Translated by A.P. Strelkova

Research Article
https://doi.org/10.23934/2223-9022-2024-13-4-715-720

Method for Assessing the Degree of External Dislocation of the Catheter for Prolonged Brachial Plexus Block

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AIM OF STUDY To demonstrate the effectiveness and safety of a method for assessing the degree of external dislocation of a catheter for continuous brachial plexus block (CBPB) using a dislocation scale in clinical practice.

MATERIAL AND METHODS The study included 63 patients who underwent CBPB from the supraclavicular approach with fixation of the catheter on the skin with a patch sticker during operations for fractures of the bones of the upper limb. To analyze the size of the catheter dislocation, a method for assessing the degree of external dislocation of the catheter for CBPB was used.

RESULTS In 16 patients, the size of the external dislocation was from 0 mm to 5 mm (grade 1), which was assessed as no dislocation, in 30 patients it was more than 5 mm to 10 mm (grade 2), while there were no changes in the quality of pain relief, in 15 patients the dislocation was more than 10 mm to 15 mm (grade 3), while there was a deterioration in the quality of pain relief, it was necessary to increase the dose of the administered local anesthetic and strengthen the fixation of the catheter to the skin of the supraclavicular region with a fixation device, in 2 patients the size of the external dislocation was more than 15 mm (grade 4), which was defined as migration of the catheter beyond the brachial plexus and led to the cessation of CCBPB.

CONCLUSION The physician operating the catheter for prolonged brachial plexus block, using the method of assessing the degree of external dislocation, has the opportunity to determine the likelihood of deterioration in the quality of anesthesia based on the size of the dislocation and prevent its cessation.

Keywords: prolonged brachial plexus block, catheter dislocation, method for assessing the degree of catheter dislocation

For citation Yamshchikov ON, Marchenko AP, Emelianov SA, Ivanova OD. Method for Assessing the Degree of External Dislocation of the Catheter for Prolonged Brachial Plexus Block. *Russian Sklifosovsky Journal of Emergency Medical Care.* 2024;13(4):715–720. https://doi.org/10.23934/2223-9022-2024-13-4-715-720 (in Russ.)

Conflict of interest Authors declare lack of the conflicts of interests

Acknowledgments, sponsorship The study had no sponsorship

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ASA – American Society of Anesthesiologists
CBPB – prolonged brachial plexus block
NSAIDs – non-steroidal anti-inflammatory drugs

INTRODUCTION

Continuous brachial plexus block (CBPB) is an effective method of pain relief that is widely used in clinical practice in surgical interventions on the upper limb and shoulder girdle. This method is based on the perineural administration of local anesthetic, which blocks the transmission of pain signals. The anesthetic is administered through the lumen of a catheter previously installed in the brachial plexus [1]. However, one of the most common problems that physicians encounter when using a CBPB catheter is catheter migration, which can lead to incorrect distribution of the analgesic and insufficient pain relief for the patient [2]. Therefore, this article will consider a method for assessing the degree of external dislocation of the CBPB catheter.

Successful brachial plexus block requires accurate placement of the catheter near the brachial plexus. There are several ways to assess the degree of external dislocation of the catheter placed in the brachial plexus. One of the most common methods is the use of ultrasound imaging [3]. Ultrasound scanning can visualize the position of the catheter and determine its deviation relative to the brachial plexus [4]. Typically, a supraclavicular approach is used for CBPBB, which requires correct insertion of the catheter into the space between the first rib and the brachial plexus. Ultrasound navigation allows visualization of this area and determination of the position of the catheter relative to the brachial plexus [5].

Another method of assessment is based on the use of an X-ray contrast agent. After the contrast agent is introduced into the catheter, an X-ray examination is performed, which allows visualization of the position of the catheter and its dislocation relative to the starting point on the patient's X-ray [6]. However, this method has some limitations due to the logistical features of conducting an X-ray examination with contrast and unreasonable labor intensity.

There are also methods of visual assessment based on the type of signal received during nerve stimulation. If the catheter is in the correct position, the signal will have an optimal shape and amplitude. If the catheter is displaced, the shape and amplitude of the signal will be changed, which allows us to conclude that there is an external dislocation of the catheter [7].

Accurate determination of the position of the catheter for the CBPB is an important aspect in providing effective analgesia of the upper limb and shoulder girdle.

We have developed a method for assessing the dislocation of a catheter for CBPB. This visual assessment method allows one to assess the degree of risk of deterioration in the quality of the performed anesthesia and its termination based on the size of the catheter dislocation. The essence of the invention is a scale that contains four degrees from 1 to 4. Each degree corresponds to a certain size of the external dislocation from the control mark. Each degree has a characteristic that allows one to assess the risk of deterioration in the quality of the performed anesthesia and its termination [8].

In conclusion, it should be noted that the assessment of the degree of external dislocation of the catheter for CBPB is an important aspect of this procedure. Ultrasound scanning and visual assessment using a dislocation scale are the two most convenient and effective methods for assessing the position of the catheter.

The aim of the study: to demonstrate the possibility of using the method for assessing the degree of external dislocation of the catheter for CBPB in clinical practice.

MATERIAL AND METHODS

During brachial plexus blockades using ultrasound examination, the transverse size of the brachial plexus in the supraclavicular region on both sides was measured in 126 patients. It was found that

the average transverse size of the brachial plexus in the supraclavicular region was 1.5±0.27 mm.

In accordance with the aim of this study, we developed a scale for assessing the degree of external dislocation of the catheter for CBPB (table): 1st degree from 0 mm to 5 mm - no dislocation and no change in the quality of pain relief, 2nd degree - dislocation more than 5 mm to 10 mm - the likelihood of deterioration in the quality of pain relief, and when using the catheter it is necessary to be more careful and attentive and ensure its more reliable fixation, including the use of special fixing devices, 3rd degree - more than 10 mm to 15 mm - deterioration in the quality of pain relief, increased alertness is required when using the catheter, additional more reliable fixation and an increase in the dose of the administered local anesthetic, 4th degree - dislocation more than 15 mm - migration of the catheter beyond the brachial plexus, cessation of pain relief [8].

Table

Scale for the degree of external catheter dislocation for prolonged brachial plexus block

Degree of dislocation	Meaning	Dislocation characteristics
1	From 0 mm to 5 mm	Lack of dislocation
2	More than 5 mm to 10 mm	No change in the quality of pain relief provided
3	More than 10 mm to 15 mm	The likelihood of deterioration in the quality of pain relief provided
4	More than 15 mm	Migration of the catheter beyond the brachial plexus, cessation of the administered anesthesia

In this study, we analyzed 63 cases of continuous plexus block with fixation of the catheter for CBPBB in the subclavian region using fixation devices. Anesthesia was performed during operations for fractures of the upper limb bones. There were 48 cases of proximal humerus fractures, 4 cases of humeral diaphysis fractures, 4 cases of distal humerus fractures, and 7 cases of forearm bone fractures. Of the 63 patients, 18 were men and 45 were women. The age of the patients ranged from 30 to 95 years. There were 6 young patients, 16 middle-aged patients, 21 elderly patients, 18 old patients, and 2 centenarians. The average age of the patients was 64.86±15.69 years. 100% of the patients had concomitant pathology. The physical status of the patients was assessed according to the *ASA* (American Society of Anesthesiologists) scale. Physical status class 2 was in 40 patients (62.5%), class 3 — in 23 patients (37.5%). Even in a 30-year-old patient, the physical status was assessed according to the *ASA scale* as class 2 (smoking for 10 years, obesity stage 2, hypertension stage 2). As can be seen, all patients had an unfavorable high class of physical condition. To perform CBPBSS, we used disposable epidural anesthesia kits of the German company *B/Braun Perifix ONE* 451 *Filter Set with a 1.3 mm (G18) / 80 mm* Tuohy guide needle and an epidural catheter 0.85 × 0.45 × 1000 mm (*G* 20). There are basic landmarks on the catheter, by which it is possible to assess the degree of external dislocation of the catheter for CBPB relative to the skin surface. The longitudinal size of the catheter is 1000 mm. Three side holes are located at a distance of 14 mm from the distal end of the catheter. Marks are applied to the catheter. The first mark in the form of a single strip is located at a distance of 55 mm from the distal end of the catheter. Marks in the form of a single strip are repeated every 10 mm. At a distance of 105 mm from the distal end of the catheter, two adjacent marks are located, and at a distance of 115 mm there is one long mark. At a distance of 155 mm from the distal end, three adjacent marks are located. It is very easy to navigate and determine the degree of dislocation of the catheter by the location of two adjacent marks. The largest transverse size of the brachial plexus with supraclavicular access is 15 mm. Note that the optimal distance to which it is necessary to pass the catheter into the brachial plexus area (as a rule, the catheter is installed under the brachial plexus) is 15 mm. To place the catheter at this distance, it must be advanced so that the two adjacent marks are located in the needle pavilion near the proximal end of the 80 mm Tuohy guide needle. With this positioning of the catheter under the plexus, all three lateral openings on the distal end of the catheter will be within the brachial plexus, and all injected local anesthetic solution will be distributed perineurally (near the brachial plexus).

The clinician performing a plexus block of the upper limb from the supraclavicular approach must be familiar with the topography of the brachial plexus in this area, as well as be able to use ultrasound navigation to visualize the brachial plexus. Advancing the catheter less than 15 mm may result in dislocation and catheter loss. With catheter dislocation greater than 15 mm, all three lateral openings will be located outside the brachial plexus. Thus, part of the local anesthetic solution will spread in the tissues beyond the brachial plexus, and part will flow out. Using these existing marks on the catheter, it is possible to assess the level of catheter dislocation, taking into account the distance from the skin surface to the previously designated control mark on the catheter at the time of its installation. The degree of external dislocation of the catheter is assessed when changing the adhesive tape or fixing device [8]. Additionally, the catheter for CBPB was fixed to the skin of the subclavian region with an adhesive tape.

Postoperative analgesia was performed in the form of CBPB for several days (from 2 to 5) with a ropivacaine solution of 2 mg/ml at a dose of 4 mg/h. Aseptic adhesive tapes were changed daily at the site of the catheter exit onto the skin in the subclavian region. The duration of postoperative analgesia ranged from 1 to 3 days. 1 day in 2 patients, 2 days in 27 patients, 3 days in 34 patients. The average duration of postoperative analgesia was 60.19±13.44 hours. The aseptic fixing sticker was changed on the 2nd and 3rd days without fail due to the fact that wound discharge accumulated under the fixing sticker and was removed, and then the wounds were treated with an antiseptic solution in the area of the catheter for CBPB and the exit point onto the skin, and the degree of its possible dislocation was assessed. Subsequent changes of aseptic fixing stickers were carried out as needed.

RESULTS

The degree of external dislocation of the catheter for the CBPB was assessed during the change of the aseptic fixing sticker and at the time of catheter removal. For clarity, the results are shown in the graph (Fig. 1).

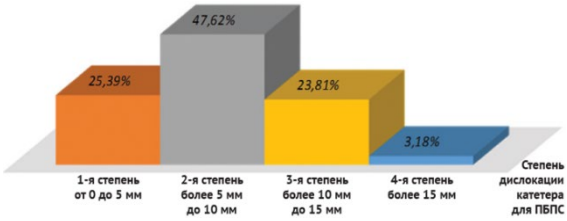

Fig. 1. Degree of catheter dislocation for prolonged brachial plexus block

The analysis showed that grade 1 dislocation was present in 16 cases, which was 25.39%. Grade 2 dislocation was present in 30 cases (47.62%), and grade 3 dislocation was present in 15 cases (23.81%). Grade 4 dislocation was found in 2 cases (3.18%).

For ease of use of the assessment method in the daily work of an anesthesiologist-resuscitator, we combined the degrees of dislocation into groups, taking into account their significance for the quality of epidural anesthesia. For clarity, the degrees of dislocation of the catheter for CBPB are shown in Fig. 2–5.

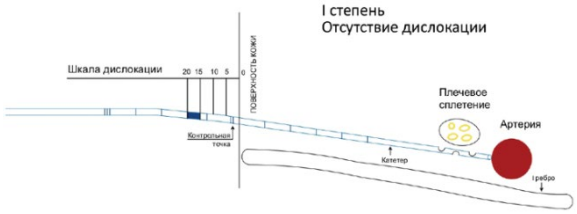

Fig. 2. Grade 1 (dislocation from 0 mm to 5 mm) — no dislocation

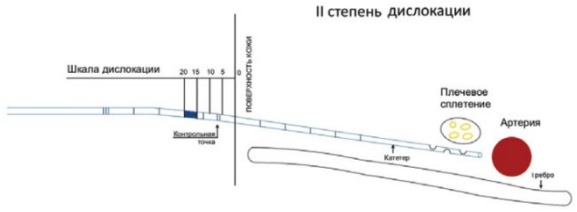

Fig. 3. Grade 2 (dislocation more than 5 mm to 10 mm), no change in the quality of pain relief

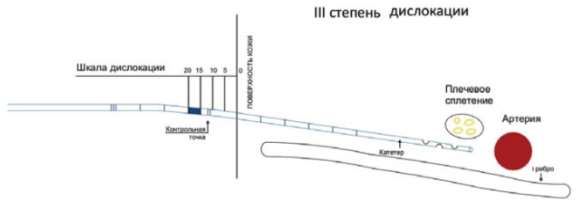

Fig. 4. Grade 3 (dislocation more than 10 mm to 15 mm), probability of deterioration in the quality of the performed anesthesia

Fig. 5. Grade 4 (dislocation more than 15 mm) migration of the catheter beyond the brachial plexus, cessation of the administered anesthesia

The assessment of the degree of external dislocation of the catheter for CBPB allowed us to determine the risk of deterioration in the quality of the pain relief provided and to take measures to prevent deterioration in quality and termination of postoperative analgesia. Based on this, an algorithm of actions was developed upon detection of dislocation of the catheter for CBPB.

In case of 1st degree dislocation from 0 mm to 5 mm (no dislocation), CBPB was performed without additional fixation measures, and care for the catheter for CBPB (change of aseptic fixation sticker and wound treatment) was performed by the nursing staff independently. In our study, this was 16 cases (25.39%).

In case of dislocation of the 2nd degree more than 5 mm to 10 mm (no change in the quality of the performed anesthesia), no additional fixation measures were required. Analgesia was performed in the previous mode, and the care of the catheter for CBPB was performed by the nursing staff only under the supervision of a physician. In our study, this was 30 cases (47.62%).

In case of 3rd degree dislocation of more than 10 mm to 15 mm (probability of deterioration of the quality of the performed anesthesia), additional measures were required to strengthen the fixation of the catheter for CBPB (special fixing devices were used). After such additional fixation, CBPB was continued. All manipulations related to the care of the catheter for CBPB were performed personally by the doctor. In our study, this was 15 cases (23.81%).

In case of 4th degree dislocation of more than 15 mm, the fact of catheter loss for CBPB was established, the administration of local anesthetic was stopped, and the catheter was removed. Analgesia was continued, if necessary, by administration of nonsteroidal anti-inflammatory drugs (NSAIDs) and paracetamol. In our study, there were 2 cases (3.18%).

Implementation of this algorithm allowed to provide high-quality postoperative analgesia in 61 patients. In 44 patients, when dislocation of 2–3 degrees was detected, special fixing devices *˝Perifix˝* were used for additional fixation, which allowed to continue performing CBPB. In 2 cases (3.18%) CBPB had to be stopped, since after 24 hours the 4th degree of dislocation of the catheter for CBPB was established (dislocation by 15 mm), as a result of which the catheter was removed. Postoperative analgesia was continued by administration of NSAIDs.

CONCLUSION

The scale we developed allows us to systematize the assessment of the degree of catheter dislocation and provides important criteria for making decisions on correction and improving the effectiveness of prolonged brachial plexus block.

1. The use of the method for assessing the degree of external dislocation of the catheter for prolonged brachial plexus block in the daily practice of an anesthesiologist-resuscitator allows one to assess the risk of deterioration and termination of the prolonged plexus block.

2. The use of the developed algorithm in identifying the dislocation of the catheter for prolonged brachial plexus block helps to take measures to prevent catheter loss and its postoperative termination.

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Received on 20/11/2023
Review completed on 03/22/2024
Accepted on 17/09/2024