

# Changes in the Internal Size of the Jugular Vein in Adult Patients with Hypovolemia

## Abstract

The present study is aimed at establishing the values of internal jugular vein (IJV) anterior-posterior and medial-lateral sizes in patients with hypovolemia. A total of 25 adult Intensive Care Unit patients with hypovolemia were studied. It was found that the anterior-posterior vein size in patients with hypovolemia was significantly less than medial-lateral size during inhalation and during exhalation as well ( $P < 0.05$ ). Besides, the value of the anterior-posterior size ( $D_{\min}$ )  $< 7$  mm was recorded in 20 from 25 patients (80%). At the same time, the medial-lateral size ( $D_{\min}$ )  $< 7$  mm was recorded only in six patients (24%). In patients with hypovolemia, the medial-lateral diameter of IJV is more than its anterior-posterior diameter. These data might be useful for justifying the benefits of using lateral access for IJV catheterization under ultrasound imaging in patients with hypovolemia.

**Keywords:** Central line, hypovolemia, ultrasound

## Introduction

Currently, ultrasound navigation is widely used for internal jugular vein (IJV) catheterization.<sup>[1-3]</sup> However, it is known that ultrasound guidance for puncture and catheterization of IJV with a small diameter does not eliminate complications associated with the vein double wall perforation.<sup>[4]</sup> Valsalva maneuver and Trendelenburg position are known to increase the IJV size.<sup>[5]</sup> In emergency medicine, the application of these maneuvers can have certain limitations.<sup>[6]</sup> One of the possible solutions for this problem may be choosing the access that provides a vein puncture along its maximum size axis. Central and lateral accesses are well-known ways for IJV puncture.<sup>[2,7,8]</sup> In central access, a puncture needle pierces the front wall of the vein. In lateral access, the lateral wall of the vein is punctured, and the needle moves in the lateral-medial direction.<sup>[7]</sup> However, in the current guidelines, there is no information on the choice of IJV access for its catheterization, based on its actual anterior-posterior and medial-lateral sizes in patients with hypovolemia.<sup>[2]</sup> The present study is aimed at establishing the values of IJV anterior-posterior and medial-lateral sizes in patients with hypovolemia.

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## Subjects and Methods

A total of 25 adult Intensive Care Unit patients with hypovolemia were studied during October 2016–March 2017. We selected patients, whose subclavian vein was catheterized to measure CVP. CVP measurement was performed by direct method after inserting the intravascular catheter into the central vein (subclavian) and subsequent X-ray control of its location. At the same time, their IJV remained intact and available for the examination. IJV ultrasound scanning and diameter measuring in the anterior-posterior and medial-lateral direction were performed using a 7.5 MHz linear ultrasound probe and ultrasound system (Alpinion E-CUBE 9, South Korea). Spontaneous breathing and signs of hypovolemia (central venous pressure  $\leq 2$  mmHg, tachycardia, and hypotension) were considered as the criteria for including patients in the study group. Criteria for excluding patients from the study group included age younger than 16 years, mental illness, Glasgow score  $< 14$  points, pregnancy, and neck trauma. The ultrasound probe was mounted on the patients' neck between the heads of sternocleidomastoid muscle, and IJV cross-scanning was carried out. The measurements of the IJV size were conducted by the same person with minimum pressure applied on the ultrasound probe. Anterior-posterior and medial-lateral IJV sizes

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were recorded during inhalation ( $D_{\min}$ ) and exhalation ( $D_{\max}$ ). Quantitative data are presented as the arithmetic mean ( $M$ ) and standard deviation. To assess the statistical significance of the differences, Wilcoxon signed-rank test was used. The critical level of significance for checking the statistical hypotheses in this study was  $\leq 0.05$ . The research plan was approved by the Medical Academy Ethics Committee based on the principles set in the World Medical Association Declaration of Helsinki. Informed voluntary consent was obtained from all participants.

## Results

Ultrasound examination of the right IJV was carried out in 25 adult patients aged 40–61 years. Eighty percent of patients were male. Patients' height was 162–179 cm, and their weight was 64–87 kg. Results of measurement of IJV anterior-posterior and medial-lateral sizes in different respiration phases are presented in Table 1.

It was found that the anterior-posterior vein size in patients with hypovolemia was significantly less than medial-lateral size during inhalation and during exhalation as well ( $P < 0.05$ ) [Figure 1]. Besides, the value of the anterior-posterior size ( $D_{\min}$ )  $< 7$  mm was recorded in 20 from 25 patients (80%). At the same time, the medial-lateral size ( $D_{\min}$ )  $< 7$  mm was recorded only in six patients (24%).

## Discussion

The routine use of ultrasound navigation during central vein catheterization and IJV, in particular, significantly

increased its safety. In modern clinical practice, central and lateral accesses are well-known methods for IJV puncture. However, the scientific literature review revealed that no recommendations are given concerning the choice of access for IJV puncture and catheterization based on the actual size of its diameter.<sup>[2]</sup> The matter is that performing IJV puncture with a diameter of  $< 7$  mm does not eliminate the risk of complications associated with a double-wall perforation, even under ultrasound guidance.<sup>[4]</sup> In this regard, our task was to find solutions to improve the catheterization safety of IJV with a small diameter by choosing the optimal access for its puncture. The results of our study showed that, in most patients with hypovolemia, a decrease in IJV size during inhalation occurred in the anterior-posterior direction. At the same time, in most patients, the mean medial-lateral vein size was more than 7 mm, despite its decrease during inhalation. In these conditions, previously proposed lateral short axis in-plane technique has obvious advantages over other methods.<sup>[7]</sup> This method allows us to perform the puncture of the lateral vein wall along the axis of its maximum size. However, bigger size of medial-lateral diameter may not mean greater success or less complication. Nevertheless, our findings will allow us to determine the sample size for future studies. The lack of standardization of the pressure on USG probe is the limitation of this study.

## Conclusion

In patients with hypovolemia, the medial-lateral diameter of IJV is more than its anterior-posterior diameter. These data might be useful for justifying the benefits of using lateral access for IJV catheterization under ultrasound imaging in patients with hypovolemia.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

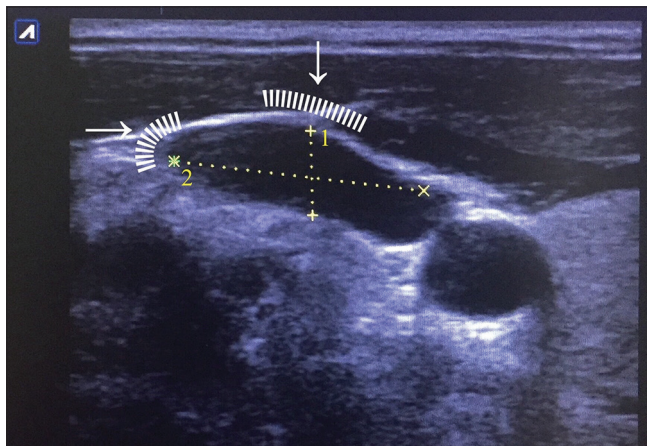
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**Table 1: The cross-section sizes (mm) of patient's internal jugular vein**

	Anterior-posterior size	Medial-lateral size	P
$D_{\min}$ (mean $\pm$ SD)	4.1 $\pm$ 2.6	11.5 $\pm$ 4.6	$< 0.05$
$D_{\max}$ (mean $\pm$ SD)	8.3 $\pm$ 2.0	13.6 $\pm$ 5.1	$< 0.05$

SD: Standard deviation



**Figure 1: Ultrasound image of the right internal jugular vein in a hypovolemic patient: sectors and directions for vein puncture in the anterior-posterior (1) and lateral-medial directions (2) have been identified.**

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