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Research Article

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Total Knee Arthroplasty and Adductor Canal Block: Chronic Pain and Functional Evaluation After Surgery

Stefano Doria[1], Ait Ali Braham Yasmine[2], Francesco Zuccarini[1], Alessandra Maggiore[1], and Fridoline Ebongo[1*]

[1]*Iris-Zuid Ziekenhuizen, Hôpitaux Iris-Sud, Brussels, Belgium*

[2]*Université Libre de Bruxelles, Brussels, Belgium*

[*]**Corresponding author:** Fridoline Ebongo, Iris-Zuid Ziekenhuizen, Hôpitaux Iris-Sud, Brussels, Belgium.

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Abstract

*This research focuses on evaluating chronic pain and functional disability after **Total Knee Arthroplasty (TKA)**, comparing two anaesthesia techniques: **Adductor Canal Block (ACB)** and **Local Infiltration of Anesthesia (LIA)**. The primary goal was to determine the efficacy of these methods in pain reduction and improved mobility six months post-surgery. The study used the **Oxford Knee Score (OKS)** and **Numeric Rating Scale (NRS)** to assess outcomes. Findings indicated no significant difference between ACB and LIA in terms of pain relief or functional improvement, suggesting that both methods are equally effective for managing chronic pain post-TKA.*

Keywords: Local Anesthesia, Adductor Canal Block, Total Knee Arthroplasty, Chronic Pain

Abbreviations

- **IASP:** International Association for the Study of Pain
- **CPSP:** Chronic Postsurgical Pain
- **TKA:** Total Knee Arthroplasty
- **IPACK:** Infiltration of the Local Anaesthetic Between the Popliteal Artery and Capsule of the Knee
- **LFC:** Lateral Femoral Cutaneous Nerve Block
- **ACB:** Adductor Canal Block
- **SFA:** Superficial Femoral Artery
- **OKS:** Oxford Knee Score
- **NRS:** Numeric Rating Scale

Introduction

The International Association for the Study of Pain (IASP) has recently updated the definition of pain to: "An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage". The definition has been completed by notes focused on the importance of the personal dimension of pain and its susceptibility to biological, psychological and social factors, indeed pain may have adverse effects on function and social and psychological well-being [1].

Chronic postsurgical pain (CPSP) is defined as pain developed after a surgical procedure persisting at least 3 months after surgery [2]. The risk for the development of chronic pain after surgery has been underestimated in the past: regarding postsurgical pain, data suggest an incidence from 5% to 85% varying with the type of operation [3]. Severe chronic postsurgical pain ranges between 2% to 15% depending on the types of surgeries: 17-21% for abdominal surgery, 6-55% for caesarean section, 5-65% for thoracotomy, 27% for hip arthroplasty and 13-44% for knee arthroplasty [4].

The therapeutic goals of osteoarthritis treatment are to improve joint mobility and reduce pain. Stepwise treatment options include: exercise, weight loss, physical therapy, analgesics, anti-inflammatory drugs, intra-articular steroids and hyaluronic acid, arthroscopic surgery and, in severe cases, total joint replacement with follow-up rehabilitation [5].

Total knee arthroplasty (TKA) is one of the most successful and effective surgical options to reduce pain and restore function for patients with severe osteoarthritis. The most common causes of patient dissatisfactions include residual pain and limited function [6]. Referring specifically to CPSP after TKA, pain severity

plateaus are reached between three and six months after surgery [7]. Indeed, patients and surgeons consider the operation as unsuccessful if the patient experiences a poor long-term pain outcome and a poor functional improvement [8]. Moreover, senior patients with chronic pain after TKA can experience interferences with relationships and social isolation: all dimensions of health-related quality of life can be associated with depression, anxiety, sleep problems and long-term opioid misuse [9, 10].

Different factors are linked to chronic pain and functional disability in patients undergoing TKA: intense preoperative pain, psychological factors, comorbidities, chronic opioids treatment and TKA surgery revision [11]. Some studies also showed that the acute postsurgical pain intensity, as for other surgeries, is linked to the development of chronic pain [12]. Conventional pain treatment in TKA includes: intravenous patient-controlled opioid-based analgesia, peripheral nerve blocks along with intravenous patient-controlled (PCA) opioid-based analgesia, and local infiltration [11].

Peripheral nerve blocks reduce postoperative pain, opioids consumption, opioid-related adverse effects, and length of hospital stay [13]. However, at this time, there is not any optimal analgesic block strategy for TKA.

The European Society of Regional Anaesthesia & Pain Therapy (ESRA, 2006) published recommendations for TKA pain management (PROSPECT): the association of a femoral block with spinal or general anaesthesia was proposed [14]. The combination of femoral and obturator nerve blocks or the combination of femoral and sciatic nerve blocks are not recommended, due to limited evidence. The association of a systemic analgesia (paracetamol, NSAID, opioid-PCA) with cooling and compression techniques are recommended for the postoperative period [15]. The realisation of Infiltration of the local anaesthetic between the popliteal artery and capsule of the knee (IPACK) seems to improve the pain scores but it does not improve opioid consumption [16].

To date, the ideal regimen of regional analgesia for TKA is evolving and the optimal pain control has to be balanced with competing goals like early mobility [17].

A network meta-analysis proposed a triple block approach with the combination of femoral, sciatic, and obturator nerve blocks to achieve the best pain control, moreover, authors suggest to add the lateral femoral cutaneous (LFC) nerve block [18, 19]. However, an important concern about the quadruple blocks combination is the ambulation time. Indeed, early mobilisation is the cornerstone of enhanced recovery programs. Moreover, the execution of four different blocks in four different regions brings to some concerns about the execution time, the local anaesthetic concentration and the patient comfort regarding the four different injections needed.

John Hunter originally described adductor canal block (ACB) in the 18th century [20]. ACB is performed at the mid-high level, approximately halfway between the anterior superior iliac spine and the superior border of the patella. The superficial femoral artery (SFA) is identified at the midthigh level underneath the sartorius muscle. The saphenous nerve is usually visible as a hyperechoic structure anterolateral to the artery [21]. Apart from reports of muscle weakness following ACB due to further spread, no major complications have been reported with the block [22].

ACB seems to provide equivalent analgesia to FNB for primary TKA with the added advantage of less quadriceps weakness, early ambulation, and a trend toward earlier discharge: however, at the best of our knowledge there are no studies who evaluates the effect of ACB on chronic functional disability and chronic pain in TKA.

The primary outcome of this retrospective study is to compare the efficacy of adductor canal block and articular capsule infiltration with respect to pain and functional disability after TKA performed under spinal anaesthesia, 6 months after surgery [23].

Methods

In this study, approved by the local Ethic Committee CEHIS 2024/08, we included patients who underwent TKA between the 1st November 2022 and the 1st March 2024.

Inclusion criteria are: patients between 18 and 90 years old undergoing selective unilateral TKA under spinal anaesthesia with bupivacaine with or without abductor canal nerve block and articular capsule infiltration.

Exclusion criteria are: patients who underwent to bilateral knee replacement or general anaesthesia and patients affected by fibromyalgia patients or chronic pain non-related to the knee [24].

Patients are divided in two groups Group LA: operated under spinal anaesthesia (hyperbaric bupivacaine 10-12.5 mg ± sufentanil 2.5 µg) and articular capsule infiltration (ropivacaine 100-200 mg) **Group ACB:** operated under spinal anaesthesia (hyperbaric bupivacaine 10-12.5 mg ± sufentanil 2.5 µg), and adductor canal nerve block (ropivacaine 50-75 mg).

Patients are called at least 6 months after the surgery to evaluate

- **Functional disability by the mean of the Oxford Knee Score (OKS):** primary outcome
- **Knee pain by the mean of the Numeric Rating Scale (NRS) before the surgery and during the interview:** secondary outcome

Methods: OKS and NRS

The OKS was developed in 1998 and then revised in 2016, it has been developed and validated specifically to assess function and pain after TKA [25-27]. OKS is a patient reported outcome measure that consists of 12 questions on activities of daily living and pain side effects over the preceding four weeks. The scoring system ranges from 0 to 4 where four is the best outcome. The overall score is reached by summing the scores of each individual question; this results in a continuous score ranging from 0 (worst outcome) to 48 (best outcome). In particular, an OKS greater than 41 indicates an excellent, 34 to 41 a good, 27 to 33 a fair and less than 27 a poor joint function. It should, however, be noted that the absolute score tends to decrease with age [28]. Therefore, in elderly patients, a 'normal' score may be somewhat less than 48.

With the NRS patients are asked to rate verbally the pain on a defined scale (0–10) where 0 is "no pain at all" and 10 is "the worst pain ever possible". Therefore, this scale can be used for phone call interviews. [24]. In this study, patients were asked to evaluate the pain before and 6 months after surgery: in this way, we are able to calculate the ΔNRS. The statistical analysis is realised through the Prisma software.

Results

Continuous variables were compared between groups with Wilcoxon test, discrete variables with Chi2 Pearson test. P<0.05 was considered as significant 383 patients were eligible, 64 were recruited: 23 in the ACB group, 41 in the LA group. There was no difference in terms of gender and age between the groups (P<0.05). There was no difference in terms of the Oxford Knee Score between the two groups (38.8±5,9 vs 38.3±7.4 p=0.77). Fig. 1

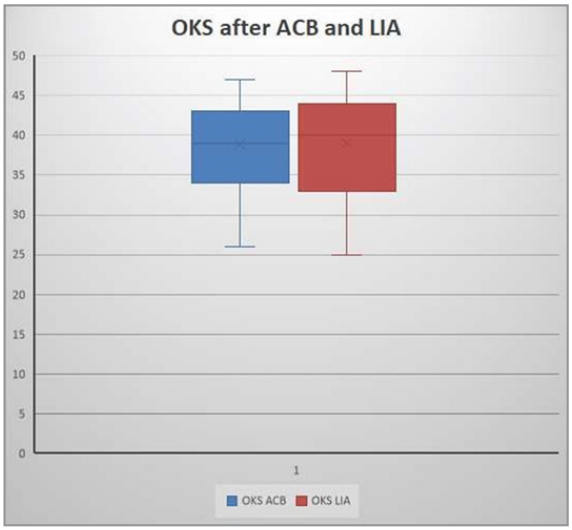

Figure 1: Oxford Knee Score comparison between adductor canal block and local infiltration of anesthesia

There was no difference in terms of NRS reduction after the surgery between the two groups (6.2±2.2 vs 5.7±2.4 p=0.45). Fig. 2. Fig 3.

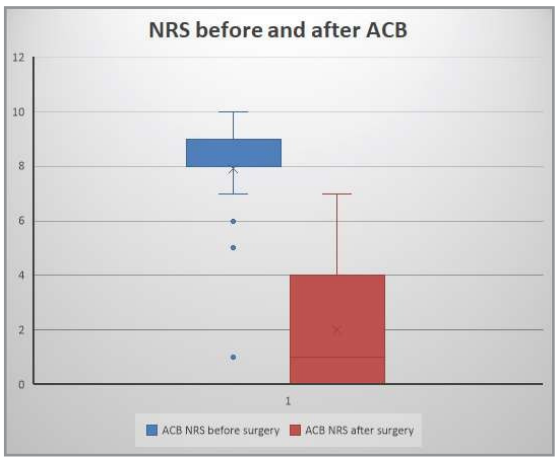

Figure 2: Numerical rating scale of pain before and after adductor canal block

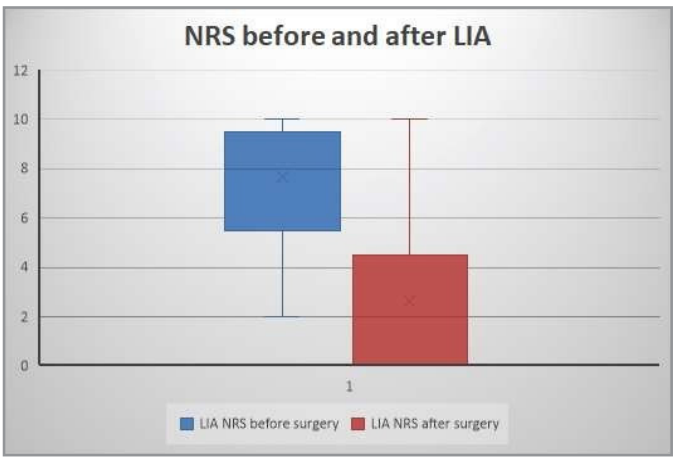

Figure 3: Numerical rating scale of pain before and after local infiltration of anesthesia

Discussion

Regional anaesthesia, and especially ACB and LIA, is a recommended intervention in the management of acute post-operative pain after TKA [29]. The effectiveness of these interventions on chronic pain and long-term function has not yet been confirmed, with some studies suggesting that acute post-operative pain is a risk factor for developing chronic CPSP [30, 31].

As far as the authors are aware, this is the first trial comparing the effects of adductor canal block and local infiltration of anaesthetics on chronic post-operative pain and functional disability. According to the results published, there is no difference between these two techniques on either pain, as evaluated by NRS, or on functional disability, as assessed by OKS, at six months after the surgery.

This seems to suggest that when choosing an analgesia strategy, there is no difference between providing the patient with ACB or LIA with respect to a chronic post-surgical pain outcome.

Currently both interventions should be administered together as a first line in total knee arthroplasty, as the adductor canal block only provides analgesia to the anterior and part of the medial aspect of the knee joint. As emerges from our study, none of the two regional anaesthesia techniques seem to provide a clear benefit with respect to the other in terms of CPSP development or functional outcomes.

There are several risk factors which have been tied to the development of CPSP, such as female gender, BMI, pain catastrophizing, sleep deprivation, anxious and depressive disorders [32, 33]. A single intervention can hardly have a lasting effect on a multifactorial outcome such as rehabilitation and disability after TKA and should therefore be a part of a multimodal analgesia protocol.

Our study presents multiple limitations. First of all, while this is technically a prospective study, the "prospective" part of it is only the administration of the OKS questionnaire; the protocol was started only after the interventions were performed so the anaesthesia regimen for the individual operations was not standardised, and neither was the postoperative rehabilitation. As a consequence, factors such as regional anaesthesia technique, doses, volumes, operators differed between patients. No randomisation was performed either.

Equally, basic analgesics such as paracetamol and COX-1 inhibitors were not administered to all patients; some of the patients received a multimodal anaesthesia regimen including dexamethasone, ketamine and a-2 agonists, while others did not. Given the small sample size of the population it was not possible to perform subgroup analyses for these variables.

A second major limitation is that, due to the lack of data in literature, no power analysis was performed before deciding the sample size. This trial can be interpreted as a pilot study for further trials to investigate the efficacy of these two regional anaesthetic techniques on long- term functional outcome after TKA.

The fact that no pre-operative OKS was established is also a consequence of this being only partially a prospective study, as the surgeries had already been performed when the trial began. The OKS was not systemically administered to the patients in the preoperative consultation at the start of the recruitment period.

The study is also limited by the fact that, while the volume of patients who could be enrolled was considerable, only a portion of the subjects replied to the phone and not all of them accepted to participate in the study. This resulted in a smaller ACB group, and no matching was performed between the two groups.

Finally, preoperative NRS for pain was asked to the patients and was not recorded before surgery, and it is thus subject to recollection bias.

This trial compared the long-term effect of two different regional anaesthesia techniques (single-shot adductor canal block and single-shot local infiltration of anaesthetics) on the functional outcome of elective total knee arthroplasty. No technique was shown to be superior to the other in terms of Oxford Knee Score. Similarly, no difference was shown between the two blocks in terms of pain as assessed by the Numerical Rating Scale.

Future investigations are needed and ideally should be designed as long-term prospective randomised controlled trials.

Conclusion

Neither Adductor Canal Block (ACB) nor Local Infiltration of Anesthesia (LIA) provided superior outcomes in reducing chronic pain or improving functional mobility six months after Total Knee Arthroplasty (TKA). Both techniques were found to be equally effective in managing postoperative pain and function, and thus, should be considered part of a multimodal analgesia strategy. Future research should involve larger, prospective, randomized studies to further explore the long-term impact of these analgesic techniques.

Conflicts of Interest

All authors declare that they have no conflicts of interest

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