

# ANATOMICAL VARIATIONS OF THE INTERNAL JUGULAR VEIN IN RELATION TO COMMON CAROTID ARTERY IN LESSER SUPRA CLAVICULAR FOSSA – A COLOUR DOPPLER STUDY

Shanta Chandrasekaran\*, V.P.Chandrasekaran\*\*

## ABSTRACT :

Internal jugular vein (IJV) is carrying more importance in the era of critical care for various life saving interventions. Cannulation of this vein is mainly carried out in developing countries by anatomical landmark guidance. Hence this study is aimed on the anatomical variations of IJV in cannulating position. This is a prospective study done in medical college hospital. Doppler ultrasound was done in cannulating position and the relation of IJV to common carotid artery was seen on both the sides of the neck. The anterior relationship of IJV to common carotid artery was considered dangerous relation and lateral or anterolateral was considered as safe relation. 86 healthy volunteers were included in the study. Mean age of the volunteers was 20.91 years. The safe relation of IJV to common carotid artery (lateral or anterolateral) on left side 80% and on the right side 74%. The dangerous relation (Anterior) of IJV to common carotid artery on left side 20% and on right side 26% which is statistically significant. ( $p < 0.001$ ). Hence this study concludes that significant numbers of volunteers are having dangerous relationship with common carotid artery which may end up in arterial puncture while cannulating the IJV with landmark guided approach.

**Key words :** Internal jugular vein, Common carotid artery, Lesser supraclavicular fossa

Many life supporting interventions like central venous pressure monitoring, pulmonary artery catheter insertion & pulmonary artery wedge pressure monitoring, emergency dialysis, transvenous cardiac pacing, administration of essential life saving drugs and total parenteral nutrition all require rapid and reliable methods of central venous access.<sup>(1)</sup> Central venous catheterizations through peripheral veins are not preferred as they are easily collapsible, thrombosed frequently and commonly require long catheters to

reach the superior vena cava. The internal jugular vein, subclavian and femoral vein are used frequently for central venous catheterization.<sup>(1)</sup>

Since the subclavian catheterization is associated with up to 50% incidence of thrombosis and stenosis<sup>(2)</sup>, and also the bleeding complication is more due to its non-compressible location and poor recognizing signs in case of arterial bleeding it is less utilized. Femoral vein cannulation is not performed much due to frequent incidences of sepsis and deep vein thrombosis. The internal jugular vein is preferred due to the facts that this vein has got good external landmarks, low risk of pneumothorax, bleeding can be easily recognized and controlled, malposition of catheters is rare due to its relatively straight course to superior vena cava on the right side and palpation of carotid pulsations during IJV cannulation helps to prevent the inadvertent arterial puncture and hematomas.

The standard approach of internal jugular vein cannulation using visual and palpable anatomic landmarks is associated with 95% success rate<sup>(3,4)</sup>. But it carries the complications from inadvertent puncture of surrounding structures including the common carotid artery due to significant variation in the anatomic location of internal jugular vein when patients are placed in a cannulating position<sup>(5)</sup>.

With this background this study is aimed to demonstrate the anatomic variations of internal jugular vein in relation to common carotid artery in cannulating position among the random healthy young volunteers.

## OBJECTIVE :

To demonstrate the anatomic variations of internal jugular vein in relation to common carotid artery in cannulating position among a random healthy young volunteers with the use of Colour Doppler Scan.

## MATERIALS & METHODS

This prospective study was conducted in a teaching hospital. The population for this study included young healthy volunteer of different age group ranging from 16 to 38 years. The volunteers presenting with big scar, mass, previous Surgery in the neck, torticollis, anatomical abnormality, fracture clavicle and short neck were excluded.

After explaining the procedure, the volunteers were asked to lie supine. A pillow was placed under the shoulder blades. The cot was tilted to 30° down-Trendelenberg position. (Picture-9) The head was turned 45° to the contra lateral side and the head was supported by a folded blanket to avoid further head movements and to relax the neck muscles. The degree of head rotation was confirmed to be accurate with an indigenously designed head styllet & protractor to achieve the cannulating position. The **sedillot triangle**, which is a useful landmark in locating the course of IJV, was identified by using visual and palpatory method, which was formed by medial and lateral heads of the sternocleidomastoid muscle and base by medial end of the clavicle.

In case of difficulty in locating the triangle, the subject was asked to lift the head actively against resistance given by the investigator to make the muscle rigid and locate the triangle easily. Doppler ultrasound was done by a doctor trained in Ultrasonography on an aloka – SSD 5500 Dynamex machine using a high frequency RECTELENA probe of 7.5 / 10 MHz. Both longitudinal and cross sectional images were studied in Gray scale and Colour mode.

Technique of identifying IJV and common carotid artery was by visualization of structures as well as considering distinct low velocity of venous flow (**Picture-1**) and pulsetile sound of blood flow in carotid artery (**Picture-2**). Initially the exact location of IJV is identified and its relation to the carotid artery was studied.

The location of IJV in relation to carotid artery was recorded as anterolateral (**Picture-4**), lateral (**Picture-3**) and anterior (**Picture-5**). Anterolateral and lateral were considered as **safe relations**, where as anterior location was considered as **dangerous relation**.<sup>(2)</sup> The diameter of the common

carotid artery was also measured. The procedure was done on both left and right sides of each volunteer.

Apart from this all the volunteers were asked to do Valsalva maneuver and the apparent distension of internal jugular vein was noted. <sup>(4)</sup>

### Statistical Analysis

We summarized descriptive data as mean (SD), median, or percentage. Categorical data were compared using the chi-square test. We compared continuous variables using student's t – test for normal distributions. We used univariate analysis to compare demographic and anatomical variations. A p value of <0.5 was considered statistically significant. All analysis were done using SPSS 13.0

### RESULTS :

Of the 86 volunteers who have consented for colour Doppler study on anatomical variations of internal jugular vein on both the sides of the neck in cannulating position, 5 were excluded. The study was conducted on 81 young volunteers including 42 males and 39 females. They belong to the younger age group ranging from 17 to 36 years.

On the left side 80% of the volunteers had their IJV either anterolateral or lateral to common carotid artery which is known to be safe relation for cannulation and other 20% had anterior relation which is known to be dangerous (Table-1 and Figure-1), which is statistically significant. (p<0.001)

On the right side 74% of the volunteers had their IJV in safe relation and other 26% had anterior dangerous relation (Table-2 and Figure-2), which is statistically significant. (p<0.001)

The anatomical variations among the volunteer groups from <20 years, 20 – 25 years and > 25 years were not significant (p>0.05) similarly there was no significant anatomical variations between the male and female genders. (p >0.05)

The diameters of internal jugular veins on the right and left sides were noted. The mean diameter of the right IJV was 8.7mm and left IJV 8.6mm (Table-3), and the difference is not statistically significant. (p>0.05)

The diameters of common carotid artery on the right and left sides were also noted. The mean diameter of the right CCA was 6.563mm and left CCA was 6.532mm (Table-4), and the difference is not statistically significant ( $p > 0.05$ ).

## DISCUSSION :

Literature analysis revealed a number of variations in relation of internal jugular vein to common carotid artery in different groups. Trianos et al<sup>(12)</sup> had done the study on 1,136 surgical patients who underwent right internal jugular vein cannulation, reported a rate of anterior relation of internal jugular vein to common carotid artery was 54%. But the present study revealed that the anterior relation of internal jugular vein to common carotid artery is 20.4% (19.8% in the left side and 21.0% in the right side).

This difference could be explained by the following factors:

a) Trianos et al<sup>(12)</sup> included the elderly aged patients whose carotid artery was elongated and tortuous presumably from atherosclerosis. Present study included healthy and younger age groups in whom the common carotid artery was not tortuous and the relation to internal jugular vein was not much altered while the head was turned to the cannulating position.

b) In Trianos et al<sup>(12)</sup> the degree of head rotation was not confirmed to be accurate, whereas in the present study the degree of head rotation was confirmed with a protractor and styllet which is fixed on the head in sagittal plane using a head band.

This observation is more closer with the observation of Lin BS et al<sup>(13)</sup> who had used a 'SiteRite' ultrasonographic device to inspect the anatomical structure of the internal jugular veins (IJV) in 104 consecutive uraemic patients undergoing creation of internal jugular vein temporary angio access and reported that the anterior relation of internal jugular vein to common carotid artery was 16.4% in the left side and 18.3% in the right side.

This observation is also closer with the observation of Caridi JG et al<sup>(14)</sup> who had used an ultrasonographic study and reported that the anterior relation of internal jugular vein to common carotid artery was 15%.

Although the present study explains the anterior position of internal jugular vein (Left – 19.8%, Right – 21.0%) in real practice, the incidence of common carotid artery puncture is 2 – 16%.<sup>(15)</sup> The low incidences of common carotid artery puncture could be explained by the following facts.

1. Using the palpation technique and preventing common carotid artery puncture by attempting lateral to the arterial pulsations.

2. The common carotid artery gets punctured only when the cannulating needle passes beyond the anteriorly situated internal jugular vein. If the venous cannulation is succeeded during needle advancement without passing beyond the vein there will be no chance of arterial puncture.

3. Mangar et al<sup>(16)</sup> reports that access to internal jugular vein is achieved 50% of the time with needle advancement and 50% the time with needle withdrawal. Hence even if the anterior position of internal jugular vein to common carotid artery is present the chances for common carotid artery puncture are only about 50%.

Cannulation of internal jugular vein is commonly performed by blind techniques using palpable and visual landmarks<sup>(16)</sup>. Anatomically internal jugular vein is anterolateral to the common carotid artery and techniques that incorporate the palpation of the common carotid artery pulse result in lower incidences of carotid artery puncture.<sup>(110)</sup>

If the internal jugular vein is located anterior to common carotid artery, initial attempts of the internal jugular vein cannulation will be unsuccessful. If the common carotid artery pulse is the sole landmark, subsequent repositioning of the cannulating needle medially may result in common carotid artery puncture.<sup>(111)</sup> Common carotid artery can get punctured if the cannulating needle traverses the posterior wall of internal jugular vein, when internal jugular vein overlies common carotid artery.

Our study shows significant number of volunteers carrying dangerous relation; hence IJV cannulation in critically ill patients can be done with the use of Doppler to prevent complications. Doppler guided

approaches to the IJV have been described which are reported to reduce both the number of needle passes required to locate the vein and the incidence of inadvertent carotid puncture. (12,13,14) Such techniques may be particularly appropriate for use in children where the incidence of carotid puncture is particularly high. (15,16) Two other systematic reviews (17,18) have concluded that ultrasonic guidance during central venous cannulation increases the successful cannulation and significantly reduces the incidence of complications in adults. A technique of Doppler guided internal jugular cannulation using a trans-esophageal probe has also been recently described. (19)

In the present study it was found that the valsalva maneuver had distended the internal jugular vein in all subjects, whereas in Bart-G-Denys (4) Study 3.6% of the subjects did not show distension of internal jugular vein on Valsalva maneuver. This is because all of the 3.6% patients were posted for cardiac transplant, who needed multiple cannulations, which lead their vein to get scarred, thrombosed, distally stenosed or occluded.

Comparing the diameters of the internal jugular vein and the common carotid arteries with other studies, (2,20) in the present study there is 2 mm less in mean diameters and this is because the present study was done on

Younger populations were as other studies have included elderly populations .It is a notable observation.

A pair of valves was seen in all the subjects at the lower end of internal jugular vein as described by Gray's anatomy. (21)

Two of the eighty-one volunteers had venous ectasia in the right internal jugular vein. This could be a developmental anomaly.

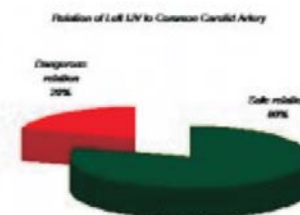
## CONCLUSION

This colour Doppler study confirmed that significant number of young volunteers had their IJV located anterior to common carotid artery in canulating position.

**Table – 1 and Figure-1: Showing safe and dangerous relation of left IJV to Common Carotid Artery.**

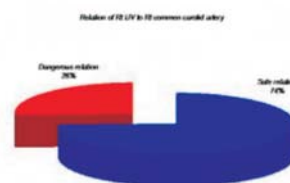
Valid	Frequency	Percent	Valid Percent	Cumulative Percent
L	12	14.8	14.8	14.8
AL	53	65.4	65.4	80.2
A	16	19.8	19.8	100.0
Total	81	100.0	100.0	

Safe relation: AL – Anterolateral, L- Lateral  
Dangerous relation: A – Anterior



**Table-2 and Figure-2. Relation of Right IJV to Common Carotid Artery in term of position.**

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
L	18	22.2	22.2	22.2
AL	42	51.9	51.9	74.1
A	21	25.9	25.9	100.0
Total	81	100.0	100.0	



**Table-3. Diameter of Internal Jugular Veins**

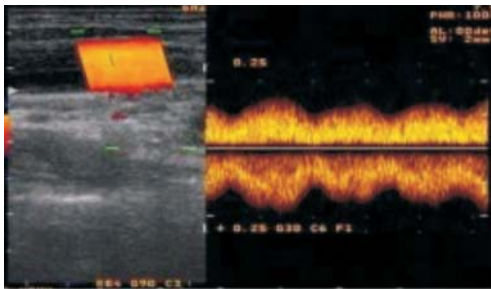
	N	Minimum	Maximum	Mean	Std. Deviator
DIA. OF IJV- Lt	81	6.2	18.2	8.606	1.696
DIA. OF IJV- Rt	81	6.1	19.2	8.722	1.776
Valid N (listwise)	81				

**Table-4 Diameter of Common Carotid Artery**

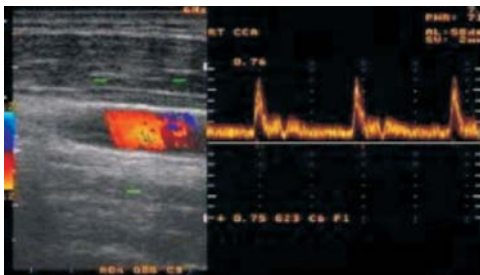
**Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
DIA OF CA - Lt	81	4.9	8.4	6.532	.702
DIA OF CA - Rt	81	5.0	9.1	6.583	.743
Valid N (listwise)	81				

**Picture-1. Venous flow wave of IJV.**



**Picture-2 Pulsatile flow wave of Common carotid artery.**



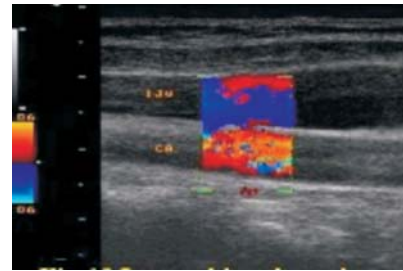
**Picture-3. Lateral relation of IJV to CCA (Cross section).**



**Picture-4. Anterolateral relation of IJV to CCA (Cross section).**



**Picture-5. Anterior relation of IJV to CCA (Longitudinal section).**



**Picture-6. Valves at Lower end of IJV**



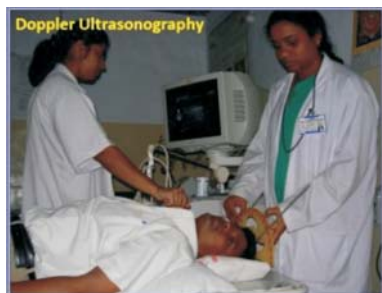
**Picture-7. Venous Ectasia (Longitudinal View).**



**Picture-8. Venous Ectasia (Cross section View).**



### Picture-9. Showing Method of positioning and Doppler Ultrasonography.



1. **Pillow under the shoulder.**
2. **Head rest to relax the head.**
3. **Styilet fixed to head with hair band.**
4. **Protractor to measure the degree of head rotation.**

#### REFERENCES :

1. James.Robert, (1998) Central venous catheterization and Central venous pressure monitoring. In: **Clinical procedures in Emergency Medicine Chapter22.pg.412-413.**, Fourth edn. Publ., Saunders, The Curtis center, Independence Square west, Philadelphia,PA 19106-3399.
2. Trianos CA .Kuwik RJ;Pasqual JR,Lim AJ,1996) Internal jugular vein and carotid anatomic relations as determined by ultrasonography. *Anesthesiology*: 85:43-48.
3. Jobes DR,Schwartz AJ,Stephenson LW,Ellison (1983) Safer jugular vein cannulation recognitions of arterial puncture and preferential use of the external jugular route. *Anesthesiology*:59:353-355.
4. Bart G,Denys,MD;Barry F;Uretsky MD;and P.Sudhakar Reddy MD, (1993) Ultrasound assisted cannulation of the internal jugular vein cannulating during insertion or withdrawal of the needle during central venous cannulation. *Anesth.Analg.* :76:1375.
5. Wisherart JD,Hassan MA Jackson JW(1972.) A complication of percutaneous cannulation of the internal vein. *Thorax*:24:496-499.
6. Lin BS, Kong CW, Tarng DC, Huang TP, Tang (1998 Jan) Anatomical variation of the internal jugular vein and its impact on temporary haemodialysis vascular access: an ultrasonographic survey in uraemic patients. *Nephrol Dial Transplant*. 13(1):134-138.
7. Cardi JG, Hawkins IF Jr, Wiechmann BN, Pevarski DJ, Tonkin JC. (1998 Nov) Sonographic guidance when using the right internal jugular vein for central vein access. *Am J Roentgenol*;**171(5):1259-1263**.
8. Armstrong PJ, Sutherland R, Scott DH (1992 Apr). The effect of position and different maneuvers on internal jugular diameter **Acta Anaesthesiol Scand**, **38:229 – 231**
9. Mangar WS, Moqhaled SA: (1993): Is the interna jugular vein cannulated during insertion or withdrawal of the needle during central venous cannulation? **Anesth. Analg.****76:1375**
10. Defalque RJ(1974) percutaneous catheterization of internal jugular vein. **Anesth. Analg.**:**53:116- 121**
11. Mc.Enany MT,Austien WG, (1977) Life threatening hemorrhage from inadvardant cervical arteriotomy. **Ann thoracic.surg.** **24:233-236**
12. Seldinger SI (1953) Catheter replacement of the needle in percutaneous arteriography. **Acta Radiol** **39:368**
13. Gratz I: Afshar M: Kidwell P;Weiman;Shariff(1994 may) Doppler – guided cannulation of the internal jugular vein: a prospective randomized trial. **J Clin Monit**, **10(3):185-188**.
14. Gilbert TB; Seneff MG; Becker RB (1995) Facilitation of internal jugular venous cannulation by audio-guided Doppler ultrasound vascular device: results from a prospective, dual – center, randomized, cross over clinical study. **Crit Care Med**, **23:60-65**.
15. Hayshi Y, Uchida O, Takaki O, et al: (1992) Internal jugular vein catheterization in infants undergoing cardiovascular surgery: An analysis of the factors influencing successful catheterization. *Anesth Analg* 74:688-693.

16. Verghese ST, McGill WA, Patel RI, Sell JE, Midgley FM, Ruttimann UE (1999 Jul;) Ultrasound-guided internal jugular venous cannulation in infants: a prospective comparison with the traditional palpation method. *Anesthesiology* 91(1):71-77.
17. Randolph AG, Cook DJ, Gonzales CA, Pribble (1996 Dec) Ultrasound guidance for placement of central venous catheters: a meta-analysis of the literature. *Crit Care Med.*;24(12):2053-2058.
18. Keenan SP ( 2002 Jun) Use of ultrasound to place central lines. *J Crit Care*;17(2):126-137.
19. Sha K, Simokawa M Kawaguchi M et al (1998) Use of transesophageal Echocardiography Probe Imaging to Guide Internal Jugular Vein Cannulation. *Anesth Analg*; 87 1032-1033.
20. D.Dolla, F.Cavatorta, S.Galli, A.Zollo. R.Ervo. (2001) Anatomical variations of the Internal jugular vein in non-uremic outpatients. *The Journal of Vascular Access* 2:60-63.
21. Peter L.William (2000) In: *Gray's Anatomy*, 38<sup>th</sup> Edn: Pg 1579 – 1580 ELBS, Churchill Livingstone .Publ., London, Newyork, Philadelphia. Sydney and toronto

---

**Authors :**

1. Shanta Chandrasekaran, Assistant Professor Department of Anatomy.  
Correspondence email: drshantasekaran@yahoo.co.in.
2. V.P.Chandrasekaran, HOD Department of Accident, Emergency and Critical care