Perioperative Precision Medicine
ISSN: 2957-5443

Zentime

Review Article https://doi.org/10.61189/768941essmpc

Ultrasound-guided forearm selective nerve block: A bright future on the horizon

Ziwei Xia[1,2], Guangkuo Ma[1,2], Huanjia Xue[1,2], Hui Wu[1,2], Liwei Wang[1,2], Kai Wang[1,2]

[1]Graduate School, Xuzhou Medical University, Xuzhou 221009, Jiangsu Province, China. [2]Department of Anesthesiology, Xuzhou Central Hospital, Xuzhou 221009, Jiangsu Province, China.

Corresponding author: Kai Wang.

Acknowledgement: This work was supported by the Department of Anesthesiology of Xuzhou Central Hospital. The authors would like to thank all the guest editors and anonymous reviewers for their constructive comments.

Declaration of conflict of interest: None.

Received January 25, 2024; Accepted April 2, 2024; Published September 30, 2024

Highlights

- In the realm of forearm, wrist, and hand surgeries, ultrasound-guided forearm selective nerve block techniques offer distinct advantages over alternative methods such as Bier's block, brachial plexus block, and wrist block. These advantages include reduced anesthesia-related time, prolonged duration of analgesia, and minimal interference with upper extremity motor function.
- Ultrasound-guided forearm selective nerve block stands as a straightforward and conducive anesthesia method ideally suited for distal upper limb surgeries. This approach harmonizes seamlessly with the principles of fast surgical recovery and enhances patient comfort during both diagnostic and therapeutic procedures.
- Supplementation of dexmedetomidine or dexamethasone in ultrasound-guided selective nerve blocks of the forearm has been shown to significantly prolong the duration of analgesia.

Abstract

Objective: In light of the advancement of modern medicine, anesthesiologists and surgeons are increasingly prioritizing patient comfort in diagnostic and therapeutic procedures. A growing body of research revolves around the utilization of ultrasound-guided forearm selective nerve blocks for surgeries involving the distal upper limb. This review aims to provide an overview of regional anesthesia techniques in forearm, hand, and wrist surgeries, laying a theoretical foundation for the prospects of ultrasound-guided forearm selective nerve blocks in optimizing comfort during diagnostic and therapeutic procedures. **Methods:** A retrospective review of literature sourced from the PubMed database was conducted to comprehensively evaluate and elucidate the advantages and drawbacks of ultrasound-guided forearm selective nerve blocks, brachial plexus blocks, Bier blocks, and wrist blocks. Additionally, a summary was provided regarding the selection of local anesthetics for ultrasound-guided forearm selective nerve blocks. **Results:** Overall, ultrasound-guided forearm selective nerve block techniques exhibit several advantages over Bier's block, brachial plexus block, and wrist block for the majority of forearm, wrist, and hand surgeries. These advantages include reduced anesthesia-related time, prolonged duration of analgesia, and minimal impairment of upper extremity motor function. Consequently, these techniques enhance surgical safety and facilitate postoperative recovery. Furthermore, the addition of dexmedetomidine or dexamethasone to ultrasound-guided selective nerve blocks of the forearm could extend the duration of analgesia. **Conclusion:** Ultrasound-guided forearm selective nerve block is a straightforward and conducive anesthesia method for distal upper limb surgeries, aligning with the principles of fast surgical recovery and enhanced patient comfort during diagnostic and therapeutic procedures. Given its manifold benefits, widespread promotion and adoption of this technique in clinical practice are warranted.

Keywords: Ultrasound; distal peripheral forearm block; brachial plexus block; dexmedetomidine; dexamethasone

Address correspondence to: Kai Wang, Department of Anesthesiology, Xuzhou Central Hospital, No. 199 Jiefang South Road, Quanshan District, Xuzhou 221009, Jiangsu Province, China. Tel: +86-18112012729; E-mail: wangkaistream99@sina.com or 760020230115@xzhmu.edu.cn.

Introduction

In the early stages of anesthesia development, even routine upper limb surgeries required general anesthesia. However, perioperative pain management for upper limb procedures has undergone a paradigm shift, with regional anesthesia now assuming a pivotal role and often preferred over general anesthesia [1, 2]. Various regional anesthesia techniques, such as Bier block, brachial plexus block, and wrist block, have been widely employed in surgeries involving the forearm, hand, and wrist. However, each method carries its own set of drawbacks: Bier block often results in postoperative tourniquet pain; brachial plexus block may induce prolonged motor paralysis leading to the phenomenon of "dead arm"; wrist block often entails multiple puncture attempts. Therefore, there has been a collective call within the field to identify an anesthesia approach that offers precise analgesia without compromising postoperative upper limb motor function. Within this context, ultrasound-guided forearm selective nerve block has emerged as a viable option. This article will chronologically review and compare anesthesia methods for forearm, hand, and wrist surgeries, aiming to provide valuable insights and guidance for future clinical anesthesia work. (**Figure 1**)

Traditional regional anesthesia techniques for forearm, hand, and wrist surgeries

Bier block

In 1908, German surgeon August Gustav Bier introduced the technique of Intravenous Regional Anesthesia (IVRA), commonly known as the Bier block technique. This method relies on the application of tourniquets and bandages to achieve regional anesthesia by slowly injecting anesthetic agents through a venous catheter [3, 4]. It is a simple procedure that allows for adequate muscle relaxation [5]. Upper limb IVRA encompasses both traditional upper arm IVRA and forearm IVRA techniques. Traditional IVRA typically requires the administration of 40 ml of 0.5% lidocaine, whereas forearm IVRA achieves comparable anesthesia blockade with a reduced volume of 25 ml of 0.5% lidocaine, thereby lowering the incidence of tourniquet related discomfort [6]. However, a notable limitation of the Bier block technique, when compared to ultrasound-guided nerve blocks, is the occurrence of tourniquet pain. The most severe complications associated with Bier block involve inadvertent release of the tourniquet, leading to rapid systemic toxicity due to the sudden release of local anesthetic [5]. Additionally, Bier block carries risks such as arterial puncture injury and the development of ventricular septal syndrome [7].

Brachial plexus nerve block

Brachial plexus block is a commonly used regional anesthesia technique for upper limb surgeries [8]. Common approaches for brachial plexus nerve block include the interscalene, supraclavicular, infraclavicular, and axillary routes, with additional variations such as posterior clavicular brachial plexus nerve block and selective proximal and distal brachial plexus nerve block within the plexus itself [9, 10]. Despite its widespread utilization, brachial plexus nerve block is associated with several potential complications, including pneumothorax, arterial puncture, hematoma formation, Horner's syndrome, and phrenic nerve block, among others [11]. Furthermore, the use of long-acting local anesthetics in proximal brachial plexus blocks can result in prolonged motor paralysis, commonly termed as the "dead arm", which extends the patient's postoperative recovery period and reduces patient satisfaction [12]. Despite the efficacy of ultrasound-guided brachial plexus block for most upper limb surgical anesthesia requirements, instances of incomplete anesthesia or block failure with isolated brachial plexus nerve blocks have been reported, necessitating additional local anesthetics or adjunctive intravenous medication [13].

Wrist block

Wrist block, performed in the proximal forearm near the wrist, represents a distal peripheral nerve block when compared to forearm selective nerve block. This technique entails the blockade of six nerves, including the median nerve, ulnar nerve, superficial branch of the radial nerve, dorsal branch of the ulnar nerve, posterior interosseous nerve, and anterior interosseous nerve, in addition to the primary nerves [14, 15]. Wrist block serves as a standalone method during surgery or as an adjunct to general anesthesia, such as in wrist release procedures [16]. However, it requires six punctures, heightening the risk of infection and potentially influencing patient satisfaction, in contrast to ultrasound-guided selective nerve blocks of the forearm, which require a maximum of four punctures. Moreover, in cases of tendon and nerve damage or severe compression injuries, an upper arm tourniquet may be indispensable to ensure bloodless surgery and prevent ischemic necrosis in the distal limb. However, the use of an upper arm tourniquet is contraindicated in wrist block procedures,

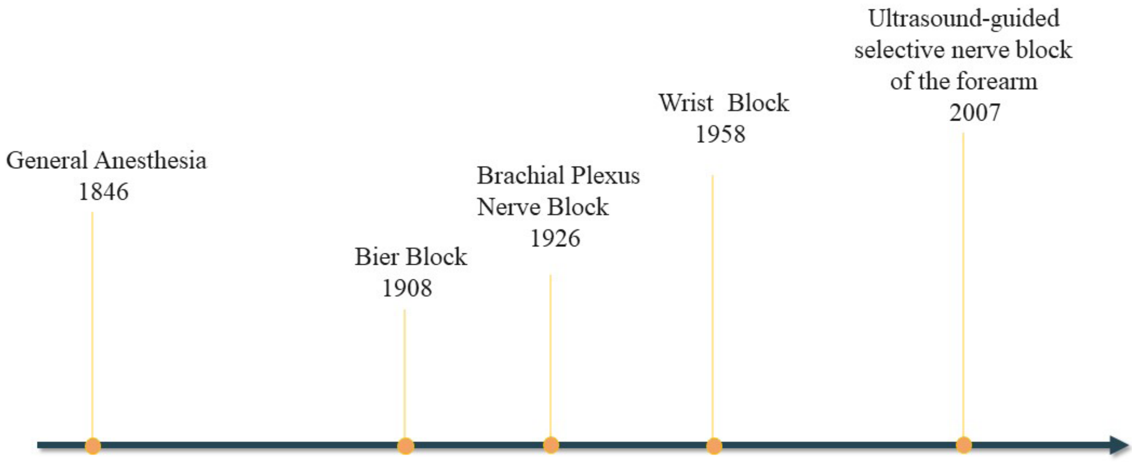

Figure 1. Historical development of anesthesia methods for forearm, hand, and wrist surgeries.

which limits its applicability [17]. Consequently, ultrasound-guided forearm selective nerve blocks have a wider range of applications than wrist blocks [18].

Ultrasound-guided forearm selective nerve block

Currently, with increasing policy demands and higher patient expectations regarding postoperative outcomes, anesthesiologists are facing growing pressures throughout the perioperative period [19]. There is a growing awareness of the benefits associated with ultrasound-guided forearm selective nerve blocks within the context of comfort diagnostic and therapeutic procedures. It is becoming increasingly apparent that proficiency in this technique is a crucial skill that anesthesiologists ought to possess.

Ultrasound-guided forearm selective nerve block technique

Ultrasound technology serves as a pivotal tool in the practice of regional anesthesia, facilitating precise administration of anesthesia while mitigating associated risks [20]. The sensory and motor functions of the forearm, hand, and wrist are predominantly governed by the radial nerve, ulnar nerve, median nerve, and musculocutaneous nerve, along with their respective branches. With the guidance of ultrasound, anesthesiologists can selectively or concurrently block various nerves as required by the surgical procedure, ensuring anesthesia coverage for diverse regions of the forearm, hand, and wrist [21].

The procedure for ultrasound-guided forearm nerve block is relatively straightforward. The ultrasound probe is positioned horizontally in the mid-forearm, and the injection of local anesthetics is performed in three stages, targeting the ulnar nerve, superficial branch of the radial nerve, and median nerve, sequentially. In forearm surgeries, it is often imperative to perform selective nerve blocks of the radial nerve, ulnar nerve, and median nerve concurrently with a musculocutaneous nerve block in the upper arm [22]. In contrast, wrist surgeries typically require selective blockage of the ulnar nerve, superficial branch of the radial nerve, and median nerve [23]. To reduce the number of needle insertions, NC Lam et al. introduced a technique for simultaneously blocking the median nerve and ulnar nerve with a single needle insertion [24]. The ultrasound probe is positioned 5 cm proximal to the wrist fold on the inner side of the forearm and then shifted towards the ulnar side to visualize the ulnar nerve adjacent to the ulnar artery [24]. Once these structures are identified, subcutaneous local anesthesia is administered at the inner edge of the ultrasound probe, followed by needle insertion from the inner side to the outer side, reaching the vicinity of the ulnar nerve for ulnar nerve blockade [24]. At the same horizontal level as the ulnar nerve injection site, the median nerve becomes visible [24].

Employing an in-plane approach, the needle is advanced from the ulnar side towards the median nerve for median nerve blockade [24]. Similarly, I. Ince et al. proposed a method for simultaneous blockade of the radial nerve and median nerve [25]. The ultrasound is positioned in the middle or slightly above the forearm, where the superficial branch of the radial nerve can be clearly observed [25]. After blocking the superficial branch of the radial nerve, the ultrasound probe is shifted from the outer side to the inner side to visualize the median nerve [25]. Subsequently, the needle is advanced towards the median nerve to perform median nerve blockade [25]. It is important to note that these techniques, involving the simultaneous blocking of two nerves in one needle insertion, may require a high level of expertise from the anesthesiologist, and further research is needed as no additional studies on this technique have been conducted to date.

Comparison and advantages of ultrasound-guided forearm selective nerve block technique over others

Firstly, in comparison to ultrasound-guided axillary brachial plexus nerve block, ultrasound-guided forearm selective nerve block offers the advantages of simplicity and safety, leading to a potential reduction in anesthesia-related time [26]. It is associated with fewer severe complications, such as phrenic nerve block and pneumothorax, making it a technique that even junior residents can relatively easily master and perform [27]. The study also demonstrated that ultrasound-guided forearm selective nerve blocks, when compared to ultrasound-guided brachial plexus nerve blocks, could reduce the incidence of moderate to severe postoperative wrist pain and provide superior anesthesia and analgesia [27].

Secondly, when compared to forearm Bier block, ultrasound-guided forearm nerve block in patients undergoing outpatient hand surgeries results in only 10% of cases requiring additional analgesics due to incomplete block, whereas this proportion can be as high as 31% in Bier block procedures in the operating room [4, 28]. Research also indicates that ultrasound-guided forearm nerve block can reduce the incidence of moderate to severe postoperative wrist pain, providing superior anesthesia and analgesia outcomes [12, 28].

Finally, ultrasound-guide forearm selective nerve block also proves to be cost-effective. According to a survey, the cost of operating room time in the United States averages $15 per minute, with each forearm selective nerve block procedure saving approximately 20 minutes of anesthesia time [29]. This efficiency allows patient pathways to transition from a serial to a "parallel processing mode," wherein surgeries can be performed simultaneously, saving approximately $300 per nerve block procedure [29]. This not only significantly reduces resource and financial costs but also has the potential to enhance patient satisfaction [30, 31]. Overall, the primary advantages of peripheral nerve blocks in the forearm over other anesthetic methods include maximizing the preservation of finger and distal muscle function, requiring fewer local anesthetics, reducing anesthesia-related time, prolonging the duration of analgesia, and expediting postoperative recovery. These advantages collectively contribute to improving the patient's prognosis [32-34] (**Table 1**).

Currently, ultrasound-guided forearm nerve block has emerged as a reliable method for providing precise analgesic effects and has become a method for anesthesia and analgesia in acute pain management of hand and wrist injuries [35]. It can be employed in outpatient settings and emergency department surgeries [28, 36, 37]. Furthermore, ultrasound-guided forearm selective nerve block has demonstrated remarkable efficacy across various orthopedic surgeries [35, 38]. For example, in the United States, it has proven successful in interventions such as finger reduction, upper limb fractures, dislocations, and abscess drainage [39, 40]. In addition, it serves as a valuable tool for postoperative pain management, aligning with the growing trend of employing peripheral nerve blocks for adult postoperative pain control, which has proven to be both well-tolerated and effective [41]. Following surgery, the implementation of forearm selective nerve block not only enhances pain management but also reduces the need for opioid medications and mitigates associated side effects such as vomiting [42].

Selection of local anesthetics and adjuvant medications for ultrasound-guided forearm selective nerve block

Long-acting local anesthetics, such as ropivacaine or bupivacaine, play a pivotal role in enhancing postoperative pain management. Ropivacaine is a long-acting amide-type local anesthetic that exhibits superior selectivity for A δ and C nerve fibers over A β nerve fibers, resulting in sensory-motor separation [43, 44]. While high doses of ropivacaine can effectively block both sensory and motor fibers, forearm nerve block procedures typically utilize lower doses. However, when local anesthetics are used alone, there may arise situations where the duration of block is insufficient, making it challenging to avoid the use of opioid medications postoperatively. Therefore, the addition of adjuvant medications to local anesthetics is often considered to enhance the analgesic effects of the local anesthetic [45, 46]. This approach proves beneficial for patients in overcoming postoperative pain-related obstacles, facilitating early hand function exercises, and expediting postoperative recovery [47]. Adjuvant medications for local anesthesia encompass a wide array of options, among which adrenaline, clonidine, opioid medications, ket-

Table 1. Comparison of common regional anesthesia methods for hand and wrist surgeries

Methods of regional anesthesia	Punctures	Motor block	Sensory block	Contraindication	Complications	Advantages	Major shortcomings
Ultrasound-guided forearm selective nerve block	1, 2, 3, 4, (depending on the needs of the surgical site)	Little motor block	1. Compared to brachial plexus nerve block, it prolongs the duration of sensory blockade. 2. It accelerates the onset of sensory blockade.	1. Patient declined multiple needle punctures. 2. Local anesthetic allergy. 3. Infection at the puncture site. 4. Coagulation abnormalities. 5. Distorted or absent anatomical landmarks.	1. Peripheral nerve injury. 2. Local anesthetic toxicity. 3. Vascular damage. 4. Infection.	1. Smaller local anesthetic doses. 2. Shorter anesthesia-related times. 3. Prolonged postoperative analgesic effects. 4. Higher safety profile. 5. Most studies indicate no need for additional rescue anesthesia measures [32-34]. 6. Cost-effective. 7. Preserving motor function, and aiding in postoperative recovery. 8. Successfully employed in a variety of surgical procedures.	Multiple punctures
Brachial plexus nerve block	1	Prolonged motor block	Prolonged sensory block	1. Anatomical deformity. 2. Infection at the puncture site. 3. Coagulation abnormalities. 4. Allergic reaction to local anesthetics.	1. Intercostal space approach: ipsilateral diaphragmatic paralysis, etc. 2. Supraclavicular approach: pneumothorax, etc. 3. Infraclavicular approach: pneumothorax, diaphragmatic paralysis, etc. 4. Axillary approach: local anesthetic toxicity reactions and arterial puncture, etc.	1. Brachial plexus nerve block is a clinically proven and reliable anesthesia method. 2. Brachial plexus nerve block has multiple approaches that can be selected based on the specific patient's condition.	"Dead arm"
Bier block	1	Adequate muscle relaxation	Compared to general anesthesia, forearm Bier block can enhance the anesthetic and analgesic effect.	1. Patients requiring prolonged use of tourniquets. 2. Infection at the puncture site.	1. Relatively higher risk of compartment syndrome. 2. Systemic toxicity (potential cardiac and neurological toxicity). 3. Arterial puncture.	1. Compared to traditional upper arm Bier block, forearm Bier block requires a shorter tourniquet time. 2. It has a broad spectrum of applications and is suitable for various surgeries. 3. Compared to traditional upper arm Bier block, forearm Bier block has a lower incidence of tourniquet pain.	Tourniquet pain
Wrist block	6	Elbow joint immobility	Adequate sensory block	1. Consistency with ultrasound-guided selective nerve block in the forearm. 2. Patients requiring upper arm tourniquet.	Consistency with ultrasound-guided selective nerve block in the forearm.	1. Smaller local anesthetic doses. 2. Higher safety profile. 3. Cost-effective.	Multiple punctures

amine, and midazolam, when co-administered with local anesthetics around the nerves, have been shown to have limited effectiveness [48]. However, dexamethasone and dexmedetomidine have demonstrated efficacy in enhancing the effects of peripheral nerve blocks, including those performed for hand and wrist surgeries [49, 50]. Overall, the use of adjuvant medications can prolong the duration of analgesia, speed up the onset of action, and mitigate complications or risks.

Dexmedetomidine, an α-2 agonist with an affinity approximately 8 times greater than that of clonidine, is frequently utilized as an adjunct medication in various regional anesthesia procedures [51]. While the precise mechanisms underlying the analgesic and sedative effects of α-2 adrenergic agonists remain not fully understood, they are believed to involve multiple factors. Peripherally, α-2 agonists can diminish norepinephrine release and exert an inhibitory effect on nerve fiber action potentials, independent of α-2 receptors. They also directly block the Ih cation current activated during hyperpolarization, thereby producing analgesic effects [52]. Dexmedetomidine has been demonstrated to reduce postoperative pain and opioid consumption [53]. Studies indicate that supplementing lidocaine with dexmedetomidine in selective forearm nerve blockade can extend the duration of analgesia by 364 minutes, in contrast to a mere 21-minute extension with systemic administration of dexmedetomidine [54]. It's worth noting that the addition of dexmedetomidine to local anesthetics does not significantly prolong the duration of motor blockade [55]. Additionally, research indicates that both peripheral and systemic use of dexmedetomidine can effectively enhance analgesic effects, which is advantageous for patients' postoperative recovery [56]. This further underscores the effectiveness of dexmedetomidine as an adjunct medication in regional anesthesia.

Dexamethasone, a synthetic corticosteroid, is one of the most extensively studied adjuvant medications in anesthesia [57]. It boasts analgesic, antiemetic, and anti-inflammatory properties, effectively alleviating tissue inflammation and inflammation-related pain. When compared to clonidine or dexmedetomidine, the addition of dexamethasone to ropivacaine has been shown to prolong analgesia without inducing rebound pain [58, 59]. Furthermore, dexamethasone extends the duration of analgesia when combined with local anesthetics while concurrently reducing the onset time for sensory and motor blockade [60]. A meta-analysis revealed that both peripheral administration and intravenous infusion of dexamethasone prolonged the duration of supraclavicular brachial plexus block, with intravenous administration extending analgesia by 76.4 minutes and peripheral administration by 11.4 minutes [46]. However, peripheral use of dexamethasone is associated with fewer adverse reactions compared to intravenous administration. Additionally, an animal study indicated that combining nerve blockade with dexamethasone did not increase neurotoxicity, underscoring its safety and reliability [61, 62]. Nevertheless, conflicting findings were reported in a study where researchers supplemented a standard peripheral nerve blockade model with dexamethasone, concluding that its impact on sensory blockade with ropivacaine lacked clinical or statistical significance [57]. This discrepancy highlights the necessity for further experimental studies to clarify this issue.

Conclusion

In summary, ultrasound-guided forearm selective nerve block represents a promising and straightforward anesthesia technique for forearm, hand, and wrist surgeries. It holds the potential to expedite anesthesia onset, prolong analgesia duration, mitigate patient discomfort, foster postoperative recovery, and improve patient outcomes. Furthermore, the duration of analgesia can be extended when ultrasound-guided selective nerve blocks of the forearm are supplemented with dexmedetomidine or dexamethasone. Future research should focus on refining puncture approaches, minimizing the number of puncture attempts, and highlighting the benefits of preserving motor function. This focus aims to meet the requirements of surgical anesthesia while further enhancing patient outcomes and satisfaction. Additionally, in thumb surgery, further research could explore the blockage of branches of the musculocutaneous nerve on the lateral forearm. This approach circumvents the impact on elbow joint motor function while meeting the anesthesia requirements of thumb surgery. Future studies in this direction could provide a more comprehensive theoretical framework and guidance for selective forearm nerve blocks

Author Contributions: Ziwei Xia: essay writing, form preparation. Guangkuo Ma: collection of information, organizing the literature. Huanjia Xue: collection of information, organizing the literature. Hui Wu: collection of information, organizing the literature. Liwei Wang: dissertation guidance. Kai Wang: dissertation guidance, proposing the topic, thesis revision.

References

[1] Turbitt LR, Mariano ER, El-Boghdadly K. Future directions in regional anaesthesia: not just for the cognoscenti. Anaesthesia 2020;75(3):293-297.

[2] Vietor R 3rd, Buckenmaier C 3rd. Regional Anesthesia in the Field for Trauma Victims. Anesthesiol Clin 2021;39(2):337-351.

[3] van Zundert A, Helmstädter A, Goerig M, et al. Centennial of intravenous regional anesthesia. Bier's Block (1908-2008). Reg Anesth Pain Med 2008;33(5):483-489.

[4] Nijs K, Lismont A, De Wachter G, et al. The analgesic efficacy of forearm versus upper arm intravenous regional anesthesia (Bier's block): A randomized controlled non-inferiority trial. J Clin Anesth 2021;73:110329.

[5] Löser B, Petzoldt M, Löser A, et al. Intravenous Regional Anesthesia: A Historical Overview and Clinical Review. J Anesth Hist 2019;5(3):99-108.

[6] Ghaderi K, Rahmani K, Rahmanpanah N, et al. Comparison of lidocaine-dexmedetomidine and lidocaine-saline on the characteristics of the modified forearm bier block: A clinical trial. J Anaesthesiol Clin Pharmacol 2021;37(4):610-615.

[7] Teunkens A, Vermeulen K, Belmans A, et al. Patient satisfaction with intravenous regional anaesthesia or an axillary block for minor ambulatory hand surgery: A randomised controlled study. Eur J Anaesthesiol 2020;37(10):847-856.

[8] Grape S, Pawa A, Weber E, et al. Retroclavicular vs supraclavicular brachial plexus block for distal upper limb surgery: a randomised, controlled, single-blinded trial. Br J Anaesth 2019;122(4):518-524.

[9] Georgiadis PL, Vlassakov KV, Patton ME, et al. Ultrasound-guided supraclavicular vs. retroclavicular block of the brachial plexus: comparison of ipsilateral diaphragmatic function: A randomised clinical trial. Eur J Anaesthesiol 2021;38(1):64-72.

[10] Zhang J, Li M, Jia HB, et al. Clinical application of ultrasound-guided selective proximal and distal brachial plexus block in rapid rehabilitation surgery for hand trauma. World J Clin Cases 2020;8(11):2137-2143.

[11] Xing T, Ge L. Ultrasound-Guided Brachial Plexus Block by Costoclavicular Space Approach: A Narrative Review. Med Sci Monit 2023;29:e939920.

[12] Bao N, Chen L, Xia Y, et al. Effect of Ultrasound-guided Nerve Block With 0.75% Ropivacaine at the Mid-forearm on the Prevalence of Moderate to Severe Pain After Hand Surgery. Clin Ther 2018;40(6):1014-1022.

[13] Gunjiyal MS, Mohammed S, Bhatia P, et al. Effect of combined versus sequential injection of 2% lidocaine and 0.5% bupivacaine on the onset and duration of supraclavicular brachial plexus block: A double blinded randomised controlled trial. J Clin Anesth 2021;72:110313.

[14] Kocheta A, Agrawal Y. Landmark Technique for a Wrist Block. JBJS Essent Surg Tech 2018;8(1):e7.

[15] Bloc S, Mercadal L, Cadas H. Distal Block for Wrist Bone Analgesia: The Anterior and Posterior Interosseous Nerves Must Be Blocked. J Hand Surg Am 2015;40(10):2114-2115.

[16] Sallum Y, Fodor L, Mărginean G, et al. Combined distal median nerve block and local anesthesia with lidocaine:epinephrine for carpal tunnel release. Heliyon 2022;8(3):e09119.

[17] Burnham PJ. Regional block at the wrist of the great nerves of the hand. J Am Med Assoc 1958;167(7):847-850.

[18] Sohoni A, Nagdev A, Takhar S, et al. Forearm ultrasound-guided nerve blocks vs landmark-based wrist blocks for hand anesthesia in healthy volunteers. Am J Emerg Med 2016;34(4):730-734.

[19] Sun EC, Memtsoudis SG, Mariano ER. Regional Anesthesia: A Silver Bullet, Red Herring, or Neither? Anesthesiology 2019;131(6):1205-1206.

[20] O'Donnell BD, Loughnane F. Novel nerve imaging and regional anesthesia, bio-impedance and the future. Best Pract Res Clin Anaesthesiol 2019;33(1):23-35.

[21] Chandrasoma J, Harrison TK, Ching H, et al. Peripheral Nerve Blocks for Hand Procedures. N Engl J Med 2018;379(10):e15.

[22] Kawase S, Horiuchi T, Nagahata T. Use of Ultrasound-Guided Selective Sensory Nerve Blocks to Provide Satisfactory Postoperative Analgesia Without Motor Paralysis in Bilateral Distal Radius Fracture Fixation: A Case Report. A A Pract 2021;15(8):e01514.

[23] Mori T, Nomura O, Ihara T. Ultrasound-guided peripheral forearm nerve block for digit fractures in a pediatric emergency department. Am J Emerg Med 2019;37(3):489-493.

[24] Lam NC, Charles M, Mercer D, et al. A triple-masked, randomized controlled trial comparing ultrasound-guided brachial plexus and distal peripheral nerve block anesthesia for outpatient hand surgery. Anesthesiol Res Pract 2014;2014:324083.

[25] Ince I, Aksoy M, Celik M. Can We Perform Distal Nerve Block Instead of Brachial Plexus Nerve Block Under Ultrasound Guidance for Hand Surgery? Eurasian J Med 2016;48(3):167-171.

[26] Nijs K, Van Rossum M, Ory JP, et al. Ultrasound-guided axillary brachial plexus block versus distal peripheral forearm nerve block for hand and wrist surgery: a randomised controlled trial. Br J Anaesth 2023;131(1):e20-e22.

[27] Winter J, McLeod G, Quaife T, et al. Surgeon-administered Ultrasound-guided Peripheral Nerve Blocks in Outpatient Procedures of the Upper Extremity. Plast Reconstr Surg Glob Open 2020;8(11):e3227.

[28] Snyman J, Goldstein LN. Nervous breakdown! A registry of nerve blocks from a South African emergency centre. Afr J Emerg Med 2019;9(4):177-179.

[29] Macachor JD, Kumar CM, Seet E, et al. Peripheral Nerve Blocks in a Regional Anesthesia Block Area: An Economic Model. Reg Anesth Pain Med 2018;43(4):448-449.

[30] Chazapis M, Kaur N, Kamming D. Improving the Peri-operative care of Patients by

instituting a 'Block Room' for Regional Anaesthesia. BMJ Qual Improv Rep 2014;3(1):u204061.
[31] Guay J, Rosenblatt MA. Peripheral nerve blocks for elective primary total hip arthroplasty: Have we yet found the optimal solution? J Clin Anesth 2020;67:109964.
[32] Sehmbi H, Madjdpour C, Shah UJ, et al. Ultrasound guided distal peripheral nerve block of the upper limb: A technical review. J Anaesthesiol Clin Pharmacol 2015;31(3):296-307.
[33] Marhofer P, Harrop-Griffiths W, Kettner SC, et al. Fifteen years of ultrasound guidance in regional anaesthesia: part 1. Br J Anaesth 2010;104(5):538-546.
[34] Jalil H, Polfliet F, Nijs K, et al. Efficacy of ultrasound-guided forearm nerve block versus forearm intravenous regional anaesthesia in patients undergoing carpal tunnel release: A randomized controlled trial. PLoS One 2021;16(2):e0246863.
[35] Wiederhold BD, Garmon EH, Peterson E, et al. Nerve Block Anesthesia. In: editors. StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Emily Garmon declares no relevant financial relationships with ineligible companies. Disclosure: Elisha Peterson declares no relevant financial relationships with ineligible companies. Disclosure: Joshua Stevens declares no relevant financial relationships with ineligible companies. Disclosure: Maria O'Rourke declares no relevant financial relationships with ineligible companies. StatPearls Publishing Copyright © 2024, StatPearls Publishing LLC., 2024. p.
[36] Wheelock M, Petropolis C, Lalonde DH. The Canadian Model for Instituting Wide-Awake Hand Surgery in Our Hospitals. Hand Clin 2019;35(1):21-27.
[37] Vrablik M, Akhavan A, Murphy D, et al. Ultrasound-Guided Nerve Blocks for Painful Hand Injuries: A Randomized Control Trial. Cureus 2021;13(10):e18978.
[38] Divella M, Vetrugno L, Orso D, et al. Which regional anesthesia technique is the best for arthroscopic shoulder surgery in terms of postoperative outcomes? A comprehensive literature review. Eur Rev Med Pharmacol Sci 2021;25(2):985-998.
[39] Amini R, Patricia Javedani P, Amini A, et al. Ultrasound-Guided Forearm Nerve Blocks: A Novel Application for Pain Control in Adult Patients with Digit Injuries. Case Rep Emerg Med 2016;2016:2518596.
[40] Stone MB, Price DD, Wang R. Ultrasound-guided supraclavicular block for the treatment of upper extremity fractures, dislocations, and abscesses in the ED. Am J Emerg Med 2007;25(4):472-475.
[41] De Windt AC, Asehnoune K, Roquilly A, et al. An opioid-free anaesthetic using nerve blocks enhances rapid recovery after minor hand surgery in children. Eur J Anaesthesiol 2010;27(6):521-525.
[42] Campoy L. Locoregional Anesthesia for Hind Limbs. Vet Clin North Am Small Anim Pract 2019;49(6):1085-1094.
[43] Fang G, Wan L, Mei W, et al. The minimum effective concentration (MEC90) of ropivacaine for ultrasound-guided supraclavicular brachial plexus block. Anaesthesia 2016;71(6):700-705.
[44] Huang R, Zhu J, Zhao Z, et al. The effect of programmed intermittent epidural bolus compared with continuous epidural infusion in labor analgesia with ropivacaine: a meta-analysis of randomized controlled trials. Ann Palliat Med 2021;10(3):2408-2420.
[45] Sehmbi H, Brull R, Ceballos KR, et al. Perineural and intravenous dexamethasone and dexmedetomidine: network meta-analysis of adjunctive effects on supraclavicular brachial plexus block. Anaesthesia 2021;76(7):974-990.
[46] Imani F, Farahmand Rad R, Salehi R, et al. Evaluation of Adding Dexmedetomidine to Ropivacaine in Pediatric Caudal Epidural Block: A Randomized, Double-blinded Clinical Trial. Anesth Pain Med 2021;11(1):e112880.
[47] Hade AD, Okano S, Pelecanos A, et al. Factors associated with low levels of patient satisfaction following peripheral nerve block. Anaesth Intensive Care 2021;49(2):125-132.
[48] Cummings KC 3rd, Napierkowski DE, Parra-Sanchez I, et al. Effect of dexamethasone on the duration of interscalene nerve blocks with ropivacaine or bupivacaine. Br J Anaesth 2011;107(3):446-453.
[49] Xuan C, Yan W, Wang D, et al. The Facilitatory Effects of Adjuvant Pharmaceutics to Prolong the Duration of Local Anesthetic for Peripheral Nerve Block: A Systematic Review and Network Meta-analysis. Anesth Analg 2021;133(3):620-629.
[50] Hashemi N, Modir H, Moshiri E, et al. Effects of adding dexmedetomidine, fentanyl, and verapamil to 0.5% ropivacaine on onset and duration of sensory and motor block in forearm surgeries: a randomized controlled trial. Med Gas Res 2021;11(2):47-52.
[51] Edinoff AN, Houk GM, Patil S, et al. Adjuvant Drugs for Peripheral Nerve Blocks: The Role of Alpha-2 Agonists, Dexamethasone, Midazolam, and Non-steroidal Anti-inflammatory Drugs. Anesth Pain Med 2021;11(3):e117197.
[52] Lu TL, Lu TJ, Wu SN. Effectiveness in Block by Dexmedetomidine of Hyperpolarization-

Activated Cation Current, Independent of Its Agonistic Effect on α(2)-Adrenergic Receptors. Int J Mol Sci 2020;21(23):9110.
[53] Zha J, Ji S, Wang C, et al. Thoracic Paravertebral Nerve Block with Ropivacaine and Adjuvant Dexmedetomidine Produced Longer Analgesia in Patients Undergoing Video-Assisted Thoracoscopic Lobectomy: A Randomized Trial. J Healthc Eng 2021;2021:1846886.
[54] Bao N, Shi K, Wu Y, et al. Dexmedetomidine prolongs the duration of local anesthetics when used as an adjuvant through both perineural and systemic mechanisms: a prospective randomized double-blinded trial. BMC Anesthesiol 2022;22(1):176.
[55] Abdallah FW, Dwyer T, Chan VW, et al. IV and Perineural Dexmedetomidine Similarly Prolong the Duration of Analgesia after Interscalene Brachial Plexus Block: A Randomized, Three-arm, Triple-masked, Placebo-controlled Trial. Anesthesiology 2016;124(3):683-695.
[56] Motaghi E, Ghasemi Pirbalooti M, Bozorgi H, et al. Safety and Efficacy of Dexmedetomidine in Breast Surgeries: A Systematic Review and Meta-Analysis. J Perianesth Nurs 2021;36(2):179-186.
[57] Marhofer P, Columb M, Hopkins PM, et al. Dexamethasone as an adjuvant for peripheral nerve blockade: a randomised, triple-blinded crossover study in volunteers. Br J Anaesth 2019;122(4):525-531.
[58] Dong X, Wu CL, YaDeau JT. Clinical care pathways for ambulatory total shoulder arthroplasty. Curr Opin Anaesthesiol 2022;35(5):634-640.
[59] Maagaard M, Stormholt ER, Nielsen LF, et al. Perineural and Systemic Dexamethasone and Ulnar Nerve Block Duration: A Randomized, Blinded, Placebo-controlled Trial in Healthy Volunteers. Anesthesiology 2023;138(6):625-633.
[60] Ahmed NA, Altaei AH, Jasim MA. COMPARISON OF THE ONSET OF SENSORY BLOCK USING LIDOCAINE 1.5% WITH ADRENALINE OR LIDOCAINE 1.5% WITH ADRENALINE AND DEXAMETHASONE IN ULTRASOUND GUIDED AXILLARY NERVE BLOCK FOR BELOW ELBOW SURGERIES. Wiad Lek 2021;74(9 cz 2):2337.
[61] Marty P, Bennis M, Legaillard B, et al. A New Step Toward Evidence of In Vivo Perineural Dexamethasone Safety: An Animal Study. Reg Anesth Pain Med 2018;43(2):180-185.
[62] Duggan NM, Nagdev A, Hayes BD, et al. Perineural Dexamethasone as a Peripheral Nerve Block Adjuvant in the Emergency Department: A Case Series. J Emerg Med 2021;61(5):574-580.