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Effect of Postoperative Epidural Analgesia on Rehabilitation and Pain after Hip Fracture Surgery

A Randomized, Double-blind, Placebo-controlled Trial

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Background: **Hip fracture surgery usually carries a high demand for rehabilitation and a significant risk of perioperative morbidity and mortality. Postoperative epidural analgesia may reduce morbidity and has been shown to facilitate rehabilitation in elective orthopedic procedures. No studies exist on the effect of postoperative epidural analgesia on pain and rehabilitation after hip fracture surgery.**

Methods: **Sixty elderly patients were included in a randomized, double-blind study comparing 4 days of continuous postoperative epidural infusion of 4 ml/h bupivacaine, 0.125%, and 50 μg/ml morphine *versus* placebo. Both patient groups received balanced analgesia and intravenous nurse-controlled analgesia with morphine. All patients followed a well-defined multimodal rehabilitation program. Pain, ability to participate in four basic physical functions, and any factors restricting participation were assessed on the first 4 postoperative days during physiotherapy.**

Results: **Epidural analgesia provided superior dynamic analgesia during all basic physical functions, and patients were significantly less restricted by pain, which was the dominating restricting factor in the placebo group. Motor blockade was not a restricting factor during epidural analgesia. Despite improved pain relief, scores for recovery of physical independence were not different between groups.**

Conclusion: **Postoperative epidural analgesia after hip fracture surgery provides superior analgesia attenuating pain as a restricting factor during rehabilitation without motor dysfunction. However, superior analgesia did not translate into enhanced rehabilitation. Future studies with multimodal rehabilitation are required to establish whether superior analgesia can be translated into enhanced rehabilitation and reduced morbidity in hip fracture patients.**

THE number of patients with hip fractures is increasing steadily and presents a mounting challenge for healthcare professionals involved in the perioperative care of these frail individuals.[1] These patients have a high postoperative morbidity and mortality,[2] and they often require extensive rehabilitation before their return to the community. Epidural anesthesia potentially reduces perioperative morbidity after major orthopedic procedures,[3] and postoperative epidural analgesia may reduce myocardial ischemia after hip fracture surgery.[4] Postoperative epidural analgesia also facilitates rehabilitation after major elective orthopedic procedures,[5–7] but no studies have examined the effects of continuous postoperative epidural analgesia on pain and rehabilitation after surgery for hip fracture.

The purpose of the current study was to evaluate the effects of postoperative epidural analgesia on pain and rehabilitation in hip fracture patients within the setting of a well-defined perioperative care program. The study was conducted as a randomized, double-blind, placebo-controlled clinical trial in which postoperative continuous epidural analgesia with local anesthetic and low-dose opioid was compared to a conventional intravenous opioid regimen.

Materials and Methods

Patients and Design

From January 2003 to April 2004, all patients presenting with a primary hip fracture at Hvidovre University Hospital (Copenhagen, Denmark) were screened for inclusion into the study. Inclusion criteria were age greater than 65 yr, residence in own home, intact cognitive status on admission, ability to provide written informed consent, and a New Mobility Score of 3 or more (indicating independent indoor ambulation).[8,9] Exclusion criteria were refusal to participate in the study, prefracture hospitalization, contraindications to epidural analgesia, regular prefracture opioid or glucocorticoid therapy, alcohol or substance abuse, morphine intolerance, and postoperative surgical restrictions for ambulation. The study was approved by the local ethics committee (Copenhagen and Frederiksberg, Denmark) and the Danish data protection agency (Copenhagen, Denmark).

In total, 425 patients presented themselves for inclusion during the study period; 94 patients were not included because of unavailability of the investigators. Primary exclusion criteria for the remaining patients were dementia (29), age less than 65 yr (37), prefracture hospitalization (24), prefracture opioid therapy (17), prefracture steroid therapy (7), known morphine intol-

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erance (13), alcohol abuse (10), nursing home residence (80), refusal to participate (8), insufficient prefracture ambulation (33), multiple fractures (6), and restrictions in postoperative mobilization (4) (assessed preoperatively), and in 3 patients, epidural analgesia was not technically possible.

Sixty included patients were randomly assigned to two groups of 30. Stratification *via* New Mobility Score was used to achieve an equal potential for rehabilitation in the two groups.[9] In group A, patients received postoperative epidural infusion with local anesthetic and low-dose opioid, and in group B, patients received an epidural saline infusion. The study was double blind. Randomization was performed *via* a computer-generated list, and the epidural cassettes were packed by the local pharmacy and blinded and supplied with a randomization number by a person not affiliated with the project.

Procedures

Immediately after arrival in the emergency room, patients received regional analgesia by a fascia iliaca compartment blockade with 40 ml bupivacaine, 0.25%, or mepivacaine, 1%, both with 1:200,000 epinephrine,[10,11] and fluid therapy with 15 ml/kg rehydration fluid (40 mmol/l sodium, 20 mmol/l potassium, 250 mmol/l glucose) was initiated. After radiographic confirmation of the fracture, the patients were taken to the postanesthesia care unit, where an epidural catheter was inserted in the L2–L3 or L3–L4 interspace and tested with 60 mg lidocaine, 2%, with 1:200,000 epinephrine. Epidural analgesia was provided with a bolus of 25 mg bupivacaine, 0.25%, followed by a continuous epidural infusion of 0.125% bupivacaine and 50 μg/ml morphine at a rate of 4 ml/h. In case of hypotension, the patients were given 10 mg intravenous ephedrine, if necessary, followed by volume replacement with 500 ml hydroxyethyl starch, 6%, 130/0.4. The patients were advised to eat and drink freely until 6 h before surgery and to drink clear fluids and protein drinks until 2 h before.

Anesthesia for surgery was provided by an epidural "top-up" with 50 mg bupivacaine, 0.5%, in increments of 5 ml and 1 mg epidural morphine (2 mg for patients younger than 70 yr). No premedication was given, but slight sedation with propofol was provided at a rate of 10–40 $\mu g \cdot kg^{-1} \cdot min^{-1}$ on patient request. Hypotension was treated by 10 mg ephedrine intravenously and 40 mg intramuscularly. Standardized fluid therapy consisted of intraoperative infusion of 5 $ml \cdot kg^{-1} \cdot h^{-1}$ isotonic saline supplemented by 6% hydroxyethyl starch, 130/0.4, on signs of hypovolemia. Blood loss was replaced by 6% hydroxyethyl starch, 130/0.4, at a rate of 1:1 until hemoglobin decreased below 6.0 mmol/l, at which point transfusion of erythrocytes was initiated. The first author conducted or supervised all anesthesia. Postoperatively, the patients were taken to the postanesthesia care unit, where the continuous epidural infusion was initiated after the patients achieved a Bromage score of II. Patients in group A received 4 ml/h bupivacaine, 0.125%, and 50 μg/ml morphine, whereas patients in group B received 0.9% saline. The infusions were continued until 8:00 AM on the fourth postoperative day for a total of 90–94 h. During the period with randomized epidural infusion, the patients also had a nurse-controlled analgesia pump[12] with intravenous morphine at a dose of 40 μg/kg and a 20-min lockout and no continuous infusion. All patients received additional analgesia with 1 g paracetamol 6 hourly and 25 mg rofecoxib once daily from admission and during the entire study period. A prophylactic antibiotic (1.5 g cefuroxime) was given intraoperatively, and 40 mg/day enoxaparin was given as antithrombotic prophylaxis. No prophylactic antiemetic was administered; on-demand antiemetic treatment consisted of 2 mg intravenous ondansetron.

Postoperatively, all patients were admitted to a specialized hip fracture unit and treated according to a well-defined multimodal fast-track rehabilitation regimen.[13] The patients were mobilized on the day of surgery and were expected to be out of bed for 4 h on the first postoperative day, 6 h on the second postoperative day, and 8 h per day thereafter. Patients participated in two daily physiotherapy sessions of 30–45 min each, and rehabilitation was planned to continue in the unit until discharge to permanent residence. From admission until the fourth postoperative day, patients received supplemental oxygen therapy at 2 l/min whenever they were supine. Immediately after surgery, the patients received a regular diet supplemented by three daily protein drinks. Postoperative fluid therapy was standardized, and intravenous fluids were administered only if oral intake was less than 1,500 ml daily, or in the case of hypovolemia, 500 ml hydroxyethyl starch, 6%, 130/0.4, was given. Hemoglobin was measured in the postanesthesia care unit and every morning until the fifth postoperative day, and erythrocyte transfusion was initiated if the patient had a hemoglobin level less than 6.0 mmol/l.

Study Parameters

The ability of the patients to participate in physiotherapy exercises was evaluated by a project physiotherapist on each postoperative day during one of the two daily sessions. The ability of the patients to do four basic functions, including hip and knee flexion, supine to sitting transfer, standing to sitting transfer, and walking, was scored on a validated three-point scale: 2 = ability to perform the function independently, 1 = only able to perform the function with assistance by another person, and 0 = unable to perform the function (N. B. Foss, M.D., M. T. Kristensen [Physiotherapist], H. Kehlet, M.D., Ph.D., Copenhagen, Denmark, unpublished data, 2004: a cumulated ambulation score for prediction of

postoperative outcome). If the patient was unable to perform a specific function independently, the physiotherapist noted the primary factor responsible as one of the following: pain, motor blockade, nausea and vomiting, dizziness, cognitive dysfunction, or exhaustion. Exhaustion was only noted as the primary factor if no other restricting factor was relevant. Walking distance during the training session was assessed as 0 = 0 m, 1 = 1–15 m, 2 = 16–30 m, and 3 = > 31 m.

Pain at rest was assessed after the patient had been resting in bed for 15 min, immediately before the commencement of physiotherapy. Pain on moving was assessed by the attending physiotherapist during the training sessions for each of the four basic functions. Pain was measured on a five-point verbal ranking scale from 0 to 4 with the categories none, light, moderate, severe, and intolerable pain. The nursing staff assessed pain at rest and on hip flexion and nausea every 4 h, unless the patient was sleeping. Nausea was assessed on the scale 0 = no nausea, 1 = slight nausea, and 2 = moderate to severe nausea. All instances of vomiting were recorded by the nursing staff.

Patients were tested with the Mini-Mental State Examination,[14] preoperatively and on the second, fourth, and seventh postoperative days. The maximum decline in the Mini-Mental State Examination was calculated as the difference between the preoperative Mini-Mental State Examination score and the lowest postoperative score.

Statistics

Preliminary data sampling indicated that 26 patients were needed in each group to demonstrate a 40% difference in the number of patients who were able to walk independently on the first postoperative day, with a level of significance of 0.05 and a power of 0.80. Thirty patients were included in each group to compensate for exclusions. Tests for significant differences between groups were done with the chi-square test for categorical data and adjusted for linear-by-linear association for ordinal scales, whereas the Mann–Whitney U test was used for continuous numeric data that were not normally distributed. All data analyses were conducted with SPSS for Windows version 10.1 (SPSS Inc., Chicago, IL).

Results

Patients and Compliance

After randomization, five patients were excluded from the study, three had postoperative surgical restrictions on ambulation, and two were excluded because of apparent morphine intolerance—one had excessive nausea and vomiting and wished to be excluded, and one was opioid sensitive responding to intravenous opioid therapy (2 mg morphine) with extreme sedation and respiratory insufficiency (both of these patients were from the epidural group). The two groups of patients were identical in their prefracture physical and mental status (table 1). There was a high degree of compliance with the described epidural regimen in the remaining 55 patients included in the analysis. Two patients, one from each group, had their epidural infusion terminated on the second postoperative day as a result of accidental patient removal of the epidural catheter. One patient from group A was not tested on the ability to walk and transfer from sitting to standing on the first postoperative day because of severe postoperative anemia (3.7 $mmol^{-1}$ hemoglobin, which was still not adequately corrected at the time of the physiotherapy session). One patient in group B was not tested on any functions on day 4 because of a dislocated prothesis after a fall during the night.

Table 1. Demographics and Perioperative Data in Hip Fracture Patients Randomly Assigned to Postoperative Epidural Analgesia (Group A) or Placebo (Group B)

	Group A	Group B	*P* Value
n	28	27	
Age	81 (10.8)	84 (11.4)	0.18
Sex, M/F	4/24	6/21	0.45
ASA, I/II/III/IV	0/2/18/8	0/1/14/12	0.21
Weight, kg	65 (11.0)	60 (10.0)	0.25
New Mobility Score	9 (2.0)	9 (2.0)	0.55
Preoperative MMSE score	26 (4.3)	25 (6.0)	0.88
Type of operation, A/I/P/S	10/0/6/12	8/4/4/11	0.20
Delay to preoperative epidural, h	7 (9.25)	5 (6.0)	0.35
Delay to surgery, h	16 (6.8)	18 (10.0)	0.30
Intraoperative bleeding, ml	200 (300)	200 (175)	0.46
Lowest intraoperative MAP	65 (22.5)	65 (20.0)	0.94

Values are given as median (interquartile range) where applicable.

A = arthroplasty; ASA = American Society of Anesthesiologists (physical status); I = intramedullar nailing; MAP = mean arterial pressure; MMSE = Mini-Mental State Examination; P = parallel screws; S = sliding screws.

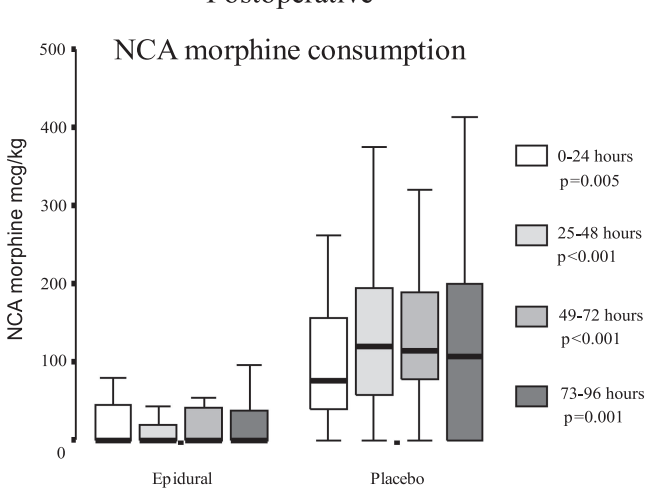

Fig. 1. Patient consumption of intravenous morphine *via* nurse-controlled analgesia pump (NCA) in hip fracture patients randomly assigned to postoperative epidural analgesia (n = 28) or placebo (n = 27), represented in 24 hourly intervals from the end of surgery.

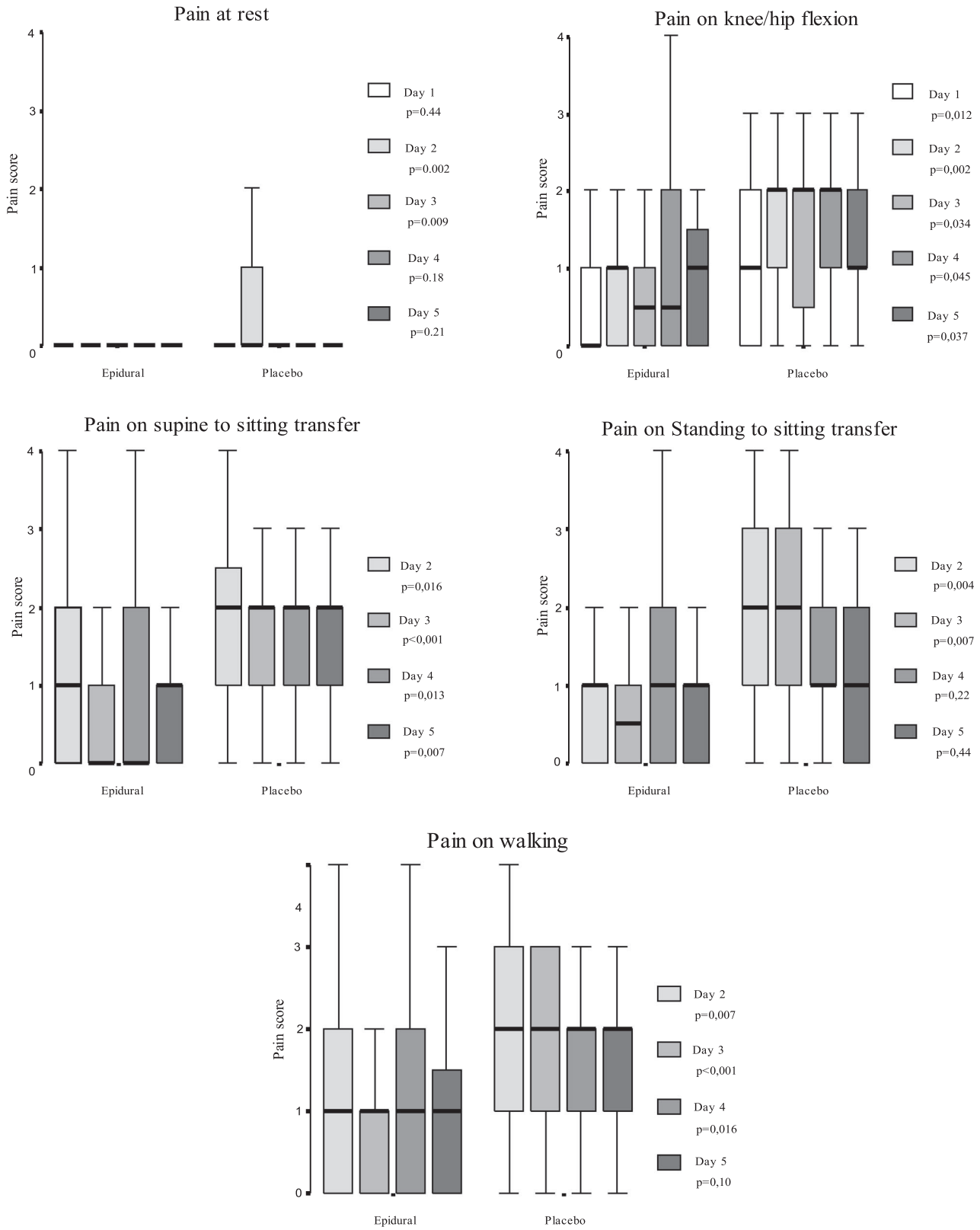

Fig. 2. Pain scores at rest before physiotherapy and during the four basic mobility exercises in hip fracture patients randomly assigned to postoperative epidural analgesia (n = 28) or placebo (n = 27). Day 1 is the day of surgery. Pain scores: 0 = no pain, 1 = light pain, 2 = moderate pain, 3 = severe pain, and 4 = intolerable pain.

Analgesia and Postoperative Nausea and Vomiting

None of the patients received any opioids or other supplementary analgesics in the postanesthesia care unit. The total amount of nurse-controlled analgesia–delivered morphine is presented in figure 1 in 24-h intervals. The patients in group B received significantly more morphine *via* nurse-controlled analgesia during all intervals. Pain at rest and during the four basic physical exercises is shown in figure 2. Only a few patients had physiotherapy sessions on the day of surgery due to their return to the ward after 2:00 PM, and pain at rest and during hip/knee flexion on the day of surgery is consequently presented *via* the measurements obtained by the ward nurse 6 h postoperatively. Pain was significantly lower during all exercises on all study days, except for the function of standing to sitting on the third and fourth postoperative days. Pain at rest was low in both groups, but significantly lower in group A on the first and second postoperative days.

Nausea was analyzed *via* the highest score for the given patient in each 24-h interval. Vomiting was categorized as no vomiting or vomiting on the given day (fig. 3). No patients had any episodes of vomiting or required any antiemetics during their stay in the postanesthesia care unit. There were no significant differences in nausea and vomiting between groups when analyzed categorically or when corrected for linear-to-linear association to adjust for differences in severity.

Functional Scores and Restricting Factors

The patients' ability to participate in each of the basic physical functions is shown in table 2. There were no significant differences between the two groups, nor were there any differences in the walking distance the patients could perform during their physical exercises. The restricting factors for patients unable to perform a given function independently are presented in table 3 for the two functions of hip flexion and walking. The two other functions (supine to sitting and standing to sitting) are not presented in the table for the sake of simplicity, but the results are similar to the other functions. There was a significantly larger portion of patients in group B who were restricted by pain in all functions on the first and second postoperative days ($P < 0.01$ for all functions except hip flexion, where $P < 0.05$). Postoperative nausea and vomiting was more often a restricting factor for the functions of standing to sitting and walking in group A on the first postoperative day only.

There were no significant differences between groups in the number of patients who were restricted by motor blockade in any of the four measured functions. The total numbers of hours that the patients in the two groups spent out of bed on each postoperative day are shown in figure 4. There were no significant differences between the two groups.

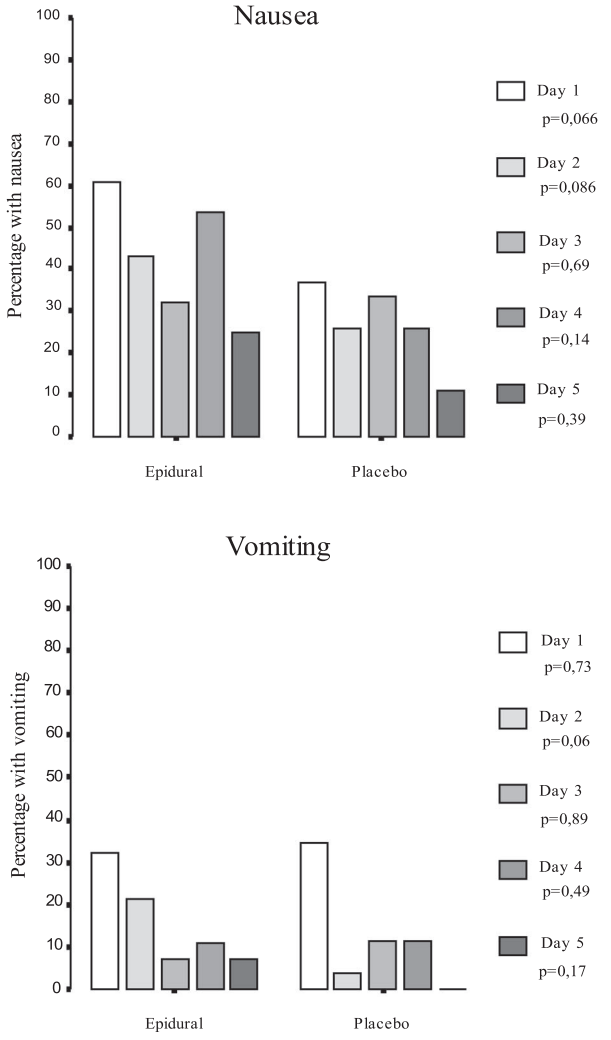

Fig. 3. Incidence of patients with nausea and vomiting according to treatment group in hip fracture patients randomly assigned to postoperative epidural analgesia (n = 28) or placebo (n = 27). Day 1 is the day of surgery.

Clinical Course and Complications

There was one fatality within 30 days in each group. The patient in group A had acute incompensated heart failure and died on the sixth postoperative day, whereas the patient in group B had postoperative delirium, pneumonia, and respiratory insufficiency and died after a 1-week stay in the intensive care unit. Hospital stay and the incidence of postoperative complications are shown in table 4 ($P > 0.05$ between groups).

Discussion

This first study in hip fracture patients shows that postoperative epidural analgesia with local anesthetic and low-dose morphine compared with nurse-controlled intravenous analgesia with morphine provides superior dynamic analgesia during basic physical functions required in a multimodal rehabilitation setting. The anal-

Table 2. Ability to Participate in Physiotherapy Exercises of Basic Mobility Functions in Patients Randomly Assigned to Postoperative Epidural Analgesia (Group A) or Placebo (Group B)

	Postoperative day 1			Postoperative day 2			Postoperative day 3			Postoperative day 4		
	A	B	*P* Value	A	B	*P* Value	A	B	*P* Value	A	B	*P* Value
Hip flexion												
Unable to perform function	1	3		2	1		2	1		1	1	
Able to perform function with assistance	7	10	0.12	6	10	0.58	6	6	0.70	5	5	0.89
Performs function independently	20	14		20	16		20	20		22	20	
Supine to sitting transfer												
Unable to perform function	1	1		4	0		1	2		1	0	
Able to perform function with assistance	10	15	0.19	7	15	0.91	11	11	0.58	6	7	0.90
Performs function independently	17	11		17	12		16	14		21	19	
Standing to sitting transfer												
Unable to perform function	6	4		6	0		4	3		2	1	
Able to perform function with assistance	14	17	0.84	10	16	0.28	8	7	0.64	7	5	0.44
Performs function independently	7	6		12	11		16	17		19	20	
Walking												
Unable to perform function	7	4		7	3		7	5		5	1	
Able to perform function with assistance	16	19	0.49	12	15	0.43	7	7	0.58	7	7	0.17
Performs function independently	4	4		9	9		14	15		16	18	

gesia provided by the epidural regimen resulted in the patients being significantly less restricted by pain during all the parts off their well-defined physiotherapy exercises to regain independent ambulation. Furthermore, the superior analgesia was not gained at the expense of motor dysfunction, because there was no difference between groups in motor blockade as a restricting factor for the ability to participate in exercises. Neither was

Table 3. Distribution of Primary Limiting Factor of Patients Unable to Perform a Basic Mobility Function Independently in Patients Randomly Assigned to Postoperative Epidural Analgesia (Group A, n = 28) or Placebo (Group B, n = 27)

	Postoperative day 1			Postoperative day 2			Postoperative day 3			Postoperative day 4		
	A	B	*P* Value	A	B	*P* Value	A	B	*P* Value	A	B	*P* Value
Pain												
Hip flexion	2	10	0.02	1	7	0.03	3	8	0.004	1	4	0.079
Walking	2	17	< 0.001	2	12	< 0.001	4	5	0.484	1	6	0.001
Motor block												
Hip flexion	1	1	0.72	1	2	0.74	3	0	0.07	0	0	NA
Walking	2	0	0.15	0	0	NA	2	0	0.17	0	0	NA
PONV												
Hip flexion	0	0	NA	0	0	NA	0	0	NA	0	0	NA
Walking	6	0	0.009	1	0	0.32	1	0	0.35	0	1	0.19
Dizziness												
Hip flexion	0	0	NA	0	0	NA	0	0	NA	0	0	NA
Walking	5	1	0.08	4	0	0.04	1	1	0.91	2	0	0.24
POCD												
Hip flexion	1	0	0.19	2	0	0.08	1	0	0.33	0	0	NA
Walking	1	1	1.0	2	2	0.95	1	1	0.91	0	0	NA
Exhaustion												
Hip flexion	4	2	0.09	4	2	0.14	2	0	0.16	5	2	0.08
Walking	7	4	0.30	10	4	0.06	5	5	0.76	10	1	0.004

Values are number of patients in whom the factor was deemed to be the main limitation in their ability to perform the given function independently.
NA = not applicable; POCD = postoperative cognitive dysfunction; PONV = postoperative nausea and vomiting.

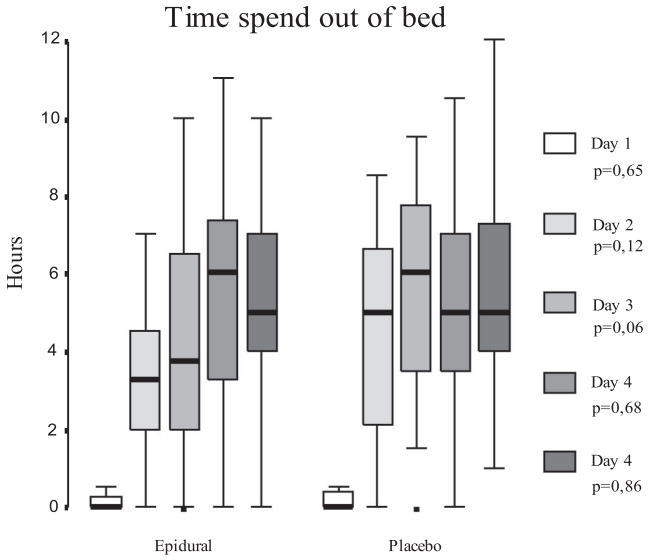

Fig. 4. Time out of bed on each postoperative day separately in hip fracture patients randomly assigned to postoperative epidural analgesia (n = 28) or placebo (n = 27). Day 1 is the day of surgery.

there any difference in the ability to perform basic physical functions independently, which would be expected if motor blockade was a limiting factor with postoperative epidural analgesia.

In contrast to the advantageous effect of the epidural analgesia, this did not readily translate into a clinically relevant improvement in overall physical performance by means of gaining independent ambulation and earlier discharge. This apparent discrepancy between improved analgesia and performed physical activity may have several potential explanations. Therefore, other limiting factors, such as postoperative nausea and vomiting, dizziness, and exhaustion, were more often noted as the restricting component in the epidural analgesia group, which potentially could represent side effects induced by the treatment. However, postoperative nausea and vomiting constituted a significant limiting factor for walking and standing to sitting only on the first postoperative day, and there was no significant difference in nausea score or incidence of vomiting. Unfortunately, we did not perform quantitative measurements for either dizziness or exhaustion, which could have further elucidated the problem. Another potential explanation is that pain was such an overriding limiting factor that it dominated in the placebo group despite the presence of other restricting factors that may only become apparent in the absence of moderate to severe pain as obtained in the epidural group. Nevertheless, our study emphasizes the problem that improved pain relief does not readily translate into improved rehabilitation, as shown before in other randomized trials with epidural analgesia in other surgical procedures.[15,16] Although a well-defined enforced physiotherapy program was instituted in all patients, further enforcement may be required, together

Table 4. Postoperative Complications and Clinical Data in Hip Fracture Patients Randomly Assigned to Postoperative Epidural Analgesia (Group A) or Placebo (Group B)

	Group A	Group B	*P* Value
n	28	27	
Time in PACU, min	85 (33.8)	120 (97.5)	0.007
Postoperative transfusions, n	1 (2)	2 (3)	0.15
Postoperative colloids	0 (500)	0 (200)	0.09
Pneumonia	3	3	0.96
Deep venous thrombosis	0	2	0.14
Pulmonary embolus	1	0	0.33
Cardiac complication	1	1	0.98
S-creatinine > 200, mM	1	1	0.98
Surgical wound infection	0	2	0.14
Patients with at least one major medical complication	6	8	0.49
Maximum decrease in MMSE score	0.5 (3.75)	1.0 (3.25)	0.85
Total duration of hospital stay (preoperative and postoperative)	11 (12)	13 (13)	0.78
30-Day mortality	1	1	0.98

Values are given as median (interquartile range) where applicable.
MMSE = Mini-Mental State Examination; PACU = postanesthesia care unit.

with elimination of other limiting factors, to achieve earlier rehabilitation in these high-risk patients with very limited prefracture physical capabilities. In the current study, we chose a combination of local anesthetics and low-dose opioid because this combination has shown analgesia superior to that of local anesthetics alone in other surgical procedures.[16] Whether this combination provides the optimal balance between dynamic analgesia and the risk of opioid-related side effects in hip fracture patients remains to be clarified. Future studies with multimodal rehabilitation program are required and should include an opioid-free multimodal analgesic regimen.[17]

Our study has several methodologic strengths that support its conclusions. First, it has a double-blind, placebo-controlled setup that facilitates valid measurements of potentially difficult outcome evaluations, such as motor blockade and the ability to perform physical functions after surgery in the lower extremities. Second, the perioperative setup was highly standardized, eliminating confounding factors such as differences in preoperative analgesia, anesthesia, fluid therapy, transfusion thresholds, postoperative restrictions on ambulation, nutrition, oxygen therapy, and discharge criteria, all of which potentially could influence the patients' ability to perform basic postoperative rehabilitation. However, the study may also have potential problems. First, one could question whether nurse-controlled analgesia provides optimal opioid analgesia in the placebo group, because

patient-controlled analgesia is the accepted standard. However, hip fracture patients are elderly, acute surgical patients, and problems with education and implementation of patient-controlled analgesia can occur when these patients are scheduled to undergo surgery shortly after their fracture. Also, the data suggest that the amount of morphine administered in the placebo group was adequate, because patients had very low resting pain scores. Finally, the administered amount of morphine is equivalent to that reported in other studies.[4,18] Second, the functional score used in the current study might not be sensitive enough to ascertain potential differences in the ability to perform physical exercises in such a relatively small series. A large variability in postoperative physical capabilities exists in these patients, restricting their ability to participate in more discriminating tests, such as timed walking and treadmill exercises, in the early postoperative phase. Third, our study focused only on the subgroup of hip fracture patients (approximately 50%) that has the highest potential for a functional outcome benefit of epidural analgesia, and the result may not necessarily be the same in the remaining patients with low prefracture mobility.

The study was not powered to show any differences in morbidity and hospital stay, and none was shown. It has previously been shown that intraoperative regional anesthesia potentially can reduce morbidity and mortality after lower extremity surgery in general, and in hip fracture surgery specifically.[3,19] Also, preoperative epidural analgesia reduced preoperative cardiac complications before hip fracture surgery in the only available study.[20] Postoperative epidural analgesia has been shown to attenuate cardiac ischemia in hip fracture patients,[4] and postoperative epidural analgesia has been shown in a meta-analysis of a variety of surgical procedures[21] to reduce the incidence of postoperative pulmonary complications. Therefore, a strong case already exists for perioperative epidural analgesia for hip fracture patients, provided that the technique does not inhibit physical rehabilitation of motor function. In addition, several studies in elective lower extremity orthopedic procedures have shown enhanced rehabilitation by postoperative regional analgesic techniques.[5–7] However, these studies were all performed in major elective knee surgery and had nonblinded designs. Any potential effect on rehabilitation would be more difficult to demonstrate in a group of frail elderly patients after acute surgery for hip fracture.

In conclusion, the current study showed that postoperative epidural analgesia with local anesthetic and low-dose morphine provided superior pain control during dynamic exercise in patients who underwent surgery for hip fracture and that patients were significantly less restricted by pain in their ability to perform basic functions without motor blockade. However, overall ability to perform basic mobility functions independently was not significantly improved, potentially because of other confounding limiting factors, such as nausea and exhaustion, that impeded physical function despite the absence of pain. Future studies should evaluate whether an opioid-free epidural regimen may provide a superior rehabilitation potential to hip fracture patients within an enforced multimodal perioperative rehabilitation program.

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