e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(6); 2309-2319

Original Research Article

Study on Regional and Local Anesthesia in the Prevention of Chronic Post-Surgical Pain

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Received: 23-04-2023 / Revised: 23-05-2023 / Accepted: 26-06-2023

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Conflict of interest: Nil

Abstract:

Introduction: During regional anesthesia, an anesthetic is injected close to nerves to block pain signals without completely knocking a patient out. Reduced drug doses, a quicker recovery time, and no airway manipulation are just a few of the benefits of regional anesthesia compared to general anesthesia. In order to prevent chronic postoperative pain, however, more research is needed to resolve limitations and optimise outcomes.

Aims and Objectives: This research aims to determine if regional and local anesthesia effectively reduces the risk of long-term discomfort following surgery.

Methods: The study was conducted for one year and enrolled 75 individuals with knee osteoarthritis who underwent" Local Infiltration Anesthesia (LIA)" or "Ultrasonic-Guided Regional Anesthesia (USRA)". Comparatively, the USRA group underwent peripheral nerve blocks whereas the LIA group received injections of dexmedetomidine and ropivacaine. No drains or postoperative antibiotics were used, but they were given as a precaution. Together, LIA/USRA and general/spinal anesthesia were used. The patients' pain levels were measured using the numeric rating scale (NRS), and they were given oral analgesics and postoperative opioids as necessary.

Result: Except for the primary anesthetic technique, there were no significant differences in baseline characteristics between the LIA (n=37) and USRA (n=38) groups of subjects. While the LIA group had improved NRS scores during exercise on day one postoperatively, they needed more opioids on the day of surgery. Dexmedetomidine was well tolerated with no reported side effects. The regression analysis showed that sex, LIA type, and anesthesia type were not significant factors.

Conclusion: Multimodal analgesia is enhanced by dexmedetomidine's opioid-sparing effects after total knee arthroplasty, although more study is required.

Keywords: Local Anaesthesia, Dexmedetomidine, Arthroplasty, Regional Anaesthesia.

Introduction

In order to prevent or reduce pain, regional anesthesia involves injecting an anesthetic drug into a peripheral nerve and interrupting signal transmission. It is distinct from general anesthesia because it does not lower the patient's awareness to ease the pain. There are a number of benefits over general anesthesia, including avoiding airway manipulation, lower dosages, fewer systemic medication

adverse effects, quicker recovery, and noticeably less discomfort following surgery. With significantly less discomfort after surgery and early involvement in physical therapy, postprocedural recuperation has been proven to be shortened. In addition to being used postoperatively, regional anesthesia can be used with general anesthesia to treat a variety of chronic as well as acute pain disorders [1].

Anatomy and landmarks will vary depending on the different kinds of blocks being executed. In order to achieve neuraxial anesthesia, drugs (local anesthetic, opioids, etc.) are administered close to the nerves of the central nervous system. Direct injection into the subarachnoid or epidural area of the spinal cord is used for this procedure. Epidural, spinal, and spinal-epidural combination procedures are the most often used neuraxial methods.

In order to administer During spinal anesthesia, an incision is placed between the lumbar vertebrae, typically between L4 and A Conus modular ceases in adults at approximately L1/L2; local anesthetic either with or without opioid is administered in the subarachnoid space around level L5.

The device traverses the supraspinal tendons, interspinous ligament, and ligamentum flavum [2]. Intravenous regional anesthesia is now seldom utilised due to improvements in regional methods and ultrasound-guided blocks. Anesthesiologists and pain specialists have adopted regional anesthesia in large numbers.

It calls for formal education and in-depth anatomical understanding. Whether a regional block ought to be used depends on the kind of procedure, the medical history of the patient, and the anesthesiologist's personal preferences. Among the indications are postoperative pain control, the treatment for specific chronic pain issues, and avoiding side effects of drugs used during general anesthesia (such as respiratory depression) [3].

The most common varieties of regional anesthesia include

- (Epidural and spinal anesthesia) Neuraxial anesthesia
- Blocks to peripheral nerves
- regional intravenous anesthesia.
- The following are absolute prohibitions against using regional anesthesia:
- The patient's opposition
- local anesthetic allergy
- Associated contraindications include:
- Active infection near the injection site
- sufferers of coagulopathies
- existing neurological impairment
- Lack of cooperation

Chronic postoperative pain affects chronic pain's financial burden and lowers the quality of life. It has significant emotional and social repercussions. As a result, preventing persistent postoperative pain is a priority. The International Association has designated 2017 for the Study of Pain (IASP) as the Global Year Fighting Pain During Surgery. "chronic postoperative pain" refers to the discomfort that persists for at least three months after surgery, confined to the surgical site, is absent before the procedure, is different from pre-operative pain, and has no other apparent explanation [4].

Researchers are beginning to realise that surgery may be critical to developing chronic pain. Early research found that as much as forty percent of clients at many pain clinics around the UK suffered from chronic pain brought on by surgery or trauma. In addition to confirming substantial incidences of ongoing postoperative pain following a range of surgical procedures, later studies have identified significant risk factors for prolonged postoperative pain, including demographic, genetic, & psychological variables that may help in research planning, prevention, and therapy. While severe damage is unpredictable, elective

surgery enables us to examine possible contributors to prolonged pain. Multimodal analgesia is the simultaneous administration of various analgesic medications or techniques that block several nociceptive and neuropathic pain receptors. This reduces acute postoperative pain and the stress response associated with surgery and may affect the kinetic a series of circumstances that might cause prolonged postoperative discomfort. Regional anesthesia (RA) is the cornerstone of efforts to deliver. Using multimodal techniques, drug-free or drug-reduced anesthesia can be achieved methods [5].

To stop more harm or damage, discomfort is an evolutionary adaptation to harmful stimuli. However, the damage brought on by surgery may trigger several molecular processes that ultimately cause discomfort that outlast its value. Both acute and chronic pain following surgery are attributed to a number of unique mechanical pain types. To variable degrees, a surgical incision may affect all three (nociceptive, inflammatory, and neuropathic). Peripheral nociceptors emit impulses in response to surgical damage, triggering nociceptive circuits in the spinal and supraspinal regions of the brain. Continuous stimulation, and acidosis, with inflammation close to Increased excitability & spontaneous firing, particularly ectopic firing, are fed by the injury site in peripheral nociceptors [6].

Modifications in the expression of genes inside the dorsal root, in the cell bodies of peripheral nociceptors ganglia) as a result of surgical damage also contribute to longer-long-lasting excitability or signal transmission from the senses. Central sensitization at the spinal cord level may also happen with the sustained transmission of such nociceptive impulses. The intensity and length of the discomfort and also its progression into a more chronic condition are influenced by the degree of stimulation caused by a medical insult as well as the reaction of surrounding glial, stromal, and immune cells that are seen in both the outer regions as well as the spinal cord itself [7].

By modifying the pain signals caused by a surgical incision, local Either perioperative prevention of ongoing postoperative pain may be significantly aided by using neuraxial and peripheral nerve blocks during anesthesia. Localised Anaesthesia and other multimodal analgesics prevent the pain pathway from being activated. Although the majority of surgical damage is too peripheral nerves, which activate Surgery has the potential to cause nociceptive discomfort, inflammatory, and neuropathic alterations that might impact both the central and peripheral nervous systems and contribute until the start of persistent discomfort following surgery [6]. Although there is still much to learn about how RA affects these variables, some potential processes include blocking or dampening nociceptive nerve impulses, regulating glial cell-to-glial cell communication, and decreasing the plasticity of neuronal synapses. Local anesthetics' anti-inflammatory qualities may help lessen sensitization [7].

Local anesthetics may decrease ectopic neuronal activity, the generation of cytokines and other mediators of inflammation, and neutrophil priming, according to animal models or in-vitro research. Additionally, RA prevents sensitization of the central nervous system by indirectly reducing pain signals sent to the nociceptive centers of the cortical, supraspinal, and spinal cords. The acute stage of RA has been replicated in several animal models to reduce central sensitization; notably, one study found that RA reduced long-term pain sensitivity, which might be a proxy for reducing chronic pain [8].

According to reports, 5% of patients in the USA report using new persistent opioids, defined as being used 3 months following surgery in a patient who has never used opioids before. Genetics, prior more

invasive procedures, a history of drug misuse or opioid usage, and pre-and post-operative care Opioids are among the risk factors for long-term opioid usage. Dose and duration, underlying mental health conditions including depression, extremes of age, being in a lower socioeconomic bracket, having less education, and having A history of substance abuse issues in the family. Several danger factors also increase the likelihood of persistent discomfort following surgery. The ability of RA to control pain without causing other side effects is one of its key benefits, primarily depending on narcotic drugs [9]. In particular, among patients who have a strong baseline propensity to overestimate their pain, RA may lower postoperative opioid intake, according to a new prospective observational research. Emifentanil, in particular, is a high-dose intraoperative. Owing to opioid-induced hyperalgesia, opioids may increase early postoperative pain scores and analgesic use. Although many studies have shown that opioids can cause hyperalgesia during recovery after surgery, only a few papers discuss hyperalgesia in the context of the development of chronic pain [10].

In any event, RA may help patients use high-dose intraoperative opioids less frequently, making it a desirable pain management option that is especially helpful for some patient demographics. With the frequency of cesarean sections growing worldwide and reports of persistent postoperative discomfort as high as 6–18%, pain management following a cesarean section has assumed increasing importance. By blocking abdominal wall nerves, the transversus abdominis plane block, a well-known RA method, may lessen pain during cesarean delivery. The use of RA is often linked to a decrease in persistent postoperative pain (OR 0.46 (95%CI 0.28-0.78, p = 0.004)) [11]. With fewer encouraging findings thus far, most recent studies have concentrated on the relationship between RA and associated gynecological treatments, including hysterectomies and the effect of adjunctive drugs on RA. The evidence supporting RA's ability to prevent persistent postoperative pain is less apparent when it comes to the effect of RA in relation to additional surgical operations, including hysterectomy, prostatectomy, hernia repair, laparotomy, and heart surgery. Additionally, research on phantom limb pain following amputation is expanding, and numerous ongoing studies could assist in closing the information gap for treating these individuals disproportionately at the chance of chronic pain following surgery (30–85% after limb amputation) [12].

Methods

Study design

75 adult patients planned for significant knee osteoarthritis (OA), and the initial total knee arthroplasty (TKA) procedures were the subject of the study. Local infiltration anesthesia (LIA) or ultrasonic-guided regional anesthesia (USRA) groups were randomly allocated to participants. LIA containing the patients who received local anaesthesia and USRA group containing patients who received regional anaesthesia.

In order to block distal nerve fibers, patients in the LIA group had periarticular injections of 100 g ml1 of dexmedetomidine and 60 ml of ropivacaine 0.5% applied all around the knee joint, excluding the posterior capsule. Before placing the liner, infiltration was carried out following the insertion of the tibial and femoral components. According to the regional standard of care, Both single-shot blocks of peripheral nerves were performed in the USRA group shortly before the onset of general anesthetic or spinal anesthesia. Every patient underwent a single dose of preoperative prophylactic antibiotics (30 minutes before making the skin incision, provide 2 g or cefazolin intravenously). The patients received neither postoperative antibiotics nor any use of wound drains.

General or spinal anesthesia was used in addition to LIA or USRA. Participants were only given remifentanil during general anesthesia to prevent long-lasting opiates from altering their experience of pain throughout the early stages of recovery in order to prevent a potential carry-over effect with the anesthetic approach. According to the regional standard of care, all patients received fixed dosages of oral non-opioid analgesics (ibuprofen 600 mg) thrice a day following surgery. Additionally, every patient was administered opioids (piritramide) for pain management by the ward nurses after the operation. An 11-point Numerical Ratings Scale (NRS) for self-rating pain at rest and during exercise was used to collect data on it four times daily.

Inclusion and exclusion criteria

The study included patients who had severe osteoarthritis and provided consent for primary total knee arthroplasty. Pregnant women, breastfeeding patients, and patients who are allergic to medications used in the study are excluded.

Statistical analysis

Practical statistical analysis was performed on the study using SPSS 25. While discrete data is provided as frequencies and their corresponding percentage, continuous data is reported as mean and standard deviation. The study used ANOVA as a statistical analysis method. The threshold for significance was set at P 0.05.

Ethical approval

Each patient's permission was gained once they had been informed of the study's methodology. The concerned hospital's Ethical Committee has accepted the study's methodology.

Results

Table 1 lists the general features of the participants in a study, comparing two groups: LIA (n=37) and USRA (n=38). Regarding the individuals who took part in patients' baseline characteristics, The two groups did not differ.

Only the primary worker's anesthetic technique differed significantly (general anesthesia was utilized with greater frequency in the USRA group).

Table 1: Baseline characteristics of the patients in both the group

	LIA, n=37	USRA, n=38	P-value
Age	69.2 ± 10.9	68.2 ± 11.4	0.772
Female	18 (48.6)	15 (39.5)	0.570
Height	168.2 ± 9.8	171.5 ± 12.4	0.439
Weight	77.4 (77.4-88.9)	85.8 (71.2-131.8)	0.438
BMI	28.7 (25.9-31.7)	27.9 (24.5-33.9)	0.735
ASA physical status			0.438
I	0 (0)	2 (5.3)	
II	15 (40.5)	11 (28.9)	
III	22 (59.4)	25 (67.9)	
Main anesthetic technique			0.038
General anesthesia	8 (21.6)	17 (44.7)	
Spinal anesthesia	29 (78.4)	21 (55.3)	
Days of hospitalization	6.3 (6.3-7.2)	6.3 (6.3-7.2)	0.640

The LIA group also required more The patient was discharged by the PACU doctors and received opioids on the ward on the day of surgery (15.5 [IQR 0.0-15.4] mg vs. 0.0 [IQR 0.0-0.0] milligrams, P 0.001). As a result, the LIA group required more opioids overall on the day of surgery in the PACU or the ward (27.3 [IQR 16.9-35.6]

milligrams vs. 3.4 [IQR 0.0-23.7] milligrams, P=0.001).

Table 2: Oral morphine equivalents (OME) postoperatively

	LIA, n=37	USRA, n=38	p
In the PACU, OME	12.4 (10.2-20.9)	0.0 (0.0 - 18.6)	0.048
Day 0 of OME within the Ward	15.6 (0.0 - 15.3)	0.0 (0.0 - 0.0)	<0.001
OME in the ward and PACU (day 0)	27.3 (16.9 - 35.6)	3.4 (0.0 - 23.7)	0.001
OME 48h (PACU, ward, day 0 of post-TKA)	42.6 (23.8 - 57.4)	27.5 (0 - 33.6)	0.023
On the ward, OME			
Day 1	15.5 (0 - 15.4)	0.0 (0.0 - 22.7)	0.571
Day 2	0.0 (0 - 15.4)	0.0 (0.0 - 22.7)	0.769
Day 3	0.0 (0.0 - 0.0)	0.0 (0.0 - 15.8)	0.565
Day 4	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.268
Day 6	0.0 (0.0 - 0.0)	0.0 (0.0 - 0.0)	0.978

On the first postoperative day, the Significantly, LIA group outperformed the USRA group in terms of NRS scores when exercising (USRA group 0.0 [0-2.0] against LIA group 2.4 [1.0-4.5]; P2=0.001). Additionally, there was no discernible difference between the NRS results during the second day following surgery and in the PACU. The research groups did not significantly differ after the second postoperative day. Neither research group experienced any negative effects with dexmedetomidine during preoperative or postoperative appointments.

Table 3: The highest postoperative numeric pain ratings (NRS) during rest and after physical activity

	LIA, n=37	USRA, n=38	P-value
Maximum NRS in/at rest			
PACU	0.0 (0.0 - 2.1)	0.0 (0.0 - 0.8)	0.092
Day 1	1.2 (0.0 - 3.4)	0.0 (0.0 - 0.8)	0.007
Day 2	2.4 (1.0 - 4.5)	1.2 (0.0 - 3.8)	0.314
Day 3	1.3 (0.0 - 2.1)	1.3 (0.0 - 1.5)	0.622
Day 4	0.0 (0.0 - 1.4)	0.0 (0.0 - 1.4)	0.724
Day 5	1.5 (0.0 - 1.5)	0.7 (0.0 - 1.7)	0.908
Day 6	0.0 (0.0 - 1.8)	1.8 (0.0 - 3.2)	0.268
Maximum NRS at the time of exercise in/at			
PACU	0.0 (0.0 - 3.2)	0.0 (0.0 - 1.8)	0.012
Day 1	2.2 (1.2 - 4.3)	0.0 (0.0 - 2.8)	0.001
Day 2	2.4 (2.4 - 5.8)	2.4 (1.2 - 5.8)	0.283
Day 3	2.3 (1.0 - 3.8)	2.3 (1.3 - 2.9)	0.913
Day 4	1.2 (0.7 - 2.5)	1.2 (0.7 - 2.5)	0.874
Day 5	1.2 (0.7 - 2.5)	2.3 (01.2 - 2.5)	0.346
Day 6	1.2 (1.2 - 4.3)	2.9 (1.2 - 4.3)	0.237

Identifying a shaky association between discomfort during activity in the PACU and LIA and the necessary OME was possible. There were slight correlations between LIA with the OME within the PACU in the initial postoperative day and between LIA with pain experienced during activity on the ward. The kind of anesthesia (spinal anesthesia), LIA, and sex were there. They

were removed from the logistic regression analysis since they were not significant.

Table 4: Logistic regression on painkiller usage in the first 48 hours following surgery and exercise-related discomfort on day two

Opioid consumption	OR	95% CI	p-value
Spinal anesthesia	1.018	0.319 -3.732	0.964
LIA	2.512	0.772 - 8.212	0.129
Male sex	1.092	0.318 - 3.734	0.897
Pain			
Spinal anesthesia	1.124	0.631 - 1.997	0.698
LIA	1.634	0.512 - 5.234	0.417
Male sex	0.786	0.236 - 2.617	0.70

Discussion

A dangerous aftereffect of major surgery called continuous post-surgical pain (CPSP) can degrade a patient's quality of life. Complex biological, psychological, and environmental factors that are still being wholly understood participate in the creation of CPSP. Currently, perioperative pharmacologic therapies reduce pain and the need for analgesics in acute and long-term pain by suppressing and preventing sensitization. The corpus of research devoted to therapy methods to lessen CPSP is still tiny and understudied despite the negative impact of CPSP on patients [13]. The primary pharmacologic possibilities in managing CPSP are reviewed in an article, along with the treatment of minimising immediate post-operative discomfort and preventing its potential for escalation to chronic pain in the future through prophylactic analgesia and novel methods. The establishment of independent Services for managing transitional pain is intended for those at a high risk of experiencing persistent post-surgical discomfort. This is another crucial area of focus for clinical practice [14]. Other significant fields among the areas of concentration for clinical practice are the multifunctional treatment of CPSP customers, psychological moderators for the feeling of pain, and the management of patients. The likelihood of persisting postoperative pain (PPP) may be reduced by regional anesthesia—the 2017 revision of the Cochrane Review, which was first released in 2012. PPP risk is lower when regional anesthesia is used. Small research size, attrition bias, and performance null and bias significantly undermined our findings. The studies cannot generalise to children or other treatments [15].

In order to improve patient outcomes and postoperative patients' overall quality of life, persisting postsurgical pain (PPP) may be prevented by employing regional anesthesia procedures to control acute pain. The review's objective is to summarise the most recent research on perioperative regional anesthesia procedures to tackle and avoid PPP. Results from randomised controlled studies that had been separated into groups based on various surgical subspecialties were used to gather and analyse the data [16]. Conclusions on the effects of local anesthesia or regional anesthesia on the long-term outcomes found in the studies analysed were made for each surgery category. By controlling optimum perioperative analgesia with regional anesthesia and preoperative consultations anesthesia & Following various types of surgery, local analgesia plays a crucial role in avoiding and controlling postoperative pain to limit the possibility of PPP. The regional significance anesthesia plays in preventing chronic postsurgical pain (CPSP) has to be confirmed by more research in various surgical subspecialties [17].

A common and incapacitating disease, prolonged (chronic) pain following surgery, may be less likely under regional anesthetic. We contrasted regional anesthesia with traditional analgesics to prevent persistent postoperative pain (PPP). Epidural anesthesia and paravertebral block are administered to one out of each four and five patients, respectively, who could avoid PPP following thoracotomy for breast cancer surgery [18]. Our results are undermined by small sample sizes, performance bias, attrition, and insufficient outcome data, particularly at 12 months. Previous research suggests that truncal regional anesthesia (TRA), which includes methods like paravertebral block, may considerably add to analgesia following mastectomy [19]. However, individual differences in postoperative pain intensity and effect make it possible to take significant steps towards individualised perioperative treatment by identifying those who would benefit from TRA the most. Preoperative TRA or a lack of blockwas given to mastectomy patients in a prospective observational trial, according to their psychological features, including pain catastrophizing. On the day of surgery, TRA gave rapid analgesic relief for patients with a mastectomy, but this effect was more prominent and maintained in those with higher baseline catastrophizing [20]. The frequency of ongoing pain following surgery, a common and incapacitating disease, may be decreased with a regional anesthetic. To assess the effectiveness of conventional analgesia vs. local anesthesia and regional anesthesia in preventing postoperative pain six or twelve months following surgery [21]. We examined the Cochrane Central Register of Controlled Trials (CENTRAL) without regard to language restrictions. Free text analysis and restricted vocabulary search were combined. Only randomised controlled clinical trials (RCTs) were included in the findings. We manually searched through reference lists for trials, reviews, and conference abstracts that were included. We incorporated RCTs with a pain result at six or twelve months following surgery that contrasted local or regional anesthesia with traditional analgesia [22]. We express caution since our evidence synthesising is merely based on a few pieces of research. There is a need for more high-quality methodological studies that include a range of surgical procedures and age ranges, including youngsters. About 18 million surgical operations are carried out in Germany annually [23]. A moderate to severe form of persistent post-surgical pain (CPSP) that can significantly reduce quality of life develops in 10% to 15% of surgical patients. To be considered chronic, the pain must last at least three months; however, pain that develops after some time without symptoms is not disqualified. The frequency of CPSP may be reduced by using local anesthetics during surgery [24]. Techniques for local and regional anesthesia and the intravenous injection of lidocaine are covered. Intravenous lidocaine and local and regional anesthetic methods reduce the risk of CPSP following specific kinds of surgical operations. Lidocaine is administered intravenously CPSP off-label use is avoided, and the patient is notified that agreement is needed. The evidence supporting the metrics discussed here must be better to medium [25].

The prevalence of chronic post-surgical pain (CPSP) has not decreased over the past few decades, raising concerns about the effectiveness of preventative measures. While local analgesia is employed to manage acute pain, its ability to prevent CPSP is still up for dispute. Using targeted analgesia to prevent the escalation of acute pain into chronic discomfort will be reviewed, as well as its successes in the future. Perioperative regional analgesia fails to stop CPSP after thoracotomy. In highly catastrophizing individuals following breast cancer, an operation, paravertebral block, may delay the intensity

and impact of CPSP on everyday life for up to 12 months.

Even if current trials have numerous biases, perioperative regional analgesia, and preoperative genicular nerve neuro ablation cannot avoid CPSP in knee arthroplasty [26]. To completely comprehend the positive impacts of early pain relief, further study is required for efficient localised analgesia in trauma patients. We should reevaluate the use of regional analgesia during surgery if it cannot stop the development of CPSP. Using patient stratification to target individuals who would benefit from regional analgesia the most, such as those with high pain thresholds, may be helpful. We should reevaluate the use of regional analgesia during surgery if it cannot stop the development of CPSP. Using patient stratification to target individuals who would benefit from regional analgesia the most, such as those with high pain thresholds, may be helpful. More research is needed to determine how localized analgesia affects secondary pain-related outcomes, including intensity and neuropathic nature, despite no difference in CPSP incidence [27].

Conclusion

In conclusion, adding dexmedetomidine to local anesthetics in total knee arthroplasty (TKA) has shown encouraging results in enhancing the opioid-sparing impact of both the local infiltration analgesia (LIA) and the ultrasound-guided regional anesthesia (URSA) procedures. Dexmedetomidine's opioid-sparing effects appear to last longer in the LIA group than what has been documented in the most up-to-date research. These results indicate that combining LIA or URSA methods with dexmedetomidine can improve multimodal analgesia regimens. However, more study is needed to discover the optimal concentrations of ropivacaine and the correct dosage of dexmedetomidine for achieving the desired effects. These findings lay the groundwork for additional research, which may one day lead to better pain relief options for people receiving TKA. The study's single-center approach and lack of control groups without dexmedetomidine make it challenging to expand the results. The results were not significantly affected by differences in the primary anesthetic technique. Without ketorolac, we could compare the effects of dexmedetomidine more directly, but we could not evaluate the effectiveness of combinations. The generalizability of LIA may be affected by the use of very high doses of ropivacaine, as determined by the attending surgeon.

In contrast to worldwide studies, the average length of stay in Austria following TKA is longer due to local healthcare logistics. Anaesthesia technique planning and ensuring professional involvement in USRA procedures are areas for further study to resolve these limitations.

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