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# Anatomical variations of internal jugular vein as seen by "site rite II" ultrasound machine--an initial experience in Pakistani population

Hameedullah  
*Aga Khan University*

M. A. Rauf  
*Aga Khan University*

Fazal Hameed Khan  
*Aga Khan University, fazal.hkhan@aku.edu*

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## Original Articles

### Anatomical Variations of Internal Jugular Vein as seen by "Site Rite II" Ultrasound Machine - an initial experience in Pakistani Population

Hameedullah, M. A. Rauf, F. H. Khan

Department of Anaesthesia, The Aga Khan University Hospital, Karachi.

#### Abstract

**Objective:** To determine the anatomical variations of the internal jugular vein (IJV) in Pakistani adult population with the help of Site Rite II ultrasound machine.

**Material and Method:** The right IJV relation to the carotid artery was visualized at four different landmarks (angle of the mandible, thyroid cartilage, cricoid cartilage, and the supraclavicular area). Size of IJV in comparison to carotid artery was also seen.

**Results:** In 49 cases the IJV was found in aberrant relation to carotid artery at the angle of the mandible (p value < 0.05), 22 at the thyroid cartilage, 20 at the cricoid cartilage, and 46 at the supraclavicular area (p value < 0.05). In 93% of cases the IJV was found to be larger than the carotid artery.

**Conclusion:** Care should be taken while cannulating IJV at the angle of the mandible and supra clavicular area by external landmark guided technique. Ultrasound guided technique should be used in every anticipated difficult case (JPMA 51:105;2001).

#### Introduction

Central venous cannulation is a commonly performed procedure by the anaesthesiologists in the operating room and intensive care unit for various reasons like massive volume resuscitation, administration of vasopressor agents, monitoring central haemodynamic parameters, temporary transvenous pacemaker insertion, infusion of irritant solutions and administration of total parental nutrition<sup>1</sup>.

It can be inserted through various sites like the antecubital veins, subclavian vein, internal jugular vein, external jugular vein and femoral vein. The right internal jugular vein (IJV) is a commonly used route for access to

central circulation by most anaesthesiologists because of its consistent anatomical position, easy accessibility during surgery, direct route into the right atrium, large diameter during trendelenberg position, predictable location and minimal likelihood for obstruction along its route to the right atrium<sup>2</sup>. It can also be reached faster than the subclavian vein<sup>3</sup>. The standard approach to right IJV cannulation uses visual and palpable anatomic landmarks to guide needle placement and is associated with a 95% success rate<sup>4</sup>. However various types of complications have been reported, even with internal jugular vein cannulation, including failure to locate the vein, carotid artery puncture, puncture of the stellate ganglion, vagal

nerve pulmonary artery, vertebral artery, aorta, mediastinum and pleura<sup>5</sup>.

Ultrasound may be used to give images of both the carotid artery and internal jugular vein in the neck<sup>6</sup>. There are a variety of ultrasound machines available but they tend to be large, complicated, expensive and not readily available. A new device, the "Site Rite-II" (Dymax) is a portable, light weight, real time ultrasound imaging system especially designed for viewing the internal jugular vein and carotid artery. It gives images similar to the large ultrasound machines and when used aseptically during cannulation, direct visualization of the position and direction of the locating needle can aid internal jugular vein location<sup>7</sup>.

Although the ultrasound method has compared favorably with the landmark technique, its widespread use has been hampered by the impracticality and expense of full sized echo devices and by the absence of larger prospective study data<sup>8</sup>.

The anatomical position of the IJV is generally lateral and anterior to the carotid artery<sup>9,10</sup>. An aberrant anatomical position of the internal jugular vein or unreliability of the external landmarks may be the underlying cause of difficult access or damage to adjacent structures<sup>11</sup>. Thus the objective of this study was to determine the anatomical variations of the internal jugular vein, if any, in the adult Pakistani population with the help of Site Rite II ultrasound machine.

## Materials and Methods

After approval from the Human Subject Protection Committee of The Aga Khan University Hospital, a descriptive, observational and cross sectional study was started in the operating rooms of the university. Two hundred subjects were randomly selected which included patients coming for elective surgeries, doctors and paramedical staff working in the operating rooms, on the basis of convenient sampling. Subjects were of either sex aged greater than 16 years. Subjects with history of any previous surgery on the neck, neurosurgical cases, those having swelling or mass in the neck, younger than 16 years and who refused the procedure were excluded from the study.

### Technique of Procedure

Verbal consent was taken from every individual entering the study before performing the procedure. Right side of the neck was selected as the study site for internal jugular vein examination. All the patients were made to lie supine without a pillow on the operating table with their head maximally rotated to the left<sup>11</sup>. The relationship of the

internal jugular vein to the carotid artery was recorded at the angle of mandible, at the level of thyroid cartilage, cricoid cartilage and 2 cms. above the clavicle and, the sizes of the vein and to the artery were compared.

### Statistical Analysis

The data was analyzed on Epi-info 6.02 software package. The differences between the established documented anatomy of internal jugular vein in International text books<sup>9,10</sup> and this study sample were determined by applying Chi square test of independence. Five percent of flexibility was allowed and p value <0.05 was considered statistically significant.

## Results

Total number of cases studied were 200. The demographic data of these subjects is shown in Table 1. The relationship of internal jugular vein with that of carotid artery was studied at four different sites and the following differences were noted:

### 1. Angle of the Mandible

At the angle of mandible, the IJV was not visible in 19 cases. One hundred thirty two cases (66%) had normal relation of IJV with carotid artery (antero-lateral and lateral), while in 5 cases it was anteromedial, in 40 cases anterior, in 2 postero-lateral and 1 each posteromedial and medial to the artery. The results showed a 14.56 degree of freedom with p value <0.05 (Table 2).

### 2. Thyroid Cartilage

At this site 178 cases (89%) had normal anatomy of IJV in relation with carotid artery (antero-lateral and lateral). Twenty two cases showed abnormal placement of these 5 were antero-medial 16 anterior and 1 was postero-medial. The results showed a 2.45 degree of freedom with non-significant p value (Table 2).

### 3. The Cricoid Cartilage

One hundred eighty cases (90%) had normal relation i.e. anterolateral and lateral. In 2 cases the internal jugular vein was anteromedial to the artery, in 17 anterior and in 1 it was posteromedial. The Chi square test with 5% flexibility came out to be 1.80 degree of freedom and p value was statistically non-significant (Table 2).

### 4. At Supraclavicular Area

At this landmark, the internal jugular vein or carotid artery were visualized in 2 cases. In 4 cases the vein was antero-medial to the artery, in 31 anterior, in 121 antero-lateral, in 41 lateral and in 1 case it was posterolateral. At this point anterior and anterolateral was considered as the

Table 1. Demographic data mean ± SD.

Variable	Total No.	Mean ± SD	Range	Mode
Age (years)	200	37.33 ± 14.92	17.0 - 74.0	30
Weight (kg)	200	65.21 ± 11.60	40.0 - 99.0	60
Height (cm)	200	163.12 ± 7.72	140 - 182.5	165
Sex (M:F)	200	131: 69		

Table 2. Relation of IJV to carotid artery at various positions (normal relation = bold and underlined).

Position	Angle of mandible		Thyroid cartilage		Cricoid cartilage		Supraclavicular area	
	No.	%	No.	%	No.	%	No.	%
Not visible	19	9.5	Nil	Nil	Nil	Nil	2	1
Anteromedial	5	2.5	5	2.5	2	1	4	2
Anterior	40	20	16	8	17	8.5	31	15.5
Anterolateral	99	49.5	135	67.5	140	70	121	60.5
Lateral	33	16.5	43	21.5	40	20	41	20.5
Posterolateral	2	1	Nil	Nil	Nil	Nil	1	0.5
Posteromedial	1	0.5	1	0.5	1	0.5	Nil	Nil
Medial	1	0.5	Nil	Nil	Nil	Nil	Nil	Nil

normal in 152 cases (76%). By applying Chi square test of independence and considering 5% as flexibility the result was 14.56 degree of freedom and p value was <0.05 that is statistically highly significant (Table 2).

#### Size of Internal Jugular vein to Carotid Artery

Of the 200 cases the internal jugular vein was larger than the carotid artery throughout the course in 186 cases, which was expected and considered normal. In 12 cases the vein was equal and in 2 it was smaller than the artery. By applying the Chi square test with 5% flexibility the p value was non-significant.

### Discussion

Central venous cannulation is now becoming a standard procedure in many patients for various reasons<sup>1</sup>. Different sites for central venous access have been used but the internal jugular vein is the most popular site among anaesthetists because of its consistent anatomical position, large diameter in Trendelenberg position, easy accessibility intraoperatively and minimal likelihood of obstruction along its route to the right atrium<sup>12</sup>.

Internal jugular vein cannulation is commonly

performed using external anatomical landmarks<sup>13</sup>. The physicians with little experience tend to have a higher complication rate during IJV cannulation<sup>14</sup>. Injury to one of the adjacent arteries is a major complication of which the most common is carotid artery puncture<sup>15</sup>. To decrease the complication rate accurate knowledge of the location of internal jugular vein is important for its cannulation<sup>14</sup>.

The anatomical position of IJV is generally lateral, anterior and/or anterolateral to the carotid artery and variation in relative position of these vessels can complicate the IJV cannulation<sup>12</sup>. To prevent this, Doppler and (2-D) two-dimensional ultrasound have been developed as technical aids to assist central venous catheterization through the IJV route. The 'Site Rite II' 2-D ultrasound machine (Dymax Corporation, Pittsburg, PA) was used in this study for imaging the relative anatomy of IJV. The superiority of this technique compared with landmark guided cannulation is that the machine is simple to use with minimal technical problems. It improves the subjective ease of cannulation, reduces the number of attempts required to locate the internal jugular vein, shortens the procedure time, and lessens the complication rate<sup>7</sup>.

The hypothesis that an aberrant anatomical position of the internal vein or unreliability of the external landmarks may be associated with racial and geographical variation of IJV was assessed in this study. The static anatomic features of IJV with carotid artery at the angle of the mandible, thyroid cartilage, cricoid cartilage and supra-clavicular area were evaluated. At these points the relation of the internal jugular vein to carotid artery, as well as their size relations were recorded.

Based on the ultrasound findings the relation of the IJV to the carotid artery at the angle of the mandible was found to be normal i.e. anterolateral and lateral in 66% cases. In 9.5% of cases the vein was not visible on ultrasound at this location which was the most dramatic aberrancy. This could be because of many reasons including observer bias, congenitally absent vein on right side, anatomical variation and thrombosis or occlusion due to previous cannulation<sup>8</sup>. There are two other possible explanations for this non-visualization. Firstly, the ultrasound scanner could not identify the IJV because the diameter of vein was so small and secondly, the ultrasound probe occluded the vein by excessive pressure of the probe on the neck vasculature. Twenty percent of IJVs were directly anterior to the carotid artery, 2.5% were anteromedial, 1.0% posterolateral and 0.5% were medial and posteromedial each. So in 24.5% of cases the anatomy of the IJV was sufficiently aberrant to complicate access by a blind method.

At the thyroid and cricoid cartilage, the incidence of normal relation with carotid artery was 89% and 90% respectively. Here the IJV was positioned in intimate contact, laterally and anterolaterally to the carotid artery. Thus statistically insignificant number of patients had an aberrant anatomy of IJV at these locations.

Finally at the supra clavicular area the IJV was found at its expected position i.e. anterior and anterolateral in 76% of cases, leaving 24% in abnormal locations. At this site also the cannulation would lead to complications if only external landmark technique is used.

The results of this study are comparable with the ultrasound based study by Armstrong et al, which demonstrated variation in size and anatomic relationship of the carotid artery to the IJV. It revealed that 5.0% of IJVs were lying at abnormal location at the level of the cricoid cartilage<sup>7</sup>.

Another study examined anatomic variations of IJV using an ultrasound device in 200 adult patients<sup>11</sup>. They found that in 8.0% of patients, the position of the IJV did not correspond well to that expected from standard surface landmarks. In 3.0% patients the IJV was unusually small and did not increase in diameter during the Valsalva

maneuver.

Alderson et al. showed the IJV anatomy in the paediatric age group<sup>16</sup>. They found that in 82.0% of patients the IJV ran anterolaterally to the carotid artery while in 4.0% of patients the vein was in a similar position relative to the carotid artery, but was of unusually small diameter. In 10.0% the vein ran medially, in 2.0% it ran widely lateral to the carotid artery.

Lin and Kong et al. studied 104 uraemic patients with the help of 'Site Rite' and observed the IJV anatomy on both sides. They found the anatomical variation on right IJV in 19 cases (18.3%) and left IJV in 17 cases (16.4%). This might contribute to difficulty in external landmark guided IJV cannulation<sup>17</sup>.

It is concluded that there are anatomical variations of internal jugular vein in Pakistani population. The angle of the mandible and supraclavicular area are the landmarks where statistically significant (p value <0.05) anatomical variations of IJV are found. So while cannulating IJV with external landmark guided technique, one should avoid these landmarks and use either the thyroid cartilage or cricoid cartilage as landmarks. In cases where anatomical landmarks are not clear or distorted and there is expected difficult cannulation, the ultrasound device, 'Site Rite' should always be used. Patients who cannot be cannulated by using anatomical landmarks alone may be successfully cannulated by ultrasound guidance.

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## **Maternal Deaths in a Developing Country: a Study from the Aga Khan University Hospital, Karachi, Pakistan 1988-1999**

R.N. Qureshi, S. Jaleel, R. Hamid, S.F. Lakha

Department of Obstetrics and Gynaecology, The Aga Khan University Hospital, Karachi.

### **Abstract**

**Objective:** The maternal deaths occurring over a twelve-year period (1988-1999) in a tertiary referral center were reviewed. The purpose of the study was to assess the causes of these maternal deaths.

**Setting:** The Aga Khan University Hospital (AKUH) Karachi, Pakistan.

**Methods:** The medical records of maternal deaths were reviewed. These were women who had either registered for delivery at the hospital; or were referred from another hospital or from home, when an emergency developed. They were either admitted to the Medicine, Surgery and the Obstetrics and Gynaecology Departments at the hospital.

**Results:** A total of 81 maternal deaths were identified, of which five were the registered patients. Causes of deaths were eclampsia, puerperal sepsis and pulmonary embolism. The maternal mortality ratio in the registered patients was 20 per 100,000 live births. Ninety percent of the women were between the age group of 15-35 years. Of these forty two percent were primigravidas, forty four percent of the women died due to direct causes, of which sepsis was the most common cause and accounted for twenty five percent of the total deaths. Indirect causes were responsible for 55.6% of the deaths, including hepatic failure in 21%, other infectious disease in 17% and malignancy in 5% of the cases.

**Conclusion:** In developing countries other than obstetrical causes, infectious diseases contribute to the death of women during childbearing years. Comprehensive medical services and adequate obstetrical emergency services can lower maternal mortality rates at all levels (JPMA 51:109;2001).

### **Introduction**

Pakistan like other developing countries of South Asia has high maternal mortality rates<sup>1</sup>. In a country where the total population is 130 million the estimated maternal mortality rate is 340 per 100,000 live births<sup>2</sup>. The magnitude and causes of the problem are difficult to measure as many estimates are based on hospital statistics. Seventy percent of the women (83% in the rural area and 40% in urban areas) do not receive any antenatal care. Majority (85%) deliver at home and in only 35% of the cases trained personnel are available. These deliveries and deaths may never be registered<sup>3,4</sup> and not many women who develop obstetric complications, may reach a hospital facility for treatment. Amongst those who go to hospital for prenatal care, majority go to private hospitals rather than Government hospitals<sup>5</sup>.

In developing countries other than obstetrical causes, infectious diseases contribute to the death of women during childbearing years. The response to infections in pregnancy

is altered, such as in malaria and hepatitis E, which are prevalent in Pakistan<sup>6</sup>.

This report is based on analysis of the maternal deaths that occurred over a twelve-year period in the Surgical, Medical and Ob-Gyn Departments of a tertiary referral private University hospital in Karachi. Most of these women had no prior contact with any trained health personnel<sup>3</sup>.

### **Material and Method**

The Aga Khan University Hospital (AKUH) is a private referral hospital with comprehensive services at tertiary level. The Hospital is located in Karachi, which has a population of over 13 million. The Obstetrics and Gynaecology department was commissioned in 1987 and the number of deliveries has increased to approximately 3000 per year. Ninety eight percent of these deliveries are registered patients who have attended the antenatal clinics at least once.