“EFFECT OF BODY POSITION ON THE CROSS-SECTIONAL AREA OF THE RIGHT SUBCLAVIAN VEIN MEASURED WITH THE AID OF 2-DIMENSIONAL ULTRASONOGRAPHY: ONE YEAR OBSERVATIONAL STUDY”

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ENDORSEMENT

This is to certify that the dissertation entitled **"EFFECT OF BODY POSITION ON THE CROSS-SECTIONAL AREA OF THE RIGHT SUBCLAVIAN VEIN MEASURED WITH THE AID OF 2-DIMENSIONAL ULTRASONOGRAPHY: ONE YEAR OBSERVATIONAL STUDY"** is a bonafide research work done by **Reg No: BA0118005.**

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ABBREVIATIONS

ASA	-	American society of Anesthesiologists
BMI	-	Body mass index
CCA	-	Common carotid artery
CI	-	Confidence interval
cm	-	Centimeter
CSA	-	Cross-Sectional area
CVC	-	Central venous catheter
CVP	-	Central venous pressure
ICA	-	Internal carotid artery
IJV	-	Internal jugular vein
kg	-	Kilogram
MHz	-	Mega hertz
min	-	Minute
ml	-	Milliliter
mm	-	Millimeter
MRI	-	Magnetic resonance imaging
RBCs	-	Red blood cells
SCM	-	Sternocleidomastoid muscle
SCV	-	Subclavian vein
SD	-	Standard deviation
SVC	-	Superior vena cava
US	-	Ultrasound
USG	-	Ultrasonography
yrs	-	Years

ABSTRACT

TITLE:

"EFFECT OF BODY POSITION ON THE CROSS-SECTIONAL AREA OF THE RIGHT SUBCLAVIAN VEIN MEASURED WITH THE AID OF 2-DIMENSIONAL ULTRASONOGRAPHY: ONE YEAR OBSERVATIONAL STUDY"

Background:

Studying the effects of ipsilateral tilt position and its combination with Trendelenburg position on the Cross-sectional Area (CSA) of the Subclavian vein (SCV) may introduce us to a manoeuvre that can be used in facilitating the ease of subclavian vein cannulation.

Objectives:

To know the optimal body position that will maximize the CSA of the right SCV and to know the optimal body position that maximizes the flow of the right SCV.

Methods:

100 healthy volunteers were included in the study. The cross-sectional diameter, the CSA and the flow in the right SCV were measured using ultrasound guidance in four different body positions namely Flat (supine), 10^0 Trendelenburg, 15^0 Ipsilateral (right) tilting and 10^0 Trendelenburg with 15^0 Ipsilateral (right) tilting. The measurements were compared among all the four positions.

Results:

Among all the four positions the 10^0 Trendelenburg with 15^0 ipsilateral tilt position had the maximum SCV cross-sectional diameter (1.18 ± 0.12 cm), SCV CSA (1.10 ± 0.22 cm^2) and the SCV flow (1011.92 ± 262.44 ml/min). There was significant increase ($p < 0.0001$) in the CSA when the position was changed from supine to both the Trendelenburg (24%) and the Ipsilateral (right) tilt (22.6%).

Conclusion:

Among the four different positions studied, the 10^0 Trendelenburg with 15^0 Ipsilateral (right) tilt position maximizes the CSA and the flow of the right SCV. Hence, Trendelenburg along with ipsilateral (right) tilt can be considered while cannulating the right SCV. Ipsilateral (right) tilting can be considered as an alternative to trendelenburg position while cannulating the right SCV.

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INTRODUCTION

Central venous access plays a great role in the management of patients who are hemodynamically unstable, about to undergo a major surgery or critically ill.[1]Its role involves monitoring central venous pressure, administration of intravenous fluids, medications and parenteral nutrition and dialysis.[2,3] Commonly used veins are the IJV, the subclavian vein (SCV) and the femoral vein. The SCV cannulation by infra-clavicular approach was first introduced by Aubnaniac in 1952.[4] The SCV cannulation has the added advantages of being more comfortable for the patients on prolonged use, reduced risk of infection and low collapsibility even during hypovolemic states.[1,5,6] But it has the drawback of having a higher risk of causing pneumothorax when compared with internal jugular vein cannulation.[7]

Studies done on SCV using various imaging modalities suggests that Trendelenburg position, lower limb elevation, cannulation at end expiration, keeping head and shoulders in neutral position, increasing the intra-thoracic pressure by applying inspiratory hold and caudal placement of the ipsilateral shoulder can facilitate SCV cannulation.[1,8–12] Use of ultrasound with additional afore mentioned manoeuvres for cannulation enhances the success rate. It also lowers the complication rate of cannulation.[13,14] Ultrasound with B-mode and doppler signals guide in identifying and studying the anatomy, anatomic relations and flow of the SCV.

Logically, easier will be the cannulation if the cross-sectional area (CSA) of the vein is larger. Successful cannulation of a vein is directly related to the CSA of that vein which can be altered by altering the patient positioning.[15] Hence, it is important to place the patient in a position that increases the CSA of the vein. There have been studies that compared various body positions and manoeuvres which will potentiate easy cannulation. Trendelenburg position had shown to significantly increase the CSA of the SCV in previous studies.[9,10,16,17] The changes in CSA and flow with ipsilateral titling and Trendelenburg with Ipsilateral tilt has not been well studied yet. In this study the CSA and the flow of the right SCV were measured and compared in Supine, Trendelenburg, Ipsilateral tilt and Trendelenburg with Ipsilateral tilt positions using ultrasound.

OBJECTIVES OF THE STUDY

PRIMARY OBJECTIVE:

The primary objective is to know the optimal body position that will maximize the CSA of the right SCV.

SECONDARY OBJECTIVE:

To know the optimal body position that will maximize the flow of the right SCV.

REVIEW OF LITERATURE

Central venous catheterization, a method of securing a pathway through the major veins in the venous system in a short span of time. The added advantages over a peripheral venous line include longer duration of its utility with a bigger lumen, stability in situ, less risk of phlebitis, multiple ports for administering different drugs, fluids, parenteral nutrition and central venous pressure measurement. The subclavian vein (SCV) is accessed through subclavian and supraclavicular approaches with subclavian remaining the most common blind approach. The SCV has the advantages of providing greater patient comfort, lower infection potential and lower risk of arterial puncture. The complications that can occur while catheterizing a central vein are arterial puncture, hematoma, hemothorax, pneumothorax, thrombosis, air embolism, arrythmias.[2] Hence, to avoid the afore said complications various techniques and manoeuvres were studied, tried and employed during the catheter placement. With the introduction of bedside ultrasonography, the techniques of catheterizing the central veins have changed.

The Technical report "Guidelines on the insertion and management of central venous access devices in adults" by L. Bishop, L. Dougherty, A. Bodenham, J. Mansi, P. Crowe, C. Kibbler, M. Shannon, J. Treleaven in 2006 reviewed the basic principle of central venous catheterization.[18] The report gives the indications of catheterizing a central vein to be in patients with poor venous access, in patients requiring long term use of intravenous chemotherapy or parenteral nutrition or blood products, in cases where drugs causing venous sclerosis to be given, in ambulatory chemotherapy requiring patients and in patients requiring repeated blood sampling or requiring venous section. It is said that subclavian approach has a lower incidence of infection but has more risk of thrombosis leading to secondary stenosis. They recommend a little lateral approach in SCV cannulation as it has lower risk of the catheter getting trapped between the first rib and clavicle (‘pinch off’ of catheter). It is also said that ultrasonography guided cannulation results the puncture site to be moved little lateral.

In 2003, a review article authored by David C. McGee and Michale K. Gould titled “Preventing complications of central venous catheterization” discussed the various complications that are associated with the central venous catheterization and the interventions to prevent them. Following inferences were taken from the article[19]. The infections related to catheterization can be minimized by the use of antimicrobial impregnated catheters, subclavian vein preference, using strict aseptic precautions while catheterization, avoiding the use of antimicrobial ointments, avoiding routine catheter changes and appropriate removal. The mechanical complications can be prevented by identifying the risk factors for difficult catheterization (history of difficult catheterization, or catheterizing at previous surgery sites, anatomical deformities or scarring), acquiring assistance of an experienced clinician, avoiding femoral venous route (frequency of mechanical complications is higher when compared to other sites), ultrasound guidance while catheterizing. The thrombotic complications can be prevented by preferring the subclavian site.

“Ultrasound validation of maneuvers to increase internal jugular vein cross-sectional area and decrease compressibility” by Marc A. Bellazzini MD, Peter M. Rankin RN, BSN, Ronald E. Gangnon PhD, Lars PetterBjoernsen MD was aimed at finding the manoeuvres that will end up in providing the largest CSA and reduced collapsibility of the IJV.[20] The study was done on 52 healthy adults. The CSA was measured using ultrasonogram at the normal baseline, while Valsalva, with hepatic pressure, and hepatic pressure with Valsalva. These manoeuvres were performed in supine as well as Trendelenburg position. The degree of collapse was measured by using the ultrasound probe to mimic the venipuncture. The study resulted in increase of CSA in Valsalva and Trendelenburg ($p < 0.0001$). Hepatic pressure did not have any influence over the CSA ($p = 0.94$). Valsalvamanoeuvre in both supine and Trendelenburg resulted in largest CSA (1.13 cm and 1.20 cm respectively). The study concluded that Valsalvamanoeuvre if used, lead to more than 50% increase in CSA and the collapse of the vein prevention by 50% or more with simulated venipuncture, if used alone or even in combination.

V. Dhulked, A. Reddy, A. Gupta, P. Dhulked investigated “An observational Study of Change in Diameter Of Right Internal Jugular Vein With Various Body Positions In Volunteers With The Aid of 2 – Dimensional Ultrasonography” with main objective to determine the most appropriate position culminating in the largest right IJV diameter.[15] The observational study was done on 100 subjects of either sex aged between 18 – 60 years and utilizing 2D ultrasound to calculate the lateral diameter of right IJV in different body positions. From the study it was found that the mean diameter in supine position with levelled table was 12.7 +/- 2.02 mm which raised to 13.3 +/- 2.4 mm ($p < 0.05$) with pillow below the head and diameter advanced to 15.8 +/- 2.6 mm in 15-degree Trendelenburg position. But there was no alteration in diameter (15.39 +/- 2.71 mm) with head rotated to left. Hence, they inferred that the by positioning the subject in supine with pillow below the head, 15^0 Trendelenburg tilt, head in centre or turned no more than 45^0 to left, in absence of shoulder pad and by excluding carotid artery palpation the ideal position for IJV cannulation can be attained.

Paul F. Mansfield, David C. Hohn, Bruno D. Fornage, Mary Ann Gregurich, David M. Ota in their Prospective randomised controlled study on “Complications and Failures of Subclavian Vein Catheterization” in 1994 was done on 824 patients.[21] The evaluated factors include age, sex, height, BMI, time taken for insertion of the catheter, years of experience of the person catheterizing, number of attempts and history of major surgeries or radiotherapy in the same site. Ultrasound linear probe of 7.5 MHz was used in this study. Likelihood ratio and chi square test were used for statistical analysis. Comparison was done between ultrasound guided and standard insertion procedure. The study showed results with risk ratio (RR) for complications was 1 (95% CI, 0.66 – 1.52) and RR for failures was 1.04 (95% CI, 0.72 – 1.50). They concluded that SCV catherization under US guidance was not useful and in patients in whom a higher risk of complications or failures can be expected, experienced personnel must be employed for catheterization.

TarekMarei authored the study titled “Real-time in-plane ultrasound-guided supraclavicular approach to subclavian vein cannulation in cardiac surgery: An underused approach” in 2014 enrolled 40 patients[22]. In this study it was found that an average of 43.8 (1.49) seconds was needed for in-plane ultrasound-guided supraclavicular SCV cannulation and a median of 1 (range: 1-3) skin puncture was needed to cannulate the vein. All the lumens of catheter were patent before and after sternal retractor usage. The CVP was recorded in all cases except one and the tip of catheters were located less than 1.6 cm from the crista terminalis using trans-esophageal echocardiography. So, it was inferred from this study that US guided in-plane supraclavicular technique of SCV catheterization is easy and safe in cardiac surgeries.

MariantinaFragou, Andreas Gravvuanis, VasiliosDimitriou, ApostolosPapalois, GregoriosKouraklis, Andreas Karabinis et al designed and conducted a prospective randomized study on “Real-time Ultrasound Guided Subclavian Vein Cannulation versus Landmark method in critical care patients” with aim of comparing various complications encountered during SCV cannulation using real time ultrasound versus the landmark technique.[13] Infraclavicular needle insertion was performed in both ultrasound and landmark technique which revealed that SCV cannulation was 100 % successful in ultrasound in contrast to 87.5% in landmark technique, and other complications with landmark technique like artery puncture and hematoma(4.5%), hemothroax(4.4%), pneumothorax(4.5%), brachial plexus injury(2.9%),phrenic nerve injury(1.5%),cardiac tamponade(0.5%) were in excess than complications seen with ultrasound group. Hence it was inferred from this study that USG cannulation of SCV when compared to landmark technique is superior and should be first choice in critical care patients.

The study titled “Patient positioning for subclavian vein catheterization” was authored by Jerry M. Jesseph, Dewey J. Conces, Gary T. Augustyn.[12] The study was aimed to determine the optimal positioning of the patient for catheterizing the SCV using Magnetic resonance imaging and anatomical examination (gross anatomical dissection). 5 human cadavers were dissected in the subclavian region and their structural relationship was used as a reference for MRI. MRI was done using 2.0 Tesla scanner (at 1.5 tesla) in five healthy volunteers. The positions under which the studies were made are 1) supine anatomical position, 2) supine with head turned sideways and 3) placing a rolled towel in-between the scapulae to retract the shoulders. The results of the study showed that on turning the head sideward the angle of junction between the SCV and the IJV increased by 15^0 and made the CCA come in close relation to this junction on the left side. On retracting the shoulders, the SCV got compressed antero-posteriorly between the clavicle and the 1st rib. Hence, they concluded that head and shoulder neutral positioning of the patient is recommended for cannulating the SCV.

Norihito Kitagawa, M.D., MayukoOda, M.D., TadahideTotoki, M.D., Noriaki Miyazaki, M.D., IchirohNagasawa, M.D., Takahiko Nakazono, M.D. et al in the year 2004 authored a study titled “Proper shoulder position for subclavian venipuncture”.[11] In this study they had done thoracic multi-slice CT scan on seven adult males. Study was done on the percentage of overlap between the clavicle and the subclavian vein, the distance between them and the diameter of the SCV in three different shoulder positions. The positions were shoulder being neutral, elevated and lowered. Later the success rate of SCV cannulation was compared between the elevated and lowered shoulder positions in 30 patients. They found out that the overlap was more when the shoulder was lowered (40%) when compared to elevated (33.5%) and neutral (36.9%) positions. The distance between the clavicle and the SCV was found to be lesser in shoulder lowered position (3.6mm) when compared to elevated (6.8mm) and neutral (5mm) positions. SCV puncture was also found to be have significant success rate (p = 0.003) in the lowered shoulder position when compared to the elevated position. There was no change in the diameter of the vein on changing the shoulder positions. The results of this study showed that when the shoulders were lowered the distance and the proximity between the SCV and the clavicle increased without altering the SCV diameter. Thus, proper use of lowered shoulder position will result in a safer puncture of SCV.

John B. Fortune and Paul Feustel conducted a study titled “Effect of patient position on size and location of the subclavian vein for percutaneous puncture” in 2003.[9] It was a prospective comparison study that enrolled 10 healthy individuals with mean age as 30years, mean height as 172.6cm and mean weight as 76.5kg. Using ultrasonography, they measured the size of the SCV, its distance from the clavicle and its flow. The measurements were made in 5 different positions by changing head tilts, shoulder arching and Trendelenburg positioning. The variance analysis (Dunnett’s comparison) was done with position 5 (which was Trendelenburg with neutral head and shoulders) as reference point. The mean diameter of the SCV was found to be maximum in the position 5 (0.99 [SD - 0.06] cm) with p value < 0.02 and least in the position 2 [supine position with shoulders arched and head neutral] (0.84 [SD - 0.05] cm). The measured flow rate had no statistical significance among the positions. The distance of the SCV from the clavicle was minimum in position 4 [shoulder arching with Trendelenburg] (0.75 [SD - 0.07] cm). They concluded that neither rotation of the head nor arching the shoulders increased the SCV diameter and the Trendelenburg position without any other manoeuvreswas helpful in increasing the vein diameter.

Mi-Young Kwon, Eun-Kyung Lee, Hye-Ju Kang, Ho-young Kil, Kee-Hoon Jang, Min-Seok Koo et al under the title “The effects of the Trendelenburg position and intrathoracic pressure on the subclavian cross-Sectional area and distance from the subclavian vein to pleura in anesthetized patients” conducted a study in 2010.[10] They included 30 patients who are undergoing elective surgery in the study. Their mean age was 50.6 ± 17.1 years with BMI 23.3 ± 2.3 kg/m^2. They recorded and compared the CSA of the right SCV and the shortest distance between the pleura and the vein using ultrasonography (13-6 MHz linear probe). The recordings were done in horizontal (supine) and Trendelenburg positions at end-expiration (opening of pressure relief valve) and at inspiratory hold with airway pressure of 20 cm H_2O for 10 seconds after placing the patient in volume-controlled ventilation. Considering 15% change as relevant, only Trendelenburg with application of positive inspiratory hold provided relevant change ($p < 0.0001$). They concluded that Trendelenburg combined with inspiratory hold application resulted in greater increase in the CSA of the SCV without resulting in any significant change in the distance between pleura and the vein.

In 2012, Kyung-Jee Lim, Jung-Man Lee, Hyo-Jin Byon, Hee-Soo Kim, Chong-Sung Kim, Soo-Kyung Lee et al authored a study titled "The effect of full expiration on the position and size of the subclavian vein in spontaneously breathing adults".[1] The study was conducted on 20 healthy males aged between 20 and 30 years. The CSA of the right SCV and its distance from pleura (SCVcentre to pleura and inferior border of SCV to pleura) were measured under ultrasound guidance (8–13 MHz linear probe) with patient in supine position at end inspiration and end expiration. The measurements were also done in Trendelenburg position. They found that the CSA of the SCV increased by at least 43% (95% CI, 21.8%-64.2%) after full expiration when compared to at end inspiration, in supine position, whereas the increase was 22% (95% CI, 14%-30%) in Trendelenburg position. The distance between vein and pleura did not alter with the inspiration and expiration ($p > 0.05$). They concluded that after full expiration the distance between SCV and pleura did not change. However, there was substantial increase in the CSA so that cannulating the vein can be facilitated by the simple technique.

BASIC SCIENCES

ANATOMY:

Veins are the blood vessels that carry the deoxygenated blood from peripheral tissues to the heart from where they are pumped to the lungs to get oxygenated. The small veins that carry the blood from the peripheral tissues unite to form the larger vessels (deep veins) that comprise the major venous systems. By gaining access to any of these larger veins, one can get access to the heart. The major venous systems include the internal jugular veins (IJV) that carry blood from the head and neck, the subclavian veins (SCV) that carry blood from the upper extremities, the femoral veins which drains the lower extremities. All these veins drain into the superiorand inferior-venacava before reaching the heart(Figure 1). Hence placing a catheter in one of these large veins will help in providing large volume of fluids and blood products (in scenarios like trauma resuscitation), in administering inotropic drugs (which when administered in the peripheral smaller veins may cause vasospasm), for parenteral nutrition.[23] As the catheter tips of the central venous lines of SCV and IJV lie in proximity to the junction between superior-venacava (SVC) and the right atrium, these catheters can be used for measuring the central venous pressure (which provide us about the intra vascular volume status of the person) using which fluid resuscitation can be carried out judiciously.[24,25]

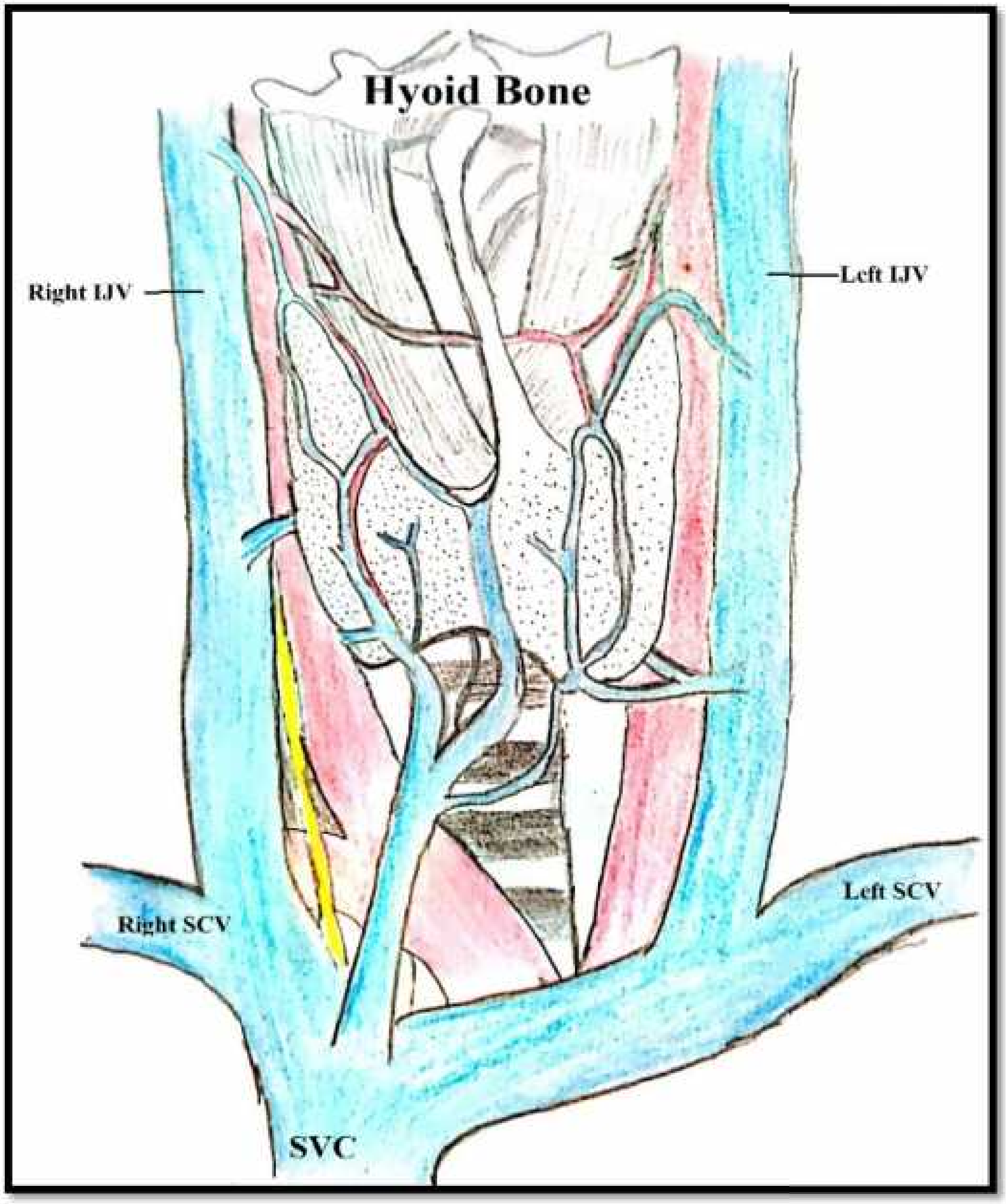


FIGURE 1: Relation of SCV with IJV and SVC

Subclavian Vein (SCV):

The SCV is paired, right and left. They are the continuation of the axillary vein (direct). It drains the upper limb and the lateral part of the thorax. The SCV starts its course at the first rib's lateral border after which it courses below the clavicle (hence the name, subclavian) and ends by draining into the IJV forming the brachiocephalic vein (also called the innominate vein).[24,25]

Course: As SCV travels below the clavicle, it lies on its groove over the first rib. Then it travels postero-medially towards the clavicle's sternal end where it's course end just at the anterior scalene muscle's medial border. (Figure 2)

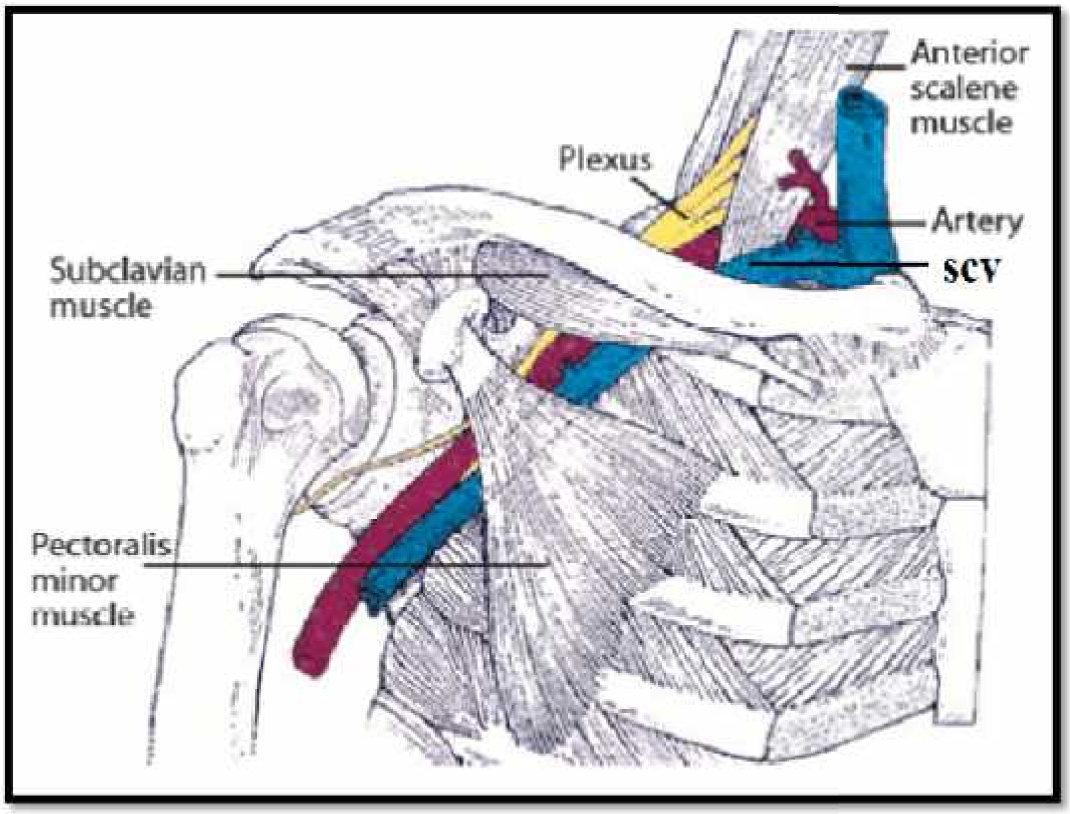


FIGURE 2: Course of right SCV

Tributaries:

The following veins drain into the SCV

- The Jugular veins
  - Internal and External - Draining the lateral cervical region,
  - Anterior – Draining the anterior part of the neck.
- The Dorsal scapular vein – Draining the dorsal scapular region.[24,25]

Relation:SCV is accompanied by the subclavian artery which lies posterior to it and separated by the anterior scalene muscle(Figure 3). Posterior to the vein also lies the phrenic nerve which later courses anterior to internal thoracic artery and then enters the thorax.

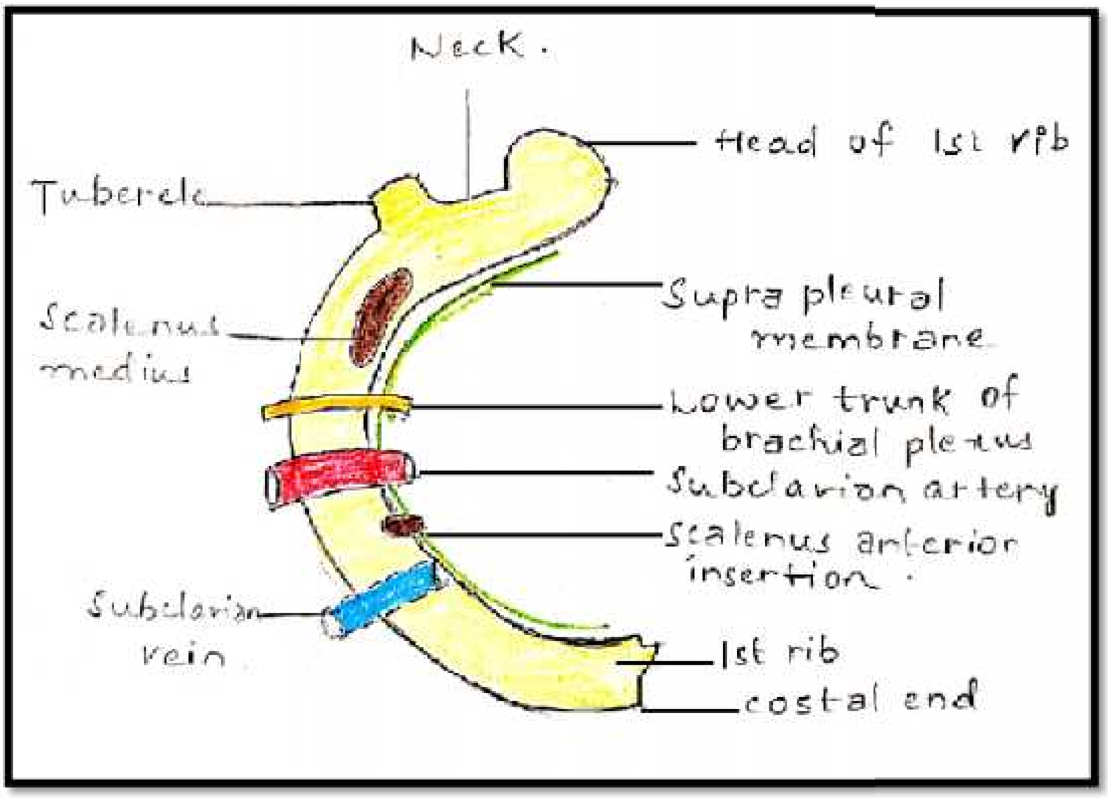


FIGURE 3: Relations of SCV above the First Rib (cut section)

The SCV's medial relations include the thoracic duct (Figure 5), brachiocephalic trunk, trachea and vagal trunks (Figure 4). Laterally it is related to the brachial plexus's inferior trunk.

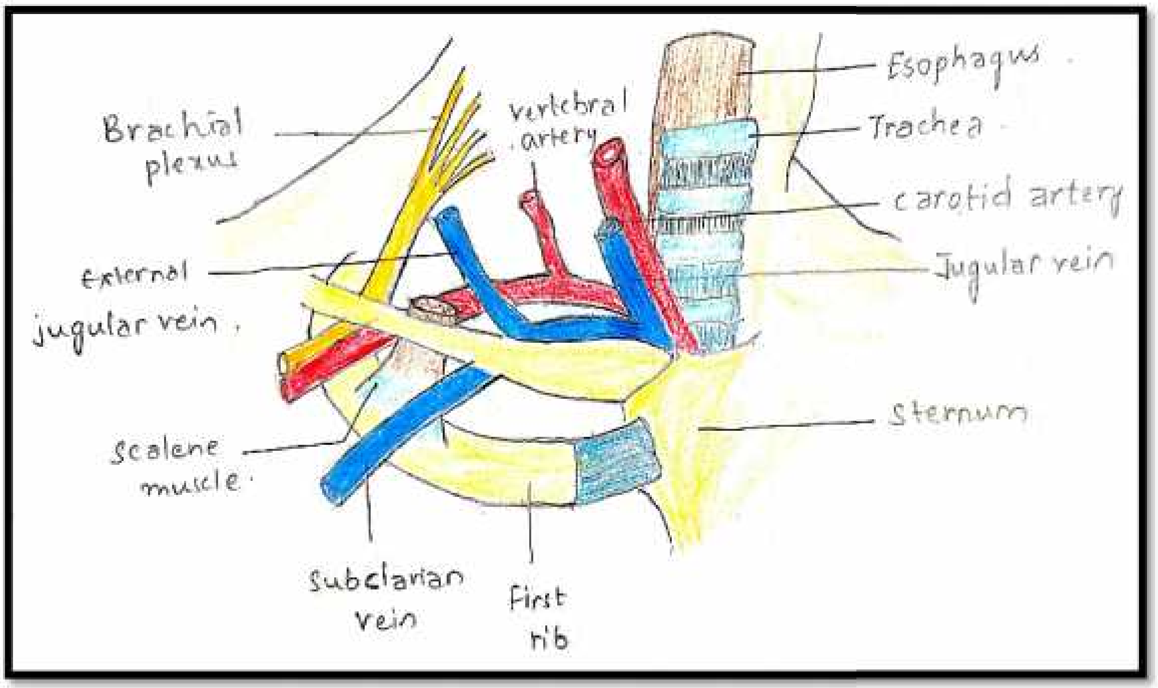


FIGURE 4: Anterior view of SCV and its anatomical relation

It is important to know that the upper dome of the lungs lie in close relation to the SCV inferiorly. Hence the risk of puncturing the pleura and causing pneumothorax is high. The subclavius muscle relates to the vein anteriorly. All these relations are present in normal human anatomy.[24,25]

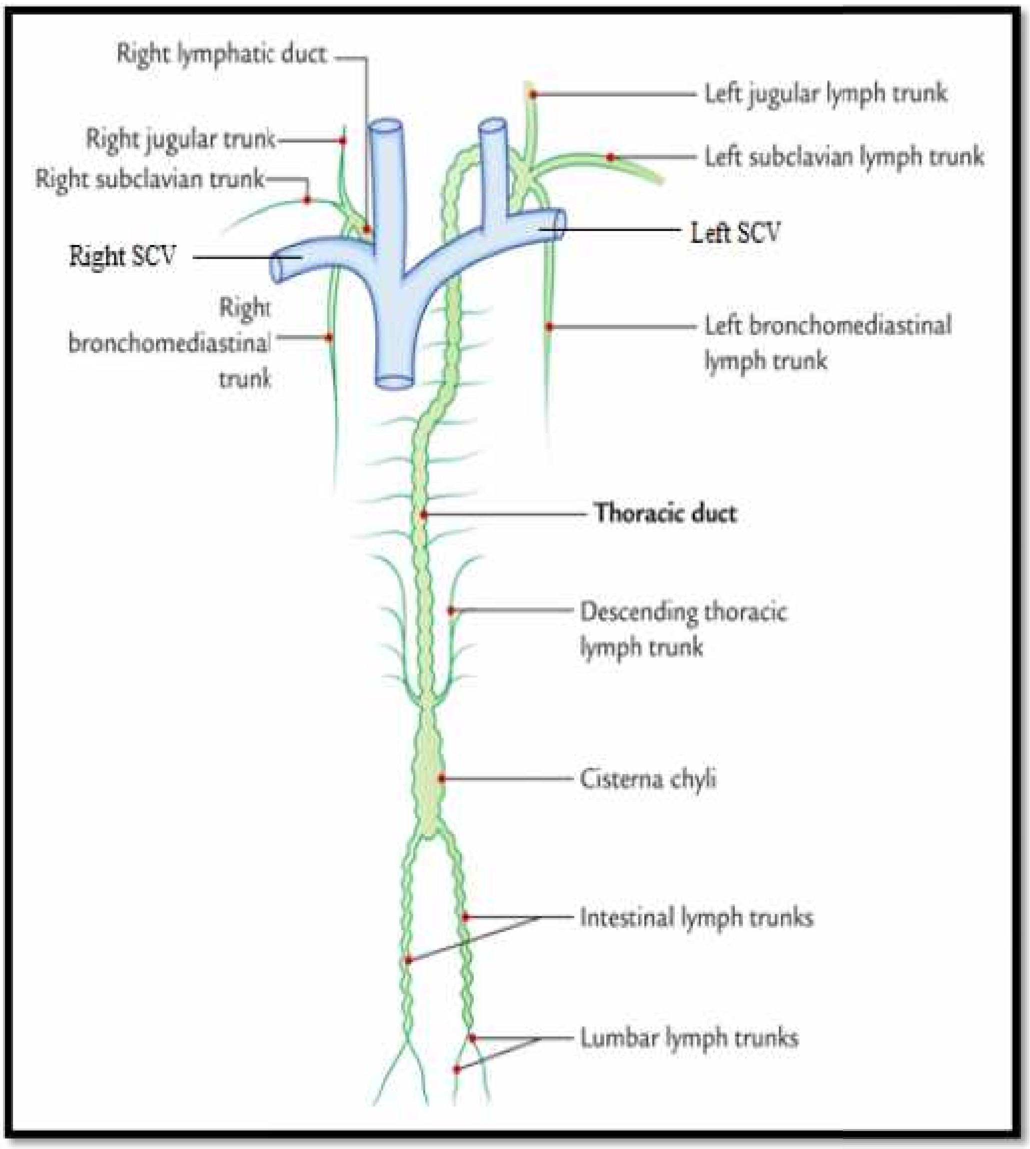


FIGURE 5: Subclavian vein and Thoracic duct

Function: The SCVs not only carry the deoxygenated blood to the heart but it also drains the lymph from the thoracic duct (by the left SCV) and the right lymphatic duct (by the right SCV).[24,25]

ULTRASONOGRAPHY:[26–28]

Ultrasound, nothing but sound waves in frequency range of around 2 to 15 megahertz has a wide range of diagnostic and treatment purpose in the field of medicine. The ultrasonography works on the principle of Piezoelectric effect. This effect converts mechanical / kinetic energy into electrical energy by deformation of crystals. Piezoelectric effect can also be reversed i.e., by electrical energy the crystals can be oscillated to form ultrasound waves (mechanical energy).

The ultrasound transducer has the function of producing the ultrasound by the above said mechanism. This ultrasound produced travels through tissues and gets reflected back. The returned echo waves after reaching the transducer gets changed to electrical energy which is later processed and produce an image. The transducers work in a range of frequencies. Transducers with higher frequencies (5 – 7.5 MHz) are used in imaging superficial structures whereas the ones with lower frequencies (2.5 – 3.5 MHz) produce images of deeper structures.

It is on the surface that lies between tissues of varying density, the ultrasound gets reflected. If the difference in densities is higher, the sound waves that get reflected is also high and the opposite also holds true. Therefore, with very high difference of densities (bones, air, calculi) the sound will be completely reflected back. This produce the acoustic shadowing. If the tissues are homogenous in their densities, then echo-free images are seen (blood, urine, ascites).

Transducer:

This is the hand held part of the ultrasound machine. It has the function of inter-converting the energies (electrical and mechanical) based on piezoelectric effect. They contain lead zirconatetitanate crystals commonly. They produce the ultrasound waves in either linear(sequential) arrays or phased array.

It comprises 5 major components:

- Crystals: possessing piezoelectric property. Can be arranged in either linear or curvilinear manner.
- Electrodes: positive and ground. For electrical connection
- Damping block: to dampen stray sound waves.
- Matching layer: one or multiple. For proper transmission of sound waves to the tissues.
- Housing.

Linear Transducer(Figure6)**:**

- The piezoelectric crystals – Linearly arranged.
- Produce rectangular ultrasound beam.
- Used for superficial imaging.
- Footprint – wide with frequency of 2.5 – 12MHz at the centre in 2D imaging probe and frequency 7.5 – 12 MHz at the centre in 3D imaging probe.
- Applications:
    - ❖ Vascular examination, venous puncture (catheterization),
    - ❖ Breast imaging,
    - ❖ Thyroid imaging,
    - ❖ Tendons and joints,
    - ❖ During laparoscopic procedures,
    - ❖ Measuring body fat thickness,
    - ❖ Ultrasonic velocity change imaging.

FIGURE 6: Linear USG probe

Curvilinear Transducer(Figure7)**:**

- The Piezoelectric crystals – curvilinear arrangement.
- They produce convex ultrasound beam.
- Used to image deeper tissues.
- As depth of imaging increases, image resolution decreases.
- Foot print is wide with central frequency being, 2.5 – 7.5MHz for 2D imaging and 3.5 – 6.5MHz for 3D imaging.
- Applications,
  - ❖ Abdominal examinations,
  - ❖ Transvaginal and transrectal examinations,
  - ❖ Diagnosis of organs.

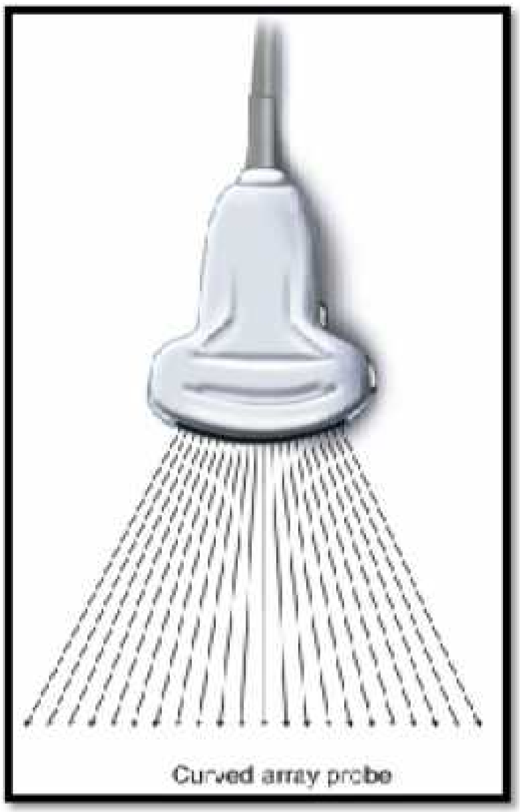
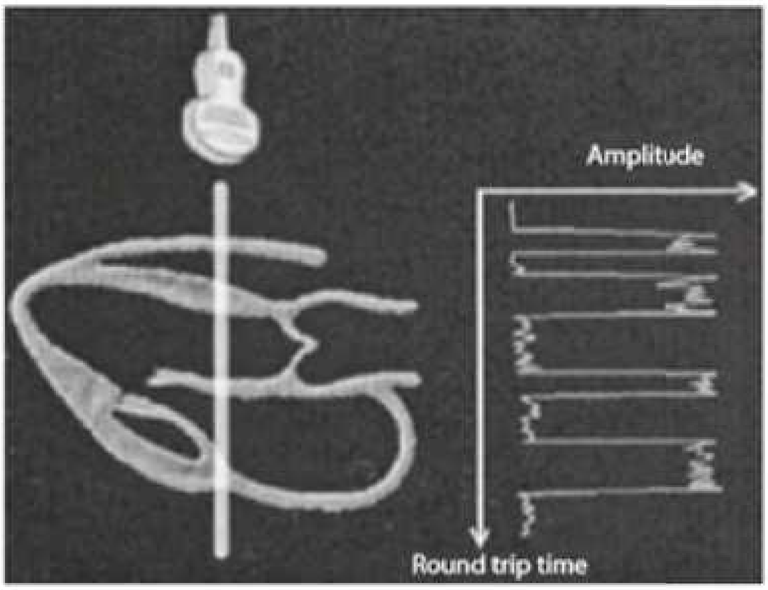


FIGURE 7: Curvilinear USG probe

MODES OF IMAGING:

A Mode:

Amplitude mode or A mode is the basic technology which was used initially. As the reflected echo returns to the probe, their amplitudes are charted as spikes. It is one dimensional. The amplitude of the spike corresponds to the distance of the tissue from which the ultrasound got reflected back to the transducer(Figure8). Hence it is used in measuring depths and lengths. It is frequently used in ophthalmology for measuring the corneal thickness and axial length measurements.[28]

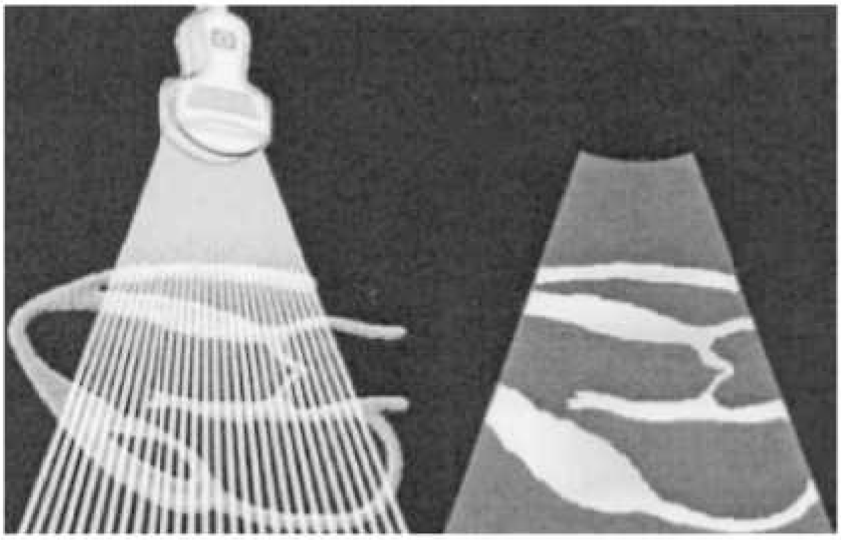


In A-mode scanning, the amplitudes of the reflected echoes are displayed unidimensionally, representing the distances of the reflecting boundaries in the tissue from the transducer (Courtesy of Hitachi Ltd.)

FIGURE 8: USG A – mode

B Mode:

Brightness mode or B mode scan(Figure9) records the reflected echo waves as dots rather than spikes as seen with A mode. Higher the amplitude (strength) of the echo wave is brighter will be the dot. The reflected waves from an emitted pulse form the dots in a straight line. Only after the reflected waves reach the transducer back (after the formation of dots from the first emitted pulse) the next pulse of ultrasound is emitted. When all the emitted waves reach the transducer back, the 2D ultrasound image (B mode) is formed.[28]

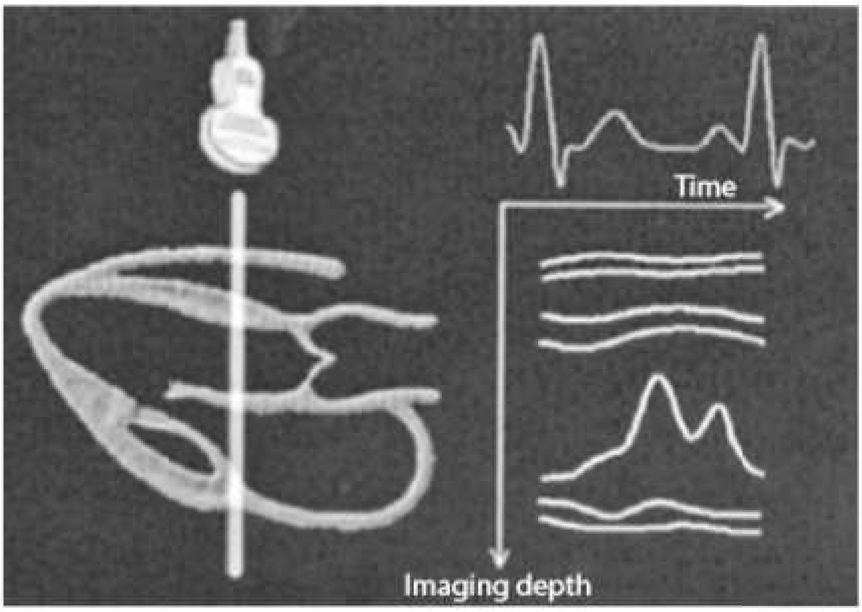


In B-mode scanning, the echoes reflected from boundaries between tissues of different acoustic impedance are displayed two-dimensionally as bright/dark spots with brightness levels representing the intensity of the reflected echoes (Courtesy of Hitachi Ltd.)

FIGURE 9: USG B – mode

M Mode:

Motion mode or M mode or Time-Motion (TM) mode(Figure10), here the transducer is stationed and ultrasound beam is generated repeatedly. The ultrasound gets reflected from moving objects in the path of the beam at different times. The M mode image is displayed in a wave like fashion depicting the movement of an object with relation to time. M mode is used in imaging moving structures like cardiac valves, lung pleura, echocardiography (wall movements). It provides a high temporal resolution.[28]



In M-mode scanning, the temporal changes in returning echoes are displayed, representing the motion of reflecting interfaces toward and away from the transducer over time (Courtesy of Hitachi Ltd.)

FIGURE 10: USG M – mode

Doppler Imaging:

Doppler effect: Change in frequency of the sound/light wave when there is a relative motion between the source of the wave and the observer. For example, when the observer is stationary and the source is moving towards the observer, the perceived frequency by the observer will be higher than the frequency with which the wave was emitted. The reverse holds true i.e., if the source is moving away from the observer, the frequency perceived will be lower than that of the frequency emitted by the source. It is also called as doppler shift. This effect is made use of in the doppler imaging to measure the flow velocity of moving blood.

While measuring the flow velocity of the blood, doppler effect occurs twice. First, when the ultrasound is emitted from the transducer towards the blood vessel the source (transducer) is stationary and the perceiver (blood) is moving. Next, when the wave gets reflected back from the red blood cells (RBCs) and moves towards the transducer the source (blood-RBCs) is in motion while the perceiver (transducer) is stationary. The direction of the blood flow either towards or away from the transducer determines whether the frequency of the returning wave is higher or lower respectively. The shift in frequency (doppler effect) depends upon the frequency with which it was emitted from the transducer, the velocity with which the blood cells move and the angle between the moving blood cells and the transducer. This angle is known as doppler angle(Figure11). It is important that the emitted beam from the transducer cannot be parallel to the moving blood cells, when the transducer is placed on the skin.This relationship between them can be expressed as the following equation:

$$F_d = F_r - F_0 = \frac{2F_0 \cdot v \cdot \cos\alpha}{c}$$

Where, F_d – Doppler shift in frequency.

F_r – Frequency of reflected wave.

F_0 – Frequency of the emitted wave from the source.

v – Velocity of the moving RBCs.

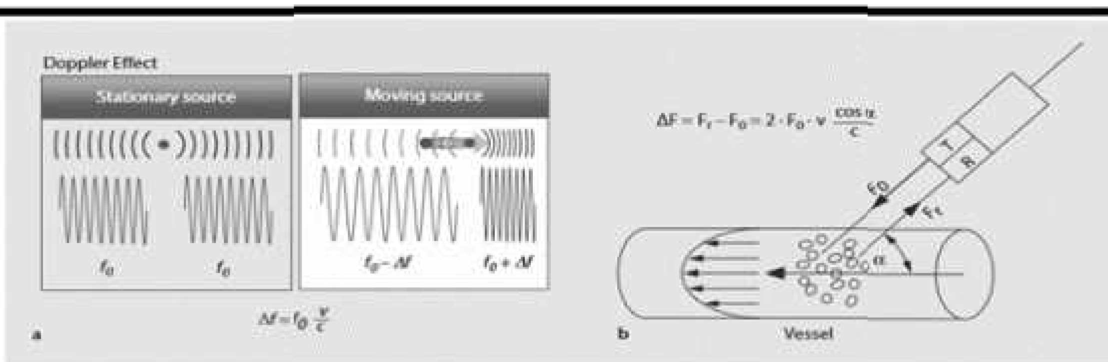
c – Speed with which the sound travels in the soft tissue (≈ 1540 m/s).

α – Angle between the transducer and the blood flow's direction.

from the above equation, the flow velocity (v) of the blood can be determined by substituting the other values. The equation of measuring the velocity will thus be:

$$v = (F_r - F_0) \cdot \frac{c}{2F_0 \cdot \cos\alpha}$$

If the transducer is placed at 90^0 to the vessel then ($\cos 90^0 = 0$) there wont be any doppler shift in frequency. Hence the velocity cannot be determined. As the angle (α) decreases the cosine function will increase and so will the doppler shift. At angles 60^0 and less the accuracy of the velocity calculated will be good.[28]



Doppler effect. a Dependence of the Doppler shift (change in frequency between source and receiver) on the velocity of the moving source and its direction of motion relative to the reflector. b Diagram of Doppler interrogation of a vessel with laminar blood flow. The arrows in the vessel are vectors representing different flow velocities. Blood flow is fastest in the center and decreases toward the wall. The drawing illustrates the effect of the angle of incidence on the Doppler measurement. In the equation for calculating the Doppler shift, this angle is represented by the cosine function. The Doppler shift increases with the acuity of the angle (cosine of 90° = 0) (T, tranumitter; R, receiver; F_0, emitted frequency; F_r, reflected frequency)

FIGURE 11: Doppler effect

Duplex / Pulsed Wave Doppler Ultrasound:

This mode is similar to that of the brightness mode, wherein pulses of ultrasound are emitted from the piezoelectric crystals and the returning echoes are received. Here the depth till which the ultrasound traveled can be determined as we have the velocity with which it travels (≈1540 m/s) in the tissues and calculating the overall (round-two way) time travelled by the sound waves.

Initially, a pulse of wave is emitted by the system and the system goes in for temporary off mode when no returning echoes will be perceived then then it goes into the receiving mode. Thus only the echoes that return during the receiving mode will be processed leaving the remaining echo waves. This time window when the system is in the receiving mode is termed 'the range gate'. By controlling this window period (range gate) one can adjust the volume of sample or doppler window. Typically the doppler window is adjusted to get the whole diameter of the vessel that is targetted. Pulse repitition frequency is the number of pulses that are emitted in one second. Thus by decreasing the pulse repitition frequency we will be able to scan deeper structures (as the time required for the echoes to return back increases).

As we know the velocity of the ultrasound in the tissues is approximately constant, just by using a time filter one can adjust the depth till which they need the scanning to be done. An elctronic gate will be opened for a brief period when the returning echoes will be allowed in, while blocking the waves that come a little before or after. Hence, we will be able to record doppler singnals from a particular depth selectively.

The duplex scan combines this pulsed doppler imaging and the 2D real time imaging providing us the information about the flow in a blood vessel at a defined depth. The flow velocity of the blood canbe estimated by the duplex scan using the doppler shift in frequency as by using theB-mode image, the doppler angle can be determined.[28]

SONOANATOMY:

The SCV can be imaged using an ultrasonogram in supraclavicular approach and infraclavicular approach.

While imaging a blood vessel using an ultrasonogram, the foot print of the transducer can be placed either at right angle to the course of the vessel producing a cross-sectional view (short-axis) or longitudinal along the course of the vessel giving us the long-axis view. The short axis view(Figure12) helps in identifying the surrounding structures (clavicle, subclavian artery, pleura) and gives a good orientation in midline. This view will let us to perform out of plane technique of needle insertion in which only a cross-section of the needle will be seen on the image.

FIGURE 12: Ultrasonogram of SCV – Cross-sectional view

The long axis view(Figure13) images the vessel along its longitudinal plane. The subclavian artery and vein will not be visualized simultaneously in this view. The long axis view let us to perform in-plane technique in which the whole of the needle with its tip can be visualized while cannulating the vein.[27,28]

FIGURE 13: Ultrasonogram of SCV – Longitudinal view

TRENDELENBURG POSITIONING(Figure14)**:**

Initially the term trendelenburg position meant classical 45^0 head down position. Nowadays the term is used for any degree of head down position. The position shifts the blood into the central compartment. Because of gravity, the cerebral veins are not drained adequately leading to raised intracranial and raised intraocular pressures. There is no evidence showing any adverse effect in an otherwise normal healthy individual, whereas for a patient with raised intracranial tension trendelenburg position is contraindicated. On a prolonged period of time, it may lead to edema of upper airway and face. In such cases, at the time of extubation care has to be taken to prevent airway obstruction post-extubation by doing cuff leak test. In a surgery where the patient is placed in trendelenburg position with considerable amount of intraoperative intravenous fluid use, it is sensible to put the patient in head up position post surgery so that fluid redistribution takes place. The respiratory changes that occur with this position include a fall in pulmonary compliance, vital capacity and the functional residual capacity. In a patient who is mechanically ventilated it may increase the peak airway pressure. In some patients where shoulder braces were used to prevent the patient from falling, brachial plexus injury was seen.[29]

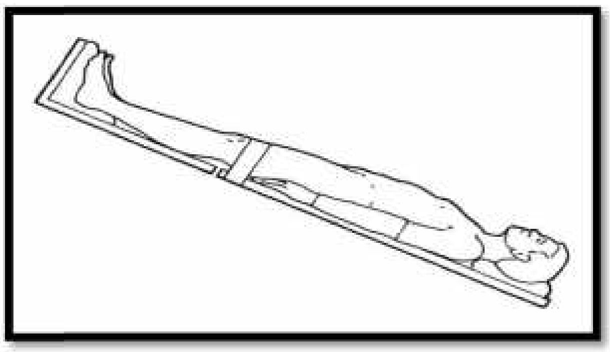


FIGURE 14: Trendelenburg Position

CLINOMETER(Figure15)**:**

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[30]

FIGURE 15: Clinometer

MATERIALS AND METHODS

Duration of study and study population:

Healthy volunteers of both sexes, aged between 18 and 60 years, belonging to ASA I and ASA II between January 2019-December 2019 at KLE'S Dr.PrabhakarKore Charitable Hospital And Medical Research Center, Nehru Nagar, Belagavi-590010 were recruited as per inclusion and exclusion criteria. (Data Collection-12 Months)

Type of study: Observational study.

CRITERIAS FOR SELECTION:

Inclusion Criteria:

- Individuals belonging to ASA physical status I and II.
- Individuals Aged between 18 and 60 years.

Exclusion Criteria:

- Previous neck surgeries.
- Pathology of the neck or thorax.
- Pregnant women.
- BMI >30.

Sample Size:

Total sample size is 100

Calculation of sample size:

The minimum sample size formula that is based on mean and standard deviation is

$$n = \frac{(z_\alpha + z_\beta)^2 (s_1^2 + s_2^2)}{(\bar{x}_1 - \bar{x}_2)^2}$$

Where, z_α is associated with the level of significance,

z_β is associated with the power of the test.

For achieving 5% level of the significance and 80% power of the test, the following values of z_α and z_β are required,

$z_\alpha = 1.96$ $z_\beta = 0.84$.

$\bar{x}_1$ - Mean of the first group (position 1-supine) = 0.78,

$\bar{x}_2$ - Mean of the second group (position 5-trendelenburg) = 0.66,[9]

s_1 - Standard deviation of the first group (position 1-supine) = 0.10,

s_2 - Standard deviation of the second group (position 5-trendelenburg) = 0.09.[9]

With these values the sample size of 10 was obtained.

In order to improve the study's validity, in each group a sample size of 50 was taken.

Methodology:

Approval for conducting the study was obtained from the Departmental research committee and the clearance from the institutional ethical board. Written informed consent was obtained before enrolling healthy volunteers who are aged between 18 and 60 years belonging to ASA I and II category, in the study.

100 healthy volunteers participated in the study. The examinations were done in the USG room adjacent to the OT complex equipped with adjustable OT table. The volunteers were made to lie flat (supine) on the table and asked to breathe normally and to refrain from contracting or moving their shoulders in any abnormal manner.

A duplex scanner (Model: Sonosite-M turbo) was used in the study to examine the SCV. Images of the vein were made using the B-mode. The doppler signal was used to measure the average blood velocity through the vein. The flow (ml/min) of the vein was calculated by multiplying the time average velocity (cm/sec) with the CSA (cm^2) of the vein and converting it to milliliters per minute. The ultrasound imaging was done using a 13-6 MHz linear transducer.

The ultrasound was set on vascular imaging mode. The ultrasound transducer was placed perpendicular to the skin just inferior to the medial $2/3^{rd}$ and lateral $1/3^{rd}$ junction of the right clavicle. When traced from medial to lateral, the right SCV was visualized just below the clavicle. Using the venous waveforms in the doppler mode the vein was confirmed and differentiated from the pulsatile subclavian artery.When optimal visualization in short axis view was confirmed, the antero-posterior diameter of the right SCV was measured. The transducer was rotated 90^0 to visualize the long axis view of the right SCV. Using doppler mode, the time average velocity of the vein was measured. The fluctuations in the vein size due to respiration were not considered. Same person did all the ultrasound examinations.

The examination and measurements were made in four different body tilt positions. The tilts were measured using an android application, Clinometer. After tilting the table, the position was maintained for one minute before taking the measurements. The head and shoulders were maintained in neutral position throughout the examination. The different positions in which examinations were made are:

1) Flat (supine),
2) 10^0Trendelenburg position,
3) 15^0Ipsilateral (right) tilt,
4) 10^0Trendelenburg with 15^0Ipsilateral (right) tilt.

The observations were tabulated as,

	POSITIONS			
	1	2	3	4
SCV diameter (cm)				
SCV CSA(cm^2)				
Flow (ml/min)				

RESULTS

Study design: Observational study.

Study positions:

1) Flat (supine),
2) 10^0 Trendelenburg position,
3) 15^0 Ipsilateral (right) tilt,
4) 10^0 Trendelenburg with 15^0 Ipsilateral (right) tilt.

TABLE 1: GENDER DISTRIBUTION OF THE VOLUNTEERS STUDIED.

GENDER	NUMBER
FEMALE	43
MALE	57
TOTAL	100

GRAPH 1:

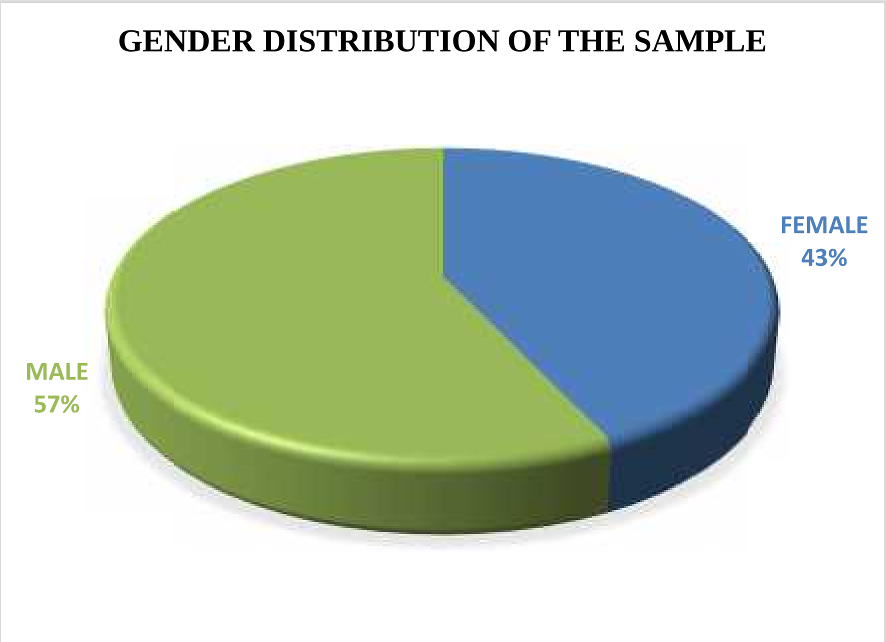


TABLE 2: DEMOGRAPHIC DISTRIBUTION OF THE STUDY POPULATION

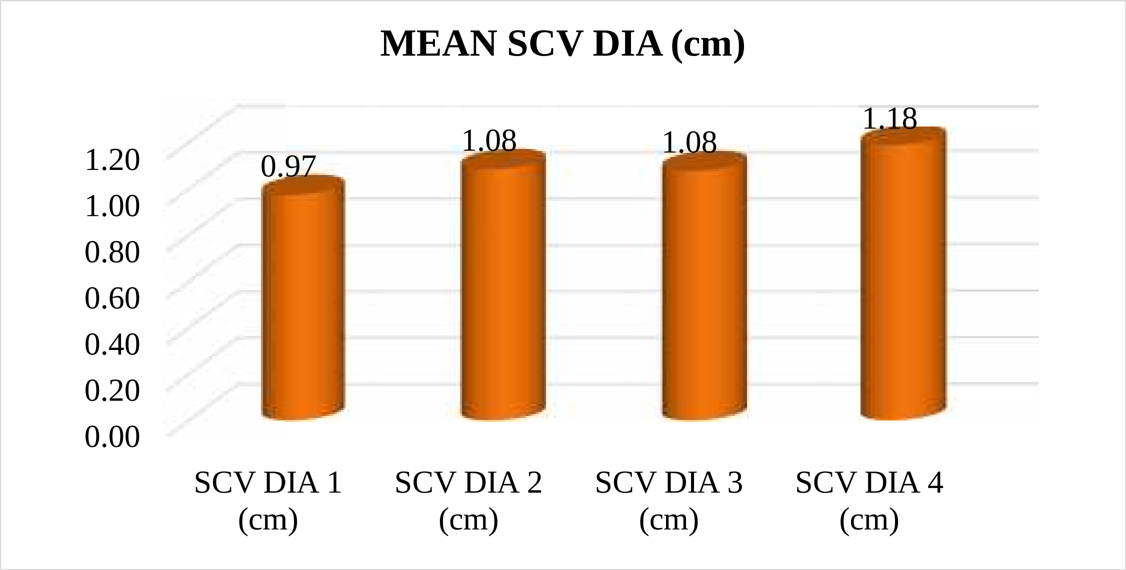
	MEAN	SD	MINIMUM	MAXIMUM
AGE (yrs)	25.94	4.0919	17	42
WEIGHT (kg)	63.82	12.083	42	103
HEIGHT (cm)	163.31	8.862	145	181

TABLE 3: MEAN RIGHT SCV DIAMETER DISTRIBUTION AMONG ALL THE POSITIONS.

	MEAN	SD	MINIMUM	MAXIMUM
SCV DIA 1 (cm)	0.97	0.11	0.68	1.28
SCV DIA 2 (cm)	1.08	0.11	0.82	1.36
SCV DIA 3 (cm)	1.08	0.11	0.76	1.38
SCV DIA 4 (cm)	1.18	0.12	0.88	1.43

(SCV DIA: subclavian vein diameter) (1,2,3 & 4: The study positions)

GRAPH 2:



ONE WAY ANALYSIS OF VARIANCE FOR SCV DIA:

There is no homogeneity among the means of the four groups.

TABLE 4: SCHEFFE TEST TO FIND OUT BETWEEN WHAT PAIRS THERE IS SIGNIFICANT DIFFERENCE (SCV DIAMETER).

	DIA 2	DIA 3	DIA 4
DIA 1	< 0.0001	< 0.0001	< 0.0001
DIA 2	--	0.9708	< 0.0001
DIA 3		--	< 0.0001

Maximum diameter was measured in position 4 (Trendelenburg with ipsilateral tilt) which was statistically significant ($p < 0.0001$) when compared to other positions. Whereas the diameter was found to be minimum in the supine position, which increased to statistically significant ($p < 0.0001$) values when changed to position 2, 3 and 4.

Except between the positions 2 and 3 ($p = 0.9708$), the rest all diameters had statistically significant changes among them.

There is no significant difference between diameter 2 and diameter 3 ($p = 0.9708$).

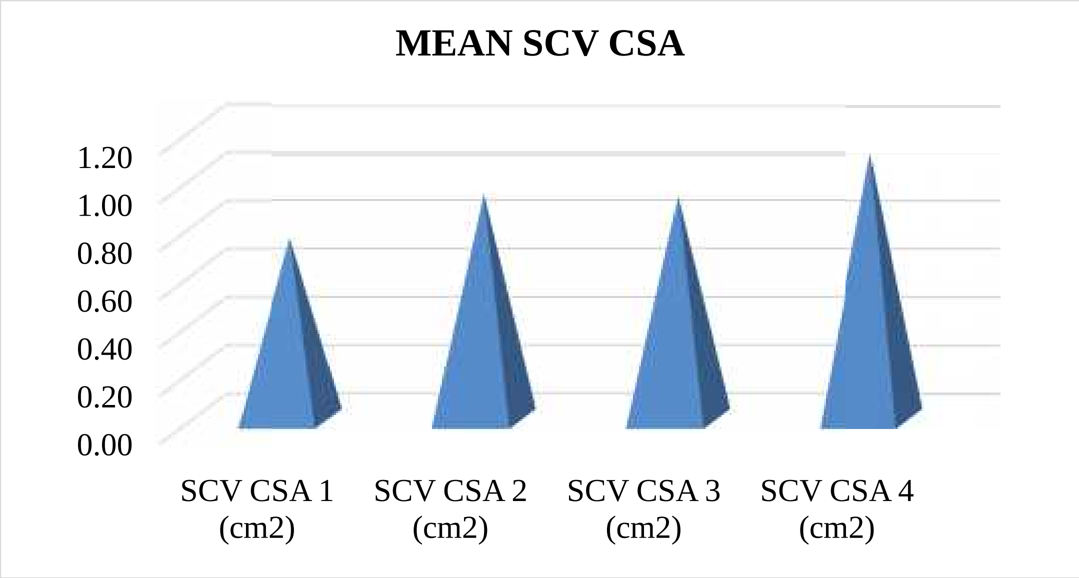
There is highly significant difference in the SCV diameter between the rest of the pairs ($p < 0.0001$).

TABLE 5: MEAN RIGHT SCV CSA DISTRIBUTION AMONG ALL THE POSITIONS.

	MEAN	SD	MINIMUM	MAXIMUM
SCV CSA 1 (cm^2)	0.75	0.17	0.36	1.28
SCV CSA 2 (cm^2)	0.93	0.20	0.52	1.45
SCV CSA 3 (cm^2)	0.92	0.19	0.45	1.49
SCV CSA 4 (cm^2)	1.10	0.22	0.60	1.60

(SCV CSA: Subclavian vein cross-sectional area)

GRAPH 3:



ONE WAY ANALYSIS OF VARIANCE FOR SCV CSA:

There is no homogeneity among the means of the four groups.

TABLE 6: SCHEFFE TEST TO FIND OUT BETWEEN WHAT PAIRS THERE IS SIGNIFICANT DIFFERENCE (CSA OF THE SCV).

	AREA 2	AREA 3	AREA 4
AREA 1	< 0.0001	< 0.0001	< 0.0001
AREA 2	--	0.9835	< 0.0001
AREA 3		--	< 0.0001

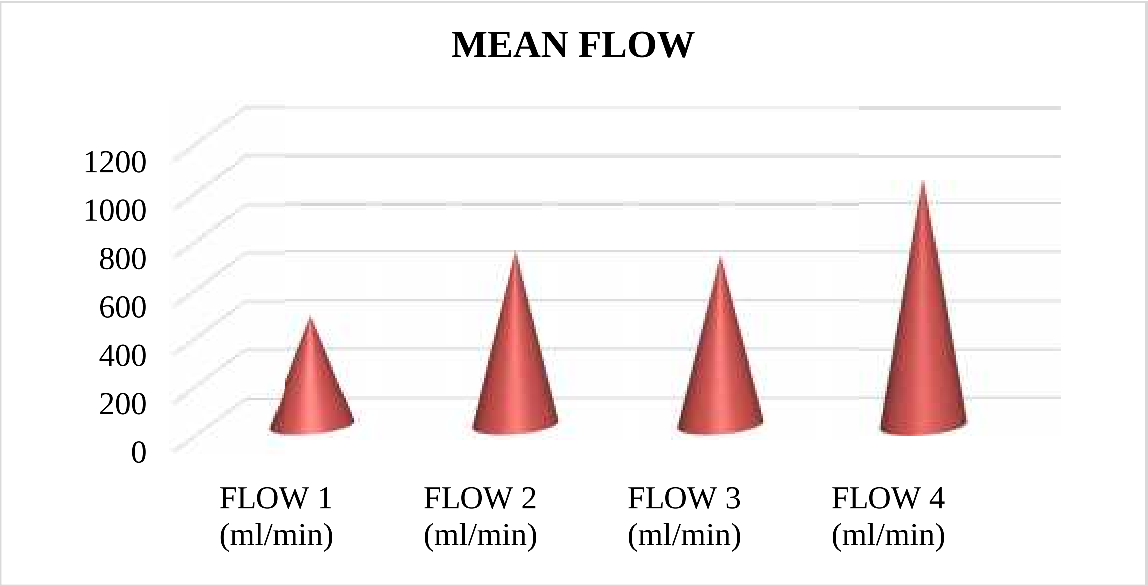
Maximum cross-sectional area was measured in position 4 (Trendelenburg with ipsilateral tilt) which was statistically significant ($p < 0.0001$) when compared to other positions. Whereas the cross-sectional area was found to be minimum in the supine position, which increased to statistically significant ($p < 0.0001$) values when changed to position 2, 3 and 4.

Except between the positions 2 and 3 (p = 0.9835), the rest all diameters had statistically significant changes among them.

TABLE 7: MEAN RIGHT SCV FLOW DISTRIBUTION AMONG ALL THE POSITIONS.

	MEAN	SD	MINIMUM	MAXIMUM
FLOW 1 (ml/min)	445.58	139.32	176	864
FLOW 2 (ml/min)	709.80	189.88	313	1218
FLOW 3 (ml/min)	690.11	187.20	216	1142
FLOW 4 (ml/min)	1011.92	262.44	420	1706

GRAPH 4:



ONE WAY ANALYSIS OF VARIANCE FOR RIGHT SCV FLOW:

There is no homogeneity among the means of the four groups.

TABLE 8: SCHEFFE TEST TO FIND OUT BETWEEN WHAT PAIRS THERE IS SIGNIFICANT DIFFERENCE (SCV FLOW).

	FLOW 2	**FLOW 3**	**FLOW 4**
FLOW 1	< 0.0001	< 0.0001	< 0.0001
FLOW 2	--	0.9218	< 0.0001
FLOW 3		--	< 0.0001

Maximum flow was measured in position 4 (Trendelenburg with ipsilateral tilt) which was statistically significant ($p < 0.0001$) when compared to other positions. Whereas the flow was found to be minimum in the supine position, which increased to statistically significant ($p < 0.0001$) values when changed to position 2, 3 and 4.

Except between the positions 2 and 3 ($p = 0.9218$), the rest all diameters had statistically significant changes among them.

Statistical Analysis:

The parameters are recorded in more than two positions for each patient.

One-way analysis of variance was done for repeated measures, for comparison.

Mean and standard deviation – for representing Continuous Quantitative variables.

Median – for representing Discrete variables.

Rates, ratios and percentages – for representing Categorical data.

Chi-square test or Fisher's exact test were used to test the association between the outcome, clinical and demographic characteristics.

p value of < 0.05 (5%) is considered statistically significant for all the tests.

DISCUSSION

The SCV cannulation having the advantages of infection risk lesser than that of internal jugular vein cannulation, good patient comfort, lesser complications during the time of insertion by an experienced personnel and ease of dressing, is preferred commonly for patients who require central venous catheters for a long term.[1,5,6] The left SCV though having the potential advantage of easier sweeping curve in its route to the SVC, have the risks of the apex of the left pleura being much superior than that of the right pleura (the pleura's apex is related inferior to the medial part of SCV), proximity of the thoracic duct to junction of left SCV and left internal jugular vein.[24,25,31]

The SCV catheterization has complications such as hematoma formation, accidental arterial puncture and pneumothorax.[2] Using ultrasound for guiding in the central venous cannulation has gained more attention in view of reducing complications during cannulation. MariantinaFragou et al[13] compared ultrasound guided and landmark guided subclavian vein cannulation in critically ill patients. They concluded that an increased success rate and a fall in mechanical complications is seen with ultrasound guided SCV cannulation when compared with the conventional landmark technique.

The mechanical complications during SCV cannulation can be decreased by increasing the first pass success rate. Having a larger CSA of the vein provides us with higher success rate of venipuncture.[15,17] Most of the operating tables in the operating rooms have the ability to be tilted laterally and also to be placed in Trendelenburg position. By increasing the central venous pressure, the SCV can be distended. As the Trendelenburg position distends the SCV due to venous pooling by gravity, the same can be expected if the individual is tilted towards the side of the corresponding SCV. The effects of ipsilateral tilting of the body on the SCV has not been much explored. In this study we hypothesized that tilting an individual ipsilaterally (right) and Trendelenburg position along with ipsilateral tilting will increase the CSA of the right SCV.

In our study, the study subjects had almost equal sex distribution (Male-57, Female-43). The height and weight of the volunteers were equally distributed. On changing the position from neutral to Trendelenburg, the cross-sectional diameter of right SCV increased by 11.34% (0.97 ± 0.11cm to 1.08 ± 0.11cm) and the CSA increased by 24% (0.75 ± 0.17cm^2 to 0.93 ± 0.20cm^2). This change is similar to that seen in previous studies.[9,10,15–17] The study conducted by Makoto Kawano et al[17] on SCV using ultrasonography also showed that Trendelenburg position increased the subclavian venous diameter (0^0 - 12.1 ± 1.9mm to 10^0 - 13.3 ± 1.8 mm). In their study maximum diameter was found in 10^0 Trendelenburg position. They suggested that 15^0 Trendelenburg will be the maximum optimal clinical degree of tilt that can be achieved. Our result of increase in the CSA with Trendelenburg position is also similar to the result obtained by the study done by John B. fortune et al[9], where the CSA area was measured in various body positions by turning the head, arching the shoulders and giving Trendelenburg position. They had concluded that just Trendelenburg position alone increased the SCV CSA [supine- 0.66(0.09) cm^2 to Trendelenburg - 0.78(0.10) cm^2]. Similarly, study conducted by Mi-Young Kwon et al[10] measuring and comparing the CSA of the SCV in supine position, Trendelenburg position with 10 seconds positive pressure inspiratory hold and 10 second open airway in intubated anaesthetized patients showed that there was statistically significant increase in the CSA (Δ CSA S_0 and T_0 is 0.11cm^2) when Trendelenburg position was given. But clinically significant increase in CSA was seen when Trendelenburg was combined with inspiratory hold (Δ CSA S_0 and T_{20} is 0.23cm^2). Similar study was done on internal jugular vein (IJV) by V Dhulkhed et al.[15] They found out that a 15^0 Trendelenburg tilt increased the right IJV cross-sectional diameter. The Trendelenburg position increases the CSA of the SCV. Head low position also has reduced risk of air embolism while cannulating the SCV.

In our study, when the volunteer was ipsilaterally(right) tilted, the CSA of the right SCV increased by 22.6% (0.75 ± 0.17cm^2 to 0.92 ± 0.19cm^2). The increase in the CSA of the right subclavian vein on neutral to ipsilateral tilting was almost similar to that of tilt from neutral to Trendelenburg position. This increase can be attributed to the gravity dependent venous pooling in the tilted side similar to which is seen in Trendelenburg position. Thus, Ipsilateral tilting can be used in place of Trendelenburg position in facilitating the right SCV cannulation.

In our study, when the position was changed to Trendelenburg along with ipsilateral tilt from supine position the increase in the CSA of the right SCV was maximum with almost 46.6% (1.1 ± 0.22 cm^2). This is almost twice that is seen with either Trendelenburg position or Ipsilateral tilting alone. Thus, positioning the patient in this position (Trendelenburg with ipsilateral tilt) will be superior in aiding the right SCV cannulation.

In our study, the flow in the right SCV measured in ml/min increased on changing the patient position from supine to Trendelenburg, ipsilateral tilt and Trendelenburg with ipsilateral tilt positions. The maximum increase was seen when Trendelenburg with ipsilateral tilt was given. This result is in contrast to the study conducted by John B et al[9] where there was no significant change in the venous flow when patient was tilted to Trendelenburg position from neutral.

Various body positions and manoeuvres were done and studied in an attempt to increase the CSA of the SCV thereby easing cannulation. Kung-Jee Lim et al[1] studied the relation between full expiration and the SCV size and position and found that full expiration significantly increases the CSA of the SCV by approximately 43%. There was no change in the distance between SCV and pleura after full expiration. Study conducted by John B. Fortune et al[9] demonstrated that shoulder arching and rotating the head reduced the target size of the SCV in turn causing unfavourable condition for cannulation. It also demonstrated that the Trendelenburg position without any positioning manoeuvres may aid in SCV cannulation by increasing its CSA (with $p < 0.02$).

Our study was done on healthy individuals whose hydration status was normal. The change in the cross-sectional area can be magnified in individuals in hypovolemic states (critically ill or post trauma), who usually are in need of central venous cannulation.

LIMITATIONS:

In this study, intervention by cannulating the SCV was not done. Hence, applicability of these positions during the right SCV cannulation by studying the first pass rate, time for cannulation and incidence of procedure related complications could be determined by this study.

Tilting a conscious individual to either Trendelenburg or ipsilateral position may give them a sense or phobia of fall. Proper precautions like providing reassurance or strapping them with the bed might be required.

CONCLUSION

From our study, we conclude that among the four different positions studied the 10^0 Trendelenburg with 15^0 Ipsilateral (right) tilt position maximizes the CSA of theright SCV. 10^0 Trendelenburg with 15^0 Ipsilateral (right) tilt position maximizes the flow in the right SCV.

Hence, Trendelenburg along with ipsilateral (right) tilt can be considered while cannulating the right SCV. Ipsilateral tilt (right) can be considered as an alternative to Trendelenburg position while cannulating the right SCV.

SUMMARY

In this study titled "**EFFECT OF BODY POSITION ON THE CROSS-SECTIONAL AREA OF THE RIGHT SUBCLAVIAN VEIN MEASURED WITH THE AID OF 2-DIMENSIONAL ULTRASONOGRAPHY: ONE YEAR OBSERVATIONAL STUDY"** we have measured and compared the cross-sectional areas (CSA) of the right subclavian vein (SCV) among four different body positions comprising flat (supine), 10^0 Trendelenburg position, 15^0 Ipsilateral (right) tilt and 10^0 Trendelenburg with 15^0 Ipsilateral (right) tilt.

In this study 100 healthy volunteers aged between 18 and 60 years belonging to ASA category I and II and meeting the inclusion criteria were included. Imaging and measurements (the cross-sectional diameter, the CSA and the flow of the right SCV) of all the volunteers in all the four positions were measured and tabulated separately.

All the volunteers were similar in terms of age, weight and height. The CSA of the right SCV increased significantly when the position was changed from both supine to Trendelenburg position and supine to Ipsilateral (right) tilt position. The increase was maximum when the position was changed to Trendelenburg with ipsilateral tilt position. The increase in the CSA was not significant between the Trendelenburg and the ipsilateral tilt positions. The flow of the right SCV was found to be maximum in the Trendelenburg with ipsilateral tilt position.

It is concluded that the maximum increase in the CSA of the right SCV is seen in 10^0 Trendelenburg with 15^0 ipsilateral (right) tilt and the increase in CSA on ipsilateral titling is similar to that on Trendelenburg positioning.

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ANNEXURE I - INFORMED CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr. /Mrs. /Miss. ______________________________, we are requesting you to enroll yourself in the study titled **"EFFECT OF BODY POSITION ON THE CROSS-SECTIONAL AREA OF THE RIGHT SUBCLAVIAN VEIN MEASURED WITH THE AID OF 2-DIMENSIONAL ULTRASONOGRAPHY: ONE YEAR OBSERVATIONAL STUDY"** conducted by Dr**.** ____________, Post Graduate in M.D. Anaesthesiology under the guidance of Dr.__________MD, Professor, Department of Anaesthesiology, 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: To know the optimal body position that maximizes the Subclavian vein cross sectional area and its flow.

Procedure Involved: On the day of study, the volunteer will be brought to the USG room adjacent to OT complex with adjustable OT table and placed in supine position on the OT table. They will be told to lie comfortably on the table, breathe normally and avoid any contraction or abnormal movements of the shoulders.

A duplex scanner (Model-Sonosite-M turbo) will be used to determine the size of the Subclavian vein. The duplex scanner images the vein with B-Mode ultrasonography. It can measure the time average velocity of flow through the vein using Doppler signal. Flow will be calculated by multiplying the time average velocity (cm/sec) by the calculated area (cm^2) of the vessel.This will give us the measurement of flow in milliliters per minute. The measurement of the size of the subclavian vein will be done by a 13-6MHz linear probe. The right subclavian vein will be imaged by placing the probe just inferior to the medial $2/3^{rd}$ and lateral $1/3^{rd}$ junction of the right clavicle and tracing it form medial to lateral. The subclavian vein will be confirmed using the venous waveforms in the doppler mode. The Antero-posterior diameter of the vein will be measured in the short axis view. The cross-sectional area can be calculated from this Antero-posterior diameter. The transducer will be rotated 90^0 to visualize the long axis view of the right subclavian vein. The time average velocity will be measured using the doppler mode. The respiratory fluctuations in the size will not be considered. The same person will be performing all the ultrasound examinations.

Measurements will be made in 4 different positions that will involve differences in body tilt. For the Trendelenburg position, the subject will be placed flat (or supine) with the entire operation table in 10^0 head down position. The tilted positions will be achieved by tilting the operating table by 15^0 ipsilaterally i.e., towards right. All the table tilts will be measured and adjusted using clinometer, an android application. The volunteer’s head and body will be placed in neutral position. Each position will be maintained for 1 min before the measurements be taken. The head and shoulders of the volunteer will be in neutral position throughout the procedure.

The four different positions in which the Subclavian vein will be studied are as follows:

1. Flat (or supine), head and shoulders neutral.
2. 10^0 Trendelenburg, head and shoulders neutral.
3. 15^0 ipsilateral tilt, head and shoulders neutral.
4. 10^0 Trendelenburg with 15^0 ipsilateral tilt, head and shoulders neutral.

Voluntary Participation/Withdrawal:

Taking part in the study is voluntary. You may choose not to enroll 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.

Privacy and Confidentiality:

The only people to know that you are a research subject are you and the 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 will remain 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 Dr. __________ at Department of Anaesthesiology, J.N. Medical College or by Ph. No:

Questions:

If you have any queries about your rights as a study subject, you may call Dr. RoopaBellad$_{MD}$, Professor, Department of Pediatrics and Chairman, J.N. Medical College Institutional Ethical Committee for Human Subjects Research, Phone number: 9448113403, J.N. Medical College, Belagavi.

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH TRIAL

"EFFECT OF BODY POSITION ON THE CROSS-SECTIONAL AREA OF THE RIGHT SUBCLAVIAN VEIN MEASURED WITH THE AID OF 2-DIMENSIONAL ULTRASONOGRAPHY: ONE YEAR OBSERVATIONAL STUDY."

I, Mr./Ms./Mrs. ________________________________ voluntarily agree for the participation as a subject of the 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

"EFFECT OF BODY POSITION ON THE CROSS-SECTIONAL AREA OF THE RIGHT SUBCLAVIAN VEIN MEASURED WITH THE AID OF 2-DIMENSIONAL ULTRASONOGRAPHY: ONE YEAR OBSERVATIONAL STUDY."

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

Pre examination evaluation:

Past History:

- HTN / DM/ IHD / Arrhythmia / LVH / Valvular heart disease
- H/o uncontrolled hypertension/diabetes mellitus

General physical examination:

Weight (Kg)	:	Height (cm)	:	Temperature (^{0}F)	:
Pallor	:	Cyanosis	:	Pedal edema	:
Clubbing	:	Pulse rate	:	Blood pressure	:

Respiratory rate:

Systemic examination:

RS	:	CNS	:
CVS	:	GIT	:

Preoperative physical status: ASA Grade I II III IV V

Inclusion Criteria:

- ASA physical status I and II.
- Age between 18 and 60 years.

Exclusion Criteria:

- Previous neck surgery.
- Pathology of the neck or thorax.
- Pregnant women.
- BMI >30.

METHODOLOGY:

100 healthy volunteers will participate in this study. They will be brought to the USG room adjacent to OT complex with adjustable OT table and placed in supine position on the operating table. They will be told to lie comfortably on the table, breathe normally and refrain from contracting or moving their shoulders in any abnormal manner.

A duplex scanner (Model-Sonosite-M turbo) will be used to determine the size of the subclavian vein. The duplex scanner images the vein with B-Mode ultrasonography. It can measure the time average velocity of flow through the vein using Doppler signal. Flow will be calculated by multiplying the time average velocity (cm/sec) by the calculated area (cm^2) of the vessel.This will give us the measurement of flow in milliliters per minute. The measurement of the size of the subclavian vein will be done by a 13-6MHz linear probe. The right subclavian vein will be imaged by placing the probe just inferior to the medial $2/3^{rd}$ and lateral $1/3^{rd}$ junction of the right clavicle and tracing it form medial to lateral. The subclavian vein will be confirmed using the venous waveforms in the doppler mode. The Antero-posterior diameter of the vein will be measured in the short axis view. The cross-sectional area can be calculated from this Antero-posterior diameter. The transducer will be rotated 90^0 to visualize the long axis view of the right subclavian vein. The time average velocity will be measured using the doppler mode. The respiratory fluctuations in the size will not be considered. The same person will be performing all the ultrasound examinations.

Measurements will be made in 4 different positions that will involve differences in body tilt. For the Trendelenburg position, the subject will be placed flat (or supine) with the entire operation table in 10^0 head down position. The tilted positions will be achieved by tilting the operating table by 15^0 ipsilaterally i.e., towards right. All the table tilts will be measured and adjusted using Clinometer, an android application. The volunteer's head and body will be placed in neutral position. Each position will be maintained for 1 min before the measurements be taken. The head and shoulders of the volunteer will be in neutral position throughout the procedure.

The four different positions in which the Subclavian vein will be studied are as follows:

1. Flat (or supine), head and shoulders neutral.
2. 10^0 Trendelenburg, head and shoulders neutral.
3. 15^0 Ipsilateral tilt, head and shoulders neutral.
4. 10^0 Trendelenburg with 15^0 ipsilateral tilt, head and shoulders neutral

OBSERVATIONS:

The observations will be tabulated as,

	POSITIONS			
	1	2	3	4
SCV diameter (cm)				
SCV CSA(cm^2)				
Flow (ml/min)				

SIGNATURE OF THE ANAESTHESIOLOGIST - ___________________

SIGNATURE OF THE PRINCIPAL INVESTIGATOR - __________________

ANNEXURE III - ETHICAL CLEARANCE

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/ 27 **Date: 24/11/2018**

To,

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 **"EFFECT OF BODY POSITION ON THE CROSS SECTIONAL AREA OF THE RIGHT SUBCLAVIAN VEIN MEASURED WITH THE AID OF 2-DIMENSIONAL ULTRASONOGRAPHY: ONE YEAR OBSERVATIONAL STUDY"**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

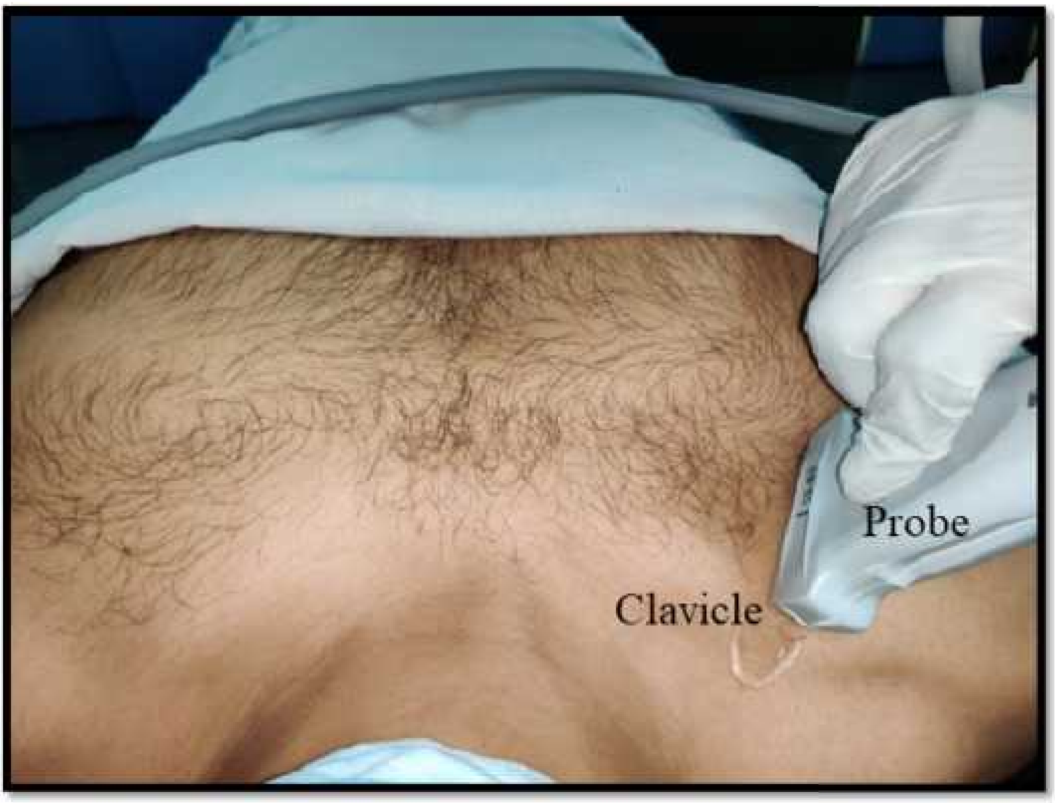
(Dr. Arathi Darshan)
Member Secretary
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

(Dr. Roopa M Bellad)
Chairman,
JNMC Institutional Ethics Committee
on Human Subjects Research,
J.N.Medical College, Belagavi.

ANNEXURE – IV- PHOTOGRAPHS

PHOTOGRAPH 1: USG machine with probe

PHOTOGRAPH 2: Linear ultrasound probe

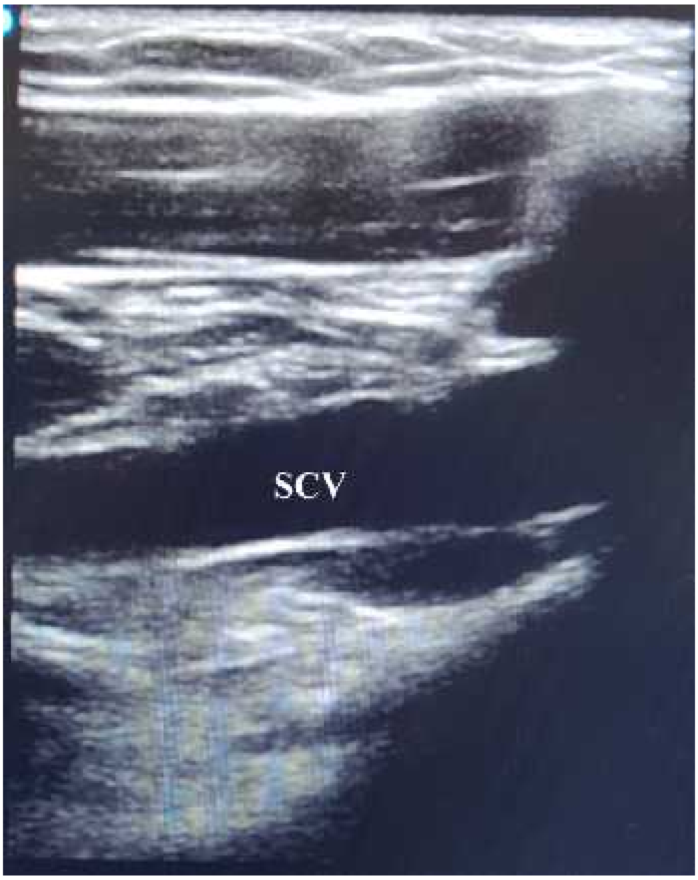


PHOTOGRAPH 3: Probe placement (Vertical)

PHOTOGRAPH 4: Probe placement (Transverse)

PHOTOGRAPH 5: SCV Short axis view

PHOTOGRAPH 6: Cross-sectional diametermeasurement



PHOTOGRAPH 7: SCV Long axis view

PHOTOGRAPH 8: Doppler imaging

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
kg	Kilogram
M	Male
min	Minute
ml	Milliliter
SCV	Subclavian vein
yrs	Years

ANNEXURE – VI - MASTER CHART

SL No.	AGE (yrs)	GENDER	WEIGHT (kg)	HEIGHT (cm)	DATE	ASA	SCV DIA 1 (cm)	SCV DIA 2 (cm)	SCV DIA 3 (cm)	SCV DIA 4 (cm)	SCV CSA 1 (cm2)	SCV CSA 2 (cm2)	SCV CSA 3 (cm2)	SCV CSA 4 (cm2)	FLOW 1 (ml/min)	FLOW 2 (ml/min)	FLOW 3 (ml/min)	FLOW 4 (ml/min)
1	26	M	67	158	25-Jan	1	0.83	0.92	0.91	0.96	0.54	0.66	0.65	0.72	259	475	585	648
2	34	M	73	178	21-Jan	1	0.79	0.93	0.85	0.94	0.49	0.68	0.57	0.7	176	326	273	420
3	23	M	50	170	21-Jan	1	0.82	1.01	0.98	1.04	0.53	0.8	0.75	0.85	254	432	405	510
4	28	M	70	178	02-Jan	1	1	1.2	1.2	1.3	0.78	1.13	1.13	1.32	374	881	813	1267
5	28	M	52	164	21-Jan	1	0.78	0.86	1.04	1.19	0.48	0.58	0.85	1.11	230	313	459	666
6	30	M	54	162	16-Jan	1	0.82	0.96	1.06	1.11	0.53	0.72	0.88	0.95	318	562	739	855
7	25	M	52	162	21-Jan	1	0.79	1.01	0.9	1.13	0.49	0.8	0.6	1	176	384	216	600
8	25	M	52	164	14-Jan	1	0.96	0.99	1.02	1.07	0.72	0.77	0.82	0.9	389	508	541	810
9	26	M	55	172	02-Jan	1	0.82	0.98	0.96	1.12	0.53	0.75	0.72	0.98	318	540	475	823
10	23	M	53	162	23-Feb	1	0.86	0.98	1.1	1.2	0.58	0.75	0.95	1.13	418	675	855	1152
11	25	M	92	170	01-Apr	1	1	1.24	1.2	1.42	0.78	1.2	1.1	1.58	561	1152	990	1706
12	28	M	65	168	01-Apr	1	1.02	1.13	1.16	1.28	0.82	0.98	1.05	1.28	492	764	819	1382
13	25	M	72	176	25-Jan	1	0.95	1.01	1.03	1.12	0.71	0.8	0.83	0.98	426	576	599	941
14	28	M	68	172	01-Apr	1	0.9	1.06	1.08	1.16	0.63	0.88	0.91	1.06	340	634	600	890
15	27	F	60	166	17-May	1	0.84	0.96	0.94	1.02	0.55	0.72	0.69	0.82	198	346	331	492
16	21	F	42	152	08-Apr	1	0.86	0.98	0.98	1.06	0.58	0.75	0.75	0.88	313	585	540	792

17	26	M	72	165	09-Apr	1	0.86	0.98	1	1.15	0.58	0.75	0.78	1.03	418	720	702	1112
18	28	F	62	160	12-Jan	1	0.9	0.98	0.98	1.04	0.63	0.75	0.75	0.85	378	630	585	867
19	28	M	66	158	22-Mar	1	1.06	1.2	1.22	1.34	0.88	1.13	1.16	1.4	528	814	835	1260
20	22	M	90	164	25-Apr	1	0.96	1.14	1.1	1.24	0.72	1.02	0.95	1.2	518	979	855	1296
21	26	F	68	160	25-Apr	1	0.68	0.82	0.76	0.88	0.36	0.52	0.45	0.6	216	406	324	576
22	27	M	80	172	25-Apr	1	0.8	0.85	0.84	0.96	0.5	0.57	0.55	0.72	240	410	429	648
23	27	F	68	159	24-May	1	0.88	0.96	0.94	1.04	0.61	0.72	0.69	0.85	366	605	538	816
24	26	F	63	158	10-May	1	0.92	0.98	1	1.18	0.66	0.75	0.78	1.09	318	585	562	981
25	20	F	48	148	18-Apr	1	0.84	0.94	0.96	1.06	0.55	0.69	0.72	0.88	264	497	518	845
26	22	F	70	176	12-Apr	1	0.86	0.98	1	1.14	0.58	0.75	0.78	1.02	348	585	608	979
27	26	M	86	178	08-Jan	1	0.98	1.08	1.07	1.14	0.75	0.91	0.89	1.02	450	764	747	979
28	26	M	80	176	15-May	1	0.94	1.04	1.02	1.14	0.69	0.85	0.82	1.02	331	612	639	979
29	28	F	59	166	24-May	2	0.86	0.94	0.96	1	0.58	0.69	0.72	0.78	278	497	518	655
30	25	M	70	170	17-May	1	0.86	0.96	0.94	1.06	0.58	0.72	0.69	0.88	348	562	497	739
31	36	M	66	160	03-May	2	1.02	1.16	1.14	1.26	0.82	1.05	1.02	1.24	590	1008	918	1265
32	42	M	58	154	03-May	1	0.88	0.99	0.98	1.08	0.61	0.77	0.75	0.91	293	554	585	874
33	23	M	82	174	03-May	1	0.98	1.08	1.06	1.12	0.75	0.91	0.88	0.98	450	756	739	941
34	23	M	76	165	15-Apr	1	0.98	1.08	1.06	1.18	0.75	0.91	0.88	1.09	360	540	528	667
35	26	M	78	174	16-Aug	1	1.02	1.1	1.08	1.16	0.82	0.95	0.91	1.05	492	741	655	1008
36	25	M	54	148	16-Aug	1	0.96	1.02	1	1.1	0.72	0.82	0.78	0.95	346	492	468	741
37	29	M	56	160	09-Aug	1	0.98	1.06	1.04	1.14	0.75	0.88	0.85	1.02	450	739	612	918
38	24	M	46	160	26-Mar	1	0.88	0.95	0.96	1.38	0.61	0.71	1.06	1.49	366	511	890	1609
39	26	M	58	162	22-Mar	1	0.88	0.92	0.9	0.98	0.61	0.66	0.63	0.75	293	554	454	675
40	25	M	60	163	09-Aug	1	0.86	0.98	0.96	1.04	0.58	0.75	0.72	0.85	278	450	345	612
41	25	F	60	166	10-May	1	1	1.08	1.06	1.16	0.78	0.91	0.88	1.06	468	655	633	890

42	26	F	64	160	12-May	1	0.94	1.02	1.02	1.16	0.69	0.82	0.82	1.06	414	689	689	1018
43	25	M	47	156	09-Aug	1	1.02	1.06	1.04	1.1	0.82	0.88	0.85	0.95	492	634	612	798
44	25	F	62	150	20-Aug	1	0.88	0.96	0.94	1.02	0.61	0.72	0.69	0.82	293	518	455	689
45	25	F	64	159	22-Aug	1	1	1.08	1.06	1.12	0.78	0.91	0.88	0.98	562	764	739	941
46	25	F	56	154	20-Aug	1	1.02	1.1	1.08	1.18	0.82	0.95	0.91	1.09	590	855	764	1046
47	27	F	67	156	21-Aug	1	0.96	1.02	1	1.08	0.72	0.82	0.78	0.91	346	541	468	764
48	24	F	67	158	20-Aug	1	0.96	1.06	1.04	1.1	0.72	0.88	0.85	0.95	432	686	612	912
49	25	F	58	150	09-Aug	1	0.96	1.04	1.02	1.08	0.72	0.85	0.82	0.91	432	714	689	874
50	35	F	48	152	25-Oct	1	0.86	1.08	1.06	1.14	0.58	0.91	0.88	1.02	348	655	633	856
51	30	F	56	149	25-Oct	1	0.94	1.02	1.04	1.18	0.69	0.81	0.84	1.09	331	583	504	915
52	22	M	103	178	28-Aug	1	1.2	1.32	1.3	1.38	1.13	1.38	1.32	1.49	678	979	950	1251
53	21	F	53	160	10-Oct	1	0.86	0.96	0.94	1.1	0.58	0.72	0.69	0.95	278	518	496	912
54	28	F	57	172	14-Dec	1	1.12	1.28	1.26	1.36	0.98	1.28	1.24	1.45	588	921	892	1392
55	34	M	62	152	25-Oct	1	1.14	1.25	1.24	1.3	1.02	1.24	1.2	1.32	490	893	864	1109
56	23	M	85	176	19-Oct	1	0.76	0.9	0.88	1.02	0.45	0.63	0.6	0.81	270	529	504	875
57	32	M	46	164	10-Oct	1	1.06	1.12	1.14	1.24	0.88	0.98	1.02	1.2	422	705	612	1152
58	25	F	60	164	10-Oct	1	0.98	1.06	1.08	1.16	0.75	0.88	0.91	1.05	450	739	655	1008
59	24	F	70	166	25-Oct	1	0.94	1.08	1.06	1.12	0.69	0.91	0.88	0.98	496	764	739	1058
60	22	M	77	177	28-Jul	1	1.1	1.2	1.18	1.28	0.95	1.13	1.09	1.28	684	949	915	1382
61	27	M	73	173	19-Oct	1	1.04	1.16	1.18	1.24	0.84	1.05	1.09	1.2	403	630	654	864
62	21	M	50	163	25-Oct	1	1.24	1.36	1.38	1.42	1.2	1.45	1.49	1.58	864	1044	1072	1363
63	22	F	64	161	19-Oct	1	1.04	1.26	1.24	1.34	0.84	1.24	1.2	1.41	504	893	864	1353
64	25	F	54	164	14-Dec	1	1.02	1.16	1.14	1.22	0.81	1.05	1.02	1.16	486	756	734	1113
65	27	F	52	145	21-Oct	1	1.08	1.18	1.16	1.24	0.91	1.09	1.05	1.2	655	915	882	1152
66	26	F	58	166	28-Dec	1	1.06	1.2	1.18	1.26	0.88	1.13	1.09	1.24	633	949	915	1190

67	22	F	52	165	19-Oct	1	1.04	1.18	1.2	1.32	0.84	1.09	1.13	1.36	504	785	814	1306
68	24	M	68	159	25-Oct	1	1.02	1.16	1.14	1.3	0.81	1.05	1.02	1.32	389	756	734	1109
69	21	M	63	158	25-Jan	1	1.08	1.16	1.15	1.2	0.91	1.05	1.03	1.13	546	882	865	1085
70	24	F	58	162	10-Oct	1	1.02	1.18	1.16	1.24	0.81	1.09	1.05	1.2	583	915	882	1296
71	31	F	60	162	25-Oct	1	0.84	1.02	1	1.08	0.55	0.81	0.78	0.91	396	680	748	982
72	23	M	87	181	25-Oct	1	1.06	1.18	1.16	1.24	0.88	1.09	1.05	1.2	633	915	882	1152
73	19	M	64	152	28-Jul	1	0.98	1.08	1.06	1.16	0.75	0.91	0.88	1.05	450	764	739	1008
74	35	F	52	174	18-Aug	1	1.02	1.16	1.12	1.24	0.81	1.05	0.98	1.2	486	756	705	1008
75	28	F	48	150	18-Jul	1	1	1.12	1.1	1.2	0.78	0.98	0.95	1.13	468	823	798	1084
76	26	F	55	167	25-Oct	1	1.02	1.1	1.08	1.16	0.81	0.95	0.91	1.05	388	570	546	756
77	26	F	51	158	25-Oct	1	0.86	1.04	1.02	1.14	0.58	0.84	0.81	1.02	278	504	486	734
78	28	F	64	160	19-Oct	1	1.06	1.18	1.18	1.32	0.88	1.09	1.09	1.36	528	915	915	1365
79	26	F	52	158	24-Aug	2	0.98	1.06	1.08	1.16	0.75	0.88	0.91	1.05	540	739	764	1008
80	24	M	74	177	24-Aug	1	1.02	1.1	1.08	1.18	0.81	0.95	0.91	1.03	583	798	764	988
81	41	F	65	152	28-Jul	1	0.94	1.02	1	1.12	0.69	0.81	0.78	0.98	414	583	561	882
82	25	M	68	158	10-Oct	1	0.98	1.06	1.04	1.18	0.75	0.86	0.84	1.09	360	604	504	784
83	22	M	57	176	21-Oct	1	1.08	1.14	1.16	1.24	0.91	1.02	1.05	1.2	546	856	882	1152
84	22	M	88	179	14-Oct	1	1.02	1.2	1.18	1.28	0.81	1.13	1.09	1.28	486	813	741	1075
85	17	M	42	150	10-Oct	1	1	1.12	1.1	1.2	0.78	0.98	0.95	1.13	561	882	855	1220
86	27	M	60	146	24-Aug	1	1.04	1.12	1.1	1.2	0.84	0.98	0.95	1.13	504	823	789	1084
87	23	M	94	160	14-Dec	1	1.28	1.32	1.3	1.43	1.28	1.36	1.32	1.6	768	979	950	1536
88	23	M	68	170	10-Oct	1	1.18	1.24	1.22	1.3	1.09	1.2	1.16	1.32	523	864	835	1109
89	28	F	54	153	19-Oct	1	0.96	1.04	1.02	1.14	0.72	0.84	0.81	1.02	432	605	583	1102
90	23	M	78	178	14-Dec	1	1.2	1.34	1.32	1.4	1.13	1.41	1.36	1.53	813	1184	1142	1468
91	22	M	58	174	19-Oct	1	0.98	1.1	1.08	1.18	0.75	0.95	0.91	1.09	450	684	655	1046

92	26	F	59	154	19-Oct	1	0.98	1.1	1.1	1.24	0.75	0.95	0.95	1.2	450	684	684	1008
93	22	F	68	165	19-Oct	1	1.1	1.22	1.2	1.38	0.95	1.16	1.13	1.49	570	835	813	1430
94	21	M	81	164	14-Dec	1	1.18	1.36	1.36	1.42	1.09	1.45	1.45	1.58	654	1218	1131	1706
95	28	F	56	152	14-Dec	1	1.1	1.24	1.22	1.36	0.95	1.2	1.16	1.45	570	864	835	1218
96	24	F	58	156	04-Nov	1	0.98	1.06	1.04	1.12	0.75	0.88	0.84	0.98	540	739	705	940
97	25	M	66	164	04-Nov	1	1.02	1.1	1.12	1.24	0.81	0.95	0.98	1.2	583	684	823	1152
98	27	F	60	160	13-Nov	1	1.04	1.18	1.16	1.22	0.84	1.09	1.05	1.16	604	981	945	1252
99	30	M	74	170	08-Nov	1	1.04	1.12	1.1	1.18	0.84	0.98	0.95	1.09	504	705	684	1046
100	32	M	74	172	21-Sep	1	1.1	1.2	1.18	1.28	0.95	1.13	1.09	1.28	684	949	915	1228