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Assessing Pain Level, Patient Satisfaction, and Frequency of Injury to Adjacent Anatomical Structures During Central Venous Catheter Placement Under Local Anesthesia

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Abstract

Background: Central venous catheters (CVCs) are increasingly used for central vein pressure measurement, fluid replacement, blood-product transfusion, hemodialysis, and chemotherapy. Considering the urgent nature of placing CVCs in many patients, local anesthesia is used in order to facilitate recovery and prevent the side effects of general anesthesia. The successful placement of CVCs can reduce injury to adjacent structures.

Objectives: This study aimed to assess the patients' pain level, satisfaction, and injury to adjacent structures.

Patients and Methods: This case series evaluated 213 patients with end-stage renal disease (ESRD) who had been referred for dual-lumen hemodialysis catheter (large-bore) placement during the year 2011 at Hasheminejad kidney center (Tehran, Iran). Catheters were placed by a single surgeon, and 5 ml of subcutaneous lidocaine 2% was used at the site of catheterization. At the end of the procedure, pain was measured using a visual analog scale, and the patients' satisfaction was verbally determined with regard to whether they would accept local anesthesia if they required catheter placement again in the future.

Results: Fifteen patients reported that they would prefer general anesthesia for a similar procedure in the future. Five of these patients experienced mild pain with the present procedure, and the remainder had severe pain. The mean pain scores were 1.93 ± 0.799 in patients who preferred general anesthesia and 1.26 ± 0.450 in the remainder. The difference between the two groups was significant. One hundred ninety-eight patients experienced mild pain during catheter placement, of which 187 (94.4%) would accept local anesthesia for this procedure in the future. Twenty-two (10.3%) patients underwent arterial puncture, 163 had single-attempt venous puncture, and 50 had two or more puncture attempts. In nine patients, the puncture was unsuccessful and the vein could not be found despite three attempts to insert the needle; for these patients, the anatomical area approached for access was changed.

Conclusions: Local anesthesia facilitates quick recovery, is time-saving, and can reduce hospital expenses. It seems to be a suitable method for reducing complications and increasing patient satisfaction.

Keywords: Central Venous Catheter (CVC), Pain, Patient Satisfaction, Anesthesia, Complications

1. Background

Central venous catheters (CVCs) are increasingly used for measuring central vein pressure, replacing fluids, administering blood and blood products, and performing hemodialysis and chemotherapy. In recent years, the number of patients suffering from kidney failure has increased; 89% of these patients undergo hemodialysis treatment, and 15% - 50% begin the treatment with dual-lumen CVCs (1). Considering the side effects of general anesthesia and the urgent nature of CVC placement in many patients, local anesthesia seems to be a better choice in such situations.

Placing a CVC is a painful and stressful experience for patients. By decreasing pain, local regional anesthesia plays an important role in patient satisfaction and facilitating CVC placement. Regional anesthesia is performed in order to facilitate recovery after CVC placement and to reduce the side effects of general anesthesia and the cost of treatment, especially in hemodialysis candidates.

Successful CVC placement can reduce injury to adjacent structures (such as the brachial plexus, trachea, recurrent laryngeal nerve, and arteries), hemorrhage, hematoma, blood leakage to subcutaneous tissue, pneumothorax, hemothorax, nerve damage, arrhythmia, air emboli, rupture of the vena cava, tamponade, and the risk of postoperative infection (2-5). Pain is a mental experience with many contributing factors, such as ethnicity, race,

and sex (6). Lack of pain control creates anxiety, fear, and dissatisfaction, while preventing pain facilitates CVC placement for surgeons. Based on previous studies, the visual analogue scale is a valid and reliable instrument for measuring pain levels (7-10).

In order to determine patient satisfaction levels, different methods have been used, but no comprehensive method has been recommended.

2. Objectives

We aimed to accurately assess patients who had undergone CVC placement under local anesthesia in order to assess complications and trauma to adjacent anatomical structures around the vein at the time of CVC placement. We also aimed to assess the patients' levels of pain and satisfaction.

3. Patients and Methods

This descriptive study (a case series) was performed during the year 2011 at Hasheminejad kidney center in Tehran, Iran. Using the convenience sampling method, we selected a total of 213 patients, 129 (60.6%) men and 84 (39.04%) women (Table 1), with an age range of 55.67 $\pm$ 16.09 years. All patients had been diagnosed with end-stage renal disease (ESRD) in need of urgent dialysis, and had been referred for CVC placement.

Dual-lumen hemodialysis catheters (12Fr) were placed using Seldinger's standard method by a single experienced surgeon to minimize the possibility of bias, since it has been shown that the incidence of complications is related to the physician's level of training and experience . The catheters were inserted into the internal jugular vein in 205 patients and the subclavian vein in 8 patients (Table 2). In 25 cases of unsuccessful attempts, the surgeon chose another site for CVC placement.

We arranged the classic technique for CVC insertion into five steps and named it the "5 P's Protocol":

1) Position: the patient is placed in the Trendelenburg position.

i) Internal jugular approach: the patient must look away from the site of catheter placement.

ii) Subclavian approach: the patient must look at the ceiling.

2) Percutaneous anesthesia: there is no need for sedation or general anesthesia. Only the skin and subcutaneous tissue should be anesthetized using 3 - 5 mL of lidocaine 2%. The lidocaine is not injected deeply because this would numb the arterial wall and the patient would not feel any pain if the tip of the needle pierced it.

i) Internal jugular approach: the superior carotid triangle is anesthetized.

ii) Subclavian approach: the deltopectoral space is anesthetized.

3) Puncture:

i) Internal jugular approach: the carotid artery is palpated with the physician's non-dominant hand and pushed to the midline. A 21- or 23-gauge pathfinder needle is inserted into the skin at an angle of 45° - 60°, one inch below the tip of the anterior triangle of the neck. The tip of the pathfinder must face the ipsilateral nipple. The pathfinder is inserted while aspirating, until the internal jugular vein is reached and venous blood is aspirated. If the internal jugular vein is not found initially, it probably lies further laterally. An 18-gauge introducer needle is slid alongside the pathfinder needle until free blood return is confirmed.

Unfortunately, the path of the wire cannot be predicted. The use of fluoroscopy is recommended unless it is unavailable or the situation is an emergency.

ii) Subclavian approach: the deltopectoral space is palpated and used as a landmark to advance below. The 18-gauge pathfinder is inserted, directed 90° from the skin, and advanced to a depth of the thickness of the clavicle. The tip of the pathfinder is then pointed toward the suprasternal notch and advanced while aspirating, to reach the subclavian vein.

- If the venous blood flow is not adequate or is poor, the procedure is discontinued and then restarted.

- If the patient complains of pain during the procedure or the needle pierces the artery even once, the procedure is discontinued.

- A new site is chosen for catheter placement after an unsuccessful procedure.

4) Pull out: the guide wire is inserted and advanced to a depth of 20 - 25 cm. There must be no feeling of resistance; the presence of resistance indicates an unsuccessful procedure that must be terminated. After the guide wire is placed, the 18-gauge needle is removed. The skin is incised approximately 2 - 3 mm and a dilator is inserted to about half its length. The procedure is discontinued if the patient encounters any kind of pain. Finally, the dilator is removed.

5) Placement: the catheter is advanced over the guide wire. It is generally recommended that CVCs be inserted to a depth of 13 - 16 cm on the right and 15 - 20 cm on the left. No resistance should be felt during catheter insertion.

After catheter placement is completed, the guide wire is removed and blood is aspirated from both lines with a 10 cc syringe. The blood must flow easily and be pushed back without any difficulty or pain. Both lines are then filled with heparinized saline (1,000 IU/mL) (11).

Table 1. Comparingson of the Complications and Consequences of Catheter Placement Between the Two Groups

Variable	Group 1: Preferred Local Anesthesia (n = 198)[a]	Group 2: Preferred General Anesthesia (n = 15)[a]	P Value
Sex			0.025
Female (n = 84)	74 (88.1)	10 (11.9)	
Male (n = 129)	124 (96.1)	5 (3.9)	
Age, y (mean ± SD)	56.48 ± 16.17	45.56 ± 15.68	0.052
Arterial puncture			0.054
Yes (n = 22)	18 (81.8)	4 (18.2)	
No (n = 191)	180 (94.2)	11 (5.8)	
Nerve damage			0.000
Yes (n = 9)	4 (44.4)	5 (55.6)	
No (n = 204)	194 (95.1)	10 (4.9)	
Pain severity			0.014
Mild (n = 198)	187 (94.4)	11 (5.6)	
Severe (n = 15)	11 (73.3)	4 (26.7)	

[a]Values are presented as No. (%) unless otherwise indicated.

Table 2. Comparison of Severity of Pain and Selecting the Analgesia and Anesthesia Method Based on Site of Catheter Placement[a]

Site	Radiating Pain	Low Pain Severity	High Pain Severity	Request For Local Anesthesia	Request For General Anesthesia
Right internal jugular (n = 183)	9 (4.9)	170 (92.9)	13 (1.7)	168 (91.8)	15 (8.2)
Left internal jugular (n = 22)	0	21 (95.5)	1 (4.5)	22 (100)	0
Right subclavian (n = 4)	0	3 (7.5)	1 (25)	4 (100)	0
Left subclavian (n = 4)	0	4 (100)	0	4 (100)	0

[a]Values are presented as No. (%).

After the procedure, pain was measured using a visual analog scale, with scores ranging from 0 (completely painless) to 10 (highest perceived pain). A score of < 3 was considered mild pain, while higher scores were considered severe pain. Each patient's satisfaction concerning the procedure was verbally questioned after its completion.

Finally, the data regarding pain levels, patient satisfaction, success of the procedure, complications, and injury to adjacent structures were analyzed using SPSS software, version 11.5. Kolmogorov-Smirnov and Levene's tests were used for checking normality and homogeneity, respectively. Chi-square and Fisher's exact tests were used for gender differences, arterial puncture, pain level, neural injury, success of insertion, and patient satisfaction. $P < 0.05$ was considered statistically significant.

4. Results

Of the 213 evaluated patients, 96.1% of the men and 88.1% of the women preferred catheter placement under local anesthesia ($P = 0.025$), and this difference was not statistically significant. One hundred ninety-eight patients (out of 213) experienced mild pain during catheter placement, and 15 felt severe pain.

Fifteen patients stated that they would prefer general anesthesia for a similar procedure in future; 11 had experienced mild pain with the present procedure and the rest had severe pain. The mean pain score was 1.93 ± 0.799 in the patients who preferred general anesthesia and 1.26 ± 0.450 in the remainder (Table 3). The difference between these two groups was significant ($P = 0.014$). Nine (4.22%) of the 213 patients experienced radiating pain at the time of CVC placement, possibly due to injury to adjacent nerves by the puncture needle. Five of these patients preferred general anesthesia and the remaining four preferred catheter placement with local anesthesia for a similar operation. The radiating pain was statistically meaningful in this regard ($P < 0.0001$). Of the remaining 204 patients who did not have radiating pain, 194 (95.1%) preferred CVC placement under local anesthesia.

Of the 22 patients with arterial punctures, 18 (81.8%) preferred placement with local anesthesia, while the corresponding figures for the 191 patients without punctures were 94.2%, a difference that was not significant ($P = 0.054$). In our study, none of the patients experienced brachial

Table 3. Comparison of Complications and Pain Severity Based on Analgesia and Anesthesia Methods[a]

Variable	Request for No General Anesthesia (n = 198)	Request for General Anesthesia (n = 15)	P Value
Pain severity			0.002
Mild	187 (94.4)	11 (73.3)	
Severe	11 (5.6)	4 (26.7)	
Vein puncture			0.031
Yes	18 (9.1)	4 (26.7)	
No	180 (90.9)	11 (73.3)	
Radiating pain			0.000
Yes	4 (2)	5 (33.3)	
No	194 (98)	10 (66.7)	
Place of catheter			0.427
Internal jugular	190 (96)	15 (100)	
Subclavian	8 (4)	0	

[a]Values are presented as No. (%).

plexus nerve injury, laryngeal nerve injury, cardiac tamponade, hemothorax, or pneumothorax.

5. Discussion

CVCs are widely used for quick access to the central vein and it is well known that they should be placed under ultrasonographic guidance; however, such a procedure requires a well-trained surgeon, which is not available at every medical center. Under these conditions, the 5 P's protocol is ideal for catheter placement.

Considering the increasing number of patients in need of CVCs and the complications of general anesthesia, local anesthesia seems to be a suitable alternative method for reducing such complications, especially in severely ill patients. Moreover, local anesthesia facilitates quick recovery, is time-saving, and can reduce hospital expenses. In a study by Masroor and colleagues on 518 patients regarding the mechanical complications of CVC placement, the researchers found that 16 (3%) patients experienced complications, including two cases (0.4%) of pneumothorax, one case of hemothorax (0.2%), and misplacement of the catheter in the remaining 13 patients (12). In contrast, we did not observe any cases of pneumothorax, hemothorax, or catheter misplacement.

In our series, arterial puncture was performed in 22 (10.3%) patients. Using local anesthesia, the patients were awake, and when the needle came into contact with the artery, they became reluctant to continue the procedure. Thus, pain acted as an alert for the possibility of arterial puncture. Nine (8.3%) patients experienced radiating pain, probably the result of injury to the nerves surrounding the vein.

Different methods have been proposed to determine the level of patient satisfaction; however, none are completely acceptable and reliable. In one study on patients undergoing port placement for chemotherapy, the level of satisfaction was assessed using a questionnaire. The patients reported a very high satisfaction with local anesthesia (13). In another similar study, the researchers reported a lower level of satisfaction than the previous study (14). We used a questionnaire in our 213 cases to evaluate the level of patient satisfaction after surgery, and found that only 15 patients preferred general anesthesia for similar future procedures. This could probably be attributed to the patients' anxiety during CVC placement, as pain was considerably lower in the group preferring local anesthesia. We did not find a significant relationship between sex and the level of pain. This finding contradicted several reports showing a significant difference in pain levels between men and women (15, 16). Although we did not evaluate the duration of surgery, it can be inferred that local anesthesia can reduce the duration and indirectly reduce hospital expenses. This is especially crucial for patients urgently in need of hemodialysis.

5.1. Conclusion

While fluoroscopy and ultrasonography are preferred supplementary techniques for CVC placement, the classic technique is still used in their absence. The use of local anesthesia can be a cheaper and less risky method of CVC placement, compared to general anesthesia. It can also reduce arterial and nerve injuries due to the patient being awake during the procedure.

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