ORIGINAL ARTICLE

Subclavian Vein Catheterization using the 90° Angle Technique: A New Technical Trial

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ABSTRACT

Objective: The objective of this study is to examine the outcome of subclavian vein catheterizations using the 90° angle technique. **Design:** This was a retrospective study. **Setting:** The study was conducted at the operating room in the university hospital. **Participants:** A total of 454 patients undergone craniotomy, including 18–70 years aged, and evaluated as the American Society of Anesthesiologists I-II-III status were selected. **Interventions:** Subclavian vein catheter was inserted to the patients using 90° angle technique. **Measurements and Main Results:** The number (*n*) and frequency (%) of pneumothorax, difficulty level, number of attempts during the process (*n*), duration of intervention (s), anesthetist satisfaction, and number (*n*) and frequency (%) of other complications were analyzed. Pneumothorax occurred in three patients (0.6%). The difficulty level of the process was graded 1 (easy) in 454 patients (100%). Subclavian catheter was successful in 450 patients (99%) in the first attempt and 4 patients (1%) in the second attempt. The duration of intervention was determined to be 45 ± 32.1 s on average. The performing anesthetist's satisfaction was 100% (median minimum–maximum: 1.0 (1.0–1.0). The number of other complications (arterial puncture, pneumothorax, and catheter misplacement) was 6 (1.2%). Of all these patients, three had pneumothorax, one had arterial puncture, and two had misplaced catheters. **Conclusion:** In our study, easy and short time applicability and fewer number of attempts along with low complication rates were obtained in 454 patients, on whom subclavian vein catheterization was performed using the 90° angle technique.

Key words: Complications, practices, subclavian vein catheterizations, technique

INTRODUCTION

Central venous catheterization is mostly recommended in cases with hemodynamic monitorization, drug administrations, rapid volume replacement or nutritional support, and difficult peripheral venous cannulation.[1] There are several methods, such as surgical venous cutdown,[2] landmark technique,[3] and ultrasound-guided percutaneous technique,[4] which provide central venous access. Several complications are related to these methods, such as arterial puncture, air embolism, hemothorax, and pneumothorax, which have been reported at an incidence rate of 15–33% in the literature. The safety of the central venous catheterization insertion process is critical to prevent complications.[5] The objective of this study is to examine the outcome of subclavian vein catheterizations using the 90° angle technique. The advantages of the 90° angle technique and ways to improve catheterization practices are discussed.

MATERIALS AND METHODS

This study was carried out according to the Helsinki Declaration (October 2013) after obtaining the approval of the local ethics committee. Retrospective 454 cases aged 18–70 who were evaluated as the American Society of Anesthesiologists risk class I-II-III and who underwent craniotomy between the dates of January 2011 and December 2015 were included in our study. All these patients accepted treatment after informed consent. The gender ratios (*n*, %), age (year), and body mass index (BMI, kg/m^2) were recorded based on the demographic

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data of patients. Electrocardiography, non-invasive blood pressure (mean arterial blood pressure, mmHg), heart rate (HR) (beat/min), and pulse oximetry monitorization (%) were performed on the patients after informing the patient about both the general anesthesia and catheterization technique and receiving their written approval. A 20G peripheral venous catheter (I.V. FLON®, La-med Healthcare Pvt. Ltd., Haryana, India) was inserted into the dorsum of the left hand. The patient was started on a 0.9% physiological saline solution at a rate of 200 ml/h. While the patient was ventilated with 100% O_2, for general anesthesia induction, 3–4 mg/kg sodium thiopental (Pental Sodium®, 0.5 g vial, Ibrahim Etem Ulugay Pharmaceutical Industry Turkish INC., Turkey), 2 mcg/kg fentanyl citrate (Talinat®, 0.5 mg/10 ml, Vem Pharmaceutical, Turkey), and 0.5 mg/kg rocuronium bromide (Curon®, 50 mg/ml, Mustafa Nevzat Pharmaceutical Industry Inc., Turkey) were administrated intravenously. While female patients were intubated with a spiral endotracheal tube No. 7.5, male patients were intubated with a spiral endotracheal tube No. 8.5 (GALENA®, Hamburg, Germany). The right radial artery catheterization was performed with a 22G catheter after the patients were intubated (I.V. FLON®, La-med Healthcare Pvt. Ltd., Haryana, India). Invasive arterial blood pressure monitorization was performed using a disposable transducer set (OKUMAN®, SCW Medicath LTD, Guangdong, China). All invasive catheterizations were performed by the same experienced anesthetist, and the evaluations were carried out and recorded by an another anesthetist. The rules of the Infection Control Committee were applied to prevent the risk of catheter-related infection. A sterile glove (Beby®, Silver Ultra, Malaysia) was used after the handwashing process. While the patient was in the supine position standing on his/her right side, the patient's table was raised by 30° from the thoracic level and the head was also raised by 30°. While the patient's head was in the neutral position, the neck, shoulders, breasts, sternum, and infraclavicular areas including the suprasternal incisura were cleaned with povidone-iodine (Poviiodeks Antiseptic®, KIMPA Pharmaceutical, 10%-1000 ml, Turkey) solution. The intervention site was isolated with a sterile cover. Central venous catheterization was performed using a 7F Arrow 3-lumen catheter (Arrow International Inc., Reading, PA). In the 90° angle technique that we used when inserting the subclavian vein catheter, the starting and the ending points and the mid-point of the clavicle were specified. The needle was advanced forward from the midpoint of the clavicle at a 90° angle to the clavicle and up into the first half of the clavicle thickness just beneath the clavicle [Figures 1 and 2]. Afterward, negative pressure was applied to the syringe to allow aspiration, the needle tip was turned from beneath the clavicle to the upper side of the manubrium sternum, and it was advanced by scraping the clavicle with aspiration. Thus, the 90° angle between the needle and the clavicle was reduced to 10–15° [Figures 2 and 3]. After venous blood in the subclavian vein was aspirated [Figure 4], the procedure was continued with the standard Seldinger technique.[6] We called this "subclavian venous catheterization technique at a 90° angle." All patients were checked by taking a chest radiography for complications and misplacement after the process.

In patients who were inserted with a subclavian catheter (SVC) using the 90° angle technique, the number (*n*) and frequency

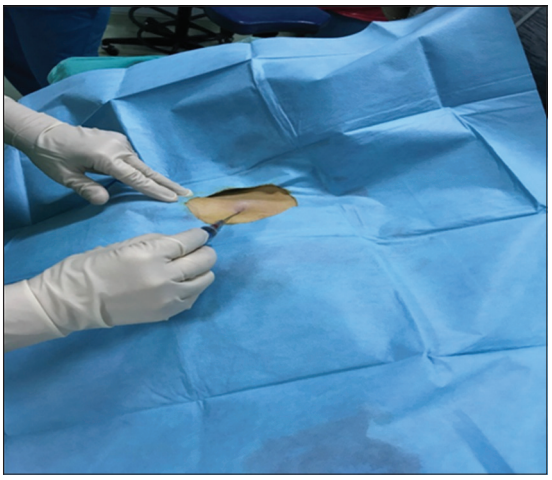

Figure 1: The needle was at 90° angle to the clavicle

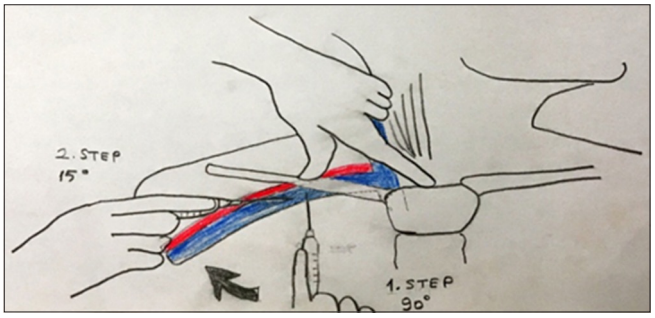

Figure 2: Image of the needle at 90° angle and 10–15°

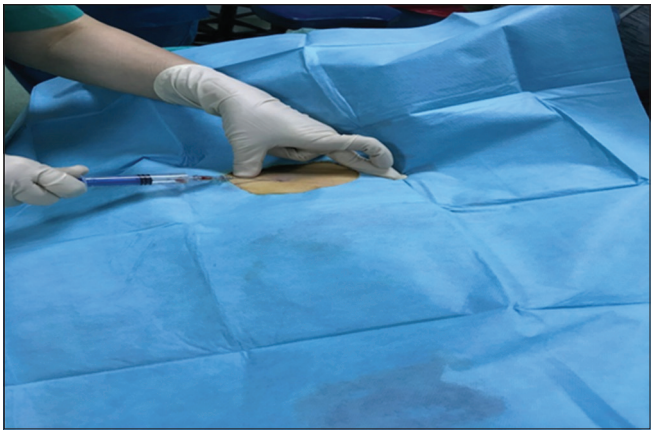

Figure 3: The needle was at 10° -15° angle to the clavicle

(%) of pneumothorax, difficulty level, number of attempts during the process (*n*), duration of intervention (s), anesthetist satisfaction, and number (*n*) and frequency (%) of other complications (arterial puncture, air embolism, hemothorax, hematoma, and catheter misplacement) were recorded. An 0 was given to indicate a female patient and 1 to indicate a male. Anesthetist satisfaction was coded as 1 for satisfied and 0 for dissatisfied. The difficulty level of the process was coded as 1 for easy and 0 for hard. The number of attempts was recorded as 1, 2, and ≥3. The number (*n*) and incidence (%) of patients with pneumothorax were recorded. The duration of intervention was defined as the time (s) from the penetration of the needle in the skin to the aspiration of blood with the syringe.

Statistical analysis was performed using STATA 11.2 (Statacorp, Texas, USA). Data are represented as mean (with standard deviation), median (with range), or number (with percentage). Chi-square analysis was performed to compare categorical variables. Non-parametric numerical data were analyzed using Mann–Whitney U-test. $P < 0.05$ was considered as statistically significant.

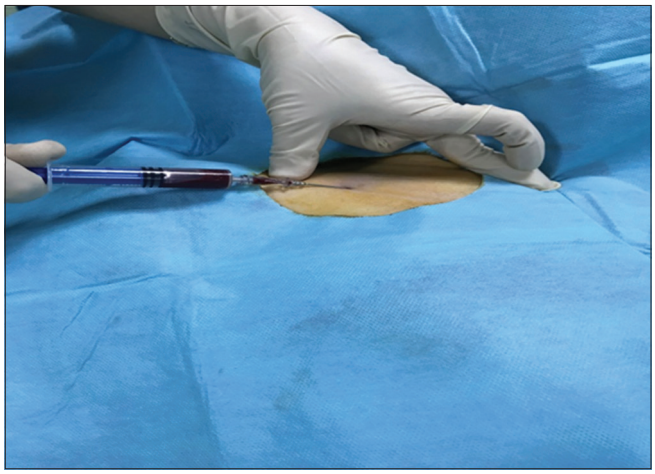

Figure 4: The needle was at 10° -15° angle to the clavicle

Table 1: Demographic data of patients

Sex (male/female)	237/217 (52%/48%)
Age (year)	60.6±6.6
BMI (kg/m²)	22.2±2.8

n=454. BMI: Body mass index

RESULTS

Of the 454 craniotomy cases included in the study, 237 (52%) were male and 217 (48%) were female. The mean age was found to be 60 ± 6.6 (ages 18–70). The BMI was 22.2 ± 2.8 kg/m² [Table 1].

Pneumothorax occurred in three patients (0.6%) [Table 2].

The difficulty level of the process was graded 1 (easy) in 454 patients (100%) [Table 2].

SVC was successful in 450 patients (99%) in the first attempt and 4 patients (1%) in the second attempt [Table 2].

The duration of intervention was determined to be 45 ± 32.1 s on average [Table 2].

The performing anesthetist's satisfaction was 100% (median minimum–maximum: 1.0 [1.0–1.0]) [Table 2]. The number of other complications (arterial puncture, pneumothorax, and catheter misplacement) was 6 (1.2%). Of all these patients, three had pneumothorax, one had arterial puncture, and two had misplaced catheters [Table 2].

The mean arterial pressure (MAP) [Figure 5] and HR [Figure 6] were observed within the normal limit before, during, and after SVC.

DISCUSSION

In our study, easy and short time applicability and fewer number of attempts along with low complication rates were obtained in 454 patients, on whom subclavian vein catheterization was performed using the 90° angle technique.

Table 2: Number and frequency of pneumothorax, difficulty level, number of attempts during SVC, duration of intervention, anesthesiologist satisfaction, and number of other complications in patients

Pneumothorax ***n*** (%)	3 (0.6)
Difficulty level (minimum–maximum), *n* (%)	1.0 (1.0–1.0), 454/0 (100/0)
Number of attempts, *n* (%)	Attempt (450, 99%) Attempt (4, 1%)
Duration of intervention (s)	45.4±32.1
Anesthesiologist satisfaction, median (minimum–maximum), *n* (%)	1.0 (1.0–1.0), 454 (100)
Other complications, *n* (%) (arterial puncture and misplaced catheters)	3 (0.6)
Total complications, *n* (%)	6 (1.2)

n=454. SVC: Subclavian catheter

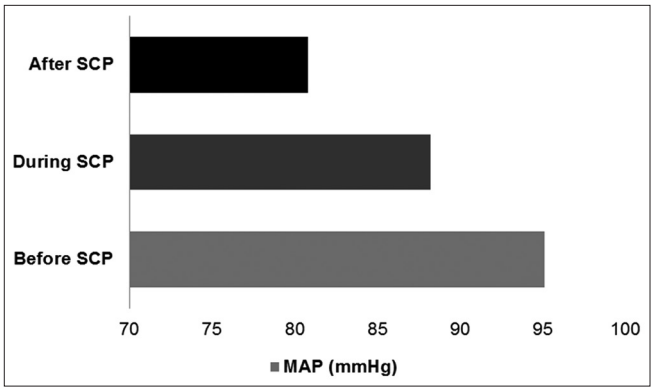

Figure 5: The mean arterial blood pressure of the patients before, during, and after subclavian catheter placement by 90° technique – *n* = 454

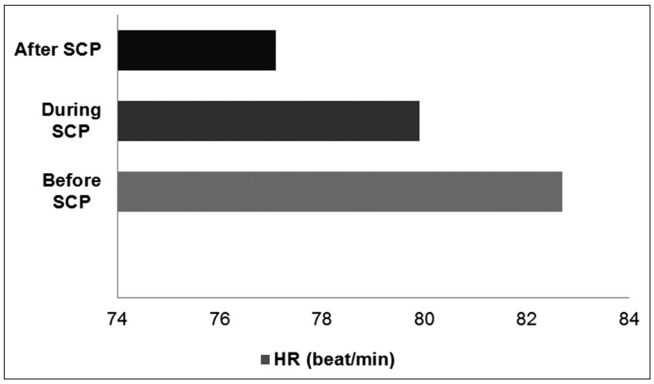

Figure 6: The heart rate of the patients before, during, and after subclavian catheter placement by the 90° technique – *n* = 454

The central venous catheter insertion process is a standard procedure in patients undergoing craniotomy. Subclavian vein catheterization was defined by Aubanic for the 1st time. Percutaneous subclavian venous cannulation with the infraclavicular approach was first performed in 1950 by Aubanic.[7] Subclavian vein catheterization has advantages, such as low infection complication, good patient comfort, and easier catheter maintenance. It has also been reported that less incidence of thrombosis and arterial puncture (1.9% and 3.1–4.9%, respectively) is encountered than at other central vein catheter insertion sites.[8,9] Subclavian vein cannulation complications include inability to cannulate the vein (5.7% in 389 patients), subclavian artery puncture (3.1% in 389 patients), pneumothorax (1.8% in 389 patients), hemothorax (0.3% in 389 patients),[10] misplacement of catheter (32% in 500 patients),[11] cardiac tamponade (0.5% in 201 patients), and nerve injuries (2.9% in 201 patients),[12] and there are studies describing practices that aim to prevent these complications under ultrasonography guidance.[13-15]

Although clinicians have recommended that subclavian vein catheterization should be performed under ultrasound guidance, it has been reported that its clinical use is limited.[16] In addition, ultrasound devices may not always be universally available.[17] The other disadvantages of using ultrasound can be considered as the requirement of a high level of training, reduced ability of catheterization using the conventional technique over time,[18] and the cost and time-consuming preparation process in emergency cases.[19] In the 90° angle technique, the 30° head-up position given to the patient primarily allows the lungs to be farther away from the apex and, therefore, from the subclavian procedure site. The needle is advanced towards to the midpoint of clavicula by 90°angle while aspirating it until the needle tip is under the clavicula midpoint. Then the needle tip is advanced towards to the manubrium sterni with aspiration by reducing this angle to 10–15°, ensures that the needle reaches the subclavian vein by venous blood aspiration. First, advancing to the subclavian area with a 90° angle up to the half of the clavicle and then advancing toward the manubrium sterni with aspiration by reducing the angle to 10–15° result in the needle remaining far from the artery, while advancing beneath and toward the anterior of the subclavian artery thereby increases the possibility of puncturing the subclavian vein. The needle reaches subclavien vein easily without the risk of arterial puncture by this method because the needle tip enters subclavian vein approximately 0.5–1 cm closer than the conventional technique. The 90° and 10–15° angles made by the needle prevent the needle from changing its direction by constraining the surrounding tissues and also prevent bleeding of the punctured vessel and risk of hematoma.

Post-operative pneumothorax was detected in three of the 454 patients included in our study who underwent craniotomy surgery. In a study by Fragou *et al*.,[12] the incidence of pneumothorax was 1.8% in 201 patients who underwent conventional SVC technique, while in our study, this incidence is 0.6%. We think that the incidence of pneumothorax in our study is lower primarily due to the 30° head-up position of the patient and also to the first 90° angle of the needle perpendicular to the clavicle and the second 10–15° angle obtained by advancing toward the manubrium sterni.

Definitions of successful intervention have been evaluated in various studies using different parameters (number of attempts, operating surgeon's level of experience, frequency of complications, duration of intervention, etc.). It was reported that hemothorax and thrombosis occurred at a rate of 0.3% and 2.1%, respectively, in 389 patients in a study previously performed using the usual landmark technique.[17] We can explain the lower complication rates in our study by the fact that the 90 and 10–15° angles made by the needle make it easier to reach the vein and that they reduced or prevented the risk of vein perforation or arterial bleeding by constraining the surrounding tissues. Furthermore, 30° head up position of the patient may have decreased the possibility of bleeding and hematoma by reducing the arterial blood pressure.

The misplacement of central venous catheterization should be prevented to improve the prognosis of patients. In our study, catheter misplacement was observed in 3 patients (0.6%) in our study. In literature, it is reported that the incidence of catheter misplacement is within the range of 2.1–21.4%.[20,21] Our technique does not require any special position or practice that needs assistance (pulling the arm, pulling the shoulder down, putting an elevator under the back, and turning the head to the other side.)... This also renders the practice more easier and less time-consuming. In a study, Mansfield *et al*. reported that they took into consideration the increased risk of complication in more than two interventions by the same physician; it was indicated that it is not recommendable for the same physician to perform more than two attempts, especially if the catheter insertion is elective. At the same study, 49 (12%) failed attempts were detected in 410 patients with the standard SVC technique. Furthermore, complication rates were reported as 9.8% in this group.[22] In our study, of all patients who underwent SVC by one experienced physician, the second attempt was necessary in only 4 and all attempts were successful after the second. We believe that the level of experience of the physician performing the interventions and the needle maneuvers and the angle adjustments in the manner of applying the technique are related to the low number of these attempts and the low complication rates.

The duration of intervention of 44% ± 54.9 s in a previous study was found to be similar to our results.[12] The lower possibility of subclavian vein puncture with the 90° angle technique using a high angle and a 99% success rate in one attempt provide an advantage by ensuring the completion of the process within a shorter time and making it more practical. The reason why the level of difficulty was low for the physician performing the procedure in our study can be considered to be the fact that these angles allowed the target to be reached in a short time and that they facilitated the correct orientation of the needle. The satisfaction of the anesthetist performing the SVC process with this technique was found to be high due to the short duration of intervention, and provides easy intervention without requiring any extra asisstance.

The MAP and HR of the patients included in the study which were evaluated before, during, and after the process were within normal ranges, and no hemodynamic complications were observed. Therefore, this technique is recommendable as it does not require much experience, it is convenient, its complications are low, and it does not require additional equipment and help.

Similar studies may be performed with more subjects.

CONCLUSION

When we compare the 90° angle technique with the traditional subclavian technique, we found that the SVC insertion process using the 90° angle technique is a technical application that is much more reliable, easier, faster applicable, and more practical than the traditional technique with a high success rate and has much less complications such as pneumothorax, arterial perforation, hemothorax, hematoma, and catheter misplacement.

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