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Effect of ultrasound-guided costoclavicular space brachial plexus block in patients undergoing upper limb fracture surgery

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Abstract: **Objective** To investigate the application of ultrasound -guided costoclavicular space brachial plexus block (BPB) in anesthesia for patients undergoing upper limb fracture surgery, and to study its effects on block efficacy, immune function, and postoperative pain. **Methods** Eighty patients undergoing upper limb fracture surgery at Anqing First People's Hospital Affiliated to Anhui Medical University from May 2021 to October 2024 were selected and randomly divided into a control group (n=40) and an experimental group (n=40) . Both groups received ultrasound-guided BPB and open reduction internal fixation surgery. The control group adopted the coracoid approach, while the experimental group adopted the costoclavicular space approach. The anesthetic block efficacy, brachial plexus block status at 5, 10, 20, and 30 minutes after drug injection respectively, Visual Analog Scale (VAS) score at rest and during movement at 12, 18, 24, and 36 hours postoperatively, immune function markers ($CD3^+$, $CD4^+$, $CD8^+$) before and after surgery, and perioperative side effects were compared between the two groups. **Results** Compared with the control group, the experimental group had shorter block operation time [(6.14±1.35) min *vs* (7.94±1.17) min, t=6.373, P<0.01], longer block maintenance time [(434.51 ± 20.31) min *vs* (412.47 ± 19.63) min, t=4.935, P<0.01], and shallower needle insertion depth [(2.58±0.22) min *vs* (3.36±0.27) min, t=14.164, P<0.01]. Compared with the control group, the experimental group showed higher sensory block rates of the musculocutaneous, ulnar, radial, and median nerves at 5 and 10 minutes after drug injection (P<0.05), and higher motor block rates of the musculocutaneous, radial, and ulnar nerves at 10 minutes after injection (P<0.05). The inter-group effect, time effect, and interaction effects of VAS scores at rest and during movement at 12, 18, 24, and 36 hours postoperatively were statistically significant in both groups (P<0.05). Postoperatively, immune function levels decreased in both groups, and the control group had lower levels of $CD3^+$, $CD4^+$, $CD8^+$ compared to the experimental group (t=4.762, 7.106, 2.152, P<0.05). There was no statistically significant difference in the incidence of perioperative side effects between the two groups [10.00% (4/40) *vs* 15.00% (6/40), χ^2 =0.457, P=0.499]. **Conclusion** Ultrasound-guided costoclavicular space BPB demonstrates significant block efficacy in patients undergoing upper limb fracture surgery, with rapid onset of sensory and motor blockade, lower postoperative pain levels, reduced impact on immune function, and good safety.
Keywords: Upper limb fracture; Brachial plexus block; Costoclavicular space; Ultrasound guidance; Block effect; Immune function; Pain
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Brachial plexus block (BPB) refers to the injection of local anesthetics near the trunks of the brachial plexus to block nerve conduction in the innervated area. It is commonly used for anesthesia in upper extremity fracture surgery, with the advantages of simple operation, minimal trauma, and rapid postoperative recovery [1]. The coracoid approach is a traditional approach for BPB, which has low *in vitro* requirements and good analgesic effect, but its visualization under ultrasound is unclear and positioning is difficult, which affects the surgical operation [2]. In recent years, with the development of ultrasound technology and in-depth research in the field of anesthesiology, a new surgical approach for BPB has been proposed, namely the costoclavicular space approach. Due to the fixed position of the brachial vessels and nerve bundles in this region, its localization is simple, and the brachial plexus structure is superficial, which makes it easy to achieve a blocking effect. However, the blocking effect of BPB in patients undergoing upper extremity fracture surgery has not yet been clarified [3-4]. This study investigates the blocking effect of ultrasound-guided costoclavicular space BPB in patients undergoing upper extremity fracture surgery, with the aim of providing a reference for improving the blocking effect in such patients.

1 Materials and Methods

1.1 General Information

The study subjects were 80 patients with upper extremity fractures who received treatment at Anqing First People's Hospital from May 2021 to October 2024. They were divided into the control group (40 cases) and the experimental group (40 cases) according to the random number table method.

Inclusion criteria: (1) Diagnosed with upper extremity fracture by imaging examination; (2) American Society of Anesthesiology (ASA) classification [5] of grade I-III; (3) Signed informed consent form; (4)

Received open reduction and internal fixation surgery and ultrasound-guided BPB; (5) Aged 18 years or older.

Exclusion criteria: (1) Allergy to anesthetic drugs used in this study; (2) Suffering from mental illness; (3) Abnormal coagulation function; (4) Infection at the puncture site; (5) Suffering from nervous system diseases; (6) Muscle injury on the same side as the fracture; (7) Severe cardiopulmonary dysfunction; (8) Malignant tumor. There was no statistically significant difference in general information between the two groups of patients (P>0.05), as shown in **Table 1**. This study was reviewed and approved by the Medical Ethics Committee of Anqing First People's Hospital (No. AQYY-YXLL-LWLL-06).

Tab.1 Comparison of general information between the two groups ($\bar{x}\pm s$)

Group	Number of cases	Gender		Age (years)	BMI (kg/m²)	ASA classification		
		Male	Female			I	II	III
Experimental group	40	24	16	43.64±6.39	23.48±1.76	23	13	4
Control group	40	26	14	45.35±6.54	23.29±1.30	17	18	5
$\chi^2/t/Z$ value		0.213		1.183	0.549	1.541		
P value		0.644		0.240	0.584	0.214		

1.2 Methods

After admission, both groups of patients received routine oxygen inhalation, with monitoring of blood pressure, electrocardiogram and peripheral blood oxygen saturation. An upper extremity venous access was established, and 0.1 μg/kg of sufentanil citrate injection (National Medical Product Administration Approval No. H20203652, Jiangsu Nhwa Pharmaceutical Co., Ltd.) was intravenously administered 10 minutes before anesthesia. Patients were placed in the supine position, with the head turned to the non-operative side and a thin pillow placed under the shoulder. A color Doppler ultrasound diagnostic instrument (Siemens AG) was used for localization, with a probe frequency of 5-12 MHz.

Control group: The probe was placed at the inferior border of the clavicle adjacent to the coracoid process, and cross-sectional scanning was performed to display the pectoralis major/minor muscles and the three nerve bundles of the brachial plexus. A 22G puncture needle was inserted from the clavicular end, with the tip of the needle reaching between the axillary artery plane and the posterior cord of the brachial plexus. After no blood was observed on aspiration, 15 mL of 0.375% ropivacaine hydrochloride (National Medical Product Administration Approval No. H20113381, Guangdong Jiabo Pharmaceutical Co., Ltd.) was injected. After the drug diffused around the axillary artery, the needle was appropriately withdrawn, and 15 mL of 0.375% ropivacaine hydrochloride was injected around the lateral cord of the brachial plexus adjacent to the axillary artery.

Experimental group: The probe was placed at the midpoint of the clavicle, and sliding probe scanning was performed to display the pectoralis major muscle, subclavius muscle, axillary artery and vein, thoracoacromial artery, the three nerve bundles of the brachial plexus, and the cephalic vein. A 22G puncture needle was inserted from the lateral side of the axillary artery to the position between the lateral cord and the posterior cord. After no blood was observed on aspiration, 30 mL of 0.375% ropivacaine hydrochloride was injected.

1.3 Observation indicators

(1) Anesthesia block effect. (2) At 5, 10, 20 and 30 minutes after drug administration, the degree of sensory block in the main innervated areas of the brachial plexus was evaluated using the pinprick method, and motor block was assessed using the muscle strength grading method. (3) The Visual Analogue Scale (VAS) [6] was used to evaluate the pain degree of patients at 12, 18, 24 and 36 hours postoperatively, with scores ranging from 1 to 10, and the score was positively correlated with the pain degree. (4) Immune function indicators: Venous blood samples were collected from patients before and after surgery, and the levels of $CD3^+$, $CD4^+$ and $CD8^+$ were measured using a flow cytometer (Beckman Coulter, USA). (5) The incidence of side effects such as nausea and vomiting, skin pruritus and drowsiness during the perioperative period was recorded and compared between the two groups.

1.4 Statistical methods

SPSS 24.0 statistical software was used for data processing. Measurement data conforming to normal distribution were expressed as $\bar{x}\pm s$. Comparison between the two groups was performed using the independent sample t-test, multi-time point comparison was performed using repeated measures analysis of variance, and pairwise comparison was performed using the LSD-t test. Count data were expressed as case (%), and comparison was performed using the χ^2 test, while multi-time point comparison was performed using the generalized estimating equation. A P value<0.05 was considered statistically significant.

2 Results

2.1 Comparison of anesthesia block effects between two groups

Compared with the control group, the experimental group had shorter block operation time, longer block duration, and shallower needle insertion depth (P<0.01), as shown in **Table 2**.

2.2 Comparison of block rates at different time points between two groups

Compared with the control group, the sensory block rates of the musculocutaneous nerve, ulnar nerve, radial nerve, and median nerve in the experimental group were significantly higher at 5 min after drug administration (χ^2=8.538, 6.486, 7.314, 5.333, P<0.05) and 10 min after drug administration (χ^2=6.667, 5.165, 6.646, 9.038, P<0.05). The motor block rates of the musculocutaneous nerve, radial nerve, and ulnar nerve at 10 min after drug administration were also significantly higher in the experimental group (χ^2=7.440, 6.050, 7.813, P<0.05), as shown in **Table 3** and **Table 4**.

2.3 Comparison of VAS scores at different time points between two groups

There were statistically significant differences in the inter-group, time, and interaction effects of VAS scores at rest and during movement at 12, 18, 24, and 36 h postoperatively between the two groups ($F_{inter\text{-}group}$=609.600, F_{time}=494.900, $F_{interaction}$=40.300, P<0.05). Compared with the control group, the experimental group had significantly lower VAS scores at rest (t=17.705, 13.754, 12.292, 21.157, P<0.05) and during movement (t=22.322, 13.570, 7.490, 9.904, P<0.05) at 12, 18, 24, and 36 h postoperatively, as shown in **Table 5**.

2.4 Comparison of immune function indicators between two groups

The levels of immune function indicators decreased in both groups after surgery, and the decrease was more significant in the control group compared with the experimental group (P<0.05), as shown in **Table 6**.

Tab.2 Comparison of anesthetic block effects between two groups (n=40, $\bar{x}\pm s$)

Group	Block operation time (min)	Block duration (min)	Needle insertion depth (cm)
Experimental group	6.14±1.35	434.51±20.31	2.58±0.22
Control group	7.94±1.17	412.47±19.63	3.36±0.27
t value	6.373	4.935	14.164
P value	<0.001	<0.001	<0.001

Tab.3 Comparison of sensory block rate at different time points between the two groups [n=40, case (%)]

Time point	Median nerve		Ulnar nerve		Radial nerve		Musculocutaneous nerve	
	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group
5 min after injection	10(25.00)[a]	1(2.50)	6(15.00)[a]	0	9(22.50)[a]	1(2.50)	5(12.50)[a]	0
10 min after injection	15(37.50)[a]	5(12.50)	9(22.50)[a]	2(5.00)	12(30.00)[a]	3(7.50)	14(35.00)[a]	3(7.50)
20 min after injection	33(82.50)	27(67.50)	30(75.00)	24(60.00)	29(72.50)	25(62.50)	26(65.00)	23(57.50)
30 min after injection	36(90.00)	37(92.50)	35(87.50)	33(82.50)	37(92.50)	31(77.50)	33(82.50)	30(75.00)
χ^2/P_{time} value	75.821/0.026		1025.884/<0.001		66.233/<0.001		885.960/<0.001	
$\chi^2/P_{inter\text{-}group}$ value	4.937/<0.001		262.419/<0.001		7.911/0.005		275.579/<0.001	
$\chi^2/P_{interaction}$ value	5.548/0.136		6.572/0.037		5.182/0.159		5.304/0.071	

Note: compared with the control group at the same time point, [a]P<0.05.

Tab.4 Comparison of motor block rates at different time points between the two groups [n=40, case (%)]

Time point	Median nerve		Ulnar nerve		Radial nerve		Musculocutaneous nerve	
	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group	Control group
5 min after injection	1(2.50)	0	3(7.50)	0	0	1(2.50)	2(5.00)	0
10 min after injection	3(7.50)	0	11(27.50)[a]	2(5.00)	13(32.50)[a]	4(10.00)	16(40.00)[a]	5(12.50)
20 min after injection	21(52.50)	13(32.50)	30(75.00)	25(62.50)	29(72.50)	21(52.50)	28(70.00)	21(52.50)
30 min after injection	30(75.00)	23(57.50)	33(82.50)	29(72.50)	35(87.50)	30(75.00)	32(80.00)	27(67.50)
χ^2/P_{time} value	633.633/<0.001		613.899/<0.001		287.588/<0.001		463.000/<0.001	
$\chi^2/P_{inter\text{-}group}$ value	879.896/<0.001		248.754/<0.001		143.528/<0.001		275.008/<0.001	
$\chi^2/P_{interaction}$ value	0.007/0.935		2.703/0.259		0.886/0.642		2.088/0.352	

Note: compared with the control group at the same time point, [a]P<0.05.

Tab.5 Comparison of VAS scores at rest and exercise status between two groups (n=40, point, $\bar{x}\pm s$)

Time point	VAS at rest		VAS during movement	
	Experimental group	Control group	Experimental group	Control group
12 h postoperatively	0.26±0.05[a]	0.81±0.19	0.64±0.16[a]	1.49±0.18
18 h postoperatively	0.85±0.14[a]	1.69±0.36	1.85±0.31[a]	2.97±0.42
24 h postoperatively	0.64±0.11[a]	1.05±0.18	1.44±0.20[a]	1.81±0.24
36 h postoperatively	0.13±0.02[a]	0.57±0.13	0.91±0.15[a]	1.34±0.23
χ^2/P_{time} value	804.100/<0.001		609.600/<0.001	
$\chi^2/P_{inter\text{-}group}$ value	415.100/<0.001		494.900/<0.001	
$\chi^2/P_{interaction}$ value	24.660/<0.001		40.300/<0.001	

Note: compared with the control group at the same time point, [a]P<0.05.

Tab.6 Comparison of immune function indicators between two groups (n=40, %, $\bar{x}\pm s$)

Group	CD3⁺		CD4⁺		CD8⁺	
	Preoperatively	Postoperatively	Preoperatively	Postoperatively	Preoperatively	Postoperatively
Experimental group	73.07±11.51	62.79±10.46[a]	45.24±7.37	34.80±6.32[a]	38.58±5.32	32.26±5.24[a]
Control group	72.62±11.34	52.69±8.40[a]	42.94±7.45	25.29±5.63[a]	38.24±5.15	29.48±6.27[a]
***t* value**	0.176	4.762	1.388	7.106	0.29	2.152
***P* value**	0.861	<0.001	0.169	<0.001	0.772	0.035

Note: compared with preoperatively, [a]P<0.05.

2.5 Comparison of side effects between two groups

During the perioperative period, 2 cases of nausea and vomiting, 1 case of skin pruritus, and 1 case of drowsiness occurred in the experimental group; while 3 cases of nausea and vomiting, 1 case of skin pruritus, and 2 cases of drowsiness occurred in the control group. There was no statistically significant difference in the total incidence of side effects between the experimental group and the control group (10.00% *vs* 15.00%, χ^2=0.457, P=0.499).

3 Discussion

Upper limb fractures are mostly caused by indirect violence, which limits the limb movement of patients and seriously affects their daily life and work [7]. Open reduction and internal fixation is commonly used in clinical treatment of upper limb fractures, and BPB is usually performed before surgery [8]. The key points of nerve block lie in accurate positioning and appropriate anesthesia depth. If the anesthesia depth is too shallow, patients will feel pain during the operation. If the anesthesia is too deep, it may lead to respiratory depression in patients [9-10]. In the past, BPB adopted the coracoid approach. Since this position is located medial to the glenohumeral joint with abundant muscle tissue, it is easy to cause blurred imaging field of view [11]. The three nerve bundles around the costoclavicular space are gathered together, so only a small amount of local anesthetic drugs can achieve a good anesthetic block effect [12].

The results of this study showed that compared with the control group, the experimental group had shorter block operation time, longer block maintenance time, and shallower needle insertion depth. The sensory block rates of musculocutaneous nerve, radial nerve, ulnar nerve and median nerve were higher at 5 and 10 min after drug injection, and the motor block rates of musculocutaneous nerve, radial nerve and ulnar nerve were higher at 10 min after drug injection. The analysis suggests that the nerve bundles in the costoclavicular space are gathered together and located superficially, so local anesthetics can quickly enter the brachial plexus for effective block. In addition, with ultrasound guidance and the superficial block position, it is conducive to the accurate positioning of the block site, which can effectively avoid the deviation of local anesthetics during injection and achieve the purpose of precise block, thereby improving the utilization rate of local anesthetics and prolonging the action time of local anesthetics [1,8].

Upper limb fracture surgery is prone to acute postoperative pain due to large incision and deep wound surface [13]. Opioids are the most effective drugs for clinical postoperative analgesia, but they are easy to cause adverse reactions such as dizziness, nausea and respiratory depression, and heavy use may lead to addiction. Therefore, safer regional nerve block is currently advocated in clinical practice [14]. The results of this study showed that compared with the control group, the experimental group had lower VAS scores at 12, 18, 24 and 36 h postoperatively in both resting and movement states, indicating that the postoperative analgesic effect of the costoclavicular space approach is better than that of the coracoid approach, which is consistent with the research results of Zuo *et al.* [15]. The reason for this analysis is that during the coracoid approach, the ultrasound imaging will be blocked by the subcutaneous fat in the neck and chest of the patient, which affects the anatomical operation during block. However, the anatomical position of the costoclavicular space approach is relatively shallow, so anesthesiologists can perform puncture more accurately, reduce the damage to surrounding nerves and blood vessels, and thus reduce postoperative pain. Trauma, surgical trauma and pain can cause the body to produce a stress response, thereby inhibiting immune system function and increasing the risk of infection [16]. The results of this study also showed that the costoclavicular space approach can reduce the impact on the immune system, which may be because the costoclavicular space approach can reduce the pain and stress stimulation during surgery, thereby reducing the release of stress substances such as cortisol and alleviating the impact on immune function. There was no statistically significant difference in the incidence of perioperative side effects between the two groups, suggesting that the costoclavicular space approach does not increase the side effects of block and has good safety.

In summary, for patients undergoing upper limb fracture surgery, ultrasound-guided BPB via the costoclavicular space can improve the block effect, accelerate sensory and motor block, reduce postoperative pain and the impact on immune function, with good safety.

Conflict of Interest None

Reference

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·临床麻醉专题·论著·

超声引导下肋锁间隙臂丛神经阻滞在上肢骨折手术患者中的效果

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摘要：目的 探讨超声引导下肋锁间隙臂丛神经阻滞(BPB)在上肢骨折手术患者麻醉中的应用,研究其对阻滞效果、免疫功能以及术后疼痛的影响。**方法** 选取2021年5月至2024年10月在安徽医科大学附属安庆第一人民医院就诊的80例上肢骨折手术患者,随机分为对照组(n=40)和试验组(n=40)。两组均接受超声引导下BPB及切开复位内固定手术治疗,对照组采用喙突入路,试验组采用肋锁间隙入路。比较两组患者麻醉阻滞效果、注药后(5、10、20、30 min时)臂丛神经阻滞情况、术后(12、18、24、36 h时)静息状态和运动状态的视觉模拟评分(VAS)、手术前后免疫功能($CD3^+$、$CD4^+$、$CD8^+$)以及围手术期副作用。**结果** 与对照组相比,试验组阻滞操作时间更短[(6.14±1.35)min *vs* (7.94±1.17)min, t=6.373, P<0.01]、阻滞维持时间更长[(434.51±20.31)min *vs* (412.47±19.63)min, t=4.935, P<0.01]、进针深度更浅[(2.58±0.22)cm *vs* (3.36±0.27)cm, t=14.164, P<0.01]。与对照组相比,试验组注药后5、10 min时肌皮神经、尺神经、桡神经、正中神经的感觉阻滞率更高(P<0.05),且试验组注药后10 min时肌皮神经、桡神经、尺神经运动阻滞率更高(P<0.05)。两组术后12、18、24、36 h时静息和运动状态VAS评分的组间、时间和交互效应均有统计学意义(P<0.05)。术后,两组免疫功能水平均下降,且术后对照组$CD3^+$、$CD4^+$、$CD8^+$水平均低于试验组(t=4.762、7.106、2.152,P<0.05)。两组围手术期副作用发生率比较差异无统计学意义[10.00%(4/40) *vs* 15.00%(6/40),χ^2=0.457,P=0.499]。**结论** 超声引导下肋锁间隙BPB在上肢骨折手术患者中的阻滞效果明显,感觉和运动阻滞起效快,术后疼痛程度低,可以降低对免疫功能的影响,且安全性好。

关键词：上肢骨折；臂丛神经阻滞；肋锁间隙；超声引导；阻滞效果；免疫功能；疼痛
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Effect of ultrasound-guided costoclavicular space brachial plexus block in patients undergoing upper limb fracture surgery

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Abstract: Objective To investigate the application of ultrasound-guided costoclavicular space brachial plexus block (BPB) in anesthesia for patients undergoing upper limb fracture surgery, and to study its effects on block efficacy, immune function, and postoperative pain. **Methods** Eighty patients undergoing upper limb fracture surgery at Anqing First People's Hospital Affiliated to Anhui Medical University from May 2021 to October 2024 were selected and randomly divided into a control group (n=40) and an experimental group (n=40). Both groups received ultrasound-guided BPB and open reduction internal fixation surgery. The control group adopted the coracoid approach, while the experimental group adopted the costoclavicular space approach. The anesthetic block efficacy, brachial plexus block status at 5, 10, 20, and 30 minutes after drug injection respectively, Visual Analog Scale (VAS) score at rest and during movement at 12, 18, 24, and 36 hours postoperatively, immune function markers ($CD3^+$, $CD4^+$, $CD8^+$) before

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and after surgery, and perioperative side effects were compared between the two groups. **Results**　Compared with the control group, the experimental group had shorter block operation time [(6.14±1.35)min *vs* (7.94±1.17)min, t=6.373, P<0.01], longer block maintenance time [(434.51±20.31)min *vs* (412.47±19.63)min, t=4.935, P<0.01], and shallower needle insertion depth [(2.58±0.22)min *vs* (3.36±0.27)min, t=14.164, P<0.01]. Compared with the control group, the experimental group showed higher sensory block rates of the musculocutaneous, ulnar, radial, and median nerves at 5 and 10 minutes after durg injection (P<0.05), and higher motor block rates of the musculocutaneous, radial, and ulnar nerves at 10 minutes after injection (P<0.05). The inter-group effect, time effect, and interaction effects of VAS scores at rest and during movement at 12, 18, 24, and 36 hours postoperatively were statistically significant in both groups (P<0.05). Postoperatively, immune function levels decreased in both groups, and the control group had lower levels of $CD3^+$, $CD4^+$, $CD8^+$ compared to the experimental group (t=4.762, 7.106, 2.152, P<0.05). There was no statistically significant difference in the incidence of perioperative side effects between the two groups [10.00%(4/40) *vs* 15.00% (6/40), χ^2=0.457, P=0.499]. **Conclusion**　Ultrasound-guided costoclavicular space BPB demonstrates significant block efficacy in patients undergoing upper limb fracture surgery, with rapid onset of sensory and motor blockade, lower postoperative pain levels, reduced impact on immune function, and good safety.

Keywords: Upper limb fracture; Brachial plexus block; Costoclavicular space; Ultrasound guidance; Block effect; Immune function; Pain

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臂丛神经阻滞(brachial plexus block,BPB)指在臂丛神经干附近注入局麻药物,达到阻滞支配区域神经传导的目的,常用于上肢骨折手术的麻醉,具有操作简便、创伤小、术后恢复快等优点[1]。喙突入路是BPB的传统入路方式,其体外要求低、镇痛效果良好,但在超声下显像不清晰,不易定位,影响手术操作[2]。近年来,伴随超声技术的发展以及麻醉领域的深入研究,提出了新型的BPB手术入路方式,即肋锁间隙入路,由于该部位的臂丛血管和神经束位置固定,其定位简单,且臂丛结构表浅,容易达到阻滞效果,但在上肢骨折手术患者中行BPB的阻滞效果尚未明确[3-4]。本研究探讨超声引导下肋锁间隙BPB在上肢骨折手术患者中的阻滞效果,以期为上肢骨折手术患者阻滞效果的提升提供参考。

1　资料与方法

1.1　一般资料　研究对象来自安庆第一人民医院2021年5月至2024年10月接受治疗的80例上肢骨折手术患者,按随机数字表法分为对照组(40例)和试验组(40例)。纳入标准:(1) 经影像学确诊为上肢骨折;(2) 美国麻醉医师协会(American Society of Anesthesiology,ASA)分级[5]为Ⅰ~Ⅲ级;(3) 均签署知情同意书;(4) 均接受切开复位内固定手术治疗以及超声引导下BPB;(5) 年龄18周岁及以上。排除标准:(1) 对本研究中使用的麻醉药物过敏;(2) 患有精神类疾病;(3) 凝血功能异常;(4) 穿刺部位感染;(5) 患有神经系统疾病;(6) 骨折同侧肌损伤;(7) 严重心肺功能障碍;(8) 恶性肿瘤。两组患者的一般资料比较差异无统计学意义(P>0.05),见表1。本研究经安庆市第一人民医院医学伦理委员会审查批准(编号:AQYY-YXLL-LWLL-06)。

表1　两组一般资料比较　($\bar{x}$±s)

Tab.1　Comparison of general information between the two groups　($\bar{x}$±s)

组别	例数	性别(例)		年龄(岁)	身体质量指数(kg/m²)	ASA分级(例)		
		男	女			Ⅰ级	Ⅱ级	Ⅲ级
试验组	40	24	16	43.64±6.39	23.48±1.76	23	13	4
对照组	40	26	14	45.35±6.54	23.29±1.30	17	18	5
χ^2/t/Z值		0.213		1.183	0.549	1.241		
P值		0.644		0.240	0.584	0.214		

1.2　方法　两组患者入院后常规吸氧,监测血压、心电图及外周血氧饱和度,建立上肢静脉通路,于麻醉前10 min静脉注射枸橼酸舒芬太尼注射液(国药准字H20203652,江苏恩华药业)0.1 μg/kg。患者取仰卧位,头偏向非手术侧,肩下垫薄枕。使用彩色多普勒超声诊断仪(西门子公司)进行定位,探头频率5~12 MHz。

对照组:将探头置于喙突旁锁骨下缘,行横断面扫描显示胸大/小肌、臂丛神经3个神经束。使用22G穿刺针从锁骨端进针,针尖前端到达腋动脉平面和臂丛后束之间。回抽无血后,注射15 mL 0.375%盐酸罗哌卡因(国药准字H20113381,广东嘉博制药),待其在腋动脉周围扩散后,适当退针,注射15 mL 0.375%盐酸罗哌卡因于腋动脉旁臂丛外侧束周围。

试验组:将探头置于锁骨中点,滑动探头扫描显

示胸大肌、锁骨下肌、腋动静脉、胸肩峰动脉、臂丛神经3个神经束、头静脉。使用22G穿刺针从腋动脉外侧进针至外侧束和后束之间。回抽无血后，注射30 mL 0.375%盐酸罗哌卡因。

1.3　观察指标　(1) 麻醉阻滞效果。(2) 注药后5、10、20、30 min时，分别采用针刺法评估臂丛神经主要支配区域感觉阻滞程度；采用肌力分级法评估运动阻滞情况。(3) 使用视觉模拟评分法(Visual Analogue Scale, VAS)[6]对患者术后12、18、24、36 h时的疼痛程度进行评价，分值为1~10分，评分与疼痛程度呈正比。(4) 免疫功能指标：于手术前后取患者的静脉血，使用流式细胞仪(贝克曼库尔特，美国)测定$CD3^+$、$CD4^+$、$CD8^+$水平。(5) 记录并比较围手术期患者恶心呕吐、皮肤瘙痒、嗜睡等副作用发生情况。

1.4　统计学方法　使用SPSS 24.0统计软件处理数据。符合正态分布的计量资料以$\bar{x}\pm s$表示，两组间比较采用独立样本t检验，多时点比较采用重复测量方差检验，两两比较采用LSD-t检验。计数资料以例(%)表示，比较采用χ^2检验，多时点比较采用广义估计方程。$P<0.05$为差异有统计学意义。

2　结　果

2.1　两组麻醉阻滞效果比较　与对照组相比，试验组阻滞操作时间更短，阻滞维持时间更长，进针深度更浅($P<0.01$)。见表2。

2.2　两组不同时间点阻滞率比较　与对照组相比，试验组肌皮神经、尺神经、桡神经、正中神经的感觉阻滞率在注药后5 min(χ^2=8.538、6.486、7.314、5.333, $P<0.05$)和10 min(χ^2=6.667、5.165、6.646、9.038, $P<0.05$)更高，注药后10 min时肌皮神经、桡神经、尺神经运动阻滞率更高(χ^2=7.440、6.050、7.813, $P<0.05$)。见表3、表4。

2.3　两组不同时间点VAS评分比较　两组术后12、18、24、36 h静息和运动状态时VAS评分的组间、时间和交互效应均有统计学意义($F_{组间}$=609.600, $F_{时间}$=494.900, $F_{交互}$=40.300, $P<0.05$)；与对照组比较，试验组术后12、18、24、36 h有更低的静息状态VAS评分(t=17.705、13.754、12.292、21.157, $P<0.05$)和运动状

表2　两组麻醉阻滞效果比较　(n=40, $\bar{x}\pm s$)

Tab.2　Comparison of anesthetic block effects between two groups　(n=40, $\bar{x}\pm s$)

组别	阻滞操作时间(min)	阻滞维持时间(min)	进针深度(cm)
试验组	6.14±1.35	434.51±20.31	2.58±0.22
对照组	7.94±1.17	412.47±19.63	3.36±0.27
t值	6.373	4.935	14.164
P值	<0.001	<0.001	<0.001

表3　两组不同时间点感觉阻滞率比较　[n=40,例(%)]

Tab.3　Comparison of sensory block rate at different time points between two groups　[n=40, case(%)]

时间	正中神经		尺神经		桡神经		肌皮神经	
	试验组	对照组	试验组	对照组	试验组	对照组	试验组	对照组
注药后5 min	10(25.00)[a]	1(2.50)	6(15.00)[a]	0	9(22.50)[a]	1(2.50)	5(12.50)[a]	0
注药后10 min	15(37.50)[a]	5(12.50)	9(22.50)[a]	2(5.00)	12(30.00)[a]	3(7.50)	14(35.00)[a]	3(7.50)
注药后20 min	33(82.50)	27(67.50)	30(75.00)	24(60.00)	29(72.50)	25(62.50)	26(65.00)	23(57.50)
注药后30 min	36(90.00)	37(92.50)	35(87.50)	33(82.50)	37(92.50)	31(77.50)	33(82.50)	30(75.00)
$\chi^2/P_{时间}$值	75.821/0.026		1 025.884/<0.001		66.233/<0.001		885.960/<0.001	
$\chi^2/P_{组间}$值	4.937/<0.001		262.419/<0.001		7.911/0.005		275.579/<0.001	
$\chi^2/P_{交互}$值	5.548/0.136		6.572/0.037		5.182/0.159		5.304/0.071	

注：与对照组同一时间点对比，[a]$P<0.05$。

表4　两组不同时间点运动阻滞率比较　[n=40,例(%)]

Tab.4　Comparison of motor block rate at different time points between two groups　[n=40, case(%)]

时间	正中神经		尺神经		桡神经		肌皮神经	
	试验组	对照组	试验组	对照组	试验组	对照组	试验组	对照组
注药后5 min	1(2.50)	0	3(7.50)	0	0	1(2.50)	2(5.00)	0
注药后10 min	3(7.50)	0	11(27.50)[a]	2(5.00)	13(32.50)[a]	4(10.00)	16(40.00)[a]	5(12.50)
注药后20 min	21(52.50)	13(32.50)	30(75.00)	25(62.50)	29(72.50)	21(52.50)	28(70.00)	21(52.50)
注药后30 min	30(75.00)	23(57.50)	33(82.50)	29(72.50)	35(87.50)	30(75.00)	32(80.00)	27(67.50)
$\chi^2/P_{时间}$值	633.633/<0.001		613.899/<0.001		287.588/<0.001		463.000/<0.001	
$\chi^2/P_{组间}$值	879.896/<0.001		248.754/<0.001		143.528/<0.001		275.008/<0.001	
$\chi^2/P_{交互}$值	0.007/0.935		2.703/0.259		0.886/0.642		2.088/0.352	

注：与对照组同一时间点对比，[a]$P<0.05$。

态VAS评分(t=22.322、13.570、7.490、9.904, P<0.05)。见表5。

2.4 两组免疫功能指标比较 术后两组免疫功能指标水平均下降,与试验组相比,对照组免疫功能指标水平下降更显著(P<0.05)。见表6。

2.5 两组副作用比较 围手术期试验组发生恶心呕吐2例,皮肤瘙痒1例,嗜睡1例。对照组发生恶心呕吐3例,皮肤瘙痒1例,嗜睡2例。试验组和对照组副作用总发生率比较差异无统计学意义(10.00% *vs* 15.00%, χ^2=0.457, P=0.499)。

表5 两组静息和运动状态VAS评分比较 (n=40, 分, $\bar{x}\pm s$)

Tab.5 Comparison of VAS scores at rest and exercise status between two groupss (n=40, point, $\bar{x}\pm s$)

时间点	静息状态VAS		运动状态VAS	
	试验组	对照组	试验组	对照组
术后12 h	0.26±0.05[a]	0.81±0.19	0.64±0.16[a]	1.49±0.18
术后18 h	0.85±0.14[a]	1.69±0.36	1.85±0.31[a]	2.97±0.42
术后24 h	0.64±0.11[a]	1.05±0.18	1.44±0.20[a]	1.81±0.24
术后36 h	0.13±0.02[a]	0.57±0.13	0.91±0.15[a]	1.34±0.23
$F/P_{组间}$值	804.100/<0.001		609.600/<0.001	
$F/P_{时间}$值	415.100/<0.001		494.900/<0.001	
$F/P_{交互}$值	24.660/<0.001		40.300/<0.001	

注:与对照组同一时间点对比,[a]P<0.05。

表6 两组免疫功能指标比较 (n=40, %, $\bar{x}\pm s$)

Tab.6 Comparison of immune function indicators between two groups (n=40, %, $\bar{x}\pm s$)

组别	$CD3^+$		$CD4^+$		$CD8^+$	
	术前	术后	术前	术后	术前	术后
试验组	73.07±11.51	62.79±10.46[a]	45.24±7.37	34.80±6.32[a]	38.58±5.32	32.26±5.24[a]
对照组	72.62±11.34	52.69±8.40[a]	42.94±7.45	25.29±5.63[a]	38.24±5.15	29.48±6.27[a]
t值	0.176	4.762	1.388	7.106	0.290	2.152
P值	0.861	<0.001	0.169	<0.001	0.772	0.035

注:与术前对比,[a]P<0.05。

3 讨论

上肢骨折多由于间接暴力所致,患者肢体活动受限,严重影响日常生活和工作[7]。临床一般行切开复位内固定术治疗上肢骨折,而在术前通常采用BPB[8]。神经阻滞的重点在于准确定位以及合适的麻醉深度,麻醉程度过浅,患者在手术中会感到疼痛;麻醉过深,可能导致患者出现呼吸抑制[9-10]。既往BPB采用喙突入路,由于该位置在盂肱关节内侧,肌肉组织丰富,容易造成影像视野模糊[11]。而肋锁间隙周围的3个神经束聚集在一起,仅需少量局部麻醉(局麻)药物,就能实现较好的麻醉阻滞效果[12]。

本研究结果显示,与对照组比较,试验组阻滞操作时间更短,阻滞维持时间更长,进针深度更浅;注药后5、10 min时肌皮神经、桡神经、尺神经、正中神经的感觉阻滞率更高,注药后10 min时肌皮神经、桡神经、尺神经运动阻滞率更高。分析认为,肋锁间隙处的神经束聚集在一起,且位置表浅,局麻药物可以快速进入臂丛神经进行有效阻滞,而且利用超声引导,再加上阻滞位置表浅,有利于精准定位阻滞部位,能有效避免局麻药物在注射时产生偏移,达到精准阻滞的目的,从而提高局麻药物的利用率,延长局麻药物的作用时间[1,8]。

上肢骨折手术由于切口大、创面深,术后容易出现急性疼痛[13]。阿片类药物是临床术后镇痛最有效的药物,但容易引起头晕、恶心、呼吸抑制等不良反应,且大量使用可能会导致成瘾,因此目前临床提倡更为安全的区域神经阻滞[14]。本研究结果显示,与对照组相比,试验组术后12、18、24、36 h静息和运动状态时VAS评分更低,提示相比喙突入路,肋锁间隙入路术后镇痛效果更好,与左小明等[15]研究结果一致。分析其原因,喙突入路时,超声显像会被患者颈胸部皮下脂肪阻挡,影响阻滞时的解剖操作,而肋锁间隙入路的解剖位置较浅,麻醉医师能更准确地进行穿刺,减少对周围神经、血管的损伤,从而降低术后疼痛。外伤、手术创伤以及疼痛会导致机体产生应激反应,从而抑制免疫系统功能,增加感染风险[16]。本研究结果还显示肋锁间隙入路可以减轻对免疫系统的影响,可能是由于肋锁间隙入路能降低手术时的疼痛和应激刺激,从而减少皮质醇等应激物质的释放,减轻对免疫功能的影响。围手术期两组副作用发生率比较差异无统计学意义,提示肋锁间隙入路不会增加阻滞副作用,安全性好。

综上所述,对于上肢骨折手术患者,行超声引导下肋锁间隙BPB可以提高阻滞效果,加快感觉和运动阻滞,减轻术后疼痛和对免疫功能的影响,且安全性好。

利益冲突 无

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