 (55)	2 (6)	3 (10)
5	12 (36)	10 (32)	1 (3)	0

Values are actual numbers (%).

* $P < 0.05$ beetween the two groups.

PCA = patient-controlled analgesia; PCEA = patient-controlled epidural analgesia.

cept obviously necessitates a sufficient preoperative mental status. In addition, preoperative confusion may be exaggerated after surgical procedure in patients with preexistent cognitive dysfunction,[12] which may result in a probable misuse of the patient-controlled device. However, the use of this technique was not precluded if transient minor alterations in patient mental status occurred. The current study showed a 25% incidence of postoperative delirium. A recent multicenter study that recruited up to 60 elderly patients undergoing major surgery reported a closely comparable incidence of delirium and identified only age as a predictor of deficit (and not hypoxia, hypotension, or both).[15] Preoperative patient selection using AMT scores allowed us to identify those with preexisting cognitive impairment, who were subsequently not enrolled in the study. This would probably explain why only 3% of the selected patients refused the patient-controlled device and required conventional analgesia. Moreover, the patients with cognitive impairment required no particular surveillance with regard to postoperative pain treatment. This high degree of acceptance encourages us to recommend the routine perioperative use of AMT with an effective strategy to take care of postoperative pain in the elderly patient, especially if a patient-controlled technique is used.

As in previous studies,[9,16,17] we failed to show any difference in incidence of delirium, regardless of the route of postoperative analgesia. To understand this, the choice of sufentanil, a highly lipid soluble opioid, for PCEA must be taken into account. Because epidural sufentanil may have a marked systemic effect,[18] a potential reduction in postoperative delirium by trying to prevent the systemic effect of opioids may not be prevented by using the epidural route. However, in the PCEA group, we observed from the fourth postoperative day a more rapid recovery of mental status assessed by AMT score. This indicates, as suggested by previous studies,[2,9] that the quality of postoperative analgesia is probably of more importance than is the route of administration or the consumption of opioids in the preservation of cognitive function.

The better analgesic effectiveness with respect to low incidence of side effects could probably explain the superiority of PCEA techniques, as pointed out by the higher patient satisfaction scores. In addition, it is important to emphasize that the PCEA regimen was only partly patient controlled and offers the possibility of setting a background infusion. First, this is particularly useful in confused or not yet totally awake patients who cannot handle the device. Second, background infusion improves analgesia achieved by PCEA without further side effects.[19] In contrast, continuous infusion should be avoided by the intravenous route because this would mean an increased risk of respiratory depression, even at a low dose.[20] Third, it is important to consider that older patients prefer to have analgesics administered by hospital staff, rather than by self-administration.[21] Taken together, these considerations could undoubtedly favor the PCEA technique.

Delayed postoperative recovery of gastrointestinal functions after abdominal surgery has been related to surgical bowel anastomosis,[22] prolonged placement of a nasogastric tube,[23] and use of inhaled anesthetics[24] or parenteral opioids.[25] In contrast, thoracic epidural analgesia with local anesthetics, whether associated with

Table 8. AMT Scores (No. of Patients with Scores of ≤ 8/9/10)

		PCA	PCEA
Preoperative		2/15/18	1/14/20
Postoperative Days			
0	PM	11/12/10	9/11/11
1	AM	12/10/11	9/8/14
	PM	10/9/14	7/11/13
2	AM	7/13/13	7/6/18
	PM	6/12/15	5/6/20
3	AM	6/13/14	4/7/21
	PM	8/10/15	6/5/20
4	AM	5/11/17	1/5/25*
	PM	3/10/20	3/5/23
5	AM	6/9/18	3/7/21
	PM	5/13/15	1/7/23*

* $P < 0.05$ between the two treatment groups.

PCA = patient-controlled analgesia; PCEA = patient-controlled epidural analgesia.

opioids, may improve bowel activity in comparison with parenteral analgesia.[6] Patients in the PCA group received significantly more intraoperative intravenous opioids and isoflurane. Therefore, it was not surprising that, in the PCA group, first feces and oral intake were delayed as compared with the PCEA group. However, the time to the first passage of flatus was not significantly different between the two groups. In the PCA group, the greater consumption of ketoprofene, a nonsteroidal antiinflammatory agent that accelerates the rate of recovery of gastrointestinal function,[26] could probably explain this fact. Interestingly, studies in which the epidural catheter was located at or below T12 or in which the duration of epidural analgesia lasted no more than 24 h[27-29] have not found any advantage for epidural analgesia with regard to recovery of bowel function. Therefore, we took care to always position the catheter at the thoracic level and to provide an effective thoracic sensory blockade. Four patients (5.9%) experienced anastomosis leak: three in the PCA group and one in the PCEA group. Unexpectedly, this incidence was substantially lower than in most previous studies in younger patients that reported a range of 7-23%.[30-32]

The incidence of pulmonary complications in this study was similar to that in other studies that included younger patients undergoing the same type of surgery.[1,13] The choice of the analgesic technique did not seem to influence the incidence of moderate and major pulmonary complications. Cardiovascular changes were without clinical importance. As expected, in the PCEA group, hemodynamic instability was more pronounced intraoperatively, necessitating a higher consumption of ephedrine, and postoperatively, in which five patients experienced a moderate episode of hypotension. However, the current study did not have the power to detect significant differences in cardiorespiratory outcome because of the small number of patients.

With epidural analgesia, the risk of orthostatic hypotension and motor blockade of the lower limbs during postoperative mobilization could counteract the benefit of the accelerated postoperative recovery.[33] A self-adjustment by the patient probably explains in the current study the lack of significant hemodynamic instability and motor blockade and, in turn, does not interfere with the possibility of earlier walking.

Finally, there was no difference between the two groups of elderly patients for the duration of the hospital stay. However, because we did not define precisely the discharge criteria before the study, we could not draw definite conclusions.

In summary, the current study showed that postoperative PCA techniques by either the epidural or the parental route is effective in the elderly patient. When compared with the parenteral route, epidural analgesia with local anesthetics and an opioid provides better pain relief and improves mental status and bowel activity but does not reduce postoperative delirium incidence and cardiorespiratory morbidity. This method of postoperative analgesia is a promising new technique for healthy elderly patients undergoing major abdominal surgery.

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