

Effect of Pre-Incisional Continuous Regional Block on Early and Late Postoperative Conditions in Tibial Osteotomy and Total Knee Arthroplasty

C. Motamed*, X. Combes, S.-K. Ndoko and G. Dhonneur

Service d'Anesthésie - Réanimation, Hôpital Henri Mondor, AP-HP et Université Paris XII, Créteil, France

Abstract: *Background:* Postoperative regional anesthesia hastens recovery and reduces the length of hospital stay of orthopedic surgical patients. This study was designed to assess the impact of pre-incisional continuous femoral block on postoperative conditions (POC) of tibial osteotomy and total knee arthroplasty patients.

Methods: After insertion of a femoral catheter under peripheral nerve stimulation control, 111 patients scheduled for total knee arthroplasty or tibial osteotomy were randomized to receive either pre-incisional (treatment) or postoperative (control) continuous femoral block. Anesthesia and postoperative management was standardized. An assessor blinded to the randomization process recorded early and late postoperative conditions (POC) which included pain scores, opioid demands, length of stay in Postoperative care unit and patients' satisfaction.

Results: Eleven patients were excluded from the final analysis because of catheter disconnection or malfunction. Thus 100 patients (50 in each group) were analyzed for POC. Treatment failed to influence patients overall satisfaction but significantly improved early POC. Subgroup analysis demonstrated that late POC were significantly improved in tibial osteotomy as compared to total knee arthroplasty patients. No complication occurred during the study period.

Conclusion: Continuous femoral nerve block before surgery significantly improved early postoperative conditions in both surgery while late postoperative conditions were improved only in tibial osteotomy.

Keywords: Postoperative pain, total knee arthroplasty, tibial osteotomy, femoral block, bupivacaine.

INTRODUCTION

Regional anesthesia at the lower limb has been demonstrated to be a valuable technique for the management of immediate postoperative pain after orthopedic surgery [1-4]. In addition, postoperative continuous femoral block has been shown to hasten recovery and rehabilitation processes and therefore decrease the length of hospital stay of knee surgery patients [5]. However, no study has assessed the impact of continuous pre-incisional regional analgesia on postoperative conditions after major orthopedic procedures [6]. We have postulated that pre-incisional regional analgesia may decrease pain scores and reduce opioid requirements in the immediate post-operative period and consequently improve overall postoperative conditions after two types of knee surgery. Therefore, we investigated the effect of preincisional femoral block on postoperative conditions in patients scheduled for total arthroplasty and tibial osteotomy.

PATIENTS AND METHODS

Patients

After ethical committee approval and written informed consent, 111, ASA status I-III, premedicated (oral 50mg hydroxyzine) patients, scheduled for total arthroplasty (n = 56) and tibial osteotomy (n = 55), were enrolled into the study.

Procedures

Anesthetic and postoperative management was in accordance with our National Society of Anesthesiology practice recommendations. All patients arrived in the pre-anesthetic holding area were equipped with a complete set of anesthetic monitoring device. After the insertion of the intravenous line (IV), a femoral nerve catheter ipsi-lateral to the site of surgery was placed according to Winnie [7] landmarks using a peripheral nerve stimulator. The position of the needle was considered adequate when femoral nerve stimulation induced typical jerk of the patella for an amperage threshold level of 0.5 mA or below. No echo image was used. Five milliliter of saline was injected to ease the catheter placement, which was pushed through the introducer (5-10cm) under the skin. No sciatic posterior nerve block was performed.

Patients were then randomly assigned (sealed envelopes) to receive either a pre-incisional (treatment) or a standard postoperative (control) femoral block. All patients received a total of 7 injections through the femoral nerve catheter during their hospital stay. In group control, patients received preoperatively 30 ml of saline while in group treatment; patients received preoperatively 30 ml of a local anesthetics mixture [lidocaine 2% (15ml) and bupivacaine 0.125% (15 ml) with epinephrine (1/200000)]. Upon arrival in Post Anesthetic Care Unit (PACU), patients of the control group, received 30 ml of a local anesthetics mixture [lidocaine 2% (15ml) and bupivacaine 0.125% (15ml) with epinephrine (1/200000)] and those of the group Treatment, received 30 ml Saline. In the wards, all patients received 6 successive 20

*Address correspondence to this author at the Service d'Anesthésie - Réanimation, Institut Gustave Roussy, 39 Rue Camille Desmoulins, 94805 Villejuif, Cedex, France; Tel: 33-1-42114436; E-mail: motamed@igr.fr

ml injections (8 hours interval) of bupivacaine 0.125% with epinephrine (1/200000) which was started 8 hours after the injection in PACU a single top up bolus of bupivacaine 0.125% (5ml), and lidocaine 2% with epinephrine 1/200000 (5ml) was allowed each day under the supervision of a physician if pain scores were above 40 mm. Balanced anesthesia was used with thiopental fentanyl and isoflurane.

Two senior surgeons performed all surgical procedures in accordance with our University Hospital routine care, including infection and deep venous thrombosis prophylaxis. One hour before completion of surgery patients received IV propacetamol and ibuprofen. With central temperature above 36 °C, normal oxygenation parameters and ventilatory autonomy recovery, conscious extubation was allowed in the operating room or in the PACU.

PACU and surgical ward pain management was standardized. Schematically, it consisted of continuous monitoring of the sensory function at the operated lower limb (cold and pinprick testing, CPT), repetitive measurement of maximum pain scores (visual analogical scale 0-100, VAS) in two situations (rest and physical therapy in the ward), and systematic evaluation of patients' comfort and satisfaction (VAS score, 0 worst-100 best). PACU length of stay was decided by the physician in charge of the PACU blinded to the randomization procedure and according to usual general criteria for PACU stay [8, 9] (Table 1) and pain scores of less than 40 mm.

Morphine IV titration (PACU) and rescue subcutaneous injections (wards) were adapted after pain score measurements, however the subcutaneous morphine injections were allowed only after the top up dose of local anesthetics. In addition, IV injection of propacetamol and ibuprofen were repeated every 8 hours during 48 hours, then, administrated orally.

Postoperative Conditions

An assessor blinded to the randomization process recorded postoperative conditions (POC). Early postoperative conditions were assessed in PACU, and late postoperative conditions were assessed until removal of the femoral catheter.

POC conditions were judged according to six main criteria: patients' comfort and satisfaction, opioid requirements, maximum pain scores and PACU length of stay.

Statistical Analysis

The sample size of 100 patients (50 total arthroplasty and 50 tibial osteotomy) was determined to obtain a difference in the pain score of 30 mm (within a 101 mm scale) with a standard deviation of 15mm, $\beta = 0.8$, $\alpha = 0.05$. Intergroup and subgroup (for each type of surgery) comparisons were performed. According to distribution, Student t test or Mann Whitney rank sum test were used to compare numerical data while categorical data were analyzed with Chi square and Fisher exact test as appropriate.

RESULTS

111 patients were randomized to participate this study, since 11 (7-Control and 4-treatments) were excluded (6 total arthroplasty and 5 tibial osteotomy) because of accidental removal, dislodgement and or malfunction of the femoral catheter, before arriving in PACU (n = 3) and before the last injection (n = 8). These patients were replaced until a total number of 50 patients were included in each group consisting of total arthroplasty (n = 25) and tibial osteotomy (n = 25) patients. Thus, 100 patients were analyzed. Table 2 shows patients' demographics, baseline and intraoperative characteristics. Tables 3 and 4 show postoperative conditions. Treatment significantly improved early POC without affecting late POC.

The length of stay in PACU was significantly shorter in treated as compared to control patients.

Pain scores were lower, rescue titration shorter necessary, in treated as compared to control tibial osteotomy patients. Although duration of rescue morphine injection was shorter in the treatment group for TO patients ($P < 0.05$), no difference was noticed in maximum pain scores in the surgical wards within each sub-group.

DISCUSSION

The results of our study show that continuous femoral block performed before surgery reduces PACU length of

Table 1. Modified Aldrete and Kroulik [8] Scoring System Consisting of the addition of the individual indicators of recovery. A Score 13 Sustained for at Least 2 Measurements at 20 min Intervals and a Core Temperature of 36 °C Indicated the "Fitness for Discharge" if Pain Scores were Below 40 mm

	0 Point	1 Point	2 Points
Activity	No movement	No purposeful movement	Raises on arm on command
Respiration	Apnoea	Dyspnoea or limited breathing	Breathes deeply and coughs freely
SPO2 on Room Air (%)	90 %	90-95%	> 95%
Consciousness	Unresponsive (Š3)	Arouses to verbal stimuli (Š2)	Fully awake (Š1)
Blood Pressure	> or < 50% of baseline	20-50% of baseline	0-20% of baseline
Heart Rate (Beats/min)	< 45 or >120	45-49 or 101-120	50-100
Gastrointestinal Tract	Little or no vomiting	Severe nausea and vomiting	Vomiting within 30 min
Renal Function	Anuria	0.3 ml.kg-1.h-1	> 0.3 ml.kg-1.h-1

(Š3/Š2/Š1) = Sedation score.

stay in major knee procedures and reduces the duration of rescue morphine requirements in tibial osteotomy patients. The physiopathological background for these findings could be the effect of pre-emptive sensory block on modification of nociceptive processing [6] although we recognize this assumption as being purely speculative.

Table 2. Demographic Characteristics Intraoperative Anesthetic Requirements and Duration of Surgery

	Treatment Group (n = 50)	Control Group (n = 50)
Age (yr)	65 ± 9	65 ± 10
Weight (kg)	76 ± 15	78 ± 12
Height (cm)	165 ± 8	164 ± 7
Gender (F/M)	34/16	38/12
ASA (I/II/III/IV)	14/23/13	11/36/3
Thiopentone (mg)	458 ± 108	460 ± 110
Fentanyl (µg)	370 ± 150	390 ± 140
Duration of Surgery (min)	180 ± 70	170 ± 80

Values are mean ± SD when appropriate.

Postoperative peripheral nerve blocks were demonstrated to improve analgesia and decrease the need of morphine after major orthopedic surgery [5]. In addition postoperative femoral block was shown to reduce the length of stay in the

surgical ward and improve the post-operative rehabilitation process [5]. Prolonged opioid sparing after total knee arthroplasty was supposed to be the result of preemptive analgesic effects of peripheral nerve blocks performed under spinal anesthesia [2, 10]. However, clear clinical evidence for preemptive analgesia has yet to be established, despite what appears to be convincing experimental evidence. Animal studies have demonstrated that under specific conditions, noxious impulses generated by localized peripheral tissue trauma can lead to sensitization of the CNS and enhancement of painful stimuli thereafter [11]. Preventing these impulses from reaching CNS can significantly reduce the post injury hypersensitivity to pain. Neurosciences have dissected mechanisms involved in both short term and long-term hyperesthesia. Unfortunately, experimental settings are not strictly transposable to human studies. This limiting factor certainly explains why clinical studies have failed to demonstrate the concept of pre-emptive analgesia. Many confounding factors were demonstrated to promote preemptive analgesic effects, which may pollute interesting clinical results [12]. Although some of them were unavoidable (i.e. opioid intraoperative use, nitrous oxide inhalation) in our setting, we have designed our study in order to limit these confounding factors. In order to standardize the intensity of noxious stimuli, we have selected orthopedic highly painful localized knee surgery and restricted the number or surgeon empowered to perform surgical procedures. Concerning the antinociceptive treatment, effective peripheral nerve blocks were installed before surgery and continued during the three post-operative days. Nevertheless, we were aware that general anesthesia might have induced partial

Table 3. PACU Events

	Treatment Group (n = 50)	Control Group (n = 50)
Total Knee Arthroplasty	n = 25	n = 25
VAS Pain Score at First Evaluation (mm)	26 ± 15	60 ± 18*
Necessity to Titrate (y/n)	2/25	12/25*
Duration of Titration (min)	30 ± 15	30 ± 12
Amount of Morphine in the PACU (mg)	9 ± 4	10 ± 9
Sedation score After Extubation (S1-S2-S3)	10/15/0	7/17/1
Nausea and Vomiting (%)	33	42
Fitness to Discharge (min)	161±60	245 ± 87*
Tibial Osteotomy	n = 25	n = 25
VAS Pain Score at First Evaluation (mm)	35 ± 15	53 ± 18*
Necessity to Titrate (y/n)	4/25	13/25*
Duration of Titration (min)	10 ± 4	25 ± 6*
Amount of Morphine in the PACU (mg)	6+2	10 ± 3*
Sedation Score After Extubation (S1-S2-S3)	8/17/0	15/10/0
Nausea and Vomiting (%)	36	40
Fitness to Discharge (min)	135 ± 40	160 ± 50*

Values are mean ± SD when appropriate.*p < 0.05.

Table 4. Surgical Ward Events

	Treatment Group (n = 50)	Control Group (n = 50)
Total Knee Arthroplasty	n = 25	n = 25
Necessity to Use Rescue Morphine (y/n)	24/25	25/25
Duration of Rescue Morphine (Hours)	51 ± 25	63 ± 20
Total Amount of Morphine in the Ward (mg)	24 ± 13	31 ± 15
Maximum Pain Scores (Rest and Movement) (mm)	53 ± 14	59 ± 19
Patients Satisfaction in VAS (mm)	77 ± 7	75 ± 9
Tibial Osteotomy	n = 25	n = 25
Necessity to Use Rescue Morphine (y/n)	15/25	18/25
Duration of Rescue Morphine (Hours)	37 ± 27	54 ± 12*
Total Amount of Morphine in the Surgical Ward (mg)	15 ± 6	21 ± 10
Maximum Pain Scores (Rest and Movement) (mm)	49 ± 15	58 ± 20
Patient Satisfaction, in VAS (mm)	75 ± 6	73 ± 8

Values are mean ± SD when appropriate, *p < 0.05.

preemptive effect in the control group while bolus injection of bupivacaine 0.125% in the postoperative period might only intermittently interrupt nociceptive input, nevertheless this concentration was chosen in order to avoid motor block. In addition, rescue subcutaneous morphine is probably not the best way to assess postoperative opioid requirements because it might significantly rely on nurse availability. In addition, the study was not designed to analyze cost benefit of continuous femoral block plus morphine on demand versus postoperative morphine alone.

Decreasing the length of stay in the PACU in our study was associated with a decrease in the initial pain scores, no other difference was noticed in parameters such as temperature or nausea and vomiting which could influence the length of stay [13]. In the present study we could not demonstrate any decrease in the intraoperative opioid requirements for patients who had a preincisional block. An explanation of this could be the fact that all patients had tourniquet inflation requested by surgeons to avoid intra-operative blood loss. In order to tolerate the tourniquet induced pain, a sciatic posterior nerve block could have been performed in association with the femoral block [14] however this type of block has no beneficial effect in the post operative period [2].

The decrease in the length of stay was not as important for the TO subgroup which is a shorter and less complex procedure in comparison to TKA subgroup. Many factors contribute to the length of stay in the PACU including hemodynamic status [15], central temperature [16], nausea and vomiting, duration and complexity of surgery and the amount of perioperative opioids requirements [17]. The length of stay in the PACU might have some clinical importance in teaching hospitals with a high turnover of patients.

In summary preincisional femoral block followed by intermittent bolus injection of bupivacaine reduced pain scores and the length of stay in the PACU for TKA patients while it reduced pain scores and the duration of rescue mor-

phine requirements in the TO patients without having significant effect in surgical ward.

REFERENCES

- [1] Brodner G, Buerkle H, Van Aken H, *et al.* Postoperative analgesia after knee surgery: a comparison of three different concentrations of ropivacaine for continuous femoral nerve blockade. *Anesth Analg* 2007; 105(1): 256-62.
- [2] Allen HW, Liu SS, Ware PD, Nairn CS, Owens BD. Peripheral nerve blocks improve analgesia after total knee replacement surgery. *Anesth Analg* 1998; 87(1): 93-7.
- [3] Edwards ND, Wright EM. Continuous low-dose 3-in-1 nerve blockade for postoperative pain relief after total knee replacement. *Anesth Analg* 1992; 75(2): 265-7.
- [4] Capdevila X, Pirat P, Bringuier S, *et al.* Continuous peripheral nerve blocks in hospital wards after orthopedic surgery: a multicenter prospective analysis of the quality of postoperative analgesia and complications in 1,416 patients. *Anesthesiology* 2005; 103(5): 1035-45.
- [5] Capdevila 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(1): 8-15.
- [6] Bonica J. Postoperative Pain. 2nd ed. In: Bonica J, Ed. The Management of Pain. Philadelphia: Lea & Febiger 1990; pp. 461-80.
- [7] Winnie AP, Ramamurthy S, Durrani Z. The inguinal paravascular technic of lumbar plexus anesthesia: the "3-in-1 block". *Anesth Analg* 1973; 52(6): 989-96.
- [8] Aldrete JA, Kroulik D. Postanesthetic recovery score. *Anesth Analg* 1970; 49(6): 924-34.
- [9] Lenhardt R, Marker E, Goll V, *et al.* Mild intraoperative hypothermia prolongs postanesthetic recovery. *Anesthesiology* 1997; 87(6): 1318-23.
- [10] Ganapathy S, Wasserman RA, Watson JT, *et al.* Modified continuous femoral three-in-one block for postoperative pain after total knee arthroplasty. *Anesth Analg* 1999; 89(5): 1197-202.
- [11] Yashpal K, Mason P, McKenna JE, Sharma SK, Henry JL, Coderre TJ. Comparison of the effects of treatment with intrathecal lidocaine given before and after formalin on both nociception and Fos expression in the spinal cord dorsal horn. *Anesthesiology* 1998; 88(1): 157-64.
- [12] Kissin I, Lee SS, Bradley EL Jr. Effect of prolonged nerve block on inflammatory hyperalgesia in rats: prevention of late hyperalgesia. *Anesthesiology* 1998; 88(1): 224-32.

- [13] Kissin I. Preemptive analgesia. Why its effect is not always obvious. *Anesthesiology* 1996; 84(5): 1015-9.
- [14] Rosaeg OP, Krepski B, Cicutti N, Dennehy KC, Lui AC, Johnson DH. Effect of preemptive multimodal analgesia for arthroscopic knee ligament repair. *Reg Anesth Pain Med* 2001; 26(2): 125-30.
- [15] Frank SM, Higgins MS, Breslow MJ, *et al.* The catecholamine, cortisol, and hemodynamic responses to mild perioperative hypothermia. A randomized clinical trial. *Anesthesiology* 1995; 82(1): 83-93.
- [16] Hines R, Barash PG, Watrous G, O'Connor T. Complications occurring in the postanesthesia care unit: a survey. *Anesth Analg* 1992; 74(4): 503-9.
- [17] Lehmann M, Mezzarobba P, Niederkorn S, *et al.* Explanatory factors for length of stay in the postoperative intensive care unit. *Ann Fr Anesth Reanim* 1997; 16(4): 343-9.

Received: March 11, 2009

Revised: March 18, 2009

Accepted: April 6, 2009

© Motamed *et al.*; Licensee *Bentham Open*.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.