REVIEW ARTICLE

Application and Research Progress of Ultrasound-Guided Brachial Plexus Block Through Costoclavicular Space Approach in Upper Limb Surgery

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ABSTRACT

Objective • Exploring newer approaches to brachial plexus block is crucial for improving surgical outcomes and patient comfort. This study aims to review the application and research progress of ultrasound-guided brachial plexus block via the costoclavicular space approach in upper limb surgery.

Methods • This study provides a comprehensive review of existing literature, studies, and clinical cases related to the costoclavicular approach. The advantages and disadvantages of conventional approaches for brachial plexus block, including the intermuscular groove method, supraclavicular method, and axillary approach, are discussed. The anatomical characteristics of the costoclavicular space are examined, and the methods of brachial plexus nerve block using ultrasound-guided costoclavicular space approach are described. It holds great promise for enhancing patient care and increasing the overall success rate of surgical procedures.

Results • The costoclavicular space approach for brachial plexus block offers several advantages, including stable anatomical structure, low nerve variation rate, and clear visualization of each nerve bundle under ultrasound imaging. Compared to traditional approaches, ultrasound-guided brachial plexus block via the costoclavicular space approach has a high success rate, rapid onset of anesthesia, and high safety.

Conclusion • Ultrasound-guided brachial plexus block via the costoclavicular space approach is effective and safe in upper limb surgery. It provides good anesthesia and postoperative analgesia, making it a valuable technique for various upper limb surgeries. The potential clinical significance of our findings lies in the possibility that ultrasound-guided costoclavicular space approach, with its enhanced precision and patient outcomes, could play a pivotal role in improving upper limb surgical procedures. (*Altern Ther Health Med.* 2024;30(1):24-30).

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INTRODUCTION

A brachial plexus nerve block is mainly used by injecting anesthetic drugs around the trunk of the brachial plexus to produce nerve block in its innervating area. By blocking the transmission of peripheral injury impulses to the central nervous system, the brachial plexus block reduces hemodynamic changes caused by injury stimulation during surgery. Brachial plexus blocks help reduce pain and discomfort during surgery by blocking the conduction of the nerves in the upper extremity, making the surgical site painless. This anesthesia technique provides high-quality pain management, allowing patients to experience less pain during surgery, reducing the physical and emotional stress of surgery. It also prolongs the duration of postoperative analgesia, leading to improved pain management. Compared with general anesthesia, this form of anesthesia can ensure the quality of intraoperative anesthesia and have good postoperative analgesic effect, which has been widely used in various upper limb surgeries.[1] Brachial plexus blocks have many advantages over general anesthesia, including local pain control, reduced risk of general anesthesia, improved surgical efficiency and faster recovery, while reducing the need for analgesics, providing safer, personalized pain for surgical procedures management style. There are several approaches for brachial plexus block; the most classical ones include intermuscular groove, axillary, and supraclavicular methods, and the block effects, advantages, and disadvantages of different approaches are also different.[2] The intermuscular approach is achieved by puncturing the intermuscular groove of the humerus, the axillary approach is via an axillary approach, and the supraclavicular approach is via a supraclavicular approach. Costoclavicular space is a new approach for brachial plexus block in recent years, which has a stable anatomical structure, low nerve variation rate, and can clearly distinguish each nerve bundle of brachial plexus under ultrasound imaging.[3,4] The costoclavicular space approach is a method of injecting anesthetic drugs around the brachial plexus trunk through a specific anatomical space. This anatomical space is usually located between the clavicle and the first rib and is a relatively stable and easily accessible area. By guiding the needle in this space, the anesthetic drug can be accurately injected into the brachial plexus to achieve local anesthetic effect. Compared with traditional brachial plexus block, ultrasound-guided brachial plexus block via costoclavicular space approach has the advantages of high success rate, rapid onset of anesthesia, and high safety. This study reviews the application and research progress of ultrasound-guided brachial plexus block via costoclavicular space approach in upper limb surgery. This study aims to review the application and research progress of costoclavicular approach in brachial plexus block. The costoclavicular approach is considered a newer technique that involves the injection of anesthesia in the specific anatomical space between the clavicle and first rib for the purpose of local anesthesia. By evaluating the effectiveness and safety of the costoclavicular space approach, this study aims to provide valuable information for clinicians and researchers in the field.

ADVANTAGES AND DISADVANTAGES OF THE CONVENTIONAL APPROACH FOR BRACHIAL PLEXUS BLOCK

Intermuscular groove method

Anatomical location of the interscalene approach

The intermuscular groove is a depression located between the anterior scalenus muscle and the middle scalenus muscle. Each trunk of the brachial plexus exits the scalene space laterally and enters the axilla from a posterior direction of the clavicle.[5] For the brachial plexus block puncture via the intermuscular groove approach, the patient was positioned supine with the pillow removed, and a thin pillow was placed under the shoulder to ensure that the upper limb was close to the side of the body. The triangular gap created by the posterior border of the sternocleidomastoid, the anterior and middle scalenus muscles, and the omohyoid muscle was probed above the clavicle. The patient's strange feeling is a reliable indicator of successful puncture. [6]

Advantages and limitations of the rib-lock gap method

Brachial plexus block via the intermuscular groove approach can simultaneously block the lateral thoracic, subscapular, and axillary nerve, making it the primary method of anesthesia for shoulder and upper arm surgeries. By impeding the transmission of peripheral injury impulses to the central nervous system during the early stages, it can mitigate the related hemodynamic changes resulting from injury stimulation and prolong the duration of postoperative analgesia.[7,8] The anesthesia technique of the costoclavicular space approach reduces the physiological stress response of the patient to external stimuli during the operation by blocking the sensory nerves in a targeted manner. This provides superior pain relief, maintains the patient's hemodynamic stability, and prolongs postoperative analgesia, thereby enhancing surgical safety and the patient's surgical experience. However, anesthetic drugs administered in this area can easily spread to the phrenic nerve of the anterior scalenus muscle, resulting in a nerve block that affects the patient's pulmonary ventilation function, leading to reduced postoperative tidal volume. Phrenic nerve block is a potential limitation of the costoclavicular approach because of the potential for anesthesia to spread to the anterior scalene phrenic nerve when anesthetized in this area. This condition can lead to block of the phrenic nerve, which in turn affects the patient's diaphragm function, thereby reducing tidal volume and respiratory function. This condition may be particularly important in patients with pre-existing respiratory problems, as it may lead to postoperative dyspnea and hypoxemia, which may even require additional measures of respiratory support. Consequently, it has clear limitations in anesthesia and analgesia applications for patients with respiratory dysfunction.[9] Lars Bergmann et al.[10] also confirmed that different injection sites in ultrasound-guided interscalene brachial plexus blocks did not reduce the risk of tissue diffusion of local anesthetics and phrenic nerve blocks. Furthermore, the patient's vital capacity and ventilation level were reduced.

SUPRACLAVICULAR METHOD

Supraclavicular Approach: Comprehensive Anesthesia for Upper Limb Surgeries

The supraclavicular pathway is a commonly used approach for brachial plexus block, offering several distinct advantages for upper limb surgeries. It provides targeted anesthesia of the brachial plexus trunks and cords, ensuring comprehensive analgesia of the entire upper limb. The supraclavicular nerve is the brachial plexus nerve's most concentrated and superficial anatomical site. The supraclavicular approach is a technique used for brachial plexus blocks that has important implications in upper extremity surgery. This method effectively achieves a block of the brachial plexus by injecting an anesthetic drug at a specific location above the collarbone, thereby producing a local anesthetic effect. The use of the supraclavicular approach in surgery has significant clinical relevance and can help improve surgical quality and the patient's surgical experience. The brachial plexus nerve goes to the middle and lateral side of the first rib posterior to the clavicle, and the upper, middle, and lower nerve trunks are divided into the anterior and posterior strands, respectively. After passing through the midpoint of the clavicle, the brachial plexus continues to branch and reassemble into the medial, lateral, and posterior bundles.[11] During the puncture of the supraclavicular brachial plexus block, the patient was placed in the supine position, a thin pillow was placed under the shoulder of the affected side, and the head was inclined to the healthy side. The needle was inserted from about 1 cm above the midpoint of the clavicle, and the first rib was probed inward, backward, and downward Then the abnormal sensation was found along the ribs to indicate the puncture was in place.

Advantages and Security Comparison

Supraclavicular brachial plexus block has a good application effect in anesthesia and analgesia for distal 2/3 upper limb surgery and shoulder surgery.[12] Compared with other approaches, the course of supraclavicular brachial plexus is relatively concentrated, which is more conducive to the wrapping and blocking of local anesthetic drugs, and the onset rate of drugs is faster.[13] The supraclavicular approach offers effective local anesthesia due to its concentration of nerves in the supraclavicular region, making it ideal for various upper limb surgeries, particularly in the distal two-thirds of the upper limb and shoulder. Compared with the brachial plexus block via the interscale approach, the puncture point and needle direction of supraclavicular brachial plexus block are farther than those of the central nerve and phrenic nerve, and the risk of Horner syndrome, ipsilateral diaphragmatic paralysis, and other complications is relatively lower.[14,15] Horner syndrome is damage to some part of the sympathetic nervous system, usually manifested by miosis (small pupils), drooping of the upper eyelids (blepharoptosis), and a slight drooping of the facial muscles. In both approaches, hoarseness and phrenic nerve palsy can occur. However, in the supraclavicular approach, the risk is higher because of the anatomic location of the supraclavicular approach to the phrenic and sympathetic chains. In the prospective cohort study of Ferre F et al.[16], the incidence of hemi-phrenic paralysis in the supraclavicular brachial plexus block group was 59.5 %, which was much lower than 95.3 % in the interscaline block group, which also confirmed that the risk of nerve injury related complications in the supraclavicular brachial plexus block was lower than that in the interscaline approach, but the anatomical location of the two groups was relatively similar. Therefore, hoarseness and ipsilateral phrenic nerve palsy risk is still relatively high. At the same time, because the anatomical site of the puncture point of supraclavicular nerve block is close to the apex of the lung, it is easy to cause lung and pleural injury during the puncture process, leading to pneumothorax and other complications.[17] The proximity of the puncture point to the lung apex increases the risk of lung and pleural injury. When the needle is close to the apex of the lung, inadvertent puncture can damage the lung tissue, leading to pneumothorax or pleural effusion. These complications can lead to difficulty breathing, chest pain, and the need for further medical intervention, such as chest drainage or drainage of the lungs. For patients, this can prolong hospital stays, increase treatment costs, and even lead to other health problems.

Axillary approach

The axilla is a cone-shaped cavity between the medial walls of the upper wall and the lateral walls of the remaining thorax, which is composed of the top, bottom, and four walls. The middle third of the clavicle surrounds the top, the outer edge of the first rib, and the upper edge of the scapula, while the neurovascular bundle containing the brachial plexus flows from the top through the axilla to the elbow.[18] The brachial plexus nerve bundle at the puncture point of the axillary approach was composed of three nerve bundles, namely the lateral head of the median nerve, the musculocutaneous nerve, the medial head of the median nerve, the ulnar nerve, the medial cutaneous nerve of the anterior wall, the medial brachial cutaneous nerve, the posterior axillary nerve, and the radial nerve, to form the terminal nerve. During the brachial plexus tissue puncture through the axillary approach, the patient was placed in the supine position without the pillow, and the operative limb was fully exposed by 90 degrees of abduction and 90 degrees of flexion. The highest point of axillary artery fluctuation was taken as the puncture point.

The axillary brachial plexus block is mainly suitable for anesthesia and analgesia in the lower 1/3 of the upper arm, the hand, the wrist, and the ulnar side of the anterior wall. The axillary approach is suitable for a variety of procedures in the lower third of the upper arm, hand, wrist, and ulnar anterior wall, as it provides precise local anesthesia while reducing the risk of neurological and respiratory complications, thereby improving surgical efficiency safety and success rate. This approach is particularly beneficial for surgery in these areas, as it efficiently localizes the brachial plexus, ensuring adequate anesthesia of the surgical area while avoiding interference with the central nervous system and lung apex. This approach is far from the lung's central nerve and apex. Compared with the intermuscular sulcus and supraclavicular approaches, the risk of complications is relatively low. A significant advantage of the axillary approach is its greater distance from the central nervous system and lung apex, thereby reducing associated risks. This approach is particularly advantageous in specific clinical scenarios, as it reduces the risk of complications associated with the proximity of the central nervous system and lung apex. By injecting anesthesia into the armpit area, the brachial plexus can be blocked more safely with less chance of accidentally injuring the central nerve or causing pulmonary complications. This is especially important for patients with pre-existing respiratory problems or other health risks, as it reduces the risk of postoperative complications and helps improve the safety and success of the procedure. In the clinical practice of Cho S et al.[19], the success rate of axillary brachial plexus block with different drug injection methods reached 80.8 to 88.5 %, which confirmed that the effect of axillary brachial plexus block was ideal. However, due to the relatively rich blood vessels in the axillary region, the rate of toxicity and side effects caused by local anesthetics is higher than that of other approaches. At the same time, because musculocutaneous nerves are mostly outside the vascular nerve sheath, and axillary nerves are mostly emitted from higher parts of the axilla, axillary brachial plexus block has a poor blocking effect on both of them.[20] Some challenges and limitations may arise due to the effect of an axillary brachial plexus block on the musculocutaneous and axillary nerves. For example, this approach may cause sensory and motor disturbances in the surgical field, affecting the dexterity of the surgical procedure. In addition, effects on the musculocutaneous and axillary nerves may cause postoperative pain or discomfort, which may require additional analgesic measures. These limitations need to be considered when choosing to use an axillary brachial plexus block, especially if it is necessary to maintain surgical flexibility and minimize postoperative discomfort.

Anatomical characteristics of the costoclavicular space

The costoclavicular space is a stable space between the middle third of the clavicle and the first rib. It's situated between the middle third of the clavicle and the first rib, highlighting its precise boundaries. The brachial plexus nerve runs from the supraclavicular posterior to the subclavian artery through the clavicular space and continues to the axillary artery to form three bundles. The costoclavicular space is an important anatomical structure that contains three major nerve bundles, each composed of different nerves. First, the superior oblique bundle includes the fibers of the C5 and C6 spinal nerves, which are primarily responsible for supplying part of the upper extremity, including the muscles of the shoulder, upper arm, and elbow. Second, the mesoscale nerve bundle consists of fibers of the C7 spinal nerve, which primarily controls another part of the upper extremity, including the muscles of the forearm. Finally, the inferior oblique bundle consists of fibers of the C8 and T1 spinal nerves that supply the muscles of the hand, wrist, and fingers.

These three bundles of nerves meet at the costoclavicular space, and then branch out to different parts of the upper limb through different innervation. This fine distribution and innervation ensures sensory and motor function in the upper extremities. The costoclavicular space is a key location for brachial plexus block. By injecting local anesthetics, these nerve bundles can be effectively anesthetized, thereby producing the effect of local anesthesia. This process is critical to many surgical and pain management procedures as it provides effective pain relief and muscle relaxation, helping to improve the patient's surgical experience and postoperative recovery.

When passing through the costoclavicular space, the three bundles of nerve all run parallel to the lateral side of the axillary artery. After penetrating the gap, the distal end of the branch of the humeral suture artery of the axillary artery separated and not only walked to the depth independently.[21] The clear course and stable positional relationship of nerve bundles in the costoclavicular space are crucial for ultrasound-guided brachial plexus block. These anatomical features make it easier for physicians to identify neural structures and ensure accurate injections. Additionally, they help improve surgical success rates, reduce the risk of complications, and provide a higher level of patient care.Each bundle of nerves in the costoclavicular space has a clear course and a stable positional relationship. The anatomical structures of the lateral bundle, medial bundle, posterior bundle, and blood vessels can be easily distinguished under ultrasound imaging, which provides a good anatomical basis for brachial plexus block.[22] The use of ultrasound imaging in brachial plexus blocks provides medical professionals with real-time, high-resolution images that allow them to precisely target and inject anesthetic drugs. Ultrasound allows doctors to visualize nerve bundles, surrounding tissue, and the spread of anesthesia. This real-time imaging allows doctors to adjust the location of punctures and injections, ensuring that the drug is accurately covering the nerve structure, thereby improving the success rate of the procedure.

METHODS OF BRACHIAL PLEXUS NERVE BLOCK BY ULTRASOUND-GUIDED COSTOCLAVICULAR SPACE APPROACH AND THEIR ADVANTAGES AND DISADVANTAGES

The upper limb of the affected side was fixed after 90° abduction, and the head was tilted to the healthy side. The ultrasound probe was placed between the midpoint of the clavicle and the second intercostal space, and the ultrasound probe was slowly moved caudally to the medial side of the coracoid process to determine the positional relationship among the serrate anterior muscle, subclavian muscle, axillary artery, and brachial plexus. It can be seen that the lateral cephalic vein merges into the axillary vein and crosses the three bundles of brachial plexus nerves, and the position before the cephalic vein merges into the axillary vein is taken as the puncture section. Under ultrasound guidance, the puncture process should avoid the blood vessels and try to locate at the center of the nerve bundle until the medial bundle is reached, and local anesthetic drugs are injected into the lateral bundle and the medial inter bundle space for nerve block.[23]

Compared with the brachial plexus block of traditional approach, the brachial plexus block of the costoclavicular space approach has the following advantages: (1) The insertion process of the costoclavicular space brachial plexus block penetrates the subclavian muscle and pectoralis major muscle, the anatomical position is stable, it is not easy to be affected by joint activity, and it can effectively reduce catheter prolapse and displacement during continuous anesthesia and analgesia.[24] In a prospective study by Capdevila X et al.[25], the risk of catheter location-related complications for ultrasound-guided costicoclavicular interspace brachial plexus block was much lower than that of conventional brachial plexus block (60%-70%). The reason is mainly related to the small mobility of the skin in the costoclavicular space and the "muscle tunnel" formed by the serratus and subclavian muscles. (2) The lateral bundle, medial bundle and posterior bundle of the proximal brachial plexus in the intercostal space approach are fixed in parallel and in a relatively close position, and only local anesthetics injected between the lateral and medial bundles can achieve a good block effect of the brachial plexus.[3,23,26] Karmakar MK et al.[24] also pointed out that similar to supraclavicular approach, during the anesthesia process of intercostal space brachial plexus block, local anesthetic drugs can quickly infiltrate and wrap around the brachial plexus bundle to quickly exert analgesic and anesthetic effects.

However, the difference from the value is that the similar space approach can make the anesthetics wrap around the three nerve bundles more completely, reduce the dosage of local anesthetics to ensure the block effect on each branch, and reduce the physiological damage caused by excessive anesthetics. (3) The anatomical position of the brachial plexus in the costoclavicular space is relatively superficial, the puncture depth during the block is relatively low, and the positional relationship of each nerve bundle is relatively fixed, and the variation rate is lower than other approaches, which reduces the operation difficulty of ultrasound-guided puncture block to a certain extent.[24,27] (4) Compared with the traditional approaches such as intersulcus and supraclavicular approach, the puncture point and needle insertion site of the costoclavicular space for brachial plexus block are far away from the central nerve, and the risk of serious complications such as Horner syndrome and high epidural anesthesia is low. However, there are relatively few clinical studies on the risk of intraoperative complications between the costoclavicular space and other approaches. However, at the same time, there are important blood vessels, such as the axillary artery parallel to the brachial plexus in the costoclavicular space, and the space of the approach is relatively narrow, which leads to the difficulty of hemostasis after accidental injury of blood vessels during puncture. If the patient has coagulopathy or fails to stop bleeding effectively in time, hematoma and tissue edema may also compress local nerves and blood vessels.

Eventually, it leads to thoracic outlet syndrome and aggravates the physiological pain of patients.[28,29] In addition, compared with the intermuscular sulcus approach, the puncture point of the costoclavicular space for the brachial plexus block is closer to the pleura. If the pleura is accidentally injured during the puncture process, it may lead to complications such as pneumothorax and hemothorax. However, Karmakar MK et al.[24] also pointed out in their report on the advantages of ultrasound-guided brachial plexus block between the intercostal clavicular space that there have been more than 100 cases of ultrasound-guided brachial plexus block between the intercostal clavicular space without pleural or vascular injury. Therefore, in actual clinical practice, The risk of related complications can be reduced to a certain extent by improving the level of operation and more advanced ultrasound guidance technology, and the limitations of the application of costoclavicular space brachial plexus block can be reduced. To enhance patient safety during brachial plexus block procedures using the costoclavicular space approach, healthcare providers can take several measures. These include continuous education and training in ultrasound-guided techniques, real-time ultrasound imaging for accurate needle placement, proper patient positioning, careful needle selection, obtaining informed consent with a discussion of potential complications, maintaining sterile technique, continuous patient monitoring, and the readiness to consult with specialists in complex cases. By incorporating these best practices into clinical procedures, clinicians can minimize risks and improve the overall safety and effectiveness of the costoclavicular space approach.

In conclusion, the ultrasound-guided costoclavicular approach has multiple advantages in anesthesia and analgesia applications, including stable anatomy, low variability, good drug coverage, and low risk of complications. This approach works excellently in upper extremity surgery, especially in procedures on the hand, wrist, forearm, and ulnar anterior wall. However, the risks associated with this approach, such as possible vascular and pleural injury, still need to be carefully managed. Overall, the ultrasound-guided costoclavicular approach provides a promising approach to improve the safety and efficacy of the procedure, especially with the guidance of appropriate training and clinical practice, it can minimize the patient's risks of.

APPLICATION EFFECT OF ULTRASOUND-GUIDED BRACHIAL PLEXUS BLOCK THROUGH COSTOCLAVICULAR SPACE APPROACH IN DIFFERENT TYPES OF UPPER LIMB SURGERY

Shoulder surgery

The most important nerve involved in shoulder surgery anesthesia is the suprascapular nerve. Critical nerves in forearm, elbow, and hand surgery include the median, radial, ulnar, and musculocutaneous nerves. These nerves are responsible for controlling the movement of the hand muscles and providing sensation in the hand. Understanding their function is critical to surgery to ensure that these functions are not compromised, preserving the patient's normal movement and sensation. The suprascapular nerve originates from the upper trunk of the brachial plexus, formed by the anterior branch of the C5 and C6 nerves. After the reduction, the deep surface of the superior transverse ligament and the supraspinatus fossa gives off branches to innervate the shoulder muscles and skin respectively.[30] Brachial plexus block via intermuscular groove approach is one of the most common and ideal anesthesia schemes for shoulder surgery. In the comparison of the analgesic effect of brachial plexus block via intercostal clavicular space and intermuscular groove approach in shoulder arthroscopic surgery, Aliste J et al.[31] showed that the analgesic effect of intercostal clavicular space approach was not significantly different from that of intermuscular groove approach. Ultrasound-guided brachial plexus block via the costoclavicular approach has shown significant advantages in several clinical studies. This method usually has a high success rate and can safely and effectively locate and block the targeted nerve. Studies have also shown that it has a lower rate of complications than traditional methods, including a lower risk of nerve damage. In addition, ultrasound guidance provides real-time imaging that helps medical professionals pinpoint nerves, thereby ensuring accurate anesthesia of the surgical area. This method is also known for its fast onset time, which helps to reduce the patient's pain quickly and improve the efficiency of the operation. The patients also had a lower risk of unilateral diaphragmatic paralysis, which also confirmed the ideal anesthetic effect of brachial plexus block through the costoclavicular space approach in shoulder surgery and could effectively reduce the risk of common complications such as diaphragmatic paralysis. In conclusion, ultrasound-guided blocks through the costoclavicular approach are widely used in different surgical procedures. Precise anesthesia for forearm, elbow and hand surgery such as median nerve, radial nerve, ulnar nerve and musculocutaneous nerve is its advantage. It is equally suitable for shoulder and upper arm procedures such as shoulder surgery and clavicle fracture repair. In addition, there are clear advantages for wrist and hand surgery, such as wrist surgery and palm surgery. Overall, this approach has high applicability across a wide variety of surgical procedures, providing high success rates and low risk of complications, helping to improve surgical efficiency and patient experience.

Although ultrasound-guided blocks through the costoclavicular approach have demonstrated many advantages in a variety of surgical procedures, there are some potential limitations. First, this approach may not be suitable for certain patients, especially those with anatomical variations or traumatic injuries. Second, despite the relatively low risk of complications, highly trained and experienced medical professionals are still required to perform this technique, which may limit its widespread adoption in certain regions or settings. In addition, although this approach can reduce the amount of local anesthetic drug used, it still requires careful monitoring to avoid excessive drug use. Finally, for those patients requiring postoperative analgesic management, additional drugs or techniques may be required to manage postoperative pain given its local effects.

Overall, ultrasound-guided blockade via the costoclavicular approach has shown versatility and high efficiency in upper extremity surgery, successfully used in various surgical types, and with a low complication rate. Despite some limitations, the method is promising as research and technology develop. Future studies could further expand the applicability and reduce the risk of complications. This approach provides an important anesthesia and analgesia option for upper extremity surgery.

Forearm, elbow, and hand surgery

The median, radial, ulnar, and musculocutaneous nerve are the main nerves involved in anesthesia of the anterior two-thirds of upper limb surgery. It is difficult to achieve a good block effect by single injection of local anesthetic drugs through the traditional subclavian approach for brachial plexus block, and multi-point injection is needed to completely fall the nerve to achieve the ideal block effect. It not only increases the risk of damage to peripheral nerves, blood vessels, and tissues during puncture but also increases the dosage of local anesthetics and the risk of toxic and side effects of local anesthetics.[32] Li JW et al.[23] performed ultrasound-guided brachial plexus block between the costicoclavicular space in 30 patients who planned to undergo hand or forearm surgery. After injecting 20 mL of 0.5% ropivacaine, 97% of the patients achieved complete sensory block of the median, radial, ulnar, and musculocutaneous nerve within 30 minutes. Most patients had sensory loss in the corresponding innervation area 5 minutes after injection, and all patients had direct complications related to local anesthesia. It is confirmed that ultrasound-guided brachial plexus block through costicoclavicular space is effective and safe in hand and anterior wall surgery anesthesia. The clinical study of Garcia-Vitoria C et al.[33] also confirmed that ultrasound-guided continuous brachial plexus block via costoclavicular interspace approach was ideal for anesthesia and postoperative analgesia in elbow surgery. Compared with the traditional supraclavicular approach, it had better mechanical stability and could achieve a larger safer range of neck motion.

CONCLUSION

Future research will focus on continuously improving the ultrasound-guided block approach for the costoclavicular approach to expand its use in upper extremity surgery. Investigators will aim to further reduce the risk of complications, improve the success rate, and determine the best application of this method in a specific case. In addition, new techniques and tools will be explored to better visualize and localize nerve tracts to increase surgical precision. Most importantly, future studies will continue to evaluate the long-term clinical outcomes of the costoclavicular approach in different types of upper extremity surgery to determine its optimal role in clinical practice. These efforts will provide surgeons with more effective options for anesthesia and analgesia, improve surgical outcomes, reduce patient discomfort, and provide better medical care for patients. Current brachial plexus block research using supraclavicular access should focus on several key areas. Firstly, efforts should be made to enhance the procedure's safety by minimizing the risk of complications such as pneumothorax and phrenic nerve paralysis. This could involve developing advanced imaging techniques or needle guidance systems to improve accuracy and precision during needle placement. Secondly, there is a need to optimize the efficacy of anesthesia provided by the supraclavicular pathway. This could be achieved by investigating different local anesthetics or adjuvants to prolong the duration and depth of nerve blockade, leading to more effective postoperative pain management.

Additionally, the individualization of the technique based on anatomical variations in the brachial plexus should be explored, using modalities like ultrasound and magnetic resonance imaging to identify specific nerve locations and tailor the approach accordingly. Comparative studies comparing the supraclavicular pathway to other brachial plexus block techniques, such as the interscalene or axillary pathways, can also provide valuable insights into each approach's relative effectiveness and safety. These studies contribute to a better understanding of the relative advantages and disadvantages of pathways on bone compared with other techniques. By comparing the success rates, safety, and efficacy of various approaches, we can gain a clearer understanding of the potential and limitations of the supraclavicular approach. This helps medical professionals make more informed choices about the appropriate block approach in different clinical scenarios for optimal pain management and surgical outcomes. In addition, these studies provide opportunities to improve existing techniques and develop new tools to further enhance the effectiveness of supraclavicular access, reduce the risk of complications, and optimize surgical outcomes. Therefore, these studies provide useful direction and guidance for the future development of supraclavicular access.Finally, future research should consider the impact of the supraclavicular pathway on functional outcomes, such as postoperative range of motion and strength in the upper limb. By addressing these areas, future research can contribute to the continued improvement of the supraclavicular pathway for brachial plexus block, ultimately leading to better patient outcomes in upper limb surgeries.

In general, supraclavicular and costoclavicular pathways have unique advantages and applications as nerve block methods for upper extremity surgery. A supraclavicular approach may be more appropriate in some circumstances, while a costoclavicular approach may be more appropriate in others. With further research, we may better understand the relative advantages and limitations of these techniques and provide medical professionals with more options to improve outcomes for patients undergoing upper extremity surgery. The ultimate goal is to achieve better medical care and better patient outcomes by continuously improving these methods, reducing the risk of complications, increasing surgical success rates, improving postoperative pain management, and better responding to patients' needs. Research in this area has important implications for improving patient quality of life and surgical outcomes. .

CONFLICT OF INTEREST

The authors have no potential conflicts of interest to report relevant to this article.

AUTHOR CONTRIBUTIONS

MZ and WS designed the study and performed the experiments, MZ collected the data, WS analyzed the data, MZ and WS prepared the manuscript. All authors read and approved the final manuscript.

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