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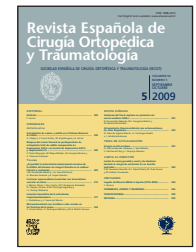

ORIGINAL PAPERS

Femoral nerve block further to total knee replacement: a comparison between bupivacaine 0.25% and bupivacaine-mepivacaine 2% mixture

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KEYWORDS
Femoral nerve block;
Three-in-one block;
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Abstract
Purpose: To assess the efficacy of femoral nerve block (single neurostimulation-guided puncture) as an analgesic technique in postoperative total knee replacement (TKR) in an attempt to identify any potential differences between the use of bupivacaine 0.25% (30 ml) or a bupivacaine 0.25% (15 ml)+mepivacaine 2% (15 ml) mixture as local anesthetics, as regards the inception of their activity and/or the duration of their analgesic effect.
Material and methods: Prospective randomized observational study of a group of 40 patients subjected to TKR, with femoral nerve block being used as postoperative analgesic technique.
Results: Statistically significant differences were found in terms of the onset of analgesic effect using an anesthetics-mixture (X: 2.90 min; SD: 1.36) as compared with bupivacaine on its own (X: 3.85 min; SD: 1.21); (p=0.027). The analgesic effect lasted longer with bupivacaine (X: 22 h; SD: 10.47) as compared with the mixture (X: 15.2 h; SD: 9.2) (p=0,036).
Conclusions: Addition of mepivacaine to bupivacaine does not contribute any clinical benefit to the nerve block as far as reducing the latency of onset. The use of the mixture could even be counterproductive given the shortening in the effect of analgesia. Femoral block is a safe technique with few complications, which is well accepted by patients.

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PALABRAS CLAVE
Bloqueo femoral;
Bloqueo 3 en uno;
Analgesia postoperatoria

Bloqueo del nervio femoral en postoperatorio de artroplastia total de rodilla: comparación de bupivacaína 0,25% con mezcla de bupivacaína 0,25% y mepivacaína 2%

Resumen
Objetivos: Valorar la eficacia del bloqueo del femoral (punción única guiada por neuroestimulación) como técnica analgésica en el postoperatorio de artroplastia total de rodilla (ATR) y comparar si hay diferencias si se utilizan como anestésico local bupivacaína 0,25% sola (30 ml) o mezcla de bupivacaína 0,25% (15 ml) con mepivacaína 2% (15 ml), en cuanto al inicio de acción o duración del efecto analgésico.
Material y método: Estudio prospectivo, observacional, aleatorizado, de un grupo de 40 pacientes, intervenidos de ATR, mediante la utilización del bloqueo del femoral como técnica analgésica en postoperatorio.
Resultados: Se han encontrado diferencias estadísticamente significativas en tiempo de inicio de analgesia usando mezcla de anestésicos (X: 2,90 min; desviación típica [DT]: 1,36) frente al uso de bupivacaína sola (X: 3,85 min; DT: 1,21) (p = 0,027). Se obtuvo una mayor duración analgésica con la bupivacaína (X: 22 h; DT: 10,47) frente a la utilización de la mezcla (X: 15,2 h; DT: 9,2) (p = 0,036).
Conclusiones: Para la realización del bloqueo, la adición de mepivacaína a la bupivacaína no aporta ningún beneficio clínico en cuanto a acortamiento en la latencia de inicio de acción, y puede ser contraproducente el uso de la mezcla por la pérdida en horas de analgesia. El bloqueo femoral es una técnica segura, con escasas complicaciones y muy bien aceptada por los pacientes.

Introduction

Postoperative pain following orthopedic and trauma surgery is a frequent occurrence since the musculoskeletal injuries involved are usually significant and both the soft tissues and the skin are subjected to trauma. Pain scores on the visual analog scale (VAS) are usually from moderate to severe , ranging between 5 and 7 points[1].

Total knee replacement (TKR) is one of the orthopedic procedures that causes most pain in the immediate postoperative period. Pain reaches maximum intensity occurs between the first 3 and 6 hours, it stabilizes over the next 24 to 36 hours and it abates significantly as from the third day[2]. The prevalence of symptomatic knee arthritis in Spain stands at 33.7% in patients over 70 years of age[3], in whom there are often associated cardiac or pulmonary comorbidities. Moreover, increased drug sensitivity in elderly patients makes it necessary to choose an analgesic protocol with as few side effects as possible.

Post-operative pain relief can be achieved with different techniques and means of administration, from systematic intravenous analgesic administration to PCA (patient-controlled analgesia), epidural analgesia or a lumbar plexus block.

In elderly patients, opioids delivered by PCA may interfere with correct understanding of the type of treatment being administered in addition to increasing the incidence of ileus, nausea and vomiting[4].

Epidural analgesia has been considered the technique of choice for post-TKR pain relief but its benefits are minimized by the potential appearance of adverse effects (urine retention, bilateral block extension, etc.) and complications. After surgery, appropriate pain control is essential to allow patients early rehabilitation[5]. However, epidural analgesia could delay prophylaxis of thromboembolism, or at least alter its administration for the manipulation of the epidural catheter, because of the risk that an epidural hematoma may develop at the puncture site[6]. In knee replacement, the lack of anticoagulant prophylaxis is associated with a 40-70% risk of deep venous thrombosis and with a 1-2 2% risk of fatal pulmonary embolism[7].

Peripheral nerve blocks are an alternative to postoperative analgesia; these permit better control of postoperative pain than intravenous PCA. They are as efficient as peridural analgesia, but result in fewer side effects[9]. In our study we used a femoral nerve block, which is technically easier and is associated with fewer risks as regards the Management of anticoagulant prophylaxis. Furthermore, the risk of severe complications is minimal[10].

In this technique it is preferable to use anesthetics that are long-acting and have a short initial latency so that a longer and rapid-onset pain-free period can be induced thereby reducing latency time and obtain appropriate pain control as soon as possible.

The purpose of this study is to find out whether combining an anesthetic with rapid onset of action (mepivacaine) with a long-acting anesthetic (bupivacaine)[11] achieves a block with a faster onset of analgesia without reducing length of analgesia, as compared with administration of the long-acting anesthetic on its own.

Purpose

To determine the efficacy of a femoral nerve block (single injection) as an analgesic technique following TKR and find

out if there are differences as regards onset of action and length of analgesia when bupivacaine 0.25%(30 ml) is used as a local anesthetic as compared with the combination of bupivacaine 0.25%(15 ml) and mepivacaine 2%(15 ml).

Materials and methods

This is a prospective randomized observational study. It comprises a total of 45 patients whose physical status was classified as I-III on the scale of the American Society of Anesthesiologists (5 cases were excluded due to ineffectiveness of the technique) and who were recruited over a 3-month period. Patients in the study had been subjected to elective TKR, under subarachnoid anesthesia, with hyperbaric bupivacaine 0,5%(between 7 and 10 mg). All of them had reached a level between T10 and T12. The sample was randomly divided into 2 groups, as the patients left the operating theater (the first patient was included in Group 1, the second patient was included in Group 2, etc, so that even patients ended up in Group 1 and odd ones in Group 2). Previously we had confirmed that the 2 study populations were statistically comparable in terms of age, weight and height (table 1).

Group I: 30 ml bupivacaine 0.25% Group II: 15 ml bupivacaine 0.25%with 15 ml mepivacaine 2%(admixed in a single syringe).

A femoral nerve block was performed using the technique described by Winnie (the nerve is located with a nerve stimulator; stimulator output is adjusted to a level up to 0.5 mA, 2 Hz and 0.1 ms; movement of the patella indicates stimulation of the femoral nerve). 30 ml of local anesthetic is injected slowly in 2 boluses of 15 ml each, one immediately following the other, with aspirations following each 5 ml injected.

The nerve block was performed in the post-anesthesia recovery unit. The patient reported pain (VAS: 5-6 points) but no opioids were administered. The patient was monitored by means of electro-cardiogram, noninvasive blood pressure measurements every 5 min and oxygen saturation from immediately after the procedure until transfer to the ward (about an hour following nerve block).

Table 1 Demographic variables[a]

	Bupivacaine	Bupivacaine + mepivacaine
Age	72 ± 11.21	71.08 ± 7.7
Weight	78.30 ± 14.96	78.94 ± 9.32
Height	157.32 ± 9.66	156.83 ± 10.45
Sex[b]	60–40%	60–40%

[a]Quantitative variables are expressed as a mean ± standard deviation and qualitative variables are expressed in percentages; [b]The percentage of males and females in each Group is represented in order. Both groups are comparable with no statistically significant differences being found between them ($p < 0.05$).

The latency time for the onset of the analgesic effect was measured and the point at which the highest degree of analgesia was achieved was recorded; a record was also made of the lowest VAS score since the performance of the nerve block and the patient was questioned at pre-established time intervals (2 min-5 min-10 min-15 min-20 min); the point at which the local anesthetic was infiltrated was taken as minute 0.

Patients were monitored for 48 h to analyze duration of analgesia. The VAS score was recorded at the next day. Analgesia was considered to cease at the point at which the patient required rescue analgesia or on the basis of the symptoms reported by the patient.

Patient satisfaction was measured on a scale from 1 to 3 (1: poor, 2: good and 3: excellent); it was recorded at two points immediately after the nerve block and at 24 h.

Nursing staff satisfaction was rated on the basis of the possibility to enjoy a more comfortable rest period during the first night post-op, i.e. the patient did not require rescue analgesia during the night because appropriate analgesia had been administered.

Quantitative variables are expressed in the form of central trend and scatter (mean ± standard deviation [SD]). Qualitative variables are expressed as frequencies.

Student's t test was used to determine if there were statistically significant differences ($p< 0.05$) between the use of isolated as compared with combined anesthetics, as regards onset of analgesic action and duration of effective analgesia. This test was also used to determine whether there were significant differences between the demographic characteristics of the 2 study groups (table 1).

The SPSS 16.0 statistical package was used for the coding of data and the statistical analysis.

Results

We found statistically significant differences as regards the onset of analgesia when combining anesthetics (2.90 min; SD: 1.36) versus the use of bupivacaine alone (3.85 min; SD: 1.21); $p=0.027$ (fig. 1).

Statistically significant differences were also found as regards duration of analgesia and a higher number of hours was obtained with bupivacaine (22 h; SD: 10.47) versus the combined dose (15.2 h ; SD: 9.2); $p = 0.036$ (fig. 1).

Technique-related complications, i.e. difficulties for locating the nerve with nerve stimulation, injection of anesthetic injection of anesthetic with currents higher than 0.5 mA, hematoma in the area, nerve block failure and paresthesias during and after applying an electric current, were found in only 15%of patients (one of them because of difficulties in locating the nerve and another 5 because of discomfort during the procedure). The remaining 85% had no complications.

The most frequent complication was the appearance motor block rated as grade 3 on the Bromage scale in the first few hours post-op in a total of 24 patients, of whom 14 corresponded to the group administered bupivacaine alone. At 24 h, all patients obtained a score of 4 points on the Bromage scale.

Thirty-five percent (14) of patients reported pain in the popliteal fossa following the nerve block (the pain appeared

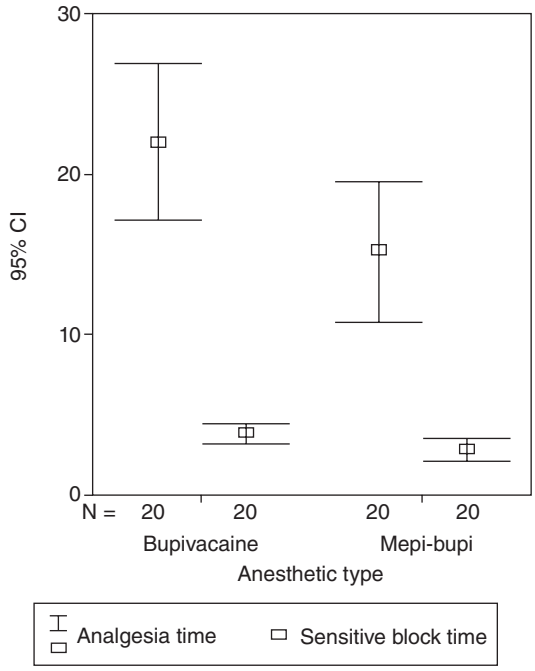

Figure 1 The graph shows the shorter latency time afforded by the use of the admixed anesthetics and, more clearly, the higher number of pain-free hours permitted by bupivacaine alone.

when greater analgesia was obtained in the anterior knee following the end of the anesthetic bolus injection). This complication was not specifically associated with either group; it occurred with patients both in the bupivacaine and the combined anesthetic groups. The same pain was reported at 24h from the nerve block. Only 5% of patients (2) presented with paresthesias following the nerve block; these wore off after 24 h.

Patient satisfaction was excellent in 90% of cases and good in 10% of cases. The technique was also well accepted by the nursing staff, and quieter night-time rest was observed during the la first night post-op as compared with patients receiving conventional analgesia, as well as a lower requirement of rescue analgesia (85% of patients did not require rescue analgesia with tramadol and the nursing staff reported a lower incidence of vomiting).

Discussion

The results of this prospective observational study show that adding a short-latency anesthetic (mepivacaine) to a longer-acting anesthetic that also has a faster onset (bupivacaine) does not contribute any clinically significant benefit related to the faster onset. Although, statistically significant differences have been found for the combination of anesthetics (2.90 min; SD: 1.36) versus the use of bupivacaine alone (3.85 min; SD: 1.21]; p = 0.027]), these are hardly significant from a clinical point of view as there is a group of patients that obtained a very low VAS score in a period of 2-5 min as compared with the other Group, where the VAS score decreases gradually until it reaches a low after 10-20 min.

On the other hand, the differences found in terms of length of analgesia in one group versus the other do have clinical relevance since in the combined anesthetic group a mean duration of appropriate analgesia of 15 h was obtained (VAS score was around 2-3 points, patients only needed non steroid anti-inflammatory drugs (NSAIDs) as adjuvant analgesics) versus the bupivacaine group, where appropriate analgesia lasted a mean of 20 h. This difference is clinically significant since the most painful period is concentrated in the first 24 h post-op[11], which means that success in controlling pain appropriately during this period will permit subsequent pain management with nothing more than NSAIDs.

On the basis of these results, adding mepivacaine to bupivacaine for performing a nerve block does not contribute any benefit regarding a shorter onset of action but may however be counterproductive considering the differences found in terms of a shorter pain-free period when the combination is used.

Mepivacaine is a local amide anesthetic with rapid onset of action and intermediate duration[2,11]. The results of this study may be due to the fact that the admixture of anesthetics could alter the pK_a anesthetics, which is the force with which molecules become dissociated (pK_a is the negative logarithm of the dissociation constant of a weak acid). T his could alter their physical-chemical properties. Furthermore, the admixture reduces the concentration of the bupivacaine used for the nerve block, which reduces the length of analgesia.

Femoral nerve block is a safe technique[8,9]. Without prejudice of the reduced size of our sample, we had a low number of complications, all of them inconsequential. It is an easy-to-perform technique with few complications for the patient and which provides the significant benefits inherent in a correct analgesia during the first few postoperative hours.

The low number of complications we encountered could have been prevented with the use of ultrasound as a guide for nerve location since this technique affords direct visualization of anatomic structures thereby assisting in accurate location and preventing inadvertent damage to the nerve with the needle and intravascular injections, which makes it possible to use lower doses of the local anesthetic. All of this would seem to tip the scales in favor of this method versus nerve stimulation. The advantages of the nerve stimulator are price, a shorter learning curve, a lower risk of intravascular injection with repeated aspirations and an avoidance of nerve lesions if output is higher than 0.3 mA[12].

As regards the persistent pain in the popliteal fossa reported by some patients, the former can be explained by the anatomy of the lumbar plexus. The knee is innervated by the lumbosacral plexus; the femoral and obturator nerves innervate the anterior region whereas the sciatic nerve innervates the posterior region[10]; this would account for the presence of residual pain in some patients – a kind of pain that would resolve if an additional sciatic nerve block was used.

With the data obtained, it can be concluded that the use of a combination of anesthetics (mepivacaine and bupivacaine)

does not contribute any significant clinical benefit as regards shorter latency times (2.90 min; SD: 1.36) versus bupivacaine in isolation (3.85 min; SD: 1.21) ($p< 0.027$). The combined dose might even be counterproductive since it shortens the duration of analgesia (15.2 h; SD: 9.2) as compared with the use of bupivacaine alone (22 h; SD:10.47) ($p<0.036$). More studies are required on this subject since there are papers that advocate combining anesthetics with other adjuvant drugs (tramadol, dexamthasone or bicarbonate)[13,14] to modify their physical-chemical properties, but there are large-scale no studies that look into the combination of different types of anesthetics.

Complications of this technique are scarce and not very serious. It is an easy-to-perform technique, which affords correct analgesia in the first few hours post-op. Femoral nerve block is a very well accepted technique both by the patient and by the nursing staff, which achieves high levels of satisfaction given its fast action and the length of analgesia obtained, without any side effects and lower opioid consumption.

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