Clinical Application of Ultrasound Microscopy-Guided Pediatric Brachial Plexus Nerve Block Anesthesia

Li Gu, Hongqiang An, Xifeng Zhang, and Wenxu Jiang

Department of Anesthesiology, Children's Hospital of Nanjing Medical University, Nanjing, Jiangsu 210000, China

Correspondence should be addressed to Xifeng Zhang; 1430405213@post.usts.edu.cn and Wenxu Jiang; 1430405218@post.usts.edu.cn

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1. Introduction

Brachial plexus block anesthesia is a common form of anesthesia used in clinical surgery and can effectively meet the need for satisfactory anesthetic outcomes in surgery [1]. According to clinical data, the use of brachial plexus nerve block anesthesia is more accurate and safer than traditional block anesthesia, but in the process of surgical anesthesia, there are strong requirements for the comprehensive ability and the professional level of the operator. Under blind exploration, the level of difficulty in performing anesthesia is high and the success rate of anesthesia is low, so it is necessary to supplement with effective measures to further ensure the effectiveness of anesthesia as shown in Figure 1 for the brachial plexus nerve diagram [2]. In order to explore the anesthetic effect and safety of the ultrasound-guided brachial plexus nerve block for pediatric upper limb surgery, analysis of the effect of ultrasound-guided brachial plexus nerve block anesthesia in pediatric upper limb surgery was proposed in the research [3, 4].
3. Methods

3.1. General Information. Case data were selected from 82 children who underwent upper limb surgery in hospital A from January 2016 to December 2017. And, they were randomly divided into two groups using the coin method, with 41 cases in each group. The research was reviewed and approved by the hospital leadership and the medical and nursing staff of the Department of Pediatrics and the Department of Anesthesia, and all the children’s families agreed to participate in the research. There were 26 males and 15 females in the research group, and the mean age was 4.6 ± 0.4 years. In the control group, there were 24 males and 17 females, and the average age was 4.5 ± 0.3 years. There was no statistically significant difference between the basic data of the children in the two groups (P > 0.05). Inclusion criteria were as follows: patients underwent upper limb surgery and brachial plexus block anesthesia [16, 17], who did not withdraw from the research midway. Exclusion criteria were as follows: patients had inflammatory reaction or infection at the puncture site, drug allergy, and mental communication disorder.

3.2. Research Methodology

3.2.1. Ultrasound-Guided Brachial Plexus Nerve Block Anesthesia. The child was placed in a semisitting position, assisted in removing the upper garment. The upper limb was abducted. The elbow was flexed. The head was slightly turned to the opposite side. The operating area was routinely disinfected.
A sterile towel was laid. A high-frequency line array probe (a color ultrasound diagnostic instrument) and a 5 cm, 22G short oblique block needle were selected. The probe frequency was set at 6–13 MHz, which was placed in the center of the neck at the same level as the cricoid cartilage, and then moved outward to observe the trachea, thyroid gland, common carotid artery internal jugular vein, anterior oblique muscle, brachial plexus, and middle oblique muscle in turn. The location of the brachial plexus under the ultrasound image was found. The skin was punctured at the lateral part of the ultrasound probe. The needle advanced through the middle oblique muscle to ensure that it was located deep in the brachial plexus. 10–15 ml of local anesthetic (0.75% ropivacaine + 2% lidocaine) was injected after retraction without blood and a large amount of gas. The diffusion of local anesthetic was observed. The puncture needle retreated slowly to the subcutis, and then the angle of the needle entry was adjusted. The needle tip advanced to the upper anterior aspect of the brachial plexus, and 5–10 ml of the local anesthetic drug was injected again after no blood was retracted.

Anesthetic drugs are injectable ropivacaine mesylate and lidocaine hydrochloride injection. The doctor needs to adjust the dose of drugs according to the individual and condition of the child and then carefully record the time of the onset of the anesthetic block, the amount of anesthetic drugs, the time of completion of anesthesia, and anesthetic complications in the child during the operation [18].

3.2.2. Conventional Anatomically Positioned Brachial Plexus Block Anesthesia. The child was placed in a flat position with the head tilted to the opposite side. A soft pillow was placed under the affected shoulder, and the upper limb was placed close to the side of the body. If the children cried, family members could accompany the implementation of surgery to reduce the children’s bad mood. The anterior and middle scalenuses were touched at the posterior border of the sternocleidomastoid above the clavicle to form a triangular gap, ensuring that the bottom edge of the triangle touched the fluctuating subclavian artery and kept the puncture point level with the sixth cervical vertebrae at the edge of the cricoid cartilage. A sterile towel was laid, and the surgical area was routinely disinfected. The anesthetist fixed the skin with the index finger of the left hand. The right hand held a 7G injection needle and stabbed vertically, advancing slightly posteriorly and inferiorly (C₃ transverse process) and feeling a sense of dehiscence after passing through the superficial fascia. If there was no foreign body sensation, the needle advanced slowly up to the C₆ transverse process. The puncture needle was slightly backed off and was connected to the anesthetic fluid syringe. If there was no blood-cephalosporin fluid or large amount of gas when back-drawing, 20 ml of 0.4% ropivacaine was injected, increasing or decreasing the dose as appropriate [19, 20].

3.3. Observation Indicators
(1) Comparison the completion time of anesthesia, the onset of the sensory block and the motor block, and the dose of anesthetic drugs used in the two groups of children

(2) Comparison of the success rate of the one-time puncture and the incidence of anesthetic complications (local anesthetic poisoning, nerve injury, pneumothorax, hematoma, and phrenic nerve palsy) in the two groups of children

(3) Assessment of the anesthetic effect:
Excellent: the child had a smooth induction of anesthesia with no agitation, choking, hemodynamic changes, good muscle relaxation, no premature or late awakening problems, normal respiration, and all circulatory indexes
Good: the child had a slight choking and coughing or hemodynamic changes during induction of anesthesia, hemodynamic changes during maintenance of anesthesia, fair muscle relaxation, slight agitation after the end of anesthesia, and slight instability of blood and respiration
Poor: the child had a strong stress response during induction, poor muscle relaxation, and the patient was agitated at the end of anesthesia:
overall excellent rate = (excellent + good) / total number of cases × 100%

4. Results and Analysis

4.1. Comparison of the Anesthetic Effect between the Two Groups of Children. The completion time of anesthesia was slightly longer in the research group than in the control group, but the difference was not statistically significant (P > 0.05). The onset of the sensory block and the motor block in the research group was earlier than in the control group and the dose of anesthetic drugs used was less; the difference between the data of the two groups was statistically significant (P < 0.05) (see Table 1 and Figure 2).

4.2. Comparison of the Puncture Success Rate and Anesthetic Complications between the Two Groups of Children. The one-time puncture success rate of children in the research group was higher than that of the control group. The rate of anesthesia complications was lower in the research group than that of the control group. P < 0.05 indicates a statistically significant difference (see Table 2 and Figure 3).

4.3. Comparison of Excellent Anesthesia Rates. The rate of excellent anesthesia was higher in the research group than in the control group. P < 0.05 indicates a statistically significant difference (see Table 3 and Figure 4).
4.4. Discussion. It was known that ultrasound technology was used in regional block anesthesia in 1978. The physicians used ultrasound blood flow detection technology to locate the subclavian artery and indirectly complete the supraclavicular brachial plexus nerve block, but the display of the nerve structure was blurred. With increasingly perfect ultrasonic technology, the neural structure was clearly displayed with the aid of high-frequency ultrasound, which facilitated the physician’s clear observation of blood vessels and the local anatomical structure, reducing anesthesia puncture injury of blood vessel and peripheral nerve tissue. At the same time, no serious complications of ultrasound-guided nerve block have been reported. It was suitable for pediatric patients and patients who were unconscious or have partial nerve blocks. However, abnormal sensation might occur during operation, so attention should be paid to avoid damage to these nerves [21]. Commonly used brachial plexus nerve blocks includes intersosseous groove block, supraclavicular block, and axillary block. The surgeon can choose the appropriate anesthesia method according to the type of surgery the patient undergoes and use ultrasound to visualize the superficial organs with high resolution to guide the anesthesia block.

In clinical practice, brachial plexus nerve block anesthesia is mostly used for amputation, nerve and vascular anastomosis, etc. These procedures are time-consuming and require a high level of anesthesia. It requires the prevention and control of adverse reactions, such as vasospasm, which can be difficult to manage anesthetically. General anesthesia is not recommended because of the long duration of the procedure, the relative difficulty of managing anesthesia, the number of postoperative complications, the possibility of agitation after awakening, and the risk of vasospasm of the anastomosis. The conventional blind exploration brachial

| Group        | Anesthesia completion time | Sensory block | Motor block | Narcotic drugs |
|--------------|----------------------------|---------------|-------------|---------------|
| Research group | 10.3 ± 2.2                 | 3.9 ± 1.4     | 5.5 ± 1.6   | 15.4 ± 1.3    |
| Control group   | 9.3 ± 3.5                  | 5.3 ± 1.5     | 8.4 ± 2.5   | 21.7 ± 1.7    |
| T-value       | 1.603                      | 4.693         | 6.562       | 20.171        |
| P value       | 0.058                      | 0             | 0           | 0             |

Table 1: Comparison of anesthetic outcomes between the two groups of children.

| Group        | One-time puncture success rate | Local anesthetic poisoning | Nerve damage | Pneumothorax | Hematoma | Phrenic nerve palsy | Total occurrence |
|--------------|-------------------------------|---------------------------|--------------|--------------|----------|---------------------|-----------------|
| Research group | 92.8                          | 2.5                       | 0            | 0            | 0        | 0                   | 2.5             |
| Control group  | 75.7                          | 4.8                       | 2.5          | 2.5          | 2.5      | 2.5                 | 14.7            |
| χ² value      | 4.478                         |                           |              |              |          |                     |                 |
| P value       | 0.035                         |                           |              |              |          |                     |                 |

Table 2: Comparison of the puncture success rate and anesthetic complications between the two groups of children.
plexus nerve block is more difficult to locate, and the anesthetic drug is often not injected into the ideal location to infiltrate all of nerve tissue, so incomplete nerve blocks and unsatisfactory anesthetic effects will often occur, and the intraoperative transfer to other anesthetic methods will cause unnecessary financial burden and pain to the patient [22, 23]. In addition, the success rate of conventional blind exploration puncture operations is low and the vessel may accidentally enter during the puncture process, leading to local anesthetic toxicity in patients or nerve injury [24].

It is well known that when a child is admitted to hospital for surgery due to a sudden trauma, the unfamiliar medical environment and surgical operation, coupled with pain in the affected limb, can lead to anxiety, fear, and tension. The advantages of the anesthetic procedure have been recognized by most scholars. The surgeon can adjust the medication according to the individual child’s condition to ensure anesthetic effectiveness while improving anesthetic safety. In conclusion, the use of ultrasound-guided brachial plexus nerve block anesthesia for upper limb surgery in children is effective and worthy of clinical application [25].

5. Conclusion

Review analysis of previous literature, the materials used the clinical application of ultrasound microscopy-guided pediatric brachial plexus nerve block anesthesia was proposed, and the value of ultrasound-guided brachial plexus nerve block anesthesia in pediatric upper limb surgery was explored in the research. The 82 children undergoing upper limb surgery were selected and randomly divided into two groups of 41 children using the coin method. The children in the research group were anesthetized by the ultrasound-guided brachial plexus nerve block, while the control group was anesthetized by the conventional anatomically positioned brachial plexus block. The anesthetic blocking effect was compared.

The results showed that the onset of the sensory block and the motor block in the research group was earlier than that in the control group. The one-time puncture success rate was higher in the research group than that in the control group. The rate of good anesthesia was higher in the research group than that in the control group. The rate of anesthesia complications was lower in the research group than that in the control group. The dose of anesthetic drugs used was less in the research group than that in the control group. The difference was statistically significant ($P < 0.05$). The completion time of anesthesia was longer in the research group than in the control group, and the difference was not statistically significant ($P > 0.05$). Ultrasound-guided brachial plexus nerve block anesthesia is effective and safe in pediatric upper limb surgery, which can reduce the dose of anesthetic drugs. Therefore, it is worthy of clinical recommendation. The use of ultrasound-guided brachial plexus nerve block during upper limb surgery in children is safe, which can effectively improve the effectiveness of anesthesia, reduce postoperative complications, and improve the prognosis of the disease.
Data Availability
The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest
The authors declare that they have no conflicts of interest.

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