Reduced hospital stay and narcotic consumption, and improved mobilization with local and intraarticular infiltration after hip arthroplasty

A randomized clinical trial of an intraarticular technique versus epidural infusion in 80 patients

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Background **Epidural analgesia gives excellent pain relief but is associated with substantial side effects. We compared wound infiltration combined with intraarticular injection of local anesthetics for pain relief after total hip arthroplasty (THA) with the well-established practice of epidural infusion.**

Methods **80 patients undergoing elective THA under spinal block were randomly assigned to receive either (1) continuous epidural infusion (group E) or (2) infiltration around the hip joint with a mixture of 100 mL ropivacaine 2 mg/mL, 1 mL ketorolac 30 mg/mL, and 1 mL epinephrine 0.5 mg/mL at the conclusion of surgery combined with one postoperative intraarticular injection of the same substances through an intraarticular catheter (group A).**

Results **Narcotic consumption was significantly reduced in group A compared to group E ($p = 0.004$). Pain levels at rest and during mobilization were similar in both groups but significantly reduced in group A after cessation of treatment. Length of stay was reduced by 2 days (36%) in group A compared to group E ($p < 0.001$).**

Interpretation **Wound infiltration combined with 1 intraarticular injection can be recommended for patients undergoing THA. Further studies of dosage (high/low) and duration of intraarticular treatment are warranted.**

Postoperative pain relief after total hip arthroplasty (THA) can be achieved by a variety of techniques such as intravenous analgesia, epidural analgesia, and peripheral nerve block techniques. With regard to pain relief, continuous epidural analgesia has proven superior to treatment with intravenous analgesia alone (Choi et al. 2003). Although continuous epidural analgesia and peripheral nerve blocks usually provide good and reliable postoperative pain relief after THA, they may cause urinary retention, nausea, hypotension, diminished muscle control, and delayed mobilization.

The challenge of new analgesic regimes is to reduce the occurrence of side effects while maintaining adequate pain relief and maximum muscle control. A new method for provision of postoperative pain relief is local infiltration combined with single-shot injection(s) or continuous infusion of local anesthetics (LA) into the surgical site. Several studies on this method have been carried out, mainly in patients undergoing total knee arthroplasty (TKA) (Badner et al. 1997, Mauerhan et al. 1997, Biancini et al. 2003, Browne et al. 2004, Rasmussen et al. 2004). Investigation of the effects of a single-shot intraarticular injection of LA after TKA has given divergent results regarding narcotic consumption and pain relief (Badner et al. 1997, Mauerhan et al. 1997, Browne et al. 2004). An open intervention study on the effect of continuous infusion of LA with added morphine

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without prior infiltration showed reduced narcotic consumption, reduced length of hospital stay, and increased pain relief after TKA (Rasmussen et al. 2004). Recent studies have shown that the combination of intraarticular infiltration and injection or infusion of LA in the surgical area is more effective compared to systemic approaches regarding pain relief and narcotic consumption after various surgical procedures (Horn et al. 1999, Gottschalk et al. 2003, Bianconi et al. 2004). A study evaluating the effect of infiltration combined with 55-h continuous intraarticular infusion in a sample of 37 TKA and THA patients showed results similar to those mentioned above (Biancini et al. 2003).

As infiltration around the hip joint combined with single-shot intraarticular injection has not been compared with epidural infusion in an evaluation study, our study was designed to determine whether this technique might enhance analgesia and improve patient outcome after THA.

Patients and methods

The ethics committee of Aarhus approved the study protocol (no. 20040199), and the study was conducted in accordance with the Declaration of Helsinki. After written, informed consent had been obtained, 80 patients with osteoarthrosis undergoing elective THA at the Department of Orthopedic Surgery, Aarhus University Hospital, from February 2005 to February 2006 were enrolled in this randomized trial. Exclusion criteria included known allergy or intolerance to one of the study drugs, simultaneous bilateral THA, general anesthesia, obesity (body mass index $\geq$ 35 kg/m^2), wound infection, regular narcotic use, neuromuscular deficit, rheumatoid arthritis, or inability to comprehend pain scales. Patients with serious alcohol or drug abuse were also excluded.

On the day of surgery, patients were randomized to receive either local infiltration or epidural infusion for postoperative pain relief by using sequentially numbered, opaque sealed envelopes. During the first 20 h postoperatively, analgesia was provided (1) by continuous epidural infusion (group E) or (2) by a combination of wound infiltration and a single-shot intraarticular injection 8 h postoperatively (group A).

On the day of surgery, 5–10 mg diazepam and 1 g paracetamol were given orally to both groups as premedication, approximately 1 h before induction of anesthesia. All operations were performed by one of 3 surgeons using a posterior approach under spinal anesthesia (3 mL bupivacaine 5 mg/mL (Marcaine Spinal plain) installed at the L2–L3 or L3–L4 interspace). Before closure, a negative-pressure vacuum suction drain was placed near the arthroplasty and under the fascia. Dicloxacillin (2 g) was given intravenously before surgery and 1 g at 8, 16, and 24 h postoperatively. To reduce blood loss tranexamic acid 10 mg/kg was given at the beginning of surgery and repeated 3 h postoperatively. No bladder catheter was inserted. For thromboprophylaxis, an injection of 2.5 mg fondaparinux (Arixtra) was administered subcutaneously for 7 days, starting on the day after surgery. All patients were instructed as to how to get out of bed and were encouraged by the investigator and a nurse to mobilize 8 ± 1 h after surgery. A physiotherapist supervised passive and active exercises on a daily basis (except Sundays).

All patients received 1 g paracetamol orally 4 times a day, starting in the post-anesthesia care unit. From 20 h postoperatively, oxycodonhydrochlorid (OxyContin) 10–20 mg was given twice daily as analgesic treatment. During the study period (0–96 h postoperatively), insufficient analgesia (VAS > 30 mm) was relieved by giving immediate-release oxycodonhydrochloride (Oxynorm) 5–10 mg orally. If pain persisted, nicomorphin (Vilan) 5–10 mg was given intravenously (and repeated if necessary) until a pain score of < 30 mm was recorded. There were no restrictions regarding the frequency of drug administration or the overall daily dose in either group. In the case of nausea and/or vomiting, ondansetron (Zofran) 2 mg intravenously or 4 mg orally was administered. All patients received laxatives: 10 mg Bisacodyl (Perilax) daily.

In group E, an epidural catheter was inserted at the same level as the spinal block (combined spinal-epidural technique). On regression of spinal block, a test dose of 3 mL lidocaine 20 mg/mL with epinephrine was given through the epidural catheter to confirm extradural positioning. An electromechanical pump (CADD, Deltec, Denmark) was used to ensure continuous epidural infusion of ropivacaine 2 mg/mL with morphine 5 µg/mL, started at a flow

rate of 4 mL/h. The pain staff varied the infusion rate in order to maintain sensory blockade of the surgical site. If analgesia was inadequate, patients were instructed to take boluses of 4 mL with a 15-min lockout interval and a total dose limit of 2 boluses per hour. If analgesia was inadequate, the infusion rate was increased by 2 mL/h.

In group A, a solution of 100 mL ropivacaine 2 mg/mL (Naropine) plus 1 mL ketorolac 30 mg/mL (Toradol) and 0.5 mL epinephrine 1 mg/mL (adrenaline) was prepared and loaded into two 50 mL syringes at the conclusion of surgery. The surgeon infiltrated the deep tissues (capsule, m. gluteus medius, m. gluteus maximus, and rotators) with 50 mL of the solution. Before wound closure, the fascia, subcutaneous tissues, and skin were infiltrated with the remaining 50 mL of the solution.

For intraarticular injection, a multihole 20-G epidural catheter was tunneled under direct visualization before closure of the fascia into the gluteus maximus muscle, with the catheter tip sited intraarticularly. The catheter was connected to a bacterial filter and stitched to the skin. The negative-pressure vacuum suction drain was not activated during the first 1 h after the surgery, to prevent aspiration of the installed mixture. The drain was active for the subsequent 8 ± 1 h and then removed. Thereafter, an intraarticular injection of 20 mL ropivacaine 7.5 mg/mL plus 1 mL ketorolac 30 mg /mL and 0.5 mL epinephrine 1mg/mL was (prepared and) injected (by the investigator) through the 20-G catheter, which was also removed.

Outcome measures

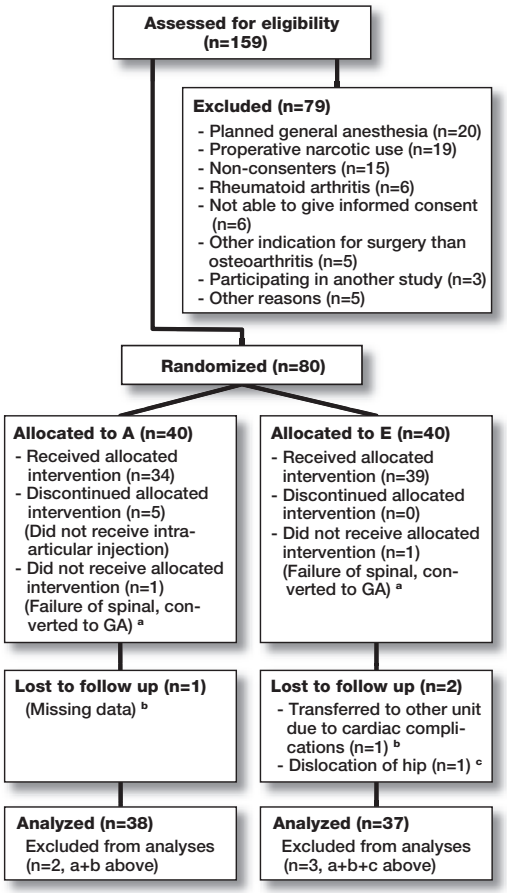
On the day before surgery and on the day of surgery, a trained nurse instructed the patients on how to register (hip) pain by using a graphic 100-mm visual analog scale (VAS; 0 mm = no pain, 100 mm = worst imaginable pain). Pain assessments were made by the patients themselves 2, 4, 6, 8, 20, 24, 28, 32, 44, 48, 52, 56, 72, 76 and 96 h after surgery—at rest and during coughing (first 20 h after surgery), and at rest and during walking (> 20 h after surgery). The highest of the 5 VAS scores recorded during the periods (2–20 h), (24–48 h) and (52–96 h) were used for analysis. We recorded the following local and systemic adverse events at the same time as the pain assessments: postoperative nausea, vomiting, itch, headache, urinary retention, constipation, fever, agitation, drowsiness, and confusion. All patients in both groups were visited by the investigator 8 h after the operation. During injection of ropivacaine, patients were carefully observed for symptoms of central nervous system toxicity. Early mobilization was assessed 8 h postoperatively from the patient's ability to walk > 3 m using a walking frame. Motor block of both legs was assessed according to the modified Bromage scale (0 = no motor block, 1 = inability to raise extended legs, 2 = inability to flex knees, 3 = inability to flex ankle joints) (Bromage 1965). If motor block scores of both legs differed, the higher score was registered. Length of hospital stay was also recorded. Discharge was decided by the surgeons according to the following discharge criteria: satisfactory pain control for self-mobility, uncomplicated wound-healing process, uncomplicated clinical and radiographic outcome, no evidence of deep vein thrombosis, and satisfactory hemoglobin level.

Statistics

Data are expressed as mean (SD) or median (interquartile range), or as frequencies. The results were analyzed using Student's t-test, the non-parametric Mann-Whitney test, or Fisher's exact test, as stated in the table and figure legends. A p-value of < 0.05 was considered to be statistically significant. Calculation of sample size was based on an expected 25% reduction in VAS score between groups. With a power of 0.80 and $\alpha = 0.05$, a sample size of 35 patients per group was obtained. A conservative sample size of 80 (40 patients per group) was then chosen to allow for incomplete data collection. EpiData, version 3.1 (EpiData Association, Odense, Denmark) was used for data entry, and analyses were performed with NCSS 2000 statistical software (Kaysville, Utah, USA). Narcotics (oxycodonhydrochloride, nicomorphine and morphine) were converted to morphine equivalents (Melzack el al. 2005).

Results

1 patient in each group was excluded after randomization because of failed spinal anesthesia.



Flow chart of patients. [a] GA = general anesthesia.

The intervention was discontinued in 5 patients in group A who, by mistake, did not receive the postoperative intraarticular injection because the surgeon forgot to place the catheter after the wound infiltration was carried out. 1 patient in group A was excluded from analysis because of missing data. 2 patients in group E were excluded from analysis: one was transferred to another care unit due to suspicion of lung embolism, and another suffered a dislocation of the prosthesis on the first postoperative day. Data from the remaining 75 patients (A group: n = 38; E group, n = 37) were analyzed (Figure).

There was no difference in patient characteristics between patients in groups A and E13% and 10% more patients in group A lived alone and had help from primary care after the operation, respectively (Table 1). These differences were not statistically

Table 1. Overall comparison of demographics and perioperative data (n = 75)

Characteristics	Group A (n = 38)	Group E (n = 37)
Sex (male / female), n	18 / 20	17 / 20
Age (years), mean (SD)	62 (14)	61 (13)
Body mass index (kg/m²), mean (SD)	27 (5)	26 (5)
ASA classification, n		
I (normal healthy)	15	18
II (mild systemic disease)	19	18
III (severe systemic disease)	4	1
Living alone, n	14	9
Help from primary care preoperatively, n	5	1
Preoperative hemoglobin (mmol/L), mean (SD)	8.7 (0.6)	8.9 (0.7)
Postoperative hemoglobin (mmol/L), mean (SD)	6.8 (0.8)	7.2 (0.9)
Day of surgery		
Tuesday	19	18
Thursday	11	8
Friday	8	11
Duration of surgery (min), mean (SD)	87 (24)	80 (20)
Type of prosthesis, n		
Uncemented	21	22
Hybrid	5	3
Cemented	12	12

significant. Other patient characteristics and perioperative data were similar (Table 1). Pain scores evaluated by VAS at rest and during coughing in the 20 h postoperative treatment period were similar in both groups. Significantly lower VAS scores were found in group A than in group E, both at rest and during mobilization, starting at > 20 h and continuing to 96 h postoperatively (Table 2). Narcotic consumption during the first 20 h was significantly reduced in group A relative to group E. This difference in narcotic consumption persisted during the whole period of observation (Table 2). Walking ability at 8 h after surgery was improved in group A (frequency 33/38) relative to group E (13/37) ($p < 0.001$), and Bromage level was higher in group E ($p < 0.001$). Furthermore, in group A a reduction in the length of hospital stay was observed relative to group E: median (interquartile range) 4.5 (3–6) and 7 (5.5–7) days, respectively ($p < 0.001$). Except for nausea, the occurrence of side effects was significantly lower in group A (Table 3). No complications related to ropivacaine infiltration and

Table 2. Maximum pain score obtained (VAS, 0–100 mm) and narcotic consumption (converted to morphine equivalents). Data are presented as median (interquartile range)

Outcome	Group A (n = 38)	Group E (n = 37)	P-value
Highest pain score at rest			
2–20 h postoperatively	30 (12–33.5)	16 (6–40.5)	0.2
24–48 h postoperatively	8 (0–22.5)	20 (3.5–39)	0.02
52–96 h postoperatively	0 (0–0)	11 (5.5–24)	< 0.001
Highest pain score during coughing			
2–20 h postoperatively	28 (14–41)	22 (7–45)	0.4
Highest pain score during mobilization			
24–48 h postoperatively	27 (0–46)	42 (20–64.5)	0.04
52–96 h postoperatively	6 (0–26.25)	30 (15–45)	0.009
Morphine consumption, mg			
Active treatment period (≤ 20 h)	17.5 (0–40.5)	26 (21–52)	0.004
Whole period until 96 h postoperatively	258 (167–366)	324 (221–543)	0.05

Table 3. Overall comparison of side effects (n = 75)

Side effects	Group A (n = 38)	Group E (n = 37)	P-value
Nausea, n	8/38	14/37	0.1
Vomiting, n	2/38	8/37	0.05
Urinary retention			
(20 h postoperatively), n	3/38	32/37	0.001
Itch, n	0/38	6/37	0.01
Constipation, n	5/38	24/37	< 0.001
Bromage scale [a]			
0	38/38	19/37	
1	–	15/37	
2	–	2/37	
3	–	1/37	< 0.001

[a] Bromage scale
0 = no motor block,
1 = inability to raise extended legs,
2 = inability to flex knees,
3 = inability to flex ankle joints.

intraarticular injections were observed. 2 patients in group A and 6 in group E developed a urinary tract infection. The difference was not significant (p = 0.2). During the follow-up period, 1 patient in each group developed deep vein thrombosis and 1 patient in the A group developed a deep hip infection, and was treated with antibiotics.

Discussion

In this randomized study comparing (1) wound infiltration combined with one intraarticular injection with (2) continuous epidural infusion after THA, we found that the former treatment was associated with a significantly reduced consumption of narcotics, reduced occurrence of side effects, reduced length of stay, and also improved early walking ability.

The differences between groups with regard to living alone and help from primary care preoperatively may be of clinical significance—especially considering length of hospital stay—even though the differences were not statistically significant. A weakness of our study was that caretakers knew which treatment the patients were receiving, and this may have introduced bias with regard to different placebo effects in the two treatment groups. Blinding as to treatment would have required that all participants should receive 2 invasive catheters. This was not considered an option, because of increased discomfort and the small but potential risk of infection. Furthermore, if blinding had been attempted, it would not have been reliable because caregivers and patients would have known which treatment they were receiving—owing to the well-known side effects of epidural treatment (motor block and urinary retention). KVA (who was not blinded because catheter placement was obvious) carried out the mobilizations, the intraarticular injections, control of epidural catheters 8 h postoperatively, and also data collection and analysis.

We have not found any published studies evaluating the effect of intraarticular injection after THA. Previous research evaluating improvement

in analgesia from intraarticular injections has mainly been carried out after TKA. These studies have given conflicting results and are difficult to compare because of different study design. In 1996, Badner et al. studied the effect of intraarticular injections of bupivacaine and epinephrine in patients undergoing TKA. They reported that injection after wound closure reduces the need for narcotics and increases the range of motion. Browne et al. (2004) studied patients undergoing TKA who underwent intraarticular injection of bupivacaine into the joint space after capsule closure. There were no significant differences in consumption of narcotics and pain levels compared to the placebo group. Mauerhan el al. (1997) compared 4 patient groups after TKA who received saline, morphine, bupivacaine, or a combination of morphine and bupivacaine through the drainage tube. There was a short-term reduction in pain scores in all treatment groups compared with placebo. Ritter et al. (1999) also compared 4 groups of patients after TKA. The comparison groups were given saline, morphine, bupivacaine, or a combination of morphine and bupivacaine. No significant differences in pain levels were found between any of the groups, but patients in the groups given morphine used significantly more morphine in the first 24 postoperative hours than groups not given morphine.

The amounts of bupivacaine used in these previous studies ranged from 25 to 150 mg. In our study, patients received 350 mg ropivacaine plus epinephrine and ketorolac. Reuben and Connelly (1995) studied the effect of ketorolac administered as an intraarticular or intravenous injection after knee arthroscopy. There was significantly improved pain relief in patients receiving intraarticular injection. Rasmussen et al. (2004) studied the effect of continuous intraarticular infusion of ropivacaine with added morphine at two different infusion rates from 24 to 72 h postoperatively, and compared it with no treatment. There was a significant reduction in pain scores and a reduced need for rescue analgesics and hospital admission in the two intraarticular groups. We found only one study in patients undergoing THA that evaluated the effectiveness of infiltration and instillation of ropivacaine. Bianconi et al. (2003) studied 37 patients (undergoing THA or TKA) in a blind randomized trial evaluating the effect of intraoperative infiltration with 200 mg ropivacain combined with 55 h continuous infusion of saline, or 550 mg ropivacaine. There was a significant reduction in pain scores both during and after treatment, and a reduced need for rescue analgesics and hospital admission. In 2006, Vendittoli et al. studied 42 patients undergoing TKA who received deep and subcutaneous infiltration of 400 mg ropivacaine with added ketorolac and epinephrine, combined with one intraarticular injection of 150 mg ropivacaine. There was significant reduction in morphine consumption, increased pain relief, and reduced duration of nausea compared to the use of intravenous morphine. We were unable to show any additional benefits of infiltration combined with a single-shot intraarticular injection on pain at rest and during mobilization within the active treatment period. We did find a reduced consumption of narcotics during active treatment. Interestingly, from 20 to 100 h after surgery when active treatment had ended, pain scores and narcotic consumption were significantly reduced in group A compared with group E. These findings are consistent with current results (Bianconi et al. 2003) and may be explained by the vasoconstrictor action of the local anesthetic and the addition of NASID.

One possible concern about this technique is the potential risk of delayed wound healing and infection. 1 patient in group A developed a deep infection during the follow-up period, but the design of the present study does not allow conclusions regarding risk of deep infection. In 3 recent studies (Bianconi et al. 2003, Rasmussen et al. 2004, Vendittoli et al. 2006), an intraarticular catheter was in place for 48 h, 55 h, and 72 h without any increased risk of infection and delayed wound healing.

Equipment and drugs were provided by Aarhus University Hospital.

There are no conflicts of interest.

Contributions of authors

KS: infiltration technique and operations. VH: informing personnel, enrolment of patients, and improvement of manuscript. MP-J: improvement of manuscript. KVA: enrolment and patient information, mobilization, administration of study-drug postoperatively, data collection and analysis,

preparation and improvement of manuscript. All authors were involved in designing the protocol. All authors read and approved the final manuscript.

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