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AN ULTRASONOGRAPHIC STUDY OF THE CHANGE IN INTERNAL JUGULAR VEIN DIAMETER IN RELATION TO THE ANGLE OF HEAD ELEVATION

Emergency Medicine

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ABSTRACT

The aim of this study is to examine the maximum and minimum diameter of internal jugular vein when subjected to varied head elevation angles.

The study was conducted at emergency department and critical care units of Peerless Hospital & B.K. Roy Research Centre, Kolkata. Ultrasound IJV was scanned and their diameter measurements were noted in 64 healthy volunteers. The ultrasound machine that was used LOGIQ P5.

Our result showed that the difference of mean both Right and Left at head elevation angle of 0, 15, 30 and 45 degree IJV in mm –minimum and maximum were decreased respectively which were statistically significant. But the difference of mean Collapsibility index of both Right and Left head elevation angle of 0, 15, 30 and 45 were increased respectively which were statistically significant.

We found that ≥70% Collapsibility index Right IJV in mm was recorded in 8 patients at 15° head elevation, in 15 patients at 30°, in 50 patients at 45° and Left IJV in mm was showed in 1 patients at 15° head elevation, in 2 patients at 30°, in 49 patients at 45°.

We concluded that the point of care Ultrasound of IJV scanning during gradual head elevation together with the collapsibility index calculation could be helpful in guidance for the venous outflow assessment.

KEYWORDS

Ultrasonographic, Internal Jugular Vein, The Angle Of Head Elevation

INTRODUCTION

Cerebral venous blood moves through the cerebral venous sinus, reaching the sigmoidal sinus, which drains in the jugular bulb and then in the internal jugular vein. Head elevation at 15-45 degrees could reduce intracranial pressure due to increased venous outflow from the cranial cavity and reduction of intracranial venous blood volume. Patients with traumatic brain injury are generally subjected to head elevation in an attempt to reduce the intracranial pressure. But of late some studies have shown that head elevation of more than 30 degrees could reduce cerebral perfusion pressure and mean pressure in carotid artery.

When central intravenous access is required and internal jugular vein (IJV) puncture is chosen, the right-sided vein is generally preferred because it provides a direct pathway to the superior vena cava and avoids thoracic duct injury[1]. Moreover, left IJV cannulation is deemed to be more difficult, carrying a higher rate of complications [2]. Finally, it has been reported that the left IJV is smaller than the right. Lobato and colleagues showed that the cross-sectional area of the right IJV was greater than that of the left IJV in the majority (80%) of 50 healthy volunteers [3]. Such asymmetry has been confirmed in intensive care patients, where the right IJV was equal or dominant in 62.5% of patients [4]. Nevertheless, in these two ultrasound studies, the precise diameter and cross-sectional area of the right and left IJV were not reported. Moreover, some limitations of the ultrasound techniques, such as excessive vessel pressure by the probe, neck positioning, and no visualization of the brachiocephalic vein, superior vena cava and mediastinum, could lead to inaccurate measurements. Anatomical variations of the IJVs and their relation to the common carotid artery were evaluated in a retrospective study of 88 patients using computed tomography (CT) scans. The right IJV was usually larger (79.5%) than the left: the mean diameters of the right and left IJVs were 14.10 mm and 11.74 mm, respectively [5]. However, the cross-sectional area was not measured and no statistical analysis was performed in this study. Moreover, it appeared that the IJVs are oblong rather than round [5].

The aim of this study is to examine the maximum and minimum diameter of internal jugular vein when subjected to varied head elevation angles.

MATERIAL & METHODS

The study was a prospective, observational study. For the purpose of this proposal, a single centre based study was conducted at emergency department and critical care units of Peerless Hospital & B.K. Roy Research Centre, Kolkata.

Ultrasound IJV was scanned and their diameter measurements were noted in 64 healthy volunteers. The ultrasound machine that was used LOGIQ P5.

The IJV scanning was carried out in 2 min after placing the volunteers in a horizontal position on their back, and in 2 min each time after the volunteers was attain the new position due to the gradual lifting the bed back section at the 15°, 30°, and 45°. The ultrasonic sensor was placed on the neck of the patient between the heads of sternocleidomastoid muscle, and veins crossscanning was carried out on both sides. The maximum and minimum vein diameter sizes were recorded. Quantitative data was presented as mean ± standard deviation, median, range, and collapsibility index. IJV collapsibility index was calculated as: IJV confidence interval (CI) = ([Dmax – Dmin]/Dmax) ×100%. The IJVCI was derived via Mmode assessment of the variation in the veins diameter (minimum versus maximum).

STATISTICAL METHODS

The statistical software SPSS version 20 was used for the analysis. An alpha level of 5% has been taken, i.e. if any p value is less than 0.05 it was considered as significant.

RESULT AND ANALYSIS

We found that the mean Right 0 degree IJV in mm -Min (mean± s.d.) of patients was 5.541 ± 0.6414. The mean Right 15 degree IJV in mm -Min (mean± s.d.) of patients was 2.422 ± 0.7450. The mean Right 30 degree IJV in mm -Min (mean± s.d.) of patients was 1.908 ± 0.5785. The mean Right 45 degree IJV in mm -Min (mean± s.d.) of patients was 0.87 ± 0.144.It was found that in One-Sample Test, mean difference of Right 0 degree IJV in mm -Min was 5.5406 with 95% confidence interval [5.380–5.701, P< 0.0001]. Mean difference of Right 15 degree IJV in mm -Min was 2.4219 with 95% confidence interval [2.236–2.608, P< 0.0001]. Mean difference of Right 30 degree IJV in mm -Min was 1.9078 with 95% confidence interval [1.763–2.052, P< 0.0001]. Mean difference of Right 45 degree IJV in mm -Min was 0.875 with 95% confidence interval [0.84–0.91, P< 0.0001].

Our study showed that the mean Right 0 degree IJV in mm-Max (mean± s.d.) of patients was 8.281 ± 1.0309. The mean Right 15 degree IJV in mm-Max (mean± s.d.) of patients was 4.97 ± 1.133. The mean Right 30 degree IJV in mm-Max (mean± s.d.) of patients was 4.473 ± 0.6605. The mean Right 45 degree IJV in mm-Max (mean± s.d.) of patients was 3.42 ± 0.613. It was found that in One-Sample Test, mean difference of Right 0 degree IJV in mm-Max was 8.2812 with 95% confidence interval [8.024–8.539, P< 0.0001]. Mean difference of Right 15 degree IJV in mm-Max was 4.969 with 95% confidence interval [4.69–5.25, P< 0.0001]. Mean difference of Right 30 degree IJV in mm-Max was 4.4734 with 95% confidence interval [4.308–4.638, P< 0.0001]. Mean difference of Right 45 degree IJV in mm-Max was 3.422 with 95% confidence interval [3.27–3.58, P< 0.0001].

In our study showed that the mean Collapsibility index Right 0 degree IJV in mm (mean± s.d.) of patients was 32.4791 ± 8.2647. The mean Collapsibility index Right 15 degree IJV in mm (mean± s.d.) of patients was 49.53 ± 15.712. The mean Collapsibility index Right 30 degree IJV in mm (mean± s.d.) of patients was 56.5931 ± 13.8679. The mean Collapsibility index Right 45 degree IJV in mm (mean± s.d.) of patients was 73.7669 ± 5.2282. It was found that in One-Sample Test, mean difference of Collapsibility index Right 0 degree IJV in mm was 32.479 with 95% confidence interval [30.4146–34.543, P< 0.0001]. Mean difference of Collapsibility index Right 15 degree IJV in mm was 49.530 with 95% confidence interval [45.61–53.45, P< 0.0001]. Mean difference of Collapsibility index Right 30 degree IJV in mm was 56.593 with 95% confidence interval [53.129–60.057, P< 0.0001]. Mean difference of Collapsibility index Right 45 degree IJV in mm was 73.7669 with 95% confidence interval [72.4609–75.0729, P< 0.0001].

In our study show that we found that the mean Left 0 degree IJV in mm -Min (mean± s.d.) of patients was 6.409 ± .7417. The mean Left 15 degree IJV in mm -Min (mean± s.d.) of patients was 4.081 ± .8114. The mean Left 30 degree IJV in mm -Min (mean± s.d.) of patients was 2.205 ± .6022. The mean Left 45 degree IJV in mm -Min (mean± s.d.) of patients was .866 ± .1556. It was found that in One-Sample Test, mean difference of Left 0 degree IJV in mm -Min was 6.4094 with 95% confidence interval [6.224–6.595, P< 0.0001]. Mean difference of Left 15 degree IJV in mm -Min was 4.0813 with 95% confidence interval [3.879–4.284, P< 0.0001]. Mean difference of Left 30 degree IJV in mm -Min was 2.2047 with 95% confidence interval [2.054–2.355, P< 0.0001]. Mean difference of Left 45 degree IJV in mm -Min was .8656 with 95% confidence interval [.827–.904, P< 0.0001].

Our study showed that the mean Left 0 degree IJV in mm-Max (mean± s.d.) of patients was 8.43 ± .788. The mean Left 15 degree IJV in mm -Max (mean± s.d.) of patients was 6.398 ± 1.0370. The mean Left 30 degree IJV in mm - Max (mean± s.d.) of patients was 4.627 ± .7482. The mean Left 45 degree IJV in mm - Max (mean± s.d.) of patients was 3.402 ± .6381. It was found that in One-Sample Test, mean difference of Left 0 degree IJV in mm-Max was 8.434 with 95% confidence interval [8.24–8.63, P< 0.0001]. Mean difference of V Left 15 degree IJV in mm-Max was 6.3984 with 95% confidence interval [6.139–6.657, P< 0.0001]. Mean difference of Left 30 degree IJV in mm-Max was 4.6266 with 95% confidence interval [4.440–4.813, P< 0.0001]. Mean difference of Left 45 degreeI JV in mm-Max was 3.4016 with 95% confidence interval [3.242–3.561, P< 0.0001].

We found that the mean Collapsibility index Left 0 degree IJV in mm (mean± s.d.) of patients was 23.756 ± 8.0865. The mean Collapsibility index Left 15 degree IJV in mm (mean± s.d.) of patients was 35.2378 ± 12.7126. The mean Collapsibility index Left 30 degree IJV in mm (mean± s.d.) of patients was 51.882 ± 11.667. The mean Collapsibility index Left 45 degree IJV in mm (mean± s.d.) of patients was 73.691 ± 6.507. It was found that in One-Sample Test, mean difference of Collapsibility index Left 0 degreeIJV in mm was 23.756 with 95% confidence interval [21.736–25.77, P< 0.0001]. Mean difference of Collapsibility index Left 15 degreeIJV in mm was 35.2378 with 95% confidence interval [32.062–38.41, P< 0.0001]. Mean difference of Collapsibility index Left 30 degreeIJV in mm was 51.88 with 95% confidence interval [48.968–54.797, P< 0.0001]. Mean difference of Collapsibility index Left 45 degreeIJV in mm was 73.69 with 95% confidence interval [72.06–72.06, P< 0.0001].

In our study showed that the negative correlation was found in Right 0 degree IJV in mm -Min vs Collapsibility index Right 0 degree and this correlation was statistically significant. The positive correlation was found in Right 0 degree IJV in mm-Max vs Collapsibility index Right 0 degree and this correlation was statistically significant. The negative correlation was found in Right 15 degree IJV in mm -Min vs Collapsibility index Right 15 degreeIJV in mm and this correlation was statistically significant. The positive correlation was found in Right 15 degreeIJV in mm-Max vs Collapsibility index Right 15 degreeIJV in mm and this correlation was statistically significant. The negative correlation was found in Right 30 degree IJV in mm -Min vs Collapsibility index Right 30 degree IJV in mm and this correlation was statistically significant. The positive correlation was found in Right 30 degree IJV in mm-Max vs Collapsibility index Right 30 degree IJV in mm and this correlation was statistically significant. The negative correlation was found in Right 45 degree IJV in mm -Min vs Collapsibility index Right 45 degree IJV in mm and this correlation was statistically significant.

We found that the positive correlation was found in Right 45 degree IJV in mm-Max vs Collapsibility index Right 45 degree IJV in mm and this correlation was statistically significant. The negative correlation was found in Left 0 degree IJV in mm -Min vs Collapsibility index Left 0 degree IJV in mm and this correlation was statistically significant. The positive correlation was found in Left 0 degree IJV in mm-Max vs Collapsibility index Left 0 degree IJV in mm and this correlation was statistically significant. The negative correlation was found in Left 15 degree IJV in mm -Min vs Collapsibility index Left 15 degree IJV in mm and this correlation was statistically significant. The positive correlation was found in Left 15 degree IJV in mm-Max vs Collapsibility index Left 15 degree IJV in mm and this correlation was statistically significant.

Our study showed that the negative correlation was found in Left 30 degree IJV in mm -Min vs Collapsibility index Left 30 degreeIJV in mm and this correlation was statistically significant. The positive correlation was found in Left 30 degreeIJV in mm-Max vs Collapsibility index Left 30 degreeIJV in mm and this correlation was statistically significant. The negative correlation was found in Left 45 degree IJV in mm -Min vs Collapsibility index Left 45 degree IJV in mm and this correlation was statistically significant. The positive correlation was found in Left 45 degree IJV in mm-Max vs Collapsibility index Left 45 degree IJV in mm and this correlation was statistically significant.

DISCUSSION

We found that the difference of mean Right 0, 15, 30 and 45 degree IJV in mm –Min were decreased respectively which was statistically significant. The difference of mean Right 0, 15, 30 and 45 degree IJV in mm –Max were decreased respectively which was statistically significant.

It was found that the difference of mean Collapsibility index Right at 0, 15, 30 and 45 were increased respectively which was statistically significant.

Our study showed that the difference of mean Left 0, 15, 30 and 45 degree IJV in mm –Min were decreased respectively which was statistically significant. We also found that the difference of mean Left 0, 15, 30 and 45 degree IJV in mm –Max were decreased respectively which was statistically significant. The difference of mean Collapsibility index Left at 0, 15, 30 and 45 were increased respectively which was statistically significant.

Decreased intracranial pressure associated with the head elevation is related to the increased venous outflow from the cranial cavity and decreased intracranial venous blood volume.[6,7] The major venous blood outflow from the cranial cavity in a supine human occurs through the IJVs. As it was shown before, the IJVs ultrasound scanning provides accurate records of changes in their diameters due to human body position change, performing functional tests, and volume expansion.[8,9]

Besides, an inverse correlation between the volume status values and collapsibility index was revealed.[10,11] The increase in collapsibility index value was associated with a reduction of venous blood volume. Thus, IJV collapse and the collapsibility index value equal to 100% may indicate the reduction of local blood volume in IJV to a minimum and show the head elevation effectiveness. Our results suggest that the elevation of the head end is accompanied by a decrease in IJVs

diameter up to their collapse. When the image of venous walls collapse appeared on the ultrasound scanner screen, collapsibility index reached 100%. [12]

We found that the negative correlation was found in Right 45 degree IJV in mm -Min vs Collapsibility index Right 45 degree IJV in mm and this correlation was statistically significant.

The positive correlation was found in Right 45 degree IJV in mm-Max vs Collapsibility index Right 45 degree IJV in mm and this correlation was statistically significant.

We found that the negative correlation was found in Left 45 degree IJV in mm -Min vs Collapsibility index Left 45 degree IJV in mm and this correlation was statistically significant.

The positive correlation was found in Left 45 degree IJV in mm-Max vs Collapsibility index Left 45 degree IJV in mm and this correlation was statistically significant.

We found that ≥70% Collapsibility index Right IJV in mm was recorded in 8 patients at 15° head elevation, in 15 patients at 30°, in 50 patients at 45°. It was showed that ≥70% Collapsibility index Left IJV in mm was recorded in 1 patients at 15° head elevation, in 2 patients at 30°, in 49 patients at 45°.

Urakov AL et al [12](2018) found that the occurrence of the vein walls collapse corresponds to the collapsibility index equal to100%. The results showed that 100% collapsibility index was recorded in 6 patients (19%) at 15° head elevation, in 12 patients (39%) at 30°, in 11 patients (35%) at 45°. In two volunteers (6%), 100% collapsibility index was not recorded even at maximum 45° headelevation.

Urakov AL et al [12](2018) found that increasing the head elevation angle by 15°, 30° and 45° resulted in a decrease in IJV diameter in the right and left sides in all patients.

Clenaghan S et al [13] (2005) found that healthy volunteers were randomised to Trendelenburg tilts of 10°, 15°, 20°, 25°, and 30°. Ultrasound was used to measure and record the lateral diameter of the right IJV at the level of the cricoid cartilage. Following each reading the table was returned to the supine position. Balanced randomisation was used to assess cumulative tilt effects. A total of 20 healthy volunteers were recruited (10 men, 10 women). Mean supine IJV diameter was 13.5 mm (95% CI 12.8 to 14.1) and was significantly greater at 10° (15.5 mm, 95% CI 14.9 to 16.1). There was no significant difference between 10° and greater angles of tilt. The effect of the previous angle of tilt did not prove to be statistically significant.

CONCLUSION

It was showed the possibility of using point of care ultrasound in IJV scanning for collapsibility index evaluation while increasing head elevation angle. We can use the image of IJV collapse on ultrasound scanner screen which can be used as a criterion of head elevation efficiency in clinical settings. We also found that IJVs ultrasound scanning can help emergency physicians as expeditious and noninvasive method of evaluating the usefulness of therapy which thereby improves venous outflow from the cranial cavity in an individual.

We concluded that the point of care Ultrasound of IJV scanning during gradual head elevation together with the collapsibility index calculation could be helpful in guidance for the venous outflow assessment.

Difference of mean Right 0 degree, 15 degree, 30 degree, 45 degree IJV in mm –Min, 0 degree, 15 degree, 30 degree, 45 degree IJV in mm –Max and Collapsibility index Right 0 degree, 15 degree, 30 degree, 45 degree IJV in mm

One-Sample Test						
	Test Value = 0					
	t	df	p-Value	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Right 0 degree IJV in mm -Min	69.111	63	<0.0001	5.5406	5.380	5.701
Right 15 degree IJV in mm -Min	26.006	63	<0.0001	2.4219	2.236	2.608
Right 30 degree IJV in mm -Min	26.381	63	<0.0001	1.9078	1.763	2.052
Right 45 degree IJV in mm -Min	48.730	63	<0.0001	.875	.84	.91
Right 0 degree IJV in mm-Max	64.262	63	<0.0001	8.2812	8.024	8.539
Right 15 degree IJV in mm-Max	35.070	63	<0.0001	4.969	4.69	5.25
Right 30 degree IJV in mm-Max	54.182	63	<0.0001	4.4734	4.308	4.638
Right 45 degree IJV in mm-Max	44.642	63	<0.0001	3.422	3.27	3.58
Collapsibility index Right 0 degree IJV in mm	31.439	63	<0.0001	32.479	30.4146	34.543
Collapsibility index Right 15 degree IJV in mm	25.219	63	<0.0001	49.530	45.61	53.45
Collapsibility index Right 30 degree IJV in mm	32.647	63	<0.0001	56.593	53.129	60.057
Collapsibility index Right 45 degree IJV in mm	112.874	63	<0.0001	73.7669	72.4609	75.0729

Difference of mean Left 0 degree, 15 degree, 30 degree, 45 degree IJV in mm –Min, Left 0 degree, 15 degree, 30 degree, 45 degree IJV in mm –Max and Collapsibility index Left 0 degree, 15 degree, 30 degree, 45 degree IJV in mm

One-Sample Test						
	Test Value = 0					
	t	df	p-Value	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Left 0 degree IJV in mm -Min	69.135	63	<0.0001	6.4094	6.224	6.595
Left 15 degree IJV in mm -Min	40.239	63	<0.0001	4.0813	3.879	4.284
Left 30 degree IJV in mm -Min	29.287	63	<0.0001	2.2047	2.054	2.355
Left 45 degree IJV in mm -Min	44.519	63	<0.0001	.8656	.827	.904
Left 0 degree IJV in mm-Max	85.579	63	<0.0001	8.434	8.24	8.63
Left 15 degree IJV in mm-Max	49.361	63	<0.0001	6.3984	6.139	6.657
Left 30 degree IJV in mm-Max	49.471	63	<0.0001	4.6266	4.440	4.813
Left 45 degree IJV in mm-Max	42.648	63	<0.0001	3.4016	3.242	3.561
Collapsibility index Left 0 degree IJV in mm	23.502	63	<0.0001	23.756	21.736	25.77
Collapsibility index Left 15 degreeIJV in mm	22.175	63	<0.0001	35.2378	32.062	38.41
Collapsibility index Left 30 degreeIJV in mm	35.575	63	<0.0001	51.88	48.968	54.797
Collapsibility index Left 45 degreeIJV in mm	90.592	63	<0.0001	73.69	72.06	72.06

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