Rebound pain after regional anesthesia in ambulatory surgery: a narrative review

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Abstract

Background: **Rebound pain is a condition that may occur after regional anesthesia, characterized by an intense pain sensation exceeding the normal surgical pain. Despite being a research topic for the past decade, the underlying causes of this phenomenon still need to be clarified, and there are currently no clear recommendations on effective management.**

Objective: **This narrative review aims to provide a comprehensive understanding of rebound pain by presenting current research on its incidence, pathophysiology theories and risk factors and discussing management strategies in ambulatory surgery.**

Methods: **A literature research was performed between January 09, 2023, and February 27, 2023, using EMBASE, MEDLINE and Web of Science. We included all records concerning rebound pain in an ambulatory setting published in the last five years, and their findings were summarized.**

Results: **Rebound pain incidence is estimated at 50% after regional anesthesia. The currently more accepted consensus on the etiology behind rebound pain is the uncovering of unopposed nociceptive stimuli as the peripheral nerve block starts to fade. Primary risk factors include female gender, younger age, bone surgery, open surgical access, and pain catastrophizing. Dexamethasone and dexmedetomidine combined improve postoperative analgesia and extends sensory but not motor block. Early implementation of multimodal analgesia and comprehensive patient education are key features in management. Implementing patient education through verbal and written instructions concerning the expected trajectory and analgesics improves therapy compliance and reduces anxiety and uncertainty.**

Conclusions: **The currently more accepted consensus on the etiology behind rebound pain is the uncovering of unopposed nociceptive stimuli upon block resolution. Dexamethasone and dexmedetomidine combined improve postoperative analgesia and extends sensory but not motor block. Early implementation of multimodal analgesia is key in rebound pain prevention. Extensive patient education and verifying their expectations should be integral parts of the preoperative assessment in regional anesthesia.**

Keywords: **Rebound pain, Nerve block, Regional anesthesia, Ambulatory surgery.**

Introduction

Ambulatory surgery is trending as never before. The development of minimally invasive techniques and novel strategies in optimizing postoperative recovery and analgesia have led to faster recovery and earlier hospital discharge. Currently, more than 50% of procedures are being performed in an ambulatory setting[1].

Peripheral nerve blocks and regional anesthesia are cornerstones in daycare surgery, especially in orthopedic procedures. Apart from reducing acute postoperative pain, it has proven beneficial in improving patient satisfaction and reducing postoperative nausea and vomiting, opioid usage, and time spent in the post-anesthesia care unit and hospital[2–5]. It may even reduce long-term outcomes such as persistent post-surgical pain, morbidity, and mortality[4,6]. It became even more important during the COVID-19 pandemic as avoiding general anesthesia led to a decreased transmission rate[7].

Rebound pain (RP) occurs after the resolution of sensory block, potentially ruining the many benefits regional anesthesia provides. This transient hyperalgesia may lead to increased opioid usage and reduced patient satisfaction compared to patients who did not receive peripheral nerve block[4,8]. Acute pain is the main reason for emergency department visits and readmissions to the hospital after peripheral nerve blocks[4,9,10]. Ongoing pain may lead to persisting chronic pain and cardiopulmonary complications[9].

Intensive research has been performed to tackle this clinically relevant problem. However, its pathophysiology remains a topic of debate, and we need more efficient tools to prevent RP reliably. Modifying the sensory block using adjuvants such as dexamethasone is promising, but its benefit as a standalone measure is limited.

This study aims to summarize the most recent literature on rebound pain after regional anesthesia in ambulatory surgery concerning incidence, etiopathogenesis, risk factors, prevention, and potential management.

Methods

We performed a literature search for records that had been published in the last five years. The research was conducted between January 09, 2023, and February 27, 2023, using MEDLINE, EMBASE and Web of Science. The MeSH terms were "Rebound pain AND "Nerve block," "Rebound hyperalgesia" AND "Nerve block," "Rebound pain" AND "regional anesthesia," and "Rebound pain" AND "Ambulatory surgery."

Inclusion criteria were papers concerning rebound pain after peripheral nerve block and neuraxial anesthesia not solely specific to orthopedic surgery but also other ambulatory surgeries published in the latest five years. Accepted languages were English, French, Dutch, and German, which are comprehensible to our readers. Upon reading the articles, additional papers found in the reference list were included if they proved to yield valuable extra information on rebound pain and were published in the latest 5 years.

We excluded papers not debating the subject of rebound pain after regional anesthesia, lectures, comments on articles, and case reports.

The database research, screening and selection process of abstracts and was not automated and performed by 1 reviewer. Approval of the ethical committee was unnecessary, given the study design is a narrative review of the available literature.

Results

1. Literature search

She initial search using the aforementioned MeSH terms on different databases yielded 331 articles in total. More specifically, 117 articles were found on MEDLINE database, 131 using EMBASE and 83 using Web of Science. 3 additional records were identified through the reference list of included articles and provided valuable extra information.

After removing all duplicates (n=255) all abstracts were screened for inclusion and exclusion criteria. 4 articles were excluded based on title. The full text was not retrievable for 1 report. After assessment of the remaining articles, 65 total abstracts were included in the review. Most papers were limited to orthopedic procedures (66%), most of which were shoulder surgeries (43%). The Prisma flow diagram is shown in Figure 1.

2. Defining the problem

Many authors have suggested different definition variations, but the core characteristics of RP remain the same (Table I). Rebound pain is generally viewed as a sudden increase of pain sensation upon resolution of the sensory block. The most frequently used local anesthetics in single-shot peripheral nerve blocks (PNBs) are often long-acting such as levobupivacaine and ropivacaine, resulting in block attenuation between 12 and 24 hours after surgery. RP has a rapid onset, usually lasting two to six hours despite treatment. Most patients suffering from RP describe it as a burning sensation and sometimes a dull ache[11]. There have been attempts to standardize the pain intensity rating. The rebound pain score developed by Williams and his colleagues is one of the first and most well-known[1]. Despite these efforts, some authors need to be more specific in their definitions, and we lack an established consensus on features such as threshold values in pain intensity scores differentiating RP from a normal postoperative pain course. This allows for a potential liberal interpretation of whether increased postoperative pain can be categorized as RP or not. Consequentially the literature on RP shows very heterogenous results, which complicates the interpretation process.

Incidence reports of RP vary depending on the definition used by the authors. In their retrospective study, Barry et al. reported an overall incidence rate of 49% in ambulatory surgery[12]. These results seem replicated in most other studies, ranging between 40-60%[3,8,13]. In contrast, some RCTs have reported diverging incidence rates of 11% and 89%[14,15].

Patients are more likely to be dissatisfied after their PNB when RP occurs. RP appears to be the most common risk factor for patient dissatisfaction8. Interestingly, patients with RP after regional anesthesia are not less satisfied compared to patients receiving general anesthesia.

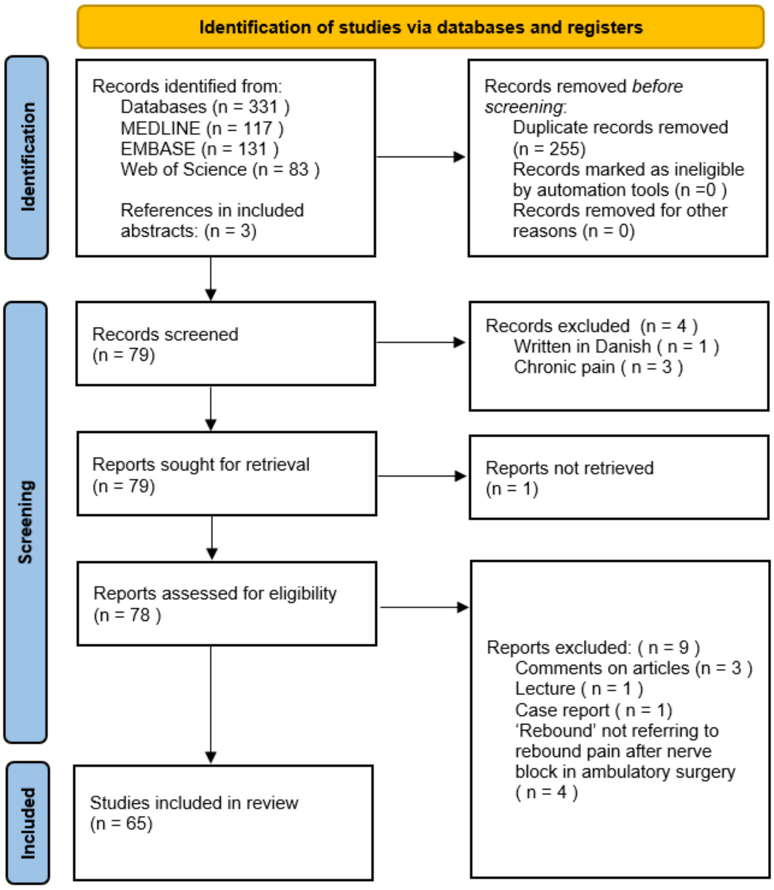

Fig. 1 — Prisma flow chart.

An indication that the early benefits of regional anesthesia are still well appreciated in the event of RP[6,16].

Although regional anesthesia does not prevent prolonged consumption of opioid analgesics after an operation, it does significantly reduce opioid usage in the early postoperative phase[17]. Rebound pain after PNB counteracts this benefit and may even sometimes lead to increased opioid intake in the first days when compared to general anesthesia without regional anesthesia[18]. Thillainadesan et al. demonstrated that a mean dose of eight mg intravenous morphine equivalents is needed to achieve initial treatment effect of RP after elective shoulder surgery[19].

RP typically occurs within 12 to 24 hours after administering a long-acting local anesthetic as a single injection. As a result, this often occurs during the initial night after surgery and negatively impacts sleep quality[11]. Increased opioid usage further reduces sleep quality, especially when regional anesthesia is combined with general anesthesia[6,20].

3. Pathophysiology hypothesis

The underlying pathophysiology has been debated and still needs to be fully understood. Questions were raised about whether the burning sensation and transient hyperalgesia could be due to neurotoxicity caused by the perineural injection of local anesthetics. Previous animal studies in rats have shown a transient hypersensitivity to heat after administration of perineural bupivacaine. Inherent pro-inflammatory properties of local

Table I. — Chronologic overview of suggested rebound pain definitions.

Author	Year	Definition
Williams et al. [1]	2007	Quantifiable difference in pain scores when the block is working versus the increase in acute pain encountered during the first few hours after the effects of peri-neural single injection or continuous infusion of local anesthetics resolve.
Lavand'homme [3]	2018	Mechanical – surgical pain caused by unopposed nociceptive inputs that are uncovered after peripheral nerve blockade resolution.
Dada et al. [21]	2019	State of hyperalgesia with an onset between 8 and 24h after block administration.
Kim et al. [65]	2021	The quantifiable difference in pain scores when a peripheral nerve block is working versus the acute pain encountered when the blocking effectiveness is reduced. Rebound pain period starts with the first increased pain score and ends after the first lowered pain score.

anesthetics may induce neurotoxicity without mechanical nerve lesions, potentially leading to RP[6,11]. Dada et al. suggested this may be mediated by abnormal spontaneous C-fiber hyperactivity and nociceptor hyper-excitability[21]. Combining perineural bupi-vacaine with dexamethasone in rats reduced this hyperalgesia[11,21]. However, the results in these animal studies were highly variable which questions their clinical relevance. Another counterargument for this theory is the occurrence of similar hyperalgesia in animal studies after surgery without any perineural local anesthetic administration[6]. Anti-inflammatory actions have also been attributed to local anesthetics through G-coupled, potassium- and NMDA receptors, contrasting the previously described pro-inflammatory tendency[21].

Patients suffering from RP often describe a burning sensation. However, heat hypersensitivity is not a typical feature[6]. If the local anesthetics were to induce RP through their potential neurotoxic and cytotoxic effects, this would result in a different, longer-lasting pain profile. Acute hyperalgesia in RP is transient, and other features resembling neuropathic pain have not been described. Furthermore, the use of locoregional anesthesia reduces the incidence of persisting post-surgical pain compared to general anesthesia[4]. Nociceptive stimuli are blocked before they enter the spinal cord while the PNB is active. This prevents the upregulation of receptors in the spinal root, a core mechanic in developing central sensitization[6].

It remains unclear whether nerve damage influences RP upon block resolution[21]. Nerve injuries usually combine pathogenic mechanisms such as ischemia, direct nerve trauma, and neurotoxicity and occur in only 0.4% of PNBs[1].

The currently more accepted consensus on the etiology behind RP is the uncovering of unopposed nociceptive stimuli as the PNB starts to fade. Blocking peripheral nerves temporarily prevents sensory input from entering the spinal cord but does not influence the local inflammatory process developing at the surgical site. An inflammatory cascade involving interleukins and cyclo-oxygenase ensues without systemic anti-inflammatory agents, resulting in peripheral upregulation of pain-related nociceptors[6].

Interestingly, two small studies (n=40 & n=50) involving the usage of perineural dexmedetomidine saw a reduced amount of serotonin, pain-related cytokines IL-8, and IL-1β22or IL-623, which are known to be a part of the inflammatory cascade. How these findings play a role in rebound pain remains unclear. This intervention seemed to decrease pain during the block further and delay the onset of RP. The sample size was too small to investigate the effects on RP incidence.

Whether RP has a specific pathophysiology behind it or is merely the result of inadequate postoperative pain management remains debatable. To address this, Stone and his colleagues proposed assigning a more neutral phrasing to this phenomenon, such as 'pain upon block resolution,' to avoid semantic confusion until its etiology becomes more apparent[24].

4. Associated risk factors for rebound pain

An overview of the most relevant risk factors is provided in Table II.

4.1 Patient-related risk factors

Young age, female gender, severe preoperative pain, and pain catastrophizing are the most important established risk factors[2,12,25]. Age and severe preoperative pain have also been identified as patient risk factors for severe acute postoperative pain and persistent post-surgical pain[12].

Both the incidence and intensity of RP are reduced in older people. This may be related to changes in

Table II. — Most important risk factors associated with rebound pain.

Risk factor	Odds ratio
Patient-related	
Age (per year)	0.98 [12]
Female gender	1.52 [12]
Severe preoperative pain	3.9 [13]- 4.2 [25]
High pain catastrophizing	4.8 [25]
Surgery related	
Bone surgery	1.82 [12] 5.2 [25]
Open surgery vs arthroscopic	4.2 [19]
Upper limb surgery	1.54 (Trending towards significance) [12]
Anesthesia-related	
No use of IV dexamethasone	1.72 [12]

pain perception but also altered tissue nociception, increased sensitivity of peripheral nerves to local anesthetics, and reduced nerve conduction speeds as we age[6,21].

Patients who catastrophized pain were less satisfied after their regional anesthesia than the control group[26]. Pain catastrophizing is a tendency among patients to amplify negative experiences related to pain stimuli, which could exacerbate their pain and influences self-reported pain scores and outcomes.

A recent study demonstrated that postoperative pain was associated with gut microbiota composition and diversity. Patients who reported more acceptable pain scores had more 'protective' bacteria, while the microbiota diversity was diminished in patients who needed more analgesics. However, they found no difference related to RP incidence[27].

4.2 Surgery-related risk factors

Rebound pain is more likely to occur depending on the type of surgery. Bone surgery has been established as an independent risk factor by different authors[12,25]. The type of surgical access makes a difference, as an open approach versus arthroscopic increases the odds[19].

A retrospective analysis by Barry et al. also showed increased odds with a trend toward significance in upper limb surgery and brachial plexus blocks[12]. The pain intensity is higher after shoulder surgery compared to knee procedures[3]. There is a perception that RP is more likely to occur after shoulder and foot surgery. We currently lack enough data to prove this sentiment. More prospective studies are needed to identify procedure-specific risks[6].

4.3 Anesthesia-related risk factors

Intravenous dexamethasone reduces RP incidence, among many other benefits in ambulatory surgery. This effect has such significance that the non-inclusion of intravenous dexamethasone with PNBs constitutes an independent risk factor for the development of RP[12]. There are no clear indications that the type of anesthesia influences the incidence or intensity of RP. The use or avoidance of general anesthesia does not have an impact[12]. Perioperative use of remifentanil and other short-acting opioids may induce postoperative hyperalgesia[11] and promote postoperative opioid usage after PNB, reflecting a higher incidence of rebound pain[28].

4.4 Block-related risk factors

No apparent risk factors have been identified regarding the block technique, the type of local anesthetic, or sensory block duration[12]. Mepivacaine, compared to bupivacaine, did not show a different postoperative pain profile upon block resolution[29]. Different initial dosing of bupivacaine before commencing continuous infusion did not significantly alter RP incidence or postoperative pain course[30].

Rebound pain is not unique to PNBs. It has also been described after neuraxial anesthesia and plane blocks[3,6,31,32]. The incidence rate of RP after spinal anesthesia is similar compared to PNBs[33,34] but seems lower in plane blocks, including erector spinae block, pectoralis, serratus plane blocks, quadratus lumborum block, and transabdominal plane block[6,35]. Similar effects can be seen in PNBs with less coverage: adductor canal block may lower RP incidence compared to femoral nerve block[36]. Not all studies confirm this, however[37]. Shoulder block, a combination of suprascapular and axillary nerve blocks, also reduced RP incidence compared to single shot interscalene blocks in arthroscopic shoulder procedures while simultaneously reducing the risk of hemidiaphragmatic paresis and motor weakness[38]. This intervention did not change postoperative analgesic usage or patient satisfaction[38–40].

A machine learning algorithm implemented by Barry and his colleagues identified 'local anesthetic drug type' and 'duration of motor block' as variables in a prediction model. How they potentially influence RP needs further investigation[12].

A recent attempt to develop a risk prediction model by Jen et al. used age, sex, surgery type, planned admission, local anesthetic type, dexamethasone use, and intraoperative anesthesia type as a priori predictors. Unfortunately, their model was unreliable in predicting RP after ankle surgery[41].

5. Modifying the block to prevent rebound pain

We can modulate our PNB for ambulatory surgery as RP preventive measures in a few ways. Prolonging the block is possible through continuous infusion using an indwelling catheter, perineural or intravenous adjuvants, or super long-acting local anesthetics.

5.1 Single shot versus continuous infusion

Extending the sensory block by continuous infusion provides superior postoperative analgesia to single-shot PNBs. It also reduces RP incidence and attenuates the peak pain scores upon block resolution[1,6,11,21,42]. However, this is not unanimously confirmed[43].

Compared to single-shot injection, continuous infusion leads to better patient satisfaction, decreased opioid usage, and lower overall pain scores in the general patient population, but not in a subgroup with a tendency to catastrophize pain[26]. In one study, 1.3% of patients were readmitted to the hospital after a single shot injection because of uncontrollable pain, whereas none of the continuous infusion group needed hospitalization despite some premature therapy failure[26].

Both electronic and elastomeric pumps can be a safe option in ambulatory settings without resulting in more adverse events than single-shot procedures. Of note, 5-13% of patients want to return to the hospital setting for catheter removal[1].

However, the use of indwelling catheters has several disadvantages. They are time-consuming, labor-intensive, require follow-up management, and have an inherent failure rate. Insertion can be challenging and has a learning curve[6]. Estimations of failure rates range between 2.7% - 20% depending on catheter location, type of surgery, and combination of primary and secondary block failure[2,26,43,44].

5.2 Adjuvants

A different way to modify and extend the effects of a single-shot peripheral nerve block is the addition of agents augmenting the block effect. Plenty of adjuvants have been studied in this setting, including clonidine, dexmedetomidine, dexamethasone, buprenorphine, midazolam, epinephrine, tramadol, ketamine, magnesium, and morphine. Out of these, dexamethasone and dexmedetomidine show the most promising results in reducing RP[7,21,45–47]. Their properties and recommendations are summarized in Table III.

Adjuvants can be administered perineurally or intravenously. Adding perineural dexamethasone to a single shot PNB reduces RP and results in a similar pain profile to continuous infusion during the first two days while being more cost-effective[48]. Both intravenous and perineural dexamethasone reduces the mean overall postoperative pain score, opioid use, and the incidence and intensity of RP[14,15,47,49–51], but the lengthening effect seems marginally more pronounced when compared to intravenous administration[6,47].

Dexmedetomidine as a single adjuvant delays the onset of RP but has less impact on the incidence[22,23]. Perineural or intravenous administration show similar results on block prolongation[47]. Dexmedetomidine has a unique differentiating sensorimotor effect in extending a sensory peripheral nerve block without prolonging motor blockade, thus impeding muscle strength[1,47]. This is potentially due to the more significant inhibitory effect on Aδ and C nerve fibers relative to motor neurons[1].

A recent study showed that combining intravenous dexamethasone and dexmedetomidine synergizes and prolongs the sensory block even more than a group who received only intravenous dexamethasone without extending the motor block. This study did not specifically investigate RP, but the intervention reduced opioid use, delayed the request to first rescue analgesic to up to three days, and improved patient satisfaction even further without causing more adverse events suggesting its merit in RP context[52].

Currently, the perineural use of all adjuvants is off-label. There are indications of induced neurotoxicity in some in vitro studies, but to our knowledge, there are no mentions of in vivo studies confirming these histopathological or neuromodulating changes[1].

5.3 Liposomal bupivacaine

Liposomal bupivacaine is an example of an extended-release local anesthetic that aims to

Table III. — Properties of dexamethasone and dexmedetomidine as adjuvants to peripheral nerve block. An adaptation from Desai et al.[1]

	Dexamethasone	Dexmedetomidine
Mechanism of action	1/Stimulation of glucocorticoid receptors on the neuronal membrane leading to an increased expression of inhibitory potassium channels and a decreased excitability of neuronal transmission 2/Localized vasoconstriction 3/Systemic anti-inflammatory effects	Highly selective alpha-2 adrenergic receptor agonist. It maintains a hyperpolarized state of the neuron while in the refractory phase of an action potential by inhibition of hyper-polarization-activated cyclic nucleotide-gated channels.
Optimal dosing IV Perineural	0,1 - 0,2 mg/kg 4 mg	1 µg/kg 50 - 60 µg
Prolonged analgesic effect	+ 402 minutes	+ 264 minutes
Prolonged sensory block	+ 419 minutes	+ 228 minutes
Prolonged motor block	+ 241 minutes	+ 192 minutes

prolong regional anesthesia by up to 96 hours. The block duration is slightly increased compared to classic long-acting agents in PNBs and local infiltration analgesia[45,47,53–55]. Related to RP, it does not significantly improve postoperative pain control[1,6]. There is currently insufficient evidence to support its use in ambulatory surgery.

6. The role of multimodal analgesia in rebound pain

Multimodal analgesia is integral to pain management in ambulatory surgery and should be implemented regardless of regional anesthesia use[7]. Regional anesthesia is a part of multimodal anesthesia and analgesia and does not replace adequate oral pain therapy. Early implementation of systemic analgesics while the block is still active diminishes the amount of peripheral nociceptive input upon PNB resolution resulting in a smooth transition phase during block resolution, reducing RP incidence and intensity[6,7,11]. In the event of RP, the remaining postoperative pain course does not differ in patients receiving only general anesthesia compared to only regional anesthesia after the initial surge of pain has subsided[6]. Possible modalities contributing to adequate pain relief and RP prevention will be discussed in this section.

6.1 Basic regimen

Without contra-indications, any basic regimen should consist of systematic administration of acetaminophen, non-steroidal anti-inflammatory drugs (NSAID), or COX inhibitors. Oral opioids should be reserved as rescue therapy[6]. A multimodal, opioid-sparing regimen may reduce postoperative pain and hospital readmissions[45].

6.2 Frequently used agents in ambulatory surgery

6.2.1 Ketamine

Ketamine is an NMDA-receptor antagonist with applications in both anesthesia and analgesia. Unlike perineural administration, perioperative intravenous ketamine does not enhance block effects and has little to no additive analgesic value on RP incidence and intensity[56].

6.2.2 Metamizole

Metamizole is unavailable in many countries because of its potential risk of causing agranulocytosis. It fills a similar role to COX inhibitors as an anti-inflammatory drug for treating acute nociceptive pain. It is often used as an alternative when classic NSAIDs are contra-indicated. To our knowledge, there is no qualitative data on its influence on RP. Combining metamizole with a classic NSAID can be a safe and feasible strategy and may provide superior pain control after ambulatory surgery compared to either alone[57].

6.2.3 Gabapentoids

Gabapentoids are a class of drugs analogous to the GABA neurotransmitter and block the α2δ subunit-containing voltage-dependent calcium channels. Commonly used examples are pregabalin and gabapentin. Reports of gabapentoid analgesics on RP in ambulatory setting are inconsistent. It has shown promising results as part of a multimodal regimen in breast reconstruction surgery[58]. In orthopedic surgery, the results are less convincing, but they may have merit after specific shoulder procedures[59].

6.3 Local infiltration analgesia

An injection of a local anesthetic mixture can be performed at the surgical site for additional pain relief as an alternative or sometimes in combination with PNB. Frequently local infiltration analgesia (LIA) applications are infiltrations in joint arthroplasty and wound infiltration techniques.

Reports on the superiority of PNBs compared to LIA are conflicting. PNBs have shown better results than LIA[59], but sometimes, it is the opposite[60]. Likewise, adding regional anesthesia in knee arthroplasty shows contradictory results when articular infiltration is already part of an established treatment protocol[61,62].

Prolonged infusion of a local anesthetic mixture through a catheter inserted in the surgical wound may be an alternative to PNBs. It has shown promising results as a part of the ERAS protocol in abdominal-based surgery[58].

6.4 Electrical nerve stimulation

Percutaneous nerve stimulation puts the gated pain control theory to practice. Proof of concept studies show this might work in reducing RP, but the results are mixed. It may reduce pain in a three cm radius with an effect lasting up to two weeks, reducing opioid usage. Sometimes the effects are unsatisfactory, requiring a rescue block[1].

Transauricular vagus nerve stimulation may decrease pain score and opioid usage and improve sleep quality during but not after its application after cruciate ligament repair. However, the electrostimulation therapy was halted after 12 hours, and pain scores were collected at the 24-hour mark. Its effect on rebound pain could not be determined[63].

7. The impact of patient education on rebound pain

Interviews of patients who underwent regional anesthesia highlighted some frequent misconceptions regarding the effects of PNBs, postoperative pain therapy, and what to do upon block resolution. This resulted in both underuse and overuse of opioids leading to unnecessary pain levels or side effects respectively. There were difficulties in understanding the block's effects and duration, resulting in fear of experiencing pain during the surgery or developing permanent nerve damage[64].

The extent to which a patient's pain control expectations are met can impact their postoperative pain experience. Pain perception is lower when adequate postoperative pain control is anticipated, an effect known as 'placebo analgesia.' When these expectations are unmet, disappointment can negatively influence the pain experience[6].

Implementing patient education through verbal and written instructions concerning the expected trajectory and analgesics improves therapy compliance and reduces anxiety and uncertainty[6].

Discussion

Incidence & definition

It is challenging to determine the actual incidence rate of rebound pain accurately given the use of many different definitions. Nevertheless, most reports indicate that RP is not uncommon and remains a clinically relevant concern in ambulatory surgery, necessitating a well-established and clear-cut definition.

By opinion of these authors, the definition of RP should encompass the key characteristics that are associated with it: the sudden increase in pain is caused by unopposed nociceptive stimuli after the resolution of any form of regional anesthesia, including neuraxial anesthesia and PNB, as a single shot or continuous infusion. The timing of onset and notable contrast in pain experience are important nuances typical for RP.

The definition proposed by Lavand'homme includes many of these specific features (Table I). Possible additions could involve broadening PNB to all forms of regional anesthesia, mentioning the remarkable pain difference experienced upon fading of the sensory block, and establishing a cutoff value on pain intensity scores.

Unlike suggested by previous debate on its pathophysiology, it seems unlikely that RP is the result of neurotoxic effects. The benefits of implementation of early analgesia and block modification suggest this phenomenon is primarily caused by unopposed peripheral pain stimuli. Given our current knowledge on its prevalence and treatment, the occurrence of severe rebound pain could be regarded as a suboptimal analgesic management.

Pain catastrophizing

Pain catastrophizing as a risk factor for RP is an important finding. Interestingly, patients who catastrophized reported worse pain outcomes when discharged with an electronic pump, unlike their control group, who were better off with a continuous infusion than a single-shot peripheral nerve block. This suggests we must alter our analgesic management and patient education to suit patients' profiles and expectations. Detecting this catastrophizing pain tendency in a preoperative assessment could help discuss their concerns and expectations of anesthesia and nerve blocks.

Block location site

Likely, regional anesthesia resulting in a less dense or wide sensory block reduces the risk of developing RP. This may be due to the surgical nociceptive input not being thoroughly numbed by these respective minimalistic blocks, reducing the relative importance of block resolution. Systemic multimodal analgesics may be given faster and more adequately after these blocks because of their incomplete analgesic coverage, possibly contributing to this phenomenon. From the perspective of RP, we can adapt our choice of a block to provide sufficient analgesic coverage without overshooting.

Block modification

Our current therapeutic options to prevent RP from occurring are scarce. If we assume the abrupt awakening of the nerve is one of the underlying mechanisms, a gradual fading of sensory block is desirable. This might help attenuate the contrast in pain sensation after the resolution of the block. The effect of regional anesthesia should preferably last around 24 hours to balance analgesic coverage during de night without interfering with early mobilization and discharge criteria. Ideally, no motor block should be present at the end of the surgery and a residual analgesic effect persisting afterward is preferred.

The synergic duo of intravenous dexmedetomidine and dexamethasone may be an elegant, noninvasive, and cost-effective solution to significantly prolong the sensory block beyond 24 hours after a single shot PNB. The specific sensorimotor differentiation of dexmedetomidine makes for a welcomed ally in preventing an unwanted extended motor block. In cases where intense pain is anticipated for a more extended period, a continuous infusion remains a very effective and safe therapeutic option.

Multimodal analgesia & tailored management

The importance of adequate, multimodal analgesia regimens cannot be stressed enough. Early implementation is mandatory, as uncovering unopposed nociceptive stimuli is one of the key mechanisms of rebound pain. Establishing a golden standard for ambulatory surgery is not feasible due to the plurality of different agents, surgeries, patient characteristics, and contra-indications. Adapting general concepts and guidelines to surgical context and patient characteristics may lead to a suitable patient-tailored therapy plan.

Our approach to regional anesthesia in ambulatory surgery would primarily focus on modifying single-shot PNBs and implementing our multimodal analgesic regimen early. Continuous infusion is still a feasible strategy, but the technique has a learning curve, is more expensive, and requires more personnel for follow-up and management. Combining intravenous dexamethasone and dexmedetomidine is an elegant alternative that possibly achieves clinically equivalent results.

Patient education & follow-up

Discussing their ideas, concerns and expectations about regional anesthesia and the postoperative course may avoid misconceptions and reduce anxiety, improving the overall perioperative experience. It is essential to consider that the amount of information patients require may vary, with some needing more detail than others. It should be a customary practice to offer the patient comprehensive information both verbally and in written form. Providing them with precise contact information for postoperative inquiries or concerns related to their regional anesthesia can be helpful. Follow-up through telephone interviews may prove interesting for feedback purposes and finetuning the procedure-specific management.

Strengths and weaknesses

This review provides an updated summary on RP and highlights the important aspects in preventive strategies. The data and conclusions of all authors were critically reviewed given the heterogenous definitions of RP throughout the articles.

A few weaker elements of this study is its smaller inclusion criterium of publication in the latest 5 years. This rendered the screening and reading process more manageable but makes interpretation of the data before 2018 reliant on the work of previous authors. This study also aimed to provide an update on RP in ambulatory setting. Despite using MeSH terms for ambulatory surgery, the majority of studies researched RP in orthopedic procedures but not specifically in ambulatory context. These results may not be entirely extrapolated.

Conclusions

Rebound pain remains a relevant clinical challenge in ambulatory surgery. According to the most recent literature, unopposed nociceptive stimuli upon block resolution are the primary cause of rebound pain rather than block-induced neurotoxicity.

The main risk factors include female gender, younger age, bone surgery, open surgical access, and pain catastrophizing. These factors must be accounted for in our patient-tailored anesthesia management as they influence rebound pain incidence rate, intensity, and pain experience. Combining intravenous dexamethasone with dexmedetomidine may be a cost-effective and elegant alternative to continuous infusion. Early implementation of multimodal analgesics is mandatory in RP prevention. Thorough patient education and verifying their expectations should be essential components of the preoperative assessment in regional anesthesia.

References

1. Desai N, El-Boghdadly K, Albrecht E. Peripheral nerve blockade and novel analgesic modalities for ambulatory anesthesia. Curr Opin Anaesthesiol. 2020;33(6):760-767. doi:10.1097/ACO.0000000000000928
2. Shams D, Sachse K, Statzer N, Gupta RK. Regional Anesthesia Complications and Contraindications. Clin Sports Med. 2022;41(2):329-343. doi:10.1016/j.csm.2021.11.006
3. Lavand'homme P. Rebound pain after regional anesthesia in the ambulatory patient. Curr Opin Anaesthesiol. 2018;31(6):679-684. doi:10.1097/ACO.0000000000000651
4. Hamilton DL. Rebound pain: distinct pain phenomenon or nonentity? Br J Anaesth. 2021;126(4):761-763. doi:10.1016/j.bja.2020.12.034
5. Samineni A V, Seaver T, Sing DC, Salavati S, Tornetta P. Peripheral Nerve Blocks Associated With Shorter Length of Stay Without Increasing Readmission Rate for Ankle Open Reduction Internal Fixation in the Outpatient Setting: A Propensity-Matched Analysis. Journal of Foot and Ankle Surgery. 2022;61(6):1165-1169. doi:10.1053/j.jfas.2021.10.017
6. Muñoz-Leyva F, Cubillos J, Chin KJ. Managing rebound pain after regional anesthesia. Korean J Anesthesiol. 2020;73(5):372-383. doi:10.4097/kja.20436
7. Nijs K, Ruette J, Van de Velde M, Stessel B. Regional anaesthesia for ambulatory surgery. Best Pract Res Clin Anaesthesiol. Published online December 16, 2022. doi:10.1016/J.BPA.2022.12.001
8. Hade AD, Okano S, Pelecanos A, Chin A. Factors associated with low levels of patient satisfaction following peripheral nerve block. Anaesth Intensive Care. 2021;49(2):125-132. doi:10.1177/0310057X20972404
9. Loewenstein SN, Bamba R, Adkinson JM. Emergency Department Utilization After Administration of Peripheral Nerve Blocks for Upper Extremity Surgery. Hand (N Y). 2022;17(4):624-629. doi:10.1177/1558944720963867
10. Womble TN, Comadoll SM, Dugan AJ, et al. Is supplemental regional anesthesia associated with more complications and readmissions after ankle fracture surgery in the inpatient and outpatient setting? Foot and Ankle Surgery. 2021;27(5):581-587. doi:10.1016/j.fas.2020.07.015

11. Nobre L V, Cunha GP, Sousa PCCBD, Takeda A, Cunha Ferraro LH. Peripheral nerve block and rebound pain: literature review. Brazilian Journal of Anesthesiology. 2019;69(6):587-593. doi:10.1016/j.bjan.2019.05.001
12. Barry GS, Bailey JG, Sardinha J, Brousseau P, Uppal V. Factors associated with rebound pain after peripheral nerve block for ambulatory surgery. Br J Anaesth. 2021;126(4):862-871. doi:10.1016/j.bja.2020.10.035
13. Admassie BM, Tegegne BA, Alemu WM, Getahun AB. Magnitude and severity of rebound pain after resolution of peripheral nerve block and associated factors among patients undergoes surgery at university of gondar comprehensive specialized hospital northwest, Ethiopia, 2022. Longitudinal cross-sectional study. Annals of Medicine and Surgery. 2022;84. doi:10.1016/j.amsu.2022.104915
14. Woo JH, Lee HJ, Oh HW, Lee JW, Baik HJ, Kim YJ. Perineural dexamethasone reduces rebound pain after ropivacaine single injection interscalene block for arthroscopic shoulder surgery: a randomized controlled trial. Reg Anesth Pain Med. 2021;46(11):965-970. doi:10.1136/rapm-2021-102795
15. Fang J, Shi Y, Du F, et al. The effect of perineural dexamethasone on rebound pain after ropivacaine single-injection nerve block: a randomized controlled trial. BMC Anesthesiol. 2021;21(1). doi:10.1186/s12871-021-01267-z
16. Makvana S, Faroug R, Venturini S, et al. Are Hindfoot Procedures More Painful than Forefoot Procedures? A Prospective Observational Study in Elective Foot and Ankle Surgery. Journal of Foot and Ankle Surgery. 2022;61(1):23-26. doi:10.1053/j.jfas.2021.04.024
17. Stubbs DJ, Levy N. Role of dexamethasone in reducing postoperative pain. Comment on Br J Anaesth 2021; 126: 862–71. Br J Anaesth. 2021;126(4):e139-e140. doi:10.1016/j.bja.2021.01.010
18. Cunningham DJ, LaRose MA, Zhang GX, Paniagua AR, Klifto CS, Gage MJ. Beware the rebound effect: regional anesthesia increases opioid utilization after humerus fracture surgery. Shoulder Elbow. 2022;14(6):648-656. doi:10.1177/17585732211048117
19. Thillainadesan T, Lee C, Mandaleson A, Hardidge A, Weinberg L, Tan C. Rebound pain after shoulder surgery with interscalene brachial plexus blockade: How often? how bad? J Pain Manag. 2019;12(2):147-154. https://www.embase.com/search/results?subaction=viewrecord&id=L2004148926&from=export
20. Charier D, Court-Fortune I, Pereira B, Molliex S. Sleep disturbances and related disordered breathing after hip replacement surgery: A randomised controlled trial. Anaesth Crit Care Pain Med. 2021;40(4). doi:10.1016/J.ACCPM.2021.100927
21. Dada O, Zacarias AG, Ongaigui C, et al. Does rebound pain after peripheral nerve block for orthopedic surgery impact postoperative analgesia and opioid consumption? A narrative review. Int J Environ Res Public Health. 2019;16(18). doi:10.3390/ijerph16183257
22. Lee JJ, Kim DY, Hwang JT, et al. Dexmedetomidine combined with suprascapular nerve block and axillary nerve block has a synergistic effect on relieving postoperative pain after arthroscopic rotator cuff repair. Knee Surgery, Sports Traumatology, Arthroscopy. 2021;29(12):4022-4031. doi:10.1007/S00167-020-06288-8
23. Hwang JT, Jang JS, Lee JJ, et al. Dexmedetomidine combined with interscalene brachial plexus block has a synergistic effect on relieving postoperative pain after arthroscopic rotator cuff repair. Knee Surg Sports Traumatol Arthrosc. 2020;28(7):2343-2353. doi:10.1007/s00167-019-05799-3
24. Stone A, Lirk P, Vlassakov K. Rebound Pain After Peripheral Nerve Blockade—Bad Timing or Rude Awakening? Anesthesiol Clin. 2022;40(3):445-454. doi:10.1016/j.anclin.2022.03.002
25. Touil N, Pavlopoulou A, Barbier O, Libouton X, Lavand'homme P. Evaluation of intraoperative ketamine on the prevention of severe rebound pain upon cessation of peripheral nerve block: a prospective randomised, double-blind, placebo-controlled study. Br J Anaesth. 2022;128(4):734-741. doi:10.1016/j.bja.2021.11.043
26. Maurice-Szamburski A, Grillo P, Cuvillon P, et al. Comparison of continuous with single-injection regional analgesia on patient experience after ambulatory orthopaedic surgery: a randomised multicentre trial. Br J Anaesth. 2022;129(3):435-444. doi:10.1016/J.BJA.2022.05.039
27. Brenner D, Cherry P, Switzer T, et al. Pain after upper limb surgery under peripheral nerve block is associated with gut microbiome composition and diversity. Neurobiology of Pain. 2021;10. doi:10.1016/j.ynpai.2021.100072
28. Kim Y, Bae H, Yoo S, et al. Effect of remifentanil on post-operative analgesic consumption in patients undergoing shoulder arthroplasty after interscalene brachial plexus block: a randomized controlled trial. J Anesth. 2022;36(4):506-513. doi:10.1007/s00540-022-03085-0
29. Sellbrant I, Karlsson J, Jakobsson JG, Nellgård B. Supraclavicular block with Mepivacaine vs Ropivacaine, their impact on postoperative pain: a prospective randomised study. BMC Anesthesiol. 2021;21(1). doi:10.1186/s12871-021-01499-z
30. Rogero R, McDonald E, Raikin SM, Fuchs D, Shakked RJ, Voskeridjian A. Randomized study of the effect of initial ropivacaine dosage during continuous popliteal nerve blocks on rebound pain in foot and ankle surgery. Foot Ankle Int. 2019;40(2 SUPPL):112S-113S. doi:10.1177/1071100719882410
31. Kwon HJ, Kim YJ, Lee D, et al. Factors Associated with Rebound Pain after Patient-controlled Epidural Analgesia in Patients Undergoing Major Abdominal Surgery: A Retrospective Study. Clinical Journal of Pain. 2022;38(10):632-639. doi:10.1097/AJP.0000000000001067
32. Chang WK, Li YS, Wu HL, Tai YH, Lin SP, Chang KY. Group-based trajectory analysis of postoperative pain in epidural analgesia for video-assisted thoracoscopic surgery and risk factors of rebound pain. J Chin Med Assoc. 2022;85(2):216-221. doi:10.1097/JCMA.0000000000000647
33. Sort R, Hald LL, Brorson S, et al. Peripheral nerve blocks compared with spinal anaesthesia do not reduce opioid consumption related to initial rebound pain in ankle fracture surgery. Reg Anesth Pain Med. 2019;44(10):A111. doi:10.1136/rapm-2019-ESRAABS2019.127
34. Sort R, Brorson S, Gögenur I, et al. Peripheral nerve block anaesthesia and postoperative pain in acute ankle fracture surgery: the AnAnkle randomised trial. Br J Anaesth. 2021;126(4):881-888. doi:10.1016/j.bja.2020.12.037
35. Kamiya Y, Hasegawa M, Yoshida T, Takamatsu M, Koyama Y. Impact of pectoral nerve block on postoperative pain and quality of recovery in patients undergoing breast cancer surgery: A randomised controlled trial. Eur J Anaesthesiol. 2018;35(3):215-223. doi:10.1097/EJA.0000000000000762
36. Patel R, Lynch J, Okoroha KR, Lizzio V, Meta F, Moutzouros V. Adductor Canal Block Versus Femoral Nerve Block for Pain Control After Anterior Cruciate Ligament Reconstruction: a Prospective Randomized Trial. Arthroscopy - Journal of Arthroscopic and Related Surgery. 2018;34(12):e35. doi:10.1016/j.arthro.2018.10.097
37. Özgüner Y, Alptekin A. Comparison of Rebound Pain and Postoperative Tramadol Requirement in Patients Who Had Femoral Nerve Block or Adductor Canal Block for Pain after Total Knee Arthroplasty. Anestezi Dergisi. 2021;29(4):254-262. doi:10.5222/jarss.2021.60590
38. Rhyner P, Midez R, Farron A, Albrecht E. Respiratory complications after interscalene brachial plexus block versus a shoulder block: A randomized, controlled, single-blinded trial. Reg Anesth Pain Med. 2019;44(10):A89-A90. doi:10.1136/rapm-2019-ESRAABS2019.86
39. Ko SH, Park SH, Jang SM, Lee KJ, Kim KH, Jeon YD. Multimodal nerve injection provides noninferior analgesic efficacy compared with interscalene nerve block after arthroscopic rotator cuff repair. Journal of Orthopaedic Surgery. 2021;29(2). doi:10.1177/23094990211027974

40. Saini S, Rao S, Agrawal N, Gupta A. Comparison of analgesic efficacy of shoulder block versus interscalene block for postoperative analgesia in arthroscopic shoulder surgeries: A randomised trial. Indian J Anaesth. 2021;65(6):451-457. doi:10.4103/ija.IJA_110_21
41. Jen TTH, Ke JXC, Wing KJ, et al. Development and internal validation of a multivariable risk prediction model for severe rebound pain after foot and ankle surgery involving single-shot popliteal sciatic nerve block. Br J Anaesth. 2022;129(1):127-135. doi:10.1016/j.bja.2022.03.030
42. Kim JH, Koh HJ, Kim DK, et al. Interscalene brachial plexus bolus block versus patient-controlled interscalene indwelling catheter analgesia for the first 48 hours after arthroscopic rotator cuff repair. J Shoulder Elbow Surg. 2018;27(7):1243-1250. doi:10.1016/j.jse.2018.02.048
43. Ganta A, Ding D, Fisher N, Lavery J, Jain S, Tejwani NC. Continuous infraclavicular brachial block versus single-shot nerve block for distal radius surgery: A prospective randomized control trial. J Orthop Trauma. 2018;32(1):22-26. doi:10.1097/BOT.0000000000001021
44. Hauritz RW, Hannig KE, Balocco AL, et al. Peripheral nerve catheters: A critical review of the efficacy. Best Pract Res Clin Anaesthesiol. 2019;33(3):325-339. doi:10.1016/J.BPA.2019.07.015
45. Zangrilli J, Szukics P, Austin L, Horneff JG. Perioperative Pain Management in Ambulatory and Inpatient Shoulder Surgery. JBJS Rev. 2021;9(5). doi:10.2106/JBJS.RVW.20.00191
46. Wiegele M, Marhofer P, Lönnqvist PA. Caudal epidural blocks in paediatric patients: a review and practical considerations. Br J Anaesth. 2019;122(4):509-517. doi:10.1016/J.BJA.2018.11.030
47. Schubert AK, Wiesmann T, Dinges HC. Measures to prolong duration of sensory block after regional anaesthesia. Curr Opin Anaesthesiol. 2023;36(1):103-108. doi:10.1097/ACO.0000000000001204
48. Kim YS, Park Y, Koh HJ. Is There a Difference between Perineural Dexamethasone with Single-Shot Interscalene Block (SSIB) and Interscalene Indwelling Catheter Analgesia (IICA) for Early Pain after Arthroscopic Rotator Cuff Repair? A Pilot Study. J Clin Med. 2022;11(12). doi:10.3390/jcm11123409
49. Streb T, Schneider A, Wiesmann T, et al. [Rebound pain-From definition to treatment]. Die Anaesthesiologie. 2022;71(8). doi:10.1007/S00101-022-01120-Z
50. Morita S, Oizumi N, Suenaga N, Yoshioka C, Yamane S, Tanaka Y. Dexamethasone added to levobupivacaine prolongs the duration of interscalene brachial plexus block and decreases rebound pain after arthroscopic rotator cuff repair. J Shoulder Elbow Surg. 2020;29(9):1751-1757. doi:10.1016/j.jse.2020.04.019
51. Holmberg A, Hassellund SS, Drægni T, et al. Analgesic effect of intravenous dexamethasone after volar plate surgery for distal radius fracture with brachial plexus block anaesthesia: a prospective, double-blind randomised clinical trial*. Anaesthesia. 2020;75(11):1448-1460. doi:10.1111/anae.15111
52. Kang RA, Jeong JS, Yoo JC, et al. Improvement in postoperative pain control by combined use of intravenous dexamethasone with intravenous dexmedetomidine after interscalene brachial plexus block for arthroscopic shoulder surgery A randomised controlled trial. Eur J Anaesthesiol. 2019;36(5):360-368. doi:10.1097/EJA.0000000000000977
53. Hillesheim RA, Kumar P, Brolin TJ, et al. Periarticular liposomal bupivacaine mixture injection vs. single-shot interscalene block for postoperative pain in arthroscopic rotator cuff repair: a prospective randomized controlled trial. J Shoulder Elbow Surg. 2021;30(12):2691-2697. doi:10.1016/j.jse.2021.08.012
54. Namdari S, Nicholson T, Abboud J, Lazarus M, Steinberg D, Williams G. Interscalene block with and without intraoperative local infiltration with liposomal bupivacaine in shoulder arthroplasty: A randomized controlled trial. Journal of Bone and Joint Surgery - American Volume. 2018;100(16):1373-1378. doi:10.2106/JBJS.17.01416
55. Namdari S, Nicholson T, Abboud J, Lazarus M, Steinberg D, Williams G. Randomized controlled trial of interscalene block compared with injectable liposomal bupivacaine in shoulder arthroplasty. Journal of Bone and Joint Surgery - American Volume. 2017;99(7):550-556. doi:10.2106/JBJS.16.00296
56. Zhu T, Gao Y, Xu X, Fu S, Lin W, Sun J. Effect of Ketamine Added to Ropivacaine in Nerve Block for Postoperative Pain Management in Patients Undergoing Anterior Cruciate Ligament Reconstruction: A Randomized Trial. Clin Ther. 2020;42(5):882-891. doi:10.1016/j.clinthera.2020.03.004
57. Schneider T, Mauermann E, Ilgenstein B, Jaquiery C, Ruppen W. Analgesic benefit of metamizole and ibuprofen vs. either medication alone: a randomized clinical trial. Minerva Anestesiol. 2022;88(6):448-456. doi:10.23736/S0375-9393.22.16346-7
58. Rendon JL, Hodson T, Skoracki RJ, Humeidan M, Chao AH. Enhanced Recovery after Surgery Protocols Decrease Outpatient Opioid Use in Patients Undergoing Abdominally Based Microsurgical Breast Reconstruction. Plast Reconstr Surg. Published online 2020:645-651. doi:10.1097/PRS.0000000000006546
59. Dong X, Wu CL, YaDeau JT. Clinical care pathways for ambulatory total shoulder arthroplasty. Curr Opin Anaesthesiol. 2022;35(5):634-640. doi:10.1097/ACO.0000000000001174
60. Updegrove GF, Stauch CM, Ponnuru P, Kunselman AR, Armstrong AD. Efficacy of local infiltration anesthesia versus interscalene nerve blockade for total shoulder arthroplasty. JSES Int. 2020;4(2):357-361. doi:10.1016/j.jseint.2019.12.007
61. Laoruengthana A, Jarusriwanna A, Rattanaprichavej P, Eiamjumras W, Kositanurit I, Pongpirul K. Additional Peripheral Nerve Block to Periarticular Injection Has No Benefit for Patients Undergoing TKA: A Factorial Propensity Score–Matched Analysis Comparing Four Multimodal Analgesic Techniques. Journal of Arthroplasty. 2022;37(1):39-44. doi:10.1016/j.arth.2021.09.011
62. Toolyodpun S, Laoruengthana A, Kositanurit I, Podjanasupawun S, Saenghirunvattana C, Pongpirul K. Effect of multiple analgesic pathways including local infiltration analgesia, peripheral nerve blocks, and intrathecal morphine for controlling pain after total knee arthroplasty. Eur J Orthop Surg Traumatol. Published online 2022. doi:10.1007/S00590-022-03405-W
63. Zhou Q, Yu L, Yin C, et al. Effect of Transauricular Vagus Nerve Stimulation on Rebound Pain After Ropivacaine Single Injection Femoral Nerve Block for Anterior Cruciate Ligament Reconstruction: A Randomized Controlled Trial. J Pain Res. 2022;15:1949-1958. doi:10.2147/JPR.S370589
64. Henningsen MJ, Sort R, Møller AM, Herling SF. Peripheral nerve block in ankle fracture surgery: a qualitative study of patients' experiences. Anaesthesia. 2018;73(1):49-58. doi:10.1111/anae.14088
65. Kim JY, Kang MW, Lee HW, Noh KC. Suprascapular Nerve Block Is an Effective Pain Control Method in Patients Undergoing Arthroscopic Rotator Cuff Repair: A Randomized Controlled Trial. Orthop J Sports Med. 2021;9(1). doi:10.1177/2325967120970906

doi.org/10.56126/75.S1.31