

The efficacy of the psoas compartment block versus the intrathecal combination of morphine, fentanyl and bupivacaine for postoperative analgesia after primary hip arthroplasty: a randomized single-blinded study

L. FRASSANITO, F. RODOLÀ, G. CONCINA, A. MESSINA,
A. CHIERICHINI, A. VERGARI

Dipartimento di Emergenza e Accettazione, Catholic University of Sacred Heart,
A. Gemelli Hospital – Rome (Italy)

Abstract. – Purpose: Intrathecal morphine and psoas compartment block represent two accepted techniques to provide postoperative analgesia after hip arthroplasty. We designed a prospective, randomized, single-blinded study to compare these two techniques.

Methods: Forty patients scheduled for primary hip arthroplasty under general anesthesia were randomized to receive either an intrathecal administration of 0.1 mg morphine, 0.015 mg fentanyl and 15 mg hyperbaric bupivacaine (Group I, n = 20) or a psoas compartment block with ropivacaine 0.475% 25 mL (Group II, n = 20). Pain scores, morphine consumption, associated side-effects were assessed for 48 hr postoperatively. In addition, patient's satisfaction and acceptance of the postoperative analgesic technique were also recorded.

Results: During the first 24 hr, pain scores (12 ± 27 vs 24 ± 25 at H+12, 12 ± 46 vs 20 ± 26 mm at H+24, 16 ± 19 vs 20 ± 29 mm at H+36) and tramadol consumption (30 ± 70 vs 210 ± 400 mg at H+12, 180 ± 120 vs 320 ± 100 mg at H+24) were slightly lower in Group I than in Group II, but there were no statistically significant differences. Itching was the most frequent side-effect occurring in 45% of cases in Group I vs 10% in Group II ($P < 0.05$). No major complication occurred. There was no difference in satisfaction scores between the two groups.

Conclusion: Intrathecal administration of a combination of morphine, fentanyl and bupivacaine and single-shot psoas compartment block both provide very good postoperative analgesia after primary hip arthroplasty.

Key Words:

Hip arthroplasty, Postoperative analgesia, Intrathecal opioids, Psoas compartment block.

Introduction

Total hip replacement is a common surgical procedure that aims to relieve joint pain, increase mobility and improve quality in life of patients with degenerative disease of the hip joint or, more acutely, in a share of patients with proximal femoral fracture¹.

Evidence supports the concept that there is a relationship between the immediate functional outcome following major orthopedic surgery and the quality of the postoperative analgesia^{2,3}. Postoperative analgesia for hip replacement presents a challenge, as patients are typically elderly and may have significant comorbid conditions: hypertension, ischaemic heart disease, renal dysfunction, obstructive pulmonary disease, vascular diseases, diabetes mellitus and obesity, all of which can adversely affect patient management in the peri-operative period. It is therefore important to choose an effective analgesic regimen with minimal side-effects to allow timely mobility, optimal functional recovery and to decrease postoperative morbidity and mortality. Intrathecal (IT) opioid analgesia is a popular method in the treatment of postoperative and labor pain. To obtain pain relief during labor, more lipophilic drugs, such as sufentanil or fentanyl, are administered and their onset and duration of action are well documented^{4,6}. Whereas, IT morphine is more frequently used for postoperative analgesia, providing excellent and long-lasting analgesia after different types of surgical procedures⁷⁻⁹.

In this regard, intrathecal administration of morphine has been shown to provide adequate pain control after hip arthroplasty^{10,11}. Actually, previous studies demonstrated that the dose of intrathecal morphine providing optimum postoperative pain relief with minimal side effects ranges from 0.1 to 0.2 mg^{12,13}.

The psoas compartment block, a technique that produces a complete block of the branches of the lumbar plexus involved in the innervation of the hip (femoral nerve, obturator nerve, lateral femoral cutaneous nerve), has also been demonstrated to be effective for postoperative analgesia after hip arthroplasty^{14,15}.

We designed a prospective randomized single-blinded study to compare these two techniques (intrathecal morphine vs. psoas compartment block) for postoperative analgesia after hip arthroplasty.

Patients and Methods

Forty patients ASA (American Society of Anesthesiologists) physical status I-III scheduled for primary unilateral hip arthroplasty (cemented prosthesis, lateral approach) were included in this prospective, randomized and single-blinded study. Local Ethical Committee approved the protocol. After appropriate informed consents were obtained, the patients were randomly assigned to one of the two groups: Group IFM (intrathecal fentanyl plus morphine) or Group PCB (psoas compartment block).

Exclusion criteria included: renal dysfunction, allergy to opioids, local anesthetics, non-steroidal anti-inflammatory drugs and paracetamol, preoperative respiratory insufficiency, coagulopathy, and/or treatment with anticoagulants or aspirin.

Prior to surgery, a 18-gauge catheter was inserted in the forearm. All patients received premedication with 0.03 mg•kg⁻¹ of midazolam i.v. 30 minutes before anesthesia, and a crystalloid infusion was started (8 mL•kg⁻¹ over 30 min) and then left at the anesthesiologist's discretion. Vital signs were obtained (electrocardiogram, pulse oxymetry and arterial blood pressure).

The procedures were performed by a senior anaesthesiologist, highly trained in both techniques and not involved in the postoperative evaluation of the patients.

In IFM group the patients were placed in the sitting position and after local anesthesia of the

skin (3 mL of lidocaine 2%), a dural puncture was performed with a 25-gauge spinal needle (Whitacre) at the L3-L4 inter-vertebral space. Aspiration of cerebrospinal fluid confirmed the adequate placement of the needle. This was followed by the administration of hyperbaric bupivacaine 15 mg, 15 mcg of fentanyl and 100 mcg of morphine over 30 sec.

In PCB group, the patients were placed in the lateral position with the hip to be operated uppermost. After local anesthesia of the skin (3 mL of lidocaine 2%), a psoas compartment block was performed according to the landmarks described by Capdevila et al¹⁵. A 20-gauge insulated 120-mm b-bevelled needle connected to a nerve stimulator set up to deliver 2 mA, 2 Hz and 0.1 msec was introduced perpendicularly to the skin until a stimulation of the femoral nerve was obtained. The position of the needle was adjusted to maintain the same motor response (contraction of the quadriceps muscle associated with movement of the patella) with a current of 0.5 mA. After negative blood aspiration, 0.4 ml/kg of ropivacaine 0.5% were slowly injected. The intensity of the block was confirmed at the end of the procedure by pinprick test in the femoral nerve territory (anterior aspect of the thigh).

During the performance of regional anesthesia (intrathecal fentanyl and morphine or psoas block), the following variables were recorded: number of attempts, duration of the procedure (from the introduction of the needle to its removal), pain score during the procedure using a visual analogue scale (VAS) ranging from 0 mm (no pain) to 100 mm (worst imaginable pain), side effects (paresthesias, blood aspiration, failure, etc).

In both groups, general anesthesia was induced with propofol (2 mg/kg) and fentanyl (2 mcg/kg). The trachea was intubated after muscle relaxation with vecuronium bromide (0.8 mg/kg) and anesthesia maintained with 2% Sevoflurane end-tidal concentration in 40% oxygen and fentanyl in supplemental boluses 100 mcg according to clinical needs. Maintenance of anesthesia and fluid loading were left at the anesthesiologist's discretion.

Two hours after recovery, the patients left the postanesthesia care unit for a conventional hospitalization ward supervised by an anesthesiologist blinded to group assignment. They received 3 L•min⁻¹ of oxygen for the first 6 hrs. Postoperative pain was assessed with a visual analogue scale VAS at 4 hours, 12 hrs, 24 hrs and at 36 hrs.

When VAS was > 40 mm at rest, tramadol 100 mg was given intravenously in 15 min as a rescue analgesic. Postoperatively, paracetamol (1 g i.v. four times daily) and ketorolac (30 mg i.v. three times daily) were administered to all patients during the study period. In case of urinary retention, the bladder was catheterized. Major arterial hypotension was defined as an hypotension requiring unusual amounts of iv ephedrine and/or fluids.

Tramadol consumption in the postanesthesia care unit, and during the first 36 hr were recorded. In addition, postoperative itching, urinary retention, nausea, vomiting, respiratory depression (respiratory rate less than 10 min⁻¹), epidural anesthesia, excessive sedation, major arterial hypotension and headache were recorded. At the end of the study period, patients were questioned about their satisfaction with the management of postoperative pain. Satisfaction was measured with a VAS from 0 (absolutely not satisfied with pain management) to 100 (entirely satisfied with pain management).

Results

Results are presented as mean ± SD. Statistical analyses were performed using Mann-Whitney test and Student's t test or Chi square as required. A P value < 0.05 was considered significant.

Demographic data of patients are presented in Table I. There was no statistically significant difference in age, height, weight, gender and intraoperative fentanyl requirements.

The number of attempts of the regional techniques was similar in both groups. Dural puncture was successful in all patients in Group I and femoral block was effective in all patients in Group II. The difference between the dura-

Table I. Demographic data. Values are mean ± SD (P > 0.05).

	IFM	PCB
N	20	20
Age (years)	69.8 ± 12.2	70.2 ± 11.1
Gender (m/f)	6/14	12/8
Height (cm)	167.4 ± 6.5	162.3 ± 21.2
Weight (kg)	74.1 ± 12.6	71.0 ± 6.5
Intraoperative fentanyl (mcg)	0	7.5 ± 24.5

Table II. Side effects. Values are percentage and n (*P < 0.05).

	IFM	PCB
Urinary retention	4 (20)	3 (15)
Itching	9 (45)*	2 (10)
Nausea	5 (25)	4 (20)
Vomiting	3 (15)	3 (15)
Respiratory depression	0	0
Headache	0	0
Epidural anesthesia	0	1 (5)
Major hypotension	0	0

tion of each procedure was not statistically significant.

The frequency and types of adverse effects are presented in Table II. Incidence of itching was higher in IMF group. Nausea and vomiting were not different among the groups. Incidence of urinary retention was similar in the two groups. No episodes of excessive sedation, respiratory depression or major hypotension were recorded.

The VAS pain scores are shown in Figure 1. Despite the absolute VAS was higher in PCB group, no statistically significant difference between the two groups was observed (see Table I).

Tramadol consumption is shown in Figure 2. Tramadol consumption was lower in IFM group than in PCB group: 30 ± 70 mg vs. 210 ± 400 mg during the first 12 hrs, 180 ± 120 mg vs. 320 ± 100 mg during the first 24 hrs, but the difference was not statistically significant (P > 0.05).

Satisfaction scores were not statistically different (91.74 ± 14.03 mm in Group I vs. 84.79 ± 14.41 mm in Group II).

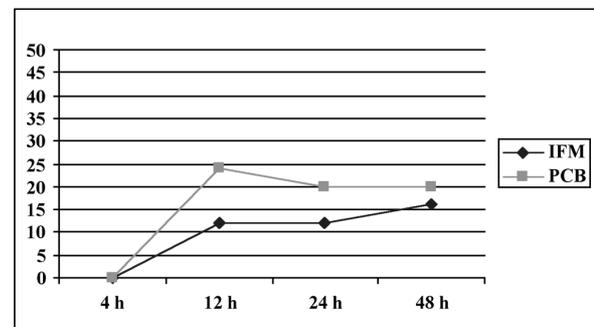


Figure 1. Mean visual analogue scale (VAS) pain scores during the first 48 hrs after surgery.

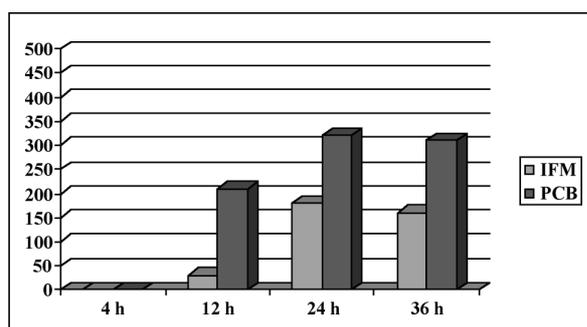


Figure 2. Cumulative Tramadol consumption (mg) during 36 hrs after surgery given as mean, i.v. in 15 min.

Discussion

Our study shows no statistically significant difference between intrathecal combination of fentanyl and morphine and psoas compartment block after primary total hip arthroplasty. The need for additional IV analgesic drugs during the first 36 hours was higher in PCB group, but the difference was not statistically significant.

The innervation of the hip depends both on the lumbar plexus, and on the sacral plexus that gives sensitive afferents to the acetabulum and to the articular capsula¹⁶. Consequently, according to Souron et al¹⁷, it is unlikely that a psoas compartment block can provide complete anesthesia of the hip without a combined sciatic nerve block. Thus, as a sole anesthesia technique, a psoas compartment block has been shown inadequate to achieve surgical anesthesia for hip fracture surgery in 85% of cases¹⁸. Lumbar plexus block represents an effective strategy to control postoperative pain in total hip replacement, but alone it is not indicated as the technique of choice. Instead, spinal combination of bupivacaine, fentanyl and morphine, represents an effective postoperative analgesia technique, but it is also a suitable choice as the sole anesthesia for hip arthroplasty^{1,19,20}.

Intrathecal (IT) opioid analgesia is a popular method for treatment of postoperative and labor pain. For pain relief during labor, more lipophilic drugs, such as sufentanil or fentanyl, are administered and their onset and duration of action are well documented. Opioids and local anesthetics administered together intrathecally have a potent synergistic analgesic effect. Intrathecal opioids enhance analgesia from subtherapeutic doses of

local anesthetic and make it possible to achieve successful spinal anesthesia using otherwise inadequate doses of local anesthetic. Yet because intrathecal fentanyl causes neither by itself nor in combination with bupivacaine any further depression of efferent sympathetic activity, it is possible to enhance the sensory blockade without altering the degree of sympathetic blockade²¹⁻²³.

In contrast, many studies have shown that the intrathecal administration of morphine provides excellent postoperative pain relief in major orthopedic surgery. However, because of its hydrophilic properties, the administration of IT morphine can be associated with delayed respiratory depression, requiring prolonged monitoring, which is not always available.

However several studies demonstrate that small-dose ITMS provides good pain relief after total hip arthroplasty. The addition of ITMS reduces the doses of supplemental IV analgesics required for pain control after hip replacement. The optimal dose of ITMS for pain control after total hip arthroplasty appears to be between 0.1 and 0.2 mg, dose in which side effects are minimized and the analgesic effect is maximized.

Moreover, our study confirms that most of the pain occurs during the first 24 hrs following hip arthroplasty²⁴. Consequently, it seems that no sophisticated analgesia technique is needed 24 hr after primary total hip replacement. The use of continuous peripheral nerve blocks (three-in-one or psoas compartment block via a perineural catheter) remains a subject of debate (except probably for hip revision surgery)¹⁵.

IT administration of opioids was also associated with a higher incidence of itching (45% vs. 10% in the psoas compartment group). The incidence of vomiting did not differ between groups. The increased incidence of severe itching represents the main concern with intrathecal opioids. Psoas compartment blocks appeared to be safe in our study. Epidural block did not occur, in contrast with the previously recorded percentages of 4 to 10%²⁴.

Patient's acceptance of regional techniques depends on different factors, such as the number of nerve stimulations, intensity of stimulation, electrical paresthesia(s), repeated needle insertions, infiltration of needle puncture site(s) with local anesthetics, muscle contractions, bony contacts and associated sedation^{15,25}. Pain and/or discomfort may lead to patient's dissatisfaction or rejection of the technique for future operations beyond effective analgesia. Pain due to the regional

technique was higher in the psoas compartment block compared to spinal analgesia, probably because performance of the psoas compartment block is associated with uncomfortable electrical sensations.

In our study, satisfaction scores were comparable in both groups. However, satisfaction with regional analgesia is a complex phenomenon that cannot be assessed well by a single global measurement, such as a VAS, which generally results in high satisfaction ratings²⁶. Although regional anesthesia improves patient's outcome, it is not clear whether the use of regional analgesia improves patient's satisfaction^{27,28}. The comparison of two regional techniques usually fails to demonstrate any significant differences with regard to the degree of patient's satisfaction²⁷. The reduction of the side-effects associated with low doses of IT morphine (urinary retention, itching) could improve satisfaction with this technique. Actually urinary retention represent one of the most important side-effect associated with the use of IT opioids. Slappendel et al¹² have reported an incidence of urinary retention of more than 70%¹². In our study, we found an incidence of 20% of urinary retention vs. 15% in the psoas compartment block group, and patients required bladder catheterization. The incidence of side-effects is decreased with lower doses of IT morphine, but the quality of postoperative analgesia decreases also¹². It is also important to consider, as previously underlined, that while it is possible to perform hip arthroplasty with spinal anesthesia alone, it is advisable to associate the psoas compartment block to a general anesthesia: therefore further studies would be useful to confront difference in patient's satisfaction when general anesthesia is administered only in PCB group.

In summary, although VAS pain scores during performance of the blocks and in the postoperative period were slightly lower with intrathecal administration of bupivacaine plus morphine and fentanyl, both spinal combination of local anesthetic plus fentanyl and morphine and psoas compartment block provide very good postoperative analgesia after primary hip arthroplasty.

References

- 1) FISCHER HB, SIMANSKI CJ. A procedure-specific systematic review and consensus recommendations for analgesia after total hip replacement. *Anaesthesia* 2005; 60: 1189-1202.
- 2) CAPDEVILLA X, BARTHELET Y, BIBOULET P, RYCKWAERT Y, RUBENOVITCH J, D'ATHIS F. Effects of perioperative analgesic technique on the surgical outcome and duration of rehabilitation after major knee surgery. *Anesthesiology* 1999; 91: 8-15.
- 3) CHELLY JE, GREGER J, GEBHARD R, COUPE K, CLYBURN TA, BUCKLE R, CRISWELL A. Continuous femoral blocks improve recovery and outcome of patients undergoing total knee arthroplasty. *J Arthroplasty* 2001; 16: 436-445.
- 4) PALMER CM, CORK RC, HAYS R, VAN MAREN G, ALVES D. The dose-response relation of intrathecal fentanyl for labor analgesia. *Anesthesiology* 1998; 88: 355-361.
- 5) CAMMAN WR, MINTZER BH, DENNEY RA, DATTA S. Intrathecal sufentanil for labor analgesia. *Anesthesiology* 1993; 78: 870-874.
- 6) HERMAN NL, CALICOTT R, VAN DECAR TK, CONLIN G, TILTON J. Determination of the dose-response relationship for intrathecal sufentanil in laboring patients. *Anesth Analg* 1997; 84: 1256-1261.
- 7) FOURNIER R, VAN GESSEL E, MACKSAY M, GAMULIN Z. Intrathecal morphine versus nalbuphine for postoperative pain relief after total hip replacement. *Anesthesiology* 1998; 89: A867.
- 8) MILNER AR, BOGOD DG, HARWOOD RJ. Intrathecal administration of morphine for elective caesarean section. *Anaesthesia* 1996; 51: 871-873.
- 9) WANG JK, NAUSS LE, THOMAS JE. Pain relief by intrathecally applied morphine in man. *Anesthesiology* 1979; 50: 140-151.
- 10) GRACE D, FEE JPH. A comparison of intrathecal morphine-6-glucuronide and intrathecal morphine sulfate as analgesics for total hip replacement. *Anesth Analg* 1996; 83: 1055-1059.
- 11) REAY BA, SEMPLE AJ, MACRAE WA, MACKENZIE N, GRANT IS. Low-dose intrathecal diamorphine analgesia following major orthopaedic surgery. *Br J Anaesth* 1989; 62: 248-252.
- 12) SLAPPENDEL R, WEBER EWG, DIRKSEN R, GIELEN MJM, VAN LIMBEEK J. Optimization of the dose of intrathecal morphine in total hip surgery: a dose-finding study. *Anesth Analg* 1999; 88: 822-826.
- 13) RATHMELL JP, PINO CA, TAYLOR R, PATRIN T, VIANI BA. Intrathecal morphine for postoperative analgesia: a randomized, controlled, dose-ranging study after hip and knee arthroplasty. *Anesth Analg* 2003; 97: 1452-1457.
- 14) STEVENS RD, VAN GESSEL E, FLORY N, FOURNIER R, GAMULIN Z. Lumbar plexus block reduces pain and blood loss associated with total hip arthroplasty. *Anesthesiology* 2000; 93: 115-121.
- 15) CAPDEVILA X, MACAIRE P, DADURE C, CHOWUET O, BIBOULET PH, RYCKWAERT Y, D'ATHIS F. Continuous psoas compartment block for postoperative analgesia after total hip arthroplasty: New landmarks, technical guidelines, and clinical evaluation. *Anesth Analg* 2002; 94: 1606-1613.

- 16) TESTUT JL. *Système Nerveux Périphériques, Organe des Sens, Appareil de la Respiration et de la Phonation. Traité d'Anatomie Humaine, tome 3.* Lyon; 1922.
- 17) SOURON V, DELAUNAY L, SCHIFRINE P. Intrathecal morphine provides better postoperative analgesia than psoas compartment block after primary hip arthroplasty. *Can J Anaesth* 2003; 50: 574-579.
- 18) CHUDINOV A, BERKENSTADT H, SALAI M, CAHANA A, PEREL A. Continuous psoas compartment block for anesthesia and perioperative analgesia in patients for hip fractures. *Reg Anesth Pain Med* 1999; 24: 563-568.
- 19) FOURNIER R, VAN GESSEL E, WEBER A, GAMULIN Z. A comparison of intrathecal analgesia with fentanyl or sufentanil after total hip replacement. *Anesth Analg* 2000; 90: 918-922.
- 20) AMBULKAR R, SHANKAR R. Analgesia after total hip replacement. *Anaesthesia* 2006; 61: 507; author reply 507-508.
- 21) BEN-DAVID B, SOLOMON E, LEVIN H, GOLDIK Z, ADMONI H. Intrathecal fentanyl with small-dose dilute bupivacaine: better anesthesia without prolonging recovery. *Anesth Analg* 1997; 85:560-565.
- 22) MAVES TJ, GEBHART GF. Antinociceptive synergy between intrathecal morphine and lidocaine during visceral and somatic nociception in the rat. *Anesthesiology* 1992; 76: 91-99.
- 23) TEJWANI GA, RATTAN AK, McDONALD JS. Role of spinal opioid receptors in the antinociceptive interactions between intrathecal morphine and bupivacaine. *Anesth Analg* 1992; 74: 726-734.
- 24) BENEDETTI C, BONICA JJ, BELLUCI G. Pathophysiology and therapy of postoperative pain: a review. In: Benedetti C, Bonica JJ, Belluci G. (Eds.). *Advances in Pain Research and Therapy, vol. 7.* New York: Raven Press; 1984: pp. 373-407.
- 25) KINIRONS BP, BOUAZIZ H, PAQUERON X, ABABOU A, JANDARD C, CAO MM, BUR ML, LAXENAIRE MC, BENHAMOU D. Sedation with sufentanil and midazolam decreases pain in patients undergoing upper limb surgery under multiple nerve block. *Anesth Analg* 2000; 90: 1118-1121.
- 26) KOSCIELNIAK-NIELSEN ZJ, RASMUSSEN H, JEPSEN K. Effects of impulse duration on patients' perception of electrical stimulation and block effectiveness during axillary block in unsedated ambulatory patients. *Reg Anesth Pain Med* 2001; 26: 428-433.
- 27) FUNG D, COHEN MM. Measuring patient satisfaction with anesthesia care: a review of current methodology. *Anesth Analg* 1998; 87: 1089-1098.
- 28) WU CL, NAOIBUDDIN M, FLEISHER LA. Measurements of patient satisfaction as an outcome of regional anesthesia and analgesia: a systematic review. *Reg Anesth Pain Med* 2001; 26: 196-208.