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Research Article

Ultrasound-Guided Catheterisation of Axillary Vein of a Small Size

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Abstract

Introduction: It is recommended nowadays to perform invasive procedures under ultrasound guidance. Efficacy profile for axillary/subclavian vein catheterization, however, was not shown to improve under ultrasound guidance according to the results of six meta-analyses. Small size is an obvious obstacle to catheterization of any vessel and should be taken into account during the procedure.

Aim: To study safety and effectiveness profile of ultrasound-guided catheterisation of Axillary Vein of a Small Size.

Materials and Methods: Ultrasound-guided catheterisation of axillary vein of a small size was performed using optimised technique in 12 patients.

Results: Technique was successful at first skin and vein puncture without needle redirections in 11 out of 12 cases, mean time to guidewire insertion was 171 ± 6s. There were no mechanical complications.

Conclusion: Optimised technique for ultrasound-guided catheterisation of axillary vein of a small size is effective and safe and can be introduced into clinical practice.

Keywords: *Central Vein Catheterization; Subclavian Vein; Axillary Vein; Ultrasound-Guided Catheterization; Long-Axis View; Cross-Sectional Area*

Introduction

Unlike internal jugular vein, ultrasound guidance during subclavian/axillary vein catheterisation remains debatable [1-6]. Even though rare mechanical complications such as pneumothorax are excluded with the use of ultrasound [7,8], effectiveness profile remains unchanged. There is little or no improvement in the time for catheterisation, number of attempts, successful catheterisations, including at first time, redirections of the needle [1]. These facts make ultrasound guidance optional during axillary/subclavian vein catheterisation despite the fact that it is the safest site for central venous catheterisation concerning all kinds of complications, i.e. infectious, thrombotic and mechanical ones [9,10].

In an array of studies influence of positioning of the patient was studied on effectiveness of catheterisation of axillary/subclavian vein. Shoulders retraction (i.e. with an interscapular roll) [11] and arm caudal traction [12] are no longer recommended. Ipsilateral head turn helps to increase cross-sectional area [13]. Trendelenburg position and passive leg elevation can be of help increasing diameter [14], especially in combination with positive end-expiratory pressure [15]. New positions - upper arm 90° abduction, bending and external rotation [16] and lumbar elevation [17] - are shown to increase diameter of the vessel. Despite doubt expressed by Kashani (2018) whether 10% vein increase is clinically relevant, further search of new positions, including combination of already known useful maneuvers, is of

clinical relevance for effective and uncomplicated catheterisation of axillary/subclavian vein [18]. Some positions are obviously not applicable, though, as supine position after the procedure results in misplacing of the catheter tip.

Cross-sectional area of the vein is one of the factors affecting successful catheterisation. It was shown for internal jugular vein that a small size of the vein is associated with the high rate of unsuccessful catheterizations and complications [19]. The same holds true for axillary/subclavian vein [20].

Aim of the Study

The aim of this study was to evaluate safety and effectiveness of catheterisation of axillary vein of a small size using optimised ultrasound technique with respect to positioning of the patient.

Materials and Methods

Series of 12 cases of catheterisation of axillary vein less than 7 mm was analysed. All procedures took place in cardiac the intensive care unit in September 2018 - January 2020 in Pokrov City Hospital, Saint-Petersburg, Russia, and were performed by the author of the article with 3 years of personal medical experience and 3 years of experience in vascular ultrasonography. Linear probe of ultrasound machine 'AU4Idea' (Italy) and central venous catheters 'Certofix' and 'Intradyn' were used. Patients aged over 18 years old requiring central venous catheterisation were included in the study. Exclusion criteria were as follows: refusal to participate, local inflammatory process in subclavian fossae, severe thrombocytopenia and coagulopathy. The study was approved by the Local Ethical Committee of North-Western State Medical University when the author was performing academic research in the form of randomised controlled study. All participants signed informed consent form.

Technique

At first, axillary/subclavian vein was visualized on both sides. The greater vein would have been chosen. Should veins have been the same diameter, right side would have been preferred in order not to harm the wall of superior vena cava due to differences in angles at which right and left brachiocephalic veins enter superior vena cava [21]. When antero-posterior diameter of axillar vein was less than 7 mm, standard supine position of the patient would have been changed to arm abduction with prominence under ipsilateral shoulder [22,23]. Display of the ultrasound machine was positioned on the other side of the bed in front of the eyes of the operator. Aseptic protocols with sterile sheath on the probe were employed. Firstly, axillary vein was identified in transverse view, then the probe was rotated until longitudinal view was obtained (Figure 1). Then invasive part of the procedure followed with the flush of local anaesthetic through small-bore needle which was constantly visualised on the screen. After that, 18G needle was advanced towards the vein on the same trajectory as the small needle, and axillary vein was finally cannulated using Seldinger technique under ultrasound guidance in the longitudinal view in order not to penetrate posterior wall of the vein and easily insert a guidewire at a more shallow angle than in the transverse view. The bevel of the needle as well as the J-tip of the guidewire were oriented in the caudal direction with a view to ensure correct position of the tip of the catheter in the osteum of superior vena cava [24]. After the procedure, proper position of the catheter and absence of pneumothorax were confirmed with the ultrasound protocol incorporating ultrasound visualisation of both axillary/subclavian and internal jugular veins, transthoracic echocardiography and BLUE protocol [25,26].

Figure 1: *Longitudinal view of axillary vein.*

As for optimization of the technique, axillary vein was being scanned exactly in the deltopectoral groove so that 'ghost' image artefacts were excluded, which were discovered in the subclavian fossa in the course of academic research when positioning the longer old-fashioned probe parallel to the clavicle (Figure 2). Until this research, this kind of artifact was described for the aorta when visualizing it with the linear probe through recti muscles of the abdomen [27]. In the subclavian fossa refraction occurs because of round corner of the deltoid muscle. As a result, returned refracted and non-refracted waves present as 'two' veins when in reality there is one. Most certainly, these artifacts are responsible for absence of strict recommendations to use ultrasound guidance during catheterisation of the subclavian vein [1-6].

Figure 2: *'Ghost' image artifact discovered in the subclavian fossa.*

Success rate at single puncture of the skin and the vein without redirections of the needle, time from the start of ultrasound scanning to the puncture of the skin (T1), time required for the invasive part of the procedure (T2), overall time (T3), frequency of pneumothorax, puncture of axillary/subclavian artery, formation of haematoma and proper position of the catheter were recorded and analysed using Statistica10 programme. Normality of distribution was assessed using Kolmogorov-Smirnov test, results of descriptive statistics were presented as mean ± standard deviation, time before and after puncture of the skin were compared using T-test for data of the same group. Results were considered to be statistically significant when p was < 0.05.

Results and Discussion

Characteristics of the patients are presented in table 1.

Characteristic	Value
Age, years old	77.4 ± 10.6
Height, cm	164.5 ± 8.2
Weight, lb	161 ± 37
Gender, female:male	9:3
Side of catheterisation, right:left	10:2
Indications:	
Prolonged infusion therapy	10
Inotropes	1
Placement of a temporary pace-maker	1

Table 1*: Demographic and diagnostic characteristics of the patients.*

In altered position subclavian/axillary vein enlarged in all patients. The results of the study are shown in table 2.

Endpoints	Value
Success rate at single puncture of the skin and the vein without redirections of the needle	11/12 (92%)
T1, sec	116.1 ± 37.4
T2, sec	54.7 ± 16.4
T3, sec	170.8 ± 50.5
Inadvertent puncture of the artery	0
Haematoma	0
Pneumothorax	0
Correct position of the catheter on ultrasound	11/12

Table 2: *Safety and effectiveness profile of the optimised technique.*

The only case of failure was observed in the patient with severe sepsis and was caused by thrombus formation in the needle. The difficulty was overcome by addition of heparin to the solution in the syringe.

T1 was significantly higher than T2 ($p = 0.014$) and search, identification and choosing the right point for puncture of the vein took the best part of T1, which drives scientific search in the direction of improving pre-puncture ultrasound scanning.

Lack of mechanical complications and correct position of the catheters except one supports the statement that ultrasound improves safety profile of invasive procedures [28] and substitutes chest X-Ray in confirming the right position [25] and absence of pneumothorax [26] showing the same findings. The only case of catheter misplacement (in ipsilateral internal jugular vein) was observed in the female patient with pronounced scoliosis; there were difficulties inserting the guidewire. This case necessitates cessation of the procedure and change to another catheterisation site in such circumstances.

The study has its limitations. It was held in the single centre and by the single operator. The main drawback, however, is that samples are homogenous in nature, with patients from cardiac intensive care unit demonstrating signs of heart failure. However, it is not always easy to puncture the vein with a large-bore needle as the bigger the surface, the less the pressure exerted on the wall of the vein. Puncture of the vein with a smaller needle first could be of help. Position-enlarged size of axillary/subclavian vein does not correlate with central venous pressure [29] and ease of the puncture, and in clinical practice of the author the patient with haemorrhage it was easy to puncture small axillary vein without change of position.

Conclusion

Described optimised technique of ultrasound-guided catheterisation of axillary/subclavian vein is safe, effective and after large controlled studies probably can be implemented in clinical practice.

Conflict of Interest

No financial interest and conflict of interest to declare.

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