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VARIA

The use of IPACK and the continuous adductor canal block in the perioperative management of total knee prosthesis

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Abstract: *Background: Although locoregional anesthesia techniques in total knee arthroplasty (TKA) have progressed steadily, the emergence of the adductor canal block representing a step forward for postoperative evolution in preservation of the quadriceps muscle strength, analgesia of the posterior territory of the knee still remains a challenge. The emergence of IPACK, in association with earlier techniques, offers promising preliminary results in terms of its contribution to a favourable evolution and to the satisfaction of TKA patients.*

Materials and methods: Prospective trial performed on a group of 28 patients undergoing a total knee arthroplasty intervention; analgesia control in the postoperative period was performed either with opioid and nonopioid systemic analgesics, or by associating the continuous adductor canal block with IPACK and systemic analgesics. The primary objective is pain control at rest/on mobilization, while the secondary purpose is analysis of opioid use, their side effects and recovery of joint mobility.

Results: There is a significantly better pain control in the group of patients with locoregional anesthesia, both at rest and on mobilization ($p<0.005$), accompanied by a decrease in opioid use ($p<0.00001$) and the related adverse reactions; at the same time, there is an improvement in the functional recovery of the knee joint, quantified by the flexion degree at 24 and 48 hours after surgery (61.5/71.12 degrees for continuous adductor canal block with IPACK versus 45.14/55.42 degrees for general anaesthesia)

Conclusions: The introduction of peripheral nerve blocks in the multimodal analgesia regimen after TKA results in better control of postoperative pain, both at rest and on mobilization, in a decrease in opioid use and their related adverse reactions and in an improved recovery of joint range of motion, as well.

Keywords: *continuous adductor canal block, IPACK, VAS, TKA*

INTRODUCTION

Total knee prosthesis is currently one of the most common surgeries in the field of orthopedics, the number of such interventions performed annually being on an accelerated upward trend. On the other hand, the pain stimulus that occurs in total postarthroplasty of the knee is often very intense, TKA being known as one of the most painful orthopedic surgeries , pain control is a major component in perioperative management of TKA [1].

The pain occurring in the postoperative period, as well as the systemic inflammatory response initiated following the tissue trauma will have significant consequences for the

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postoperative evolution of the patients, including prosthesis infection which can compromise the joint functionality and complicate postoperative evolution [2]. It has been shown that activating an exacerbated systemic inflammatory response leads to increased rates of local and systemic complications, increased perioperative morbidity and mortality, increased length of hospitalization and patient dissatisfaction. In view of the above mentioned, the existence of a standardized and complex protocol for the perioperative management of patients with TKA becomes an absolute requirement in order to improve the postoperative evolution, decrease the duration of hospitalization and increase patient satisfaction [3]. The multidisciplinary approach is decisive in determining the prognosis both in case of primary TKA, as for modular endoprosthetic reconstruction, as well [4].

MATERIAL AND METHOD

After getting the agreement of the Ethics Commission of the Bucharest University Emergency Hospital (SUUB), a prospective monocentric trial was performed on 28 patients undergoing unilateral total knee arthroplasty surgery in the SUUB Orthopedics and Traumatology Clinic between May 2020 and March 2021.

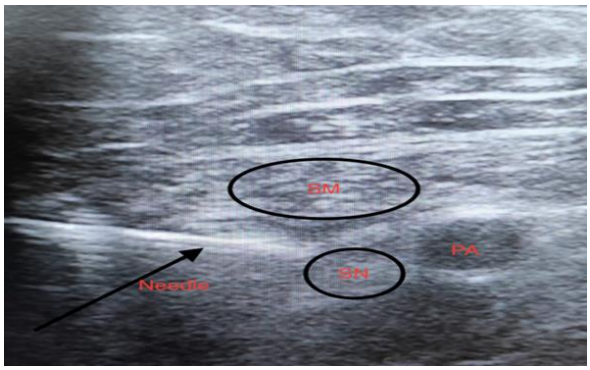
The patients included in the trial belonged to ASA risk classes 1-3; patients with ASA risk class > IV, chronic opioid users prior to presentation, obese patients with BMI>40 kg/sq.m., known allergies to analgesic medication included in the protocol, contraindications for neuraxial anesthesia, chronic kidney disease or pre-existing peripheral neuropathy were excluded from the trial. Prior to surgery, patients were informed extensively with regard to the protocol, the technique of anesthesia and analgesia, the related risks and benefits, and the patients gave their informed consent.

The total knee prosthesis surgery was performed by experienced surgeons of the Orthopedics and Traumatology Clinic of SUUB with a parapatellar anteromedial approach, with bicompartmental prosthesis and using the hemostatic band [5].

The trial was performed on 2 groups of 14 patients each, divided according to the anesthetic management and the perioperative analgesia approach. The first group comprised of patients that received balanced anesthesia with volatile pivot and intravenous multimodal postoperative analgesia. In the second group, the anesthetic technique consisted of spinal anesthesia associated with IPACK and the continuous adductor canal block. All patients (both group 1 and group 2) received preemptive analgesia, paracetamol 1 g, Gabaran 300 mg and Celecoxib 200 mg one hour before surgery; the treatment was continued for the first 72 hours postoperatively (paracetamol 1 g every 6 hours under ASAT/ALAT control, Gabaran 600 mg/day in 2 doses, Celecoxib 200 mg twice daily). The locoregional anesthesia maneuvers were performed by anesthetists of the Anesthesia-Intensive Care Department of SUUB.

Patients in group 2 were admitted to the preoperative ward approximately one hour before the time of surgery for performing the 2 peripheral nerve blocks. The patient is placed in supine position, a peripheral venous line is inserted and the patient receives standard monitorization (according to the standards required by the Romanian Anesthesia and Intensive Care Society). To perform the adductor canal block, the patient is positioned with the thigh in slight abduction and external rotation; the patient's thigh is disinfected with 2% chlorhexidine solution, the high frequency linear probe (Philips Cx50 transducer L 12-5 50 mm) is used, which is placed transversely on the thigh in its anteromedial portion approximately at the junction between the medial and distal thirds of the thigh, and the saphenous nerve located anterolaterally to the femoral artery, under the sartorius muscle is identified; under ultrasound guidance (the in-plane approach) the Touhy needle from the Contiplex Touhy Ultra-B. Braun set is advanced under careful ultrasound visualization, from the lateral to the medial area up to the vicinity of the femoral artery. After aspiration and the prior injection of 1-2 ml in order to check the position of the needle, 20 ml of ropivacaine 0.5% is infiltrated into the upper part of the artery (Figure 1).

Figure 1: Infiltration area



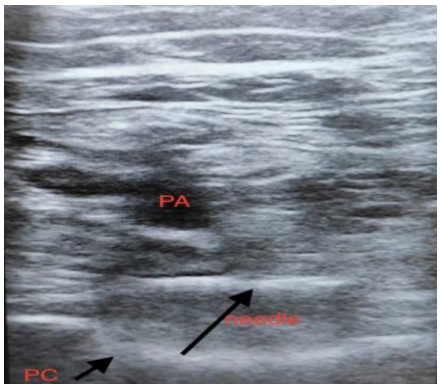
SM sartorious muscle, SN safenous nerve, PA popliteal artery

A plexus catheter is inserted in the adductor canal; the catheter is secured at 11-13 cm with Histoacryl and Tegaderm to prevent dislocation and extravasation of local anesthetic. A mixture of ropivacaine 0.2% with Fentanyl 2-gamma/ml with Easy Pump B. Braun, with a volume of 125 ml and a constant administration rate of 5 ml/hour, is administered postoperatively, allowing for the easy

mobilization of the patient. The catheter is retracted 72 hours postoperatively.

The second peripheral nerve block performed is IPACK. The patient is in a supine position with his knee slightly bent. The high frequency linear probe (Philips Cx50 transducer L 12-5 50 mm) is used, which is positioned transversely in the popliteal fossa for the visualization of the femoral condyles, the popliteal artery, the tibial nerve and the common peroneal nerve; the transducer is advanced slightly proximally until the posterior edge of the femur is visualized. After local anesthesia with 1-2 ml of lidocaine 1%, a Stimuplex Ultra 360 20G-100 mm needle is inserted, under ultrasound guidance (the in-plane approach), in the space between the popliteal artery and the posterior edge of the femur, from the lateral to the medial area, and the local anesthetic is infiltrated, 20 ml of ropivacaine 0.5% in a single injection (Figure 2).

Figure 2: Infiltration area for second peripheral nerve block



PA popliteal artery, PC posterior capsule

Postoperatively the patients are admitted to the postoperative intensive care unit for the first 24 hours. The patients in group 1 (general anesthesia) enter the multimodal analgesia protocol with morphine combined with paracetamol 1 g/6 hours, Gabaran 300 mg/12 hours and Celecoxib 200 mg/12 hours. Postoperative analgesia of patients in group 2 (spinal anesthesia with peripheral nerve blocks) is ensured by the administration of local anesthetic via adductor canal catheter, supplemented by the administration of paracetamol 1 g/6 hours, Gabaran 300 mg/ 12 hours and Celecoxib 200 mg/12 hours.

The primary objective of the trial is to record the pain score by means of the visual analogue scale (VAS) both at rest and in activity, while the secondary objectives that we followed are the consumption of opioids in the two groups, their adverse effects and the degree of mobility of the joint that correlates directly with a quick postoperative rehabilitation of the joint.

Statistical analysis

The data recorded is processed using descriptive statistics, Student t-test. The nature of the hypotesis testing was two-tailed, and P<0.005 was considered statistically significant.

RESULTS

From a demographic point of view, no significant differences are observed between the two groups of patients (tabel 1). The preoperative pain score at rest is also comparable, and in terms of chronic analgesic use it is observed that only 4 patients in group 1 and 3 patients in the group 2 were chronically using analgesics of the NSAID category (in the last 3 month) and one patient analgesics of the weak opioids class.

Table 1: Demographic data, surgical information (values are presented as mean or number and percent)

Treatment group	General anesthesia n=14	IPACK/cACB n=14
Age(y)	62 (49-70)	68 (59-74)
Gender, male, n	4 (14)	5 (14)
BMI (kg/m²)	34 (25-39)	32 (25-38)
Surgical time(min)	117 (70-170)	130 (80-180)
VAS rest at home	3 (3-4)	4 (3-5)
NSAID consumption at home (last 3 month)	4 (14)	3 (14)
No opioid consumption at home	13 (14)	14 (14)

IPACK, infiltration of local anesthetic between posterior artery and capsule of the knee; cACB, continuous adductor canal block; BMI, body mass index; VAS, Visual Analogue Scale ; NSAID, Nonsteroidal anti-inflammatory drugs

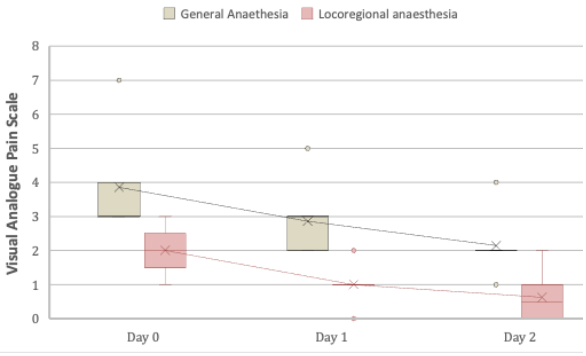
VAS score at rest and at work on day 1 and day 2 showed significantly (p<0.005) better values in locoregional anaesthesia group (lot 2) compared to general anaesthesia group (lot 1). VAS score at rest after 8 hours postoperatively also showed significantly (p<0.025) better values in locoregional anaesthesia group compared to general anaesthesia (Figure 3).

The mean ranges of movement on days 1 and 2 postoperatively for locoregional anaesthesia group (61.5 degrees and 71.12 degrees, respectively) were significantly better (p< 0.0005) than ranges of movement on day 1 and 2 for group with general anaesthesia (45.14 degrees and 55.42 degrees).

Similary, the opioid usage was lower (P<0.00001) on day 1

for pacients who received adductor canal blockade combined with IPACK.

Figure 3: Pain numerical rating scale at rest



Boxes represent 25th-75th percentiles interval. X marks mean value

DISCUSSION

Because effective analgesia is largely responsible for blocking this metabolic breakdown called systemic inflammatory response, much of the efforts undertaken by clinicians have focused on controlling postoperative pain [6]. Recent decades have witnessed the wide implementation of the concept of multimodal analgesia, a protocol in which, in order to ensure effective analgesia, conventional analgesia methods (administration of opioids, paracetamol, nonsteroidal anti-inflammatory drugs, etc.) are associated with new locoregional anesthesia techniques. This makes it possible to reach an effective analgesia threshold while significantly reducing the use of opioids and analgesic drugs, therefore decreasing the adverse reactions related to their excessive consumption [7].

The role of locoregional anesthesia in the management of the TKA patient is already well established. Numerous studies have shown that the association of different peripheral nerve blocks with the administration of systemic analgesics in the multimodal analgesia protocol (the femoral nerve block and more recently the adductor canal block) makes an important contribution to the perioperative management of such patients [8, 9]. Unlike the femoral nerve block, which often results in quadriceps muscle fatigue and increases the perioperative risk of accidental fall, the adductor canal block preserves the muscular strength of the quadriceps muscle, reduces the risk of in-hospital fall and significantly improves the functional recovery of the joint [10-12]. However, it seems that the inclusion of the femoral nerve block or the adductor canal block in the perioperative management plan does not necessarily eliminate the need for opioid administration in the perioperative period [13]. This can be explained by the fact that both variants of the femoral nerve block – the classic one and the adductor canal block – will ensure the analgesia of the anterior and mediolateral territory of the knee joint, so that the posterior area innervated by branches detaching from the sciatic nerve is completely free of analgesia, hence the need to supplement with analgesics postoperatively [14].

In this sense, different solutions have been searched to ensure efficient analgesia in this territory, without affecting the motor performances that play an important role in the rapid postoperative functional recovery. Thus, the emergence of the IPACK block (infiltration between the popliteal artery and the capsule of the posterior knee) appears as a promising solution in terms of ensuring analgesia for the posterior territory of the knee joint [15, 16]. The innervation of the posterior territory of the knee joint is ensured by articular branches detaching from 3 main trunks: the tibial nerve (whose branches represent the main source of innervation of the knee posterior capsule), the common peroneal nerve (that sends terminal branches to the anterolateral and posterolateral portion of the capsule) and the obturator nerve (3 branches ensuring the innervation of the superomedial portion of the capsule) [17]. In essence, IPACK blocks the terminal sensitive branches detached from the popliteal plexus and the obturator nerve, thus ensuring analgesia of the posterior capsule of the knee, without involving motor branches and therefore without affecting the process of functional recovery of the joint. Sparing the motor branches of the common peroneal and tibial nerves and covering the posterior territory of the knee joint are two features that can make IPACK the ideal solution, along with the adductor canal block, with a view to ensuring effective analgesia of the knee joint in the postoperative period [18, 19]. From a technical point of view, this is achieved by the infiltration of a local anesthetic into the area located between the popliteal artery and the posterior capsule of the knee, an ultrasonographically guided maneuver. So far, experience with the use of the combined technique consisting in locoregional anesthesia, adductor canal block associated with IPACK, has been limited in terms of the functional recovery of the joint, the analgesic efficiency and the opioid use.

Starting from the idea that the new techniques described in locoregional anesthesia represent a major step forward in the perioperative management of TKA patients, the trial described here will analyze the efficacy of the continuous adductor canal block associated with IPACK in improving pain control and functional recovery, in reducing opioid use and the incidence of side effects, as well as in reducing the duration of hospitalization [19].

From a demographic point of view, no significant differences

are observed between the two groups of patients. The preoperative pain score at rest is also comparable, and in terms of chronic analgesic use it is observed that only 4 patients in group 1 and 2 patients in the group 2 were chronically using analgesics of the NSAID category and one patient analgesics of the weak opioids class.

As regards the intensity of pain on the day of surgery, patients in the group with postoperative analgesia based on the combination of analgesics of the opioid class and nonopioids had a higher VAS score than those for whom locoregional anesthesia with systemic analgesics of the weak opioids class and nonopioids was used in the multimodal analgesia protocol. Also, there is a better control of pain in group 2, including days 2 and 3 postoperatively, both at rest and when mobilizing the knee joint with the help of kinetics.

Following the functional recovery of the joint, we notice that the patients in group 2 were able to suffer a higher degree of flexion of the joint in terms of pain, compared to patients without locoregional anesthesia. At the same time, the use of opoids was significantly higher in patients with systemic analgesia only.

During the trial, only one major adverse event occurred, namely one case of respiratory depression following opioid administration; adverse reactions such as nausea and vomiting were more common in patients with opioids, while in the group of patients with locoregional anesthesia no adverse effects were reported of the type systemic toxicity of the local anesthetic, extravasation of the anesthetic at the site of catheter insertion or in-hospital fall due to decreased muscle strength of the quadriceps muscle.

Although locoregional analgesia in the perioperative management of TKA is supported by the results of the trial, it has certain limitations. First of all, the trial is not a randomized one. Secondly, the follow-up of the patients was performed only in the first 72 hours postoperatively, until the removal of the adductor canal catheter, therefore we cannot provide any data on the further developments in terms of pain intensity and analgesic requirements after locoregional analgesia is suppressed. Further studies are needed in order to determine whether the benefit of locoregional anesthesia (joint mobilization, pain score) is maintained after its discontinuation. Thirdly, despite significantly higher opioid use in patients in group 1, postoperative pain is more difficult to control, therefore comparing the degree of joint mobility of the two groups may not be relevant, the intensity of the pain being an important limiting factor of the mobility degree.

In a prospective, triple-blind trial conducted by Kim D. et al in 2017 on a group of 86 patients undergoing primary unilateral knee arthroplasty, the association between IPACK and the adductor canal block at the periarticular infiltration of the local anesthetic provides a high level of analgesia and helps reduce opioid use compared to the joint infiltration associated with the systemic multimodal analgesia regimen. This trial supports the introduction of IPACK and the adductor canal block in a standardized multimodal analgesia protocol for patients undergoing orthopedic knee joint prosthesis surgery [20].

Another prospective trial by Patterson ME. et al. on 69 patients enrolled during the period 2016-2018 shows that the association of IPACK with the multimodal analgesia regimen improves pain control at rest in the postoperative period, but without bringing a significant clinical improvement (no significant differences were found between the pain in conditions of physical exertion, distance walked, length of hospitalization or opioid use), therefore the trial did not recommend the introduction of IPACK in the routine management of knee arthroplasty [21].

CONCLUSIONS

Although the results of the clinical trials conducted so far are controversial and long-term research is needed on this topic, the trial conducted in our center supports that the introduction of peripheral nerve blocks in the multimodal analgesia regimen after total knee prosthesis results in a better control of the postoperative pain both at rest and on mobilization, in the decrease of opioid use and implicitly of the incidence of the related adverse reactions. Moreover, the IPACK association seems to bring an additional benefit consisting in the control of the painful stimuli at the back of the knee joint, with a faster rehabilitation and increased joint mobilization, which in the long run will lead to a lower rate of complications caused by prolonged immobilization and to a higher degree of patient satisfaction.

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