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Original contribution

Comparison of the diameter, cross-sectional area, and position of the left and right internal jugular vein and carotid artery in adults using ultrasound☆,☆☆,★

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Abstract

Study objective: Central venous access is indicated for transduction of central venous pressure and the administration of inotropes in the perioperative period. The right internal jugular vein (RIJV) is cannulated preferentially over the left internal jugular vein (LIJV). Cannulation of the LIJV is associated with a higher complication rate and a perceived increased level of difficulty when compared with cannulation of the RIJV. Possible explanations for the higher complication rate include a smaller diameter and more anterior position relative to the corresponding carotid artery (CA) of the LIJV compared with the RIJV. In this study, the RIJV and LIJV were examined in mechanically ventilated patients to determine the validity of these possible explanations.

Design: A prospective, nonrandomized cohort study.

Setting: The operating room of a major teaching hospital.

Patients: One hundred fifty-one patients scheduled for elective heart surgery.

Intervention: Ultrasound examination of the RIJV and LIJV at the level of the cricoid cartilage with a 12-MHz linear transducer in 151 anesthetized, mechanically ventilated patients in the Trendelenburg position.

Measurements and results: In 72% of patients, the RIJV was dominant over the LIJV. The diameter and cross-sectional area of the RIJV was larger than the LIJV ($P < .001$). An anterior position of the LIJV in relation to the left CA was detected more often when compared with the RIJV and right CA (15.1% vs 5.4%, $P = .01$).

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Conclusion: This study confirms the smaller diameter and increased frequency of anterior positioning relative to the corresponding CA of the LIJV when compared with the RIJV. This validates them as possible explanations for the higher complication rate of LIJV cannulation compared with RIJV cannulation.

1. Introduction

Recently, the *Journal of Clinical Anesthesia* advocated for the measurement of internal jugular veins (IJVs) prior to catheterization [1]. Common uses for a central venous catheter include central venous pressure transduction, administration of inotropes, fluid therapy, and secure venous access. Although the incidence of complications from central venous cannulation has been significantly reduced by the use of ultrasound, the hazards of arterial puncture, hematoma formation, hemothorax, and pneumothorax remain [2–12]. Cannulation of the left IJV (LIJV) is associated with a higher complication rate and a perceived increased level of difficulty when compared with cannulation of the right IJV (RIJV) [13,14]. The higher complication rate may be due, in part, to the different anatomy of the LIJV and RIJV. It has been demonstrated that larger vessels are easier to cannulate than smaller ones [15,16].

Experience suggests that the IJVs are often asymmetric in size, but data are limited. Three small ultrasound studies have compared the diameters of LIJV and RIJV. One prospective study in intensive care unit patients demonstrated IJV asymmetry in 62.5% and a dominant RIJV in 68% [17]. A smaller study in healthy volunteers demonstrated that in 80% of the participants, the RIJV cross-sectional area (CSA) was greater than the LIJV CSA [18]. Recently, a larger study with healthy nonanesthetized volunteers was published with similar results. In addition, this study demonstrated that a small-vessel caliber (CSA < 40 mm^2) was more frequently encountered on the left side (14.6%) compared with the right side (6.5%) [1].

The clinical relevance of studies assessing IJV anatomy in spontaneously breathing supine patients to the perioperative environment may be challenged. IJV cannulation in the operating room is routinely performed in mechanically ventilated patients in the Trendelenburg position. The aim of this study is to compare the diameter, CSA, and depth from the skin of the LIJV and RIJV in anesthetized patients during mechanical ventilation in the Trendelenburg position. Secondary end points were the anatomical relationship between the IJV and the carotid artery (CA).

2. Materials and methods

Ethics approval was obtained from the hospital ethics committee (METC Catharina Hospital, Eindhoven, the Netherlands; Chairman Dr R. Grouls, date of approval February 28, 2012; clinical trials ID NCT01599299).

All patients included in the study were undergoing elective cardiovascular surgery requiring RIJV cannulation. Exclusion criteria included the following, age <18 years, coagulopathy (international normalized ratio >1.5, activated partial thromboplastin time >45 seconds, or platelets <50,000 mm^{-3}), or history of head and neck surgery, radiation therapy to the neck, thyroid hypertrophy, and skeletal deformities.

The local ethics committee deemed written informed patient consent unnecessary. Participating patients received an explanation of the procedure prior to administration of anesthesia. Following induction of anesthesia, patients were intubated and ventilated (tidal volumes 6-8 mL/kg, 5 cm H_2O positive end-expiratory pressure) and positioned in the Trendelenburg position with the head rotated to the left at a 30° angle. The ultrasound examination was then performed with a 12-MHz linear transducer (L12-3 Philips Ultrasound, Bothell, WA) at the level of the cricoid cartilage.

The maximal diameter, CSA, and depth from the skin of the IJV and CA were measured and recorded. IJV position relative to the corresponding CA was observed and classified as anterior, anterolateral, or lateral (Fig. 1). All measurements were obtained by a single investigator. Patients' age, sex, body mass index, and sternomental and thyromental distances were recorded (Table 1).

2.1. Statistical analysis

Power analysis indicated that a sample size of 150 patients would be powered to detect a clinical significant difference of 3 mm in diameter. Statistical analysis was performed using IBM SPSS Statistics 21. Dichotomous and categorical variables were expressed as percentages, whereas continuous variables were represented as mean ± SD or median [interquartile range] (range minimum-maximum) according to variable distribution. The 1-sample Kolmogorov-Smirnov test was used for determining normal distribution. The CSA and diameter of the LIJV and RIJV were compared using the Mann-Whitney *U* test. Left and right CA CSA and diameter were compared similarly. Categorical data detailing the position of the IJV relative to the CA were interrogated using analysis of variance. For all analyses, a *P* value less than .05 was considered statistically significant.

3. Results

One hundred fifty-one consecutive patients scheduled for elective cardiac surgery were included. None were excluded. Baseline characteristics of the study population are presented in Table 1. One hundred nine patients (72%) in the study