JURNAL VOKASI KESEHATAN

Article Review

Recent Advances in Regional Anaesthesia: A Comprehensive Review

Alunia Mary Baby[1*], Jishnuraj[2], Vishnu M.G[3]

[1,2]Department of ATOT, Acharya Institute of Allied Health Sciences, RGUHS, Bengaluru, India
[3]Department of MLT, Acharya Institute of Allied Health Sciences, RGUHS, Bengaluru, India
***Corresponding Author:** aluniamary2000@gmail.com

Article history:
Submited: November 12, 2024
Revised : November 29, 2024
Accepted: December 13, 2024

Keywords:
Regional anaesthesia, Ultrasound guided nerve blocks, Pain management, Opioid reduction, Perioperative

ABSTRACT

Regional anaesthesia has revolutionized modern practice in anaesthesia, and the review will focus on recent technological and procedural developments, with special emphasis on efficacy, safety profiles, and impact on patient outcomes. Recent developments, especially with the integration of ultrasound-guided techniques, have substantially enhanced procedural precision and safety and made possible substantial reductions in opioid requirements. Evidence indicates that such developments bring improved pain control into recovery results in comparison with the traditional general anaesthesia methods. The latter still modulates regional anaesthesia training and implementation through current technological developments and standard teaching methods but still presents problems in standardization of techniques and access. These advances will greatly influence perioperative care, making potentially for shorter stays and improved rehabilitation for patients, with maximum satisfaction through optimal pain management protocols.

INTRODUCTION

Regional anaesthesia has emerged as the backbone of modern anaesthetic practice, revolutionizing surgical care through a wide range of applications and numerous benefits. The perception and practice of regional anaesthetic techniques have dramatically evolved over the past decade with technological innovations and better clinical protocols. This evolution has transformed its very basis in perioperative care, in pain management, and in patient outcomes. The increasing prevalence of regional anaesthesia techniques has been supported by substantive evidence showing that they are significantly advantageous in modern surgical setups.

Recent evidence collates to validate this shift, and evidence from various studies shows that regional anesthesia constitutes an integral part of a multimodal analgesia strategy. According to Albrecht and Chin (2020), these techniques have been very successful in decreasing opioid use while improving postoperative outcomes; they also align with current efforts at reducing opioid dependency in surgery [1].

Technological development, especially imaging capacity, has played a vital role in enhancing the accuracy and safety of regional anaesthesia techniques. The success of nerve blocks increased and the rate of complications during procedures greatly diminished with the introduction of ultrasound

guidance. Elsharkawy et al. (2018) reviewed the interfacial plane blocks considerably and could present abundant evidence for this development by pointing out such revolutionary influences by ultrasound technology [2].

Beyond technical advancements, these systems impact at a different level; they relate to larger health care issues. For instance, Cozowicz et al. (2016) demonstrated that peripheral nerve blocks in total joint arthroplasties were related to a decrease in complications and hospital stays [3]. Such improvement in standardization of techniques, provision of thorough training programs, and control of rare yet significant complications are challenges this field faces, as shown by Elisha, S., & Nagelhout, J. J. (2017).

This review synthesizes current evidence on the efficacy and safety of regional anaesthesia techniques, comparing their outcomes with those of general anaesthesia, procedure-specific applications, and emerging technologies that will shape the future. Using a comprehensive analysis of recent literature, we provide an in-depth overview of the state of the art of regional anaesthesia and its potential to improve patient care over the next few years.

The primary aim of this integrated review is to critically discuss and synthesize modern developments in techniques and concepts in the science of regional anaesthesia along with their clinical applications and impact on patients' outcome in a modernistic framework of anaesthetic practice. Objectives ; To review Efficacy and Safety of Regional Anaesthesia Techniques, To analyse the Comparative Studies of Anaesthesia Methods, To determine Procedure-Specific Outcomes, To explore Pain Management and Opioid Consumption, To review Emerging Technologies, Patient Experience and Outcomes, To find Perioperative Considerations, Challenges and Complications, Review of Educational Approaches, Training, Future Directions and Research Priorities.

RESEARCH METHODS

A systematic literature review was performed using electronic databases, including PubMed and Science Direct, to locate relevant research about practices and developments in regional anaesthesia. All available literature from 2014 to 2024 that is relatively contemporary within this field has been researched for relevance.

Search Plan: Keywords used in the primary search included "regional anaesthesia," "nerve blocks," "ultrasound-guided anaesthesia," "perioperative outcomes," and "anaesthetic techniques"

Secondary terms: "opioid reduction," "patient safety," "procedural efficacy," "postoperative outcomes," and "anaesthesia education" Boolean operators (AND, OR) are used in the search to combine texts for optimal searches

Inclusion criteria: Peer-reviewed articles published in English, Original research, systematic review, and meta-analysis, Clinical trials on regional anaesthesia techniques, Studies comparing regional versus general anaesthesia outcomes, Publications related to technological achievements in regional anaesthesia.

Data Collection and Analysis: Screening the titles and abstracts for relevance, Full-text review of selected articles meeting the inclusion criteria, Data extraction focused on Clinical implications Safety profiles Technological innovations Educational developments Practice guidelines and advances.

RESULTS AND DISCUSSION

Efficacy and Safety of Regional Anaesthesia Techniques

Chahrour M, et al. (2024) concluded that patients suffering from congestive heart failure, regional anaesthesia showed a high rate of prognosis in comparison with mortality and morbidity by general anaesthesia [5]. Farrow RA, et al. (2024) successfully conducted a community teaching program on ultrasound-guided regional anaesthesia. The patients did not experience any adverse events [6]. Ganta A, et al. (2024) concluded that regional anaesthesia is safe for intramedullary nailing of low-energy tibial shaft fractures [7]. Du J, et al. (2024) meta-analysis showed that adding ketamine to lidocaine when used for intravenous regional anaesthesia may enhance effect without worsening complications [8]. Shams D, et al. (2024) observes that serious side effects of local anaesthetic are very few [9]. Yu et al. (2024) compared U-G subsheath versus extrasheath sciatic nerve blocks for tibial and foot surgeries. The subsheath gives better result compared to the extrasheath approach. [10]

Moorthy et al. (2023) compared erector spinae plane catheter to paravertebral block catheter in analgesia after video-assisted thoracoscopic surgery. Although ESP improved overall quality-of-recovery scores at 24 and 48 hours, no significant differences were reported in pain, opioid consumption, or chronic postsurgical pain at 3 months [11]. Comparing local infiltrate anaesthesia LIA with femoral nerve block (FNB), Yu et al. (2024) concluded that there were no differences in pain scores between the two interventions but observed significantly lower opioid requirement for the patients who had LIA. LIA is a preferred technique due to being simple and inexpensive.[12]

Hamid et al. (2021) published the results of a systematic review and meta-analysis comparing transversus abdominis plane TAP block with thoracic epidural analgesia (TEA) in colorectal surgery. The authors concluded that TAP block was associated with equivalent pain control, reduced intake of opioids, and faster recovery in the absence of serious adverse events. This was advantageous for laparoscopic procedures [13].

Zhao et al. (2023) investigated the comparison of middle and low interscalene brachial plexus blocks, concluding that middle interscalene approaches offered non-inferior anaesthesia for surgeries at or below the elbow [14]. Chen et al. (2024) compared femoral triangle block with adductor canal block in arthroscopic knee surgery, found out that femoral triangle block was associated with superior pain control, which led to enhanced quadriceps muscle strength in the postoperative period [15].

Aragola et al (2021) conducted a randomized trial comparing femoral nerve block to continuous periarticular injection. There was no difference in pain control between the two techniques if used in conjunction with multimodal analgesia; thus, they recommend that clinicians elect the modality that best suits the environment [16].

Comparative Studies of Anaesthesia Methods

Vallabhaneni N, et al. (2024) found that regional compared to general anaesthesia for total shoulder arthroplasty had higher readmission and reoperation rates, though shorter hospital stays [17]. Ye Y, et al. (2023) conducted a randomized controlled trial on comparing combined lumbar and parasacral ischial plane (LPIP) block with general anaesthesia on postoperative outcomes in hip surgery and found that LPIP block reduced opioid consumption [18]. Fang L et al. (2023) demonstrated that laryngeal mask general anaesthesia provides earlier postoperative recovery than spinal anaesthesia in cervical conization [19].

Uraya Y, et al. (2023) - compared local and general anaesthesia for a removal of plates after a fracture clavicle surgery based on a questionnaire from patients which concluded that they were equally acceptable [20]. Shui M, et al. conducted Meta-analysis of spinal/epidural anaesthesia and

general anaesthesia on perioperative outcomes in patients undergoing lumbar spine surgery and found that spinal/epidural had lesser incidences and better outcome. [21].

Spinal anaesthesia was studied by Perez-Roman et al. (2021) in awake surgical procedures of the lumbar spine. Using the analysis of the study, spinal anaesthesia was found to be advantageous because it reduced the anaesthetic time and also had decreased operative time with a general overall total cost as compared to general anaesthesia. The complications arisen in postoperative days were less in number while using spinal anaesthesia.[22]

Kull et al., (2024) compared femoral and sciatic nerve blocks for analgesia after medial open wedge high tibial osteotomy. It reported the results which found no clinically significant difference in morphine consumption or scores between the two blocks.[23]

Chen et al., (2022) evaluated the efficacy and safety of rhomboid intercostal block for analgesia after breast and thoracoscopic surgery. The review proved that rhomboid intercostal block had better management of acute pain post these surgeries compared to general analgesia [24].

Charvin et al. (2020) evaluated the results of femoral and sciatic nerve blocks added to general anaesthesia for femoropopliteal bypass surgery, their findings indicated enhanced quality of care after surgery in this fragile population, likely result of reduced perioperative opioid requirements [25].

Procedure-Specific Outcomes

Kukreja P, et al. (2023) have proved in the patients who are undergoing primary total hip arthroplasty with spinal anaesthesia, as the quality of improved recovery and the reduced opioid requirement with the PENG block [26]. Xu M, et al. (2023) demonstrated through Meta-analysis that the regional anaesthesia induces quality of recovery after video-assisted thoracic surgery [27].

Di Monte FF, et al. (2024) described that Locoregional anaesthesia for major abdominal surgery, in a case with primary ciliary dyskinesia is a valid and safe approach with better post-operative patient outcomes [28]. Pascarella G, et al. (2021) explored the better impact of pericapsular nerve group (PENG) block on postoperative analgesia and functional recovery after total hip arthroplasty [29].

Tang X, et al. (2022) evaluated the analgesic efficacy of IPACK (Interspace between the Popliteal Artery and the Capsule of the Posterior Knee) block with SACB (Single Adductor Canal Block) versus SACB alone after total knee arthroplasty and found that IPACK with SACB had better impact [30]. Mongelli et al. (2021) demonstrated in a systematic review and meta-analysis that pudendal nerve block reduced opioid consumption and postoperative pain, complications, and length of hospital stay. It, suggests that pudendal nerve block should be considered as a valuable adjunct to procedures for haemorrhoidectomy [31].

Gautam et al. (2020) evaluated the utility of serratus anterior plane block for postoperative pain control in patients who underwent a minimally invasive direct coronary artery bypass surgery. They found that this procedure significantly reduced postoperative pain scores and opioid consumption [32]. Likewise, Kaushal et al. (2020) showed the utility of bilateral erector spinae plane block for management of acute postoperative pain after paediatric cardiac surgeries through midline sternotomy [33].

Pain Management and Opioid Consumption

Machiyama Y, et al., (2024) reported that higher durations of sensory block in smokers than in nonsmokers during regional anaesthesia [34]. In 2021, Yung EM, et al. conducted a systematic

review and meta-analysis of intra-articular infiltration analgesia in arthroscopic shoulder surgery and they concluded that there is significant enhanced pain control and reduced opioid consumption.[35].

Harkouk H, et al. (2021) studied the effectiveness of paravertebral block in preventing chronic post-surgical pain after breast cancer surgery [36]. Pepper CG, et al. (2024) did a Systematic review with meta-analysis on the impact of perioperative regional anaesthesia on persistent opioid use and chronic pain after noncardiac surgery [37]. Mantovani et al., (2023) studied the sphenopalatine ganglion block effects on post craniotomy pain management. The treatment was safe and effective as a supplemental intervention in the first 4 days of the postoperative period of post craniotomy pain management [38].

Borys et al (2021) conducted a randomized controlled trial that was done by comparing the quadratus lumborum block (QLB), TAP block, and control. They reported that these two techniques would relieve the pain better, and less amount of morphine is required as compared to the control group. QLB, can reduce chronic postoperative pain at one to six months after discharge with long-term benefits. [39]

A systematic review with meta-analysis of 23 trials involving 1532 patients was done by Duda et al, (2023) whose study represents level 1A evidence that effectiveness of scalp block in reducing postoperative pain at 2-48 hours and is likely reducing opioid consumption within 24 hours post-craniotomy [40].

Torosis et al. evaluated the effectiveness of pudendal nerve blocks in combination with the introduction of ERAS protocols to transvaginal reconstructive surgery. They concluded that pudendal nerve blocks provided no added benefit beyond reduction of opioid use or pain control beyond what was realized by the addition of ERAS protocols [41].

Emerging Technologies, Patient Experience and Outcomes

La Via L et al. (2024) "Loco-regional anaesthesia in pain control of robotic thoracic surgery: old and new technology-new option for same improvement, but different application." [42]. Lazar AE et al. (2024) outlined the difficulties experienced with the use of regional anaesthetic techniques in intensive care units. The author states that the application of ultrasonography and other novel technology has enhanced the safety and efficiency of peripheral and neuraxial nerve blocks [43]. Yang M, et al. (2024) provided a study protocol designed to evaluate the ultrasound-guided erector spinae plane block for perioperative analgesia in laparoscopic nephrectomies [44]. Häggström M and Brodin K (2024) did a phenomenological hermeneutic study of the meaning of being awake during surgery under local or regional anaesthesia [45]. Siniakova T, et al. (2024) implemented the process for improving anaesthesia delivery using the QoR-15 tool to evaluate quality of postoperative recovery [46].

Beguinot et al. (2020) reported similar findings, where they investigated whether continuous wound infiltration of ropivacaine would be beneficial in treating post mastectomy pain due to surgery and found this technique to be efficient in helping reduce post operative pain however it had no effect on improvement of quality of life or chronic pain levels at 1, 3, and 6 months after surgery.[47]

A network meta-analysis was done by Li et al. (2024) in comparing four analgesic approaches: Liposomal bupivacaine, local infiltration analgesia, single-shot interscalene block (ssISB), and continuous interscalene block (cISB). According to their findings, early postoperative pain management was best with ssISB, but cISB was excellent for morphine consumption and hospital stay cut-down [48].

Dufour et al. (2022) established the minimum effective volume of 2% lidocaine with epinephrine to be 4 mL when using an ultrasound-guided hydro dissection technique [49].

Christiansen et al. (2020) also assessed volume of ropivacaine and duration of sciatic nerve block; they concluded that increasing the volume from 5 to 30 mL showed no significant difference in the duration of the block [50]. Rodriguez et al. (2021) compared intravenous dexamethasone and dexmedetomidine as adjuncts to prolong the duration of interscalene block in outpatient arthroscopic shoulder surgery. They showed that dexamethasone was superior to dexmedetomidine and found out that there was no additive benefit to using both adjuncts together [51].

Perioperative Considerations, Challenges and Complications

Albrecht E and Chin KJ (2020) elucidated the role of regional anaesthesia as an integral part of the multimodal anaesthetic approach, which aligns with the current trend of reducing the opioids used at surgical settings as much as possible [52]. Rawal N (2021) discussed trends in active engagement of surgeons with anaesthesiologist support to rectify the misuse of regional anaesthesia techniques and poor postoperative pain management skills [53].

Li L, et al. (2023) conducted a meta-analysis of regional nerve block added to general anaesthesia for patients with cardiovascular and thoracic surgery in relation to postoperative delirium, pain, and length of stay in the hospital [54]. Thepsoparn M, et al. (2022) investigated the effect of general anaesthesia with or without thoracic epidural block on length of stay after open spine surgery [55]. Adeola JO et al. (2023) concluded that there is racial and ethnic differences in the use of regional anaesthesia in patients undergoing total knee arthroplasty [56].

Hansen C, et al. (2021) studied a double-blind, randomized, placebo-controlled trial on transmuscular quadratus lumborum block for total laparoscopic hysterectomy, without significant reductions of opioid consumption or other pain-related outcomes [57]. Opperer M, et al. (2022) studied the influence of the cervical plexus blockade depth on phrenic nerve blockade during carotid endarterectomy and found that diaphragmatic dysfunction was most profound in the deep cervical plexus block group [58].

Guay & Kopp (2020) reviewed the use of PNBs for adult patients with hip fractures. The review concluded that, within 30 minutes of block placement, PNBs decreased pain on movement, reduced risk of acute confusional state, and probably reduced risk of chest infection and time to first mobilization [59].

King et al., (2022) evaluated the erector spinae plane block for perioperative analgesia in cardiac surgery by midline sternotomy. The block was not associated with clinically important reductions in postoperative pain, intraoperative opioid consumption, time-to-extubation, or length of stay in the ICU. [60]

Educational Approaches, Training, Future Directions and Research Priorities

Chuan A, et al. 2024: The level of experience with VR-assisted training was similar to the conventional training, but it required less faculty time to teach the ultrasound-guided needling skills [61]. Zhang X, et al. (2024) was aware of the fact that peer-led learning was the most influential educational method for trainee consultants and specialists in regional anaesthesia training, UK. [62].

According to a global Delphi study, Ferry J, et al. (2024) identified 11 questions of high priority in the scope of regional anaesthesia [63]. Dmytriiev D, et al. (2022) also pointed out the necessity for persistent use of erector spinae block in being used during battlefield medicine because of low risk and not complicated to be enforced under ultrasonic guidance [64].

Andersen CHS, et al. published a study protocol for a dose-finding trial of transmuscular quadratus lumborum block for percutaneous nephrolithotomy in 2020 [65].

CONCLUSION

In conclusion, this review highlights the significant advancements in regional anaesthesia, particularly with the integration of ultrasound-guided techniques and refined procedural protocols, which have substantially improved the precision and safety of regional blocks. These innovations have resulted in notable clinical benefits, such as enhanced pain management, reduced opioid usage, and improved postoperative recovery. However, challenges remain, including the need for comparability in technique outcomes across different clinical settings, standardized training programs, and equitable access to regional anaesthesia services. Future research should prioritize the development of evidence-based protocols, the integration of advanced technologies, and the establishment of comprehensive training standards. Continued evolution in regional anaesthesia, supported by evidence-based practices and technological advancements, is expected to further improve both efficacy and safety, ultimately optimizing patient outcomes in modern surgical care.

REFERENCES

1. Albrecht, E., & Chin, K. (2020). Advances in regional anaesthesia and acute pain management: a narrative review. Anaesthesia, 75, e101-e110.
2. Elsharkawy, H., El-Boghdadly, K., & Barrington, M. (2019). Quadratus lumborum block: anatomical concepts, mechanisms, and techniques. Anesthesiology, 130(2), 322-335.
3. Cozowicz, C., Poeran, J., Zubizarreta, N., Mazumdar, M., & Memtsoudis, S. G. (2016). Trends in the use of regional anesthesia: neuraxial and peripheral nerve blocks. Regional Anesthesia & Pain Medicine, 41(1), 43-49.
4. Elisha, S., & Nagelhout, J. J. (2017). Nurse anesthesia-E-book. Elsevier Health Sciences.
5. Chahrour, M., Chamseddine, H., Kabbani, L., & Aboul Hosn, M. (2024). Regional anesthesia is associated with improved mortality and morbidity in patients with congestive heart failure undergoing lower extremity amputation. Annals of Vascular Surgery, 108, 206–211.
6. Farrow, R. A., Shalaby, M., Newberry, M. A., Montes De Oca, R., Kinas, D., Farcy, D. A., et al. (2024). Implementation of an ultrasound-guided regional anesthesia program in the emergency department of a community teaching hospital. Annals of Emergency Medicine, 83, 509–518.
7. Ganta, A., Fisher, N. D., Gibbons, K., Ferati, S. R., Furgiuele, D., Konda, S. R., et al. (2024). Regional anesthesia is safe for use in intramedullary nailing of low-energy tibial shaft fractures. Injury, 55, 111636.
8. Du J, Li C, Zhang W, Lu X, Xia Y, Qin X. Efficacy and Safety of Adding Ketamine to Lidocaine in Intravenous Regional Anesthesia: A Meta-analysis of Randomized Controlled Trials. J Perianesth Nurs 2024. https://doi.org/10.1016/j.jopan.2024.03.013
9. Shams, D., Sachse, K., Statzer, N., & Gupta, R. K. (2024). Regional Anesthesia Complications and Contraindications. Anesthesiology clinics, 42(2), 329–344. https://doi.org/10.1016/j.anclin.2023.11.013
10. Yu, D., Wang, X., Jiang, L., Wu, Y., Han, S., & Li, J. (2024). Evaluating the impact of ultrasound-guided subsheath versus extrasheath sciatic nerve block on postoperative wound pain in tibial and foot surgeries: A systematic review and meta-analysis. International wound journal, 21(4), e14640. https://doi.org/10.1111/iwj.14640
11. Moorthy, A., Ní Eochagáin, A., Dempsey, E., Wall, V., Marsh, H., Murphy, T., Fitzmaurice, G. J., Naughton, R. A., & Buggy, D. J. (2023). Postoperative recovery with continuous erector spinae plane block or video-assisted paravertebral block after minimally invasive thoracic

surgery: a prospective, randomised controlled trial. British journal of anaesthesia, 130(1), e137–e147. https://doi.org/10.1016/j.bja.2022.07.051

12. Yu, D., Wu, Y., Han, S., Wang, X., & Jiang, L. (2024). Analgesic efficacy of local infiltration anaesthesia versus femoral nerve block in alleviating postoperative wound pain following total knee arthroplasty: A systematic review and meta-analysis. International wound journal, 21(2), e14766. https://doi.org/10.1111/iwj.14766
13. Hamid, H. K. S., Marc-Hernández, A., & Saber, A. A. (2021). Transversus abdominis plane block versus thoracic epidural analgesia in colorectal surgery: a systematic review and meta-analysis. Langenbeck's archives of surgery, 406(2), 273–282. https://doi.org/10.1007/s00423-020-01995-9
14. Zhao, Y., Qin, S., Yang, X., Gao, C., Yuan, X., Li, T., & Chen, Z. (2023). Comparison of the anesthesia effect of ultrasound-guided middle and low interscalene brachial plexus block: a randomized, controlled, non-inferiority trial. BMC anesthesiology, 23(1), 1. https://doi.org/10.1186/s12871-022-01963-4
15. Chen, B., Tan, M., Li, Q., Wang, S., Chen, D., Zhao, M., & Cao, J. (2024). Application of ultrasound-guided single femoral triangle and adductor canal block in arthroscopic knee surgery: a prospective, double-blind, randomized clinical study. BMC anesthesiology, 24(1), 182. https://doi.org/10.1186/s12871-024-02555-0
16. Aragola, S., Arenson, B., Tenenbein, M., Bohm, E., Jacobsohn, E., & Turgeon, T. (2021). Prospective randomized trial of continuous femoral nerve block with posterior capsular injection versus periarticular injection for analgesia in primary total knee arthroplasty. Canadian journal of surgery. Journal canadien de chirurgie, 64(3), E265–E272. https://doi.org/10.1503/cjs.020519
17. Vallabhaneni, N., Vanderham, L. C., Jacobson, S., Tobin, J. G., Guareschi, A. S., Eichinger, J. K., et al. (2024). Regional compared to general anesthesia for total shoulder arthroplasty. Seminars in Arthroplasty JSES, 34, 451–456.
18. Ye, Y., Papadimos, T. J., Xia, Y., & Wang, Q. (2023). Comparison of combined lumbar and PIP block versus general anesthesia on postoperative outcomes in hip surgery. Perioperative Care and Operating Room Management, 32, 100320.
19. Fang, L., Chen, X., Zhang, H., Bao, X., Duan, G., Cao, T., Jin, M., & Li, H. (2023). Laryngeal mask general anaesthesia versus spinal anaesthesia for promoting early recovery of cervical conisation: A randomised, controlled clinical study. Heliyon, 9(4), e15121.
20. Uraya, Y., Kawano, Y., Kuroiwa, T., Maeda, A., Funahashi, T., Shizu, K., Suzuki, K., & Fujita, N. (2023). Is local anesthesia or general anesthesia preferable for plate removal after clavicle fracture surgery under general anesthesia? A comparative study using a patient questionnaire. Injury, 54(12), 111144.
21. Shui, M., Zhao, D., Xue, Z., & Wu, A. (2023). Impact of Spinal/Epidural Anesthesia Versus General Anesthesia on Perioperative Outcomes in Patients Undergoing Lumbar Spine Surgery: An Updated Systematic Review and Meta-analysis. Clinical spine surgery, 36(6), 227–236. https://doi.org/10.1097/BSD.0000000000001374
22. Perez-Roman, R. J., Govindarajan, V., Bryant, J. P., & Wang, M. Y. (2021). Spinal anesthesia in awake surgical procedures of the lumbar spine: a systematic review and meta-analysis of 3709 patients. Neurosurgical focus, 51(6), E7. https://doi.org/10.3171/2021.9.FOCUS21464
23. Kull, C., Martin, R., Rossel, J. B., Nguyen, A., & Albrecht, E. (2024). Femoral vs sciatic nerve block to provide analgesia after medial open wedge high tibial osteotomy in the setting of multimodal analgesia: A randomized, controlled, single-blinded trial. Journal of clinical anesthesia, 93, 111355. https://doi.org/10.1016/j.jclinane.2023.111355

24. Chen, R., Su, S., & Shu, H. (2022). Efficacy and safety of rhomboid intercostal block for analgesia in breast surgery and thoracoscopic surgery: a meta-analysis. BMC anesthesiology, 22(1), 71. https://doi.org/10.1186/s12871-022-01599-4
25. Charvin, M., Longeras, F., Jouve, P., Cherprenet, A. L., Futier, E., Pereira, B., & Dualé, C. (2020). Effects of adding a combined femoral and sciatic nerve block with levobupivacaine and clonidine to general anaesthesia in femoropopliteal bypass surgery: A randomised, double-blind, controlled trial. European journal of anaesthesiology, 37(9), 787–795. https://doi.org/10.1097/EJA.0000000000001263
26. Kukreja, P., Uppal, V., Kofskey, A. M., Feinstein, J., Northern, T., Davis, C., Morgan, C. J., & Kalagara, H. (2023). Quality of recovery after pericapsular nerve group (PENG) block for primary total hip arthroplasty under spinal anaesthesia: a randomised controlled observer-blinded trial. British Journal of Anaesthesia, 130(6), 773-779.
27. Xu, M., Zhang, G., Tang, Y., Wang, R., & Yang, J. (2023). Impact of Regional Anesthesia on Subjective Quality of Recovery in Patients Undergoing Thoracic Surgery: A Systematic Review and Meta-Analysis. Journal of Cardiothoracic and Vascular Anesthesia, 37(9), 1744-1750.
28. Di Monte, F. F., Turri, G., Di Vittori, A., De Giulio, E., Bicelli, N., Faccioli, G., Sciortino, R., Valdegamberi, A., Ruzzenente, A., & Pedrazzani, C. (2024). Major abdominal surgery under locoregional anesthesia in a patient with primary ciliary dyskinesia: Clinical case. Surgery Case Reports, 2, 100032.
29. Pascarella, G., Costa, F., Del Buono, R., Pulitanò, R., Strumia, A., Piliego, C., De Quattro, E., Cataldo, R., Agrò, F. E., Carassiti, M., & collaborators (2021). Impact of the pericapsular nerve group (PENG) block on postoperative analgesia and functional recovery following total hip arthroplasty: a randomised, observer-masked, controlled trial. Anaesthesia, 76(11), 1492–1498. https://doi.org/10.1111/anae.15536
30. Tang, X., Jiang, X., Lei, L., Zhu, W., Fu, Z., Wang, D., Chen, J., Ning, N., & Zhou, Z. (2022). IPACK (Interspace between the Popliteal Artery and the Capsule of the Posterior Knee) Block Combined with SACB (Single Adductor Canal Block) Versus SACB for Analgesia after Total Knee Arthroplasty. Orthopaedic surgery, 14(11), 2809–2821. https://doi.org/10.1111/os.13263
31. Mongelli, F., Treglia, G., La Regina, D., Di Giuseppe, M., Galafassi, J., Majno-Hurst, P. E., & Christoforidis, D. (2021). Pudendal Nerve Block in Hemorrhoid Surgery: A Systematic Review and Meta-analysis. Diseases of the colon and rectum, 64(5), 617–631. https://doi.org/10.1097/DCR.0000000000001985
32. Gautam, S., Pande, S., Agarwal, A., Agarwal, S. K., Rastogi, A., Shamshery, C., & Singh, A. (2020). Evaluation of Serratus Anterior Plane Block for Pain Relief in Patients Undergoing MIDCAB Surgery. Innovations (Philadelphia, Pa.), 15(2), 148–154. https://doi.org/10.1177/1556984520908962
33. Kaushal, B., Chauhan, S., Magoon, R., Krishna, N. S., Saini, K., Bhoi, D., & Bisoi, A. K. (2020). Efficacy of Bilateral Erector Spinae Plane Block in Management of Acute Postoperative Surgical Pain After Pediatric Cardiac Surgeries Through a Midline Sternotomy. Journal of cardiothoracic and vascular anesthesia, 34(4), 981–986. https://doi.org/10.1053/j.jvca.2019.08.009
34. Machiyama Y, Ogawa T, Matsuo T, Sim J, Takeda J, Kameda S, et al. Association between smoking and duration of regional anesthesia – A propensity score matching study. J Orthop Sci 2024. https://doi.org/10.1016/j.jos.2024.06.012.
35. Yung, E. M., Got, T. C., Patel, N., Brull, R., & Abdallah, F. W. (2021). Intra-articular infiltration analgesia for arthroscopic shoulder surgery: a systematic review and meta-analysis. Anaesthesia, 76(4), 549–558. https://doi.org/10.1111/anae.15172

36. Harkouk, H., Fletcher, D., & Martinez, V. (2021). Paravertebral block for the prevention of chronic postsurgical pain after breast cancer surgery. Regional anesthesia and pain medicine, 46(3), 251–257. https://doi.org/10.1136/rapm-2020-102040
37. Pepper, C. G., Mikhaeil, J. S., & Khan, J. S. (2024). Perioperative Regional Anesthesia on Persistent Opioid Use and Chronic Pain after Noncardiac Surgery: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Anesthesia and analgesia, 139(4), 711–722. https://doi.org/10.1213/ANE.0000000000006947
38. Mantovani, G., Sgarbanti, L., Indaimo, A., Cavallo, M. A., De Bonis, P., Flacco, M. E., & Scerrati, A. (2023). Effects of a sphenopalatine ganglion block on postcraniotomy pain management: a randomized, double-blind, clinical trial. Neurosurgical focus, 55(6), E13. https://doi.org/10.3171/2023.9.FOCUS23549
39. Borys, M., Zamaro, A., Horeczy, B., Gęszka, E., Janiak, M., Węgrzyn, P., Czuczwar, M., & Piwowarczyk, P. (2021). Quadratus Lumborum and Transversus Abdominis Plane Blocks and Their Impact on Acute and Chronic Pain in Patients after Cesarean Section: A Randomized Controlled Study. International journal of environmental research and public health, 18(7), 3500. https://doi.org/10.3390/ijerph18073500
40. Duda, T., Lannon, M., Gandhi, P., Martyniuk, A., Farrokhyar, F., & Sharma, S. (2023). Systematic Review and Meta-Analysis of Randomized Controlled Trials for Scalp Block in Craniotomy. Neurosurgery, 93(1), 4–23. https://doi.org/10.1227/neu.0000000000002381
41. Torosis, M., Fullerton, M., Kaefer, D., Nitti, V., Ackerman, A. L., & Grisales, T. (2024). Pudendal Block at the Time of Transvaginal Prolapse Repair: A Randomized Controlled Trial. Urogynecology (Philadelphia, Pa.), 30(8), 706–713. https://doi.org/10.1097/SPV.0000000000001448
42. La Via, L., Cavaleri, M., Terminella, A., Sorbello, M., & Cusumano, G. (2024). Loco-Regional Anesthesia for Pain Management in Robotic Thoracic Surgery. Journal of clinical medicine, 13(11), 3141. https://doi.org/10.3390/jcm13113141
43. Lazar, A. E., Butiulca, M., & Farczadi, L. (2024). Challenges of the Regional Anesthetic Techniques in Intensive Care Units - A Narrative Review. Journal of critical care medicine (Universitatea de Medicina si Farmacie din Targu-Mures), 10(3), 198–208. https://doi.org/10.2478/jccm-2024-0023
44. Yang, M., Cao, L., Lu, T., Xiao, C., Wu, Z., Jiang, X., Wang, W., & Li, H. (2024). Ultrasound-guided erector spinae plane block for perioperative analgesia in patients undergoing laparoscopic nephrectomies surgery: a randomized controlled trial. Trials, 25(1), 10. https://doi.org/10.1186/s13063-023-07866-0
45. Häggström M, Brodin K. The meaning of being conscious during surgery with local or regional anesthesia–A phenomenological hermeneutic study. Int J Nurs Stud Adv 2024;7:100224.
46. Siniakova, T., Lombardi, C., Wofford, K., & Maye, J. (2024). Assessing the Quality of Postoperative Recovery: A Guide for Making Adjustments in Anesthesia Delivery. Journal of PeriAnesthesia Nursing, 39(3), 356-365.
47. Beguinot, M., Monrigal, E., Kwiatkowski, F., Ginzac, A., Joly, D., Gayraud, G., Le Bouedec, G., & Gimbergues, P. (2020). Continuous Wound Infiltration With Ropivacaine After Mastectomy: A Randomized Controlled Trial. The Journal of surgical research, 254, 318–326. https://doi.org/10.1016/j.jss.2020.05.006
48. Li, L., Liu, M., Li, S., Xu, J., Zheng, J., Lv, C., Wu, L., & Heng, L. (2023). Influence of Regional Nerve Block in Addition to General Anesthesia on Postoperative Delirium, Pain, and In-hospital

Stay in Patients Undergoing Cardiothoracic Surgery: A Meta-analysis. Journal of cardiovascular pharmacology, 82(6), 496–503. https://doi.org/10.1097/FJC.0000000000001469

49. Dufour, E., Jaziri, S., Novillo, M. A., Aubert, L., Chambon, A., Kutz, R., Vallée, A., & Fischler, M. (2022). A randomized trial to determine the minimum effective lidocaine volume for median nerve block using hydrodissection. Scientific reports, 12(1), 52. https://doi.org/10.1038/s41598-021-03660-7
50. Christiansen, C. B., Madsen, M. H., Rothe, C., Andreasen, A. M., Lundstrøm, L. H., & Lange, K. H. W. (2020). Volume of ropivacaine 0.2% and sciatic nerve block duration: A randomized, blinded trial in healthy volunteers. Acta anaesthesiologica Scandinavica, 64(2), 238–244. https://doi.org/10.1111/aas.13489
51. Rodrigues, D., Amadeo, R. J. J., Wolfe, S., Girling, L., Funk, F., Fidler, K., Brown, H., Leiter, J., Old, J., MacDonald, P., Dufault, B., & Mutter, T. C. (2021). Analgesic duration of interscalene block after outpatient arthroscopic shoulder surgery with intravenous dexamethasone, intravenous dexmedetomidine, or their combination: a randomized-controlled trial. Durée analgésique du bloc interscalénique après une chirurgie arthroscopique de l'épaule en ambulatoire avec dexaméthasone intraveineuse, dexmédétomidine intraveineuse, ou leur combinaison: une étude randomisée contrôlée. Canadian journal of anaesthesia = Journal canadien d'anesthesie, 68(6), 835–845. https://doi.org/10.1007/s12630-021-01942-2
52. Albrecht, E., & Chin, K. J. (2020). Advances in regional anaesthesia and acute pain management: a narrative review. Anaesthesia, 75 Suppl 1, e101–e110. https://doi.org/10.1111/anae.14868
53. Rawal N. (2021). Epidural analgesia for postoperative pain: Improving outcomes or adding risks?. Best practice & research. Clinical anaesthesiology, 35(1), 53–65. https://doi.org/10.1016/j.bpa.2020.12.001
54. Li, S., Chen, W., Feng, L., & Guo, X. (2024). Optimal analgesic regimen for total shoulder arthroplasty: a randomized controlled trial and network meta-analysis. Journal of orthopaedic surgery and research, 19(1), 57. https://doi.org/10.1186/s13018-023-04451-8
55. Thepsoparn, M., Punyawattanakit, P., Jaruwangsanti, N., Singhatanadgige, W., & Chalermkitpanit, P. (2022). Effects of general anesthesia with and without thoracic epidural block on length of stay after open spine surgery: a single-blinded randomized controlled trial. The spine journal : official journal of the North American Spine Society, 22(10), 1694–1699. https://doi.org/10.1016/j.spinee.2022.05.015
56. Adeola, J. O., Wall, P. V., Mehdipour, S., Macias, A. A., & Gabriel, R. A. (2023). Racial and Ethnic Differences in the Use of Regional Anesthesia for Patients Undergoing Total Knee Arthroplasty. The Journal of Arthroplasty, 38(9), 1663-1667.
57. Hansen, C., Dam, M., Nielsen, M. V., Tanggaard, K. B., Poulsen, T. D., Bendtsen, T. F., & Børglum, J. (2021). Transmuscular quadratus lumborum block for total laparoscopic hysterectomy: a double-blind, randomized, placebo-controlled trial. Regional anesthesia and pain medicine, 46(1), 25–30. https://doi.org/10.1136/rapm-2020-101931
58. Opperer, M., Kaufmann, R., Meissnitzer, M., Enzmann, F. K., Dinges, C., Hitzl, W., Nawratil, J., & Koköfer, A. (2022). Depth of cervical plexus block and phrenic nerve blockade: a randomized trial. Regional anesthesia and pain medicine, 47(4), 205–211. https://doi.org/10.1136/rapm-2021-102851
59. Guay, J., & Kopp, S. (2020). Peripheral nerve blocks for hip fractures in adults. The Cochrane database of systematic reviews, 11(11), CD001159. https://doi.org/10.1002/14651858.CD001159.pub3

60. King, M., Stambulic, T., Servito, M., Mizubuti, G. B., Payne, D., & El-Diasty, M. (2022). Erector spinae plane block as perioperative analgesia for midline sternotomy in cardiac surgery: A systematic review and meta-analysis. Journal of cardiac surgery, 37(12), 5220–5229. https://doi.org/10.1111/jocs.17005
61. Chuan A, Bogdanovych A, Moran B, Chowdhury S, Lim YC, Tran MT, et al. Using Virtual Reality to teach ultrasound-guided needling skills for regional anaesthesia: A randomised controlled trial. J Clin Anesth 2024;97:111535.
62. Zhang X, Vanstone RJ, Turbitt L, West S, Harty E. Regional anaesthesia education for consultants and specialists in the UK: a mixed-methods analysis. Br J Anaesth 2024;132:1073-81.
63. Ferry J, Lewis O, Lloyd J, El-Boghdadly K, Kearns R, Albrecht E, et al. Research priorities in regional anaesthesia: an international Delphi study. Br J Anaesth 2024;132:1041-8.
64. Dmytriiev, D., Dîrzu, D. S., Melnychenko, M., & Eichholz, R. (2022). Erector spinae plane block for affective and safe analgesia in a patient with severe penetrating chest trauma caused by an explosion in the battlefield. Clinical Case Reports, 10(10), e6433.
65. Andersen, C. H. S., Laier, G. H., Nielsen, M. V., Dam, M., Hansen, C. K., Tanggaard, K., & Børglum, J. (2020). Transmuscular quadratus lumborum block for percutaneous nephrolithotomy: Study protocol for a dose-finding trial. Acta anaesthesiologica Scandinavica, 64(8), 1224–1228. https://doi.org/10.1111/aas.13605