

Assessment of head and neck position for optimal ultrasonographic visualisation of the internal jugular vein and its relation to the common carotid artery: A prospective observational study

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Abstract

Background and Aims: There is a wide variation in the anatomical relationship of the Internal Jugular Vein (IJV) to the Common Carotid Artery (CCA). This makes landmark based techniques of IJV cannulation and head rotation questionable and may lead to accidental arterial puncture. We conducted this study to determine the anatomical relation of the IJV to the CCA using (USG) in patients undergoing IJV cannulation for central venous access, and to analyse the effect of head rotation on this relationship.

Material and Methods: A prospective observational study was conducted on 100 patients requiring central venous access, in the operation theatre or the intensive care unit. Anatomical relationship of the IJV to CCA at the level of the cricoid cartilage was analysed by noting the segment position (1-12) around the CCA using a high frequency linear USG probe on patients in neutral head position, on both sides and also with the head rotated to the contra lateral side by 15° and 45°.

Results: Antero-lateral segments 1 and 2 were the most common positions (50% on the right and 73% on the left side). Change in segment causing increase in overlap of IJV and CCA with 15° head rotation was seen in 44% subjects on the right and 39% on the left. Statistically, a higher number of subjects showed overlap with 45° rotation (99% on right and 97% on left, $P < 0.05$).

Conclusion: There is a wide variation in anatomical location of the IJV in relation to the CCA as seen by USG. Excessive head rotation causes overlap of IJV over CCA which may cause inadvertent arterial puncture, even under USG guidance. Thus, it is preferable to cannulate the IJV in neutral or near neutral head and neck position.

Keywords: Common carotid artery, internal jugular vein, Trendelenburg, ultrasonography

Introduction

Due to its easy of accessibility, the Internal Jugular Vein (IJV) is a commonly used site for central venous access.^[1] Various landmark-based techniques exist, and measures such as head rotation and the Trendelenburg position are commonly used to increase the success rate.^[2] However, there is a wide variation in the anatomical relationship of the IJV to the Common Carotid Artery (CCA). Changes in the relationship between

these two structures may make landmark based techniques and head rotation questionable and lead to accidental arterial puncture or failure to locate the IJV.^[3]

Ultrasonography (USG) permits accurate identification of the IJV and CCA, allowing us to assess the relationship between them, and to also establish the reliability of landmark based techniques and the effect of manoeuvres like head rotation.^[4] We conducted this study to determine the anatomic

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relation of IJV to the CCA at the level of the cricoid cartilage, in patients undergoing IJV cannulation for central venous access.

Material and Methods

After the approval of the hospital ethical committee, this prospective observational study was conducted on 100 patients who required IJV cannulation, either prior to surgery or in the Intensive Care Unit (ICU). It was done in both sedated/ anaesthetised patients as well as conscious patients as per the setting. Patients above 18 years of age planned for IJV cannulation were included. The exclusion criteria were history of neck surgery, present or past history of neck mass, diagnosis of Superior Vena Cava (SVC) syndrome, limited neck mobility and haemo-dynamic instability.

After obtaining appropriate consent for the study, the anatomical relationship of IJV to CCA at the level of the cricoid cartilage was analysed using a USG high frequency linear probe (5-10 MHz) on patients in neutral head position on both sides. The probe was kept perpendicular to the floor in the short axis. A side tilt was applied to establish proper contact with the skin. For assessing the relationship, a circle was drawn with the CCA in the centre and it was divided into 12 segments [Figure 1]. The position of the IJV on the ultrasound image was noted and recorded in one of the 12 segments. This was the primary objective.

In the second part of the study, the patient's head was rotated to the contralateral side by 15° and 45°. Effect of head rotation on the relationship between IJV and CCA was determined on both sides, by noting the change in segment (1-12) if present.

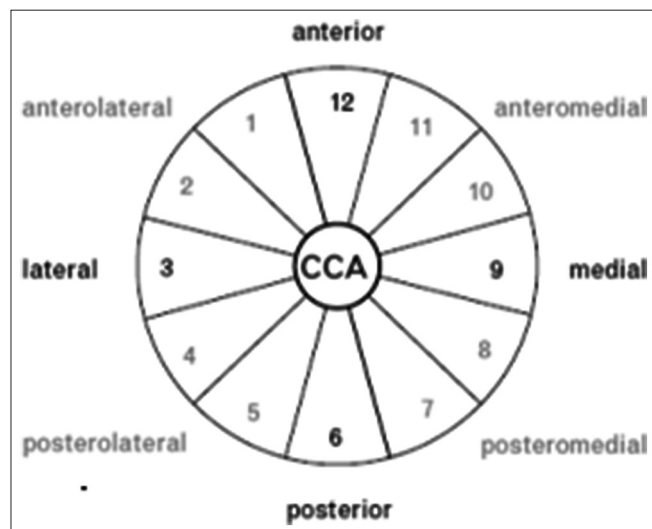


Figure 1: Relationship of internal jugular vein to common carotid artery, divided into 12 segments

Increase in overlap of CCA and IJV was also noted (due to medial shift of segment to more anterior positions). This was the secondary objective.

SPSS (Statistical Package for Social Sciences) software (version 16.0) was used for statistical analysis. The sample size decided was based on previous similar studies. The results were expressed as means, standard deviations, numbers and percentages. The effect of head rotation to 15° and 45° and incidence of change in segment and increase in overlap was analysed statistically using Chi square test. $P < 0.05$ was considered significant, considering alpha error of 5%.

Results

The mean age of the sample population was 45.2 ± 11.9 years. 62% were male and 38% were female subjects.

Figure 2 shows typical images of IJV in relation to the CCA in a neutral head position: a and b) anterolateral c) lateral and d) posterolateral. The segmental location of the IJV along with the percentages are shown in Figure 3. Antero-lateral segments 1 and 2 were the most common positions on both sides.

The incidence of segment change on the right and left sides with 15 and 45° rotation to the contralateral side are shown in Tables 1 and 2.

Increased overlap between IJV and CCA due to medial shift of position of IJV segment with respect to CCA on head rotation was seen in shift from lateral/antero-lateral positions to antero-lateral/anterior positions. A statistically higher number

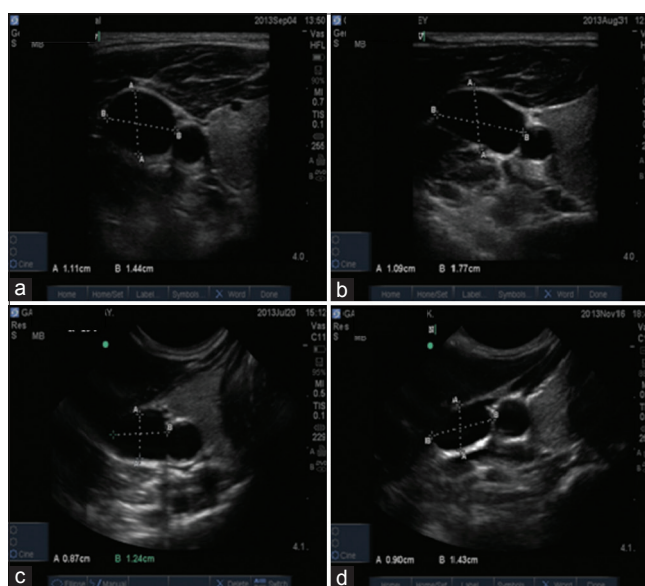


Figure 2: Ultrasonography images of internal jugular vein relation to common carotid artery. (a) Antero-lateral to Artery, Segment 1. (b) Antero-lateral to Artery, Segment 2. (c) Lateral to Artery, Segment 3. (d) Postero-lateral to Artery, Segment 4

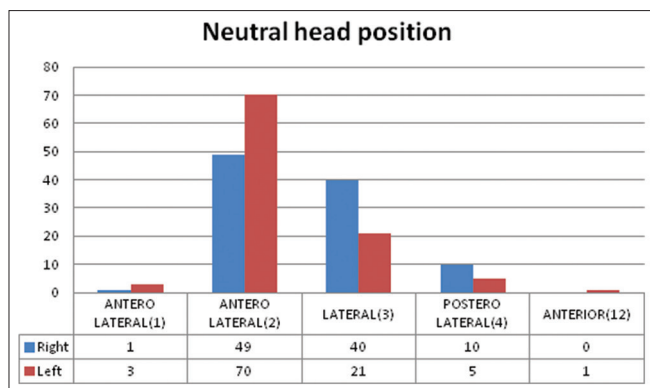


Figure 3: Internal jugular vein and common carotid artery relation in neutral head position

of subjects showed an increase in overlap on both sides, with 45° head rotation [Table 3].

Discussion

The IJV is traditionally cannulated using anatomical landmark, with IJV usually assumed to be lateral to the CCA. Anterior and anterolateral positions of the IJV increase overlap with CCA, and thus, the chance of arterial puncture. Posterolateral position makes cannulation difficult using traditional anatomical landmark-based techniques.

Macken *et al.* found IJV anterior and antero-medial in 48.7% of cases on right and 58.7% on left side with lateral appearance in only 3-3.3% cases. Atypical positions of the IJV were found in a minority of the patients with the IJV located medially in 0.7-2% of patients. In one patient the IJV was depicted posteromedially and in another, it was posterior to the CCA.^[5] However, in the present study anterolateral position was found more frequently than observed by Macken. Moreover, medial position of IJV was not found in any of the cases in present study. This variation can be explained by the fact that Macken *et al.* placed probe of the USG perpendicular to the skin (to ease visualization) rather than perpendicular to the floor (anterior posterior direction) that resulted in more anterior and antero-medial position of IJV.

Troinaos *et al.* found that IJV overlies CCA (>75% overlap) in 51% of cases, 50-75% overlap seen in 13.9% cases, 25-50% overlap in 13.9% cases, up to 25% in 10.7% cases and no overlap in 6.4% (lateral position of IJV) of cases.^[6,7] This is in contrast to our study in which anterior position of IJV (>75% overlap) was found in only one of the cases. Antero-lateral position (up to 75% overlap) was found more frequently. Lateral position (no overlap) was also found more frequently (40% on right and 21% on left side) than observed by Troinaos *et al.* This variation in the result can be explained by the fact that in the study done by Troinaos *et al.*, patients' heads were already rotated to the left as far as was comfortable;

Table 1: Incidence of Segment change on 15° head rotation

	Segment change: 15° (n=100)						No change
	2-1*	3-2*	4-3	4-2	2-3	12-11	
Right	11	33	9	1	1	0	45
Left	19	20	4	1	1	1	54

*Medial shift which increases overlap

Table 2: Incidence of Segment change on 45° head rotation

	Segment change: 45° (n=100)								
	1 to 12*	2 to 1*	2 to 12*	3 to 1,2*	4 to 3	4 to 1,2*	4 to 12*	12 to 11	No change
Right	1	38	10	40	0	9	1	0	1
Left	3	52	17	21	1	4	0	1	1

*Medial shift which increases overlap

Table 3: Incidence of increase in overlap on head rotation

Degree of head rotation	15°	45°	P*
Right	44/100	99/100	<0.05
Left	39/100	97/100	<0.05

*Chi square test, P<0.05: Significant

this resulted in more overlap seen in the results as compared to our study. They did not study the effect of head rotation on the overlap. Moreover, their study was carried out only on right side.

Sibai *et al.* found the IJV in lateral position in 51% of cases, anterolateral in 33% of cases, posterolateral in 14% of cases and anterior in 2% of the cases on the right side with the USG transducer directed perpendicular to the floor.^[8] These observations were similar to the results observed in our study. However, even in their study head was rotated to the contra-lateral side at the time of examination in contrast to the present study in which position of IJV was studied with head in neutral position. They also studied the effect of placing the transducer perpendicular to the skin which resulted in a more antero-lateral position (77%) of the IJV relative to the CCA.

With change of head position, change of IJV's relation to CCA from lateral to antero-lateral and antero-lateral to anterior, increases the overlap over CCA increasing the chances of carotid puncture. However, in those cases where change of position is from postero-lateral to lateral it could become more favourable. Also head rotation to 15° to opposite side would facilitate exposure for IJV cannulation. In the present study, when head rotation was done to 45°, the change of IJV position was observed in a significant number of subjects and overlap increase was seen in most of the cases.

These result are similar to those of Sulek *et al.* where it was shown that head rotation increases the overlap between IJV and common carotid at 40° and 80° both on left and right side. The percent overlap was larger on the left side than the right. They recommended that IJV cannulation be carried out with head in neutral or near neutral position.^[9]

Similar results were obtained by Woo *et al.* in obese Asians. They recommended less than 30° head rotation.^[10]

Conclusion

We conclude that there is a wide variation in anatomical location of the IJV in comparison to CCA as seen by USG and because of this variation, landmark-based technique of IJV cannulation may result in complications and failure to locate the IJV. Hence, the use of ultrasonography is recommended during IJV cannulation, preferably in neutral or near neutral head and neck position, as excessive rotation may cause overlap of IJA over CCA, causing inadvertent arterial puncture, even under USG guidance.

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Conflicts of interest

There are no conflicts of interest.

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