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SCIENTIFIC ARTICLE

Anesthetic requirements measured by bilateral bispectral analysis and femoral blockade in total knee arthroplasty

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KEYWORDS
Nerve block;
Pain management;
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Abstract
Background and objectives: A continuous peripheral nerve blockade has proved benefits on reducing postoperative morphine consumption; the combination of a femoral blockade and general anesthesia on reducing intraoperative anesthetic requirements has not been studied. The objective of this study was to determine the relevance of timing in the performance of femoral block to intraoperative anesthetic requirements during general anesthesia for total knee arthroplasty.
Methods: A single-center, prospective cohort study on patients scheduled for total knee arthroplasty, were sequentially allocated to receive 20 mL of 2% mepivacaine throughout a femoral catheter, prior to anesthesia induction (Preoperative) or when skin closure started (Postoperative). An algorithm based on bispectral values guided intraoperative anesthetic management. Postoperative analgesia was done with an elastomeric pump of levobupivacaine 0.125% connected to the femoral catheter and complemented with morphine patient control analgesia for 48 hours. The Kruskall Wallis and the chi-square tests were used to compare variables. Statistical significance was set at $p < 0.05$.
Results: There were 94 patients, 47 preoperative and 47 postoperative. Lower fentanyl and sevoflurane were needed intraoperatively in the Preoperative group; median values and range: 250 (100–600) vs 450 (200–600) μg and 21 (12–48) vs 32 (18–67) mL $p = 0.001$, respectively. There were no differences in the median verbal numeric rating scale values 4 (0–10) vs 3 (0–10); and in median morphine consumption 9 (2–73) vs 8 (0–63) mg postoperatively.
Conclusions: A preoperative femoral blockade is useful in decreasing anesthetic requirements in total knee arthroplasty surgery but no added effect in the postoperative analgesic control.

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PALAVRAS-CHAVE
Bloqueio de nervos;
Tratamento da dor;
Monitor de índice bispectral;
Cloridrato de levobupivacaína;
Artroplastia de joelho

Necessidade de anestésicos avaliada com a análise do índice bispectral bilateral e bloqueio femoral em artroplastia total de joelho

Resumo
Justificativa e objetivos: O bloqueio contínuo de nervos periféricos provou ser benéfico para reduzir o consumo de morfina no pós-operatório. A combinação de um bloqueio femoral e anestesia geral para reduzir a necessidade de anestésicos no intraoperatório ainda não foi avaliada. O objetivo deste estudo foi determinar a relevância do momento propício durante a realização do bloqueio femoral para a necessidade de anestésicos no intraoperatório durante a anestesia geral para artroplastia total de joelho (ATJ).
Métodos: Estudo prospectivo de coorte de pacientes agendados para ATJ. Os pacientes foram sequencialmente alocados em grupos para receber mepivacaína a 2% (20 mL) durante a inserção do cateter femoral, antes da indução da anestesia (pré-operatório) ou no início do fechamento da pele (pós-operatório). Um algoritmo com base nos valores do BIS orientou o manejo da anestesia no intraoperatório. Analgesia no pós-operatório foi administrada via bomba elastomérica de levobupivacaína a 0,125% conectada ao cateter femoral e complementada com analgesia (morfina) controlada pelo paciente durante 48 horas. Os testes de Kruskall Wallis e do qui-quadrado foram usados para comparar as variáveis. A significância estatística foi estabelecida em $p < 0{,}05$.
Resultados: Foram estudados 94 pacientes, 47 no pré-operatório e 47 no pós-operatório. Houve menos necessidade de fentanil e sevoflurano durante o período intraoperatório no grupo pré-operatório; medianas e variações dos valores: 250 (100−600) vs. 450 (200−600) µg e 21 (12−48) vs. 32 (18−67) mL $p = 0{,}001$, respectivamente. Não houve diferenças nas medianas dos valores das escalas de classificação numérica e verbal, 4 (0−10) vs. 3 (0−10), e nas medianas do consumo de morfina, 9 (2−73) vs. 8 (0−63) mg no pós-operatório.
Conclusões: O bloqueio femoral no pré-operatório é útil para diminuir a necessidade de anestésicos em ATJ, mas não tem efeito adicional no controle da analgesia no pós-operatório.

Introduction

The incidence of primary total knee arthroplasty (TKA) reported annually ranges from 30 to 199 per 100,000 inhabitants.[1] Different anesthesia techniques have been used to perform TKA, including general anesthesia and different forms of regional anesthesia: neuraxial blockade and peripheral nerve blockade of lower extremity.[2] TKA produces severe pain in the postoperative period, and treatment of this complication is challenging for both patient comfort and early rehabilitation. Standard care for adequate analgesia in TKA consists of balanced intravenous administration of opioids combined with nonsteroidal anti-inflammatory drugs. Recently, continuous peripheral nerve block has been demonstrated to be beneficial, basically through reducing postoperative morphine consumption and consequently, morphine-related side effects.[3,4]

A femoral catheter can be placed in patients undergoing TKA before anesthesia induction or after the conclusion of the surgery. Performing the block prior to surgery is intended to prevent pain; however, it has not shown a clear benefit.[5–7] The association of a neuraxial block and general anesthesia has been shown to reduce hypnotic and opioid requirements,[8–10] and to produce better postoperative pain control.[11] Nevertheless, the combination of a continuous femoral block and general anesthesia has not been studied.

The hypothesis this study addressed was that a pre-surgery incision femoral block would reduce the general anesthetic requirements during the procedure, and would reduce pain and analgesic consumption in the postoperative period. The principal objective of the study was to determine the relevance of the timing of a femoral block to intraoperative anesthetic requirements during general anesthesia for knee replacement surgery. We also studied whether the timing of the femoral blockade influenced post-operative variables, such as pain, opioid consumption and blood loss.

Methods

This was a single-center, prospective cohort study. Patients were allocated to one of two groups; the anesthesiologist in charge of the patient was not blinded. All the patients were always managed during the intraoperative period by a strict anesthesia protocol. Surgeons and physicians that followed up on patients, as well as nurses from the Postoperative Anesthesia Care Unit (PACU) and ward were blinded to patient allocation.

The study was conducted after written patient consent was given and approval was obtained from the institutional review board of the University hospital of Bellvitge

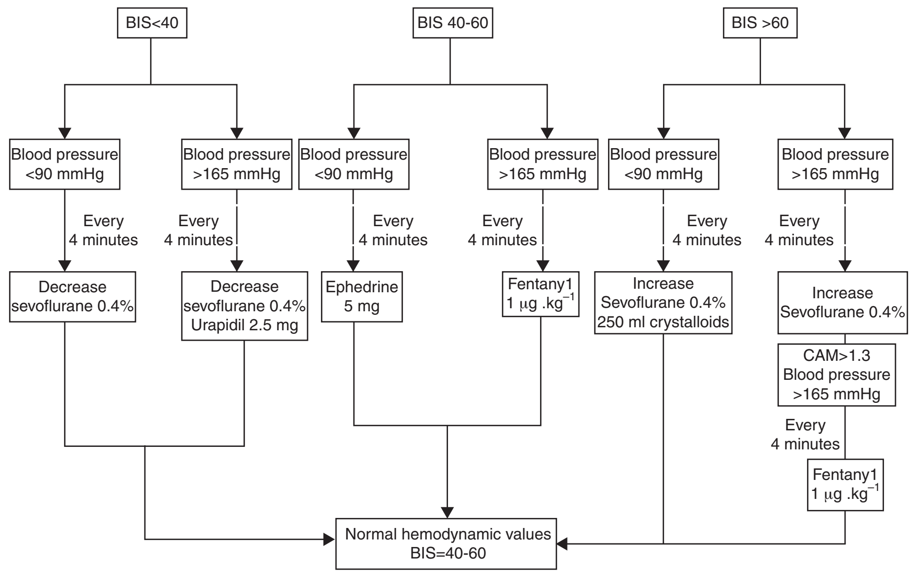

Figure 1 Anesthetic intraoperative management.

from Barcelona, on December 10th, 2009: protocol number EPA020/09.

Eligible participants were all adult patients who were scheduled for TKA. All the candidates were capable of understanding the analgesic protocol. Exclusion criteria were: the presence of neurologic disease, the use of medication acting on the central nervous system, intolerance or allergy to nonsteroidal anti-inflammatory drugs, allergy to local anesthetics, a history of uncontrolled diabetic disease, difficult airway management, a history of asthmatic disease, a history of arterial vascular limb surgery or high risk deep venous thrombosis, a history of severe cardiac disease and the inability to use a Patient-Controlled Analgesia (PCA) system. The study was explained to all the patients and they were also given written information. They were enrolled if they gave signed consent. Study recruitment took place from January 2010 to June 2011.

All the patients were admitted on the day of surgery. Before anesthesia induction, a catheter (Pajunk Stimulong Bonus 216 $\times$ 64 mm^2 set) was placed, with aseptic measures, close to the femoral nerve, using an ultrasound technique (Ultrasound scanner S-Nerve Sonosite,) for localization of the nerve and without nerve stimulation. The injection of 3–5 mL of dextrose serum around the nerve was used to confirm the catheter placement.

Patients were sequentially allocated in blocks of four to each femoral group. Three anesthesiologists who were not blinded to the random sequence participated in the allocation and in the intraoperative management of the patients. Once the catheter was placed, the patients received 20 mL of mepivacaine 2% 5 min prior to anesthesia induction (Group: Preoperative) or the same volume of local anesthetic at the end of the surgery, when skin closure started (Group: Postoperative). Again, the anesthesia administrator was not blind to the group allocation.

Oxygen was given for 5 min before anesthesia induction, which was accomplished with 3 $\mu g.kg^{-1}$ of fentanyl followed by 2 $mg.kg^{-1}$ of propofol, to obtain a Bispectral Score (BIS) of <60, and rocuronium 0.6 $mg.kg^{-1}$. After tracheal intubation, sevoflurane concentrations were set to achieve BIS values of 40–60. Anesthesia maintenance was started with an inspired fraction of sevoflurane (FI_{SEVO}) concentration of 2.5% in a fresh gas flow of 4 $L.min^{-1}$ for 4 min to reach a Minimum Alveolar Concentration (MAC) of 1.3, in order to maintain the BIS values between 40 and 60. Once this objective was achieved, the fresh gas flow was decreased to 2 $L.min^{-1}$ and therefore, the sevoflurane vaporizer was increased or decreased in 0.4% steps to reach the predetermined BIS values (Fig. 1). The lungs were ventilated to maintain the end-tidal carbon dioxide concentration ($ETCO_2$) at 30–35 mmHg. Rocurorium bolus was administered at 0.15 $mg.kg^{-1}$ if there were two responses on the Train Of Four ratio (TOF) or when the patient showed signs of inadequate neuromuscular blockade for surgery such as ventilator asynchrony or clear patient movement. Once surgery ended, the neuromuscular blockade was reversed with an adequate dose of neostigmine. Tracheal extubation was performed when the patient was conscious and breathing comfortably with an oxygen saturation of above 92%.

All patients were warmed with a system of heat convection (Warmtouch, Mallinckrodt, St. Louis, MO) to maintain body temperature between 35.5 °C and 36.5 °C. Monitoring included pulse oximetry, esophageal temperature, $ETCO_2$, TOF, BIS, composite variable index (CVI) and $FI_{SEVO} - FE_{SEVO}$ of sevoflurane (Datex Ohmeda system).

A bilateral bispectral analysis monitor (BIS Vista, Aspect Medical SystemInc., Natick, MA), was placed before induction after careful skin preparation and the electrode impedance values were found to be less than 5 kΩ. The CVI, derived from the standard deviations of BIS and an electromyogram, has been defined as a useful way to detect low levels of analgesia and can indicate inadequate anti-nociception.[12] The BIS and CVI were obtained using a bilateral front parietal electrode over a period of 2 s. After anesthesia induction, an ATS 1200 (automatic tourniquet system) was set to 350 mmHg, as indicated by the orthopedist.

All the hemodynamic, BIS and CVI values were outputted from the Datex Ohmeda and recorded on a laptop

Table 1 Patient characteristics and intraoperative data.

	Preoperative (*n* = 47)	Postoperative (*n* = 47)	*p*-value
Sex (female)	30 (32%)	29 (31%)	0.5
Age (years)	72 (58–84)	70 (52–85)	0.26
Weight (kg)	74 (54–100)	79 (53–105)	0.38
Height (cm)	162 (147–180)	160 (145–176)	0.18
ASA			0.6
I–II	33 (70%)	30 (64%)	
III	14 (30%)	17(36%)	
Surgery time (min)	88 (50–140)	90 (57–180)	0.6
Recovery time (min)	162 (81–385)	156 (70–420)	0.5
Fentanyl consumption (μg)	250 (100–600)	450 (200–600)	0.001
Sevoflurane consumption (mL)	21 (12–48)	32 (18–67)	0.001
Peroperative bleeding (mL)	275 (50–1025)	225 (50–1520)	0.9
Number of patients transfused (%)	14 (29%)	12 (25%)	0.8

Data expressed as number and (percentage) or median and (range).

running Rugloop data collection software that computed the synchronization of the information from the BIS VISTA monitor and the Datex Ohmeda patient monitor. Clinicians used the Rugloop software to record the following times, used for comparative analysis: basal situation; 1 min after anesthesia induction; 5 min after cuff ischemia prior to surgery starts; 5 min after skin incision; 5 min after unlocking of cuff ischemia; end of surgery; and after closure of the sevoflurane vaporizer when the patient was able to respond to oral commands and the tracheal tube was removed. The total dose of fentanyl and the total of sevoflurane consumption were recorded at the end of the procedure. The latter was obtained from the value registered by the anesthesia machine in mL consumed during the total procedure.

A basal blood sample was extracted from the patient at anesthesia induction and another sample was taken at the end of the surgery, to perform the following determinations: acid base status, lactate, glucose, creatinine, creatinine phosphokinase and potassium.

In order to ensure the homogeneity and safety of the anesthetic management, a specific intraoperative anesthetic protocol (Fig. 1) was implemented. Blood pressure was measured every 5 min. If the Systolic Blood Pressure (SBP) was lower than 90 mmHg and the BIS values were in the range of 40–60, a repeat bolus of 5 mg of ephedrine was administered intravenously. If the SBP was lower than 90 mmHg and the BIS value was lower than 40, the sevoflurane vaporizer was decreased by 0.4%, until a BIS value of 40 or more was achieved. If the SBP was higher than 165 mmHg and the BIS value was over 60, the sevoflurane vaporizer was increased by 0.4%, until a BIS value of 60 or less was achieved. If the SBP was higher than 165 mmHg and the BIS values were in the range of 40–60, a bolus of 1 $\mu g.kg^{-1}$ of fentanyl was administered until adequate SBP was achieved, assuming inadequate hypnosis as the main reason of hypertension. If heart rate was lower than 50 beats per minute, 1 mg of atropine was administered intravenously.

For the postoperative analgesic protocol, prior to recovery from the anesthesia, all patients in both groups received an elastomeric pump with levobupivacaine 0.125% at an infusion rate of 7 $mL.h^{-1}$, connected to the femoral catheter, and 1 g of paracetamol and 50 mg of dexketoprofen intravenously.

Once the patient reached the PACU, the nurse in charge, who was unaware of the timing of the local anesthetic administration, started a PCA system (Gemstar Siete Terapias, Hospira, Madrid, Spain) with morphine. Pain was assessed using a Verbal Numeric Rating Scale (VNRS) (0 = no pain; 1–3 = mild pain; 4–7, moderate pain; and 8–10, severe pain). Intravenous morphine boluses of 2 mg were injected every 5 min until the VNRS score was <4; thereafter, the PCA system delivered a 0.5 mg dose of morphine with a 5 min lockout time. Once the patients reached the standards, the nurse in charge sent the patient to a ward with the PCA system connected to an intravenous line and the elastomeric pump with levobupivacaine 0.125% connected to the femoral catheter. Both infusion systems were maintained for 48 h. After that, the analgesic regimen consisted in 4 mg of subcutaneous morphine administered on patient demand. The VNRS values and total dose of morphine were recorded until the end of the infusion.

The primary endpoint was the total intraoperative consumption of sevoflurane (mL). The secondary outcomes measured were: the fentanyl administered during surgery (mL); the VNRS at fixed intervals (0 h, 10 min, 20 min, 30 min, 1 h, 4 h, 24 h, 48 h and 72 h) after the end of surgery; the postoperative doses of morphine in the PACU, and at 24 h, 48 h and 72 h; peroperative bleeding, this was the sum of the intraoperative bleeding and the postoperative blood drain recorded in the PACU; the percentage of patients that required packed red blood units; and recovery time, estimated as the period from the end of surgery to admittance on the ward.

A sample size of a minimum of 40 patients in each group was calculated, taking into consideration an α-value of 0.05, a β error of 0.2, and a difference in sevoflurane consumption of 35% between the groups (primary outcome variable).

Surgeons and nurses from the PACU unit and ward, who recorded the VNRS values, where kept blinded to patient allocation. Physicians who followed up on patients were also blinded to the femoral group assignment.

The normal distribution of continuous variables was checked using the Kolmogorov–Smirnov test. We used a nonparametric Kruskall Wallis test to compare continuous variables and a Chi-square test to compare other variables. Statistical significance was set at $p < 0.05$. Data are presented as absolute number (%) or median and range. SPSS software version 15.0 (SPSS, Chicago, IL) was used for all the analysis.

Table 2 Electroencephalographic values.

	Preoperative (*n* = 47)	Postoperative (*n* = 47)	*p*-value
1 min after anesthesia induction			
BIS-L	38 (7–65)	38 (22–63)	0.81
BIS-R	39 (8–66)	42 (20–64)	0.81
CVI-L	1.7 (0.6–6.6)	2.2 (0.6–5.9)	0.54
CVI-R	2.2 (0.6–9.3)	2.1 (0.6–6.8)	0.57
5 min after cuff ischemia			
BIS-L	49 (25–74)	47 (17–68)	0.42
BIS-R	47 (24–65)	49 (18–67)	0.29
CVI-L	1.4 (0.8–9.2)	1.4 (0.8–5.7)	0.95
CVI-R	1.4 (0.8–8.1)	1.5 (0.7–3.6)	0.39
5 min after skin incision			
BIS-L	46 (23–68)	45 (24–67)	0.53
BIS-R	47 (23–68)	46 (26–67)	0.83
CVI-L	1.5 (0.7–9.5)	1.4 (0.6–4.5)	0.91
CVI-R	1.4 (0.6–9.8)	1.6 (0.6–4.5)	0.63
5 min after unlocking cuff ischemia			
BIS-L	47 (29–70)	46 (20–61)	0.30
BIS-R	46 (31–76)	45 (18–61)	0.32
CVI-L	1.5 (0.7–9.36)	1.6 (0.6–4.9)	0.43
CVI-R	1.4 (0.7–9.7)	1.4 (0.6–4.7)	0.60
End of surgery			
BIS-L	52 (32–82)	51 (32–83)	0.67
BIS-R	52 (25–82)	51 (33–79)	0.76
CVI-L	1.6 (0.7–7.4)	1.6 (0.8–7.9)	0.72
CVI-R	1.7 (0.7–7.8)	1.6 (0.9–7.0)	0.75
Patient respond to oral command and tracheal tube removed			
BIS-L	81 (42–94)	83 (36–95)	0.23
BIS-R	80 (46–97)	83 (36–95)	0.08
CVI-L	4.2 (1.1–9.5)	3.9 (1.5–9.2)	0.49
CVI-R	4.1(1.2–9.4)	3.9 (1.6–9.6)	0.98

Data expressed as median and (range).
BIS-R, right bispectral index; BIS-L, left bispectral index; CVI-L, left composite variable index; CVI-R, right composite variable index.

Results

Participant flow

One hundred and sixteen patients were assessed for eligibility after excluding, in accordance with the exclusion criteria, 22 patients. Of these 116, 9 did not agree to participate in the study; and 13 had contraindications related to medical disease. So, a total of 94 patients were included. In 47 patients, the femoral catheter was used prior to the surgery; these formed the Preoperative group. In contrast, 47 patients had the femoral catheter used at the end of surgery; they formed the Postoperative group (Fig. 2).

There were no differences in patient characteristics, surgery and recovery time between the groups (Table 1). Neither were there any differences in the biochemical determinations.

Outcomes and estimation

Significantly less fentanyl and sevoflurane were used intraoperatively in the Preoperative group (Table 1). The

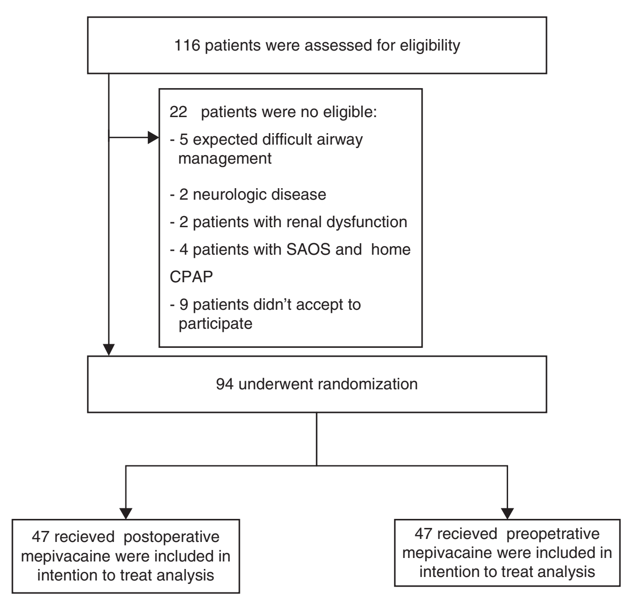

Figure 2 Diagram of participants.

Table 3 Hemodynamic values.

	Preoperative ($n = 47$)	Postoperative ($n = 47$)	p-value
1 min after anesthesia induction			
SBP	108 (75–201)	117 (63–198)	0.89
DBP	74 (48–109)	73 (42–129)	0.77
HR	67 (41–110)	72 (49–104)	0.17
5 min after cuff ischemia			
SBP	118 (65–159)	117 (84–170)	0.88
DBP	71 (43–98)	70 (49–110)	0.94
HR	67 (44–115)	70 (46–96)	0.33
5 min after skin incision			
SBP	114 (73–205)	120 (68–204)	0.17
DBP	72 (37–122)	74 (44–118)	0.29
HR	62 (40–87)	64 (47–108)	0.06
5 min after unlocking cuff ischemia			
SBP	130 (74–185)	130 (62–189)	0.51
DBP	77 (46–118)	79 (39–104)	0.83
HR	61 (37–106)	67 (50–96)	0.20
End of surgery			
SBP	106 (74–170)	119 (62–162)	0.01
DBP	67 (43–97)	70 (36–101)	0.31
HR	61 (41–109)	67 (51–117)	0.03
Patient respond to oral command and tracheal tube removed.			
SBP	130 (73–201)	143 (80–197)	0.14
DBP	83 (35–126)	84 (49–115)	0.87
HR	75 (32–116)	80 (52–126)	0.09

Data expressed as median and (range).
SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate.

hemodynamic and BIS values registered during surgery were similar in the 2 groups (Tables 2 and 3). There were no differences between the groups in any of the measured VNRS values or in morphine consumption (Table 4). Peroperative bleeding and the percentage of patients transfused were similar.

Discussion

In agreement with expectations, a preoperative femoral block with 20 mL of mepivacaine 2% reduced sevoflurane and fentanyl consumption in patients undergoing TKA. This intuitive result confirms that the femoral block had an analgesic effect and reduced nociception stress during surgery. Nevertheless, the only previous published study that explored the influence of femoral blockade on anesthesia requirements, in patients undergoing an endoscopic patellar tendon anterior cruciate ligament reconstruction, found no differences in opioid consumption. However, the lack of a hemodynamic management protocol limits the value of that study.[7] In contrast, peridural lidocaine 2% has been successful in reducing sevoflurane requirements and also leads to a reduction in stress hormones.[10] A study comparing epidural administration of saline, ropivacaine 0.2% and ropivacaine 1% found a greater reduction of end-tidal sevoflurane in the group receiving the higher concentration of ropivacaine; the authors speculated that a higher upper dermatome level created a more intense suppression of consciousness.[9] Furthermore, Ishiyama and coworkers[13] found that patients with an epidural ropivacaine 0.75% blockade showed lower BIS values during the awake phase of anesthesia than the control group. The explanation of the influence of an epidural block on anesthetic requirements could be directly related to plasma levels of local anesthetic and therefore, a supraspinal action.[14] Peripheral nerve blockade analgesia is currently a good alternative to epidural postoperative analgesia with an even better success rate and safety record if ultrasound is used to perform the blocks.[15] Furthermore, a Cochrane Review concluded that a continuous femoral nerve block provided more effective analgesia in TKA than PCA alone and was similar to epidural analgesia.[16] In our study, we were not able to demonstrate that the timing of the performance of the femoral block prior to or post the operation influenced analgesic demands. The VNRS values registered did not differ between the groups and morphine consumption registered in the PACU and ward was similar in the 2 groups. Martin and coworkers[17] found that patients on a single-shot sciatic blockade combined with a continuous femoral block experienced a positive anti-inflammatory effect measured by knee circumference and skin temperature. However, that study failed to find an association

Table 4 Postoperative VNRS values and morphine consumption.

	Preoperative (*n* = 47)	Postoperative (*n* = 47)	*p*-value
Postoperative VNRS			
PACU arrival	4 (0–10)	3 (0–10)	0.74
10 min	3 (0–8)	3 (0–9)	0.68
20 min	3 (0–8)	2 (0–7)	0.55
30 min	3 (0–8)	2 (0–6)	0.18
1 h	2 (0–8)	2 (0–5)	0.11
4 h	2 (0–7)	2 (0–4)	0.35
VNRS $\geq$ 8 at arrival	7 (15%)	5 (11%)	0.38
Ward VNRS			
24 h	2 (0–7)	2.5 (0–7)	0.49
48 h	3 (0–8)	3 (0–7)	0.27
72 h	2 (0–6)	3 (0–9)	0.69
Postoperative morphine consumption (mg)			
PACU	3 (0–12)	3 (0–12)	0.59
24 h (PACU included)	4 (0–59)	4 (0–39.5)	0.96
48 h	3 (0–44)	3 (0–48)	0.66
72 h	0 (0–10)	0 (0–4)	0.34
Total	9 (2–73)	8 (0–63)	0.46

Data expressed as median and (range).
VNRS, verbal numeric rating scale; PACU, post anesthesia care unit.

between the decrease in inflammatory mediators and analgesic requirements, as did other authors.[18] The addition of a sciatic nerve block to a continuous femoral nerve block has been demonstrated to be more effective at reducing posterior and anterior knee pain for up to 8 h, but no beyond that period of time. Therefore, that would not influence analgesic requirements on the ward.[19] We did not add the sciatic nerve block, because the aim of this study was to examine the analgesic requirements up to 72 h postoperatively. A randomized study comparing a single femoral block in addition to a spinal anesthesia before or after knee replacement surgery[5] found no significant difference in morphine consumption between groups. Barreveld and coworkers,[6] in a systematic review, documented a reduction of postoperative pain when a peripheral nerve block was compared to placebo or PCA; but the timing of the block, pre or post incision, did not appear to be of clinical significance. In addition, they found preventive analgesia action by intravenous administration of lidocaine, questioning the net effect of local anesthetic on the nerve blockade.[6] Another systematic review of peripheral nerve blockade found limited evidence of a positive effect of preemptive analgesia.[20]

In our study, the BIS values were similar in the 2 groups, as expected in relation to the methodology used in the study. Nevertheless, no differences were found between right and left BIS values. The development of the CVI is based on the variability of BIS and facial EMG, and increases during inadequate anesthesia with high-intensity nociceptive stimuli. This index helps to identify inadequate levels of analgesia with acceptable sensitivity and specificity.[12] In our study, CVI values did not differentiate the group with higher opioid consumption during surgery, in agreement to Dincklage et al.[21] who found no predictive positive or negative response of CVI to skin incision or laryngeal mask insertion.

The limitations of this study include that the three anesthesiologists in charge of intraoperative management were not blinded to the groups; but the anesthetic management protocol was defined to use sevoflurane and fentanyl according to strict rules. In contrast, BIS and hemodynamics were similar in the 2 groups, and also there were no differences in the biochemical determinations during the surgical procedure (data not shown). Otherwise, surgeons and nurses were blinded to the anesthetic management, which confirms the value of the data obtained in the study.

We conclude that a preoperative femoral blockade is useful in decreasing anesthetic requirements during the surgical procedure but does not have other beneficial effects in postoperative analgesic control.

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Conflicts of interest

The authors declare no conflicts of interest.

References

1. Vielgut I, Kastner N, Pichler K, et al. Application and surgical technique of total knee arthroplasties: a systematic comparative analysis using worldwide registers. Int Orthop. 2013;37:1465–9.
2. Macfarlane AJ, Prasad GA, Chan VW, et al. Does regional anesthesia improve outcome after total knee arthroplasty? Orthop Relat Res. 2009;467:2379–402.
3. Kadic L, Boonstra MC, Malefijt MC. Continuous femoral nerve block after total knee arthroplasty? Acta Anaesthesiol Scand. 2009;53:914–20.
4. Chan EY, Fransen M, Sathappan S, et al. Comparing the analgesia effects of single-injection and continuous femoral nerve blocks with patient controlled analgesia after total knee arthroplasty. J Arthroplasty. 2013;28:608–13.
5. Chan MH, Chen WH, Tung YW, et al. Single-injection femoral nerve block lacks preemptive effect on postoperative pain and morphine consumption in total knee arthroplasty. Acta Anaesthesiol Taiwan. 2012;50:54–8.
6. Barreveld A, Witte J, Chahal H, et al. Preventive analgesia by local anesthetics: the reduction of postoperative pain by peripheral nerve blocks and intravenous drugs. Anesth Analg. 2013;116:1141–61.
7. Matava MJ, Prickett WD, Khodamoradi S, et al. Femoral nerve blockade as a preemptive anesthetic in patients undergoing anterior cruciate ligament reconstruction: a prospective, randomized, double-blinded, placebo-controlled study. Am J Sports Med. 2009;37:78–86.
8. Kanata K, Sakura S, Kushizaki H, et al. Effects of epidural anesthesia with 0.2% and 1% ropivacaine on predicted propofol

concentrations and bispectral index values at three clinical end points. J Clin Anesth. 2006;18:409–14.
9. Zhang J, Zhang W, Li B. The effect of epidural anesthesia with different concentrations of ropivacaine on sevoflurane requirements. Anesth Analg. 2007;104:984–6.
10. Shono A, Sakura S, Saito Y, et al. Comparison of 1% and 2% lidocaine epidural anaesthesia combined with sevoflurane general anaesthesia utilizing a constant bispectral index. Br J Anaesth. 2003;91:825–9.
11. Lavand'homme P, De Kock M, Waterloos H. Intraoperative epidural analgesia combined with ketamine provides effective preventive analgesia in patients undergoing major digestive surgery. Anesthesiology. 2005;103:813–20.
12. Ellerkmann RK, Grass A, Hoeft A, et al. The response of the composite variability index to a standardized noxious stimulus during propofol-remifentanil anesthesia. Anesth Analg. 2013;116:580–8.
13. Ishiyama T, Kashimoto S, Oguchi T, et al. Epidural ropivacaine anesthesia decreases the bispectral index during the awake phase and sevoflurane general anesthesia. Anesth Analg. 2005;100:728–32.
14. Hamp T, Krammel M, Weber U, et al. The effect of a bolus dose of intravenous lidocaine on the minimum alveolar concentration of sevoflurane: a prospective, randomized, double-blinded, placebo-controlled trial. Anesth Analg. 2013;117:323–8.
15. Lavand'homme P. From preemptive to preventive analgesia: time to reconsider the role of perioperative peripheral nerve blocks? Reg Anesth Pain Med. 2011;36:4–6.
16. Chan EY, Fransen M, Parker DA, et al. Femoral nerve blocks for acute postoperative pain after knee replacement surgery. Cochrane Database Syst Rev. 2014;13:5.
17. Martin F, Martinez V, Mazoit JX, et al. Antiinflammatory effect of peripheral nerve blocks after knee surgery: clinical and biologics evaluation. Anesthesiology. 2008;109:484–90.
18. Carvalho B, Aleshi P, Horstman DJ, et al. Effect of a preemptive femoral nerve block on cytokine release and hyperalgesia in experimentally inflamed skin of human volunteers. Reg Anesth Pain Med. 2010;35:514–9.
19. Abdallah FW, Chan VWS, Gandhi R, et al. The analgesic effects of proximal, distal, or no sciaticnerve block on posterior knee pain after total knee arthroplasty. a double-blind placebo-controlled randomized trial. Anesthesiology. 2014;121:1302–10.
20. Møiniche S, Kehlet H, Dahl JB. A qualitative and quantitative systematic review of preemptive analgesia for postoperative pain relief: the role of timing of analgesia. Anesthesiology. 2002;96:725–41.
21. Von Dincklage F, Correll C, Schneider MH, et al. Utility of nociceptive flexion reflex threshold, bispectral index, composite variability index and noxious stimulation response index as measures for nociception during general anaesthesia. Anaesthesia. 2012;67:899–905.