"PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE SUBCLAVIAN VEIN/INFRACLAVICULAR AXILLARY VEIN COLLAPSIBILITY INDEX WITH INFERIOR VENACAVA COLLAPSIBILITY INDEX (DURING SPONTANEOUS BREATHING OR DEEP INSPIRATION) IN PREDICTING HYPOTENSION AFTER INDUCTION OF GENERAL ANAESTHESIA"

By

REG NO. BA0120007

Dissertation

Submitted to the

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in

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JAWAHARLAL NEHRU MEDICAL COLLEGE,

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DR. RAJESH MANE M.D. DNB
Professor and Head of the Department,
Department of Anaesthesiology,
J. N. Medical College,
Nehru Nagar, Belagavi – 10

Date: 02/01/2023
Place: Belagavi

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

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

Date: 02/01/2023
Place: Belagavi

KAHER J.N. MEDICAL COLLEGE BELAGAVI

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Nehru Nagar, Belagavi- 590 010, Karnataka, INDIA
0831 – 2471350 0831 – 2470759 www.jnmc.edu principal@jnmc.edu

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

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Chairperson-Antiplagiarism Committee &
Principal,
J. N. Medical College, Belagavi.

To,
Reg. No. BA0120007,
Postgraduate Student,
2020-21 Batch,
Department of Anaesthesiology,
J. N. Medical College, Belagavi.

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K.L.E. ACADEMY OF HIGHER EDUCATION AND RESEARCH
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JNMC INSTITUTIONAL ETHICS COMMITTEE
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 No.MDC/JNMCIEC/ 403.   **Date: 15/06/2022**

Reg.no., BA0120007

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 **"COMPARATIVE STUDY OF OXIPORT LARYNGOSCOPE BLADE VERSUS MILLER LARYNGOSCOPE BLADE USING PARAGLOSSAL APPROACH FOR INTUBATION IN PAEDIATRIC POPULATION DURING GENERAL ANESTHESIA: A RANDOMISED CLINICAL TRIAL",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

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

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

60

ABBREVIATIONS

ASA	-	American society of Anesthesiologists.
AV	-	Axillary vein.
ACE	-	Angiotensin converting enzyme.
BP	-	Blood pressure
cm	-	Centimeter.
CO	-	Cardiac output.
CLA	-	Corona long axis
CVP	–	Central venous pressure.
CI	–	Collapsibility index.
d IVC	-	diameter of Inferior vena cava.
dSCV	-	diameter of subclavian vein.
DBP	-	Diastolic blood pressure.
ECG	-	Electrocardiogram
FV	-	Femoral vein.
GA	-	General anesthesia.
HRV	-	Heart rate variability.
HPI	-	Hypotension prediction index.
HZ	-	Hertz
IVC	-	Inferior vena cava.
ICU	-	Intensive care unit.
IJV	–	Internal jugular vein.
IOH	–	Intraoperative hypotension.
IVC-CI	–	inferior vena cava collapsibility index.
IJV – CI	–	Internal jugular vein collapsibility index.

LA	-	Long axis
min	-	Minute
MAP	–	Mean arterial pressure.
MHZ	-	Megahertz.
mm	–	millimeter.
OT	–	Operation theatre
PPV	-	Pulse pressure variability.
PLR	-	Passive leg rise.
RA	-	Right atrium.
RBC	–	Red blood cells.
SBP	–	Systolic blood pressure.
SCV	–	Subclavian vein.
SCV – VI	-	Subclavian vein variability index.
SCV-CI	-	Subclavian vein collapsibility index.
SVC	–	Superior venacava.
SD	-	Standard deviation.
SA	-	Short axis.
SPO2	-	saturation of peripheral oxygen.
LA	–	Local anesthetic.
US	-	Ultrasound.
USG	–	Ultrasonography.
VCI	-	Venous collapsibility index.
Yrs	-	Years.

ABSTRACT

TITLE:

"PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE SUBCLAVIAN VEIN/INFRACLAVICULAR AXILLARY VEIN COLLAPSIBILITY INDEX WITH INFERIOR VENACAVA COLLAPSIBILITY INDEX (DURING SPONTANEOUS BREATHING OR DEEP INSPIRATION) IN PREDICTING HYPOTENSION AFTER INDUCTION OF GENERAL ANAESTHESIA".

Background: Intraoperative hypotension during general anesthesia leads to many postoperative complications which can be avoidable. In contrast with inferior vena cava, subclavian vein collapsibility index is found to be a better predictor of intravascular volume status.

Objectives:

To compare the subclavian vein/infraclavicular axillary vein collapsibility index with Inferior vena cava collapsibility index (during spontaneous breathing or deep inspiration) in predicting hypotension after induction of general anesthesia.

Methods:

In the current study, 70 American Society of Anesthesiologists I and II healthy individuals were enrolled. Using Ultrasonography diameters of subclavian vein and inferior venacava during one respiratory cycle were recorded and their collapsibility indices were calculated. SBP, DBP, MAP were noted every 2 minutes interval till incision. These intraoperative blood pressure measurements were correlated with the collapsibility indices of great veins to predict intraoperative hypotension during general anesthesia.

RESULTS:

In the current study, the mean arterial pressure (MAP) at 2 minutes and 4 minutes showed very significant correlation with the subclavian vein's collapsibility index on deep inspiration with p values of 0.0010 and 0.0020, respectively. However, the MAP at 6 minutes and 8 minutes showed highly significant correlation with the subclavian vein's collapsibility index on deep inspiration with p values of 0.0007 and 0.0012, respectively.

CONCLUSION:

In the current investigation, we have concluded that the subclavian vein's collapsibility index on deep inspiration had a highly substantial association with the MAP, compared to both the subclavian vein (spontaneous breathing) and inferior vena cava collapsibility indices.

KEY WORDS: Intraoperative hypotension, Subclavian vein, collapsibility index.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

LIST OF PHOTOGRAPHS

INTRODUCTION

Patients undergoing non-cardiac surgery under general anesthesia frequently experience intraoperative hypotension (IOH), or low arterial pressure, during the procedure. Its multifaceted etiology is associated with serious postoperative side effects which includes acute renal injury, neurological problems, cardiac damage, and mortality of patient.[1.]

Many pathophysiologic processes can result in IOH in individuals receiving general anesthesia undergoing surgery. Intraoperative hypotension could be a preventable risk factor for complications after surgery. It is essential to recognize and avoid modifiable risk factors in order to prevent the postoperative problems. There are various factors leading to IOH such as Age, Gender, ASA Class, General anesthesia, Emergency surgeries, Anti- Hypertensive medications (ACE inhibitors, and antagonists of the angiotensin II receptor). Thus, aetiology of IOH is multifactorial[.2.]

Many review studies assessed the definition of Intraoperative Hypotension used in adult patients undergoing non cardiac surgery under general anesthesia. Thus, it is peremptory to generate a definition of IOH to facilitate strategies to avoid the complications[.3.]

Intraoperative Hypotension is defined as “more than 30% reduction of mean arterial pressure from baseline or any absolute value of mean arterial pressure less than 55mmHg”.[4.]

One of the intervals of general anesthesia during which hypotension is prevalent is the period after the induction of anesthesia but before the onset of surgical stimulus. After induction of general anesthesia due to vasodilatory effects of anesthetic agents and other cardiac depressive agents, patients are more prone for hypotension. Factors like preoperative patient’s physical status, fasting, comorbidities also contribute for the susceptibility of intraoperative hypotension.[5.]

Different interventions can be adopted to overcome the intraoperative hypotension like preloading the patients with crystalloids /colloids before induction of anesthesia, avoiding drugs which cause myocardial depression, co- induction and priming principle of the induction agent etc.

There are various approaches for Blood pressure monitoring which include intermittent oscillometric, continuous Intraarterial and continuous non-invasive using a finger cuff (*i.e.*, volume clamp method**.**[6.] Many methods have been employed to anticipate the emergence of low BP following the induction of general anaesthesia with variable results. The currently used methods include Machine learning algorithm like Heart rate variability (HRV) using ANISCOPE monitor, Hypotension prediction index (HPI)algorithm etc[R7.]

Measurements of Inferior vena cava (IVC)such as its diameter and collapsibility index preoperatively has been recommended as a way to identify individuals who are at risk of developing IOH. Hence, be helpful in preloading the patients so as to overcome Intraoperative hypotension**.**[8.]

However, there are few barriers in Inferior Vena cava examination in patients with abdominal distention and pain.

The Subclavian vein is situated upstream of the Superior Vena Cava and close to the pleura and can be easily visualized in a majority of patients using a standard ultrasound linear probe. In one study, high frequency ultrasound probe demonstrated an admissible result of association between the subclavian vein and Inferior vena cava collapsibility indices in surgical patients and patients in intensive care unit[9].

Literature search did not reveal any study using subclavian vein diameter and collapsibility index that are measured preoperatively to forecast hypotension following the induction of general anesthesia.

Hence, we are making an attempt to compare the efficiency of preoperative subclavian/axillary vein collapsibility index with inferior vena cava during spontaneous and deep respiration in predicting Intraoperative hypotension (IOH) following the induction of general anesthesia in the individuals undergoing surgery.

OBJECTIVES OF THE STUDY

OBJECTIVE:

To compare the subclavian vein/infraclavicular axillary vein collapsibility index with Inferior vena cava collapsibility index (during spontaneous breathing or deep inspiration) in predicting hypotension after induction of general anesthesia.

REVIEW OF LITERATURE

After inducing general anesthesia, intraoperative hypotension is commonly seen. Uncorrected Intraoperative Hypotension may have serious implications on functioning of vital organs. It is crucial to know about the patient's intravascular volume status and to be careful in correcting the hypotension which includes fluid administration, using vasopressors etc.[8].

Central venous pressure is used to know the intravascular volume status which is an invasive technique but some studies also showed that ultrasonography of subclavian vein can be used as an adjunct to know the hemodynamic response and volume status of the patient intraoperatively to predict the hypotension. Subclavian vein/infraclavicular axillary vein collapsibility index is measured by ultrasonography and compared with Inferior vena cava collapsibility index to predict hypotension after inducing general anesthesia.

The incidence of intraoperative hypotension in adult patients who underwent noncardiac surgery were examined in a systematic analysis of observational retrospective study between 2000 and 2006 by Jilles B. Bijker, Wilton A. van Klei, Teus H. Kappen, et al. An methodical literature review was conducted prior to the observational retrospective cohort investigation in this study. These definitions of intraoperative hypotension were used with intraoperative data from a huge cohort of patients. They discovered that there is a sigmoidal relationship between the thresholds for definitions and the frequency of intraoperative hypotension. The components such as threshold principle, type of threshold, BP type, method and intervals of measurement and minimal duration of episode should be employed to define intraoperative hypotension. Only 10 out of 140 definitions have met the above mentioned criteria. After analysis of the study, they recommended that rather than dividing blood pressure measures based on predetermined criteria, intraoperative hypotension should be regarded as a dynamic phenomenon dependent on a variety of circumstances.[10]

In 2009 Jilles B. Bijker, Wilton A. van Klei, et al. examined the association between intraoperative hypotension and mortality after one year following non-cardiac surgery. Intraoperative hypotension (IOH) and 1 year mortality could not be shown to be causally related in this observational analysis. However, it revealed that in elderly patients range of blood pressure threshold and duration of hypotension episode corresponds to the 1year mortality. Other factors associated are patients age, duration of surgery which influences Intraoperative hypotension (IOH) and postoperative complications. Thus, no conclusion was drawn based on a single lowest acceptable intraoperative blood pressure and its effects on adverse perioperative outcome.[11]

In 2009 Raphael Giraud, Paul S. Abraham, and Pauline Brindel conducted a prospective clinical study to determine if fluid responsiveness in patients on mechanical ventilation correlates with variance in subclavian vein (SCV) diameter, where patients requiring a fluid challenge were included.500 ml of 0.9% Nacl as a fluid bolus was given over 10 minutes to patients who needed a fluid challenge. Transpulmonary thermodilution, pulse contour analysis, and traditional hemodynamic measures were used to quantify cardiac output (CO), dynamic parameters, including stroke volume variation (SVV) and pulse pressure variation (PPV), at baseline and following a fluid challenge. The rise in cardiac output of more than 15% has been defined as fluid responsiveness. SCV-VI was determined using ultrasonographic measurements taken in the subclavian long axis. The Subclavian Vein Variability Index(SCV-VI) was higher among responders at baseline. They observed that the sensitivity of Subclavian vein variability index was 100% for predicting fluid responsiveness. Therefore, they arrivede to the conclusion that the SCV-VI is a definitive, non-invasive indicator of fluid responsiveness at the bedside in critically sick mechanically ventilated patients.[12.]

In a prospective observational study conducted between the years of 2012 and 2013, Alistair Kent et al and others compared the SCV-CI and IVC-CI collapsibility index by sonographic evaluation of intravascular volume status in critically ill patients in a surgical ICU. The management of critically sick patients was aided by the estimating intravascular volume status. The inferior vena cava and subclavian vein's maximum and lowest diameters, as well as their collapsibility indices were assessed using ultrasonography. At the time of evaluation, the "time to data acquisition" of scan was noted. Between the two methods, the mean time to data acquisition was compared. Subclavian vein collapsibility index (SCV-CI -70 sec) required less time to acquire venous measurements than the inferior vena cava collapsibility index-99 sec (P< 0.02). The median for "time to data acquisition" of IVC-CI measured was 90 s, and median for SCV-CI measured was 47 s. The measurement bias showed more for SCV-CI and it became more prominent with increasing collapsibility values of SCV-CI which indicates that when compared to IVC-CI, SCV-CI tends to overstate the proportion of venous collapse, but overall bias was minor. The time required for data acquirement of sonographic measurements was less for subclavian vein compared to inferior vena cava. Thus, they concluded that Subclavian vein collapsibility index can be taken as a secondary hemodynamic assessment tool in patients where Inferior vena cava collapsibility index was not technically feasible or easily accessible, such as in cases of various postoperative and anatomical characteristics, surgical bandages, obesity.[9.]

In 2015, Pin Zhu, MD, Xiaobao Zhang, MD, Hengfei Luan et al measured the subclavian vein diameters during inspiration and expiration as a part of a comparative study of ultrasonographically measured diameters of the subclavian vein with CVP for estimation of patient's intravascular volume status who were posted for gastrointestinal surgery. Results revealed that after fluid resuscitation, SCV-CI maintained a favourable correlation with the CVP.[13.]

In 2016 Jie Zhang, Lester Augustus Hall Critchley et al did a pilot study of preoperative Inferior Vena Cava (IVC) ultrasonography to predict hypotension after induction of general anaesthesia. In this study using ultrasound the maximum and minimum diameters of Inferior vena cava (IVC) had been measured during preoperative period over a single respiratory cycle and collapsibility index was calculated. Cut off values of collapsibility index of Inferior vena cava (IVC) and maximum IVC diameter to anticipate low blood pressure following induction of general anaesthesia was 43% and 1.8 cm respectively. Patients who experienced low blood pressure had a IVC maximum diameter ($P < 0.0001$) which is smaller and a greater Collapsibility index, $P < 0.0001$. They have taken an optimal cut off value of 43% based on few similar studies which were done for predicting hypotension. As the size of Inferior vena cava changes among the healthy individuals, maximum diameter of Inferior vena cava (dIVCmax)was not a reliable predictor of hypotension. They came to the conclusion that Collapsibility index (CI) measurements of the IVC was more predictive of hypotension than IVC maximum diameter ($P = 0.002$) before inducing general anaesthesia. Hence, point of care ultrasonography was desired to assess patients who are at a risk of developing hypotension, particularly the elderly patients and those who were suspected of having hypovolemia in the operating room.[5.]

In 2017 a comprehensive evaluation of intraoperative hypotension and the likelihood of postoperative poor outcomes was carried out by E.M. Wesselink, T.H. Kappen, et al. They have conducted a retrospective observational methodical search of the articles to analyse the association between intraoperative hypotension and risk of postoperative unfavourable outcome. They reviewed forty two articles and used IOH definition based on MAP, SBP threshold value, duration of hypotension and researched about the postoperative complications due to Intraoperative hypotension(IOH). They evaluated the risk of overall organ damage based on blood pressure threshold and time span. It was believed that prolonged perioperative hypotension episodes or lower blood pressure levels necessarily increased the risk of organ damage. As a conclusion, the study found that mean arterial pressure of < 80 mm Hg for more than 10 minutes of exposure and < 70 mm Hg for shorter periods of time was related with slightly raised odds of any harm to end-organs. Increased periods of time with mean arterial pressure between 65-60 mm Hg or any exposure with a BP of less than 50-55mm Hg were corresponded to moderately or severely elevated risks. To conclude, it was found that organ injury might occur if MAP was < 80 mmHg for 10 mins of duration. But they were unable to draw the guidelines for blood pressure threshold leading to adverse outcomes. Further prospective observational studies are necessary to clear this topic.[14.]

During the period of 2016-2018 a prospective observational investigation was performed by Marcell Szabó, Anna Bozó1, Katalin Darvas et al to find the role of inferior vena cava collapsibility index in the prediction of hypotension associated with general anaesthesia. The collapsibility index of Inferior vena cava was measured in spontaneous breathing patients during one respiratory cycle. Cut off values for collapsibility of inferior vena cava was taken as 50%. It was observed that the patients who had inferior vena cava collapsibility >50%(collapsible group) had extreme changes in systolic blood pressure and mean arterial pressure than patients who had IVC collapsibility <50% (non-collapsible group)Therefore it was inferred that IVC collapsibility can be considered as a potential means to determine hypotension.[15.]

In 2014 Arthur K. Au, Dean Steinberg, Christopher Thom et al performed a prospective observational study to predict propofol-induced hypotension by using inferior vena cava collapse collapsibility index using ultrasound preoperatively. All patients had received propofol 2.4mg/kg bolus dose and vital signs were documented every 3 minutes from the beginning of surgery until 21 minutes of drug administration. Significant hypotension occurred in 76% of patients with an IVC-CI more than 50% compared to 39% of patients with an IVC-CI less than 50%, p=0.02. The purpose of this study was to identify the patients who were more prone to experience hypotension following a propofol IV bolus. They found that a preoperative Inferior vena cava collapsibility index (IVC-CI) ≥50% was associated with pronounced hypotension. As a result, they have concluded that ultrasound measurement of the inferior vena cava collapsibility index was taken into consideration as a viable method to evaluate whether a patient had hypotension following an intravenous propofol bolus.[8.]

Murat Haliloğlu., Beliz Bilgili, Alper Kararmaz et al performed a prospective observational clinical trial to determine the benefit of IJV-CI in sepsis in surgical intensive care unit patients. Hemodynamic and sonographic measurements of both inferior vena cava(IVC) and internal jugular vein(IJV) were noted in non intubated, non ventilated patients during spontaneous breathing in three consecutive stages i.e semi recumbent position(stage 1), supine with passive leg rise(PLR)(stage 2),semi recumbent position(stage 3).To evaluate the fluid responsiveness through the changes in cardiac index brought about by the passive leg rise position when patients were retrospectively split into two groups. Fluid responders showed rise in collapsibility index of > 15% after changing to passive leg rise manoeuvre and non- fluid responders showed change in collapsibility index as < 15%. At stages 1 and 3, responders had higher Internal jugular vein and Inferior vena cava collapsibility indices than non- responders, however this difference was eliminated following the stage 2 action which was passive leg raise. Similar to an endogenous fluid challenge, the passive leg raise procedure shifts 300 mL of venous blood from the lower body to the right heart. Thus, it was assessed that in sepsis patients who were not on mechanical ventilation, the changes in collapsibility index caused by the passive leg rise procedure is an indicator of fluid responsiveness. When compared to the inferior vena cava, the internal jugular vein required 47.5 seconds less time to obtain data. Internal jugular vein collapsibility was discovered to be a reliable, simple-to-acquire, non-invasive indicator of fluid responsiveness in sepsis patients who are breathing spontaneously. It also appeared to be an acceptable companion to the inferior vena cava collapsibility index.[16]

Alistair Kent, Prabhav Patil, Victor Davila, et al. conducted a prospective observational study from 2012 to 2014 to assess the intravascular volume status sonographically. The study concentrated on the ability to use the femoral vein or internal jugular vein collapsibility as an alternative sonographic option in the absence of adequate inferior vena cava (IVC) visualisation. Sonographic measurements of Inferior vena cava, Internal jugular vein, Femoral vein were taken simultaneously, Collapsibility indices were calculated. For each scan “time for data acquirement” was also noted and it is compared between inferior vena cava and femoral vein/internal jugular vein collapsibility index approaches. The mean time for data assessment was “34 seconds” for IJV-CI vs “89 seconds” for IVC-CI. The mean time for data assessment was “49 seconds” for collapsibility of Femoral vein vs “85 seconds” for the Inferior vena cava. Thus, these findings supported the hypothesis that, although collapsibility assessments of IJV and FV were not as accurate as compared to Subclavian vein, they can be considered as reasonable candidates for “second line” alternatives to IVC-CI in the patient for whom visualisation of the latter is impossible.[17.]

Over a period of 2017-2019 Elaine Kaptein et al compared the respiratory changes of subclavian vein and inferior vena cava in their retrospective study, analysed the charts of adult patients with kidney illness who were in the intensive care unit (ICU) and those who were not. When patients are on quiet breathing or on mechanical ventilation, ultrasonographic measurements of the inferior vena cava and subclavian vein were noted in the semi-recumbent position which is at 30 to 45 degrees. There were respiratory alterations during at least five cycles. The cut-off value of SCV-CI, corresponded to the cut-off values of IVC-CI which was <20% for hypervolemia and SCV- CI <22% for both spontaneous breathing and mechanically ventilated encounters. The SCV- CI cut off was more than 39% for both the spontaneous breathing and mechanical ventilated encounters, which corresponds to the IVC-CI cut off of more than 50% for hypovolemia. They found that cut off values of SCV-CI corresponds to IVC-CI consistent with hypervolemia (IVC-CI less than 20%) or hypovolemia (IVC-CI more than 50%), which were comparable for patients on spontaneous breathing and mechanical ventilation. They concluded that respiratory changes in IVC diameter and SCV diameter in the semi-recumbent position can be correlated.[18.]

BASIC SCIENCES

ANATOMY:[19,20,21.]

Veins in general carry deoxygenated blood from capillary beds to the heart and thus gives dark blue colour of veins. But atypically large pulmonary vein carries oxygenated blood from lungs to heart.

Normal characteristics of the Veins: Do not pulsate.

Do not spurt blood when severed.

Thinner walls compared to arteries.

Diameter is large.[19].

Large veins which are available in the mediastinum are Superior vena cava, right and left Brachiocephalic vein, Inferior vena cava, Pulmonary veins. 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 superior (Figure 1) and inferior-vena cava before reaching the heart.The veins that carry venous blood from upper extremity include axillary vein, radial, brachial, subclavian vein. Subclavian vein is one of the deep vein that drains deoxygenated blood from upper extremity. It is a continuation of axillary vein and drains deoxygenated blood from upper extremity. It is a continuation of axillary vein.

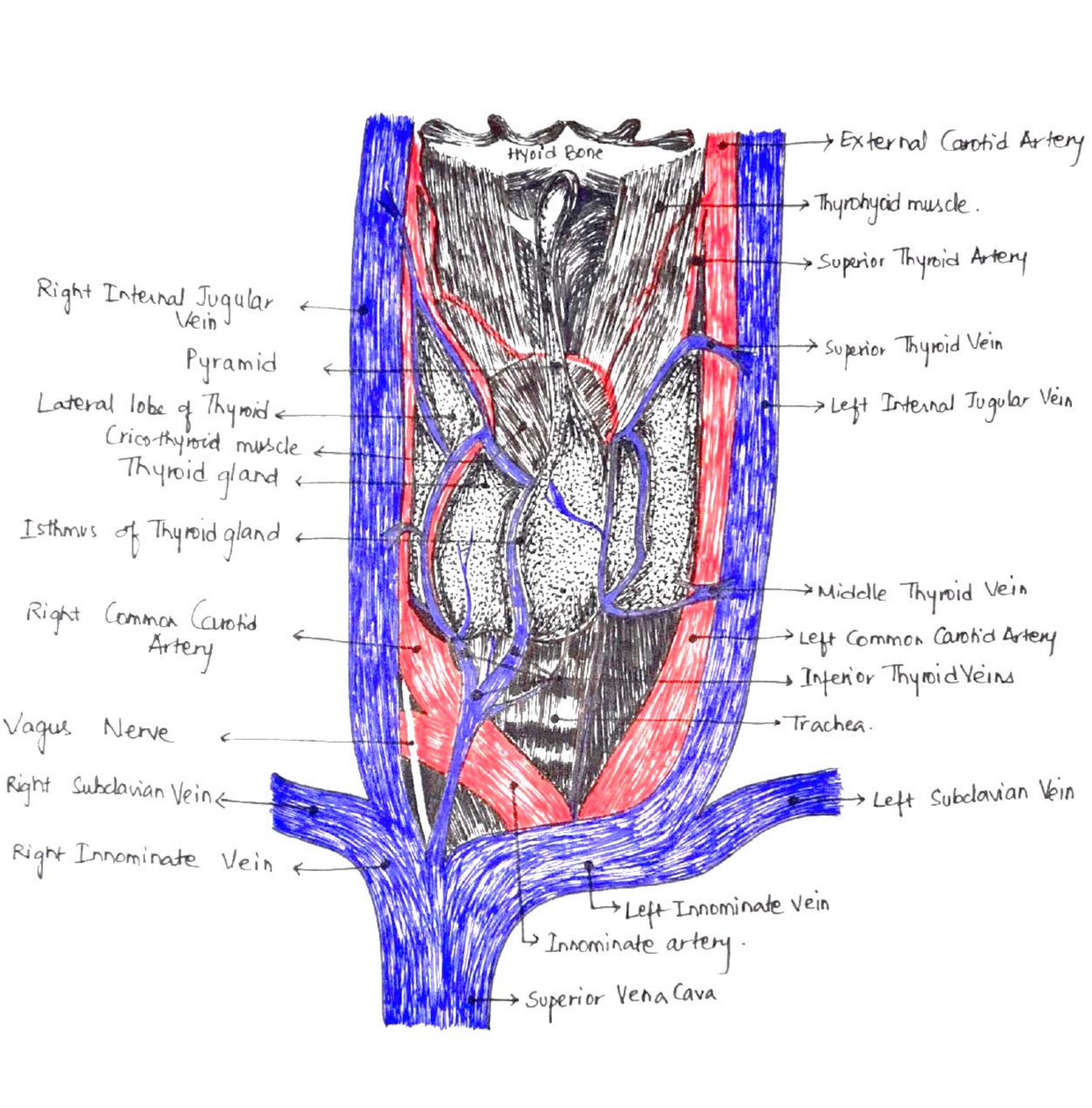

Hyoid Bone
External Carotid Artery
Thyrohyoid muscle.
Superior Thyroid Artery
Right Internal Jugular Vein
Superior Thyroid Vein
Pyramid
Left Internal Jugular Vein
Lateral lobe of Thyroid
Crico-thyroid muscle
Thyroid gland
Isthmus of Thyroid gland
Middle Thyroid Vein
Right Common Carotid Artery
Left Common Carotid Artery
Inferior Thyroid Veins
Trachea.
Vagus Nerve
Right Subclavian Vein
Left Subclavian Vein
Right Innominate Vein
Left Innominate Vein
Innominate artery.
Superior Vena Cava

FIGURE 1

AXILLARY VEIN:

The axillary vein is the continuation of the basilic vein. It lies on the medial side of the axillary artery. At the outer border of the first rib, it becomes the subclavian vein.

Is formed at the lower border of the teres major muscle by the union of the brachial veins (venae comitantes of the brachial artery) and the basilic vein and ascends along the medial side of the axillary artery. In addition to the tributaries corresponding to the branches of axillary artery, it receives the cephalic vein in its upper part. Axillary sheath is absent around the vein, which is free to expand during times of increased blood flow(Figure 2).(Figure 3).

- Continues as the subclavian vein at the inferior margin of the first rib.
- Commonly receives the thoraco epigastric veins directly or indirectly and thus provides a collateral circulation if the inferior vena cava becomes obstructed.

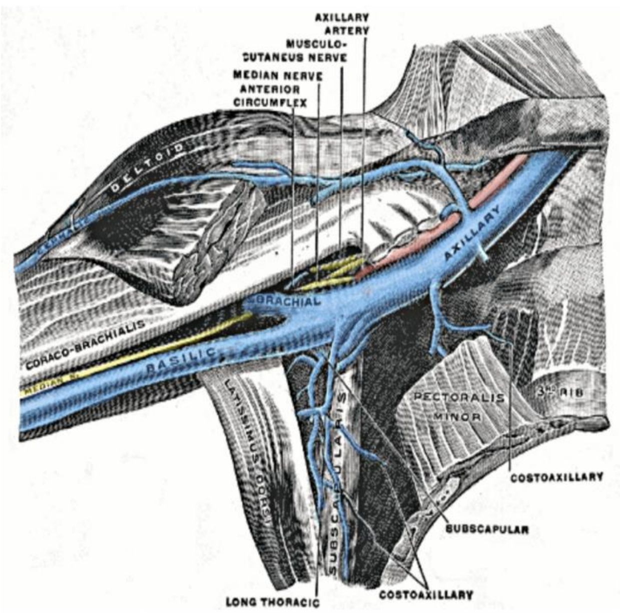


FIGURE 2

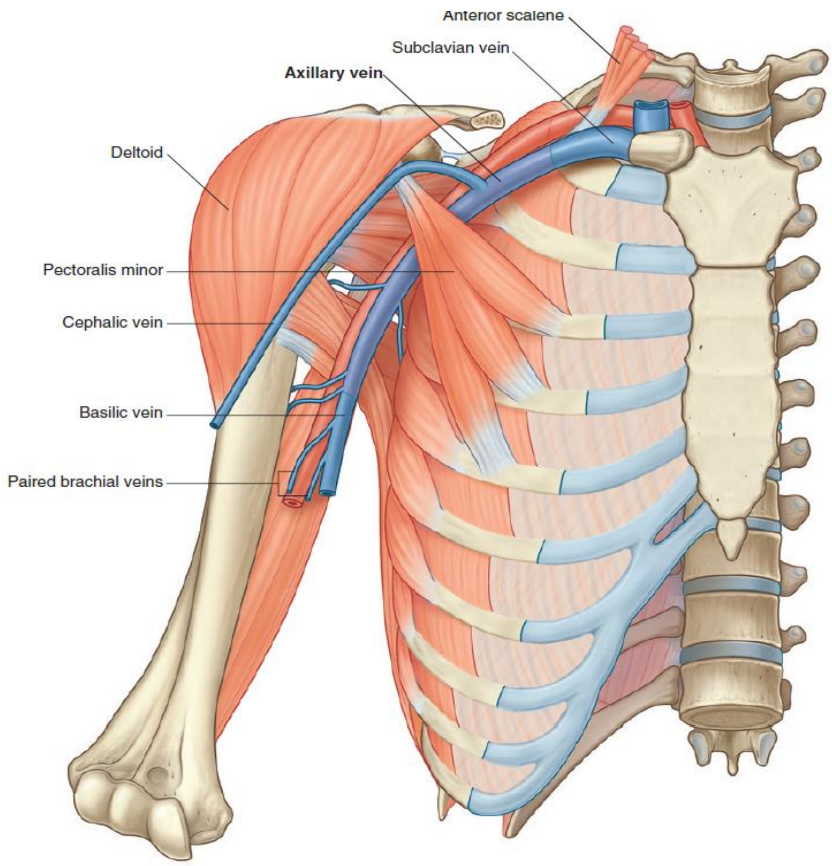


FIGURE 3

SUBCLAVIAN VEIN(SCV):

It is the continuation of axillary vein, which begins at the lateral border of first rib. It is the major vein that carries blood from the upper limb and the lateral part of thorax. It joins with the IJV and forms brachiocephalic vein. It runs posterior and medial end of the clavicle.

Course: (Figure 4)

1. Each subclavian vein (right and left) begins at the outer border of the first rib, as a continuation of the axillary vein.
2. It runs medially parallel to the subclavian artery, but lies anterior and inferior to the artery. The two vessels are separated by the scalenus anterior.

3. The subclavian vein ends at the medial margin of this muscle by joining the internal jugular vein.
4. Anteriorly, the subclavian vein is related to the clavicle. Below, the vein rests on the first rib and on the cervical pleura.
5. The phrenic nerve runs posterior to the subclavian vein and anterior to the internal thoracic artery as it enters the thorax.

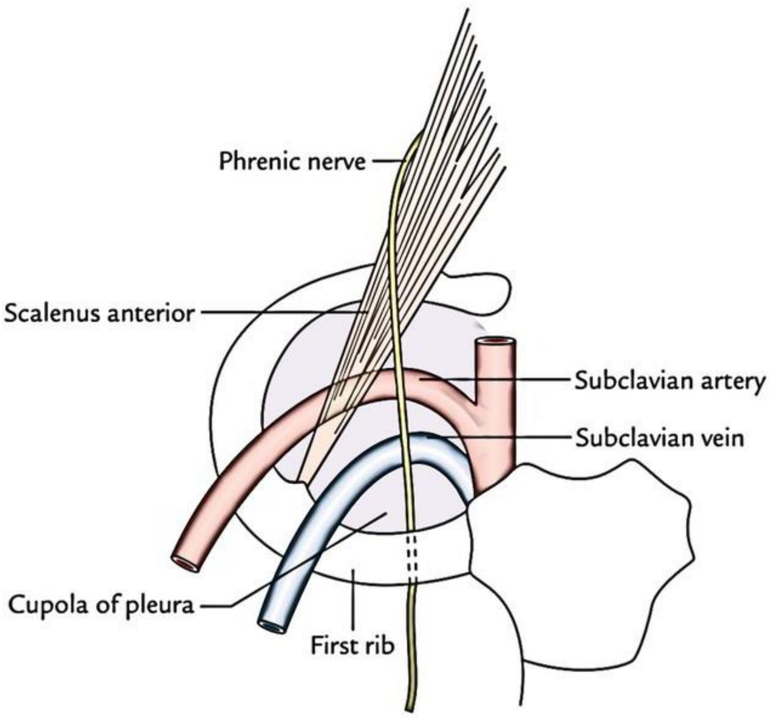


FIGURE 4

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.

Relation:

Subclavian vein is accompanied by the subclavian artery which lies posterior to it and separated by the anterior scalene muscle (Figure 5). Posterior to the vein also lies the phrenic nerve which later courses anterior to internal thoracic artery and then enters the thorax.

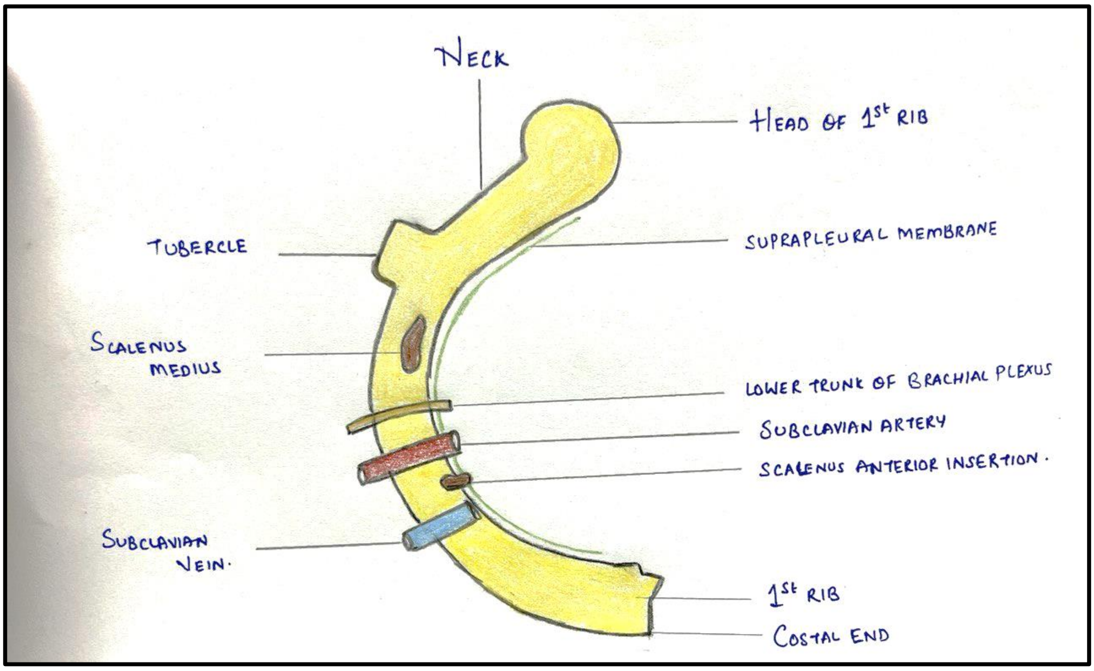


FIGURE 5

The subclavian vein's medial relations include the thoracic duct (Figure 6), brachiocephalic trunk, trachea and vagal trunks (Figure 5). Laterally it is related to the brachial plexus's inferior trunk.

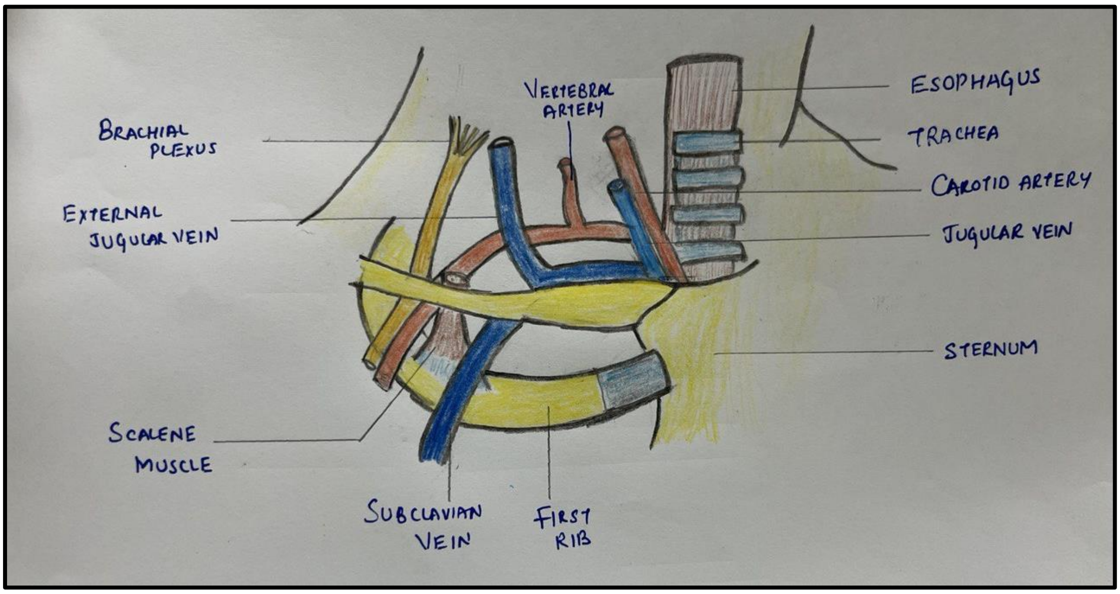


FIGURE 6

INFERIOR VENACAVA(IVC):

IVC is one of the largest vein and thin walled vessel which carry deoxygenated blood from the tissues to the heart. It has no valves until it reaches right atrium, the forward flow is driven by pressure created during normal respiration. The IVC carry deoxygenated blood from the lower limbs, most of the back, the abdominal walls, and the abdominopelvic viscera to heart. The IVC drains into the inferior part of the right atrium almost in line with the SVC at approximately the level of the 5th costal cartilage.It drains poorly oxygenated blood from the body inferior to the diaphragm and receives the venous drainage of the abdominal viscera indirectly via the hepatic portal vein, liver, and hepatic veins. Except for the hepatic veins, the tributaries of the IVC mostly correspond to the lateral paired visceral and posterolateral paired parietal branches of the abdominal aorta. Three collateral routes (two involving the anterior abdominal wall and one involving the vertebra.

Source: Common iliac vein at the level of L5 vertebra.

Course: IVC is formed at the level of L5 vertebra by union of common iliac veins. It arises on right side of the vertebral bodies of L3-L5, on the right psoas major to the right side of aorta. IVC has a short intrathoracic course which enters the thorax at T8 vertebral level through the caval opening in the diaphragm entering the heart almost simultaneously.

Relations(Figure 7):

- Anterior
  - Right common Iliac artery
  - Horizontal part of Duodenum
  - Head of Pancreas
  - Liver
- Posterior
  - Vertebrae
  - Right Psoas
  - Right crus of Diaphragm
- Right
  - Right Ureter
  - Medial border of right Kidney
  - Right lobe of Liver
- Left
  - Aorta
  - Left crus of Diaphragm

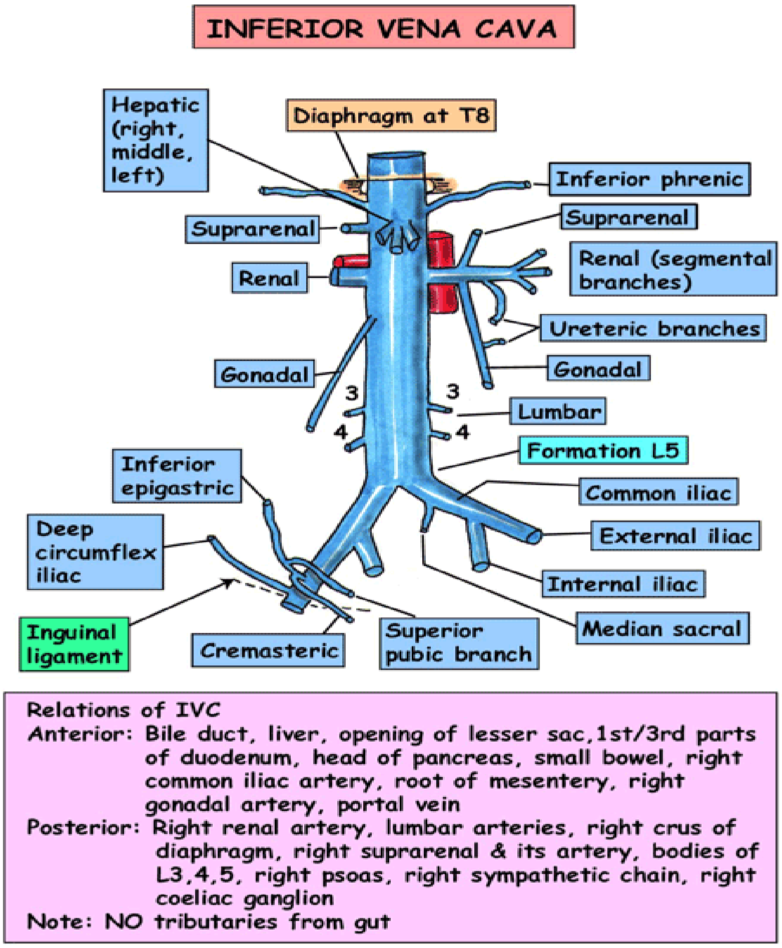


FIGURE 7

Tributaries:(figure 8)

- T8: Paired inferior phrenic veins.
- T8: Hepatic veins
- L1: right suprarenal vein
- L1: renal veins
- L2: right gonadal vein
- L1-L5: lumbar veins
- L5: common iliac veins (origin).

The ascending lumbar and azygos veins connect the IVC and SVC, either directly or indirectly and provides collateral pathways.

On deep inspiration as the diaphragm contracts, due to intrathorarcic negative pressure, a pressure gradient is created and this gradient pulls the venous blood from IVC to right side of the heart.

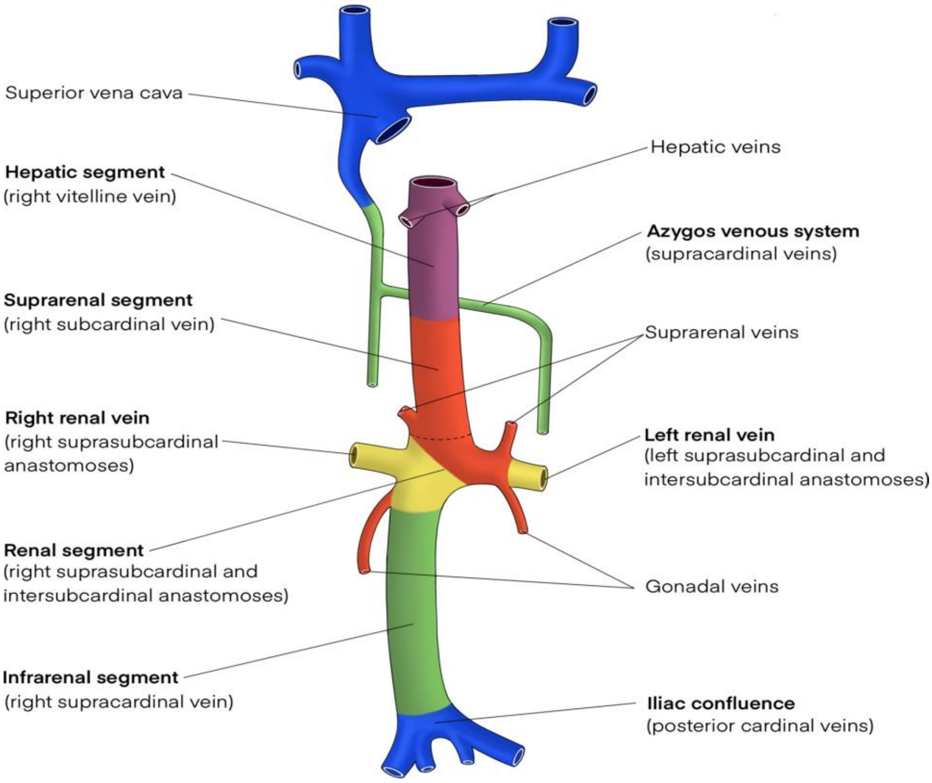


FIGURE 8

PHYSIOLOGY OF GREAT VEINS:[22,23]

The veins provide passageways for flow of blood to the heart, but they also perform other special functions that are necessary for operation of the circulation. They are capable of constricting , enlarging and thereby storing either small or large quantities of blood and making this blood available when it is required by the remainder of the circulation.

Blood from all the systemic veins flows into the right atrium of the heart; therefore, the pressure in the right atrium is called the central venous pressure. venoconstriction and veno dilation have significant effects on the distribution of total blood volume, both can affect CVP, stroke volume, and arterial blood pressure. Two factors that facilitate return of blood to the heart are presence of venous valves and the skeletal muscle pump.

Venous blood from the lower limbs is transported against gravity, and larger veins possess valves to prevent any backflow of blood.Veins run between and near skeletal muscles. Contraction of the skeletal muscles surrounding veins increases the pressure within the veins, pushing open the proximal valve and forcing blood toward the heart.Veins above heart level experience negative hydrostatic pressure and will be collapsed as the surrounding tissue pressure exceeds vein pressure, with a trickle of blood flowing through them.

Venous Return:

Venous return is the volume of blood that returns from the veins to the atria each minute and is ~5 L/min. It is the pressure differential between the peripheral and central veins that determines venous return. Pressure within the named veins is usually between 8 and 10 mmHg, and CVP is ~0–6 mmHg.

Venous return is facilitated by a number of factors, including inspiration, increased total blood volume, increased veno motor tone, the cardiac suction effect, the presence of venous valves and the skeletal muscle pump.The Frank-Starling law of the heart describes the positive relationship between ventricular myocyte stretch and force of ejection. The greater the preload (usually measured as end-diastolic volume or end-diastolic pressure), the greater the force of contraction of the ventricles, and the greater the subsequent stroke volume.

Central venous pressure (CVP):

It is the pressure of the blood in the thoracic vena cava near the right atrium. CVP is an approximation of RAP and is measured in millimeters of mercury (mmHg) or centimeters of water (cmH2O) above atmospheric pressure. A normal CVP reading is 0–8 cmH2O or 0–6 mmHg.

Changes in Inferior vena cava(IVC) :

Changes in IVC depends on few factors: the intrathoracic and abdominal pressures, the central venous pressure (CVP), and the compliance of the vessel.

Its caliber is altered by respiration , blood volume and right heart function.

IVC diameter depends on the relation between the level of extra-mural IVC pressure, i.e. the abdominal pressure, and the level of the backward pressure, i.e. the right atrial pressure .

In mechanically ventilated patients, Inferior vena cava has ability to dilate during tidal ventilation, when intrathoracic pressure is increasing more than abdominal pressure. This dilation actually reflects the ability of the IVC to receive more volume (preload reserve), like a preserved compliance. The absence of significant dilation reflects the inability of the IVC to receive more fluid (no preload reserve), owing to low compliance.In spontaneously breathing patients, the circumstances are completely different.Changes in IVC diameter reflect the interaction between CVP and the range of gradient between intrathoracic and abdominal pressures. The vein may collapse either because the CVP is very low or because the intrathoracic pressure becomes markedly negative.

Subclavian vein :

SCV is a highly compliant blood vessel, the size and dynamics vary with the changes in total body water and respirations. The SCV is a highly collapsible major vein, and its diameter closely correlates with right sided cardiac functions. Hence, it reflects volume status more closely than other parameters based on the arterial system, such as BP and others.

Mechanical ventilation generates positive pressure which increases intrathoracic pressure and decreases venous return to the right atrium, consequently leading to increased vein diameter.

Increase in the depth of breathing during the spontaneous inspiration phase leads to a short, temporary closure of the Axillary Vein, while the largest diameter is noticeable at end-expiratory. Anteroposterior diameter of the SCV decreases with inspiration and increases with expiration or a Valsalva manoeuver. Inspiration creates a decrease in the intrathoracic pressure, increases venous return, and causes the SCV to collapse, whereas expiration increases intrathoracic pressure, reduces venous return, and distends the vein. The increased dimension of the vein with expiration must result from decreased flow into the superior vena cava (SVC) and back-up into the SCV.

ULTRASONOGRAPHY: [R22,23.]

Ultrasound technique depends on the processing of reflected sound waves. On procreation of periodic and vibrating particles it results in a waveform motion, by which they create an image.

Soundwaves: These are the pressure waves that advances by series of compression and decompression of the medium they are travelling in.

Types:

1) Infrasound: Frequency less than 20 Hz

2) Audible sound: Frequency 20 Hz to 20000 Hz

3) Ultrasound: Frequency more than 20000Hz.

Ultrasound is nothing but sound waves in frequency range of around 2 to 15 megahertz and has a wide range of diagnostic and treatment purpose in the field of medicine. The frequency range used in vascular ultrasonography 2–10MHz. Sound waves are emitted by piezoelectric material, most often synthetic ceramic material (lead zirconate titanate [PZT]), which is contained in ultrasound transducers.

Piezoelectric effect:

When a rapidly alternating electrical voltage is applied to piezoelectric material, the material experiences corresponding oscillations in mechanical strain. As this material expands and contracts rapidly, vibrations in the adjacent material are produced and sound wave are generated. Mechanical properties of piezoelectric material determine the range of sound wave frequencies that are generated. Sound waves propagate through media by creating compressions and rarefactions of particles.(Figure 9).

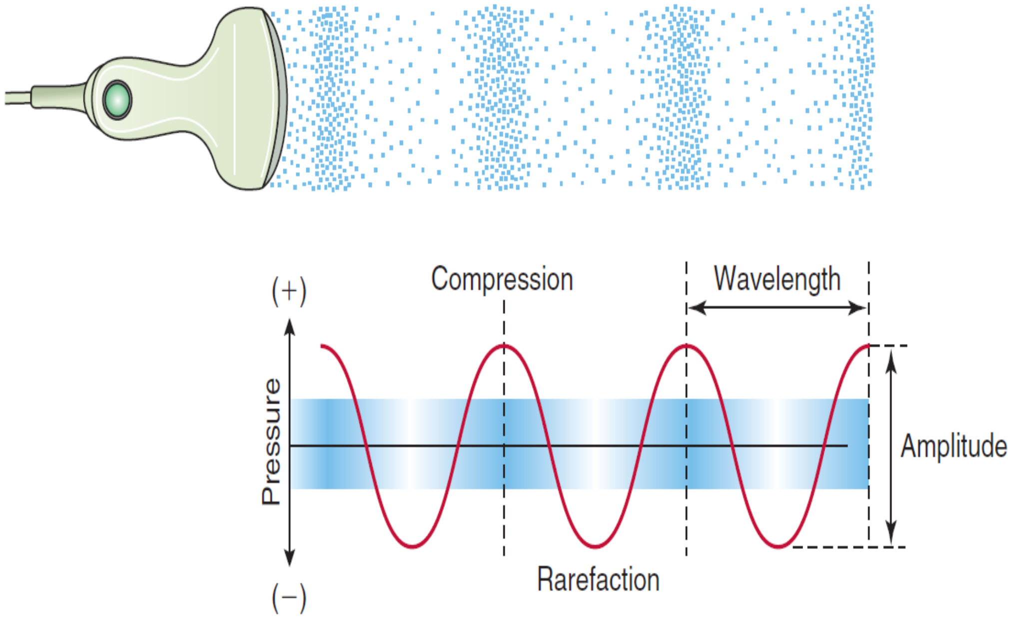


FIGURE 9

This process of generating mechanical strain from the application of an electrical signal to piezoelectric material is known as the "reverse piezoelectric effect". The opposite process, or generation of an electrical signal from mechanical strain of piezoelectric material, is known as the "Direct piezoelectric effect". Transducers produce ultrasound waves by the reverse piezoelectric effect, and reflected ultrasound waves, or echoes, are received by the same transducer and converted to an electrical signal by the direct piezoelectric effect. When it lies on the surface 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:

It is one of the component of USG machine which can be handheld.

Transducer is used for optical transmission and for reception of sound wave.

It converts electric voltage into sound waves (mechanical energy) and vice versa based on piezoelectric effect.

Most common material used is lead zirconate titanate.

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: For proper transmission of sound waves to one or multiple tissues.
- Housing.

Transducers receive and record the intensity of the returning sound waves.

TYPES OF TRANSDUCERS: There are four types of transducers:

1. Linear
2. Curvilinear
3. Phased-array.
4. Intracavitary

1.Linear Probe (FIGURE 10):

Piezoelectric crystals arranged in a flat matrix.

Produces parallel linear ultrasound beams.

Generate a rectangular image

Shorter-wavelength sound waves (axial and lateral resolution)

Visualization of superficial structures

Frequency range – 5-15 MHZ

Imaging Depth – 9 cm

Applications:

Vascular examination(Arteries/veins)

Procedures(catheterization)

Pleural examination

Skin/soft tissues

Musculoskeletal

Thyroid examination

Lymph Nodes examination

Nerves.

FIGURE 10

2.Curvilinear transducers:(figure 11)

Piezoelectric crystals curvilinear-convex arrangement

Ultrasound beam is broad and trapezoidal

It provides wide field of view

lower resolution compared with the linear transducers

Used to examine deeper tissues

Uses lower frequencies (2to 5 MHz)

Longer wavelengths

Penetrate deep structures (Depth - 5 to 25 cm)

Applications:

Imaging abdominal and pelvic organs

Imaging larger musculoskeletal structures

Transvaginal and transrectal examinations.

FIGURE 11

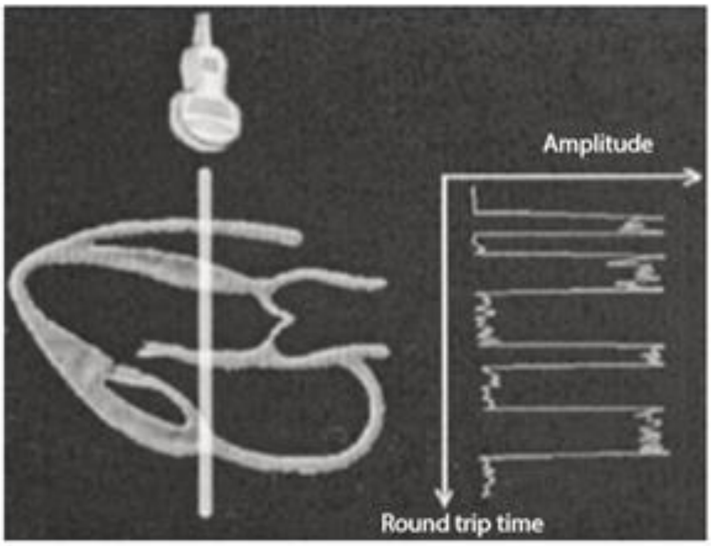
MODES OF IMAGING:

Two-dimensional (2D) or B-mode.

Motion mode (M-mode).

Doppler mode(D-mode).

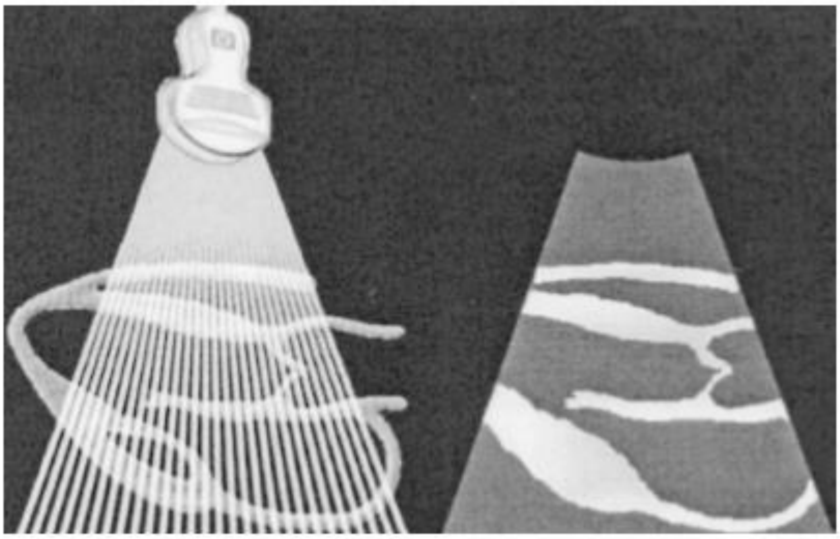
A Mode : Amplitude mode or A mode is the basic technology which was used initially. As the reflected echo returns to the probe, their amplitudes are charted as spikes (Figure 8). It is one dimensional. The amplitude of the spike corresponds to the distance of the tissue from which the ultrasound got reflected back to the transducer. Hence it is used in measuring lengths and depths. It is frequently used in ophthalmology for measuring the corneal thickness and axial length measurements.(Figure 12)



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 12

B-MODE: The majority of diagnostic ultrasound machines uses two-dimensional (2D) mode. This mode is also called B-mode, or brightness mode, because the echogenicity, or "brightness," of observed structures is regulated by the number of reflected signals and velocity. The consecutive impulses are emitted at defined intervals and encoded digitally. Only encoded echoes are used and other interfering echoes are subtracted. Amplitude of signal is reflected by moving particles and it is processed in the interval between two pulses. The echo waves are reflected as dots. 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. Higher the amplitude (strength) of the echo wave , brighter will be the dot. When all the emitted waves reach the transducer back, the 2D ultrasound image (B mode) is formed((Figure 13).



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 13

M-mode (Motion mode): It is an older imaging mode. M-mode can be applied along a single line within the 2D image. A single-axis beam is emitted along the cursor line and movements of all tissues along that line are plotted over time. . 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 often used to measure the size of cardiac chambers or movement of cardiac valves throughout the cardiac cycle. The point-of-care applications include measurement of respiratory variation of the inferior vena cava and evaluation of the lung-pleura interface in the assessment of pneumothorax.(Figure 14)

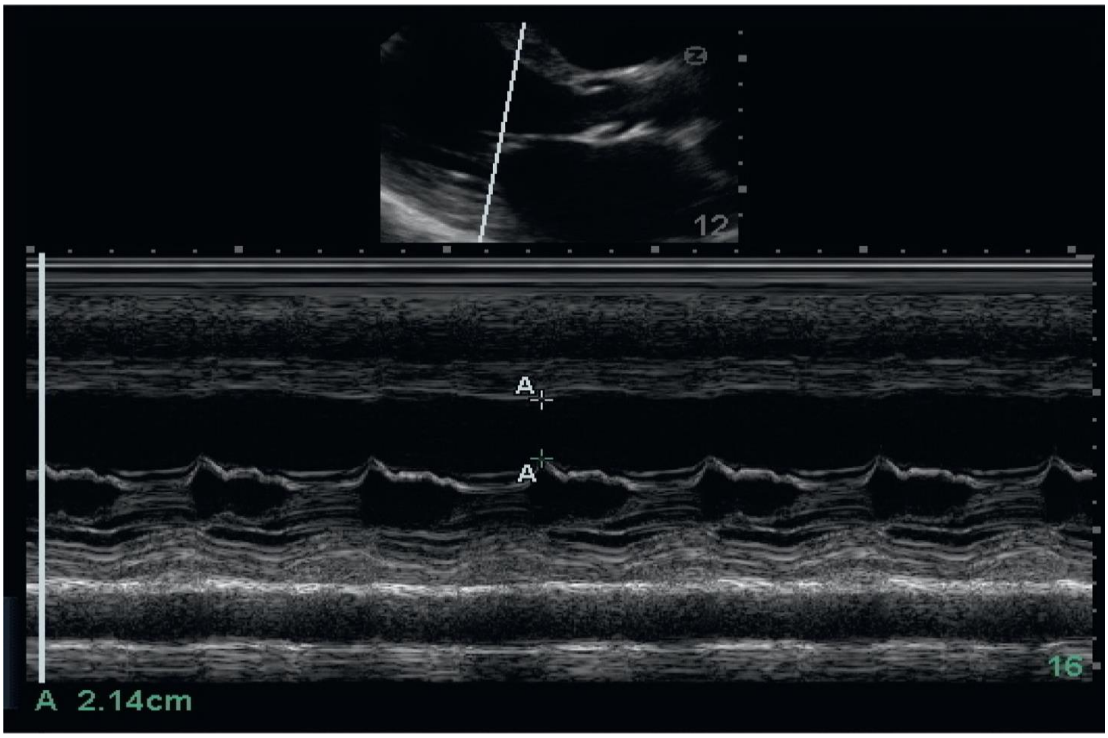


FIGURE 14

DOPPLER IMAGING:

The Doppler effect: The shift in the frequency of sound waves due to motion between the source and observer(figure 16). In ultrasonography, the primary source of sound waves is the transducer, and the same transducer is the observer for returning echoes. Movement of tissues,most often blood flow, produces a shift in frequency of returning sound waves. Blood flow moving toward the transducer shifts the echoes to a higher frequency, whereas blood flow moving away from the transducer shifts the echoes to a lower frequency.The change in frequency between the emitted and received sound waves is called as Doppler shift.

Variables that determine the amount of Doppler shift are:

1. Frequency of ultrasound waves

2. Velocity of blood flow

3. Angle of insonation.

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 (Figure 15). 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.

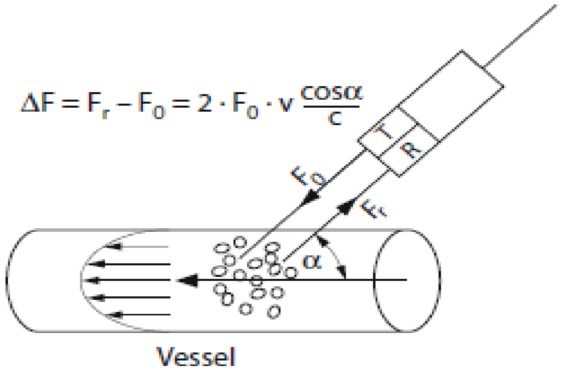


Fig. 1.1. Schematic representation of Doppler interrogation of a vessel with laminar flow. The arrows in the vessel are vectors representing different flow velocities. Blood flow is fastest in the center of the vessel and decreases toward the wall. The drawing illustrates the effect of the angle of incidence 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* transmitter, *R* receiver, F_o emitted frequency, F_r reflected frequency)

FIGURE 15

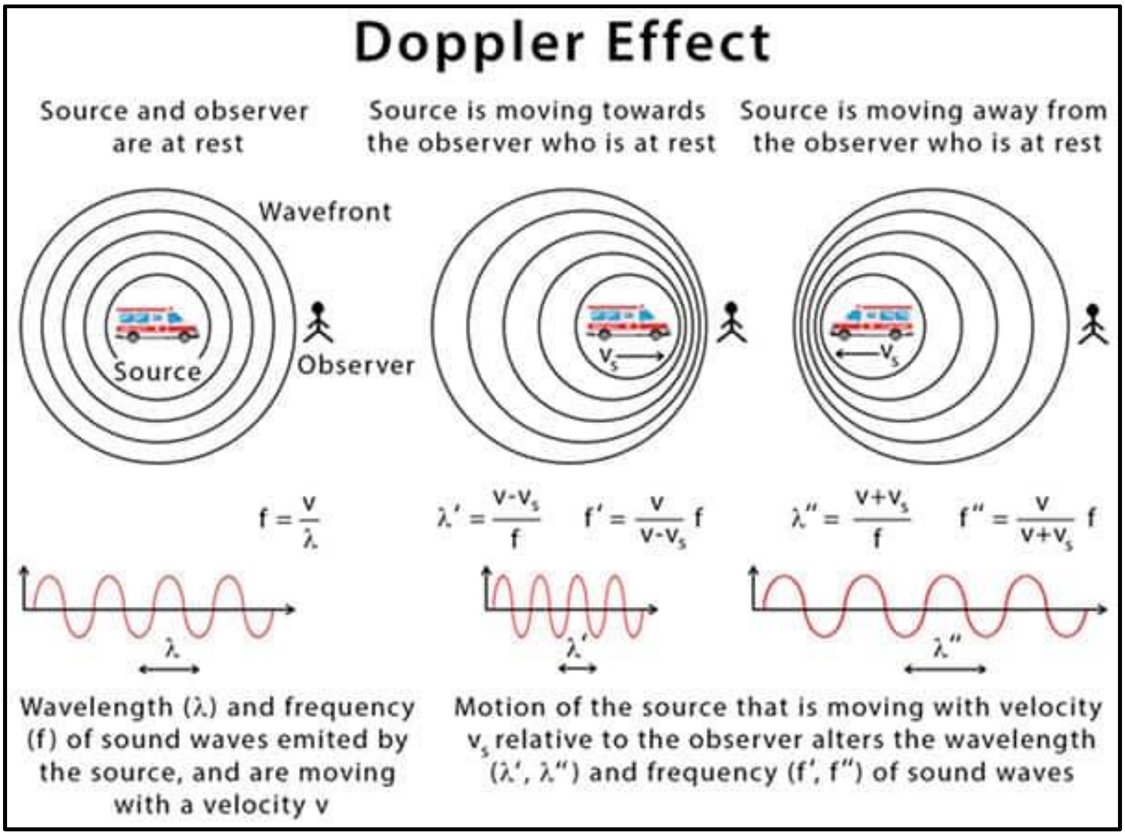


FIGURE 16

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 travelled 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 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 electronic 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 signals from a particular depth selectively.The duplex scan combines this pulse 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 can be estimated using the doppler shift in frequency as using the B-mode the doppler angle can be determined.

SONOANATOMY: The ability to distinguish arteries from veins is important. Veins are oval or triangular shaped, thin-walled, fully compressible, and change size with breathing (respiratory variation) or Valsalva.

INFERIOR VENACAVA:

Type of probe: a phased-array (frequency of 2.0–4.0 MHz) or curvilinear probe (frequency of 3.5–5.0 MHz) should be used.

Low-frequency probes provide better penetration and visualization of deep structures.

Depth: Depth of field should be adjusted to allow complete visualization of the IVC and its entrance into the right atrium. Obese patients will require an increased depth setting.

Place the probe horizontally on the subxiphoid process to do top to bottom scan and then turn to longitudinal scan, then turn the probe to 90 degree clockwise to get the image of IVC.

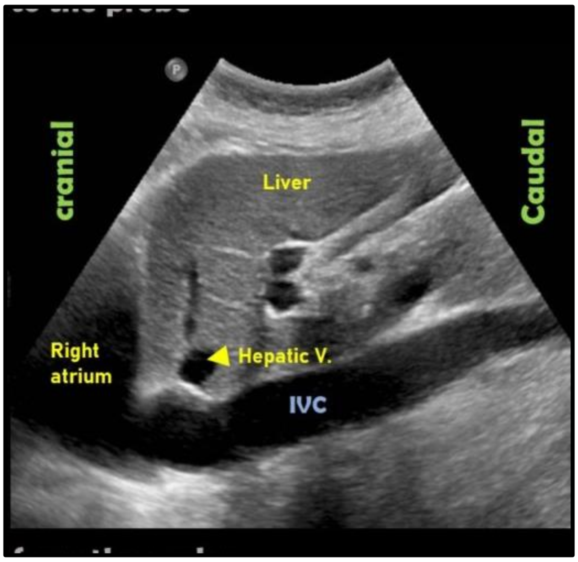


FIGURE 17

By gently fanning the probe up and down, one can visualize IVC and the aorta anterior to the central shadowing from the vertebral body. By fanning further up towards the chest, hepatic veins joining the IVC come into view .

For M-mode, IVC diameters were measured both during quiet passive respiration and then followed by a rapid inspiratory effort or "sniff." Respiratory variability with percentage collapse of the IVC was calculated as the inferior vena cava collapsibility index.

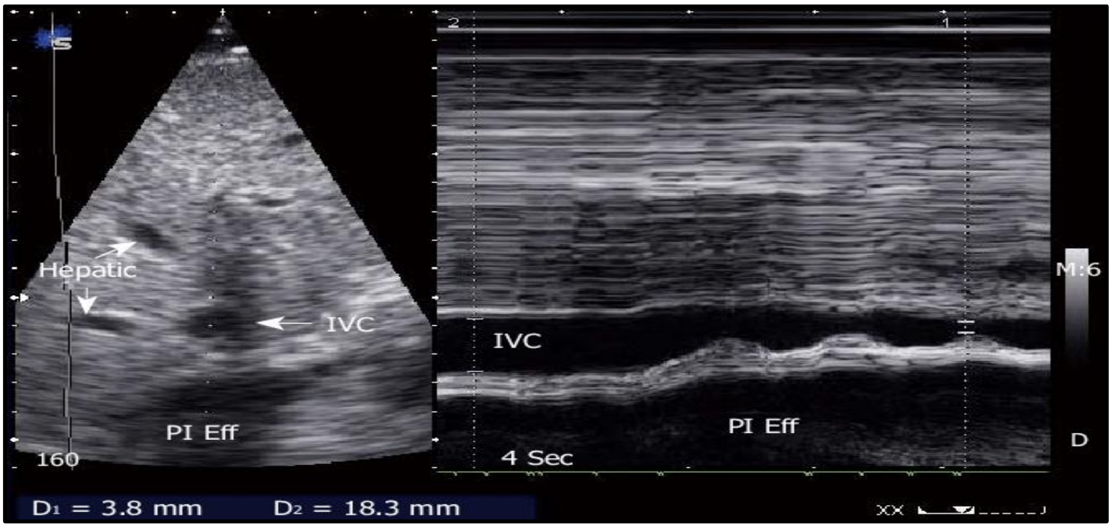


FIGURE 18

IVCCI: [(Maximum IVC diameter – Minimum IVC diameter) / Maximum IVC diameter] x 100.

Three anatomic approaches:

1) sub-xyphoid transabdominal long axis (LA) 2-3cm caudal to the right atrial (RA) junction
2) transabdominal short axis (SA) immediately inferior to the inflow of the hepatic veins
3) Right lateral transabdominal coronal long axis (CLA) (aka “rescue view”) 2-3cm caudal to the RA junction

All measurements were obtained with a 3.5-Mhz curved array ultrasound probe.

Subclavian vein:

Type of probe: Linear probe.

Approaches: 1.Supraclavicular approach 2. Infraclavicular approach.

Technique: Axillary vein, subclavian vein were examined with 7.5 MHZ transducer. The high-frequency waves give a high-resolution image to a maximum depth of 6 to 10 cm, The subclavian vein is scanned longitudinally from the supraclavicular position with recording of a Doppler spectrum and evaluation of the opening of the jugular vein. 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)

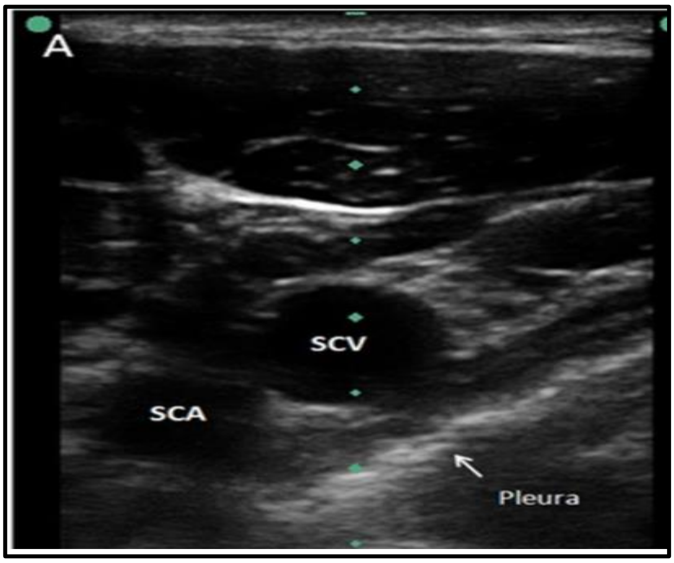


FIGURE 19

or longitudinal along the course of the vessel giving us the long-axis view. The short axis view (Fig)helps in identifying the surrounding structures (clavicle, subclavian artery, pleura) and gives a good orientation in midline.

Thus for infraclavicular approach we used short axis view in our study.

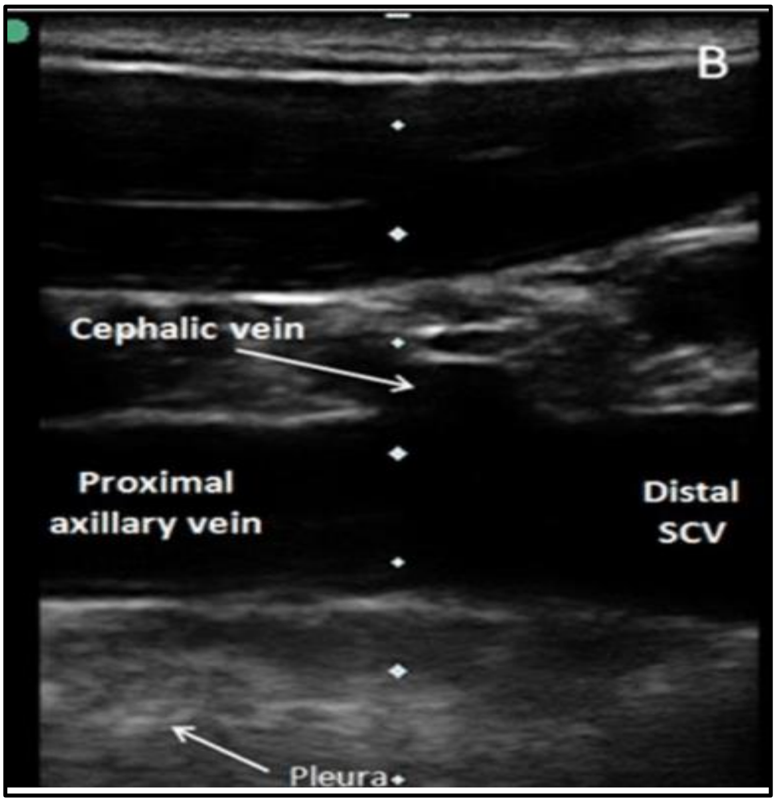


FIGURE 120

MATERIALS AND METHODS

Duration of study and study population:

Patients belonging to 18-60 years old age group, American Society of Anaesthesiologists I and II of either gender for elective surgery under general anaesthesia in supine position at "KLE's Dr. Prabhakar Kore charitable Hospital and Medical Research Centre, Nehru Nagar, Belagavi -10" during the period from January 2021 to December 2021.

Type of study: Observational study.

CRITERIAS FOR SELECTION:

Inclusion Criteria:

- American Society of Anesthesiologists physical status I and II.
- Age from 18 to 60 yrs.
- Patients posted for elective surgeries under GA.
- Provides Consent

Exclusion Criteria:

- Patient undergoing emergency surgery.
- Patient who are unable to give consent.
- Patients requiring rapid sequence intubation.

- Patient experiencing extended airway instrumentation due to difficult intubation.
- Patients on vasopressor drugs to maintain MAP >65mmHg.
- Presence of major peripheral vascular diseases
- Patients with increased intraabdominal pressure.
- Patients with implanted pacemaker/ cardioverter.
- Patient with multiple risk factors.

Sample size: Total sample size is 70.

Ethical clearance: The approval by the institutional ethical and research committee, Jawaharlal Nehru Medical College, Belagavi, was taken before starting the study.

Informed consent:

Type of research and the intervention being done was explained to all of the patients who met the selection criteria.

Prior to enrollment, we acquired written informed consent from each patient.

Sample Size Calculation:

The prevalence rate-based formula for the minimal sample size is

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

where P = percentage of prevalence and d = percentage likely difference in the prevalence.

The significance level is related to z_α . For 5% level of the significance z_α = 1.96.

With P = 46.9% and d= 25% of P = 11.73%, size of sample is 70.

Methodology:

The Approval for the study was obtained from the Departmental research committee and the clearance from the institutional ethical board. Written informed consent was taken. 70 healthy volunteers of American Society of Anesthesiologists I and II category. The study included participants who were between the age groups of 18 and 60yrs, who were having surgery while under GA.

After meeting inclusion and exclusion criteria and receiving informed consent, patients were asked to be Nil by mouth from midnight on the day before surgery. On the day of surgery, the blood pressure was recorded non-invasively in the pre-operative room, if the baseline Mean arterial pressure differs by > 30% compared with that of BP measurement recorded during pre-operative anesthesia visit, Inj. Midazolam 0.03mg/kg was administered and ten minutes of relaxation is granted. If the blood pressure difference is noted persistently, we have excluded that patient.

All the patients, who were included in the study have undergone ultrasound examination in the pre-operative holding area. Before performing the examination, all of the patients had been awake, supine, and breathing on their own for at least five minutes. Ultrasonographic evaluation of the Subclavian vein and Inferior vena cava were conducted in all the individuals.

Right Subclavian vein diameter was assessed using the high frequency(6-13Hz) linear probe of micromaxx Sonosite ultrasound apparatus. To acquire the image of the subclavian vein in short axis view, the probe was positioned below the midpoint of clavicle and scanned along the clavicle to its lateral third.

The Infraclavicular axillary vein, which begins at the outside edge of the first rib and extends for a few cms before crossing behind the clavicle, where it continues as the subclavian vein. Depending on the minute variations in the probe sites, the point at which the shape of the short axis image of the vein is the most discernible may correlate to the Subclavian or infraclavicular -axillary vein (SCV/AV). Instructions were given to patients to breathe normally while at rest (spontaneous breathing), then to breathe in deepl and out normally (deep inspiration). The minimum and maximum diameters of subclavian/infraclavicular axillary vein during spontaneous breathing and deep inspiration (dSCV/ AV $_{min}$ and dSCV /AV $_{max}$) respectively were measured in M mode. The following equation was used to determine the Collapsibility index.

Collapsibility Index: $$\frac{\{(dSCV\text{-}AVmax)\text{-}(dSCV\text{-}AVmin)\}X100}{(dSCV\text{-}AVmax)}$$

Then, with the patient in supine position and spontaneously breathing for at least 5 minutes, using low frequency curvilinear probe, using a subcostal technique and a paramedian long-axis view, inferior vena cava was observed. A two dimensional image of the Inferior vena cava was obtained where it enters the right atrium .Pulse wave Doppler was utilised to distinguish between the aorta and the inferior vena cava. Scan was performed 2 to 3 cm distal to the right atrium and M mode was used to obtain the image and to measure the respiratory changes of inferior vena cava diameter. While patients being at rest, all were told to breathe normally (spontaneous breathing), then to deeply inhale and exhale normally (deep inspiration). . The minimum and maximum diameters of Inferior vena cava (dIVC min and dIVCmax) respectively, were measured using M mode during spontaneous breathing and profound inspiration. The following equation was used to determine the collapsibility index:

$$\text{Collapsibility Index} = \frac{(dIVCmax - dIVCmin)x100}{dIVCmax}$$

The following observations were noted:

	Maximum Diameter	Minimum Diameter	Collapsibility Index
Subclavian/axillary vein (spontaneous breathing)			
Subclavian/axillary vein (deep inspiration)			
Inferior venacava(spontaneous breathing)			
Inferior vena cava(deep inspiration)			

Further the patients were shifted to OT, All the standard monitors viz SpO2, ECG & NIBP were attached. Then the patients were pre oxygenated with 100% O2 using closed circle system. Patient were pre medicated using Inj. Glycopyrrolate 0.004- 0.006mg/kg, Inj Midazolam 0.05mg/kg and Inj. Fentanyl 2mcg/kg. Patient was induced with injection Thiopentone 5mg/kg bodyweight. Endotracheal intubation was facilitated by Inj. Vecuronium 0.08- 0.1mg/kg. Oxygen + air (50:50) were used to maintain the anesthesia. Non-Invasive BP was recorded every two minutes

(Systolic BP, Diastolic BP, Mean Arterial Pressure).10 ml/kg/hr of crystalloid was infused. Throughout the analysis period, patients were in the supine position; only minimal stimulation, such as skin preparation was permitted. Mean Arterial Pressure less than 55mmHg or a fall in systolic/ diastolic/ Mean Arterial Pressure is more than 30% of the baseline greater than 2 minutes, despite prompt administration of fluid was considered to have Post-induction hypotension and was managed with an IV bolus of Inj Ephedrine 5mg. Once the surgery started, hemodynamic data collection was stopped.

TIME	SYSTOLC BP	DIASTOLIC BP	MAP
BASELINE			
INDUCTION			
2 MINUTES AFTER INDUCTION			
4 MINUTES AFTER INDUCTION			
6 MINUTES AFTER INDUCTION			
8 MINUTES AFTER INDUCTION			
INCISION			

Oxygen+ Nitrous oxide and Sevoflurane, an inhalational volatile anesthetic, was used at varying concentrations for maintenance of anesthesia. Blood and fluid replacements were made as needed. Ten minutes before finishing of the procedure, the use of Nitrous oxide and Sevoflurane was ceased, and the patient was ventilated using just 100% oxygen. At end point of procedure patients were reversed with

Glycopyrrolate(0.01mg/kg) and Neostigmine(0.05mg/kg) and extubated when regular spontaneous breathing pattern was seen and when patient started responding to pain stimuli. Patient was shifted to recovery room.

Statistical Analysis: Since this is an observational study, the following was the analysis plan. The mean and standard deviation for the continuous quantitative variables were determined.

If the data are split into two groups according to a particular qualitative attribute for comparison's sake, the continuous variables will be compared using suitable tools of statistics like student’s unpaired t test. The pre and post treatment measures was compared using student’s paired t test. Discrete variables were represented by median.

The categorical data was expressed in terms of rates, ratios and percentages. The Chi-square test, test of proportion, or Fisher's exact test were used to determine whether there was a correlation between the result, clinical, and demographic factors.

For discrete variables nonparametric tests were used.

Apart from the above suitable tools like ANOVA, correlation, regression etc., was used according to the need.

Suitable graphs were used to depict the comparison.

The value of p less than 5% (0.05) was deemed significant for all tests.

RESULTS

Study design: Observational study.

A total of 70 adult patients of ASA I and II between age group of 18 – 60year old of either sex planned for elective surgery under general anesthesia were comprehended in our study.

In our study the demographic data, collapsibility index of great veins and blood pressure readings were noted and correlated.

The attained data was chartered and transcribed into Microsoft excel spread sheet. The data was explored using various tests like Karl pearson’s correlation coefficient and results obtained were charted and tabulated as below.

TABLE 1: Gender distribution of the volunteers studied.

GENDER	NUMBER	%
FEMALE	33	47.14
MALE	37	52.86
TOTAL	70	100.00

52% of the sample are Males and remaining are Females

GRAPH 1: Pie chart depicting Gender distribution of the patients studied.

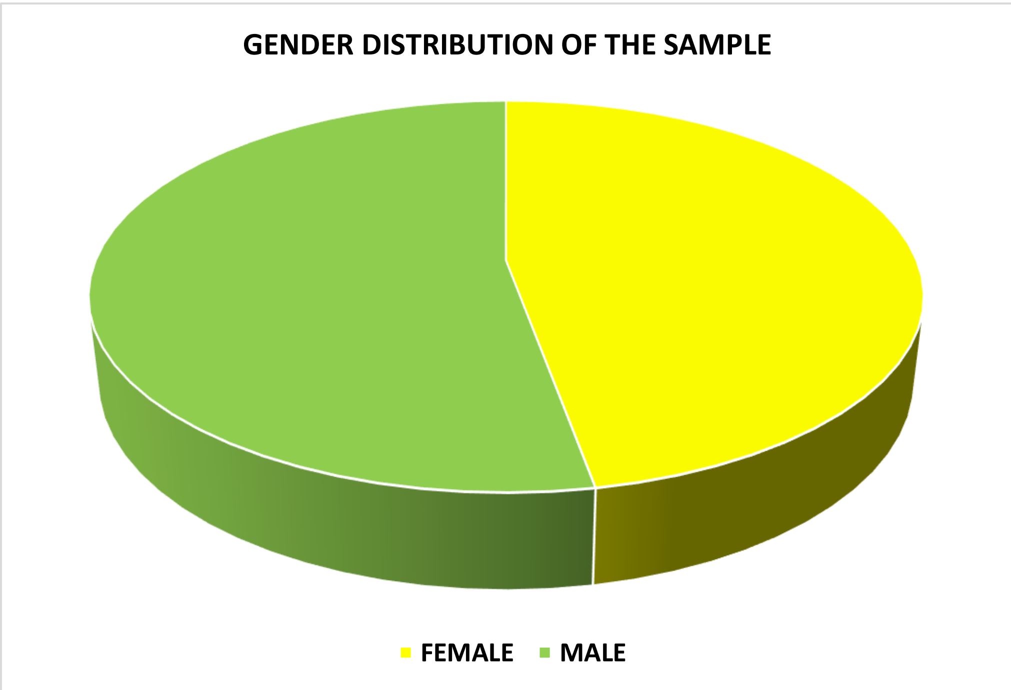


TABLE 2: Demographic Distribution of the Study Population.

AGE	NUMBER	%
15 - 24	15	21.43
25 - 34	18	25.71
35 - 44	13	18.57
45 - 54	14	20.00
55 - 64	10	14.29
TOTAL	70	100.00

GRAPH 2: Bar Graph Depicting Age Distribution of the sample.

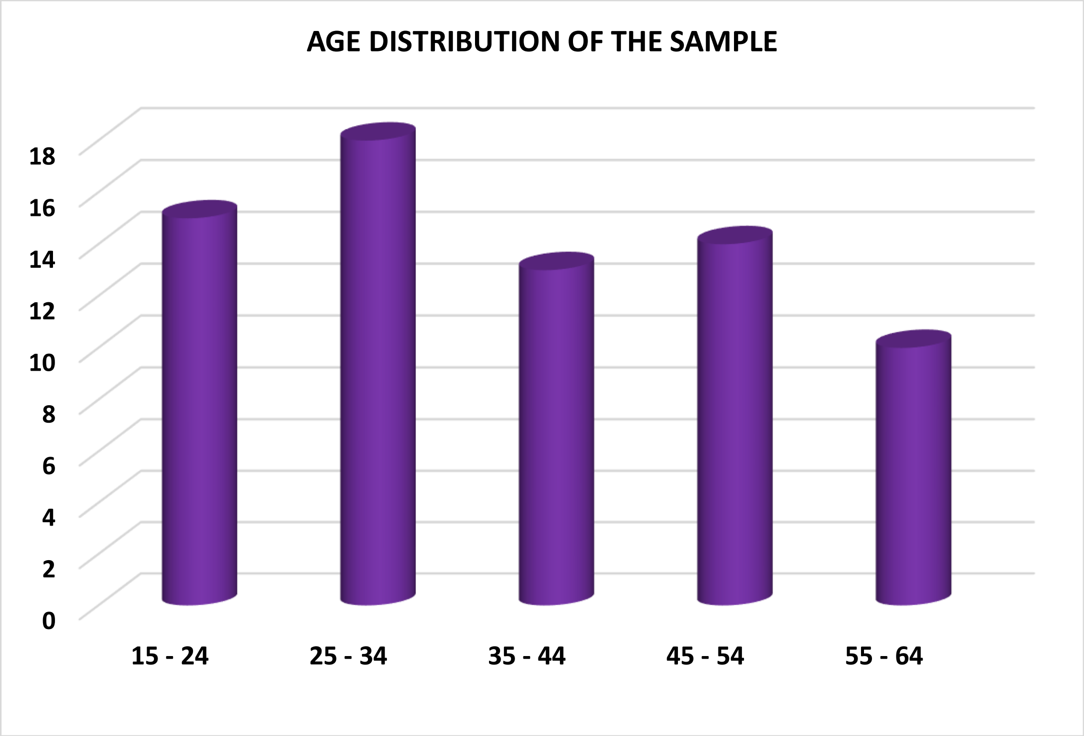


TABLE 3: The following table shows distribution of age groups.

AGE	37.74	13.06	19	60

Out of 70 patients distribution of age groups are comparable. Mean age was found to be 37.74 years with standard deviation (SD) of 13.06.

TABLE 4: The following table shows the trends of collapsibility index of Subclavian vein and Inferior vena cava.

		min	max	MEAN	SD
INFERIOR VENACAVA ON SPONTANEOUS BREATHING	MAXIMUM DIAMETER (cm)	0.37	4.46	1.32	0.53
	MINIMUM DIAMETER (cm)	0.2	1.53	0.86	0.27
	COLLAPSIBILITY INDEX	0.9	92.37	30.86	16.59

The Mean collapsibility values of Inferior venacava during spontaneous breathing is 30.86 and standard deviation (SD) is 16.59.

		min	max	MEAN	SD
INFERIOR VENACAVA ON DEEP INSPIRATION	MAXIMUM DIAMETER(cm)	0.37	22.27	1.53	2.80
	MINIMUM DIAMETER(cm)	0.18	1.8	0.69	0.27
	COLLAPSIBILITY INDEX	9.83	81.48	38.00	15.40

The Mean collapsibility values of Inferior venacava during deep inspiration is 38.00 and standard deviation (SD) is 15.40.

SUBCLAVIAN VEIN ON SPONTANEOUS BREATHING		min	max	MEAN	S.D
	MAXIMUM DIAMETER(cm)	0.13	1.46	0.37	0.25
	MINIMUM DIAMETER(cm)	0.07	1.1	0.28	0.20
	COLLAPSIBILITY INDEX	2.63	62.16	23.92	13.33

The Mean collapsibility values of Subclavian vein during spontaneous breathing is 23.92 and standard deviation (SD) is 13.33.

SUBCLAVIAN VEIN ON DEEP INSPIRATION		min	max	MEAN	S.D
	MAXIMUM DIAMETER(cm)	0.1	0.97	0.31	0.19
	MINIMUM DIAMETER(cm)	0.05	0.38	0.17	0.08
	COLLAPSIBILITY INDEX	3.7	82.71	39.42	18.05

The Mean collapsibility value of of Subclavian vein during deep inspiration is 39.42 and standard deviation (SD) is 18.05.

p VALUES ARE CALCULATED IN THE FOLLOWING TABLES USING STUDENT-PAIRED t TESTS IN RELATION TO THE BASELINE VALUES. ABBREVIATIONS: NS- NOT SIGNIFICANT S-SIGNIFICANT VS-VERY SIGNIFICANT HS-HIGHLY SIGNIFICANT.

TABLE 5 :Systolic blood pressure measurements at mentioned time intervals

		min	max	MEAN	S.D	p VALUE	INFERENCE
SYSTOLIC BLOOD PRESSURE (mmhg)	**BASELINE**	100	172	126.33	13.84	--	--
	INDUCTION	90	162	121.14	13.19	0.0124	S
	2 MINS	82	146	107.87	12.71	< 0.0001	HS
	4 MINS	70	133	97.56	13.15	< 0.0001	HS
	6 MINS	68	123	91.20	14.58	< 0.0001	HS
	8 MINS	60	149	87.63	16.39	< 0.0001	HS
	INCISION	70	150	99.60	16.94	< 0.0001	HS

In our study the systolic blood pressure at the time interval of induction showed significant p values compared to baseline, whereas at 2min,4min,6min,8min, incision it showed highly significant p values compared to the baseline.

GRAPH 3: A Line graph depicting the values of Mean systolic blood pressure at below mentioned time intervals.

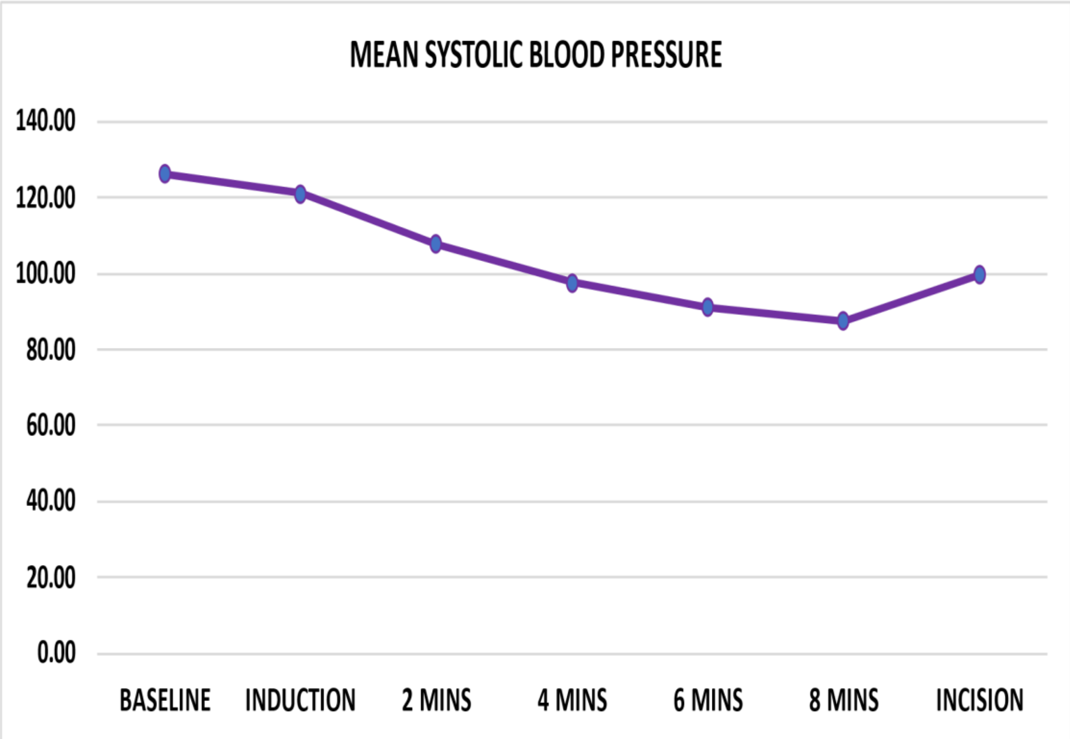


TABLE 6: **Diastolic blood pressure measurements at mentioned time intervals .**

		MIN	MAX	MEAN	S.D	p VALUE	INFERENCE
DIASTOLIC BLOOD PRESSURE (mmHg)	**BASELINE**	58	102	78.71	9.99	--	--
	INDUCTION	58	113	75.70	9.94	0.0379	S
	2 MINS	50	101	66.90	11.24	< 0.0001	HS
	4 MINS	44	89	60.13	10.98	< 0.0001	HS
	6 MINS	40	87	55.77	10.96	< 0.0001	HS
	8 MINS	40	95	53.03	12.16	< 0.0001	HS
	INCISION	40	100	62.00	14.71	< 0.0001	HS

In our study the Diastolic blood pressure at the time interval of induction showed significant p value compared to baseline, whereas at 2min,4min, 6min,8min, incision it showed highly significant p values compared to the baseline.

GRAPH 4: A Line graph depicting the values of Mean diastolic blood pressure at below mentioned time intervals.

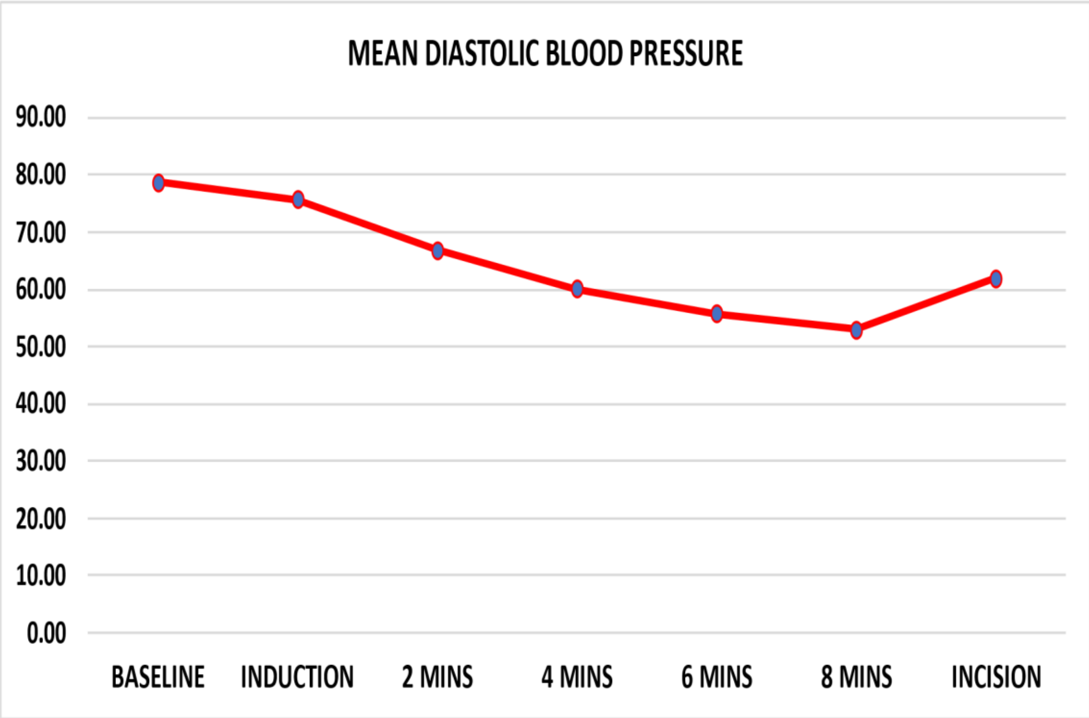


TABLE 7: Mean Arterial Pressure measurements at mentioned time intervals.

		MIN	MAX	MEAN	S.D	p VALUE	INFERENCE
MEAN ARTERIAL PRESSURE (mmhg)	**BASELINE**	68	126	93.60	10.40	--	--
	INDUCTION	70	129	90.57	10.14	0.0416	S
	2 MINS	61	116	80.79	11.12	< 0.0001	HS
	4 MINS	55	100	72.83	11.11	< 0.0001	HS
	6 MINS	50	95	67.66	11.73	< 0.0001	HS
	8 MINS	47	113	64.76	13.04	< 0.0001	HS
	INCISION	50	117	74.30	14.77	< 0.0001	HS

In our study the Mean blood pressure at the time interval of induction showed significant p values compared to baseline, whereas at 2min,4min,6min,8min,incision it showed highly significant p values compared to the baseline.

GRAPH 5: A Line graph depicting the values of Mean arterial blood pressure at below mentioned time intervals.

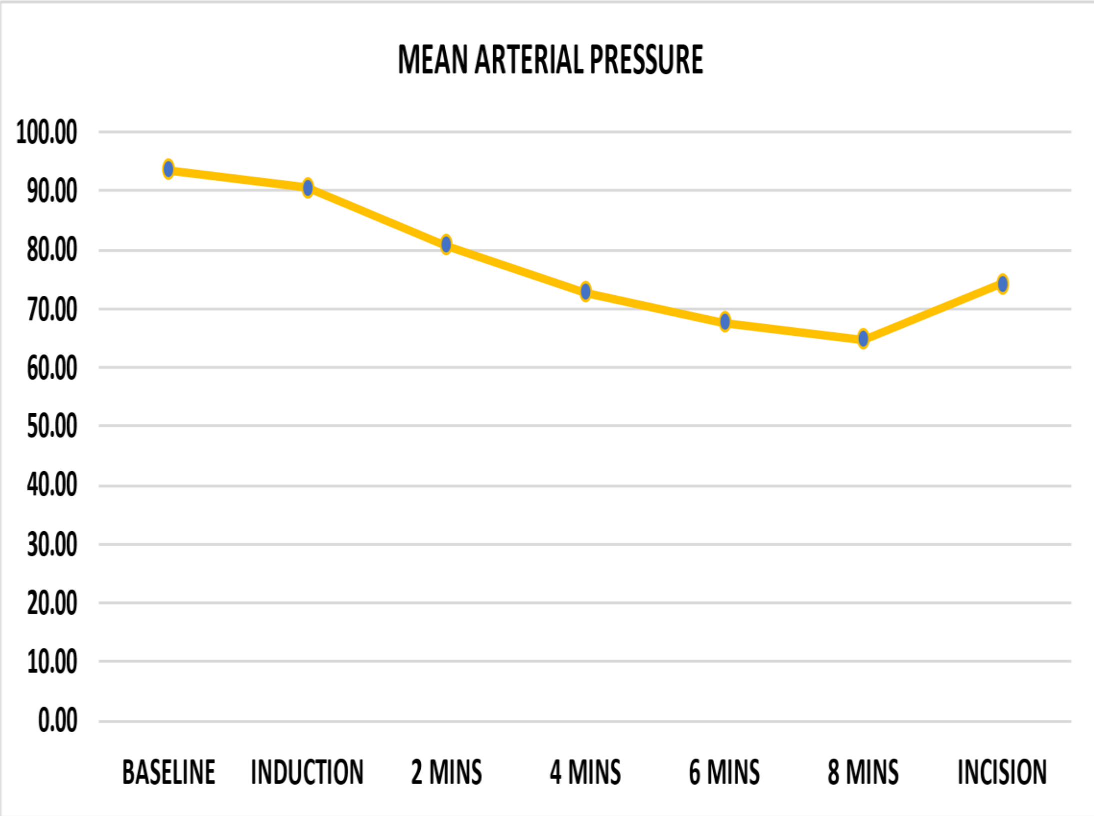


TABLE 8: KARL PEARSON'S CORRELATION COEFFICIENTS OF MAP AT 2 MINUTES WITH COLLAPSIBILITY INDICES.

	r	p VALUE	INFERENCE
Subclavian/Axillary vein (Spontaneous breathing)	-0.0839	0.4896	NS
Subclavian/Axillary vein (Deep Inspiration)	-0.3854	0.0010	VS
Inferior Vena cava (Spontaneous breathing)	-0.0578	0.6344	NS
Inferior Vena cava (Deep Inspiration)	0.0330	0.7863	NS

The correlation of Mean arterial pressure at 2 minutes with respect to collapsibility index of subclavian vein on deep inspiration was very significant with p value 0.0010.

TABLE 9: KARL PEARSON'S CORRELATION COEFFICIENTS OF MAP AT 4 MINUTES WITH COLLAPSIBILITY INDICES.

	r	p VALUE	INFERENCE
Subclavian/Axillary vein (Spontaneous breathing)	-0.0277	0.8202	NS
Subclavian/Axillary vein (Deep Inspiration)	-0.3643	0.0020	VS
Inferior Vena cava (Spontaneous breathing)	0.0021	0.9862	NS
Inferior Vena cava (Deep Inspiration)	0.1522	0.2064	NS

The correlation of Mean arterial pressure at 4 minutes with respect to collapsibility index of subclavian vein on deep inspiration was very significant with p value 0.0020.

TABLE 10: KARL PEARSON'S ORRELATION COEFFICIENTS OF MAP AT 6 MINUTES WITH COLLAPSIBILITY INDICES.

	r	p VALUE	INFERENCE
Subclavian/Axillary vein (Spontaneous breathing)	-0.0291	0.8111	NS
Subclavian/Axillary vein (Deep Inspiration)	-0.3944	0.0007	HS
Inferior Vena cava (Spontaneous breathing)	0.0098	0.9359	NS
Inferior Vena cava (Deep Inspiration)	0.1629	0.1778	NS

The correlation of Mean arterial pressure at 6 minutes with respect to collapsibility index of subclavian vein on deep inspiration was highly significant with p value 0.0007.

TABLE 11: KARL PEARSON'S ORRELATION COEFFICIENTS OF MAP AT 8 MINUTES WITH COLLAPSIBILITY INDICES.

	r	P Value	INFERENCE
Subclavian/Axillary vein (Spontaneous breathing)	-0.0158	0.8968	NS
Subclavian/Axillary vein (Deep Inspiration)	-0.3804	0.0012	VS
Inferior Vena cava (Spontaneous breathing)	-0.0546	0.6535	NS
Inferior Vena cava (Deep Inspiration)	0.1545	0.2016	NS

The correlation of Mean arterial pressure at 8 minutes with respect to collapsibility index of subclavian vein on deep inspiration was highly significant with p value 0.0012.

DISCUSSION

Intraoperative hypotension (IOH) is most frequently seen during perioperative period and it is the most common perioperative complication. It is accompanied by adverse postoperative outcomes which includes vital organ injury such as acute kidney injury, myocardial ischemia or injury, brain injury. The above mentioned adverse outcomes are due to ischemia or hypoperfusion of major vital organs. Many retrospective studies assumed about factors responsible for intraoperative hypotension during general anesthesia. Many factors contribute for post induction hypotension, which involves anesthetic agents that causes vasodilation, myocardial depression, low baseline mean arterial pressure, low pre induction blood pressure etc. The most vulnerable period after inducing general anesthesia is from the time of induction till 20 minutes, because that time period is free from surgical stimulus.[27.]

There are invasive and non-invasive methods available to assess the intravascular volume status. In other words assessment of intravascular volume status includes dynamic and static parameters. Central venous pressure is a static cardiac filling pressure which helps to guide the fluid administration. Variations in pulse pressure and stroke volume are examples of dynamic parameters.[28]

T. G. V. Cherpanath & B. F. Geertsboth et al reviewed the basic concepts of fluid responsiveness.The study proved that both static cardiac filling pressures and left ventricular end diastolic area were poor predictors of fluid responsiveness. The dynamic parameters of fluid responsiveness were predicted by observing changes in preload due to mechanical ventilation by which variations in stroke volume and pulse pressure were traced. They found that dynamic parameters are better predictors than static parameters. But this study also had few limitations such as a).inaccuracy in spontaneous breathing patients.b).controlled mechanical ventilation was necessary to acquire changes in preload.c).readings were erroneous in view of arrhythmias.[28]

T. Andrew Bowdle discussed the complications related to invasive monitoring which includes infection at punctured site, pneumothorax, damage to veins and arteries, catheter, wire, air embolism.[27.]

Recently, since few years beside noninvasive techniques, point of care ultrasonography attained good admiration in assessment of intravascular volume status during regional, general anesthesia and in critical care units. Assessment of inferior vena cava diameters was found to be a reliable indicator to ascertain the status of intravascular volume and fluid response in critically sick patients.

According to Jie Zhang et al, ultrasound measurements of Inferior vena cava recorded prior to the induction of general anesthesia were highly predictive of hypotension, with a cut off value of 43%. Collapsibility index was better predictive than maximum diameter of Inferior vena cava (dIVCmax, P = 0.002). Bedside Inferior vena cava ultrasonography evaluates about the patients who needs fluid optimization. But few limitations associated are abdomen distention, abdomen tenderness, depends on operator experience, abdominal guarding and emergency cases (emergency laparotomies, acute cholecystitis etc). They were unable to assess the accuracy of the IVC measurements.[5.]The study conducted by Alistair Kent, Prabhav Patil et al, they have concluded that correlation between collapsibility indices of inferior vena cava with femoral and internal jugular vein were weak. [17.]

To overcome the mentioned limitations, in our study, In order to anticipate hypotension following the induction of general anesthesia, we examined the collapsibility indices of subclavian vein and inferior vena cava during spontaneous and deep breathing.

We initiated a hospital centered study which was observational in the Department of Anesthesiology, KLE's Dr Prabhakar Kore Hospital and Medical Research Centre starting from January 2021 to March 2022. The study included a total of 70 adult patients aged between 18 to 60 years of age, posted for surgeries under GA. The present study's objective was to compare the subclavian-axillary vein collapsibility index with inferior vena cava collapsibility index during normal breathing and deep inspiration to predict hypotension during the induction of GA.

There is no accepted definition of Intraoperative hypotension. It is defined as "decrease of more than 30% mean arterial pressure (MAP) from baseline level or any absolute value of mean arterial pressure (MAP) less than 55mmHg"[4].

In the present study among the total 70 enrolled patients, there were 33 females accounting for 47.14% of the total population and 37 male patients accounting for 52.86% of the same. Among the enrolled individuals age groups were comparable. Mean age was found to be 37.74 years with the minimum age of 19 years and maximum age of 60 years.

In the present study the average or mean value of minimum and maximum diameters of subclavian vein during spontaneous breathing were 0.37cm,0.28 cm, mean value of maximum and minimum diameters of subclavian vein on deep inspiration were found to be 0.31cm,0.17cm which were less compared to spontaneous breathing. We have observed the variation of measurements with respiration, but did not conduct fluid challenge. In a similar study conducted by Pin zhu et al, the average diameter of the subclavian vein during expiration and inspiration in hypovolemic patients were 0.68cm,0.48 cm which was significantly low compared with the healthy volunteers which were 0.92cm, 0.73 cm. These findings were in line with the present study. After fluid resuscitation average diameters were 0.88cm,0.67cm which were significantly increased and closely correlated to the Central venous pressure (CVP). However, this comparison was not done in present study. The measurements recorded in supine position were positively correlated with the central venous pressure. Moreover, change in subclavian vein diameter(dSCV) during inspiration was significantly greater than that of subclavian vein diameter(dSCV) on expiration which was similar to present study.[13.]

As the SCV is very compliant vessel and its diameter showed meticulous correlation with right sided cardiac activities. As a consequence, it is considered that intravascular volume status is found to be closely correlated with the above mentioned parameters compared to other parameters (arterial BP, CVP etc.).

In the present study the average or mean values of minimum, maximum diameters of inferior venacava during spontaneous breathing were 0.86cm,1.32cm whereas the mean value of minimum, maximum diameters of inferior venacava during deep inspiration were found to be 0.69cm,1.53cm.Similar study which was performed by Suat Zengin et al[29] ,Lyon et al[30]found that the mean diameter of inferior venacava during inspiration in hypovolemic patients was 6.9mm(P< 0.001) and mean for the inferior venacava diameter (dIVC) was 5.4mm(p< 0.001) which was less than that of healthy individuals. Results were in concordance to Lyon et al study[30.]

In the present study the systolic blood pressure at the time intervals of induction showed significant p value 0.0124 compared to baseline, whereas at 2min,4min,6min,8min, incision it showed highly significant p values of < 0.0001 compared to the baseline. At time interval of 8 minutes after induction of general anesthesia, the systolic blood pressure (SBP) was dropped to the lowest value of 80mmhg.The diastolic blood pressure at the time interval of induction showed significant p value of 0.0379 compared to baseline, whereas at the time intervals of 2min,4min,6min,8min, incision it showed highly significant p values of < 0.0001 compared to the baseline. At time interval of 8 minutes after induction after general anesthesia, the diastolic blood pressure (DBP) was dropped to the lowest value of 50mmhg.

In the present study the Mean arterial pressure at the time interval of induction showed significant p value of 0.0416 compared to baseline, whereas at time intervals of 2min,4min,6min,8min, incision it showed highly significant p values of <0.0001 compared to the baseline. The percentage reduction in Mean arterial blood pressure after induction showed significant correlation compared to baseline blood pressure with the mean value of 90.57 and P value 0.0416. These findings were in line with the study conducted by Jie Zhang et al where the baseline mean blood pressure had a significant positive association with the percentage decrease in mean blood pressure after induction with the P=0.0001.[5.]

The collapsibility of blood vessel depends on a physiological principle which is, it causes decrease in intrathoracic pressure upon inspiration, which increases right ventricular diastolic filling, which rises the right side of the heart's caval outflow and cardiac output. In these circumstances central veins such as IVC and SVC tends to collapse. It was presumed that on deep inspiration it might aggravate this phenomenon, thus it is assessed to predict a decrease in Mean Arterial Pressure. During expiration this process is altered, accompanied by reduction of right atrial filling which leads to an increase in IVC diameter. To overcome the limitations of IVC ultrasonography, Subclavian vein was considered to predict intravascular volume status.[4,33.]

The subclavian vein is one of the most compliant blood vessels; its size and diameter vary with respiration and intravascular volume status. In contrast to the internal jugular and femoral veins, it is guarded from inadvertent external compression by the surrounding tissues and clavicle. Due to this property of subclavian vein, measurements are less likely to be affected by collapsible variables such as manipulations by ultrasonography probe. Thus, these factors further credits the use of subclavian vein ultrasonography in predicting intravascular volume status.[13.]

In the present study we used the Karl pearson's correlation coefficients to correlate the mean arterial blood pressure(MAP) readings with the collapsible indices .The collapsibility indices of subclavian/axillary vein during deep inspiration had shown very significant correlation with decrease in mean arterial pressure at 2 minutes,4 minutes,8 minutes after induction with the p value of 0.0010, 0.0020 ,0.0012 respectively and at 6minutes it was found to be highly significant correlation with decrease in mean arterial pressure with the p value of 0.0007. These findings are in concordance with the study conducted by Min Hee choi et al ,where the Mean arterial blood pressure (MAP) decline during anesthesia induction was significantly predicted by the subclavian-axillary vein's collapsibility index during deep inspiration

($P<0.001$)[R4.] Thus, from the above observations we found that SCV/AV Collapsibility index on deep inspiration is a better pre operative predictor of Intraoperative hypotension. In contrary to the present study Pin Zhu et al found no correlation existed between the parameters of the SCV Sonography (diameters of subclavian vein during inspiration and expiration) and Blood pressure.[13.]

In contrary to present study, study conducted by Prabhav Patil et al where the correlation between mean arterial blood pressure (MAP) and venous collapsibility index (VCI) was found to be poor ($R = 0.130$) and the relationship had near statistical significance ($p = 0.06$).[34.]

We found that the correlation of collapsibility indices of subclavian/axillary vein with the decrease in MAP during spontaneous breathing were not significant which were in concordance with the findings of the study performed by Min Hee choi et al where the collapsibility index of subclavian /axillary vein, on spontaneous breathing was not a reliable indicator of the drop in MAP during induction of GA ($p = 0.127$).[4.]

In the present study, significant correlation was not found between the percentage reduction in Mean arterial blood pressure and the IVC collapsibility index during spontaneous breathing and deep inspiration.

Alistair Kent et al in his prospective comparative study of subclavian vein and inferior vena cava collapsibility index found that on linear regression analysis, the paired measurements of inferior vena cava and subclavian vein collapsibility index revealed an acceptable correlation over a wide range of venous Collapsibilities ($R^2 = 0.61$).[9.]

CONCLUSION

Pre operative Subclavian vein /axillary vein collapsibility index during deep inspiration is more effective in predicting intraoperative hypotension followed by induction of general anesthesia in comparison to Subclavian vein/axillary vein collapsibility index during spontaneous ventilation and IVC Collapsibility index during spontaneous and deep breathing.

SUMMARY

In our study we found that systolic, diastolic, mean arterial blood pressure at the time interval of induction showed significant p values compared to the baseline.

The Mean collapsibility value of Subclavian vein during deep inspiration was found to be 39.42 which was more compared to the mean collapsibility values of inferior vena cava during deep inspiration which was 38.00.

In this study our main goal was to compare the collapsibility indices of great veins with the blood pressure readings to predict the hypotension .The subclavian vein's collapsibility index during deep inspiration showed very significant correlation with the mean arterial pressure at 2 minutes,4 minutes,8 minutes and highly significant correlation at 6 minutes after induction with the p value of 0.0010,0.0020,0.0012,0.0007 respectively, whereas there was no significant correlation with inferior vena cava collapsibility index during spontaneous and deep inspiration and collapsibility index of subclavian vein during deep inspiration.

From the present study we concluded that the subclavian-axillary vein collapsibility indices on deep inspiration showed very significant correlation with the mean arterial pressures recorded after induction of general anesthesia with a very significant p values and it can be taken as a significant predictor of intraoperative hypotension.

Thus, we would be able to predict intraoperative hypotension by a non-invasive technique in a preoperative period which further guides us to prevent postoperative complications.

There were no complications noted while performing the study as our study technique is non- invasive and observational.

LIMITATIONS

1. The correlation of subclavian vein and inferior vena cava collapsibility index has not been correlated with standard hemodynamic monitoring techniques to assess the intravascular volume status.

2. Although there was significant hypotension during intraoperative period as predicted by preoperative ultrasound measurements, major interventions were not taken to correct the hypotension.
3. We did not involve ASA III and IV patients in whom invasive hemodynamic is required mostly and intravascular volume status monitoring is required. Our study includes ASA I and II patients who are stable.

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ANNEXURE I – CONSENT FORM

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr. /Mrs. /Miss. ______________________________ we are requesting you to enroll you in the study titled **"**PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE SUBCLAVIAN VEIN/INFRACLAVICULAR AXILLARY VEIN COLLAPSIBILITY INDEX WITH INFERIOR VENACAVA COLLAPSIBILITY INDEX (DURING SPONTANEOUS BREATHING OR DEEP INSPIRATION) IN PREDICTING HYPOTENSION AFTER INDUCTION OF GENERAL ANAESTHESIA**"** conducted by Reg.no., BA0120007 Post Graduate in M.D. Anaesthesiology under the guidance of Dr.__________________, 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: The purpose of the study is to predict the incidence of intraoperative hypotension after the induction of general anaesthesia by measuring the collapsibility index of subclavian vein or infraclavicular axillary vein by comparing with inferior venacava pre operatively in the adult patients who were undergoing surgery under general anaesthesia.

Procedure Involved: If u agree to enroll in my study, I will ask you present, past and family history. Then you will be clinically examined in detail. Using Ultrasonography, the collapsibility indices of subclavian vein or infraclavicular axillary vein or inferior venacava will be measured to predict the intra-operative hypotension after induction of general anaesthesia**.**

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.

Risks: There is almost no risk involved in measuring the collapsibility indices of subclavian vein or infraclavicular axillary vein and inferior venacava using Ultrasonography

Benefits: By measuring the collapsibility indices of subclavian vein or infraclavicular axillary vein or Inferior venacava pre-operatively, we can predict the intra- operative hypotension after inducing general anaesthesia to prevent the major organ injury and post operative complications.

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 Dr. K H Poornima at Department of Anesthesiology, J.N. Medical college or by Ph no:8106696541.

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 Dr.________________, Department of Anesthesiology, J.N. Medical College, Belagavi. Phone number: 8106696541 Or Dr. ______________ Professor, Dept. Of Anaesthesiology, J.N. Medical College, Belagavi.

If you have any queries about your rights as a study subject, you may call Dr. **Harsha Hegde** Chairperson, JNMC, IEC & Scientist D, ICMR, National institute of traditional medicine. , J.N. Medical College Institutional Ethical Committee for Human Subjects Research, Phone number-9480422500, J.N. Medical College, Belagavi.

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH STUDY

"Prospective Observational study to compare subclavian vein/infraclavicular axillary vein collapsibility index with Inferior vena cava collapsibility index(during spontaneous breathing or deep inspiration) in predicting Hypotension after induction of general anaesthesia."

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

"Prospective Observational study to compare subclavian vein/infraclavicular axillary vein collapsibility index with Inferior vena cava collapsibility index(during spontaneous breathing or deep inspiration) in predicting Hypotension after induction of general anesthesia."

Group allotted :

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

Pre examination evaluation

Past History

- HTN DM IHD Arrhythmia Valvular heart diseases .
- H/o previous surgery/(s) where airway difficulty was encountered. Yes No

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

METHODOLOGY:

After obtaining the approval of ethical committee and written informed consent total of 60 patients undergoing surgery under general anaesthesia will be included in the study.

After having met inclusion and exclusion criteria and having obtained informed consent, patients will be asked to be nil by mouth from midnight on the day before surgery.

On the day of the surgery, the Blood Pressure will be recorded non-invasively, the Blood Pressure will be recorded non-invasively in the pre-operative room, if the baseline Mean arterial pressure differ by more than 30% compared with that measured during pre-operative anaesthesia visit, the patient will administered midazolam 0.03mg/kg and allowed to relax for 10 minutes. If the difference in the Blood Pressure persisted, the patient will be excluded.

All the patients who are included in the study will undergo ultrasonography examination in the preoperative holding area. All the patients will be conscious, lying supine and breathing spontaneously for at least 5 minutes before examination. Sonographic evaluation of the Subclavian vein a will be performed in all patients. Right Subclavian vein diameter will be checked using the high frequency (6-13HZ) linear probe of micromaxx sonosite USG apparatus. The probe will be initially placed beneath the middle of the clavicle and scanned along the clavicle to the lateral third to obtain a short axis view of the Subclavian vein. The Subclavian vein is an extension of the infraclavicular axillary vein, which originates from the outer border of the first rib and travels a few centimeters before running under the clavicle. The point at which the outline of the short axis view of the vein is most distinguishable for further calculation may correspond to the Subclavian vein or infraclavicular axillary vein (SCV-AV), depending on the subtle differences in the probe location.

Patients will be instructed to breathe normally at rest (spontaneous breathing) and then to inhale as deeply as possible and exhale naturally (deep inspiration). During spontaneous and deep inspiration, the minimum and maximum diameters of the Subclavian vein or infraclavicular axillary vein ($dSCV\text{-}AV_{min}$ and $dSCV\text{-}AV_{max}$) respectively will be assessed in M-mode. The collapsibility index will be calculated using the equation:

$$\frac{\{(dSCV - AVmax) \ -(dSCV\text{-} AVmin)\}X100}{(dSCV\text{-}AVmax)}$$

Then, with the patient in supine position and spontaneously breathing for at least 5 minutes, using low frequency curvilinear probe Inferior venacava will be visualized using a paramedian long-axis view via a subcostal approach. A two-dimensional image of the Inferior venacava as it enters the right atrium will be obtained. Pulse wave Doppler will be used to differentiate the inferior venacava from the aorta. Variations in Inferior venacava diameter with respiration will be assessed using M mode imaging performed 2 to 3 cm distal to the right atrium. Patients

will be instructed to breathe normally at rest (spontaneous breathing) and then to inhale as deeply as possible and exhale naturally (deep inspiration). During spontaneous and deep inspiration, the minimum and maximum diameters of the Inferior venacava ($dIVC_{min}$ and $dIVC_{max}$) respectively will be assessed in M-mode. Maximum and minimum Inferior Venacava diameters over a single respiratory cycle will be measured. The collapsibility index will be calculated using the equation:

$$\text{Collapsibility Index} = \frac{(dIVCmax - dIVCmin\ )x100}{dIVCmax}$$

The following observations will be noted:

	Maximum Diameter	Minimum Diameter	Collapsibility Index
Subclavian/axillary vein (spontaneous breathing)			
Subclavian/axillary vein (deep inspiration)			
Inferior vena cava(spontaneous breathing)			
Inferior vena cava(deep inspiration)			

Further the patients will be shifted to OT, All the standard monitors viz SpO2, ECG & NIBP will be attached. Then the patients will be pre oxygenated with 100% O2 using closed circle system. Patient will be pre medicated using Inj.Glycopyrrolate 0.004-0.006mg/kg, Inj Midazolam 0.05mg/kg and Inj.Fentanyl 2mcg/kg. Patient will be induced with injection Thiopentone 5mg/kg body weight. Tracheal intubation will be facilitated by Inj vecuronium 0.08- 0.1mg/kg. Anaesthesia will be maintained with oxygen + air (50:50). Non-Invasive BP will be recorded every two minutes (Systolic BP, Diastolic BP, Mean Arterial Pressure), crystalloid fluid will be infused at a rate of 10ml/kg/hr., patients will remain in supine position throughout the analysis period, only minimal stimulation such as skin preparation will be allowed. Mean Arterial Pressure less than 55mmHg or a fall in systolic/ diastolic/ Mean Arterial Pressure is more than 30% of the baseline for more than 2 minutes, despite rapid fluid administration will be considered to have Post-induction hypotension and will be treated with an intravenous bolus of ephedrine 5mg. Once the surgery begins, hemodynamic data collection will be stopped.

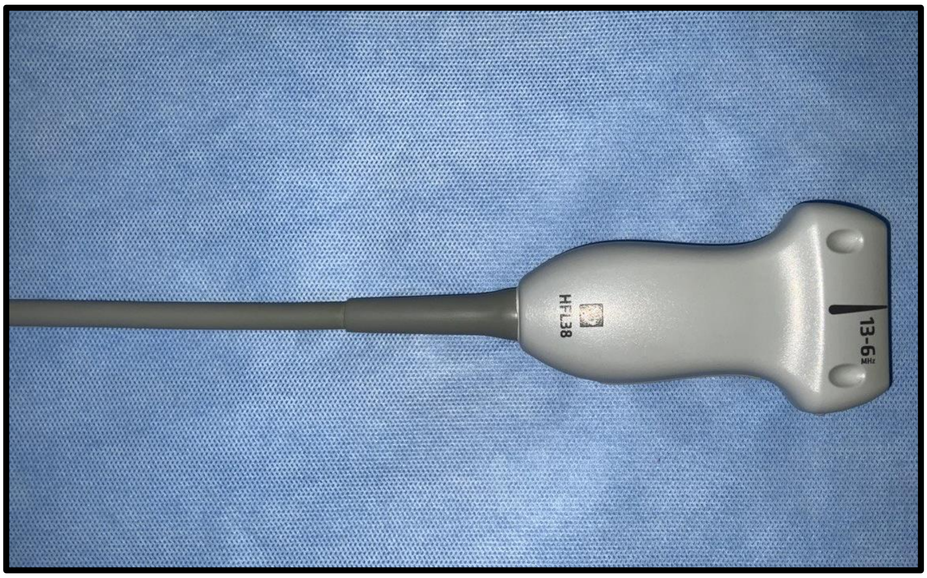
TIME	SYSTOLIC BP	DIASTOLIC BP	MAP
BASELINE			
INDUCTION			
2 MINUTES			
4 MINUTES			
6 MINUTES			
8 MINUTES			
INCISION			

SIGNATURE OF THE ANAESTHESIOLOGIST - ___________________

SIGNATURE OF THE PRINCIPAL INVESTIGATOR - __________________

ANNEXURE III- PHOTOGRAPHS

PHOTOGRAPH 1



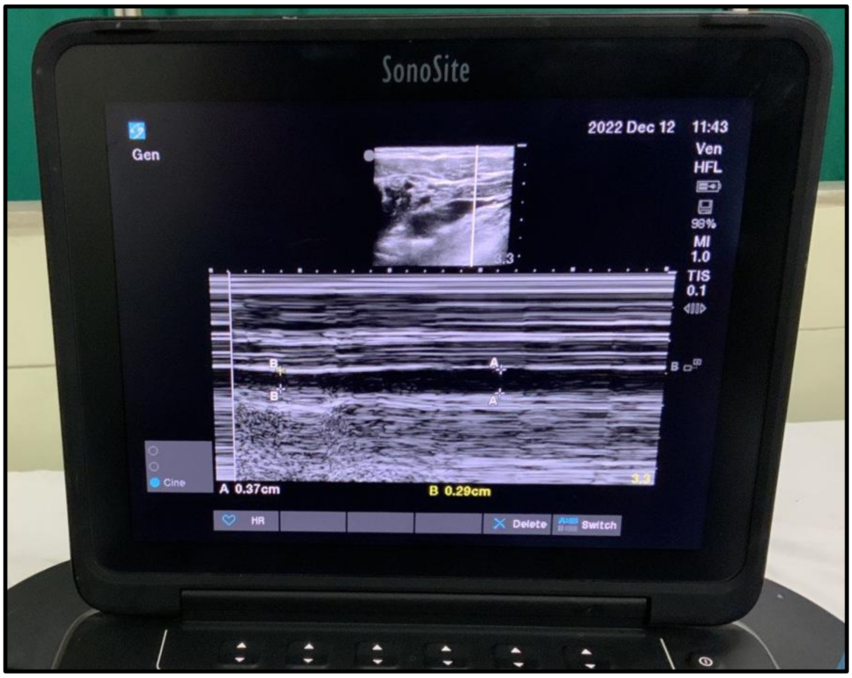
PHOTOGRAPH 2

PHOTOGRAPH 3

PHOTOGRAPH 4

Subclavian vein on spontaneous breathing.

PHOTOGRAPH 5



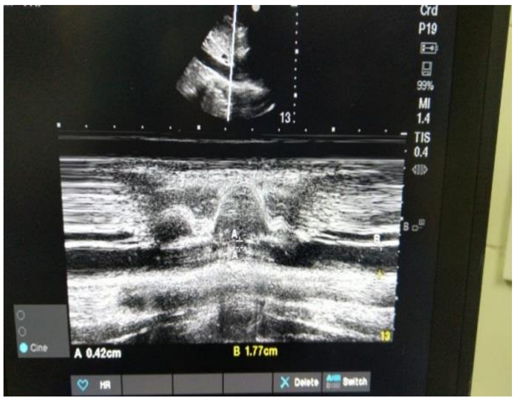
Subclavian vein on deep breathing

PHOTOGRAPH 6

PHOTOGRAPH 7

Inferior vena cava on spontaneous breathing.

PHOTOGRAPH 8



Inferior vena cava on deep breathing

PHOTOGRAPH 9

NNEXURE IV

KEY TO MASTER CHART:

YRS	:	YEARS
M	:	MALE
F	:	FEMALE
KG	:	KILOGRAM
CM	:	CENTIMETER
ASA	:	AMERICAN SOCIETY OF ANESTHESIOLOGISTS.
MIN	:	MINUTES

S.No.	PATIENT NAME	ASA STATUS	AGE	SEX	HEIGHT(cm	WEIGHT(Kg	Subclavian/Axillary vein(Spontaneous breathing)			Subclavian/Axillary vein(Deep Inspiration)			Inferior Venacava(Spontaneous breathing)			Inferior Venacava(Deep Inspiration)			Systolic Blood Pressure							Diastolic Blood Pressure							Mean Arterial Pressure						
							Maximum diameter	Minimu m Diameter	Collapsibility Index	Maximum diameter	Minimu m Diameter	Collapsibility Index	Maximum diameter	Minimu m Diameter	Collapsibility Index	Maximum diameter	Minimu m Diameter	Collapsibility Index	Baseline	Induction	2mins	4mins	6mins	8mins	Incision	Baseline	Induction	2mins	4mins	6mins	8mins	Incision	Baseline	Induction	2mins	4mins	6mins	8mins	Incision
1	RENUKA	I	23	FEMALE	160	55	0.14	0.12	14.28	0.17	0.1	41.1	1.72	0.98	43.02	1.16	0.8	31.03	120	118	96	88	84	80	102	70	68	50	48	44	40	50	87	85	65	61	57	53	67
2	VISHWANATH	I	32	MALE	168	76	0.29	0.27	6.89	0.26	0.17	34.6	0.66	0.47	28.7	0.58	0.42	27.5	120	113	102	95	88	80	88	74	74	54	50	45	41	50	89	87	70	65	59	54	63
3	NILOFER	I	32	FEMALE	158	68	0.29	0.26	10.34	0.29	0.24	17.24	1.14	1.03	9.6	1.29	0.85	31.78	130	126	112	104	88	82	85	90	75	65	50	46	40	45	90	92	81	68	60	54	58
4	ARUN PUNAPPA	I	60	MALE	160	60	0.24	0.19	20.83	0.21	0.11	47.61	0.93	0.78	16.12	0.93	0.57	38.7	121	118	104	96	90	86	88	80	76	58	50	48	45	50	93	90	73	65	62	59	63
5	Alam alisaheb	I	42	MALE	160	70	0.48	0.29	39.58	0.45	0.11	75.5	1.37	0.43	68.6	10.94	0.43	54.25	140	130	110	100	92	85	85	80	75	62	50	46	40	42	100	93	78	67	61	55	56
6	Geeta sanikappa	I	40	FEMALE	157	64	0.2	0.16	20	0.17	0.11	35.29	1.53	1.1	28.1	1.04	0.8	23.07	130	128	106	95	85	80	82	80	78	64	55	46	40	42	97	95	78	68	59	53	55
7	Navina souz	I	31	FEMALE	165	60	0.15	0.11	26.6	0.12	0.1	16.6	1.23	0.74	39.83	1.04	1.8	23	110	108	96	90	82	77	82	70	70	61	59	57	44	47	83	83	73	69	65	55	59
8	Shantakka.C	II	56	FEMALE	158	75	0.13	0.07	46.15	0.12	0.09	25	1.16	0.67	42.24	0.86	0.6	30.23	130	120	112	101	94	82	85	102	78	68	52	46	42	45	110	92	83	68	62	58	58
9	Ratna kuri	I	19	FEMALE	165	54	0.23	0.19	17.39	0.23	0.16	30.43	1.47	1.16	21.08	1.04	0.67	35.57	128	118	100	94	80	78	80	93	94	84	64	52	50	54	104	102	89	74	61	59	63
10	Omkar	I	27	MALE	170	70	0.22	0.16	27.27	0.13	0.08	38.4	1.09	0.83	23.85	1.18	0.74	37.28	108	109	100	101	81	91	93	78	77	60	59	58	57	60	88	88	73	73	66	68	71
11	Malan dulkar	II	42	FEMALE	164	65	0.28	0.2	28.57	0.2	0.09	55	1.23	0.92	25.2	0.86	0.61	29.06	140	130	106	94	86	78	80	90	80	62	52	48	40	42	107	97	77	66	61	53	55
12	Shivanand	I	40	MALE	170	70	1.08	0.96	11.11	0.27	0.26	3.7	1.1	0.92	16.36	0.98	0.8	18.36	145	136	120	117	118	111	110	91	84	78	75	77	74	72	109	101	92	89	91	86	85
13	Jithin	I	30	MALE	168	70	0.22	0.2	9.09	0.22	0.18	18.18	1.1	1.04	0.9	0.92	0.8	13.04	117	116	145	115	111	104	105	76	79	101	77	74	73	72	90	91	116	90	86	83	83
14	Mallavva	I	46	FFEMALE	165	60	0.13	0.11	15.38	0.11	0.05	54.54	1.1	1.04	5.45	0.86	0.43	50	111	100	92	84	78	72	70	71	60	52	44	40	40	40	81	73	65	57	53	51	50
15	Santhosh..K	I	21	MALE	168	55	0.37	0.26	29.72	0.22	0.13	40.9	1.41	1.16	17.7	1.04	0.67	35.57	140	162	146	121	120	149	150	89	113	90	82	76	95	98	106	129	109	95	91	113	115
16	Shivanand muliman	II	27	MALE	170	72	0.73	0.58	20.54	0.21	0.17	19.04	1.9	1.1	42.1	1.59	0.55	65.4	113	115	109	108	104	102	115	67	64	70	71	66	61	71	82	81	83	83	78	75	85
17	Savitha	I	33	FEMALE	156	65	0.43	0.29	32.55	0.25	0.16	36	0.95	0.63	33.68	0.74	0.39	47.29	130	130	122	114	100	102	100	70	80	74	68	60	55	60	90	97	90	83	73	71	73
18	Mahaveer	II	27	MALE	168	70	0.38	0.37	2.63	0.37	0.23	37.83	1.65	1.41	14.54	1.65	0.8	51.51	135	131	122	102	92	85	80	76	74	68	58	50	48	45	95	93	86	73	64	60	57
19	Vidya nadagouda	II	38	FEMALE	168	70	0.19	0.11	42.1	0.16	0.13	18.75	0.92	0.67	27.17	0.92	0.61	26.08	120	118	108	100	98	95	90	70	68	68	60	55	50	50	87	85	81	73	69	65	63
20	Sumit sanadi	II	20	MALE	168	60	0.77	0.68	11.68	0.64	0.24	62.5	1.04	0.8	23.07	1.04	0.61	41.34	130	125	102	92	86	80	74	80	78	62	54	49	45	40	97	94	75	67	61	57	51
21	Saba	I	51	FEMALE	160	75	0.53	0.4	24.52	0.48	0.37	22.91	1.23	0.61	45.52	1.1	0.67	44.54	116	112	110	102	96	90	90	85	75	68	58	50	52	54	95	87	82	73	65	65	66
22	Kallappa talawar	I	60	MALE	157	40.5	0.24	0.18	25	0.23	0.14	39.13	1.23	1..04	15.44	0.8	0.61	23.75	140	134	116	102	90	84	80	80	80	68	58	50	46	40	100	98	84	73	63	59	53
23	Kaveri .k	I	26	FEMALE	168	50	0.2	0.15	25	0.25	0.16	36	1.78	1.1	38.2	1.23	0.92	25.2	120	118	108	96	90	88	86	70	65	60	54	50	51	50	87	83	76	68	63	63	62
24	Laxmi Girigoudar	I	26	FEMALE	160	55	0.23	0.19	17.39	0.23	0.16	30.43	1.53	0.98	35.94	1.29	0.67	48.06	120	118	106	94	88	82	80	70	64	58	50	50	46	42	87	82	74	65	63	58	55
25	Sambhaji torase	II	50	MALE	164	78	0.4	0.34	15	0.34	0.24	29.41	1.19	0.98	17.64	1.19	0.93	21.84	128	120	104	90	82	80	76	78	74	62	50	48	44	40	95	89	76	63	59	56	52
26	Vaishnav khalkamb	I	23	MALE	180	52	0.58	0.53	8.62	0.56	0.16	71.4	1.72	1.2	30.23	1.77	0.42	76.27	124	122	104	94	80	74	70	80	76	68	52	50	46	40	95	91	80	66	60	55	50
27	Akash	I	19	MALE	165	50	0.31	0.27	12.9	0.31	0.21	32.25	1.35	1.16	14.07	1.5	0.96	40	120	129	124	122	117	109	104	60	78	87	87	66	69	60	80	95	99	99	83	76	75
28	Bhagyashree sanadi	I	24	FEMALE	153	39	0.24	0.15	37.5	0.21	0.15	28.57	1.41	1.16	17.73	1.41	1.1	21.98	110	108	100	98	98	106	112	70	68	60	58	57	64	61	80	81	73	71	71	78	78
29	Subhash	I	40	MALE	168	70	0.24	0.14	41.6	0.23	0.13	43.47	1.04	0.92	11.53	0.74	0.61	17.56	120	118	120	114	100	98	108	70	88	70	64	58	55	64	87	98	87	81	72	69	79
30	kamalatai iragouda	I	49	FEMALE	160	58	0.29	0.19	34.48	0.29	0.16	44.82	1.23	0.86	30.08	0.92	0.49	46.73	130	128	87	93	94	89	90	80	85	71	72	70	68	69	96	99	78	79	78	74	73
31	Roshanbi	I	52	FEMALE	148	73	0.2	0.16	20	0.2	0.14	30	0.86	0.61	29.06	0.86	0.6	30.23	140	130	112	90	82	76	70	80	80	70	51	50	42	40	100	97	84	64	61	53	50
32	Indira	I	50	FEMALE	158	68	0.33	0.28	15.15	0.33	0.22	33.33	1.53	1.16	24.1	1.53	0.98	35.9	134	130	116	108	98	96	112	80	78	66	60	60	60	72	98	95	83	76	73	72	85
33	Mumtaz ansari	II	40	FEMALE	155	85	1.46	1.1	24.65	0.5	0.38	24	2.63	0.74	71.8	1.47	0.55	62.58	159	136	132	111	110	106	118	98	93	90	78	74	72	84	118	107	104	89	86	83	95
34	Kempanna	I	41	MALE	160	60	0.18	0.14	22.22	0.15	0.11	26.6	0.79	0.47	40.5	0.79	0.45	43.03	140	140	123	133	123	111	110	70	75	92	83	72	67	60	90	99	102	100	89	82	80
35	Sanjana kamble	I	20	FEMALE	165	49	0.37	0.14	62.16	0.33	0.08	75.7	0.92	0.55	40.2	0.8	0.31	61.2	100	110	107	99	95	92	104	58	68	62	66	62	60	71	68	78	74	74	73	71	82
36	Manjula hubbali	II	42	FEMALE	165	50	0.37	0.24	35.13	0.37	0.23	37.83	1.41	0.72	48.93	0.8	0.67	16.25	130	128	112	101	96	88	150	80	78	66	58	55	50	100	97	95	81	72	69	63	117
37	Vasanth sanakki	I	50	MALE	156	65	0.87	0.65	25.28	0.97	0.38	60.82	1.23	0.8	34.95	22.27	0.92	59.47	130	102	94	80	76	74	79	80	70	62	50	48	42	56	97	81	73	60	57	53	64
38	Basanagouda patil	I	48	MALE	165	64	0.47	0.37	21.2	0.47	0.3	36.17	0.92	0.61	33.69	0.8	0.67	16.25	140	133	111	92	86	80	101	90	96	60	54	50	48	73	107	108	77	67	62	59	82
39	Lobsng chanzar	II	60	MALE	168	70	0.53	0.24	51.7	0.38	0.2	47.36	1.74	1.44	17.2	1.4	1.09	22.14	160	130	112	80	72	70	95	80	80	64	58	50	48	63	87	87	80	65	57	55	74
40	Uttam tane	I	26	MALE	165	65	0.24	0.13	45.83	0.19	0.1	47.36	0.92	0.55	40.21	0.74	0.49	33.78	140	142	110	82	71	71	91	69	73	64	62	48	47	59	87	89	72	67	52	53	67
41	Mallangouda .H	II	45	MALE	168	65	0.47	0.33	29.78	0.22	0.18	18.18	0.37	0.2	45.94	0.37	0.18	51.3	134	132	114	111	113	119	121	93	96	88	81	87	83	99	106	106	98	90	95	93	102
42	Yallappa patil	II	34	MALE	165	70	0.37	0.29	21.62	0.23	0.19	17.39	1.16	0.74	36.2	1.04	0.61	41.34	120	126	118	116	118	115	120	90	90	85	80	78	76	78	100	102	96	92	91	89	92
43	Neelavva ghodager	II	48	FEMALE	155	60	0.18	0.14	22.2	0.14	0.13	7.14	1.84	1.53	16.8	1.1	0.74	32.72	172	105	99	90	91	92	99	100	72	68	62	59	62	70	126	83	79	72	68	71	81
44	Shankar.D.Jadhav	I	50	MALE	165	74	0.97	0.47	51.5	0.9	0.21	76.6	4.46	0.34	92.37	2.26	1.2	46.18	124	94	86	80	76	70	100	74	64	58	50	48	45	64	86	74	67	60	57	53	70

45	Shobha ramappa	I	28	FEMALE	150	54	0.77	0.72	6	0.61	0.34	44.2	1.61	1.41	12.42	2.14	0.74	65.42	110	108	100	102	100	104	108	60	58	50	54	52	54	55	77	75	67	70	68	71	73
46	Muttappa muragod	I	28	MALE	171	68	0.24	0.2	16.6	0.26	0.18	50	0.83	0.52	37.34	0.78	0.47	39.74	132	124	90	80	74	70	100	77	72	60	50	44	42	50	92	89	70	60	54	51	67
47	Sadashiv Toli	I	60	MALE	162	63	0.14	0.13	7.14	0.1	0.09	10	0.67	0.6	10.44	0.61	0.55	9.83	137	124	111	92	84	80	116	90	80	70	60	52	48	86	95	95	84	71	62	59	96
48	Sourabh sawanth	I	23	MALE	170	74	0.33	0.26	21.21	0.3	0.22	26.66	1.1	0.67	39.09	1.1	0.61	44.54	140	138	120	104	92	82	119	80	80	68	60	54	50	68	100	99	85	75	67	61	85
49	Nandakishore	I	34	MALE	165	70	0.5	0.48	4	0.72	0.13	81.9	1.53	0.86	43.79	1.35	0.25	81.48	120	116	101	90	80	72	119	89	78	62	54	50	48	78	99	98	91	86	81	78	92
50	Sangeeta amati	I	32	FEMALE	165	62	0.27	0.24	11.1	0.26	0.18	30.76	0.98	0.92	6.12	0.98	0.8	18.36	100	90	82	70	68	60	98	62	60	50	48	42	40	74	73	70	61	55	51	47	83
51	Bhavana thumbare	II	54	FEMALE	158	32	0.21	0.13	38.09	0.21	0.08	61.9	0.92	0.55	40.21	0.74	0.49	33.78	110	110	96	80	70	66	87	60	70	60	50	40	40	72	80	83	72	60	50	49	78
52	Sharanavva	I	58	FEMALE	153	44	0.81	0.43	46.91	0.81	0.14	82.71	1.59	0.74	53.45	1.35	0.8	40.74	130	122	104	90	78	70	100	80	70	60	58	50	42	60	97	87	75	69	59	51	73
53	Jithin .V	I	21	MALE	173	85	0.27	0.19	29.62	0.31	0.19	38.7	1.35	0.86	36.29	1.35	0.68	49.6	130	128	122	118	117	109	125	80	64	60	77	63	52	64	97	85	81	91	78	69	82
54	Renuka	I	36	FEMALE	162	65	0.24	0.16	33.3	0.13	0.11	15.38	1.47	1.16	21.03	1.47	0.74	49.65	130	139	109	110	107	103	99	90	92	94	89	85	78	76	103	103	101	93	93	87	81
55	Prathamesh patil	I	23	MALE	168	68	0.16	0.12	25	0.12	0.11	8.33	0.92	0.87	5.43	0.92	0.65	29.34	114	118	120	112	112	114	114	76	78	80	71	72	74	76	89	91	93	85	85	87	89
56	Tahseen subeda	I	36	FEMALE	152	57	0.14	0.12	14.28	0.11	0.07	36.3	0.71	0.64	9.85	0.58	0.4	31.03	114	104	92	86	80	74	112	74	62	60	54	50	48	78	87	76	71	65	60	57	89
57	Manikchand	II	40	MALE	162	80	0.26	0.19	26.92	0.26	0.11	57.69	1.41	0.74	47.51	1.37	1.58	57.6	130	120	106	90	82	78	89	80	70	60	56	50	48	73	97	87	75	67	61	58	78
58	Jyothi	I	24	FEMALE	158	57	0.64	0.46	28.1	0.54	0.26	51.8	1.97	0.86	56.34	1.47	0.52	64.38	115	100	90	82	80	80	102	71	65	60	54	50	50	68	86	77	70	65	60	60	79
59	Amit talwar	I	20	MALE	170	60	0.29	0.15	48.27	0.22	0.13	40.9	1.13	0.68	39.82	0.53	0.34	38.84	110	110	100	106	100	95	98	70	68	60	55	60	55	54	83	82	79	72	73	68	69
60	Sagar.B	I	27	MALE	168	70	0.19	0.17	10.52	0.19	0.09	52.6	1.16	0.8	31.3	1.1	0.55	50	130	128	108	80	68	66	108	96	68	60	52	50	48	63	107	88	76	63	56	54	78
61	Surekha	I	40	FEMALE	158	60	0.16	0.14	12.5	0.11	0.06	45.45	1.04	0.92	11.5	0.74	0.55	25.67	121	118	100	80	76	70	118	79	70	60	50	50	46	76	93	86	73	60	59	54	90
62	Champakka	II	55	FEMALE	150	76	0.15	0.13	13.33	0.12	0.07	41.6	1.59	0.86	45.9	1.35	0.8	47.74	140	155	138	120	116	114	112	80	88	78	72	68	64	68	100	110	98	88	84	81	83
63	Akash sunil	I	28	MALE	168	68	0.26	0.18	30.7	0.21	0.11	47.6	0.98	0.67	31.63	0.67	0.47	29.85	120	118	100	80	72	70	104	80	76	60	50	50	48	58	93	90	73	60	57	55	73
64	Pundalik madar	II	58	MALE	169	80	0.66	0.64	3.03	0.71	0.34	52.11	1.58	1.2	24.05	1.58	1.1	30.37	140	130	100	80	76	72	130	90	80	60	50	48	45	78	107	97	73	60	57	54	95
65	Satyavva patil	II	52	FEMALE	156	60	0.28	0.25	10.71	0.24	0.15	37.5	1.4	0.97	30.7	1.1	0.78	29.09	109	104	94	98	95	95	99	72	68	65	66	65	63	65	84	80	75	77	75	74	76
66	Bharath patil	I	48	MALE	170	80	0.58	0.42	27.5	0.52	0.21	59.6	1.55	0.88	43.22	1.34	0.88	34.3	124	118	116	110	106	93	89	88	85	82	77	72	64	62	100	96	93	88	83	74	71
67	Bhagavva	I	60	FEMALE	160	65	0.27	0.21	22.22	0.22	0.15	31.8	1.14	0.88	22.8	0.83	0.72	13.25	138	130	105	86	70	68	116	90	78	60	54	50	46	74	106	95	75	65	57	53	88
68	Amal anwar	I	19	MALE	168	50	0.22	0.13	40.9	0.29	0.13	55.17	1.13	0.68	39.82	0.53	0.34	35.84	110	100	92	82	76	70	101	72	60	50	48	42	40	62	85	73	64	59	53	50	75
69	Rekha	I	23	FEMALE	164	68	0.14	0.12	14.28	0.17	0.1	41.17	1.72	0.98	43.02	1.16	0.8	31.03	120	124	118	114	110	106	103	78	80	74	68	64	62	62	92	95	89	83	79	77	76
70	Bashir	II	55	MALE	155	55	0.46	0.42	8.69	0.37	0.25	32.4	1.65	1.29	21.8	1.35	0.67	50.37	100	108	102	98	96	94	96	64	68	62	58	58	54	56	76	81	75	71	68	69	68