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EFFICACY OF BILATERAL ADDUCTOR CANAL CATHETER FOR PAIN MANAGEMENT IN POST-TOTAL KNEE REPLACEMENT SURGERY WITH HISTORY OF LUMBAR STABILIZATION: A CASE REPORT

EFICÁCIA DO CATETER BILATERAL DO CANAL ADUTOR PARA O TRATAMENTO DA DOR EM CIRURGIA DE SUBSTITUIÇÃO TOTAL DO JOELHO COM HISTÓRICO DE ESTABILIZAÇÃO LOMBAR: RELATO DE CASO

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Abstract
Postoperative pain following total knee replacement (TKR) remains a major barrier to early mobilization and optimal rehabilitation. Neuraxial anesthesia techniques such as epidural or spinal blocks are effective for analgesia but may be contraindicated in patients with prior lumbar spine surgery. This case report presents a 65-year-old female with bilateral gonarthrosis and a history of lumbar stabilization (L3-L5) who underwent bilateral TKR. Postoperative analgesia was managed using bilateral continuous adductor canal block (ACB) catheters under ultrasound guidance, supplemented by multimodal systemic analgesia. Pain scores remained low (NRS 0-1), knee range of motion improved from 0-80° to 0-100° within three days, and no motor weakness or complications were observed. The results support that bilateral continuous ACB is a safe and effective analgesic strategy for TKR in patients with contraindications to neuraxial techniques, facilitating early mobilization and rehabilitation consistent with Enhanced Recovery After Surgery (ERAS) protocols.

Keywords: Adductor Canal Block. Multimodal Analgesia. Lumbar Stabilization. Total Knee Replacement. Postoperative Pain.

Resumo
A dor pós-operatória após a artroplastia total do joelho (ATJ) continua sendo um grande obstáculo à mobilização precoce e à reabilitação ideal. Técnicas de anestesia neuroaxial, como bloqueios epidurais ou espinhais, são eficazes para analgesia, mas podem ser contraindicadas em pacientes com cirurgia prévia na coluna lombar.
Este relato de caso apresenta uma mulher de 65 anos com gonartrose bilateral e histórico de estabilização lombar (L3-L5) que foi submetida a TKR bilateral. A analgesia pós-operatória foi administrada usando cateteres bilaterais de bloqueio do canal adutor (ACB) contínuo sob orientação de ultrassom, complementados por analgesia sistêmica multimodal. Os escores de dor permaneceram baixos (NRS 0-1), a amplitude de movimento do joelho melhorou de 0-80° para 0-100° em três dias e não foram observadas fraqueza motora ou complicações. Os resultados comprovam que o ACB contínuo bilateral é uma estratégia analgésica segura e eficaz para TKR em pacientes com contraindicações para técnicas neuroaxiais, facilitando a mobilização precoce e a reabilitação, em conformidade com os protocolos de Recuperação Aprimorada Após Cirurgia (ERAS).

Palavras-chave: *Bloqueio do canal adutor. Analgesia multimodal. Estabilização lombar. Artroplastia total do joelho. Dor pós-operatória.*

1 INTRODUCTION

Total knee replacement (TKR) is one of the most frequently performed orthopedic procedures worldwide and remains the definitive treatment for advanced osteoarthritis that no longer responds to conservative therapy. The procedure is performed more than one million times annually, reflecting the global rise in degenerative joint disease due to aging populations, higher obesity rates, and increased life expectancy (Kim *et al*., 2021; Weiser *et al*., 2015; Wylde *et al*., 2018; Liu *et al*., 2018). Although TKR effectively reduces chronic pain and restores joint function, significant postoperative pain continues to be a major barrier to early mobilization and optimal rehabilitation (Kehlet and Dahl, 2003; Song S. J., 2017).

Postoperative pain following TKR is multifactorial, arising from both intra-articular and extra-articular nociceptive pathways. The anterior knee receives sensory input from the saphenous nerve, the nerve to the vastus medialis, and the medial and lateral femoral cutaneous nerves, while the posterior knee is innervated by the tibial, obturator, and common peroneal nerves (Vaienti *et al*., 2017). Surgical trauma induces tissue injury and triggers the release of inflammatory mediators, including prostaglandins, bradykinin, and substance P, which activate peripheral nociceptors and promote local sensitization (Finnerup *et al*., 2021; Campbell & Meyer, 2006). This continuous nociceptive input can lead to central sensitization in the spinal dorsal horn, amplifying pain perception and increasing the risk of hyperalgesia, allodynia, and chronic postsurgical pain when inadequately managed (Wylde *et al*., 2018; Woolf, 2011; Pitchon *et al*., 2018).

Inadequate postoperative pain control also activates the sympathetic nervous system, resulting in physiological responses such as tachycardia, hypertension, urinary retention, and delayed gastric emptying (Hebl *et al*., 2006). These complications are particularly concerning in elderly patients with multiple comorbidities. Poor analgesia further reduces participation in physiotherapy, contributing to joint stiffness, muscle atrophy, delayed ambulation, and increased risk of thromboembolic events. Additionally, insufficient pain management during the acute postoperative phase is associated with a higher likelihood of chronic persistent pain, which can significantly reduce long-term quality of life (Kehlet, 2015; Shanthanna *et al*., 2019). Importantly, insufficient pain

control in the acute postoperative phase is associated with a higher likelihood of persistent postsurgical pain, which can significantly impair long-term quality of life (Wylde *et al*., 2018; Kehlet, 2015).

The Enhanced Recovery After Surgery (ERAS) framework promotes evidence-based perioperative strategies to minimize surgical stress and accelerate functional recovery. Within ERAS pathways for TKR, multimodal analgesia plays a central role by combining different classes of pharmacologic agents with regional anesthesia techniques to provide effective pain control while reducing opioid requirements and their associated adverse effects, such as sedation, respiratory depression, and nausea (Kehlet and Dahl, 2003; Memtsoudis *et al*., 2020; Volkow and McLellan, 2016). Regional anesthesia techniques, particularly peripheral nerve blocks, are now essential components of ERAS-based postoperative care due to their ability to improve analgesia, reduce opioid use, and facilitate early mobilization (Mariano and Ilfeld, 2014).

Among the regional techniques available, the adductor canal block (ACB) has gained prominence as a motor-sparing alternative to the femoral nerve block (FNB). ACB selectively anesthetizes the saphenous nerve and medial femoral cutaneous branches within the adductor canal, providing effective sensory blockade of the anteromedial knee while preserving quadriceps motor strength (Jaeger *et al*., 2013). In contrast, FNB frequently causes quadriceps weakness, which delays ambulation and increases the risk of falls (Thobhani *et al*., 2017). Advances in ultrasound-guided regional anesthesia have further improved the accuracy and safety of ACB, reducing the risk of nerve injury and vascular puncture during block placement (Visser and Sato, 2018; Kopp *et al*., 2015).

Recent meta-analyses have demonstrated that continuous and single-shot ACB provide analgesia comparable to FNB but preserve quadriceps strength more effectively, enabling earlier ambulation and better adherence to physiotherapy goals within ERAS protocols (Elmallah *et al*., 2019). As a result, ACB is now the preferred postoperative analgesic technique for TKR, especially in patients with contraindications to neuraxial anesthesia, including those with prior lumbar stabilization (Koh *et al*., 2017).

2 CASE PRESENTATION

A 65-year-old woman was admitted for elective bilateral total knee replacement (TKR) due to advanced bilateral osteoarthritis, presenting with chronic pain, stiffness, and severe limitation of mobility. The patient had a history of posterior lumbar stabilization surgery at vertebral levels L3 to L5, which was performed five years earlier for degenerative lumbar spinal stenosis. Because of the presence of spinal implants and altered spinal anatomy, neuraxial anesthesia such as spinal or epidural block was avoided due to the potential technical difficulty and the risk of neurological injury. The decision was therefore made to administer general anesthesia combined with bilateral continuous adductor canal block (ACB) for postoperative analgesia.

Under sterile conditions and ultrasound guidance, the adductor canal was identified bilaterally at the mid-thigh level using a high-frequency linear probe. The canal was visualized as a fascial compartment bordered by the sartorius muscle and vastoadductor membrane, with the femoral artery serving as a key anatomical landmark. A 20-gauge catheter was carefully inserted on each side adjacent to the saphenous nerve. After confirming proper placement through visualization of local anesthetic spread under ultrasound, an initial loading dose of 20 mL of 0.25% bupivacaine was administered into each canal. This was followed by a continuous infusion of 0.1% bupivacaine at a rate of 5 mL per hour per limb using an infusion pump. The patient tolerated the procedure well, with no complications during placement or infusion.

For systemic analgesia, a multimodal regimen was implemented to enhance pain relief and reduce opioid requirements. The regimen included intravenous paracetamol 1 gram every six hours, intravenous parecoxib 40 milligrams twice daily, and oral pregabalin 50 milligrams nightly. Additionally, a patient-controlled analgesia (PCA) system with fentanyl was provided, allowing the patient to self-administer 25 micrograms of fentanyl with a 10-minute lockout interval for breakthrough pain. The bilateral ACB catheters were maintained for three postoperative days with continuous infusion of bupivacaine 0.1% at 5 mL per hour per side. On postoperative day four, both catheters were removed after confirming stable analgesia and preserved motor function. During catheter removal, rescue intravenous analgesia was available if needed, and PCA fentanyl was continued temporarily to ensure a smooth transition.

By postoperative day five, the patient's pain remained well controlled and PCA was discontinued. Analgesia was transitioned fully to oral medications, consisting of paracetamol 600 milligrams four times daily and celecoxib 60 milligrams twice daily. The patient demonstrated excellent postoperative pain control throughout the recovery period, reporting pain scores between 0 and 1 on the Numerical Rating Scale (NRS) both at rest and during knee flexion during the first three postoperative days. Her knee range of motion (ROM) improved markedly, increasing from 0 to 80 degrees on postoperative day one to 0 to 100 degrees by day three. Peripheral perfusion remained stable, and there were no signs of block-related complications such as hematoma, infection, or local anesthetic systemic toxicity. Importantly, no quadriceps weakness was observed, confirming that the adductor canal block provided effective sensory blockade while preserving motor function.

On postoperative day six, the patient experienced a mild increase in pain intensity (NRS 3 to 4), which remained tolerable under oral analgesic therapy. Her regimen was adjusted to include paracetamol 600 milligrams four times daily, celecoxib 60 milligrams twice daily, and a fixed-dose combination of tramadol 32.5 milligrams with paracetamol 300 milligrams as needed. By postoperative day seven, the patient achieved further improvement, with knee flexion reaching approximately 110 degrees and independent ambulation without assistance. The surgical sites remained clean and dry, with no evidence of infection or delayed wound healing. The patient was discharged on postoperative day seven in stable condition, continuing with oral multimodal analgesia and a home-based physiotherapy program aimed at strengthening periarticular muscles and maintaining joint flexibility.

3 RESULT AND DISCUSSION

3.1 Postoperative rehabilitation principles

Early postoperative mobilization within the first 24 hours following total knee replacement (TKR) is a crucial component of recovery, as it helps prevent complications such as joint stiffness, muscle atrophy, venous thromboembolism, and prolonged hospitalization (Wylde *et al*., 2018; Pozzi *et al*., 2013). Standard rehabilitation protocols

include quadriceps isometric exercises, straight leg raises, and both passive and active knee movements. In some cases, continuous passive motion (CPM) devices are utilized to maintain early knee mobility and stimulate synovial fluid circulation, though their long-term benefits remain limited (Lenssen *et al*., 2008). Recent meta-analyses suggest that while CPM can improve short-term range of motion (ROM), its contribution to long-term functional outcomes is minimal (Harvey *et al*., 2014).

Progressive physiotherapy goals typically include achieving at least 90° of flexion and partial ambulation within the first two postoperative weeks, followed by ROM of 110° to 120° and independent ambulation within six weeks (Elmallah *et al*., 2019). Attaining these milestones depends heavily on effective pain control. Patients with well-managed postoperative pain demonstrate higher compliance with physiotherapy, faster functional recovery, and shorter hospital stays (Kehlet & Dahl, 2003; Gandhi *et al*., 2019).

3.2 Pain management and rationale for ACB

Effective postoperative pain management plays an essential role in promoting early rehabilitation after TKR. A multimodal analgesic approach, combining systemic non-opioid agents such as paracetamol, COX-2 inhibitors, and adjuvant medications like pregabalin, along with regional nerve blocks, has been shown to improve pain outcomes while minimizing opioid use (Memtsoudis *et al*., 2020). Historically, neuraxial anesthesia such as epidural analgesia was considered the gold standard; however, in patients with prior lumbar instrumentation, this approach presents technical difficulties and an increased risk of neurological injury due to altered spinal anatomy (Hebl *et al*., 2010; Neal *et al*., 2018).

The femoral nerve block (FNB) has long been an alternative for TKR analgesia but often causes quadriceps weakness, delaying ambulation and increasing fall risk (Thobhani *et al*., 2017). The adductor canal block (ACB), on the other hand, provides selective sensory blockade of the saphenous nerve and medial femoral cutaneous branches while sparing motor fibers, enabling effective analgesia of the anteromedial knee without impairing quadriceps strength (Jaeger *et al*., 2013). The PROSPECT 2022 guidelines recommend ACB, whether single-shot or continuous, in combination with

multimodal analgesia and periarticular infiltration as the optimal strategy for TKR pain management (Kim *et al*., 2021).

In the present case, continuous bilateral ACB provided strong analgesia (NRS 0–1) during the first three postoperative days, while maintaining the ability to perform straight leg raises and early ambulation. The continuous infusion of 0.1% bupivacaine at 5 mL per hour maintained consistent plasma levels, avoiding peaks and troughs of analgesic effect. This approach is supported by evidence indicating that continuous ACB provides sustained analgesia with minimal systemic toxicity (Canbek *et al*., 2019; Lavand'homme *et al*., 2022).

3.3 Case discussion

Pain management after TKR is critical for ensuring rapid functional recovery, particularly in patients for whom neuraxial anesthesia is contraindicated. In this case, the patient's history of lumbar stabilization necessitated an alternative approach to regional anesthesia. Bilateral continuous ACB offered effective postoperative pain control while avoiding motor blockade and neurological complications. The patient was able to perform active knee extension and ambulate with assistance within 24 hours after surgery, confirming the motor-sparing nature of ACB, which allows preservation of quadriceps function (Mariano & Ilfeld, 2014).

These findings are consistent with previous studies demonstrating that ACB achieves equivalent analgesia to FNB but results in earlier mobilization, greater patient satisfaction, and reduced opioid consumption (Elmallah *et al*., 2019; Berikashvili *et al*., 2024). Additionally, compared with epidural analgesia, ACB is associated with a lower incidence of hypotension, urinary retention, and postoperative nausea, making it safer and more compatible with early physiotherapy (Kehlet, 2015).

Throughout the seven-day postoperative period, the patient reported stable pain scores, maintained functional mobility, and experienced no catheter-related complications. The absence of quadriceps weakness confirmed that the block provided selective sensory inhibition without interfering with motor function, consistent with findings by Kuang *et al*. (2016), who demonstrated that ACB maintains quadriceps strength better than FNB while ensuring adequate analgesia. The overall functional

outcome, with knee ROM improving from 0–80° to 0–110° within one week, supports the clinical effectiveness of continuous ACB in achieving early rehabilitation goals.

3.4 Integration with ERAS principles

The Enhanced Recovery After Surgery (ERAS) protocol aims to optimize perioperative care through multimodal strategies that minimize surgical stress, maintain physiological function, and expedite recovery (Kehlet & Wilmore, 2008). Effective pain control is central to ERAS, as inadequate analgesia delays ambulation and prolongs hospitalization. In this case, the use of bilateral continuous ACB in combination with multimodal systemic analgesia perfectly aligned with ERAS objectives.

The patient's early mobilization within 24 hours and discharge by postoperative day seven are consistent with ERAS milestones for knee arthroplasty (Memtsoudis *et al*., 2020). Moreover, the opioid-sparing regimen minimized the risk of adverse effects such as sedation and nausea, which commonly hinder early rehabilitation (Elmallah *et al*., 2019). Continuous ACB also contributes to hemodynamic stability by attenuating the sympathetic response to surgical pain and reducing perioperative stress hormone release, further promoting recovery (Mariano & Ilfeld, 2014).

3.5 Limitations and clinical implications

Despite the favorable clinical outcome, this case report has several limitations. As a single-patient observation, generalization of results must be made cautiously, since case reports primarily serve to generate hypotheses rather than establish definitive clinical evidence (Hwang & Chung, 2020). The absence of standardized outcome measures such as the Knee Society Score (KSS) or the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) limits the objectivity of functional assessment and restricts comparison with larger clinical studies (Insall *et al*., 1989; Bellamy *et al*., 1988). Moreover, the lack of long-term follow-up beyond hospital discharge prevents evaluation of the sustained analgesic efficacy and functional recovery that could be achieved with continuous adductor canal block (ACB) (Elmallah *et al*., 2019).

Nevertheless, the successful management of postoperative pain in this patient highlights the potential of bilateral continuous ACB as a safe, effective, and motor-sparing alternative for patients undergoing total knee replacement (TKR) who present contraindications to neuraxial techniques (Hebl *et al*., 2010; Jaeger *et al*., 2013). The findings of this case are consistent with accumulating evidence supporting the use of ACB within multimodal analgesic strategies as part of Enhanced Recovery After Surgery (ERAS) protocols (Kehlet & Wilmore, 2008; Memtsoudis *et al*., 2020). Continuous ACB has been shown to facilitate early mobilization, reduce opioid consumption, and enhance patient satisfaction while minimizing complications such as motor weakness and hypotension (Thobhani *et al*., 2017; Berikashvili *et al*., 2024). Therefore, this case reinforces the growing consensus that continuous ACB represents a clinically valuable, patient-centered component of modern postoperative pain management in knee arthroplasty (Kuang *et al*., 2016).

4 CONCLUSION

Effective postoperative pain management is essential for achieving early mobilization, functional recovery, and patient satisfaction following total knee replacement (TKR). In patients with prior lumbar surgery, neuraxial anesthesia may be technically challenging and potentially unsafe due to altered spinal anatomy and the presence of instrumentation (Hebl *et al*., 2010). This case demonstrates that bilateral continuous adductor canal block (ACB), when integrated with multimodal systemic analgesia, provides excellent postoperative pain control, preserves quadriceps motor function, and facilitates early rehabilitation without major complications.

Continuous ACB offers several advantages over traditional analgesic approaches, including motor-sparing properties, reduced opioid consumption, and compatibility with the goals of Enhanced Recovery After Surgery (ERAS) protocols (Kehlet & Wilmore, 2008; Memtsoudis *et al*., 2020). Compared with femoral nerve block, ACB maintains quadriceps strength, decreases fall risk, and supports independent ambulation during the early postoperative phase (Jaeger *et al*., 2013; Thobhani *et al*., 2017).

The favorable clinical outcome observed in this case reinforces the growing body of evidence that continuous ACB is a safe, effective, and patient-centered option for

postoperative analgesia in TKR, particularly for individuals with contraindications to neuraxial anesthesia. Broader clinical studies and randomized controlled trials are warranted to validate its long-term efficacy, optimize dosing regimens, and establish standardized protocols for bilateral applications in complex surgical populations (Elmallah *et al*., 2019; Kuang *et al*., 2016).

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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