"COMPARISON OF THE EFFECT OF UPPER LIMB TOURNIQUET APPLICATION WITH TRENDELENBURG POSITION ON DIAMETER AND CROSS-SECTIONAL AREA OF RIGHT AND LEFT INTERNAL JUGULAR VEIN USING ULTRASOUND IN ADULT POPULATION: A ONE YEAR PROSPECTIVE STUDY"

By

REG NO. BA0120009

Dissertation

Submitted to the

KLE Academy of Higher Education & Research
(Deemed To-Be University), Belagavi, Karnataka

In Partial Fulfillment of the requirements for the degree of

M. D.

in

ANAESTHESIOLOGY

JAWAHARLAL NEHRU MEDICAL COLLEGE,

BELAGAVI, KARNATAKA

JUNE / JULY – 2023

KLE Academy of Higher Education & Research
(Deemed To–Be University), Belagavi, Karnataka

ENDORSEMENT

This is to certify that the dissertation entitled **"COMPARISON OF THE EFFECT OF UPPER LIMB TOURNIQUET APPLICATION WITH TRENDELENBURG POSITION ON DIAMETER AND CROSS-SECTIONAL AREA OF RIGHT AND LEFT INTERNAL JUGULAR VEIN USING ULTRASOUND IN ADULT POPULATION: A ONE YEAR PROSPECTIVE STUDY"** is a bonafide research work done by **REG NO. BA0120009.**

Dr. Rajesh Mane MD, DNB
Professor and Head,
Department of Anaesthesiology,
J. N. Medical College,
Nehru Nagar, Belagavi – 10

Date: 02/01/2023
Place: Belagavi

Dr. (Mrs) N.S Mahantashetti MD(Paed)
Principal,
J. N. Medical College,
Nehru Nagar, Belagavi – 10

PRINCIPAL
J.N. Medical College,
BELAGAVI- 590 010

KAHER * BELAGAVI * J.N.MEDICAL COLLEGE

Date: 02/01/2023
Place: Belagavi

ii

UNDERTAKING

I, **REG NO. BA0120009**, hereby declare that the information and the data mentioned in my dissertation entitled **"COMPARISON OF THE EFFECT OF UPPER LIMB TOURNIQUET APPLICATION WITH TRENDELENBURG POSITION ON DIAMETER AND CROSS-SECTIONAL AREA OF RIGHT AND LEFT INTERNAL JUGULAR VEIN USING ULTRASOUND IN ADULT POPULATION: A ONE YEAR PROSPECTIVE STUDY"** belongs to me and is original I am aware of the definition of plagiarism as detailed below.

- An act or instance of using or closely imitating the language and thoughts of another author without authorization and the representation of that author's work as one's own, as by not crediting the original author.

- A piece of writing or other work reflecting such unauthorized use or imitation
- The deliberate or reckless representation of another's words, thoughts or ideas as one's own without attribution in connection with submission of academic work whether graded or otherwise

I hereby declare that the dissertation prepared by me is original one and does not involve plagiarism anywhere. In case at a later stage, it is found that I have indulged in plagiarism, then I am solely responsible for the same and the institution is at liberty to take any disciplinary action against me including cancellation of dissertation or any other penalties imposed by the University.

Date: 02/01/2023

Place: Belagavi **REG NO. BA0120009**

PLEGARISM CERTIFICATE

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

JAWAHARLAL NEHRU MEDICAL COLLEGE

(Recognized by Medical Council of India, New Delhi)

Accredited 'A+' Grade by NAAC (3rd Cycle) **Placed in Category 'A' by MHRD (GoI)**

Nehru Nagar, Belagavi- 590 010, Karnataka, INDIA

0831 - 2471350 0831 - 2470759 www.jnmc.edu principal@jnmc.edu

Ref No: MDC/PG/ Date: 14-12-2022.

ACCEPTANCE LETTER

The softcopy of thesis entitled: **"COMPARISON OF THE EFFECT OF UPPER LIMB TOURNIQUET APPLICATION WITH TRENDELENBURG POSITION ON DIAMETER AND CROSS-SECTIONAL AREA OF RIGHT AND LEFT INTERNAL JUGULAR VEIN USING ULTRASOUND IN ADULT POPULATION: A ONE YEAR PROSPECTIVE STUDY"** has been submitted for Anti-Plagiarism check through Turnitin software. The scan has been carried out and the scanned output reveals a match percentage of **07%** which is within the acceptable limits of **10%** as per the guidelines given by UGC.

Guide.

J.N. KAHER MEDICAL COLLEGE BELAGAVI

Dr. (Mrs.) N.S. Mahantashetti.
Chairperson-Antiplagiarism Committee &
Principal,
J. N. Medical College, Belagavi.

To,
Reg. No. BA0120009,
Postgraduate Student,
2020-21 Batch,
Department of Anaesthesiology,
J. N. Medical College, Belagavi.

ETHICAL CLEARANCE CERTIFICATE

K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
(Deemed – to- be- University)
Accredited 'A' Grade by NAAC (2nd Cycle) Placed in Category 'A' by MHRD (GoI)
JAWAHARLAL NEHRU MEDICAL COLLEGE,
NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)
Website: http//www.jnmc.edu
E-Mail : dome@jnmc.edu
Phone: (+ 91-(0)831 Office : 2472550
Principal: 2471701
Fax No. +91 (0)831 – 2470759

Ref: MDC/DOME/ 97 **Date: 25/01/2021**

To.

REG NO. BA0120009

PG student in Anaesthesiology,
J.N.Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"COMPARISON OF THE EFFECT OF UPPERLIMB TOURNIQUET APPLICATION WITH TRENDELENBURG POSITION ON DIAMETER AND CROSS SECTIONAL AREA OF RIGHT AND LEFT INTERNAL JUGULAR VEIN USING ULTRASOUND IN ADULT POPULATION: A ONE YEAR PROSPECTIVE STUDY",** is ethical and justifiable.

The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

(Dr. Smita Sonoli)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Harsha Hegde)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

43

ABSTRACT

TITLE: "Comparison of the effect of upper limb tourniquet application with Trendelenburg position on diameter and cross-sectional area of right and left internal jugular vein using ultrasound in adult population: A one year prospective study"

Background and Aims:

Central venous cannulation is essential for administering ionotropes, iv fluid therapy, Central venous pressure monitoring, etc. Larger the vein, easier it is locate and cannulate. Hence, various methods like Trendelenburg position, Valsalva manneuver, passive leg raising are commonly used to increase the diameter and cross sectional area of IJV. In the present study, upper limb venous return was channelized to internal jugular vein by applying tourniquet and change in diameters and CSAs of internal jugular vein bilaterally were compared with Trendelenburg position.

Methods:

94 patients were included in the study, the anteroposterior diameter and cross sectional areas of right and left IJV and the relation of IJV with carotid artery were measured using ultrasound in 2 positions.

Trendelenburg position- The patients were placed supine with 20°Trendelenburg tilt.

The patient's position was changed to 20°Trendelenburg tilt.

Tourniquet application- The patients were placed supine with both the upper limbs raised above level of heart and held for three minutes. Esbach bandage was

used to drain the veins. Blood pressure cuffs were tied to both the upper limbs and the cuff pressure was raised and fixed at 50mmHg above the systolic blood pressure.

Results:

The mean antero posterior diameters of IJV in Tourniquet application technique (left IJV- 1.00±0.26cm, right IJV-1.05±0.26cm) were very significantly greater than that of in Trendelenburg position (left IJV- 0.89±0.26cm, right IJV-0.93±0.27cm.)

The mean CSAs of IJV were very significantly greater in Tourniquet application technique (Left IJV-0.84±0.39cm^2, right IJV-0.92±0.42cm^2) as compared with Trendelenburg position (Left IJV-0.67±0.39cm^2 ,right IJV-0.74±0.43cm^2) with p value of 0.0037 and 0.0030 for left and right IJV respectively. The left and right Internal jugular veins were found most commonly in anterolateral position in relation to carotid artery in both the techniques.

ABBREVIATIONS

ASA	-	American society of Anesthesiologists
BMI	-	Body mass index
CA	-	Carotid artery
CI	-	Confidence interval
cm	-	Centimeter
CSA	-	Cross-Sectional area
CVC	-	Central venous catheter
CVP	-	Central venous pressure
IJV	-	Internal jugular vein
kg	-	Kilogram
MHz	-	Mega hertz
min	-	Minute
ml	-	Milliliter
mm	-	Millimeter
MRI	-	Magnetic resonance imaging
SCM	-	Sternocleidomastoid muscle
SD	-	Standard deviation
USG	-	Ultrasonography
yrs	-	Years
Inj.	-	Injection

CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

LIST OF PHOTOGRAPHS

INTRODUCTION

Central venous catheterisation is the insertion of catheter into a great venous vessel and the most common vein used for central venous catheterisation is right internal jugular vein. The indications of catheterisation of IJV are administration of ionotropes, fluid therapy, delivering drugs, central venous pressure monitoring, pulmonary artery catheter introduction, secure venous access and transvenous pacing wire placement[1]

The techniques used for cannulation of IJV are blind technique and ultrasound guided technique.

In blind technique, IJV is cannulated by anterior/central/posterior approach on identifying the anatomical landmarks i.e, clavicle, the two heads of sternocleidomastoid and by palpating the carotid artery. Since cannulation is done relying purely on the anatomical landmarks, blind technique has higher incidence of complications like carotid artery puncture, pneumothorax, etc, especially in those with anatomical variations.

In ultrasound guided technique ultrasound probe is placed at the apex of the triangle formed by the two heads of sternocleidomastoid and the clavicle. Internal jugular vein and carotid artery are visualised and confirmed by colour doppler mode. The vessels are visualised and confirmed before and while the insertion of the needle into IJV. As a result, the ultrasound guided technique improves cannulation success rates and lowers incidence of complications.

Because of the above mentioned advantages ultrasound guided technique is preferred over blind technique.[2]

Unsuccessful cannulation with ultrasound guided technique is frequently observed when the vein is collapsed or has lesser CSA. The larger the cross-sectional area of internal jugular vein, the easier it is to locate and catheterize.

The diameter & subsequently the CSA of internal jugular vein can be increased using various maneuvers such as Trendelenburg, Valsalva, passive leg raising among which Trendelenburg position is most commonly practiced.

Trendelenburg position increases internal jugular vein diameter by increasing the venous return. However it is also associated with various complications like decrease in vital capacity, increase in intracranial pressure, intra intraocular pressure, arterial and venous pressures and cardiac overload. [3]

Application of upper limb tourniquet using Esmach's bandage and BP cuff, directs the venous return of upperlimb to the IJV and thus may have an effect on diameter and CSA of IJV.

In the present study, upper limb venous return was channelized to internal jugular vein by applying tourniquet and the effect on the AP diameters and CSAs of IJV on both the sides were compared with Trendelenburg position. The relationship of IJV with CA was also studied in each technique.

OBJECTIVES

The aims and objectives of the present study are to compare

PRIMARY OJECTIVE:

- The diameter and cross-sectional area of left and right internal jugular vein.

SECONDARY OBJECTIVE:

- The relation of left and right internal jugular vein with carotid artery.

between 20° Trendelenburg position and Upper limb Tourniquet application in adult patients.

REVIEW OF LITERATURE

The central venous catheterization was first demonstrated by Dr. Werner Forssman in 1929. He performed it by self-inserting a ureteric catheter through the cubital vein and guided into the right side of the heart. Since then, the technique of central venous catheterization has evolved gradually. The technique of central venous catheterization, popularly known as 'Seldinger's technique" was introduced by Dr. Sven- Ivan Seldinger in 1950 which is widely practiced till date.

In a prospective observational study conducted by Mehmet S Uluer et al in 2019 titled "comparison of the effect of the right lateral tilt position and Trendelenburg position on the right internal jugular vein" among 40 healthy volunteers of age above 18 years, the CSA of right IJV and the relation of IJV with carotid artery anatomically were noted in four positions, namely, supine (baseline), 10ºTrendelenburg, 10º right lateral tilt and 10º Trendelenburg with 10ºright lateral tilt. It was observed that 10ºTrendelenburg position with 10ºright lateral tilt position and 10ºTrendelenburg position showed significant increase in the CSA area, AP and transverse diameters among all the positions. It was also observed that there was no significant difference in CSA of right IJV in 10ºright lateral tilt compared with supine position. This emphasized that Trendelenburg position was the most effective position for increasing the CSA of right IJV among all the positions.[4]

B Arslan et al, in 2018 conducted a prospective observational cross over study titled "the effects of combined Trendelenburg and passive leg raising positions on cross sectional area of right IJV" among 120 patients scheduled for any elective surgery. In this study the horizontal diameter, vertical diameter, CSA and circumference of right IJV were measured in 3 positions i.e., 20º Trendelenburg position, 20º Trendelenburg with 40º passive leg raising and supine position. It was

observed that there was a slight decrease in CSA of right IJV when measured in 20º Trendelenburg with 40º passive leg raising position as compared with 20º Trendelenburg position alone though statistically insignificant and hence there was no additional benefit of passive leg raising when combined with Trendelenburg position to increase CSA of right IJV.[5]

Shouyu Xie et al, in their study conducted in 2018 compared "the effect of different degrees of passive leg raising on the CSA of internal jugular vein and the success rate of IJV cannulation"[6] among 82 patients scheduled for thoracic surgery. The effect of BMI, gender, age, fasting time and preoperative rehydration on CSA of right IJV at different degrees of PLR was also compared. It was observed that there was significantly highest increase of CSA of IJV and highest success rate of IJV cannulation in 50º PLR position as compared to 30º PLR and supine positions. It was also observed that PLR has showed greatest increase in CSA of right IJV among patients who had fasting time more than 15 hours before thoracic surgery.

Perlin karaaslan et al, in their study conducted in 2017 among 52 healthy volunteers in a university hospital in Turkey compared Trendelenburg position Vs upper limb tourniquet in right internal jugular vein diameter. In this study "the haemodynamic measurements (systolic and diastolic blood pressure, heart rate and oxygen saturation) and CSAs & diameters of right IJV were compared between 3 positions i.e, supine, 20º Trendelenburg & supine with tourniquet application. It was observed that the cross-sectional area and diameter of right IJV were significantly increased in Trendelenburg position and supine position with tourniquet application as compared to supine position and the above-mentioned measurements were significantly increased in supine position with tourniquet application as compared with Trendelenburg position. This study concluded that tourniquet application is a

better technique than TL and the supine position on increasing the IJV diameter and CSA."[3]

A study was conducted by Hee Yeong Kim et al in 2016 on "effects of the Trendelenburg position and Positive End-Expiratory Pressure on the CSA of IJV among 47 children scheduled for the repair of simple congenital heart defects"[7]. The CSA of right IJV was measured after administering general anaesthesia in the following manoeuvres namely supine with PEEP of 5cm H2O, supine with PEEP of 10cm H2O,10º Trendelenburg without PEEP, 10º Trendelenburg with PEEP of 5cm H_2O,10º Trendelenburg with PEEP of 10cm H2O. It was observed that "10º Trendelenburg position with PEEP of 10cm H_2O showed highest increase in CSA of right IJV among all the manoeuvres and thus increasing the rate of a successful cannulation in children."[7]

Funda Gok, et al, in 2015 conducted a study titled "Comparison of the effect of the Trendelenburg and passive leg raising positions on internal jugular vein size in critically ill patients"[2] on 78 patients scheduled for central vein cannulation in intensive care unit. In this study the CSA, vertical,transverese diameters & depth of the IJV were compared between three positions i.e, supine, 10° Trendelenburg and 40° passive leg raising positions. It was observed that the size of IJV was maximum increased in Trendelenburg. The increase in size of IJV in passive leg raising position was similar and comparable with that of Trendelenburg position with supine position. Where as, the measurements taken in 10° TL were not different compared to that of 40° PLR. This study concluded that 10° TL and 40° PLR positions widen IJV to a similar extent compared to supine position.

Sarunas Judickas et al, in 2015 conducted a prospective study among 63 healthy volunteers in Lithuania to find out various manoeuvres for the improved visualization of internal jugular vein. The other manoeuvres which were compared in this study are 30° head elevation, 45° passive leg raising,10° Trendelenburg position, resting inspiration hold, hold of deep breath, resting and forced expiration hold. Among all the maneuvers, the hold of deep breath and 45° passive leg raising maneuvers showed considerable increase in size of IJV. It was observed that the increase in size of IJV by hold the breath technique was more compared to Trendelenburg technique. It was concluded by their study that hold of deep breath and 45° passive leg raise maneuvers can be used as the substitute to Trendelenburg position for the better visualization of internal jugular veins.[8]

A prospective and randomised study done by Dincyurek GN et al, in 2015 among 100 patients aged 2-12 years in a health application and research centre in Turkey to "compare the effects of the Trendelenburg position and the Valsalva manoeuvre on internal jugular vein diameter and placement". In this study right internal jugular vein diameter is measured in the various surgical positions i.e., supine position, supine position with Valsalva, 15º Trendelenburg position, 15º Trendelenburg position with Valsalva,15º reverse Trendelenburg position and 15º reverse Trendelenburg position with Valsalva. It was observed that when compared with supine position, there was significant increase in right IJV diameter in all the positions except reverse Trendelenburg position and among all the positions, the highest increase in right internal jugular vein diameter was observed in 15º TL with Valsalva.[9]

A study was conducted by Jeong Gil Lee et al in 2013 on "the effect of Trendelenburg position on right and left internal jugular vein cross sectional area"[10] among 58 patients belonging to age group of 18 to 75 years who were scheduled for abdominal or

gynaecological surgeries under general anaesthesia. The measurements noted in this study were transverse and AP diameters and CSAs of IJV on both sides in 10º Trendelenburg position. It was observed that the mean diameters and CSA of right IJV were greater than left IJV in supine position and there was a significantly greater increase of measurements of right IJV as compared to left IJV in 10º Trendelenburg position.

A study conducted by Hanke E Marcus et al in 2010 to evaluate "the impact of Trendelenburg position and positive end expiratory pressure on the internal jugular cross-sectional area"[11] among 50 patients posted for cardiothoracic surgeries. The CSA of Right IJV was measured in 5 different manoeuvres i.e., supine position with PEEP of 5cm H2O, supine position with PEEP of 10cm H2O,20º Trendelenburg position, 20º Trendelenburg position with PEEP of 5cm H2O and 20º Trendelenburg position with 10cm H2O along with the supine position (control). Among all the manoeuvres, it was observed that "the increase in CSA of right IJV was maximum in 20º Trendelenburg position with PEEP of 10cm H2O."[11]

Massimo Lamperti, et al in 2010 conducted a prospective, randomized, controlled, nonblinded study to assess the safety of 2 different head positions for right IJV cannulation among 1424 patients who had undergone major neurosurgical procedures. The 2 head positions which were compared in this study are neutral head position and 45º head rotation to contralateral side. The frequency of major and minor complications, venous access time, and perception of difficulty during the procedure were measured. It was observed there was no statistical difference in frequency of complications and perception of difficulty during the procedure between the 2 head positions. It was also observed that there was increase in the rate of complications due to increase in the venous access time but not related to either of the head position.[12]

In the study conducted by Verghese, et al, in 2002 on "the effects of the simulated Valsalva maneuver, liver compression, and/or Trendelenburg position on the cross-sectional area of IJV among 84 patients of age group 1month to 6 years, the CSA of right IJV was measured in 8 maneuvers by various combinations of positions and maneuvers. It was observed that in infants, there was maximum increase in CSA of right IJV when the following maneuvers were combined i.e., Valsalva, liver compression and Trendelenburg position and no single maneuver significantly increased CSA of right IJV when applied alone. In children, the significant increase in CSA of right IJV was observed by Valsalva maneuver alone and by the following combinations, Trendelenburg +Valsalva+ liver compression, supine+ Valsalva+ liver compression, Trendelenburg+ liver compression and Trendelenburg+ Valsalva. The increase in CSA of right IJV due to various maneuvers was more pronounced in children (1year to 6 years) than infants (1 month to 1 year)." [13]

In the present study, the effect of Trendelenburg position and upper limb tourniquet technique on the internal jugular vein diameters and CSAs on both the sides was assessed along with its relationship with carotid artery to determine the most favourable technique for IJV cannulation.

BASIC SCIENCES

VEINS:

Veins are the blood vessels present throughout the body that carry deoxygenated blood from various organs and peripheral tissues back to the heart. Veins are classified into pulmonary and systemic veins based on the type of blood they carry and deep and superficial veins based on their location. Most of the veins contain unidirectional valves which allows blood flow towards the heart.

Blood from the capillary bed after gaseous exchange enters the venules which are the smallest blood vessels in the venous system. Numerous venules converge to form veins and the large veins drain into right side of the heart eventually. The two large veins which drain blood to right atrium of the heart are superior venacava (SVC) and inferior venacava (IVC). The venous blood from brain, head, neck, thorax and upper limbs drain into SVC. IVC receives venous blood from lower limbs and abdomen. A central vein the one which lies at close proximity to the centre of circulation (heart). SVC and IVC form the central veins and gaining access to these veins allows the direct access to heart.

CENTRAL VENOUS ACCESS:

Central venous access is defined as placement of a catheter such that the catheter is inserted into a venous great vessel. These include internal jugular vein, subclavian vein, superior vena cava, brachiocephalic veins, inferior vena cava, iliac veins and common femoral vein. Central venous catheters help in haemodynamic monitoring which may not be accurately measured by non-invasive means[14]. It also helps in administering medication and nutritional support which cannot be given safely through a peripheral venous catheter. Right internal jugular vein is one of the most commonly used sites for central venous access. It has a predictable location,

ease of access during surgery, enters right atrium directly and a high success rate[15]. It has the lowest incidence of mechanical complications compared to subclavian and femoral access. Internal jugular and subclavian catheterization is associated with lower rate of blood stream infections compared to femoral catheterization[16]. Internal jugular vein cannulation is associated with low rate of severe mechanical complications compared to subclavian[17]. Left internal jugular vein cannulation is associated with more complications than right internal jugular vein cannulation[18]. Anterior approach for IJV is the better technique with success more on the right[19] Because of the above reasons and ease of access, the right internal jugular vein is preferred as the site for central venous cannulation.

Central venous cannulation is associated with complications like arterial puncture, haematoma, nerve injury, haemothorax and pneumothorax[19]. The rate of complications is less when central venous cannulation is done under ultrasound guidance along with the higher success rate of cannulation .Thus, ultrasound guided approach is preferable over landmark technique.

Anatomy of the Internal jugular vein:

Internal jugular vein is formed by the union of inferior petrosal and sigmoid dural venous sinuses in or just distal to the jugular foramen. It descends in the carotid sheath with the internal carotid artery. The Vagus nerve lies between the two. It descends down between the two heads of the sternocleidomastoid to the thorax where it joins the subclavian vein to form the brachiocephalic vein.[20] It receives blood from inferior petrosal sinus, pharyngeal veins, facial vein, lingual vein, superior and middle thyroid vein. Its relationship to carotid varies at different levels. It lies anterior, anterolateral and lateral to the carotid at C2, C3 and C4 vertebrae respectively.[21]

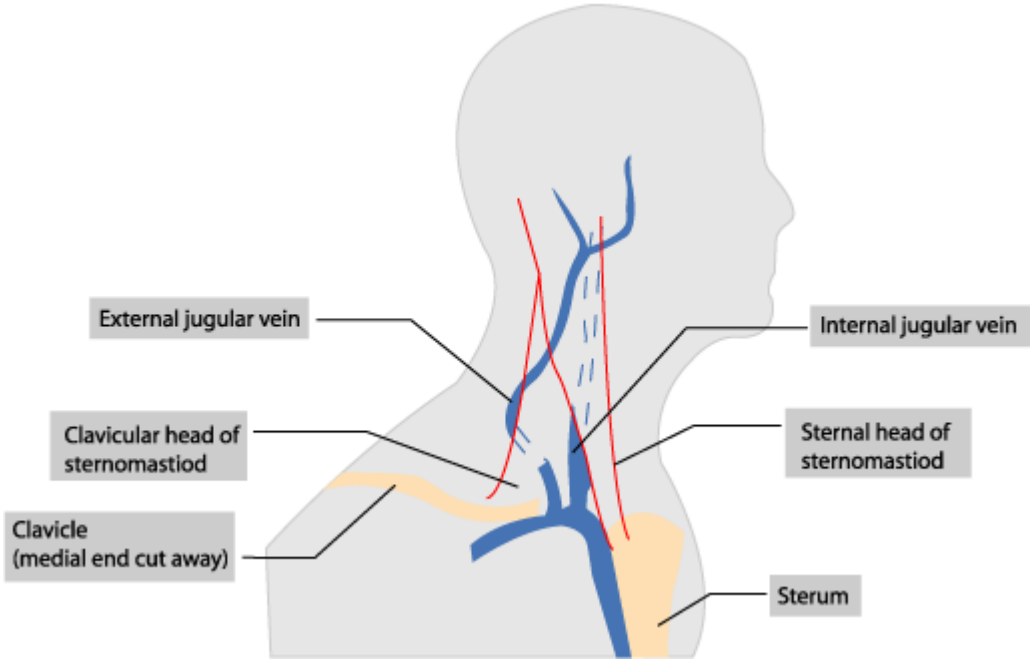


Figure 1: Surface anatomy of right Internal jugular vein

Relations of IJV:

Its anterior relations include spinal root of accessory nerve at the upper third, lower root of Ansa cervicalis at the middle third and it is crossed in the lower third by Sternocleidomastoid muscle and tendon of Omohyoid muscle.

Its posterior relations include lateral mass of C1, middle scalene muscle, anterior scalene muscle and pleura of lung apices.

The Internal Jugular Vein can be identified by using the Sedillot's triangle as the surface landmark. It includes the Sternal head of Sternocleidomastoid on the medial aspect, the Clavicular head of Sternocleidomastoid on the lateral aspect and the superior border of the medial third of the clavicle at the base. Internal Jugular Vein can be cannulated by a skin puncture at the superior aspect of this triangle.[22]

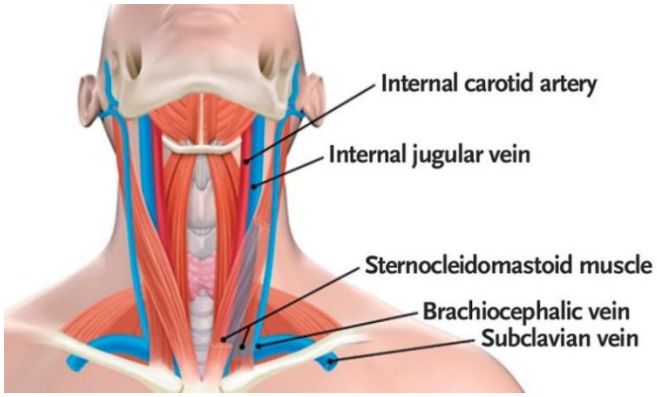


Figure 2: Relationship of IJV with carotid artery

Tributaries of IJV:

The inferior petrosal sinus, facial, lingual, pharyngeal, superior and middle thyroid veins, and occasionally the occipital vein, are the tributaries of the internal jugular vein. The internal jugular vein may communicate with the external jugular vein. The thoracic duct opens near the union of the left subclavian and internal jugular veins, and the right lymphatic duct opens at the same site on the right.

ULTRASOUND:

Ultrasonography is a diagnostic imaging technique utilizing reflected highfrequency sound waves to delineate, measure, or examine internal body structures or organs. Medical ultrasound frequencies range from 2 to 15 MHz although higher frequencies may be used sometimes[23]. The basic principle requires sending pulse of ultrasound into the body and waiting for an echo to return. These returning echoes are processed to produce an image of the internal structures.[24]

Transducer:

The waves are produced by a transducer, which can both emit ultrasound waves, as well as detect the ultrasound echoes reflected back. The active elements in ultrasound transducers are made of special ceramic crystal materials called

piezoelectrics.[25] These materials are able to produce sound waves when an electric field is applied to them, but can also work in reverse, producing an electric field when a sound wave hits them. When used in an ultrasound scanner, the transducer sends out a beam of sound waves into the body. The sound waves are reflected back to the transducer by boundaries between tissues in the path of the beam (e.g. the boundary between fluid and soft tissue or tissue and bone). When these echoes hit the transducer, they generate electrical signals that are sent to the ultrasound scanner. Using the speed of sound and the time of each echo's return, the scanner calculates the distance from the transducer to the tissue boundary. These distances are then used to generate two-dimensional images of tissues and organs.

Transducers are available in many shapes and sizes. The shape of the probe determines its field of view, and the frequency of the emitted sound waves determines how deep the sound waves penetrate and the resolution of the image. The three basic types of probe used are linear, curvilinear and phased array . The ultrasound images obtained by a linear transducer will be rectangular in shape while those obtained by curvilinear will be wider with increased depth.[26]

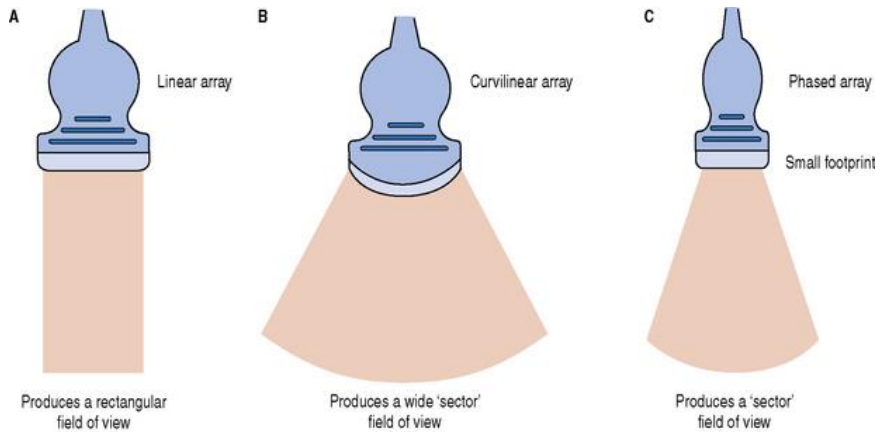


Figure 3: Different types of sectors of ultrasound probes

Modes:

Four different modes of ultrasound are used in medical imaging.

• A-mode: A-mode is the simplest type of ultrasound. A single transducer scans a line through the body with the echoes plotted on screen as a function of depth. Therapeutic ultrasound aimed at a specific tumor or calculus is also A-mode, to allow for pinpoint accurate focus of the destructive wave energy.

• B-mode: In B-mode ultrasound, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen.

• M-mode: M stands for motion. In m-mode a rapid sequence of B-mode scans whose images follow each other in sequence on screen enables doctors to see and measure range of motion, as the organ boundaries that produce reflections move relative to the probe.

Doppler mode: This mode makes use of the Doppler effect in measuring and visualizing blood flow.

The two techniques used in the present study are:

- Trendelenburg position
- Upperlimb tourniquet technique

TRENDELENBURG POSITION:

The Trendelenburg position is a surgical position where the individual lies supine, or flat on their back, with their feet raised higher than their head. Trendelenburg position is often used in lower abdominal surgeries, including colorectal, gynecological, and genitourinary procedures. In this position, gravity pulls the intra-abdominal organs away from the pelvis, allowing for better surgical access to the pelvic organs. In critical care settings, the Trendelenburg position is also used for the placement of a central venous catheter in the internal jugular or subclavian vein. Gravity causes blood to pool in the upper body, increasing the filling and distension of the upper central veins and making them easier to puncture.

Disadvantages:

The Trendelenburg position can also increase intraocular and intracranial pressure. Therefore, it should be avoided in individuals with head injuries or known intracranial hypertension. In addition, prolonged Trendelenburg positioning may result in significant facial and upper airway edema, which may lead to airway compromise after extubation. Pulmonary function may also be affected as the movement of the abdominal organs towards the diaphragm can decrease lung expansion, lung volumes and functional residual capacity. The shoulder braces used to keep individuals from sliding off the operating table can lead to brachial plexus injuries, thereby causing damage to the nerves supplying the upper limbs.

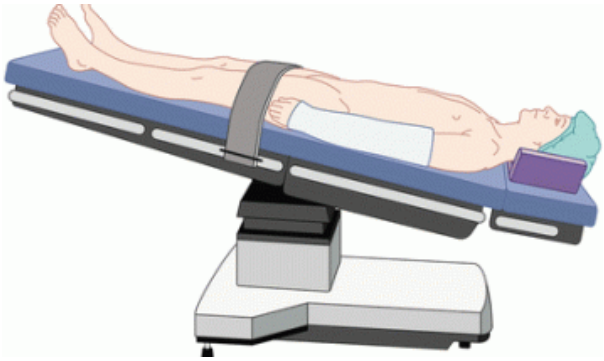


Figure 4: Trendelenburg

ESMARCH TOURNIQUET:

An esmarch bandage or esmarch tourniquet is traditionally a soft, rubber bandage that can be used in emergencies to expel excess blood from a limb that has had its blood supply cut off through the use of a tourniquet. The limb is usually elevated and the esmarch is used when blood pooling in the limb could complicate the surgery. A bloodless area is usually required to apply general anesthetic and for regional nerve block. In this study Esmarch bandage is used to drain the blood from upper limbs channelising the blood towards IJV.

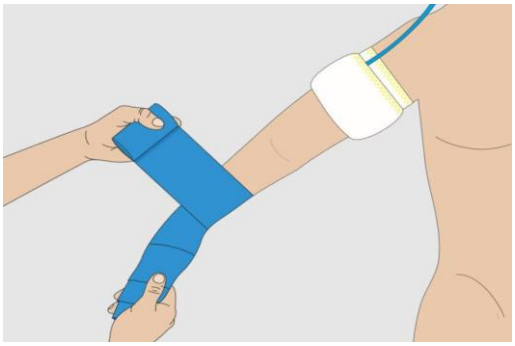


Figure 5: Esmarch bandage application

All the angles in the present study were measured by a mobile application, clinometer.

CLINOMETER:

It is an android application. It uses the gyroscope present in the smartphones to measure the plane of the phone in both horizontal and vertical axes. That is, it simply measures the degree of tilt or the degree of inclination from a neutral point on a plane surface if used perpendicular to that surface. If kept horizontally it acts similar to a spirit level and determines whether the surface is flat. It can be downloaded on android smart phones from the google play store. By using this application, the table tilts for Trendelenburg position and ipsilateral position can be measured in degrees effectively.

Figure 6: Clinometer- mobile

MATERIAL AND METHODS

The present study titled "Comparison of the effect of upperlimb tourniquet application with Trendelenburg position on diameter and cross-sectional area of right and left internal jugular vein using ultrasound in adult population: A one-year prospective study" was conducted among patients belonging to ASA grade I and II posted for elective surgeries between January 2021 to December 2021 at KLE Charitable hospital, Nehru Nagar, Belagavi and were recruited as per the inclusion and exclusion criteria.

(Data Collection-12 Months)

Type of study:

A prospective observational study

The inclusion criteria were as follows:

- ASA physical status I and II.
- Age between 18 to 60 years.
- Patients undergoing elective surgeries
- Provides Consent

The Exclusion criteria criteria were as follows:

- Patient undergoing emergency surgery.
- Any pathology of neck and thorax.
- Previous neck surgery
- Any pathology of upper limbs
- Previous internal jugular vein catheterisation
- BMI >30kg/m^2
- Pregnant women

Sample Size:

Total sample size was 94.

Calculation of sample size:

The sample size was calculated by using the results obtained in the previous study conducted by Lee et al., and the parameter considered for calculation was change in the cross-sectional area of IJV.

As per the equation given below, the required minimum sample size was calculated.

$$n = \frac{z_\alpha{}^2 P(1-P)}{d^2}$$

where P - % of prevalence

d – % of variation in prevalence.

As z_α varies with level of significance, $z_\alpha = 1.96$ (for 5% level of significance)

On substituting the following values i.e, P = 39.4%, d = 25% of P = 9.85%, 94 was the calculated sample size required.

Methodology:

After obtaining the approval of Institutional Review Board and Ethical committee and written informed consent, a total of 94 patients aged between 18 to 60 years were included in the study.

After having met inclusion and exclusion criteria and having obtained informed consent, patients were made to lie down in supine position on the adjustable bed in the preoperative room. The triangle formed by the two heads of sternocleidomastoid were marked on both the sides and the ultrasound probe was placed at the apex of triangle. Ultrasound machine of model- Sonosite-M turbo was used. The linear probe of 13-6MHZ was placed perpendicularly over the skin at the apex of the triangle. The frozen images of the vessels were taken using B-mode. The anterio posterior(AP)

diameter and CSA of IJV on both sides were noted in the two different techniques as follows.

- Trendelenburg (TL): The patient was placed in 20°Trendelenburg position with 30° head rotation to contralateral side for convenient placement of probe at the desired location and for duration of 3 minutes. All the angles were then measured using clinometer mobile application. The AP diameters and CSA of left and right IJV were measured in this position. The relation of IJV to CA anatomically was assessed at the apex of the triangle formed by two heads of sternocleidomastoid and noted as anterior/anterolateral/lateral to carotid artery

- Upperlimb Tourniquet application (TQ): The patient's position was restored to supine position . After a 10-min pause, both the upper limbs were raised above level of heart and held there for three minutes. Esbach bandage was used to drain the veins. BP cuffs were tied to both the upper limbs. The pressure was fixed at 50mmHg above the systolic BP and measurement of AP diameters and CSAs of IJV on both sides were noted in this position with head rotated 30° to contralateral side. The patient's head was kept in neutral position and the relation of IJV to carotid artery was assessed on both the sides and noted.

  All the patients underwent measurement of AP diameters and CSAs of left and right IJV in the two different techniques.

1. 20° Trendelenburg

2. Upperlimb tourniquet application

All the measurements were measured at the apex of triangle formed by two heads of sternocleidomastoid. The relation of IJV with CA was assessed at the apex of

triangle formed by two heads of sternocleidomastoid and noted as anterior/anterolateral/lateral to carotid artery in both the techniques.

The AP diameters and CSAs of IJV on both sides were recorded using 13-6MHz linear ultrasound probe. The cross sectional area was measured by using the frozen images.

The readings were tabulated as,

		TL	TQ
Right IJV	AP diameter		
	CSA		
Left IJV	AP diameter		
	CSA		

The relation of IJV to CA was tabulated as,

	TL	TQ
Relation of right IJV to CA		
Relation of left IJV to CA		

Statistical Analysis:

Descriptive statistics of AP diameter, and CSA in TL and TQ and their difference was analysed and summarised in terms of mean with standard deviation.

Student's unpaired t test was used to compare the change in the AP diameter, and CSA between TL and TQ

Demographic data (Age,gender,ASA status) and other categorical data was analysed and expressed in terms of percentage.

Median was used to denote discrete variables

For all the tests the suitable graphs were used to depict the comparison. P value less than 5 % (0.05) was considered as significant.

RESULTS

The present study titled "Comparison of the effect of upperlimb tourniquet application with Trendelenburg position on diameter and crosssectional area of right and left internal jugular vein using ultrasound in adult population: A one-year prospective study." showed the following results.

The results were assessed, analysed and tabulated as follows:

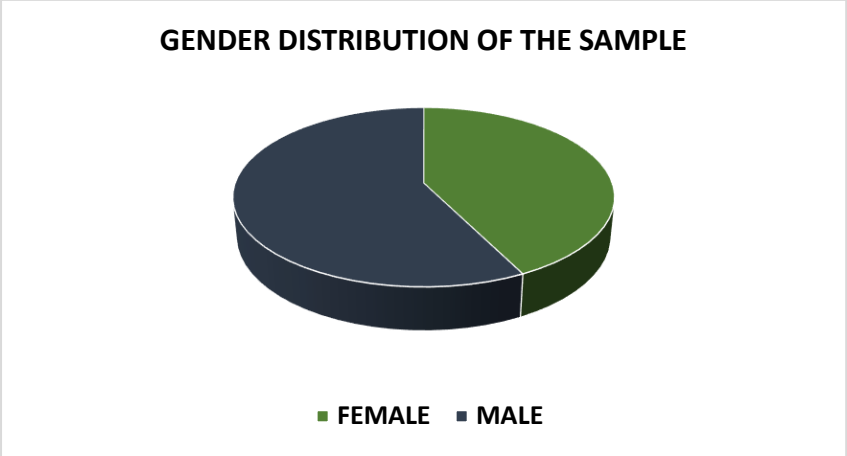
Table 1: GENDER DISTRIBUTION OF THE PARTICIPANTS

GENDER	NUMBER	%
FEMALE	40	42.55
MALE	54	57.45
TOTAL	94	100.00

Among all the participants, 54% of them were male.

The gender distribution is depicted in the graph below:

GRAPH 1:



Male to female ratio was 1 : 0.74

The age distribution of the participants is tabulated as:

Table 2: AGE DISTRIBUTION OF THE PARTICIPANTS

AGE	NUMBER	%
15 - 24	8	8.51
25-34	29	30.85
35 - 44	29	30.85
45 -54	21	22.34
55 -64	7	7.45
TOTAL	94	100.00

Majority of those participated in the study belonged to middle age group. Total of 79 out of 94 participants (84.04%) were between 25 to 54 years of age.

Table 3: MEAN AGE OF THE PARTICIPANTS

	MEAN	S.D.	MIN	MAX
AGE	37.83	10.55	19	60

The mean age of the study population was 37.83 with S.D being 10.55

The age distribution of the sample is depicted in the graph below

GRAPH 2:

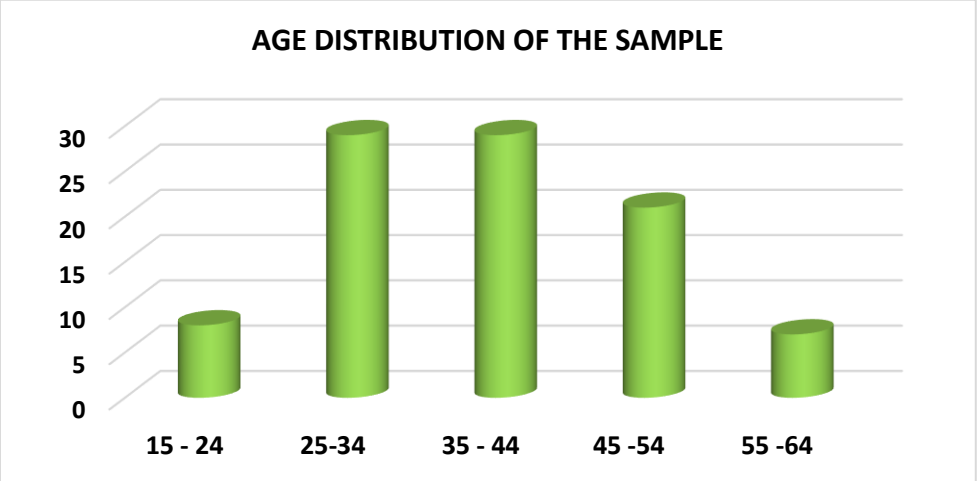


Table 4: ASA STATUS OF PARTICIPANTS

ASA	NUMBER	%
1	78	82.98
2	16	17.02
TOTAL	94	100.00

Majority of the participants belonged to ASA grade 1 i.e, 82.98% and 16% belonged to ASA grade 2.

The demographic distribution of participants is summarized in the table given below:

Table 5: DEMOGRAPHIC DISTRIBUTION OF PARTICIPANTS

	MEAN	S.D.	MIN	MAX
WEIGHT (kg)	63.29	8.09	48	87
HEIGHT (cm)	63.38	8.74	147	180

The mean weight of the participants was 63.29cm with S.D. 8.09. The minimum and maximum weight were 48kg and 87kg respectively.

The mean height of the participants was 63.38cm with S.D. 8.74. The minimum and maximum height were 147cm and 180cm respectively.

The mean diameters of right and left IJV are tabulated as:

Table 6: MEAN RIGHT AND LEFT IJV DIAMETERS IN BOTH THE TECHNIQUES

R IJV DIA TL				R IJV DIA TQ					
MEAN	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
0.93	0.27	0.09	1.92	1.05	0.26	0.11	1.76	0.0025	VS
L IJV DIA TL				**L IJV DIA TQ**					
0.89	0.26	0.05	1.85	1.00	0.26	0.09	1.69	0.0036	VS

The mean diameter of right IJV in TL was 0.93(±0.27) and in TQ was 1.05(±0.26).

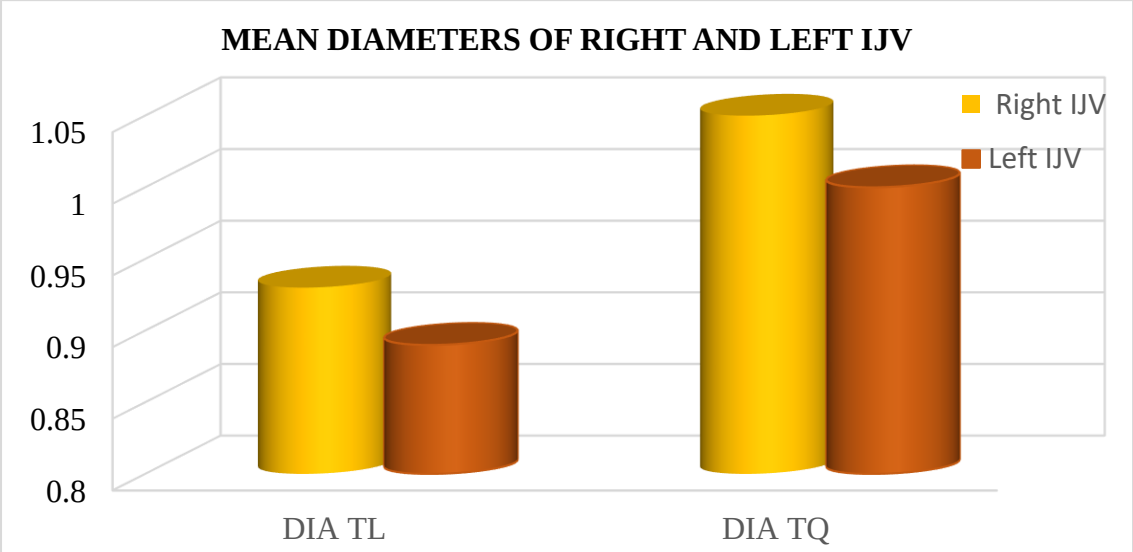
There was increase of 12.9% with the p value 0.0025 (Very significant).

The mean diameter of left IJV in TL was 0.89(±0.26) and in TQ was 1.00(±0.26).

There was increase of 12.3% with the p value 0.0036 (Very significant).

The graphic representation of mean diameters of right and left IJV is given below.

GRAPH 3:



The mean CSAs of right and left IJV is tabulated as:

Table 7: MEAN RIGHT AND LEFT IJV CSA IN BOTH THE TECHNIQUES:

R IJV CSA TL				R IJV CSA TQ					
MEAN	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
0.74	0.43	0.10	2.90	0.92	0.42	0.10	2.43	0.0030	VS
L IJV CSA TL				**L IJV CSA TQ**					
0.67	0.39	0.06	2.69	0.84	0.39	0.07	2.24	0.0037	VS

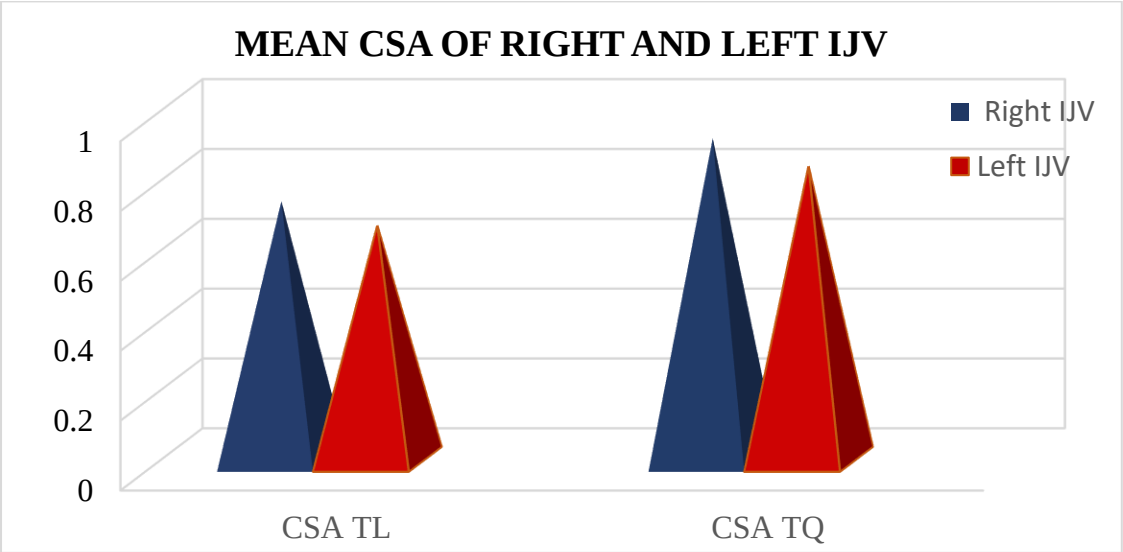
The mean CSAs of right IJV in TL was 0.74(±0.43) and in TQ was 0.92(±0.26).

There was increase of 24% with the p value 0.003 (Very significant).

The mean CSAs of left IJV in TL was 0.67(±0.39) and in TQ was 0.84(±0.39). There was increase of 25% with the p value 0.0037 (Very significant).

The graphic representation of mean CSAs of right and left IJV in TL and TQ is given below:

GRAPH 4:



The relation of Right and Left IJV with CA are tabulated as:

Table 8: RELATION OF RIGHT AND LEFT IJV WITH CA IN BOTH THE TECHNIQUES

Relation of R IJV with CA in TL			**Relation of R IJV with CA in TQ**	
	Number of participants	**Percentage (%)**	**Number of participants**	**Percentage (%)**
Anterolateral	90	95.7	90	95.7
Lateral	4	4.3	4	4.3
Anterior	0	0	0	0
Total	94	00	94	100

The relation of IJV with carotid artery was anterolateral in 90 out of 94 participants. It was similar in both right and left IJV in both the techniques.

DISCUSSION

The success of Internal jugular vein catheterization mainly depends on the size of IJV. As the size of IJV increases, it results in successful cannulation and fewer complications. In order to increase the diameter and there by the cross sectional area of internal jugular vein, various manoeuvres such as Trendelenburg, Valsalva , passive leg raising are used among which Trendelenburg position is most commonly practiced. Upper limb tourniquet application is a newer technique which can be used for IJV cannulation. The effect of upper limb tourniquet technique was compared with the Trendelenburg position on the AP diameter and cross sectional area of IJV in the present study.

Total of 94 subjects were included in the present study out of which 54 were male with male to female ratio of 1:0.74. The gender distribution is almost equal among both the genders.

Age group of subjects included in the study was 18 to 60 years. The majority of subjects were of age between 25 to 54 years.

In the present study, the mean diameter of right IJV in TL was 0.93cm(±0.27) and in TQ was 1.05cm(±0.26). There was a very significant increase by 12.9% with the p value being 0.0025.

The mean diameter of left IJV in TL was 0.89(±0.26)cm and in TQ was 1.00cm(±0.26)cm. The mean diameter of left IJV was increased by 12.3% in TQ as compared with TL. The p value was 0.0036 which is very significant.

The results obtained were similar to the study done by Perlin karaaslan, et al, on healthy adult volunteers. It was observed that the mean AP diameter of right IJV measured in TL was 11.29 (±2.76)mm and in supine position with tourniquet application was 12.12 (±2.69)mm. There was a significant increase of 7.35% in AP

diameter of left IJV in supine position with tourniquet application as compared with that of in Trendelenburg position with p value being <0.001[3]

In the study done by Funda Gok et al, in which the effect of TL and Passive leg raising on the IJV diameters and CSA was compared, it was observed that the transverse diameter of IJV in TL and PLR positions were 9.54(±2.14)mm and 9.29(±2.34)mm respectively with p value of >0.05. Hence there was no significant difference in the change in IJV diameter.[2]

In the present study,the increase of IJV diameter in TQ was observed because tourniquet application causes channelisation of venous return of upper limb towards the IJV. This causes filling of IJV by upperlimb venous return. The fullness of IJV leads to the increase in the width of IJV.

In the present study, the mean CSAs of right IJV in TL was 0.74(±0.43)cm^2 and in TQ was 0.92(±0.26) cm^2. The mean CSA of right IJV is TQ was very significantly increased by 24% as compared with that of TL with the p value being 0.003.

The mean CSAs of left IJV in TL was 0.67(±0.39) cm^2 and in TQ was 0.84(±0.39) cm^2. There is increase of 25% with the p value of 0.0037 (very significant).

These results were comparable with the study done by Perlin karaaslan, et al. In their study it was observed that CSA of right IJV was significantly increased from 0.94(0.39) cm^2 to and 1.05 (±0.36) cm^2 when measured in Trendelenburg position and in supine position with tourniquet application respectively with the p value of <0.001.[3]

The transmural pressure and the vessel compliance determines the CSA of a vessel. Transmural pressure is the difference between the intravascular pressure and

pressure exerted by the tissues outside the vessel. The higher the intravascular pressure, higher is the transmural pressure and thus the CSA of the vessel. Tourniquet application greatly increases the intravascular pressure and thus increasing the CSA of the IJV.

In the present study, the relation of IJV with CA is anterolateral in 90 out of 94 participants. The most common position of IJV in relation to CA was anterolateral (95.7%) in both the sides. The results were similar in both the techniques.

The similar results were observed in the study conducted by Shoja M et,al . It was observed that anterolateral position was the most common position of IJV in relation to carotid artery in both sides (91.7% on the right side and 84% on the left side). However, it was observed that the occurrence of lateral position of IJV in relation to CA was more frequent in right side (14%) than left side (6.3%).[27]

In the study conducted by Michael J. Bos MD, etal, the similar results were observed. In their study the most common position of right IJV in relation to CA was anterolateral with 50.7% and left IJV with 50.1%. It was observed that the anterior relation of IJV to CA was more frequent in left side (15.1%) as compared with right (5.4%) in contrast to the results observed in the present study.[28]

This difference observed was due to the anatomical variations among the sample population

Trendelenburg position increases internal jugular vein diameter by increasing the venous return. But there are few limitations to this technique. It causes various physiological changes decrease in vital capacity, increase in cerebral pressure, intraocular pressure, arterial and venous pressures and cardiac overload. More over this position cannot be achieved in non-operative room settings where the bed cannot be adjusted.[3]

To overcome these limitations, upper limb tourniquet technique was evaluated to increase the IJV diameter and cross-sectional area in the present study. In this technique the venous blood from upper limbs is directed to the internal jugular vein thus increasing the venous pressure and thus increasing the diameter and cross sectional area of IJV. Thus upper limb tourniquet application by channelising the upper limb venous blood can effectively increase the size of IJV.

The very significant increase of AP diameters and CSAs of both right and left IJV observed in our study in TQ has helped us to consider it as an alternative position to Trendelenburg position for IJV cannulation.

CONCLUSION

In conclusion from the present study, the AP diameter and CSA of IJV on both the sides were significantly greater in TQ compared to TL and IJV was most commonly anterolateral to carotid artery in both the techniques.

Therefore, the upper limb tourniquet application technique is a simpler and a better technique for widening the IJV diameter in order to facilitate successful cannulation of IJV in comparison with traditional Trendelenburg position.

SUMMARY

The current study titled “Comparison of the effect of upper limb tourniquet application with Trendelenburg position on diameter and cross-sectional area of right and left internal jugular vein using ultrasound in adult population: A one year prospective study”, was conducted among 94 ASA I and II patients aged between 18 to 60 years scheduled for elective surgeries as per the inclusion and exclusion criteria. All the participants were subjected to Trendelenburg position and upperlimb tourniquet application and the AP diameters, CSAs of left and right IJV were noted along with relation of IJV with carotid artery.

The mean AP diameters of left & right IJV were very significantly greater in TQ (Left-1.0cm, Right -1.05cm) than those of TL (Left-0.89cm, Right-0.93cm), subsequently resulting in significantly higher CSAs in TQ (Left-0.84cm^2, Right-0.92cm^2) as compared with those of TL (Left-0.67cm, Right-0.74cm^2)

The most common position of left and right IJV was anterolateral in relation with CA in both the techniques.

To summarize, in the present study, upper limb tourniquet application was found to be the better method with greater IJV diameter and CSA than the traditional Trendelenburg technique

SCOPE AND LIMITATIONS

Firstly, our study does not involve cannulation of IJV. Hence, the rate of successful cannulations and the incidence of complications could not be established in this study and further research is required.

The second limitation is the inconvenience faced by few of the participants due to tight application of Esmarchs bandage and the cuff inflation upon it. Individuals might not be comfortable with tourniquet application and making them uncoperative for IJV cannulation.

BIBLIOGRAPHY

1. Bos MJ, van Loon RF, Heywood L, Morse MP, van Zundert AA. Comparison of the diameter, cross-sectional area, and position of the left and right internal jugular vein and carotid artery in adults using ultrasound. J Clin Anesth. 2016 Aug;32:65-9. doi: 10.1016/j.jclinane.2015.12.034. Epub 2016 Mar 23. PMID: 27290948.

2. Gok F, Sarkilar G, Kilicaslan A, Yosunkaya A, Uzun ST. Comparison of the effect of the Trendelenburg and passive leg raising positions on internal jugular vein size in critically ill patients. Int J Clin Exp Med. 2015 Oct 15;8(10):19037-43. PMID: 26770530; PMCID: PMC4694430.

3. Karaaslan P, Gokay BV, Karakaya MA, Darcin K, Karakaya AD, Ormeci T, Kose EA. Comparison of the Trendelenburg position versus upper-limb tourniquet on internal jugular vein diameter. Ann Saudi Med. 2017 Jul-Aug;37(4):308-312. doi: 10.5144/0256-4947.2017.308. PMID: 28761030; PMCID: PMC6150587.

4. Uluer MS, Sargin M, Başaran B. Comparison of the effect of the right lateral tilt position and Trendelenburg position on the right internal jugular vein in healthy volunteers: A prospective observational study. J Vasc Access. 2019 Nov;20(6):672-676. doi: 10.1177/1129729819838169. Epub 2019 Apr 12. PMID: 30977416

5. Arslan B, Idem A, Arslan A. Effects of combined the trendelenburg and passive leg raising positions on the cross-sectional area of the right internal jugular vein. Niger J Clin Pract. 2021 Jun;24(6):892-895. doi: 10.4103/njcp.njcp_60_20. PMID: 34121738.

6. Xie, S., Yu, Q., Li, T. *et al.* Comparison of the effect of different degrees of passive leg raising on the internal jugular vein cross-sectional area in patients before thoracic surgery. *BMC Anesthesiol* **19**, 78 (2019).

7. Kim HY, Choi JM, Lee YH, Lee S, Yoo H, Gwak M. Effects of the Trendelenburg Position and Positive End-Expiratory Pressure on the Internal Jugular Vein Cross-Sectional Area in Children With Simple Congenital Heart Defects. Medicine (Baltimore). 2016 May;95(18):e3525. doi: 10.1097/MD.0000000000003525. PMID: 27149455; PMCID: PMC4863772.

8. Judickas Š, Gineitytė D, Kezytė G, Gaižauskas E, Šerpytis M, Šipylaitė J. Is the Trendelenburg position the only way to better visualize internal jugular veins? Acta Med Litu. 2018;25(3):125-131. doi: 10.6001/actamedica.v25i3.3859. PMID: 30842701; PMCID: PMC6392601.

9. Dincyurek GN, Mogol EB, Turker G, Yavascaoglu B, Gurbet A, Kaya FN, Moustafa BR, Yazici T. The effects of the Trendelenburg position and the Valsalva manoeuvre on internal jugular vein diameter and placement in children. Singapore Med J. 2015 Aug;56(8):468-71. doi: 10.11622/smedj.2015020. PMID: 25597750; PMCID: PMC4545137.

10. Lee JG, Park HB, Shin HY, Kim JD, Yu SB, Kim DS, Ryu SJ, Kim GH. Effect of Trendelenburg position on right and left internal jugular vein cross-sectional area. Korean J Anesthesiol. 2014 Nov;67(5):305-9. doi: 10.4097/kjae.2014.67.5.305. Epub 2014 Nov 26. PMID: 25473458; PMCID: PMC4252341.

11. Marcus HE, Bonkat E, Dagtekin O, Schier R, Petzke F, Wippermann J, Böttiger BW, Teschendorf P. The impact of Trendelenburg position and positive end-

expiratory pressure on the internal jugular cross-sectional area. Anesth Analg. 2010 Aug;111(2):432-6. doi: 10.1213/ANE.0b013e3181e2fe41. Epub 2010 May 19. PMID: 20484538.

12. Lamperti M, Subert M, Cortellazzi P, Vailati D, Borrelli P, Montomoli C, D'Onofrio G, Caldiroli D. Is a neutral head position safer than 45-degree neck rotation during ultrasound-guided internal jugular vein cannulation? Results of a randomized controlled clinical trial. Anesth Analg. 2012 Apr;114(4):777-84. doi: 10.1213/ANE.0b013e3182459917. Epub 2012 Jan 17. PMID: 22253269

13. Verghese ST, Nath A, Zenger D, Patel RI, Kaplan RF, Patel KM. The effects of the simulated Valsalva maneuver, liver compression, and/or Trendelenburg position on the cross-sectional area of the internal jugular vein in infants and young children. Anesth Analg. 2002 Feb;94(2):250-4, table of contents. doi: 10.1097/00000539-200202000-00004. PMID: 11812678.

14. American Society of Anesthesiologists Task Force on Central Venous Access, Rupp SM, Apfelbaum JL, Blitt C, Caplan RA, Connis RT, et al. Practice guidelines for central venous access: a report by the American Society of Anesthesiologists Task Force on Central Venous Access. Anesthesiology. 2012 Mar;116(3):539–73.

15. Troianos CA, Jobes DR, Ellison N. Ultrasound-guided cannulation of the internal jugular vein. A prospective, randomized study. Anesth Analg. 1991 Jun;72(6):823– 6.

16. Parienti J-J, Mongardon N, Mégarbane B, Mira J-P, Kalfon P, Gros A, et al. Intravascular Complications of Central Venous Catheterization by Insertion Site. N Engl J Med. 2015 Sep 24;373(13):1220

17. Eisen LA, Narasimhan M, Berger JS, Mayo PH, Rosen MJ, Schneider RF. Mechanical complications of central venous catheters. J Intensive Care Med. 2006 Feb;21(1):40–6.

18. Lorente L, Henry C, Martín MM, Jiménez A, Mora ML. Central venous catheterrelated infection in a prospective and observational study of 2,595 catheters. Crit Care Lond Engl. 2005;9(6):R631-635.

19. McGee DC, Gould MK. Preventing Complications of Central Venous Catheterization. N Engl J Med. 2003 Mar 20;348(12):1123–33.

20. Rivard AB, Kortz MW, Burns B. Anatomy, Head and Neck, Internal Jugular Vein. 2021 Jul 26. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan–. PMID: 30020630.

21. Mumtaz S, Singh M. Surgical review of the anatomical variations of the internal jugular vein: an update for head and neck surgeons. Ann R Coll Surg Engl. 2019 Jan;101(1):2-6. doi: 10.1308/rcsann.2018.0185. Epub 2018 Oct 16. PMID: 30322289; PMCID: PMC6303832.

22. Anatomical Consideration in placement - jaet11i1p26.pdf [Internet]. [cited 2017 Aug 31]. Available from: http://medind.nic.in/jae/t11/i1/jaet11i1p26.pdf

23. Physical principles of ultrasound | Radiology Reference Article | Radiopaedia.org [Internet]. [cited 2017 Sep 4]. Available from:

https://radiopaedia.org/articles/physical-principles-of-ultrasound-1

24. How Ultrasound Works [Internet]. [cited 2017 Sep 4]. Available from: https://www.physics.utoronto.ca/~jharlow/teaching/phy138_0708/lec04/ultrasoundx .htm 86

25. Handbook of Critical Care and Emergency Ultrasound | AccessAnesthesiology | McGraw-Hill Medical [Internet]. [cited 2017 Sep 4]. Available from:

    http://accessanesthesiology.mhmedical.com/book.aspx?bookid=517

26. Ullman JI, Stoelting RK. Internal jugular vein location with the ultrasound Doppler blood flow detector. Anesth Analg. 1978 Feb;57(1):118.

27. Mohammadali M. Shoja, Mohammad R. Ardalan, R. Shane Tubbs, Marios Loukas, Sakineh Vahedinia, Roghayeh Jabbary, Morteza Jalilvand, Abolhasan Shakeri,The relationship between the internal jugular vein and common carotid artery in the carotid sheath: The effects of age, gender and side,Annals of Anatomy - Anatomischer Anzeiger,Volume 190, Issue 4,2008,Pages 339-343,ISSN 0940-960 https://doi.org/10.1016/j.aanat.2008.04.002

28. Bos MJ, van Loon RF, Heywood L, Morse MP, van Zundert AA. Comparison of the diameter, cross-sectional area, and position of the left and right internal jugular vein and carotid artery in adults using ultrasound. J Clin Anesth. 2016 Aug;32:65-9. doi: 10.1016/j.jclinane.2015.12.034. Epub 2016 Mar 23. PMID: 27290948.

ANNEXURE I

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr. /Mrs. /Miss. _____ we are requesting you to enroll you in the study titled **"COMPARISON OF THE EFFECT OF UPPERLIMB TOURNIQUET APPLICATION WITH TRENDELENBURG POSITION ON DIAMETER AND CROSS-SECTIONAL AREA OF RIGHT AND LEFT INTERNAL JUGULAR VEIN USING ULTRASOUND IN ADULT POPULATION": A ONE YEAR PROSPECTIVE STUDY** conducted by REG NO. BA0120009 Post Graduate in M.D. Anesthesiology under the guidance of Dr. _____ Department of Anesthesiology, J.N. Medical College, Belagavi under KAHER, Belagavi.

Respected Sir/Madam, we request you to participate in our study as you are eligible for it. During the study you will be asked some questions regarding your medical history and you are supposed to answer to the best of your knowledge.

Your participation in this research is voluntary. Your decision whether or not to participate in the study will not affect your relationship with J.N. Medical College. If you decide to participate you are free to withdraw at any time.

Purpose of the study: The purpose of research is compare the Trendelenburg position with upper limb venous return blockade by applying tourniquet on right and left internal jugular vein diameters. The increase in diameter and cross sectional area of internal jugular vein facilitates successful cannulation.

Procedure Involved: If you agree to enroll in my study, you will be asked a brief present and past history along with clinical examination to evaluate if you can

participate in the study as per inclusion and exclusion criteria. You will then be given different positions by using adjustable table. The positions include

- 20° Trendelenburg position
- With tourniquet in supine position.

The internal jugular vein diameter will be measured using ultrasound by placing the probe perpendicularly on the skin of the neck. The anatomical relation of internal jugular vein to carotid artery will also be assessed.

Voluntary Participation/Withdrawal:

Taking part in the study is voluntary. You may choose not to enrol yourself in this study. Your decision will not change any health care services offered to you or your ward at K.L.E. S Hospital & MRC.

Risks:

There is no risk involved.

Benefits: Upper limb tourniquet application increases the internal jugular vein diameter which makes internal jugular vein cannulation easier and successful for the anesthesiologist.

Privacy and Confidentiality:

The only people to know that you are as research subject are you and members of the research team. No information provided by you during the research will be disclosed to other without your written permission except:

1. In emergency to protect your rights and welfare.
2. If required by law.

Authorization to Publish Results:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with your identity remaining confidential.

Financial Incentives for participation:

No financial incentives are being offered to enrolled patients. It is purely being done with the idea of research and all the cost of the study will be borne by the investigator.

Compensation:

In the event of injury related to the study, treatment will be made available through KLES Hospital and MRC, Belagavi. There is no compensation or payment for such medical treatment by law. If you get injured you may contact REG NO. BA0120009 at Department of Anesthesiology, J.N. Medical College.

Questions:

In case you have any questions related to the study, in future or in case of study related injury or illness, you can contact REG NO. BA0120009, Department of Anesthesiology, J.N. Medical College, Belagavi. Dr. _____ Professor and HOD, Dept. Of Anesthesiology, J.N. Medical College.

If you have any queries about your rights as a study subject, you may call Dr. Harsha Hegde, Chair person, JNMC, IEC & Scientist D, ICMR, National Institute of Traditional Medicine, Belagavi. Ph No: 9480422500

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH TRIAL

"COMPARISON OF THE EFFECT OF UPPERLIMB TOURNIQUET APPLICATION WITH TRENDELENBURG POSITION ON DIAMETER AND CROSS-SECTIONAL AREA OF RIGHT AND LEFT INTERNAL JUGULAR VEIN USING ULTRASOUND IN ADULT POPULATION": A ONE YEAR PROSPECTIVE STUDY.

Mr./Ms./Mrs. _____ voluntarily agree for the participation of as a subject of study. By signing this consent form I am not giving up any of my legal rights, I may withdraw from the study anytime. I am signing the consent form after having read or been read for me in vernacular language, including the risks and the benefits and having all my questions answered.

Subject Name : _____

Signature or the Left Thumb Print of Subject/Guardian: _____

Date:

Witness Name: _____ Signature: _____

Investigators Name: _____ Signature: _____

Date:

Place : _____.

ANNEXURE II- PROFORMA

"COMPARISON OF THE EFFECT OF UPPERLIMB TOURNIQUET APPLICATION WITH TRENDELENBURG POSITION ON DIAMETER AND CROSS-SECTIONAL AREA OF RIGHT AND LEFT INTERNAL JUGULAR VEIN USING ULTRASOUND IN ADULT POPULATION": A ONE YEAR PROSPECTIVE STUDY.

Name	:	Age	:
Gender	:	Weight	:
Height	:	Date of Examination	:
Address	:	Occupation	:

Pre examination evaluation

Past History

- HTN ☐ DM ☐ IHD ☐ Arrhythmia ☐ Valvular heart diseases ☐

General physical examination

Weight (Kg)	:	Temperature (^{0}F)	:	Pallor :
Cyanosis	:	Pedal edema	:	Clubbing :
PR	:	BP	:	RR :

Systemic examination:

RS	:	CNS	:
CVS	:	GIT	:

Preoperative physical status ASA Grade I☐ II ☐ III ☐ IV☐ V☐

The readings will be tabulated as,

	20° Trendelenburg	With tourniquet in supine
Right IJV diameter /cross sectional area		
Left IJV diameter/cross sectional area		

The relation of IJV to carotid artery will be tabulated as,

	20° Trendelenburg	With tourniquet in supine
Relation of right IJV to carotid artery		
Relation of left IJV to carotid artery		

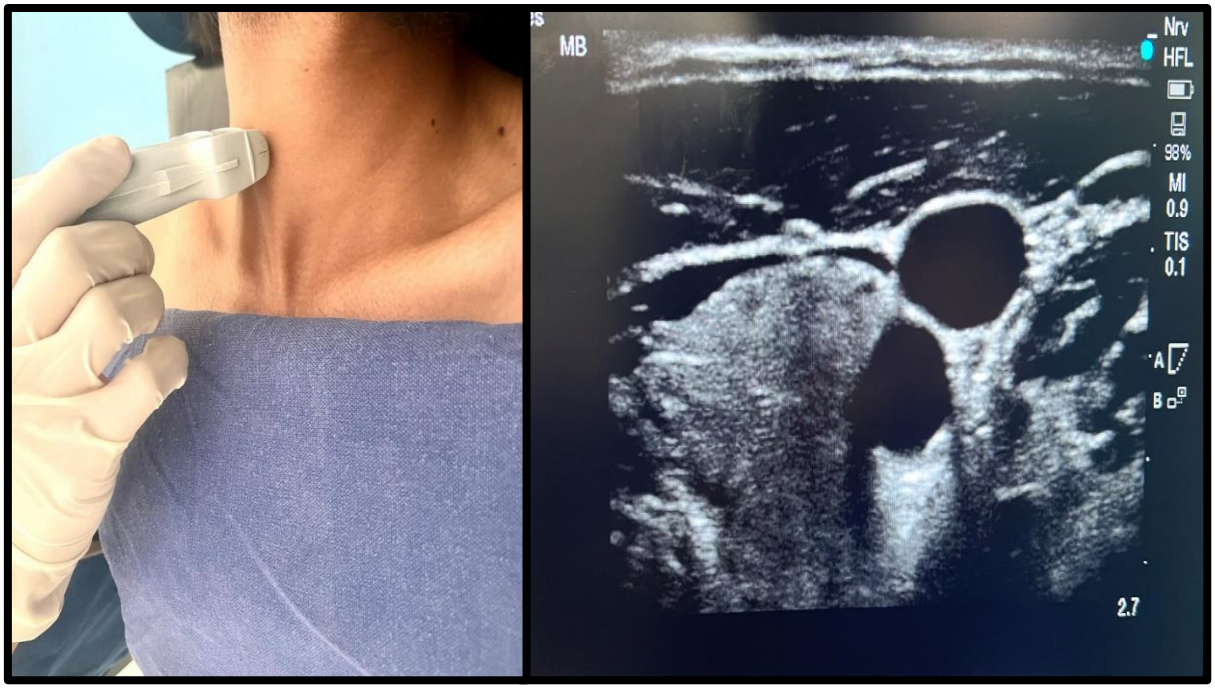
Signature of Anaesthesiologist:_____

Signature of Principal investigator:_____

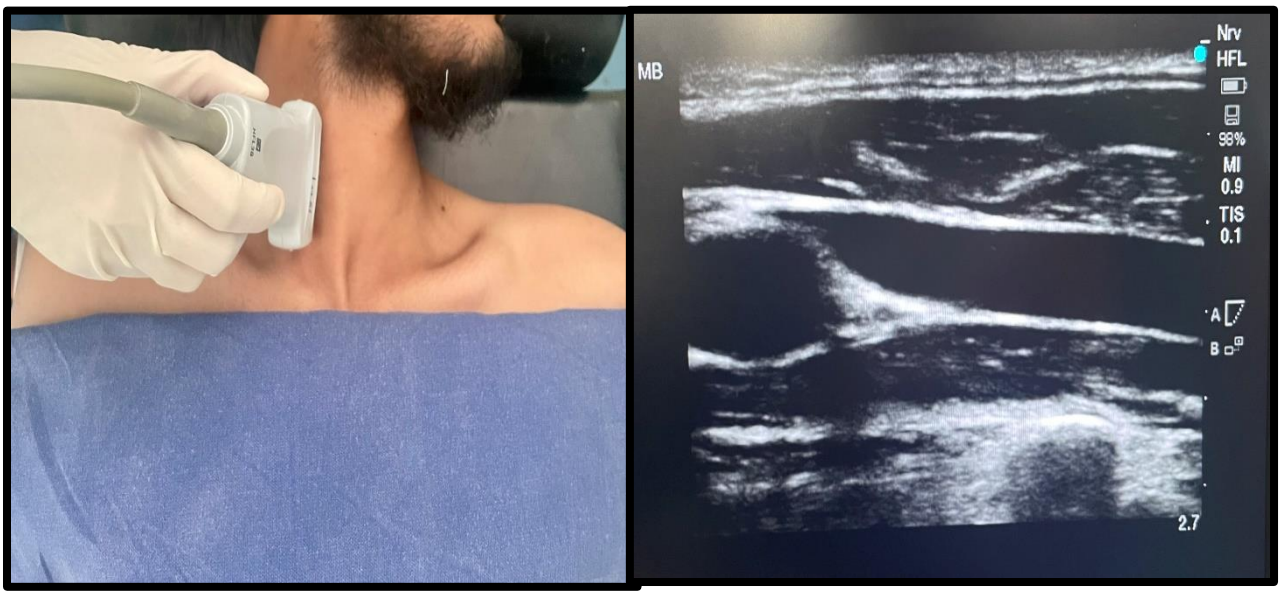
ANNEXURE – IV - PHOTOGRAPHS

PHOTOGRAPH 1: USG machine with probe

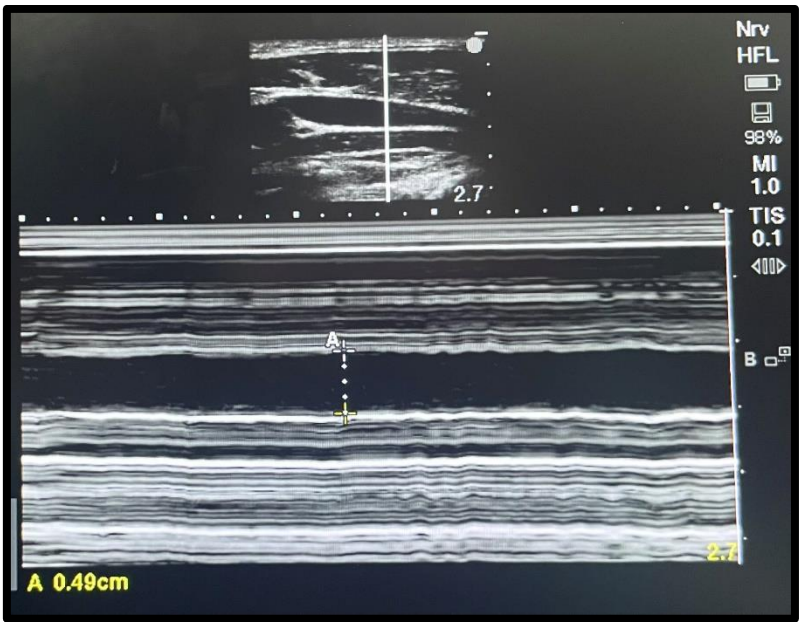
PHOTOGRAPH 2: Linear ultrasound probe



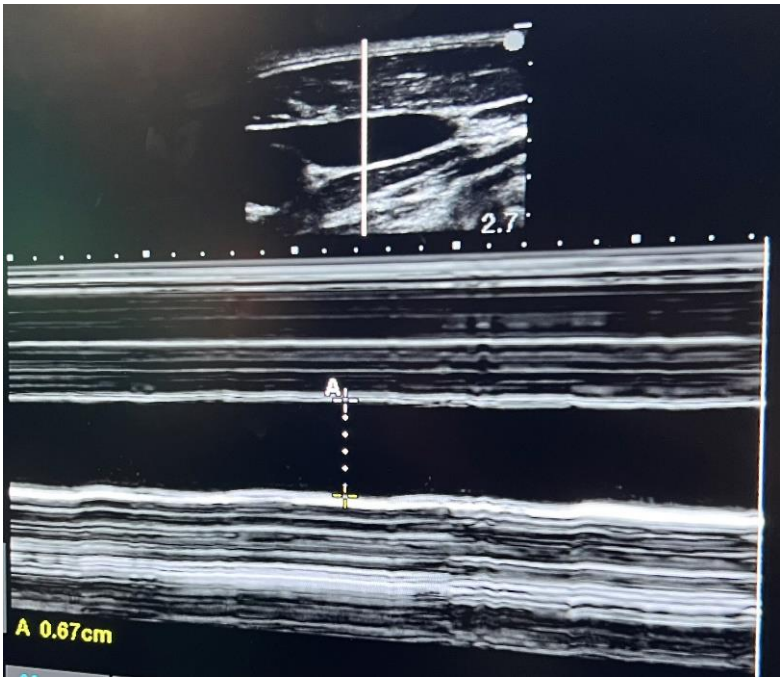
PHOTOGRAPH 3: Probe placement (Transverse) and short axis view on ultrasound



PHOTOGRAPH 4: Probe placement (Vertical) and long axis view on ultrasound



PHOTOGRAPH 5: Long axis view and measurement of diameter of IJV in TL



PHOTOGRAPH 6: Long axis view and measurement of diameter of IJV in TQ

ANNEXURE – V - KEY TO MASTER CHART

ASA	American society of Anesthesiologists (Grades I – IV)
cm	Centimeter
cm^2	Centimeter square
CSA	Cross-sectional area
DIA	Diameter
F	Female
M	Male
Kg	Kilogram
R IJV	Right Internal Jugular vein
L IJV	Left Internal Jugular vein
TL	in Trendelenburg position
TQ	with tourniquet application
REL	Relation
yrs	Years

SL. No.	AGE (yrs)	GENDER	WEIGHT (kg)	HEIGHT (cm)	DATE	ASA	R IJV DIA TL (cm)	R IJV DIA TQ (cm)	L IJV DIA TL (cm)	L IJV DIA TQ (cm)	R IJV CSA TL (cm2)	R IJV CSATQ (cm2)	L IJV CSA TL (cm2)	R IJV CSA TQ (cm2)	REL OF R IJV TL	REL OF R IJV TQ	REL L IJV TL	REL L IJV TQ
1	36	F	53kg	150cm	21-01-2021	1	1.49	1.42	1.45	1.4	1.74	1.58	1.65	1.54	AL	AL	AL	AL
2	57	F	55kg	147	23-01-2021	1	1.49	1.76	1.45	1.69	1.74	2.43	1.65	2.24	AL	AL	AL	AL
3	30	M	66kg	171	24-01-2021	1	1.09	1.2	1.07	1.17	0.93	1.13	0.90	1.08	L	L	L	L
4	58	F	58kg	158	06-02-2021	2	0.9	1.06	0.87	1.02	0.64	0.88	0.59	0.82	AL	AL	AL	AL
5	35	F	52kg	152	12-02-2021	1	0.83	0.98	0.8	0.95	0.54	0.75	0.50	0.71	AL	AL	AL	AL
6	36	M	70kg	177	19-02-2021	2	1.1	1.24	1.06	1.21	0.95	1.21	0.88	1.15	AL	AL	AL	AL
7	36	F	50kg	155	22-02-2021	1	1.03	1.25	1.02	1.23	0.83	1.23	0.82	1.19	AL	AL	AL	AL
8	35	M	72kg	178	24-02-2021	1	1.1	1.42	1.13	1.45	0.95	1.58	1.00	1.65	AL	AL	AL	AL
9	33	M	66kg	168	26-02-2021	1	0.86	1.12	0.88	1.15	0.58	0.99	0.61	1.04	AL	AL	AL	AL
10	38	M	70kg	168	10-03-2021	1	1.06	1.21	0.88	1.06	0.88	1.15	0.61	0.88	AL	AL	AL	AL
11	35	M	66kg	168	15-03-2021	1	0.63	0.49	0.59	0.43	0.31	0.19	0.27	0.15	AL	AL	AL	AL
2	29	M	68kg	168	18-03-2021	1	0.79	0.88	0.78	0.8	0.49	0.61	0.48	0.50	AL	AL	AL	AL
13	45	M	72kg	164	18-03-2021	1	0.52	0.47	0.78	0.66	0.21	0.17	0.48	0.34	L	L	L	L
14	20	M	55kg	170	18-03-2021	1	0.77	1.44	0.68	1.3	0.47	1.63	0.36	1.33	AL	AL	AL	AL
15	30	M	68kg	172	19-03-2021	1	1.32	1.4	1.07	1.09	1.37	1.54	0.90	0.93	AL	AL	AL	AL
16	28	F	56kg	153	24-03-2021	1	0.61	0.92	0.56	0.61	0.29	0.66	0.25	0.29	L	L	L	L
17	22	M	67kg	158	24-03-2021	1	0.87	1.2	0.82	0.86	0.59	1.13	0.53	0.58	AL	AL	AL	AL
18	45	M	75kg	168	03-04-2021	1	0.78	0.88	0.72	0.79	0.48	0.61	0.41	0.49	AL	AL	AL	AL
19	50	M	60kg	166	10-04-2021	2	0.98	1.08	0.94	1.02	0.75	0.92	0.69	0.82	AL	AL	AL	AL
20	28	M	66kg	170	12-04-2021	1	1.14	1.03	1.09	0.98	1.02	0.83	0.93	0.75	AL	AL	AL	AL
21	50	F	58kg	155	22-04-2021	1	0.9	1.01	0.88	0.96	0.64	0.80	0.61	0.72	AL	AL	AL	AL
22	33	F	62kg	156	22-04-2021	1	1.1	0.95	1.04	0.9	0.95	0.71	0.85	0.64	L	L	L	L
23	27	M	80kg	177	10-05-2021	2	0.74	0.85	0.7	0.82	0.43	0.57	0.38	0.53	AL	AL	AL	AL
24	40	M	70kg	171	11-05-2021	1	1.2	1.06	1.16	1.01	1.13	0.88	1.06	0.80	AL	AL	AL	AL
25	44	F	60kg	157	18-05-2021	1	0.86	0.99	0.83	0.95	0.58	0.77	0.54	0.71	AL	AL	AL	AL
26	36	M	57kg	160	24-05-2021	1	1.06	1.14	1.02	1.1	0.88	1.02	0.82	0.95	AL	AL	AL	AL
27	40	M	60kg	158	28-05-2021	1	0.92	0.95	0.9	0.92	0.66	0.71	0.64	0.66	AL	AL	AL	AL
28	52	M	50kg	155	15-06-2021	2	0.96	1.05	0.61	0.79	0.72	0.87	0.29	0.49	AL	AL	AL	AL
29	25	M	70kg	171	17-06-2021	1	0.66	0.8	0.57	0.71	0.34	0.50	0.26	0.40	AL	AL	AL	AL
30	45	M	75kg	174	17-06-2021	1	0.6	0.66	0.69	0.72	0.28	0.34	0.37	0.41	AL	AL	AL	AL
31	28	F	65kg	150	18-06-2021	1	0.79	0.98	0.76	0.86	0.49	0.75	0.45	0.58	AL	AL	AL	AL
32	36	F	54kg	148	20-06-2021	1	0.43	0.5	0.35	0.41	0.15	0.20	0.10	0.13	AL	AL	AL	AL
33	37	F	52kg	155	20-07-2021	1	0.82	1.06	0.81	1.04	0.53	0.88	0.52	0.85	AL	AL	AL	AL
33	36	F	60kg	158	23-07-2021	1	1.02	1.16	1	1.13	0.82	1.06	0.79	1.00	AL	AL	AL	AL
34	45	M	72 kg	166	27-07-2021	2	1.19	1.33	1.18	1.3	1.11	1.39	1.09	1.33	AL	AL	AL	AL
35	57	F	50kg	150	30-07-2021	2	0.66	0.94	0.68	0.92	0.34	0.69	0.36	0.66	AL	AL	AL	AL
36	40	M	72kg	170	31-07-2021	1	0.88	1.18	0.86	1.15	0.61	1.09	0.58	1.04	L	L	L	L
37	32	M	62kg	160	03-08-2021	1	1.11	1.32	1.06	1.28	0.97	1.37	0.88	1.29	AL	AL	AL	AL
38	19	F	48kg	150	04-08-2021	1	0.79	0.96	0.74	0.94	0.49	0.72	0.43	0.69	AL	AL	AL	AL
39	27	M	62kg	158	06-08-2021	1	1.05	1.28	1.03	1.23	0.87	1.29	0.83	1.19	AL	AL	AL	AL
40	27	F	58kg	164	09-09-2021	1	0.92	1.16	0.98	1.24	0.66	1.06	0.75	1.21	AL	AL	AL	AL

41	25	M	66kg	177	11-09-2021	1	1.12	1.35	1.2	1.25	0.99	1.43	1.13	1.23	AL	AL	AL	AL
42	21	F	50kg	158	14-09-2021	1	0.88	1.04	0.89	1.02	0.61	0.85	0.62	0.82	AL	AL	AL	AL
43	30	M	64kg	170	16-09-2021	1	1.22	1.38	1.29	1.34	1.17	1.50	1.31	1.41	AL	AL	AL	AL
44	56	M	80kg	172	16-09-2021	1	0.93	1.24	0.91	1.2	0.68	1.21	0.65	1.13	AL	AL	AL	AL
45	21	F	54kg	160	17-09-2021	1	1.4	1.3	1.3	1.25	1.54	1.33	1.33	1.23	L	L	L	L
46	40	F	66kg	158	18-09-2021	1	0.93	1.19	0.95	1.19	0.68	1.11	0.71	1.11	AL	AL	AL	AL
47	53	M	64kg	160	29-09-2021	1	1.1	1.16	1.06	1.1	0.95	1.06	0.88	0.95	AL	AL	AL	AL
48	23	M	60kg	180	05-10-2021	1	0.79	1	0.74	1.01	0.49	0.79	0.43	0.80	AL	AL	AL	AL
49	43	M	64kg	168	05-10-2021	1	0.91	0.98	0.8	0.99	0.65	0.75	0.50	0.77	AL	AL	AL	AL
50	28	F	60kg	160	07-10-2021	1	0.82	0.97	0.78	0.98	0.53	0.74	0.48	0.75	AL	AL	AL	AL
51	30	F	56kg	164	09-10-2021	1	0.84	0.9	0.76	0.96	0.55	0.64	0.45	0.72	AL	AL	AL	AL
52	45	F	56kg	158	09-10-2021	2	1.2	1.24	1.05	1.1	1.13	1.21	0.87	0.95	AL	AL	AL	AL
53	48	F	60kg	164	12-10-2021	2	1.4	1.31	1.18	1.1	1.54	1.35	1.09	0.95	AL	AL	AL	AL
54	50	M	56kg	160	13-10-2021	1	0.88	1.07	0.85	1.06	0.61	0.90	0.57	0.88	AL	AL	AL	AL
55	60	F	64kg	164	15-10-2021	1	1.05	1.19	1.04	1.16	0.87	1.11	0.85	1.06	AL	AL	AL	AL
56	32	F	56kg	160	18-10-2021	1	0.89	1.05	0.87	1.04	0.62	0.87	0.59	0.85	AL	AL	AL	AL
57	40	M	78kg	180	18-10-2021	1	1.16	1.3	1.15	1.28	1.06	1.33	1.04	1.29	AL	AL	AL	AL
58	45	M	70kg	160	22-10-2021	2	0.8	1.12	0.73	1.1	0.50	0.99	0.42	0.95	AL	AL	AL	AL
59	56	F	65kg	158	23-10-2021	1	0.86	0.93	0.83	0.95	0.58	0.68	0.54	0.71	AL	AL	AL	AL
61	58	F	62kg	155	25-10-2021	1	0.89	1.09	0.86	1.06	0.62	0.93	0.58	0.88	AL	AL	AL	AL
62	54	M	66kg	179	25-10-2021	1	0.09	0.11	0.05	0.09	0.11	0.11	0.06	0.07	AL	AL	AL	AL
63	44	F	55kg	156	26-10-2021	1	0.74	0.98	0.71	0.96	0.43	0.75	0.40	0.72	AL	AL	AL	AL
64	52	M	60kg	172	28-10-2021	2	0.99	1.28	0.97	1.25	0.77	1.29	0.74	1.23	AL	AL	AL	AL
65	29	F	57kg	154	12-11-2021	1	1	0.81	0.91	0.76	0.79	0.52	0.65	0.45	AL	AL	AL	AL
66	27	M	74kg	178	12-11-2021	1	1.16	1	1.04	0.91	1.06	0.79	0.85	0.65	AL	AL	AL	AL
67	40	M	70kg	166	12-11-2021	1	0.88	1.02	0.61	0.86	0.61	0.82	0.29	0.58	AL	AL	AL	AL
68	50	M	80kg	180	12-11-2021	2	0.79	0.86	0.66	0.72	0.49	0.58	0.34	0.41				
69	24	M	87kg	170	16-11-2021	1	1.38	1.3	1.18	1.22	1.50	1.33	1.09	1.17	AL	AL	AL	AL
70	29	F	60kg	157	16-11-2021	1	1.1	1.24	1.02	1.15	0.95	1.21	0.82	1.04	AL	AL	AL	AL
71	34	F	56kg	155	16-11-2021	1	0.69	0.98	0.62	0.9	0.37	0.75	0.30	0.64	AL	AL	AL	AL
72	50	M	59kg	166	17-11-2021	1	0.39	0.43	0.3	0.36	0.12	0.15	0.07	0.10	L	L	L	L
73	25	M	50kg	160	19-11-2021	1	0.61	0.73	0.55	0.68	0.29	0.42	0.24	0.36	AL	AL	AL	AL
74	31	M	74kg	170	19-11-2021	1	1.5	1.54	1.4	1.45	1.77	1.86	1.54	1.65	AL	AL	AL	AL
75	38	M	70kg	171	19-11-2021	1	0.5	0.44	0.48	0.38	0.20	0.15	0.18	0.11	AL	AL	AL	AL
76	28	M	70kg	175	19-11-2021	1	1.92	1.6	1.85	1.54	2.90	2.01	2.69	1.86	AL	AL	AL	AL
77	21	M	58kg	166	20-11-2021	1	0.59	0.71	0.6	0.69	0.27	0.40	0.28	0.37	AL	AL	AL	AL
78	37	F	64kg	156	22-11-2021	1	0.77	1.2	0.76	1.16	0.47	1.13	0.45	1.06	AL	AL	AL	AL
79	44	M	66kg	170	22-11-2021	1	0.72	0.77	0.7	0.74	0.41	0.47	0.38	0.43	AL	AL	AL	AL
80	50	F	66kg	160	22-11-2021	2	0.81	0.9	0.88	0.95	0.52	0.64	0.61	0.71	AL	AL	AL	AL
81	30	F	55kg	154	22-11-2021	1	0.74	0.77	0.76	0.78	0.43	0.47	0.45	0.48	AL	AL	AL	AL
82	42	F	62kg	162	07-12-2021	1	0.82	0.86	0.8	0.84	0.53	0.58	0.50	0.55	AL	AL	AL	AL
83	48	F	78kg	156	13-12-2021	1	0.99	1.06	0.95	1.04	0.77	0.88	0.71	0.85	AL	AL	AL	AL
84	36	M	65kg	160	20-12-2021	2	0.8	0.91	0.82	0.9	0.50	0.65	0.53	0.64	AL	AL	AL	AL
85	28	M	62kg	156	20-12-2021	1	1.04	1.12	1.01	1.07	0.85	0.99	0.80	0.90	AL	AL	AL	AL
86	52	F	58kg	155	11-01-2022	1	0.78	1.03	0.73	1.01	0.48	0.83	0.42	0.80	AL	AL	AL	AL
87	40	F	60kg	152	19-01-2022	1	0.68	0.8	0.65	0.75	0.36	0.50	0.33	0.44	AL	AL	AL	AL
88	32	M	72kg	176	19-01-2022	1	0.89	0.91	0.85	0.9	0.62	0.65	0.57	0.64	AL	AL	AL	AL
89	25	F	55kg	150	03-02-2022	2	1.14	1.2	1.1	1.16	1.02	1.13	0.95	1.06	AL	AL	AL	AL
90	35	M	75kg	176	15-02-2022	1	0.76	0.92	0.72	0.86	0.45	0.66	0.41	0.58	AL	AL	AL	AL
91	39	M	68kg	173	20-02-2022	1	0.92	1.07	0.9	1.04	0.66	0.90	0.64	0.85	AL	AL	AL	AL
92	46	F	60kg	158	04-03-2022	1	1.1	1.24	1.08	1.2	0.95	1.21	0.92	1.13	AL	AL	AL	AL
93	52	M	58kg	160	16-03-2022	2	1.2	1.28	1.18	1.25	1.13	1.29	1.09	1.23	AL	AL	AL	AL
94	38	M	66kg	179	17-03-2022	1	1.06	1.15	1.03	1.11	0.88	1.04	0.83	0.97	AL	AL	AL	AL