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How to make the axillary vein larger? Effect of 90° abduction of the arm to facilitate ultrasound-guided axillary vein puncture☆

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ABSTRACT

Purpose: Placement of central venous catheters by the infraclavicular route can be achieved by ultrasound-guided puncture of the axillary vein. However, in some cases, the axillary vein may be difficult to puncture because it is too deep or too small or because it is collapsing significantly during breathing. The objective of this observational study was to determine the effect of 90° abduction of the arm associated with forward position of the shoulder on axillary vein diameters.

Material and methods: In a group of 30 healthy volunteers and in a group of 40 patients during spontaneous breathing, we used ultrasound to examine the axillary vein, visualizing it in short axis, with the arm at 0° and at 90° abduction, pushing the shoulder forward.

Results: The axillary vein was easily identified in 100% of subjects, with relevant variability in terms of depth from the skin, diameter, and tendency to collapse during inspiration. Significant increase of axillary vein diameters was found after 90° abduction in 52 of the 70 cases studied.

Conclusion: These findings suggest that a 90° abduction of the arm, particularly if associated with a forward position of the shoulder, facilitates the visualization of the axillary vein, making its ultrasound-guided venipuncture easier.

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1. Introduction

1.1. Background and rationale

Ultrasound-guided puncture and cannulation of the axillary vein (AV) in the infraclavicular area has several potential advantages for both short-term and long-term venous access devices (VADs): in short-term central VADs, the exit site is easier to manage in terms of dressing and securement; in long-term central VADs, the infraclavicular approach is associated with shorter tunnel (in the case of cuffed tunneled catheters) or no need of tunnel (in the case of totally implantable venous ports), thus increasing the stability of the system and avoiding the subcutaneous passage of the catheter over the clavicle. In most patients, AV can be easily visualized both in short axis (transverse diameter) and in long axis (longitudinal diameter) [1,2], and it can be punctured either "in plane" or "out of plane" [1,2].

However, in some cases, AV may be difficult to puncture because it is too deep or too small, or because it is collapsing significantly during spontaneous breathing. Moving the probe downward (far from the clavicle), the transverse diameter of the AV becomes smaller and the vein collapse during inspiration more relevant, thus making the puncture even more difficult. Cadaver-based studies have been shown that the position of the arm affects the position of AV [3]. Galloway and Bodenham [4] have suggested that different degrees of abduction of the arm may have only limited effects on AV diameter, although some episodic clinical observations have suggested that the diameter of AV may be increased by the abduction of the arm at 90° if associated with a forward displacement of the shoulder.

1.2. Objective

The objective of this prospective nonrandomized observational study was to assess the effect of 90° abduction of the arm—associated with forward position of the shoulder—on the ultrasound visualization of the AV in terms of main diameter and estimated depth.

2. Material and methods

This is a single-center, prospective, nonrandomized observational study which was conducted in a large university hospital in Rome

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over a period of 2 weeks after institutional review board approval. In accordance to the principles outlined in the Declaration of Helsinki, volunteers were asked for written informed consent. Given that, according to our institutional protocol, preprocedural ultrasound of all possible venous options and measurement of their caliber are routinely performed, patients or their next of kin were asked only for informed consent to the procedure in agreement with institutional review board.

2.1. Particpants and recruitment

We enrolled 30 healthy volunteers (15 men and 15 women) older than 18 years with no history of medical abnormalities and 40 adult hemodynamically stable nonseptic patients (20 men and 20 women) requiring placement of a central VAD. Healthy volunteers were enrolled among physicians, nurses, and fellows of the Department of Intensive Care Medicine and Anesthesia (mean age, 40.5 ± 8.01 years). Volunteers were excluded from the study if they had any acute medical illness or history of clavicle fracture and/or surgery. Patients were enrolled from among those admitted to our intensive care unit for various medical or surgical conditions (mean age, 67.8 ± 10.6 years). All trauma patients and all patients requiring emergent central VADs were excluded.

2.2. Protocol

In all healthy volunteers and patients placed in a supine neutral position, we used ultrasound to examine AV, visualized in its short axis, in the infraclavicular area, soon below the lateral third of the clavicle, with the arm at 0° and at 90° abduction associated with a forward displacement of the shoulder obtained by placing a bunch of towels underneath it (Fig. 1A and B). We measured the anteroposterior (AP) and the laterolateral (LL) diameters of the vein, its tendency to collapse during normal spontaneous breathing, and its mean depth from the skin. Measurements were performed by nonradiologist, well-trained, expert physicians using a hand-carried portable ultrasound device (NanoMaxx; Sonosite Inc, Bothell, WA) with a linear "small part" 13-6–MHz transducer. According to our institutional protocol, before attempting an ultrasound-guided puncture of a central vein, we routinely performed a preprocedural ultrasound evaluation of all the possible venous options. This evaluation may bring a rational choice of the most appropriate vein to cannulate, considering such factors as vein size, possible pathological abnormalities, and collapse during breathing. The preliminary ultrasound evaluation of central veins is performed methodically, starting with the visualization of the internal jugular vein in short axis at midneck and at the basis of the neck. Just above the clavicle, with the probe angled to be in an almost frontal plane allowing to explore the anterior mediastinum, it is possible to evaluate the brachiocephalic vein (BV) and more laterally the transition between the subclavian vein (SV) and the BV, both in long axis. Below the clavicle, the AV may be easily visualized both in short axis and in long axis. In all patients enrolled, evaluation of the AV was part of the routinary abovementioned preprocedural ultrasound evaluation. Both in volunteers and in patients, the AV was only examined but not cannulated. In patients, a low lateral internal jugular vein ultrasound-guided puncture or a BV ultrasound-guided puncture was performed.

2.3. Statistical analysis

Continuous variables were expressed as means ± standard deviation. Student *t* test for paired samples was performed to determine if significant differences existed between different maneuvers. A value of $P < .05$ was considered as statistical significance. Assuming a 2-sided type I error of 0.05, a confidence level of .95, a desired total width of confidence interval of 5, and a standard deviation of the variable of 10, the recommended sample size is 61 patients. Statistical analysis was preformed with SPSS (IBM, Armonk, NY) for Windows.

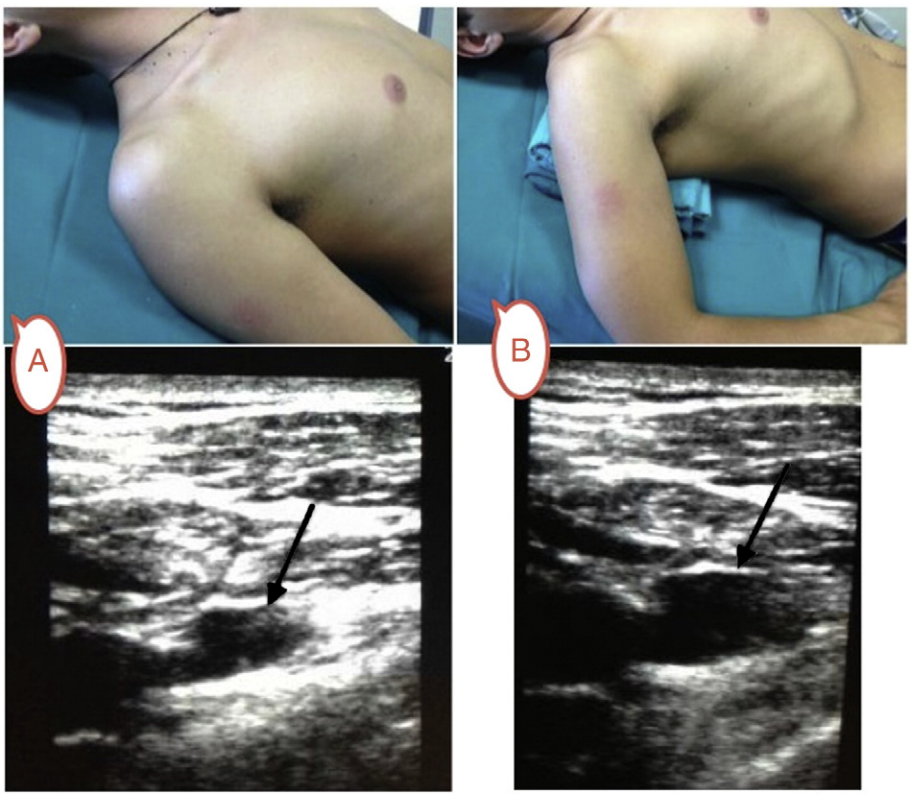

Fig. 1. Effect of forward position of the shoulder and 90° arm abduction on AV diameter. A, Neutral position of the arm and the shoulder; transversal ultrasound scan of the AV (black arrow). B, Forward position of the shoulder and 90° abduction of the arm determining increase in AV diameter (black arrow).

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