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Role of positioning posterior cord on coracoid approach brachial plexus block guided by nerve stimulator

Compared with guided by ultrasound

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Abstract

Background: Coracoid approach is efficient and safe for brachial plexus block, and is guided by nerve stimulator or ultrasound in general. Many trials have proved that ultrasonic guidance was more efficacious than nerve stimulator guidance. We hypothesized that positioning posterior cord could enhance the anesthesia effect of coracoid approach brachial plexus block (CABPB) guided by nerve stimulator.

Methods: Eighty patients were randomized into 2 groups to receive CABPB with positioning posterior cord guided by nerve stimulator (group A) or CABPB guided by ultrasound (group B). Success rate, procedure time, and onset time of sensory or motor block were recorded.

Results: Success rate was similar in 2 groups (89.7% in group A vs 87.5% in group B, $P > .05$). Procedure time was longer in group A (8 minutes), as compared with group B (4 minutes; $P < .05$). The difference of onset time of sensory and motor block was not significant between the 2 groups. The onset time of sensory and motor block for musculocutaneous nerve was significantly shorter in group A, as compared with group B ($P < .05$).

Conclusion: The 2 technologies are equivalent regarding success rate, safety, and onset time of sensory or motor block. Positioning posterior cord in CABPB guided by nerve stimulator is efficacious for upper extremity surgery.

(URL: http://www.chictr.org.cn/listbycreater.aspx ID: ChiCTR-INR-16009091 DATE: 25/8/2016)

Abbreviations: BMI = body mass index, CABPB = coracoid approach brachial plexus block, ECG = electrocardiogram.

Keywords: brachial plexus block, coracoid approach, lateral cord, medial cord, nerve stimulator, posterior cord, ultrasound

1. Introduction

Brachial plexus block is widely used for upper extremity surgery. There are a variety of approaches available for brachial plexus block, including interscalene, supraclavicular, infraclavicular, and axillary approach. The choice of puncture approach is often according to surgical site, the risk of puncture, and the experience of anesthesiologist.

Coracoid approach is a new technique for infraclavicular brachial plexus block.[1] Coracoid approach brachial plexus block (CABPB) is useful for arm surgery. It is easy positioning and safe.[1]

CABPB is carried out guided by nerve stimulator or ultrasound in general, due to the fact that brachial plexus is rather deep in coracoid plane.[2] Many trials have proved that ultrasonic guidance can provide more perfect clinical anesthesia effect than nerve stimulator guidance in regional block.[3,4] However, Lecamwasam et al[5] confirmed that stimulating posterior cord coule increased the likelihood of block success. In this research, we hypothesized that positioning posterior cord can enhance the anesthesia effect of CABPB guided by nerve stimulator and can generate similar anesthesia effect to CABPB guided by ultrasound.

2. Materials and methods

This research was approved by the medical ethics committee of the first hospital of Qinhuangdao (IRB no. 201601A013). Eighty patients were enrolled in this study. All patients provided their written informed consent. Inclusion criteria included aged 18 to 60 years; American Society of Anesthesiologists status I-II; scheduled for elbow, forearm, wrist, or hand surgery. Exclusion criteria included history of allergy to local anesthetics; local infection, coagulopathy, neuromuscular disease, or chest or shoulder deformities; and the surgery time would be longer than the local anesthetic action time.

Patients were randomly divided into 2 groups, 40 in each group. The random number was generated via a computer and sealed in an opaque envelope that was opened immediately before anesthesia. Two groups were assigned to receive either CABPB

Editor: Somchai Amornyotin.

The authors have no conflicts of interest.

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Medicine (2017) 96:45(e8428)

Received: 7 August 2017 / Received in final form: 27 September 2017 / Accepted: 28 September 2017

http://dx.doi.org/10.1097/MD.0000000000008428

guided by nerve stimulator (group A) or guided by ultrasound (group B). The procedure was implemented by anesthesiologists who were familiar with both of the 2 technologies.

Patients received conventional monitor comprised of pulse oximetry, electrocardiogram (ECG), and noninvasive blood pressure measurement at 3 minutes intervals. Low volume oxygen inhalation was supplied to each patient. Midazolam 0.05 mg/kg and fentanyl 1 μg/kg were administered intravenously to every patient. The puncture point was sterilized and infiltration anesthetized with 3.0 mL of 1% lidocaine. Subsequently, CABPB was performed.

2.1. Group A

The puncture point was 2.0 cm medially and 2.0 cm caudally to the coracoid process[2] (Fig. 1). A 55 mm, 22-gauge needle, attached to the nerve stimulator, pierced the skin vertically. Initially, the nerve stimulator was set at electric current 1.0 mA, frequency 2.0 Hz, and pulse width 0.1 ms.[6] Three motor responses would be obtained[7]: posterior cord motor response (wrist extension); lateral cord motor response (elbow flexion, finger flexion, or thumb opposition); and medial cord motor response (finger flexion, thumb, or wrist adduction). The needle was adjusted cephalically or caudally in a sagittal plane to elicit 2 different responses. Among the 2 responses, we must get posterior cord motor response (wrist extension). The other response could be either lateral or medial cord motor response. Once the optimal motor response was still achieved when electric current ranged in 0.3 to 0.5 mA, 20 mL of 0.375% ropivacaine was slowly injected with careful discontinuously withdraw.

2.2. Group B

We used a 6 to 13 MHz linear ultrasound probe (M7 expert; Shenzhen Mindray Biological Medical Electronics Co. Ltd, Shenzhen, China). The ultrasound probe was positioned just in close proximity to the coracoid in a sagittal plane (Fig. 2A). The angle of the probe was adjusted to capture an unambiguous short-axis image of the axillary vessels and brachial plexus (Fig. 2B). Then, an 8 cm, 22-gauge needle was positioned near the axillary artery, using an in-plane technique. Forty milliliters of 0.375% ropivacaine was slowly injected around axillary artery with careful discontinuously withdraw. The injection of the local anesthetic was visualized under continuous ultrasound to confirm that local anesthetic spread around the brachial plexus.

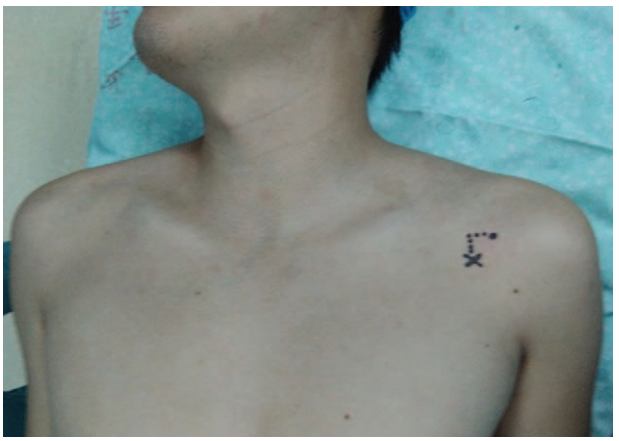

Figure 1. The puncture point for CABPB.

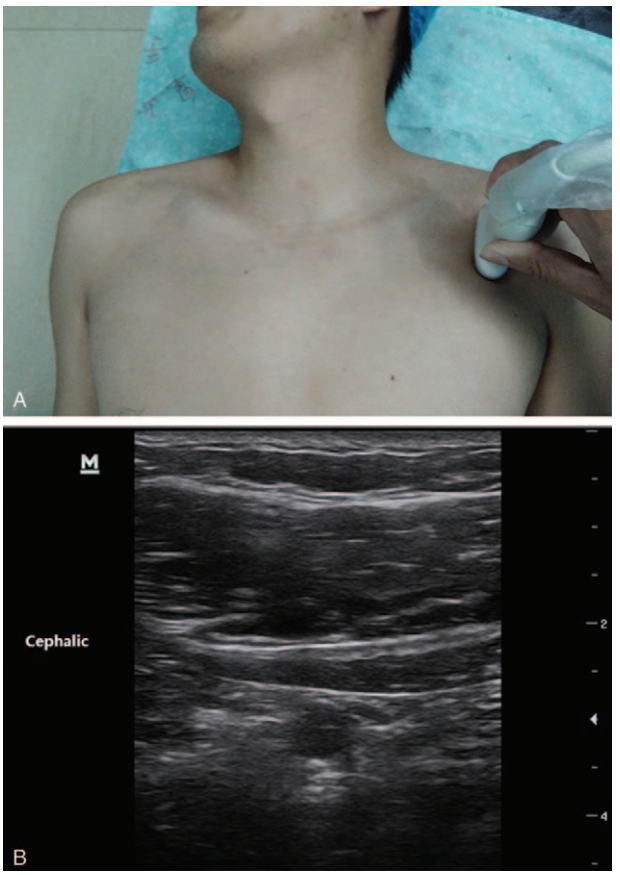

Figure 2. (A) The position and orientation of probe for CABPB. (B) The ultrasonic image for CABPB.

A supplemental local infiltration anesthesia or intravenous fentanyl would be administered if the patient complain pain when the surgery began. If this did not come into effect, general anesthesia was necessary.

Primary outcome measure consisted of success rate. Secondary outcome measures consisted of procedure time and onset time of sensory and motor block. Measured outcomes were recorded by an independent observer, who was unconscious of the grouping situation.

Success rate was defined as the percentage of the patients who received the surgery just relying on brachial plexus block, without local infiltration anesthesia, intravenous fentanyl, or general anesthesia.[8]

Procedure time meant the time required to perform the block.

Sensory and motor block was evaluated every 5 minutes. Sensory block was evaluated with stabbing the sensory distribution of musculocutaneous, median, ulnar, radial, and the medial cutaneous nerve of the forearm. The degree of sensory block for each nerve was scored as follows: 0 = sharp sensation (no block), 1 = blunt sensation (hypoalgesia), and 2 = no sensation (anesthesia). Sensory block was considered complete when the score reached 2.

Motor blockade was evaluated with making specific movements dominated by musculocutaneous, median, ulnar, and radial nerves. The tests was performed as follows[9]: flexing the elbow for the musculocutaneous nerve, flexing the wrist and the

metacarpophalangeal joints for the median nerve, extending the elbow and the wrist for the radial nerve, and abducting and adducting the fingers for the ulnar nerve. The degree of motor block for each nerve was scored as follows: 0=normal movement, 1=decreased movement, and 2=no movement. Motor block was considered complete when the score reached 2.

The total test time for sensory or motor block was 30 minutes. If the score for each nerve still did not achieve 2 beyond 30 minutes, the onset time was treated as 30 minutes.

All complications, varying from nausea to cardiovascular or central neurologic symptom, were taken note in detail. All patients were followed up for 3 days.

2.3. Statistical analysis

We set our sample size to 40 by a power analysis based on the following hypotheses: the success rate of brachial plexus block guided by nerve stimulator was about 60%[3,10] in previous studies, and we assumed it could be improved to 90% (the success rate of brachial plexus block guided by ultrasound was nearly 90%[11]); $\alpha=0.05$; and $\beta=0.20$. SPSS 17 software (SPSS Inc., Chicago, IL) was used for statistical analysis. Quantitative variable was presented with mean and standard deviation, and qualitative variable was presented with frequency and percentage. Shapiro–Wilks test was used for evaluating the distribution of data. Parametric test was performed using either 2-sample Student *t* test or Chi-square analysis, according to the type of variable. Nonparametric test was performed using Mann–Whitney *U* test. Difference was considered statistically significant if $P<.05$.

3. Results

Eighty patients participated in this study, but 1 patient in group A did not receive the study intervention and was excluded from data analyses. The reason for exclusion was that the specific motor responses were not successfully obtained. Consequently, the number of patients who underwent data analyses was 39 in group A and 40 in group B.

Demographic characteristics and the region of surgery did not differ significantly between the 2 groups (Table 1).

Successful block was attained in 35 (89.7%) patients in group A and in 35 (87.5%) patients in group B. Intraoperatively, supplemental local infiltration was necessary for 2 (5.1%) patients in group A and in 3 (7.5%)patients in group B; and intravenous fentanyl was necessary for 2 (5.1%) patients in group A and 2 (5.0%) patients in group B. General anesthesia was not required. The difference was not statistically significant (Table 2).

Procedure time was significantly longer in group A (8 minutes), as compared with group B (4 minutes, $P<.05$).

Table 1

Demographic characteristics and the surgical region.

	Group A	Group B	P
Sex (male/female)	23/16	26/14	.581
Age, y	37.5±10.3	36.1±11.5	.231
Weight, kg	63.2±12.2	65.2±12.8	.739
Surgical region			
Elbow joint	2	1	.840
Forearm	16	14	
Wrist joint	3	4	
Hand	18	21	

Data were presented with mean and standard deviation, or frequency. The difference was not statistically significant between the 2 groups.

Table 2

Anesthetic results.

	Group A (n=39)	Group B (n=40)	P
Block success	35 (89.7%)	35 (87.5%)	>.99
Supplemental local infiltration	2 (5.1%)	3 (7.5%)	
Intravenous fentanyl	2 (5.1%)	2 (5.0%)	
General anesthesia	0 (0%)	0 (0%)	

Data were presented with frequency and percentage. Statistics analysis was performed using Chi-square analysis. The difference was not statistically significant between the 2 groups.

The difference of onset time of global sensory block was not significant between the 2 groups [15 (25) minutes in group A vs 15 (15) minutes in group B, $P>.05$]. The onset time of sensory block for musculocutaneous nerve was significantly shorter in group A [10 (25) minutes], as compared with group B [15 (20) minutes, $P<.05$]. The onset time of sensory block for the other 4 nerves was similar in the 2 groups (Table 3).

The difference of onset time of global motor block was not significant between the 2 groups [15 (20) minutes in group A vs 20 (15) minutes in group B, $P>.05$]. The onset time of motor block for musculocutaneous nerve was significantly shorter in group A [10 (25) minutes], as compared with group B [15 (20) minutes, $P<.05$]. The onset time of motor block for the other 3 nerves was similar in the 2 groups (Table 4).

In group A, the other motor response was evoked from lateral cord in 24 (61.5%) patients and from medial cord in 15 (38.5%) patients, respectively.

Unexpected vascular puncture occurred in 1 patient of each group, but no further cacoethic consequence was observed through closely monitoring.

4. Discussion

The present study showed an analogous success rate and onset time of global sensory and motor block in 2 groups, while the onset time of sensory and motor block for musculocutaneous nerve was shorter in patients guided by nerve stimulator when compared with guided by ultrasound. But the procedure time was longer in patients guided by nerve stimulator.

Brachial plexus block is an effective technique for upper extremity surgery. This block can be executed using a variety of approaches. Since described by Whiffler in 1981,[1] the coracoid approach has been used extensively for surgeries of the elbow, forearm, wrist, and hand. CABPB provides comprehensive sensory block with a favorable tourniquet tolerance.[12,13] The magnetic resonance imaging (MRI) study has indicated that the

Table 3

Onset time of sensory block (min).

	Group A (n=39)	Group B (n=40)	P
Global sensory block	15 (25)	15 (15)	.939
Musculocutaneous nerve	10 (25)	15 (20)	.016*
Median nerve	10 (20)	10 (15)	.667
Ulnar nerve	15 (25)	12.5 (20)	.241
Radial nerve	10 (20)	10 (15)	.054
Medial cutaneous nerve of the forearm	10 (20)	10 (20)	.789

Data were presented with median and range. Statistics analysis was performed using Mann–Whitney *U* test.

* $P<.05$, and meant that there was significant difference between the 2 groups.

Table 4

Onset time of motor block (min).

	Group A (n = 39)	Group B (n = 40)	P
Global motor block	15 (20)	20 (15)	.565
Musculocutaneous nerve	10 (25)	15 (20)	.026*
Median nerve	10 (20)	10 (20)	.573
Ulnar nerve	15 (25)	15 (20)	.189
Radial nerve	10 (20)	15 (15)	.129

Data were presented with median and range. Statistics analysis was performed with using Mann–Whitney *U* test.

* $P < .05$, and meant that there was significant difference between the 2 groups.

pleura is deeper than brachial plexus in the coracoid plane, so the risk of pneumothorax is minimal.[14]

Traditionally, CABPB is guided by anatomic landmark. But owing to the fact that brachial plexus is deeply covered in coracoid plane,[2] CABPB guided by anatomic landmark is difficult. So, CABPB is carried out guided by nerve stimulator or ultrasound in general.

In coracoid plane, the brachial plexus includes 3 cords: posterior cord, lateral cord, and medial cord. When using a nerve stimulator, different motor responses would be elicited. Thus, dual or triple stimulation is put into practice, in order to achieve better results. Rodriguez et al[15] and Gaertner et al[10] concluded that the success rate was higher with stimulation of 2 or 3 cords of the brachial plexus. Among the 3 cords, posterior cord was associated with greater effectiveness.[5,16] But no significant difference was found between dual motor responses and triple motor responses.[15] So, we selected posterior cord motor response combined with another motor response as our stimulation target.

On the basis pf our selected motor responses, success rate and onset time of global sensory and motor block are equally encouraging in 2 groups. This is in line with our expectation. In addition, the onset time of sensory and motor block for musculocutaneous nerve is shorter in group A than in group B. It is consistent with the result that motor response evoked from lateral cord is more than from medial cord (61.5% vs 38.5%). This is similar to the conclusion by Sharma et al.[16] Maybe it is because lateral cord is easy to position. And the onset time may decrease further if dextrose is used as a diluent instead of saline.[17]

In previous studies, ultrasonic guidance could improve the success rate[3] and shorten the onset time[18] and procedure time.[7] But in our study, we just saw that procedure time was shortened.

In this study, posterior cord motor response combined with another motor response is selected as our stimulation target, which guarantees that the local anesthetic can surrounded each branches of brachial plexus, just like what happens under continuous ultrasonic guidance. So, the success rate and the onset time are similar in 2 groups. However, it consumes more time to preform CABPB in group A indeed. But this time gap between the 2 groups might be acceptable in clinical practice. And what is more, nerve stimulation guidance is easy to learn and master. Although the economic cost for ultrasonic unit is higher, it requires longer learning time to master the skills of ultrasonic.

There are still some limitations in the present study. One shortcoming of this study is that our results are not suitable for all anesthesiologists with different levels. The clinical result is dependent on performer's skill. This point is rather obvious for obtaining specific motor responses or unambiguous ultrasonic image. The second limitation is that the body mass index (BMI) of patients has not been recorded. Obviously, BMI is closely related to the difficulty of CABPB. Another limitation is that the sample size is relatively small, so the above conclusions are representative, yet to be confirmed by further studies in the future.

We conclude that positioning posterior cord in CABPB under nerve stimulator guidance develops satisfactory clinical effect. The success rate and onset time of sensory or motor block are similar to that of CABPB under ultrasonic guidance. However, the procedure time is shorter under ultrasonic guidance, while the onset time of sensory and motor block for musculocutaneous nerve (representing lateral cord) is shorter under nerve stimulator guidance than ultrasonic guidance.

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