Right Internal Jugular Vein Cross-Sectional Area: Is There an Optimal Level for Cannulation?

Oscar Aljure, MD
Catalina M. Castillo-Pedraza, MD
Greta Mitzova-Vladinov, CRNA, DNP
Edward A. Maratea, MD
Department of Anesthesiology, University of Miami—Miller School of Medicine, Miami, FL

Abstract

Background: *Perioperatively, the preferred site for central venous access by anesthesia providers is the right internal jugular vein (RIJV). Maneuvers such as Trendelenburg position and positive end-expiratory pressure are commonly performed to increase the size of the RIJV and increase the success rate of cannulation.*

Methods: *We evaluated the size of RIJV at various anatomic levels in the neck to assess the most advantageous level for cannulation with patients in a flat, supine position without use of Trendelenburg. In this study 18 healthy subjects were placed in a flat, supine position for measurements of the cross-sectional area (CSA) of the RIJV using vascular ultrasound. Three measurements were obtained at each of the 5 anatomic levels of the neck. The first baseline measurement was taken at the level of cricoid cartilage (0 cm), followed by measurements at 4 other levels: cephalad to the cricoid cartilage at +1 and +2 cm, and caudad to the cricoid cartilage at −1 and −2 cm. The measurements of the CSA in centimeters^2 were electronically calculated after manual anatomic outlining of the vein. Factors that may influence the RIJV size, including age, gender, and body surface area, were included in the data analysis.*

Results: *The average CSA of the RIJV at the 5 levels measured (from +2 to −2 cm) were 0.91, 0.97, 1.06, 1.10, and 1.14 cm^2, respectively. The CSA of the RIJV was significantly larger at every 1-cm interval from the most cephalad level at +2 cm to the −2 cm most caudad level, except for the 0 to the −1 cm interval. Statistically significant difference in the CSA ($P < .001$ or 20%), was noted from the −2 to the +2 cm levels. No differences were found based on age, gender, or body surface area.*

Conclusions: *The anatomic level of the neck in relation to the cricoid cartilage at which jugular puncture is performed should be considered together with other maneuvers that may increase RIJV size. Success of RIJV cannulation may be increased by accessing the vein at a point with the largest CSA—1 to 2 cm caudad of the cricoid cartilage—especially in cases when the patient does not tolerate Trendelenburg position or ultrasound guidance is not available.*

Keywords: *central venous cannulation, jugular vein, ultrasound guidance*

Introduction

Central venous access is frequently needed for monitoring of cardiac filling pressures, laboratory test sampling, and administration of intravenous fluids and medications.[1]

Approaches to central venous cannulation include the right and left internal jugular veins (IJVs), the femoral vein, and right and left subclavian veins. Due to its easily identifiable anatomical landmarks and the proximity relative to the heart, the right internal jugular vein (RIJV) is the most commonly accessed vein in the operating room by anesthesia providers.[2]

Knowledge of the relative sizes of the RIJV at various anatomic levels of the neck may help determine the location where it has the largest internal diameter, therefore increasing the success rates of cannulation. An adequately sized IJV is critical when cannulating this vein. Different methods aimed

Correspondence concerning this article should be addressed to GMVladinov@miami.edu
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at increasing the diameter of the IJV before an attempt at cannulation have been studied, such as Trendelenburg position, head rotation at different degrees, Valsalva maneuver, and positive end-expiratory pressure (PEEP).[1,3-8]

A systematic search of the National Library of Medicine (ie, PubMed) revealed no studies comparing and reporting the cross-sectional area (CSA) of the RIJV at various anatomic levels in the neck. The aim of our study was to measure the difference in the CSA of the RIJV at 5 anatomic levels in the neck in relation to the cricoid cartilage with ultrasound in an effort to determine the level with the largest CSA suited best for venous puncture and cannulation.

Methods

After institutional review board approval, informed consent was obtained from each patient. A convenient sample of 18 healthy subjects was obtained for study enrollment. All subjects were healthy volunteers aged 27 to 58 years who worked in a large academic institution. Exclusion criteria were presence of any chronic disease, previous central vein catheterization, neck pathology, and previous neck surgery. One subject was excluded due to hypertension. In attempt to obtain a baseline of RIJV CSA, inclusion of patients with cardiovascular comorbidities may lead to altered measurements. Imaging and measurement of the RIJV was accomplished using vascular ultrasonography (GE, Fairfield, CT) with subjects in a flat, supine position at the end of expiration. Study measurements were made from March 2012 to May 2012.

The cricoid cartilage is the level used in most studies discussing RIJV size.[2,3,6,8-10] The cricoid cartilage is an important surface anatomy landmark and is located at the level of cervical 6 vertebral body. The IJV lies in the groove between the sternal and clavicular heads of the sternocleidomastoid muscle. By projecting a line laterally from the cricoid cartilage, the apex of the triangle formed between the 2 heads of the sternocleidomastoid muscle is easily located.[11] In our study, the cricoid cartilage was used as a reference point (0 cm). Measurements were performed at 1 and 2 cm cephalad to the cricoid cartilage, (marked as +1 and +2 cm) and at 1 and 2 cm caudad to this reference point (marked as −1 and −2 cm) using a template to guide measurements (Figure 1). These measurement levels were selected because any higher anatomic level than +2 cm may risk injuries to the brachial plexus and phrenic nerves in addition to injuring the sternocleidomastoid muscle. Any lower level than −2 cm may risk causing pneumothorax.[11] The subject's head was turned approximately 30° to the left, and the anterior triangle of the neck, formed by bifurcation of the sternocleidomastoid muscle and the clavicle, was identified. The ultrasound transducer was positioned perpendicular to the neck, and minimal pressure was exerted to the vessels to avoid vascular compression and image distortion. Three measurements were obtained at each anatomic level on each subject, and the clearest, most accurate image was selected. CSA (in centimeters^2) was calculated using the ultrasound machine software after the outline of the vein was traced manually.

Statistical Methods

Demographic and clinical data are presented as means ± SD for continuous data and as percentages for categorical data. A general linear mixed model was used to calculate within-subject repeated measures analysis of variance of the interjugular diameter by distance. The fixed effect was distance; the random effect was subject. An unstructured covariance matrix was used. The means and standard errors, as well as the *P* values of pairwise comparisons among the distances, are reported. The .05 significance level was set to determine statistical significance. SAS software version 9.3 (SAS Institute, Inc, Cary, NC) was used for all statistical data analyses.

Results

No statistical differences in RIJV CSA were found based on age, gender, height, or weight. Overall measured diameters on men were higher but no statistical difference was found ($P > .05$). The average CSA of the RIJV at the 5 levels measured (from +2 to −2 cm) was 0.91, 0.97, 1.06, 1.10, and 1.14 cm^2, respectively (Figure 2). The CSA of the RIJV was significantly larger at every 1-cm interval from the most caudad level at the −2 to +2 cm most cephalad level, except for the 0 to −1 cm interval. The greatest change in CSA, 20%, was noted from the −2 to +2 cm levels. Other significant changes in RIJV CSA were seen at the following levels: −2 to +1 cm, −1 to +2 cm, −1 to +1 cm, and 0 to +2 cm (14.7%, 17.3%, 11.7%, and 14.3%, respectively) (see the Table).

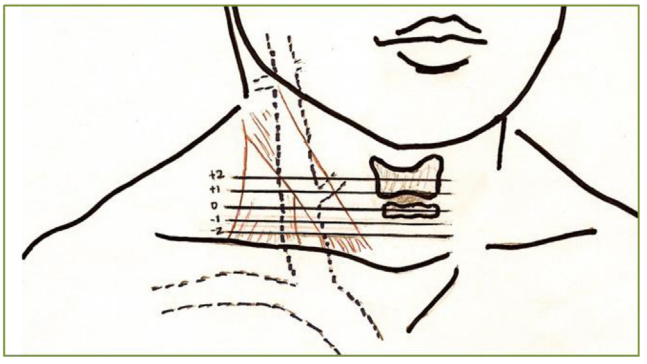

Figure 1. Scheme of points of measurements.

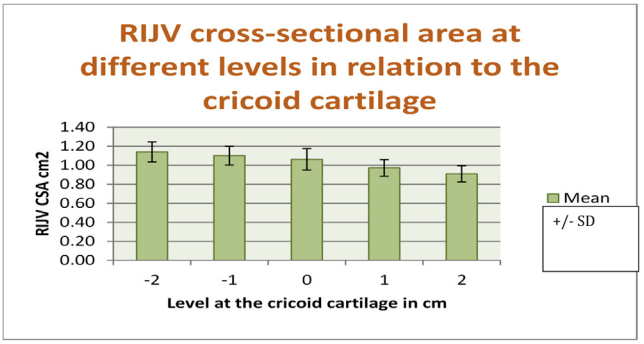

Figure 2. Comparison of the means of right internal jugular vein cross-sectional area at all levels measured.