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Research Article

Comparison of combined peripheral block techniques for pain management in total knee replacement (TKR)

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Abstract:

Introduction: Patients undergoing TKR frequently experience severe pain in the immediate postoperative period. Peripheral nerve blocks, in the context of multimodal analgesia, have been used to mitigate pain, provide comfort and accelerate the functional recovery of the patients. This research compares IPACK, ACB and PAI blocks as techniques to provide adequate analgesia avoiding muscle weakness.

Materials and methods: Experimental, prospective, randomized double-blind study. 100 undergoing patients TKR were studied during the period 2020 to 2022, divided into two groups of 50 patients each. Group 1: ACB plus IPACK and group 2: ACB plus PAI. The visual analog scale (VAS) was used to assess pain. Opioid rescues, degree of satisfaction, range of motion and distance traveled postoperatively were quantified.

Results: Both groups were homogeneous in demographic data and duration of surgery ($p>0.05$). Group 1 patients required fewer opioid rescues ($p=0.02$) and had a shorter hospital stay ($p=0.04$). The time factor showed statistical differences in the perception of pain ($p=0.001$), but not the group factor ($p>0.05$). No statistically significant differences were obtained in terms of general satisfaction with the applied techniques, distance traveled or range of movement evaluated between 24 and 48 hours of the postoperative.

Conclusions: The combination of ACB block plus IPACK showed better clinical and functional results for the approach of postoperative analgesia in TKR.

Keywords: knee; arthroplasty; regional anesthesia; postoperative pain

Introduction

Total knee replacement (TKR) is one of the orthopedic surgeries with the greatest nociceptive impact in the postoperative period. One of the main limitations in the post-surgical recovery of these patients is poor pain management[1]. Various studies have shown that the presence of severe pain in large joint replacements is associated with non-compliance with rehabilitation plans, prolonged hospitalizations and increased healthcare costs[2]. Multiple analgesic strategies have been described for intervention, but there is no agreement on a single scheme that proves to be superior[3]. Multimodal analgesia and peripheral blocks make it possible to achieve rapid functional recovery and reduce hospital times[4], in the context of intensified recovery of the surgical patient (ERAS)[5].

The ultrasound-guided adductor canal block (ACB), described for the first time in 2009 by Manickam et al.[6], is used in patients undergoing TKR due to its opioid-sparing effect and preservation of motor function[7].

Periarticular infiltration (PAI), a technique described in 2008 by Kerr and Kohan, has achieved great popularity among traumatologists since it has demonstrated effects

analgesics comparable to different regional anesthesia techniques and the benefit of preserving the motor function of the quadriceps[6-11].

The IPACK block, described for the first time in 2014, provides analgesia for the posterior portion of the knee, keeping joint function intact and preventing foot drop (steppage), which would be detrimental to mobilization and early post-surgical kinesiotherapy, with the consequent risk of falls[12–15].

The objective of this work is to be able to detect whether or not there is an advantage in the combination of IPACK+ACB and take periarticular knee infiltration as a control group, the benefits of which are well demonstrated.

Materials and Methods

- Experimental, prospective, randomized study with double-blind design. The work was approved by the institution's Bioethics committee and all patients provided written consent for the study during the preanesthetic visit.

- 100 patients undergoing TKR were studied during the period from June 2020 to June 2022, randomly divided into two groups of 50 patients respectively, at the Sanatorio Adventista del Plata, Libertador San Martín, Entre Ríos, Argentina. Group 1, represented by IPACK+ACB blocking, and group 2 by ACB+PAI.

- Inclusion criterio

- Patients undergoing primary unilateral total knee arthroplasty.

- Ages between 45 and 75 years

- ASA I–III classification

- Weight equal to or greater than 60 kg

- Exclusion criterio

- Fibromyalgia

- Chronic opioid consumption (more than 3 months prior to surgery)

- Consumption of gabapentinoids prior to surgery (within the month before surgery)

- Known allergies to local anesthetics or medications used in the protocol

- Renal and/or liver failure

- Coagulopathies

- Peripheral neuropathies

- Poorly controlled diabetes

- History of gastroduodenal ulcers or upper gastrointestinal bleeding

- Basic psychiatric disorders that make the analysis of the analyzed variables difficult

Anesthetic protocol

All patients received spinal anesthesia in a sitting position with 2 ml of 0.5% hyperbaric bupivacaine (10 mg) plus 20 micrograms of fentanyl, in the L3-L4 space with a 27G whitacre needle, under aseptic technique. Immediately after this, the patient is placed in a supine position and the corresponding blocks continue.

ACB: ultrasound-guided saphenous nerve block at the level of the adductor canal. With the patient in a supine position, with the limb in slight external rotation (frog's leg position), after asepsis of the skin, sterile fields are placed and using a linear probe (Sonosite M-Turbo) with a sterile cover, we place it transversely. on the anteromedial aspect of the thigh, in the middle third. Color Doppler was used to identify the femoral artery below the sartorius. A scan was performed proximally and distally to identify the apex of the femoral triangle. Once it was identified, 15 ml of 0.25% isobaric bupivacaine were injected distally to this vertex, where the adductor canal begins, but proximal to its end, identified by the exit of the femoral vessels through the adductor hiatus. A 21G 100mm Braun Stimuplex® needle was used, with a flat technique with a lateral to medial orientation towards the anterolateral aspect of the artery. Once the tip of the needle was located close to the artery, it was carefully aspirated, and the solution was injected. Its dispersion was observed around the artery.

IPACK: infiltration into the interspace between the popliteal artery and the distal femoral shaft with 20 ml of 0.25% isobaric bupivacaine, under ultrasound guidance. With the patient in a supine position and with the knee semi-flexed, after disinfecting the skin, placing sterile fields and using a convex probe (Sonosite M-Turbo) with a cover sterile, we place it transversely on the medial aspect of the knee, approximately 2 to 3 cm above the patella, sliding the transducer proximally/distally to identify the distal femoral shaft and the popliteal artery. Color Doppler was used to identify the artery. The needle (same used in ACB) was introduced flat, from the anteromedial aspect of the knee, towards the space between the popliteal artery and the femur, at a steep angle to remain close to the femur and avoid neurovascular injury. Once the interspace was reached, the local anesthetic was injected and its distribution along the axis of the femur was observed.

PAI: periarticular infiltration of the knee with 50 ml of solution composed of isobaric bupivacaine 0.5% 20 ml + ketorolac 30 mg + epinephrine 0.5 mg (10 ug/ml) + physiological solution 30 ml according to bibliographic citations consulted[16–18]. Of the 50 ml of said solution, 20 ml were used to infiltrate the posterior capsule prior to placement of the prosthesis and the rest of the infiltration is periarticular, over the deep region of the lateral and medial collateral ligaments, pes of the goose, around of the tissues neighboring the prosthesis and subcutaneously below the surgical wound (30ml). This infiltration is carried out by the surgeon in charge.

Intraoperative multimodal analgesia:

- Ketorolac 60 mg e.v.

- Dexamethasone 8 mg e.v.

- Paracetamol 1 g e.v.

Adjuvants used intraoperatively:

- Ranitidine 50 mg e.v.

- Metoclopramide 10 mg e.v.

- Cefazolin 2 g e.v.

- Tranexamic Acid 1 g e.v.

Postoperative analgesic plan:

- Paracetamol 1 g p.o. every 8 hours.

- Ketorolac 30 mg e.v. every 8 hours.

- Dexamethasone 4 mg e.v. every 12 hours. (2 postoperative doses and discontinue)

- Rescue pain with Tramadol e.v. 1 mg/kg if visual analogue scale (VAS) ≥4.

Adjuvants used in the postoperative period:

- Metoclopramide 10 mg e.v. (SOS)

- Ranitidine 50 mg e.v. every 8 hours.

Age, sex, weight, height, body mass index (BMI), duration of the surgical procedure, and hospital stay were recorded.

Acute pain was evaluated, both at rest and during movement, with the VAS scale, at 6, 12, 24 and 48 hours postoperatively. The administration of rescue opioid analgesics, degree of satisfaction with the analgesic plan provided (0-3 dissatisfied, 4-5 slightly satisfied, 6-7 satisfied, 8-10 very satisfied), range of joint motion measured in degrees at 48 hours. postoperative periods, distance in meters traveled at 48 hours and adverse effects.

Statistical Analysis

Qualitative variables are described with absolute frequency and percentages. Quantitative variables are described with mean and standard deviation. For the analysis of the relationship between qualitative variables and groups, the Pearson Chi square test was used and for quantitative variables the independent samples T test was used. The evaluation of pain by group over time was carried out with the repeated measures ANOVA test. Statistical significance was set at alpha equal to 0.05. The statistical power achieved was 82%.

Results

Patients in both groups were homogeneous in age, sex, BMI, and duration of surgery. Patients in group 1 received fewer opioid rescues (X2=5.0; g.l.=1; p=0.02) (Figure 1) and had a shorter hospital stay (X2=4.0; g.l.=1; p= 0.04) (Figure 2).

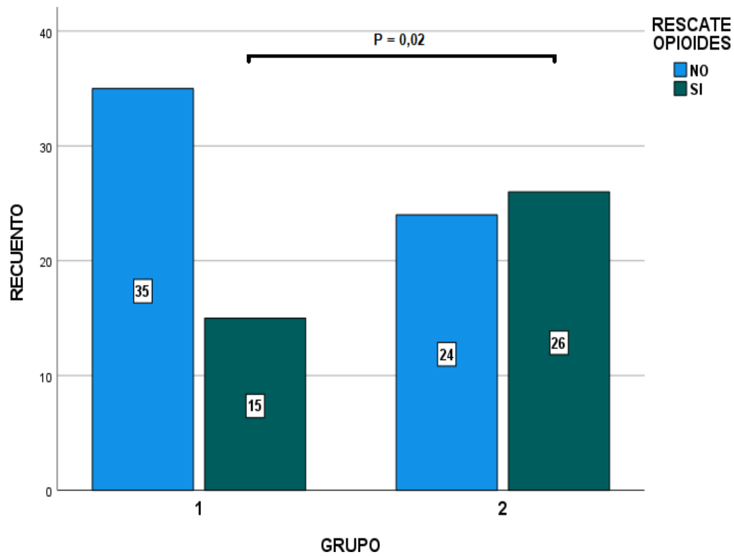
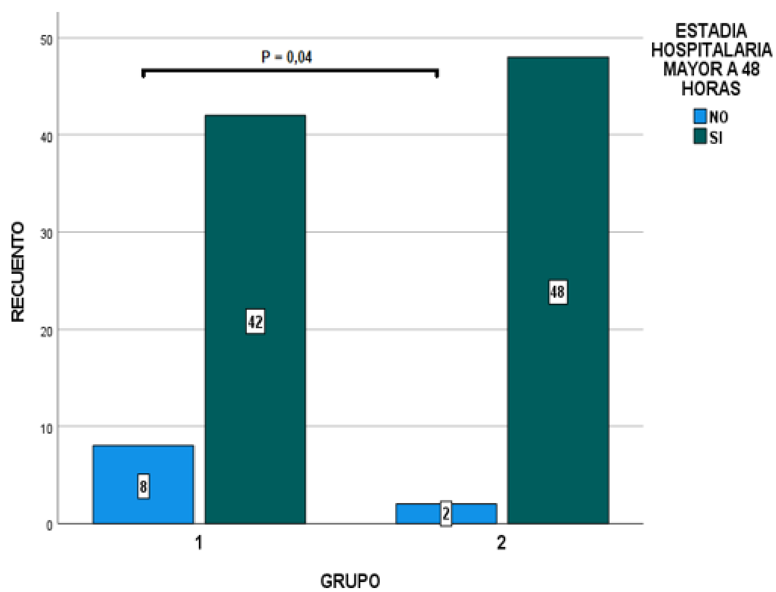


Figure 1: Grouped bar graph with difference in opioid rescue proportions between groups. Group 1 received a significantly higher number of rescues.



	GRUPO 1 (N=50)	GRUPO 2(N=50)	VALOR P
EDAD [años], media ± DE	68.2 ± 6.8	66.7 ± 8.3	0.34¥
SEXO FEMENINO, N (%)	23 (46)	26 (52)	0.55§
IMC, media ± DE	29.8 ± 5.5	29.7 ± 6.3	0.91¥
DURACIÓN DE CIRUGIA [minutos], media ± DE	108.4 ± 25.8	106.9 ± 24.6	0.77¥
RESCATE OPIOIDES, N (%)	15 (30)	26 (52)	**0.02§**
ESTADIA HOSPITALARIA MAYOR A 48HS, N (%)	42 (84)	48 (96)	**0.04§**
SATISFACCION DEL PLAN ANALGESICO, media ± DE	8.4 ± 1.3	8.1 ± 1.5	0.23¥
DISTANCIA 48HS, media ± DE	28.0 ± 11.3	29.1 ± 12.5	0.66¥
RANGOS MOVIMIENTO 48HS, media ± DE	85.1 ± 10.9	82.4 ± 14.6	0.31¥
EFECTOS ADVERSOS, N (%)	4 (8)	6 (12)	0.55§

DE: Standard Deviation. ¥ Independent samples T test. § Pearson Chi Square Test.
Significant p values are detailed in bold.

Regarding the evaluation of pain over time between both groups, the results of the statistical analysis revealed that the intra-subject factor (time) was significant in VAS at rest (F=7.9 df=3 p=0.0001). and in movement (F=6.7 df=3 p=0.0001), but the analysis of the inter-subject factor (groups) did not show differences even at rest (F= 1.0- df= 1- p= 0.32) nor in movement (F=0.2 df=1 p=0.65). (see figure 3 and 4).

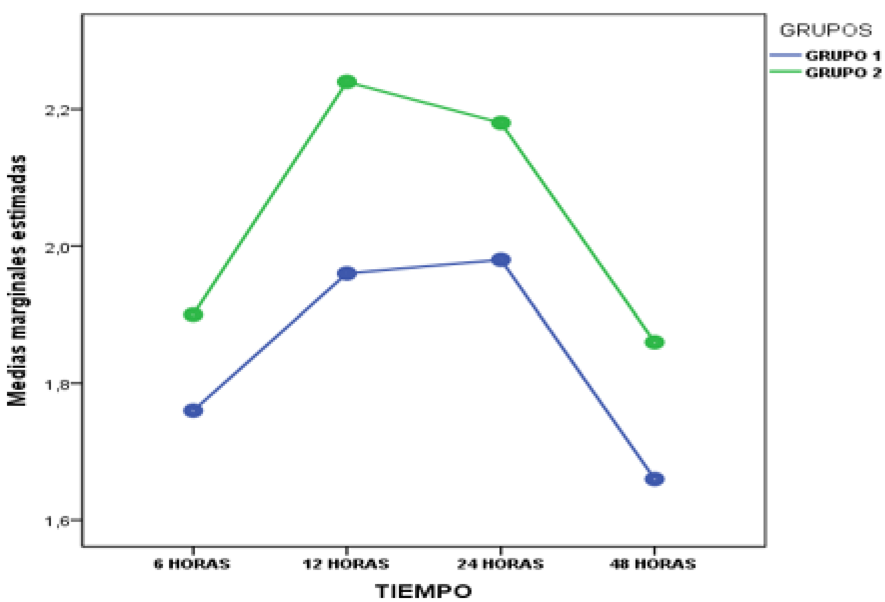


Figure 3: Profile graph of the intra-subject factor (Time) according to the inter-subject factor (Group) in evaluation at rest. There were no significant differences in the evaluation of pain at rest between groups (p=0.32).

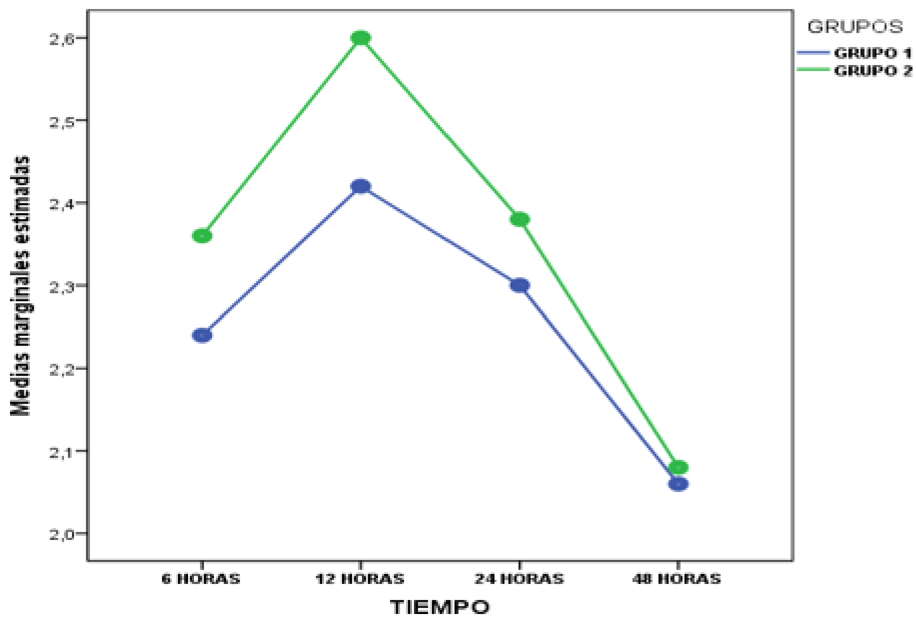


Figure 4: Profile graph of the intra-subject factor (Time) according to the inter-subject factor (Group) in motion evaluation. There were no significant differences in the evaluation of pain on movement between groups ($p=0.65$).

Discussion

Both combined peripheral block techniques were shown to be effective in the multimodal management of acute postoperative pain in patients undergoing TKR, with the great advantage of preserving quadriceps muscle strength for early mobilization and kinesiotherapy as well as mitigating potential risks. of falls that could occur if they presented muscle weakness as a result of the blocks carried out, which would prevent a “fast-track” recovery [19–20] for major orthopedic surgery[21–25].

Although in group 1 (IPACK+ACB) a lower VAS was observed compared to group

2, no statistically significant differences were evident in the analysis provided by the repeated measures ANOVA, although this was reflected clinically in the lower consumption of opioids and the shorter duration of hospital stay recorded in group 1. We consider that this effect may correspond to the greater number of Tramadol rescues in the patients in group 2, which could have masked this effect in the curve of evolution of pain over time, so when these

patients were still included in the analysis, the statistical effect was not observed. saw reflected, but the clinical results. From a medical ethics perspective, the patients could not have been excluded, evolving post-surgery without receiving rescue analgesic medication, if they needed it, for this reason it was not decided to exclude them from the analysis over time, since pain as the 5th sign vital represents a quality standard in perioperative care. Periarticular knee infiltration, although it is an effective technique, has a series of characteristics that must be known when using it as an analgesic scheme:

• **Variability:** since it was described, this technique has varied substantially not only in the way it is performed (some studies include the placement of a periarticular catheter) but also in the adjuvant drugs used.

• **Blind technique:** injection without ultrasound control in the posterior capsule could cause lateral migration of the anesthetic solution and involve the peroneal nerve, with consequent motor block.

• **Duration:** its effects vary mainly in the early postoperative period (first 24 hours).

• Analgesic effects: they have been well demonstrated in the context of a complementary multimodal analgesia scheme, although they would be less effective during movement and/or physiotherapy compared to other techniques.

• **High doses of drugs:** although there is great variability in the preparation of the infiltration, the original article by Kerr and Kohan[8] describes the technique infiltrating up to 300-340 mg of 0.2% ropivacaine (although reductions in These doses in patients with risk factors for local anesthetic poisoning, the values allow us to assume that they were usually above the 3 mg/kg recommended for ropivacaine). However, there is no in-depth characterization of the studied population in such work, which does not allow accurate conclusions to be drawn.

• **Need to use a hemostatic cuff:** although there are studies that demonstrate the usefulness of high dose local infiltrative anesthesia (HDLIA) in knee surgeries with and without a hemostatic cuff, its use would represent a "safety element" against the risks of poisoning by local anesthetics for these patients, so their systematic use would be suggested.

Previous studies comparing PAI+ACB found that, although this combination reduced postoperative pain at rest, they were unable to demonstrate a reduction in mobilization on the 1st postoperative day[20], while the use of the IPACK block allowed better pain control both at rest. as in movement in the first 24 hours, achieving early ambulation[21].

Sawhney et al. demonstrated that PAI in combination with ACB achieve better results in pain control than each technique used separately, as published in their article[24].

In contrast to our research, Kertkiatkachorn et al. found that the ACB + IPACK group was associated with greater consumption of opioid analgesics and greater difficulty ambulating on the 1st postoperative day. Despite this, this combination provided analgesia not inferior to that observed in the ACB + PAI group both at rest and during movement in patients undergoing TKR[26].

On the other hand, the IPACK block and ultrasound-guided ACB allow adequate control of the injection site of the anesthetic solution, controlling the migration of local anesthetics in the posterior capsule of the knee and in Hunter's canal, thus managing to reduce doses and volumes and provide a better safety profile to the patient.

Conclusion

The combination of IPACK blocks plus ACB obtained more favorable results for addressing postoperative analgesia in TKR, clinically evident both in the evaluation and follow-up of patients, as well as in the reduction of hospital stay and lower consumption of postoperative opioids. In any case, more research will be needed to elucidate whether or not there really is an advantage in using one analgesic scheme over the rest.

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