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Effect of ultrasound-guided brachial plexus and superficial cervical plexus nerve block anesthesia in patients with middle clavicle fractures

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Abstract: To investigate the value of ultrasound-guided brachial plexus combined with superficial cervical plexus nerve block anesthesia in the surgery of patients with mid-clavicular fracture. Eighty patients with mid-clavicular fractures admitted to a hospital from January 2020 to December 2022 were selected for the study, and they were randomly divided into a control group and a study group, 40 patients in each group, and both groups were treated with internal fixation of clavicular fractures. The anesthetic effect and anesthesia, heart rate and blood pressure at different time points, serum adrenocorticotropic hormone (ACTH) and cortisol (Cor) levels before surgery and at the time of fracture reduction, and postoperative complications were compared between the two groups. The anesthetic effect of the study group was significantly better than that of the control group (P<0.05); the onset of anesthesia and sensory block were longer (P<0.05) and the recovery time of sensation was shorter (P<0.05) in the control group than in the study group; there was no significant difference between the heart rate and blood pressure of the two groups before anesthesia (P>0.05), and the heart rate and blood pressure of the control group at the time of stripping the periosteum, at the end of surgery and at 10 min after surgery were significantly different. The heart rate and blood pressure of the control group were higher than those of the study group at the time of stripping the periosteum, at the end of surgery and 10 min after surgery (P<0.05); before surgery, there was no significant difference in ACTH and Cor levels between the two groups (P>0.05), and after fracture reduction, ACTH and Cor levels increased in both groups, and the control group was higher than the study group (P<0.05); the incidence of postoperative complications was significantly higher in the control group than in the study group. The incidence of postoperative complications in the control group was significantly higher than that in the study group. Ultrasound-guided brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia is effective in patients with mid-clavicular fracture, which can significantly improve the anesthetic effect, shorten the anesthesia time and sensory block onset time, prolong the sensory recovery time, maintain the stability of vital signs and hemodynamics, and reduce the incidence of postoperative complications, and has high application value and promotion significance.

1. Introduction

Clavicle fractures are a common clinical fracture type, and young adults are a high incidence group for clavicle fractures. According to statistics, patients with clavicle fractures account for about 10% of the total number of patients with fractures throughout the body, of which 70%-80% occur in the middle part of the clavicle [1-2]. Because the clavicle connects important organs such as the brachial plexus, subpulmonary, subclavian vessels, and the heart, fractures may damage the connected organs, including subclavian vessel injury, hemothorax, pneumothorax, and brachial plexus nerve injury [3-4]. The traditional conservative treatment is a wide-arm sling, but the recovery period is long. With the advancement of medical technology, surgical fixation therapy is gradually becoming the preferred clinical treatment for clavicle fracture disease. Clavicle fracture surgery can be performed under general anesthesia, nerve block anesthesia, and general anesthesia combined with nerve block anesthesia methods, of which nerve block anesthesia has unique advantages due to its relatively mild effect on the respiratory and circulatory system [5]. Brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia is more commonly used in clavicle fracture surgery. In this procedure, the traditional anatomical positioning of the brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia is prone to inaccurate nerve positioning, which can affect the patient's anesthetic outcome [6]. In recent years, the use of ultrasound equipment and imaging technology has been gradually incorporated into the nerve block anesthesia, and ultrasound assistance can clearly show the main branches of the brachial plexus nerve and the accompanying blood vessels [7]. The clinical pursuit is gradually to inject as little local anesthetic drug as possible at the correct location on the basis of guaranteeing the block effect. Traditional anatomical positioning to clarify the block location is somewhat blind and may damage peripheral nerves and blood vessels, while ultrasound positioning can achieve accurate positioning and puncture purposes, reduce the level of pain mediators, and help improve the anesthetic effect [8]. Therefore, this study investigates the effect of applying ultrasound-guided brachial plexus combined with superficial cervical plexus nerve block anesthesia in patients with midclavicular fractures, in order to provide a safer and more effective anesthetic solution for clinical use.

2. Materials and Methods

2.1 General Information

Eighty patients with midclavicular fractures admitted to a hospital from January 2020 to December 2022 were selected for the study and randomly divided into a control group and a study group of 40 patients each. The control group consisted of 23 male patients and 17 female patients, aged 28 to 67 years, average (43.27±8.52) years, with body mass index of 19 to 27 kg/m^2 , average (23.51±2.07) kg/m^2 , cause of injury: traffic accident 23 cases, fall 12 cases, other 5 cases, ASA grading: grade I 24 cases and grade II 16 cases. The study group consisted of 25 male and 15 female patients, aged 30-65 years, mean (43.36±8.49) years, body mass index 20-28 kg/m^2 , mean (23.62±2.14) kg/m^2 , causes of injury: traffic accidents 25 cases, falls 13 cases and other 2 cases, ASA classification: grade I 26 cases and grade II 14 cases. There was no significant difference between the general data of the two groups of patients (P>0.05).

2.2 Inclusion and exclusion criteria

Inclusion criteria: (1) all were diagnosed with mid-clavicle fracture by X-ray and high-frequency ultrasonography; (2) those who were to be treated with internal fixation of clavicle fracture; (3)

clear consciousness, normal intelligence, and normal verbal communication; (4) ASA classification [9] were grade I-II; (5) unilateral fracture; (6) patients and family members voluntarily participated in this study and signed the informed consent form.

Exclusion criteria: (1) combination of hematologic disorders and coagulation disorders; (2) contraindications to anesthesia; (3) pathologic fractures; (4) combination of malignancies; (5) combination of scaphoid fractures; (6) infection and hematoma at the puncture site; (7) history of previous clavicle fractures; (8) history of sedative and analgesic drug abuse; (8) lactating women or pregnant women.

2.3 Methods

Surgical treatment was performed on both groups of patients. After the patients entered the operating room, intravenous access was established for them and connected to a cardiac monitor, and their vital signs (including ECG, blood pressure, blood oxygen saturation and other indicators) were continuously monitored. The patient was given an intravenous infusion of 1 mg of midazolam (Yichang Renfu Pharmaceutical Co., Ltd., 2 ml: 10 mg, State Drug Administration H20067041), and he was routinely administered oxygen by nasal cannula. The patient was assisted to assume a decubitus position with the head tilted to the healthy side.

Patients in the control group were anesthetized with traditional anatomical positioning of the brachial plexus nerve combined with superficial cervical plexus nerve block. The puncture was performed at the interosseous groove of the oblique muscle about 1.5 cm above the clavicle on the affected side of the patient, and the needle was slowly entered along the lateral edge of the anterior oblique muscle, and the tip of the needle was fixed when the patient's upper limb on the affected side appeared to be foreign body sensation. When there is no cerebrospinal fluid or blood in the retraction, slowly inject 0.75% ropivacaine (Guangdong Huarun Shunfeng Pharmaceutical Co., Ltd., 75 mg, State Pharmacopoeia H20050325) 25 mL to complete the brachial plexus nerve block anesthesia. A puncture was performed at the midpoint of the posterior border of the sternocleidomastoid muscle on the patient's side, about 0.5 cm below the external jugular vein, and 5 mL of 0.75% ropivacaine was injected into the superficial cervical fascia after breaking through it to complete the superficial cervical plexus nerve block anesthesia.

Patients in the study group underwent ultrasound-guided brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia, and the interosseous groove area on the affected side of the patient was scanned axially using a SonoSite M-Turbo high-frequency line array probe (10-12 MHz), slowly from caudal to cephalad. The brachial plexus nerve was identified on the ultrasound image, punctured at the interosseous groove using an in-plane technique with a 7-gauge injection needle, and after the retraction was free of blood and cerebrospinal fluid, 20 mL of 0.5% ropivacaine injection was slowly injected to complete the brachial plexus nerve block anesthesia. An axial scan was performed with an ultrasound probe at the outer edge of the sternocleidomastoid muscle on the affected side of the patient, and the superficial cervical plexus nerve was identified at the level of the 4th cervical vertebra behind the sternocleidomastoid muscle along the deep surface of the envelope fascia. The superficial cervical plexus nerve block anesthesia was completed using an in-plane technique by puncturing the outer edge of the sternocleidomastoid muscle with a 7-gauge injection needle and injecting 10 mL of 0.5% ropivacaine injection after no blood was retracted.

2.4 Observation indicators

Comparison of the anesthetic effect of the two groups of patients. Excellent: the effect of nerve block in patients 5 min after anesthesia was ideal, with complete muscle relaxation, no

intraoperative pain and discomfort, and no obvious postoperative stress reaction; Good: the effect of nerve block in patients 10 min after anesthesia was good, with muscle relaxation, mild intraoperative discomfort, no pain, and mild postoperative stress reaction; Poor: the effect of nerve block in patients 10 min after anesthesia was poor, with no muscle relaxation, moderate to severe intraoperative discomfort or pain, and the need to change other anesthetic protocols or add opioids. Excellent rate=(excellent+good) cases/total cases ×100%.

Comparison of anesthesia in the two groups of patients. Including anesthesia completion time, sensory block onset time and sensory recovery time. The completion time of anesthesia in the ultrasound group refers to the time from the ultrasound positioning to the completion of drug administration, while the conventional group refers to the time from the injection to the completion of drug administration; the onset time of sensory block refers to the time from the administration of drug to the fading of the sensation of needling; the recovery time of sensation refers to the time from the administration of drug to the reappearance of nociception at rest.

Comparison of heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) levels before anesthesia, at the time of peeling the periosteum, at the end of surgery and 10 min after surgery in the two groups of patients.

Comparison of ACTH and Cor levels of patients in both groups before surgery and after fracture reduction. Patients' fasting venous blood 2mL was taken and centrifuged at 2000r/min for 5min with a centrifugal radius of 10mm, the serum was separated and ACTH and Cor levels were measured by chemiluminescence immunoassay.

Occurrence of postoperative complications, including the retropharyngeal nerve block, phrenic nerve block and Horner's syndrome.

2.5 Statistical methods

SPSS 25.0 was applied for statistical analysis of the data in this study, and the measurement data were expressed as ($\bar{x}\pm s$) and t-test for comparison between groups, and the count data were expressed as (%) and χ^2 was tested between groups, and $P<0.05$ was considered a significant difference.

3. Results

3.1 Comparison of anesthetic effects between the two groups

The anesthetic effect of the study group was significantly better than that of the control group ($P<0.05$). See Table 1.

Table 1: Comparison of anesthetic effects between two groups of patients [n (%)]

Group	Number of cases	Excellent	Good	Difference	Excellent rate
Control group	40	12 (30.00)	18 (45.00)	10 (25.00)	30 (75.00)
Research Group	40	23 (57.50)	14 (35.00)	3 (7.50)	37 (92.50)
χ^2					4.501
P					0.034

Note: $P<0.05$ compared with the control group.

3.2 Comparison of anesthesia between the two groups of patients

The duration of anesthesia and the onset of sensory block were longer in the control group than

in the study group (P<0.05), and the time of sensory recovery was shorter than in the study group (P<0.05). See Table 2.

Table 2: Comparison of anesthesia between two groups of patients ($\bar{x} \pm s$, min)

Group	Number of cases	Anesthesia completion time	Sensory block onset time	Sensory recovery time
Control group	40	9.14±1.36	6.52±1.27	359.66±87.26
Research Group	40	3.27±1.59	3.64±1.07	435.21±93.47
t		17.744	10.968	3.737
P		0.000	0.000	0.000

Note: P<0.05 compared with the control group.

3.3 Comparison of heart rate and blood pressure levels at different time points between the two groups

Before anesthesia, there was no significant difference in heart rate and blood pressure between the two groups (P>0.05), and the heart rate and blood pressure of the control group were higher than those of the study group at the time of stripping the periosteum, at the end of surgery, and 10 min after surgery (P<0.05). See Table 3.

Table 3: Comparison of heart rate and blood pressure between the two groups at different time points ($\bar{x} \pm s$)

Indicators	Group	Number of cases	Before anesthesia	When peeling the periosteum	At the end of surgery	10min after surgery
HR (times/min)	Control group	40	76.52±7.04	102.52±8.91	100.43±9.17	85.91±6.49
	Research Group	40	77.07±6.91	91.36±9.37*	89.52±8.37*	80.19±7.27*
	t		0.353	5.459	5.558	3.712
	P		0.725	0.000	0.000	0.000
SBP (mmHg)	Control group	40	121.32±11.41	145.62±13.27	141.25±12.11	132.74±10.29
	Research Group	40	119.27±10.41	134.52±11.92*	132.67±10.64*	124.57±9.31*
	t		0.839	3.936	3.366	3.724
	P		0.404	0.000	0.001	0.000
DBP (mmHg)	Control group	40	73.24±6.27	94.52±8.39	92.81±7.62	81.44±8.17
	Research Group	40	72.96±6.76	85.39±7.31*	83.66±6.71*	75.92±7.61*
	t		0.192	5.189	5.700	3.127
	P		0.848	0.000	0.000	0.002

Note: Compared with the control group,* P<0.05.

3.4 Comparison of ACTH and Cor levels before surgery and after fracture reduction in the two groups

Before surgery, there was no significant difference in the comparison of ACTH and Cor levels between the two groups (P>0.05), and after fracture reduction, ACTH and Cor levels increased in both groups, and were higher in the control group than in the study group (P<0.05). See Table 4.

Table 4: Comparison of ACTH and Cor levels before surgery and after fracture reduction in both groups ($\bar{x} \pm s$)

Group	Number of cases	ACTH (pg/mL)		Cor (mmol/mL)	
		Before Surgery	After fracture reset	Before Surgery	After fracture reset
Control group	40	18.61±2.15	29.14±3.17*	312.53±23.47	479.82±34.61*
Research Group	40	18.25±2.09	23.61±2.84*#	311.96±23.61	371.52±30.51*#
t		0.759	8.218	0.108	14.846
P		0.450	0.000	0.914	0.000

Note: # $P<0.05$ compared with the control group and* $P<0.05$ compared with the pre-surgery group.

3.5 Comparison of the occurrence of postoperative complications between the two groups

In the control group, there were 4 cases of postoperative recurrent laryngeal nerve block and 3 cases of phrenic nerve block, with a total complication rate of 17.50%. In the study group, there was 1 case of postoperative recurrent laryngeal nerve block, with a total complication rate of 2.50%, which was significantly lower than that of the control group ($P<0.05$). See Table 5.

Table 5: Comparison of postoperative complication rates between the two groups [n (%)]

Group	Number of cases	Recurrent laryngeal nerve block	Phrenic nerve block	Horner's syndrome	Total incidence
Control group	40	4 (10.00)	3 (7.50)	0	7 (17.50)
Research Group	40	1 (2.50)	0	0	1 (2.50)
χ^2					5.000
P					0.025

Note: $P<0.05$ compared with the control group.

4. Discussion

Clavicle fracture internal fixation surgery has the characteristics of small incision, superficial site and relatively short operation time, perfect nerve block anesthesia can provide sufficient block range and required muscle relaxation for the operation, and once the anesthesia block is incomplete, the anesthesia effect is poor and the patient cannot tolerate the operation, it will directly affect the smooth operation and lead to poor treatment results[10]. Brachial plexus combined with superficial cervical plexus nerve block anesthesia is the preferred anesthetic protocol for clavicle fracture surgery[11]. When using this anesthetic protocol for patients, it is necessary to accurately position the needle entry point so that the anesthetic drug is adequately diffused into the brachial plexus and clavicular nerve regions to ensure a successful nerve block. In the past, when performing brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia, the anesthesiologist mainly determined the puncture point according to the anatomical structure of the human body and used the "blind probe" method to perform the puncture, but some patients with clavicle fractures have displaced fracture ends, obstructed pain nerve conduction, short cervical hypertrophy, etc., which may increase the difficulty of locating the nerve and puncture, and may lead to nerve block. However, in some patients with clavicle fracture, the fracture end is displaced, the pain nerve conduction is obstructed, and the neck is short and hypertrophic. The use of ultrasound guidance for nerve block can visualize the nerve location, result and surrounding tissues based on real-time images, and facilitate timely adjustment of the puncture direction during the puncture process,

which is conducive to successful completion of the nerve block .[12]

In this study, the anesthetic effect of the study group was significantly better than that of the control group, with shorter anesthesia completion time and sensory block onset time, and longer sensory recovery time than that of the control group. This is because the brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia under ultrasound guidance can visualize the location of the brachial plexus nerve and superficial cervical plexus nerve in real time, select the best needle entry point, and show the position of the puncture needle in relation to the nerve. This allows for adequate diffusion of the anesthetic drug, which in turn ensures the success of the nerve block. Ultrasound-guided combined nerve block anesthesia can block most of the sensory nerves in the clavicular region to avoid their afferent impulses, and the sensory nerves are more delicate, and the time required for the local anesthetic to take effect is shorter. Similar to the results of the study by Yaoyao Lai et al.[13] The results of this study showed that the heart rate and blood pressure of the study group after anesthesia were lower than those of the control group, which was due to the fact that performing the traditional anatomically positioned brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia is susceptible to factors such as the operating skills and clinical experience of the anesthesiologists, resulting in incomplete nerve block, causing the patients to feel significant pain or discomfort intraoperatively and causing their vital signs to be unstable. Ultrasound-guided brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia can effectively compensate for the shortcomings of traditional nerve block anesthesia, make the nerve localization more objective and accurate, effectively block the intraoperative pulling pain of patients, and thus maintain the stability of their vital signs. Similar to the results of the study by Yuan-Fang Zhong[14] . In the results of this study, the ACTH and Cor levels in both groups were higher after fracture resetting than before surgery, and the control group was higher than the study group because the greater stimulation during clavicle fracture resetting could cause hyperfunction of the adrenal system in patients, and the combined analgesic effect of acoustically guided brachial plexus nerve and superficial cervical plexus nerve block could better suppress the stress response and make the hemodynamic index levels more stable. Similar to the results of the study by T. Wen et al.[15] The complication rate of the study group in this study was significantly lower than that of the control group because the brachial plexus nerve combined with superficial cervical plexus nerve block anesthesia under ultrasound guidance could accurately localize the local nerve, identify the relationship between the nerve and the surrounding tissues, and avoid local anesthetic drugs from entering the blood vessels and intervertebral foramina, which in turn could reduce the incidence of adverse anesthetic reactions in patients. Consistent with the results of the study by Guohua Feng[16].

In conclusion, ultrasound-guided brachial plexus combined with superficial cervical plexus nerve block anesthesia can effectively improve the anesthetic effect, shorten the completion time of anesthesia and the onset time of sensory block, prolong the recovery time of sensation, maintain the stability of patients' vital signs and hemodynamics, and reduce the incidence of patients' complications in patients with midclavicular fractures, which has high safety and clinical application value.

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