"ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBURG POSITION AND REVERSE TRENDELENBURG POSITION – A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY"

By

REG NO. BA0120016

Dissertation

Submitted to the

KLE Academy of Higher Education & Research

(Deemed to be University) Belagavi, Karnataka

In Partial Fulfillment of the requirements for the degree of

M. D.

in

ANAESTHESIOLOGY

JAWAHARLAL NEHRU MEDICAL COLLEGE,

BELAGAVI, KARNATAKA

JUNE/JULY – 2023

KLE Academy of Higher Education & Research
(Deemed to be University) Belagavi, Karnataka

ENDORSEMENT

This is to certify that the dissertation entitled **"ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBERG POSITION AND REVERSE TRENDELENBERG POSITION– A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY"** is a bonafide research work done by **REG NO. BA0120016.**

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

Date: 2/1/2023
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 BELAGAVI J.N. MEDICAL COLLEGE

UNDERTAKING

I Reg.no., BA0120016 here by declare that the information and the data mentioned in my dissertation entitled **"ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBERG POSITION AND REVERSE TRENDELENBERG POSITION– A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY"** belongs to me and is original. I am aware of the definition of Plagiarism as detailed below:

- An act or instance of using are closely imitating the language and thoughts of another author without authorization and the representation of that authors work as one's own, as by not crediting the original author.
- A piece of writing or other work reflecting such unauthorised use or imitation.
- The deliberate or reckless representation of another's words, thoughts, or ideas as one's own without attribution in connection with submission of academic work, whether graded or otherwise.

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

Date: 02/01/2023

Place: Belagavi

Shalang

(Reg.no., BA0120016)

PLAGIARISM CLEARANCE LETTER

KLE ACADEMY OF HIGHER EDUCATION AND RESEARCH

JAWAHARLAL NEHRU MEDICAL COLLEGE

(Recognized by Medical Council of India, New Delhi)

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

Nehru Nagar, Belagavi- 590 010, Karnataka, INDIA

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

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

ACCEPTANCE LETTER

The softcopy of thesis entitled: **"ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBERG POSITION AND REVERSE TRENDELENBERG POSITION- A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY"** has been submitted for Anti-Plagiarism check through Turnitin software. The scan has been carried out and the scanned output reveals a match percentage of **03%** which is within the acceptable limits of **10%** as per the guidelines given by UGC.

Guide.

KAHER BELAGAVI J.N. MEDICAL COLLEGE

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

To,
Reg. No. BA0120016,
Postgraduate Student,
2020-21 Batch,
Department of Anaesthesiology,
J. N. Medical College, Belagavi.

ETHICAL CLEARANCE CERTIFICATE

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

Ref: MDC/DOME/ 98 **Date: 25/01/2021**

To

REG NO. BA0120016

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 **"ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TREDELENBERG POSITION AND REVERSE TRENDELENBERG POSITION AND REVERSE TRENDELENBERG POSITION – A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY",** is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee on Human Subjects Research.

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

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

42

ABBREVIATIONS

TP	: Trendelenburg position
RTP	: Reverse Trendelenburg position
IAP	: Intra-abdominal pressure
ITP	: Intra-thoracic pressure
ICP	: Intracranial pressure
CSF	: Cerebrospinal fluid
IOP	: Intraocular pressure
CT	: Computed Tomography
MRI	: Magnetic Resonance Imaging
ONSD	: Optic Nerve Sheath Diameter
PONV	: Postoperative Nausea Vomiting
POHA	: Postoperative Headache
TCD	: Transcranial Doppler
RALRP	: Robot Assisted Laparoscopic Radical Prostatectomy
PEEP	: Positive End Expiratory Pressure
S. D	: Standard Deviation
SpO_2	: Oxygen Saturation
HR	: Heart Rate

NIBP : Non-invasive Blood Pressure

ECG : Electrocardiogram

$EtCO_2$: End Tidal Carbon Dioxide

RR : Respiratory Rate

MAP : Mean Arterial Pressure

SVR : Systemic Vascular Resistance

ASA : American Society of Anaesthesiologists

CA : Cerebral Autoregulation

CPP : Cerebral Perfusion Pressure

Min : Minimum

Max : Maximum

Mins : Minutes

CM : Centimeters

AVG : Average

Inj : Injection

IV : Intravenous

NS : Not Significant

S : Significant

VS : Very Significant

HS : Highly Significant

ABSTRACT

TITLE:

"ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBURG POSITION AND REVERSE TRENDELENBURG POSITION – A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY."

BACKGROUND:

Laparoscopic surgeries use carboperitoneum which is known to cause raised intracranial pressure (ICP) in addition to other systemic effects which is further accentuated by positional changes. This study aims to evaluate the change in intracranial pressure during laparoscopic surgeries non-invasively by measuring the change in optic nerve sheath diameter using ultrasound.

METHODS:

The current observational study was conducted in 60 ASA 1 and 2 patients belonging to 18-60 age group undergoing elective laparoscopic surgeries under general anaesthesia at KLE'S Dr. Prabhakar Kore charitable hospital and medical research centre, Belagavi. Ultrasonography based optic nerve sheath diameter (ONSD) measurement was carried out in all the patients at 4 different points of time during the surgery i.e, after induction of anaesthesia, after pneumoperitoneum, after positioning and after desufflation.

RESULT:

ONSD was found to be significantly elevated when compared with baseline in all the patients irrespective of positional change($p<0.0001$). When trendelenburg and reverse trendelenburg positions were compared, the optic nerve sheath diameter was found to significantly elevated after trendelenburg positioning($p<0.0001$) and also after desufflation($p<0.0001$) in supine position.

CONCLUSION:

We conclude that laparoscopy and pneumoperitoneum causes a significant increase in optic nerve sheath diameter which is a marker for raised intracranial pressure and this increase in optic nerve sheath diameter is further accentuated by trendelenburg positioning. We also conclude that there is a positive correlation between the degree of change in optic nerve sheath diameter and incidence of postoperative nausea, vomiting and headache.

KEYWORDS:

Pneumoperitoneum, Intracranial pressure, Optic nerve sheath diameter, Ultrasound.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF GRAPHS

LIST OF PHOTOGRAPHS

INTRODUCTION

Laparoscopic surgery has many advantages over open surgical procedures such as less intraoperative bleeding, decreased postoperative pain, reduced recovery time and better cosmetic outcome[1]. To enhance the visualization of the surgical field, pneumoperitoneum and additional change in position [Trendelenburg (TP), Reverse trendelenberg (RTP)] are applied to patients undergoing laparoscopic surgery[2].

However, the concurrent use of pneumoperitoneum and positional change leads to a raise in intra-abdominal pressure (IAP), which could further cause numerous physiological variations in the body, such as a fall in venous return, raise in blood flow to the brain, raise in intracranial pressure, and intraocular pressure (IOP). Moreover, carbon dioxide gas insufflation can cause hypercapnia and respiratory acidosis due to absorption of the gas across the peritoneal surface.[2,3]

Additionally, the presence of pneumoperitoneum increases cerebral blood flow due to an increase in CO_2 partial pressure and causes increased catecholamine secretion which is not dependent on CO_2 partial pressure. Acute rise in intracranial pressure might be detrimental for patients with unrecognized intracerebral vascular and mass lesions.[2]

Moreover, even in the absence of these pathologies, increase in intracranial and intraabdominal pressure might lead to hemodynamic changes, postoperative nausea vomiting (PONV) and postoperative headache (POHA). Thus, monitoring intracranial pressure during laparoscopic surgery might prevent such complications and enhance recovery during postoperative period.[2]

Insertion of invasive probes through the cranium is the gold standard technique for measuring intracranial pressure but it is associated with procedural risks and risk of infections.[4,5,6]

Therefore, the demand for non-invasive methods of determining intracranial pressure has increased.[4] Transcranial Doppler (TcD) is one such latest diagnostic tool that is used to measure intracranial pressure non-invasively. However, this method is difficult to reproduce and requires a high level of skill.[4,5]

Therefore, in modern clinical practice, Computerized Tomography (CT) or brain Magnetic Resonance Imaging (MRI) are often used methods to check for elevated intracranial pressure.[4,6] However, these tests merely provide a general impression of whether the intracranial pressure is elevated at the time of the test. More importantly, these tests cannot be performed intraoperatively or as point of care. They are also costly, time taking, and rarely accessible in remote areas.[4,6] Thus, there is a clear need for a simple, fast, and affordable bedside diagnostic test to detect elevated intracranial pressure.[4]

Ultrasonographic evaluation of optic nerve sheath and its diameter has emerged as simple, non-invasive, inexpensive, rapid, reproducible, and reliable method to determine raised intracranial tension.[4,7]

Current evidence suggests that ultrasonographic measurement of optic nerve sheath diameter is well correlated with invasive intracranial pressure measurements in various clinical settings.[4,7,8,9]

The goal of the current study is to evaluate the extent of change in intracranial pressure resulting from pneumoperitoneum and positional changes during laparoscopic surgeries by the implementation of ultrasonographic optic nerve sheath

diameter measurement technique. We also aim to investigate whether this change in optic nerve sheath diameter during laparoscopic surgeries is associated with postoperative nausea vomiting and postoperative headache.

.

OBJECTIVES

PRIMARY OBJECTIVE

Assessment of optic nerve sheath diameter for analyzing intracranial pressure changes during laparoscopic surgery in trendelenburg position and reverse trendelenburg position.

SECONDARY OBJECTIVE

To assess the association between change in optic nerve sheath diameter during laparoscopic surgeries and the incidence of postoperative nausea, vomiting and postoperative headache.

REVIEW OF LITERATURE

In a prospective observational study conducted by Nishant Sahay in Patna in 2016, which included sixty-one female patients undergoing elective laparoscopic surgery, concluded that pneumoperitoneum is associated with significant increase in intracranial pressure which is measured by optic nerve sheath diameter evaluation on ultrasound. This increase in intracranial pressure was more pronounced in head low position (trendelenburg position) than in head up position (reverse trendelenburg position). The author also concluded that up to five minutes post desufflation, optic nerve sheath diameter does not revert to baseline level[1].

Gulseren Yilmaz in a study, conducted in Turkey in 2014 concluded that the combination of pneumoperitoneum and trendelenburg position leads to a significant increase in optic nerve sheath diameter during laparoscopic hysterectomy. He also concluded that the extent of increase in optic nerve sheath diameter during the procedure is significantly correlated with post operative nausea, vomiting and headache occurring within the first three hours of recovery.[2]

A Prospective case-control study was carried out on ten healthy individuals to investigate for variations in optic nerve sheath diameter in different positions. Optic nerve sheath diameter was assessed in them in supine, trendelenburg, and reverse trendelenburg positions, with a 1-minute interval between each. The authors concluded that the diameters of the optic nerve sheath during any of the positions had no statistically significant variation. When the patient was supine, the mean ONSD in the left and right eyes was 0.45 cm and 0.46 cm respectively. During trendelenburg position, it was 0.47 cm and 0.44 cm, and in the reverse trendelenburg position, it was 0.48 cm and 0.44 cm.[10]

In China, 519 healthy people were studied to determine the natural variations in optic nerve sheath diameter. The distribution of all examined variables which include, the diameter of optic nerve sheath, diameter of optic nerve, and transverse diameter of eyeball, was found to be non-normal. The investigators found no variations between female and male subjects, or between left and right eyes which is significant statistically.[11]

A Hong Kong based observational study was done on 100 individuals which included hospital staff and non-neurological patients admitted to emergency unit. The investigators found the mean ONSD in both the groups to be 0.405 cm. They found no variation between males and females, eye side, or between personnel and patients.[12]

Yashwashi in a randomized controlled study done in India in 2019, concluded that during laparoscopic cholecystectomy, high-pressure pneumoperitoneum generates a large increase in intracranial pressure compared to low-pressure pneumoperitoneum, which can be estimated by ultrasound assessment of the diameter of optic nerve sheath, and it is completely non-invasive.[13]

A systemic review and meta-analysis were conducted at Severance Hospital in South Korea in 2016 by Eun Jung Kim et al which included a total of 460 subjects from a single randomized controlled trial and nine prospective observational studies. The results obtained from this study show that there is a significant elevation in optic nerve sheath diameter readings in both early phase (0-30 mins) and late phase (30-120 mins) of pneumoperitoneum when compared to initial baseline value recorded after anaesthesia induction. The optic nerve sheath diameter values during the late period were found to be slightly higher than those during early period, however there was no statistical significance. A subgroup analysis was done which revealed that increment

in optic nerve sheath diameter was found to be greater when pneumoperitoneum was associated with trendelenburg position (Maximum deviation = 0.48 cm) than with supine or reverse trendelenberg position (Maximum deviation = 0.24 cm) and there was no evidence found that explains optic nerve sheath diameter increase in both trendelenburg and reverse trendelenburg positions after carboperitoneum. This study also concluded that there is no significant change in optic nerve sheath diameter values measured after induction of anaesthesia and after removal of pneumoperitoneum.[14]

A single centre prospective observational study was conducted by Min-Soo-Kim et al from Department of Anaesthesia in close collaboration with Department of Urology from Yonsei University, Seoul, South Korea. This study included 20 adult males who underwent Robot Assisted Laparoscopic Radical Prostatectomy (RALRP) which demands the use of steep trendelenburg posture during surgery. The results revealed a 12.5% raise in optic nerve sheath diameter in 30' trendelenburg position when compared with baseline value. Three out of 20 patients recorded optic nerve sheath diameter value that corresponds to intracranial pressure of more than 20mmHg, but there were no verified neurological complications in them.[15]

An observational study was conducted by Ji Hyun Chin and his colleagues in Korea in 2015 which enrolled 21 patients undergoing RALRP with the purpose of demonstrating the effect of steep trendelenburg position on optic nerve sheath diameter alone and also when combined with pneumoperitoneum. They came to a conclusion that the application of the steep trendelenburg posture, even for a short period has elevated the sonographic optic nerve sheath diameter even when it is not associated with pneumoperitoneum.[16]

A 2013 study was conducted in Florida by Fernando and his colleagues in which they included 44 patients of various demographic parameters who were planned to undergo laparoscopic surgery. In this prospective study they came to a conclusion that the variations noticed in optic nerve sheath diameter were proportional to pressure used to create pneumoperitoneum and these changes were transient and reversible in nature.[8]

Ke Chen et al conducted a study on 90 patients in China who underwent Robot Assisted Laparoscopic Radical Prostatectomy in which they investigated various ultrasonographic parameters in addition to post-surgical cognitive function. They came to a conclusion that the pneumoperitoneum and trendelenburg positioning in elderly patients is associated with raised optic nerve sheath diameter which is more prominent in those with incompetent internal jugular vein valve and these individuals had increased incidence of transient cognitive dysfunction in early postoperative period.[17]

Raoul Stevens and his colleagues performed a review of literature, and they included sixty-three studies in which ultrasonographic measurement of optic nerve sheath diameter was done using different criteria. These authors came to a conclusion that the application of different criteria in assessment of optic nerve sheath diameter has led to discrepancies in standardizing the cut-off values for raised intracranial pressure. They proposed that to increase the sensitivity of optic nerve sheath diameter for detecting raised intracranial pressure, the electronic callipers should be placed on the outer margins of striped hyperechoic bands.[18]

A London based study conducted was by Robba and his colleagues on forty patients who underwent laparoscopy-based procedures in which they have compared three non-invasive techniques of intracranial pressure evaluation. They concluded that

the optic nerve sheath diameter measurement technique and transcranial doppler based cerebral blood flow velocity method are better correlated with raised intracranial pressure than Transcranial doppler derived pulsatility index method.[19]

A Pakistan based observational study was conducted by Kamran et al on 100 patients who were admitted in neuro critical care unit in whom they have evaluated optic nerve sheath diameter findings of raised intracranial pressure and compared them with CT scan findings and came to a conclusion that both are comparable to each other and that optic nerve sheath diameter value of above 0.58cm has 94% sensitivity and 96% specificity in patients with positive CT findings.[20]

A randomized controlled study was conducted by Ann Hee et al in 50 patients who underwent Robot Assisted Laparoscopic Radical Prostatectomy in which they have studied the effects of application of 5cm H_2O positive end expiratory pressure (PEEP) during laparoscopy and compared them to a control group in which no positive end expiratory pressure was applied and has come to the conclusion that application of low PEEP has not caused an increase in optic nerve sheath diameter and intraocular pressure (measured by Tono-pen) during pneumoperitoneum and steep trendelenburg positioning.[21]

BASIC SCIENCES

LAPAROSCOPY AND PNEUMOPERITONEUM:[22,23]

Laparoscopic surgery is widely practiced now a days across all centres. Benefits include reduced postoperative pain, improved cosmetic results and patient satisfaction, and reduced hospital stays. The range of laparoscopic surgical techniques is increasing in complexity and now includes cholecystectomy, adrenalectomy, nephrectomy, fundoplication, hernia repair, bowel resection and gynaecological procedures. There is also an increase in the number of emergency operations performed laparoscopically.

Laparoscopic surgery involves insufflation of a gas (usually carbon dioxide) into the peritoneal cavity producing a pneumoperitoneum. This causes an increase in intra-abdominal pressure (IAP). Carbon dioxide is insufflated into the peritoneal cavity at a rate of 4–6 litre /min to a pressure of 10–15 mm Hg. The pneumoperitoneum is maintained by a constant gas flow of 200–400 ml/min. The raised intra-abdominal pressure of the pneumoperitoneum, alteration in the patient's position and effects of carbon dioxide absorption cause changes in physiology, especially within the cardiovascular and respiratory systems. These changes, as well as direct effects of gas insufflation, may have significant effects on the patient, especially if they are elderly or have associated morbidity.

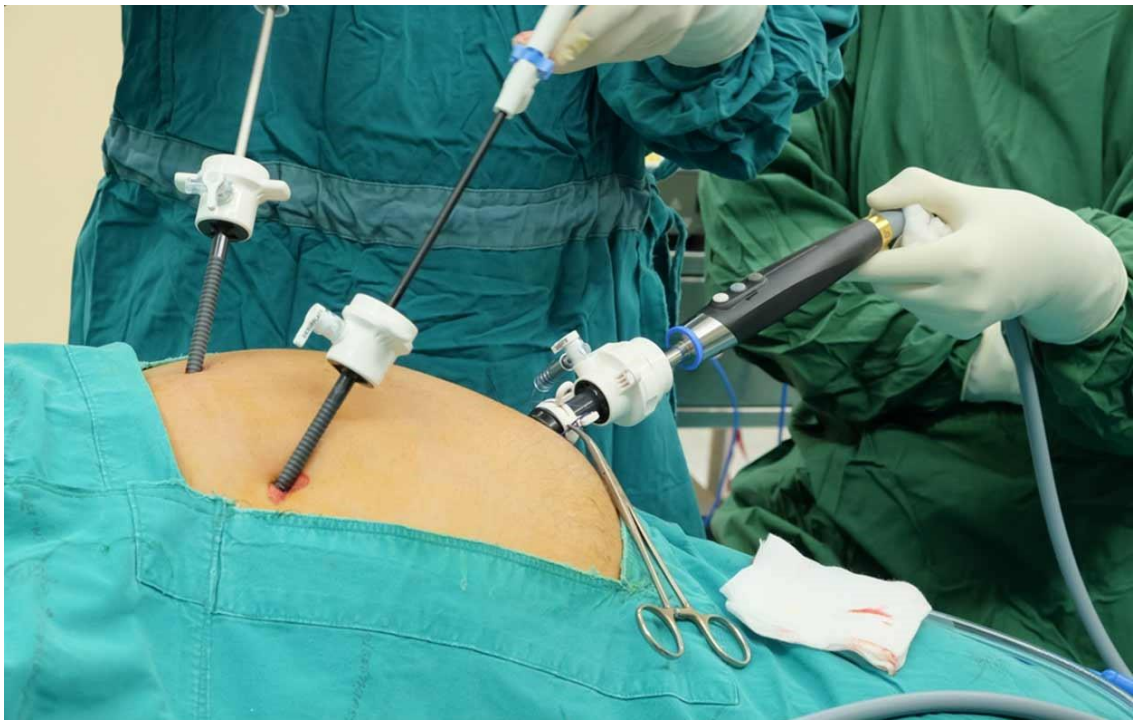


FIGURE 1: PNEUMOPERITONEUM

PHYSIOLOGICAL EFFECTS OF PNEUMOPERITONEUM: [22,23,24]

Cardiovascular effects:

Increased intraabdominal pressure affects venous return (VR), systemic vascular resistance (SVR) and myocardial function. Initially, owing to autotransfusion of pooled blood from the splanchnic circulation, there is an increase in the circulating blood volume, resulting in an increase in venous return and cardiac output. However, further increases in the intraabdominal pressure result in the compression of the inferior venacava, reduction in venous return and subsequent decrease in cardiac output. The SVR is increased because of direct effects of the intraabdominal pressure, but also because of an increase in the release of circulating catecholamines, especially epinephrine and norepinephrine. This change in systemic vascular resistance is generally greater than the reduction in cardiac output, maintaining or even increasing systemic blood pressure. The increasing systemic vascular resistance, systolic and

diastolic blood pressures, and tachycardia, result in a significant increase in myocardial workload. Consequently, myocardial ischaemia may result. Further increases in intraabdominal pressure may decrease cardiac output with a subsequent fall in blood pressure, an effect more pronounced in patients who are hypovolaemic or have cardiovascular disease.

Respiratory effects:

The supine position and general anaesthesia decrease functional residual capacity (FRC). Pneumoperitoneum and the Trendelenburg position cause cephalad shift of the diaphragm, further decreasing FRC, possibly to values less than closing volume; this causes airway collapse, atelectasis, ventilation–perfusion (V/Q) mismatch, potential hypoxaemia, and hypercarbia. There is an increase in airway resistance and reduction in compliance which potentiates the risk of barotrauma with positive pressure ventilation.

Renal effects:

Markedly increased intraabdominal pressure reduces renal function and urine output owing to an increase in renal vascular resistance and reduction in glomerular filtration rate. This is compounded by the reduction in cardiac output.

Gastrointestinal effects:

Increased intraabdominal pressure may cause regurgitation of gastric contents with associated risk of pulmonary aspiration. This is particularly significant in the obese patient.

Neurological effects:[24]

Carboperitoneum, raised intraabdominal pressure, and intrathoracic pressure, during laparoscopic surgery can modify cerebral hemodynamics. Establishment of pneumoperitoneum is known to produce a significant rise in intracranial pressure.

This increase in intracranial pressure during pneumoperitoneum is usually temporary, with the ICP normalising within 10 minutes of desufflation. The increase in intracranial pressure during laparoscopy, has been attributed mainly to the increase in venacaval pressure during intraabdominal insufflation and the subsequent engorgement of the cerebral veins within the rigid cranium. Patients subjected to laparoscopy also become mildly hypercapnic due to the absorption of CO_2 through the peritoneum and this causes intracranial arteriolar dilatation and increased cerebral perfusion. Therefore, intraoperative hypercapnia produces cerebral hypertension.

The concomitant Trendelenberg position further increases intracranial pressure during abdominal insufflation whereas the reverse Trendelenberg position does not reduce it sufficiently. The increased intracranial pressure during Trendelenberg position was mainly due to decreased venous return. The consequences of increased intraabdominal pressure on cerebral hemostasis and ICP are particularly relevant for patients affected with cranial trauma or other neuropathologies, and who might require examination by the laparoscopic technique. Lengthy laparoscopic procedures in the head down position performed in otherwise healthy patients do not significantly affect cerebral circulation. Nevertheless, this technique should be reconsidered in patients with associated neurological pathologies when the means for proper measurement of cerebral hemodynamics are not available.

Several studies reported that there was a significant increase in reports of post operative headache and nausea in patients who underwent laparoscopic procedures as compared to those who underwent open surgeries. This was suggested to be due to increase in intracranial pressure because of carboperitoneum. The headaches occurred in the immediate post operative period and were in hollow cranial location and slightly pulsatile. All cases resolved with conservative treatment consisting of bedrest

and oxygen therapy and did not delay discharge. The headaches may be related to the effect of plasma absorption of CO_2 breakdown products in the closed abdominal cavity after electrocautery.

To summarise, the effects of carboperitoneum and raised intraabdominal pressure on cerebral physiology, can be divided into two phases. One, an early mechanical phase, and two a late arterial or chemical phase. The rising ICP during early phase is due to elevated intrathoracic and intraabdominal pressures. Elevated intraabdominal pressure compresses the inferior venacava and reduces venous drainage from the central nervous system, and lumbar plexus thereby raising the CSF pressure. Raised intraabdominal pressure also causes cephalad displacement of diaphragm, thus increasing intrathoracic pressure. This leads to increased cardiac filling pressure and central venous pressure in the superior vena cava, which leads to a rise in the intracranial pressure. This concomitant increase in intracranial pressure and central venous pressure can be explained by the Monro-Kellie hypothesis that states that if one of the four compartments of the central nervous system (vascular, parenchymal, osseous, and cerebrospinal fluid) expands rapidly, there is insufficient time for other compartments to buffer those changes and the intracranial pressure raises. A late chemical phase is observed 10-15 minutes after carbon dioxide insufflation and is due to reflex vasodilation caused by rise in CO_2. Increase in intrathoracic pressure also leads to ventilation perfusion (V/Q) mismatch leading to elevated CO_2 level and decreased O_2 levels. In addition, there is peritoneal absorption of carbon dioxide. Both hypoxia and hypercapnia are potent cerebral vasodilators leading to rise in the intracranial pressure. Arterial CO_2 tension is the single most important factor controlling cerebral blood flow.

PHYSIOLOGICAL EFFECTS OF POSITIONING:[22,25]

Patient positioning depends on the operation, for example Trendelenburg position (head down) for gynaecological and lower abdominal procedures whereas Reverse Trendelenburg position (head up) for upper abdominal surgeries.

Trendelenburg (head down) position:

Initially the term trendelenberg position meant classical 45^0 head down position. Nowadays the term is used for any degree of head down position. The position shifts the blood into the central compartment. Because of gravity, the cerebral veins are not drained leading to raised intracranial and intraocular pressures. There is no evidence showing any adverse effect in an otherwise normal healthy individual, whereas for a patient with raised intracranial tension trendelenberg position is contraindicated. Trendelenberg position for a prolonged period may lead to edema of upper airway and face. In such cases, at the time of extubation care must be taken to prevent airway obstruction post-extubation by doing cuff leak test. In a surgery where the patient is placed in trendelenberg position with considerable amount of intraoperative intravenous fluid use, it is sensible to put the patient in head up position post-surgery so that fluid redistribution takes place.

The respiratory changes that occur with this position include a fall in pulmonary compliance, vital capacity, and the functional residual capacity. In a patient who is mechanically ventilated it may increase the peak airway pressure. Other respiratory effects include V/Q mismatch and greater risk of atelectasis. Endobronchial intubation, attributable to cephalad movement of the lungs and carina in relation to the fixed endotracheal tube, should be prevented. Cardiovascular effects include an initial increase in venous return with subsequent increase in cardiac output, but this causes compensatory vasodilatation with overall minimal effects on the

cardiovascular system in a patient with no cardiovascular illness. Increased venous return with Trendelenburg position may not be tolerated in patients with compromised myocardial compliance (hypertrophy and/or ischaemia).

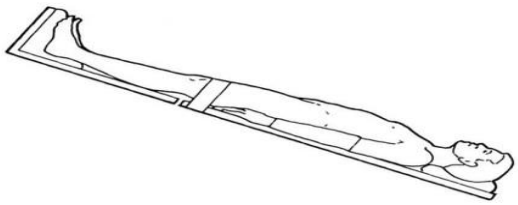


FIGURE 2: TRENDLENBERG POSITION

Reverse trendelenburg (head up) position:[22]

There are few respiratory effects in the reverse Trendelenburg position but more marked effects on the cardiovascular system. A decrease in venous return results in decreased cardiac output and therefore blood pressure. These effects are more marked in a patient who is hypovolaemic or having cardiovascular compromise.

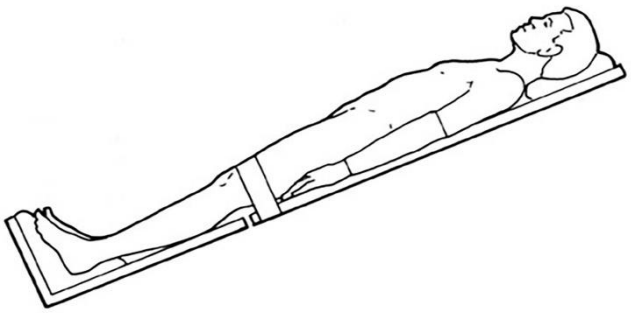


FIGURE 3: REVESE TRENDLENBERG POSITION

INTRACRANIAL PRESSURE AND MONITORING:[26,27,28]

INTRODUCTION

Intracranial pressure refers to the pressure within the cranial cavity and is influenced by the dynamics of cerebrospinal fluid, cerebral circulation, and intracranial abnormalities. Intracranial pressure is determined by the volume of intracranial contents and the cranial vault. The intracranial contents are composed of brain (80%), blood (10%), and CSF (10%) and are surrounded by a covering of duramater, encased in the semi-rigid and incompressible skull. Therefore, expansion of one of these components leads to a compensatory decrease in another to maintain the intracranial pressure. It is famously known as the Monro-Kellie doctrine.

Normally, intracranial pressure is up to 10–15 mmHg in a young adult in resting, supine position. However, it is not a static pressure and varies with arterial pulsations, respiration, and events such as coughing, sneezing, and straining. In an upright posture, the pressure is negative with an approximate mean of -10 mmHg. Although ICP values are less well-defined in children, normal values range between 1.5–6 mmHg in infants and 3–7 mmHg in older children. Intracranial pressure value may be sub atmospheric in new-born children.

PATHOPHYSIOLOGY OF RAISED INTRACRANIAL PRESSURE (ICP)

An abnormal increase in intracranial pressure is known as intracranial hypertension (ICH) and is typically defined as intracranial pressure exceeding 15–20 mmHg. Early identification of ICH is important as it decreases cerebral perfusion pressure (CPP) and can be stated by the simple relationship as given below:

CPP = Mean Arterial Pressure (MAP) – Intracranial Pressure (ICP)

Cerebral perfusion is the driving force that permits blood flow through the brain tissues. Hence, an increase in intracranial pressure or a decrease in mean arterial

pressure will reduce cerebral perfusion pressure, resulting in cerebral ischemia, neuronal injury and if untreated, brain herniation and neurologic death.The skull can be imagined as a rigid box containing the following components: brain tissue, cerebrospinal fluid, and blood (arterial and venous). The Monro–Kellie model of intracranial pressure states that for intracranial pressure to remain constant, the sum of the volumes of the components mentioned above should remain constant. Since brain tissue is assumed to be incompressible due to its high-water content, there must be a balance between the inflow and outflow of the intracranial fluids to keep intracranial pressure stable. CSF secretion must be equal to the absorption rate, and at the same time, the arterial cerebral blood flow has to equal the effluent venous drainage.

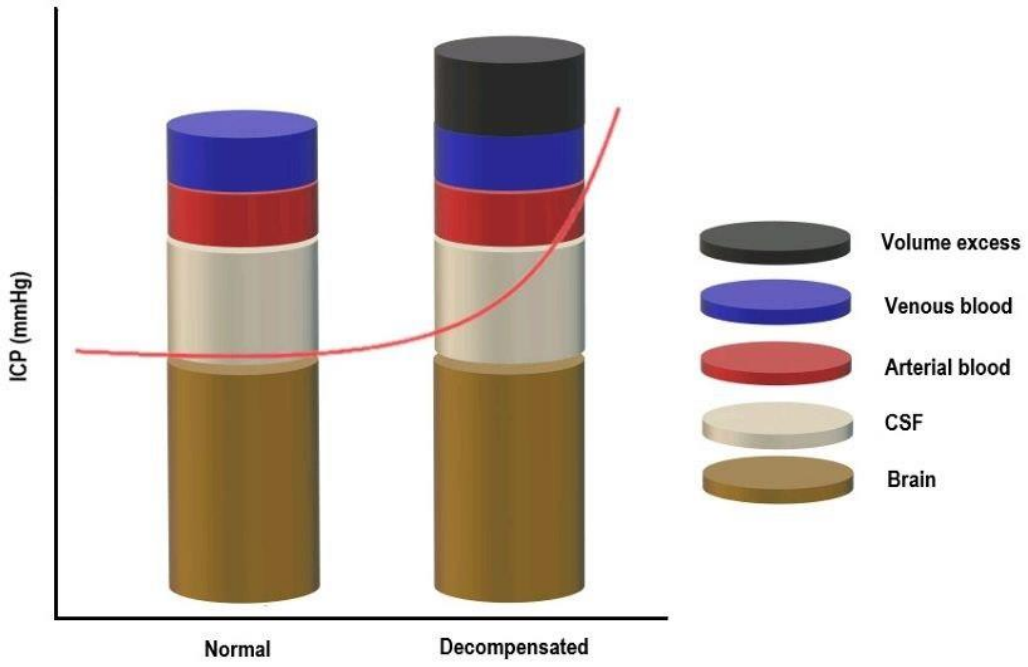


FIGURE 4: MONRE-KELLY DOCTRINE

Under normal conditions, the intracranial volume is constant. Maintaining a steady intracranial pressure depends on the volume of the intracranial compartments (brain + CSF + blood). An increase in one component will cause a compensatory decrease in one or both of the others. Raised intracranial pressure can result from any pathological condition increasing the volume of any of the three components or from the addition of a fourth component (e.g., intracranial hemorrhage, cerebral edema, or mass), overwhelming the compensatory mechanisms. Once the reserve is exhausted, the intracranial compliance will decrease, and slight elevations in the intracranial volume will lead to dramatic changes in intracranial pressure.

Cerebral blood flow is driven by cerebral perfusion pressure, which is defined as mean arterial pressure minus intracranial pressure (CPP = MAP - ICP).

Cerebrovascular autoregulation (CA) is tightly linked to cerebral perfusion pressure. It refers to the capacity of the cerebral circulation to alter the vascular arteriolar resistance to maintain a constant cerebral blood flow as mean arterial pressure (MAP, and thus CPP) varies. In healthy adults, cerebral autoregulation is normally operational across a wide range of mean arterial pressures, from 50 to 150 mm Hg. Beyond the limits of autoregulation, cerebral blood flow becomes pressure passive. On the other end of the equation, intracranial pressure elevations can compromise the cerebral perfusion pressure leading to secondary ischemic brain injury. In the face of high ICP, brain ischemia can be partially counteracted by increasing the mean arterial pressure through manipulation of the cardiac output and arterial pressure. Increased intracranial pressure can further compromise the brain parenchyma through herniation syndromes. Intracranial pressure fluctuates under physiologic conditions, including body posture (orthostatism vs. clinostatism), cardiorespiratory variations, electroencephalography activity, and changes of the

intrathoracic (ITP) and intra-abdominal pressure (IAP, if central venous pressure exceeds ICP). Intracranial pressure is referenced at the level of the foramen of Monro. Intracranial hypertension is considered as mild when it ranges from 20–30 mmHg and severe, when it exceeds 40 mmHg.

INTERPRETATION OF INTRACRANIAL PRESSURE DATA

Normal intracranial pressure waveform: The intracranial pressure waveform has a pulsatile quality at two different frequencies; one is synchronous with arterial pulse, related to the cardiac cycle (vascular wave), and another with respiration (respiratory wave). The vascular waves are caused by the pulsations of large intracranial vessels transmitted to the ventricular system by choroid plexus and brain parenchyma thereby producing oscillations of pressure in cerebrospinal fluid. The respiratory waves represent changes in intrathoracic pressure. The vascular wave has 3 upstrokes in one wave: (i) P1 (percussion wave), (ii) P2 (tidal wave) and, (iii) P3 (dicrotic wave) which are represented by arterial pulsation, intracranial compliance, and closure of aortic valve respectively. The dicrotic notch between P2 and P3 represents dicrotic notch of an arterial pressure waveform. Normally, the amplitude of the cardiac pulse is 1.1 mmHg and that of combined cardiac and respiratory components is approximately 3.3 mmHg. In normal intracranial pressure waveform P1 should have highest upstroke, P2 in between, and P3 should show lowest upstroke. A prominent P1 wave indicates the systolic blood pressure is too high and the ICP trace looks more like an arterial trace. If P2 is higher than P1, it indicates intracranial hemorrhage.

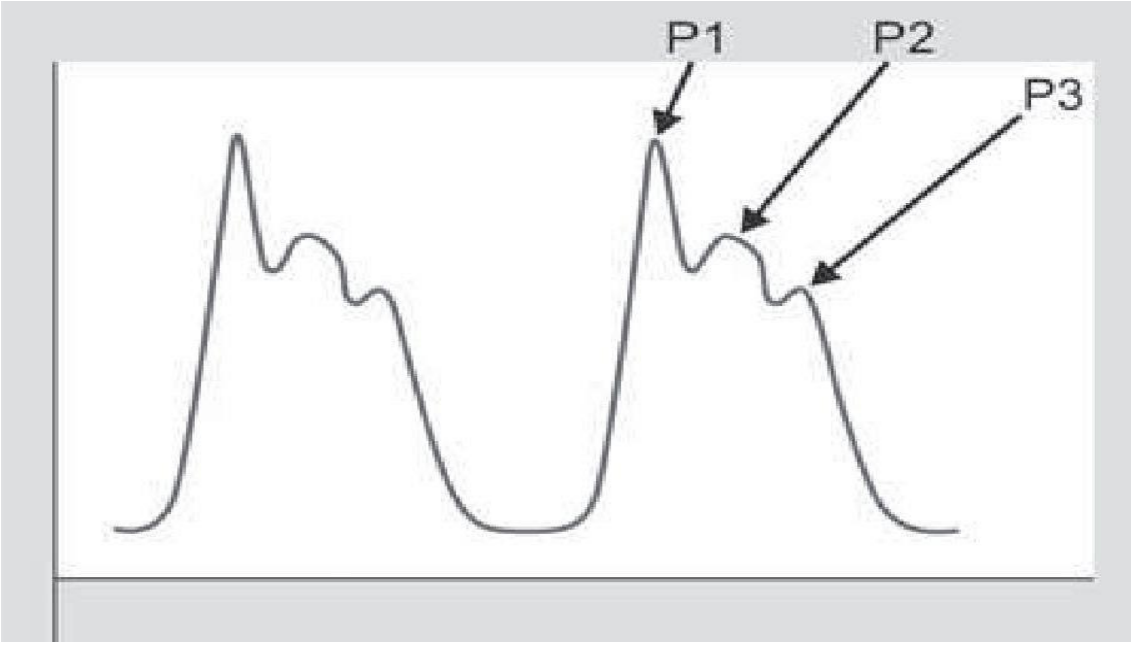


FIGURE 5: NORMAL ICP WAVEFORM

RATIONALE OF MONITORING

Measurement of intracranial pressure is of immense value in neurocritical care because clinical signs of raised intracranial pressure are not always reliable, as they may not be elicited in several cases, and may reflect only during later stages of cerebral compression. Intracranial pressure monitoring can be either used for establishing a diagnosis or as a guide for maintaining an optimal CPP. It also forms the basis of several interventions, medical and surgical, including the use of hyperosmolar agents, ventricular drainage, barbiturate coma, or decompressive craniectomy. The most widespread use of ICP monitoring is in the management of severe traumatic brain injury. However, no randomized clinical trial has established the superiority of routine intracranial pressure monitoring over standard neuroimaging and clinical assessment-based management protocols in severe brain injury.

INDICATIONS OF INTRACRANIAL PRESSURE MONITORING

There are several neurological conditions where monitoring is indicated:

1) Head Injury

2) Subarachnoid Hemorrhage

3) Brain Tumours

4) Benign Intracranial Hypertension

5) Hydrocephalus

CLINICAL FEATURES OF ELEVATED INTRACRANIAL PRESSURE

The three cardinal clinical features of raised intracranial pressure are headache, vomiting, and papilledema. Headache is described as throbbing type and is worsened by activities that increase ICP such as coughing, sneezing, or exertion. Classically, the headache is worse in the morning and has been attributed to a rise in ICP in the night owing to recumbent position; rise in arterial pressure of carbon dioxide during sleep caused by respiratory depression and possibly decreased CSF absorption in recumbency. Although papilledema is a reliable sign, it may take several days to develop. Vomiting, if present, is projectile in nature and like papilledema, it tends to be a late feature. Impairment of consciousness occurs when the intracranial pressure is remarkably high and is probably a consequence of caudad displacement of diencephalon and midbrain. Changes in blood pressure, pulse, and respiratory pattern are usually late signs of raised intracranial pressure, and these signs are related to brainstem distortion or ischemia.

METHODS OF INTRACRANIAL PRESSURE MONITORING

Invasive techniques:

• **Intraventricular monitoring**: Intraventricular fluid-filled catheter-transducer system is the "gold standard" for monitoring ICP. The lateral ventricle is cannulated by a frontal, occipital, parieto-occipital, or parasagittal coronal approach and the catheter is connected to a strain gauge pressure transducer through fluid-filled pressure tubing. The reference point for the external transducer is the foramen of Monro which corresponds to the external auditory meatus as the extracranial landmark. A stopcock can be attached to this system; hence, it is possible to drain the CSF therapeutically and also to instil drugs, dyes, or other compounds directly into the intraventricular space. The system can be used during transport or power-failure as electrical connection is not necessary, and pressure can be measured by fluid column (manometer). The catheter may get blocked, especially in presence of subarachnoid blood or CSF proteins. Antibiotic-coated catheters are also available to decrease the risk of infection. Injury to the basal ganglia has been reported during insertion of the catheter.

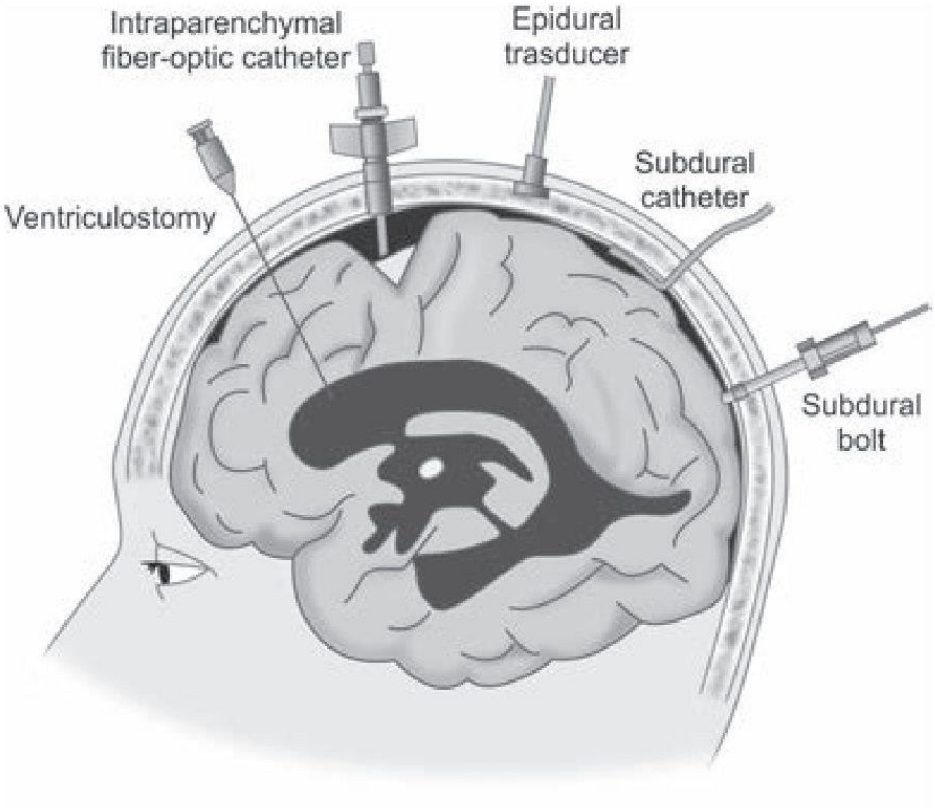


FIGURE 6: INVASIVE METHODS OF ICP MONITORING

• **Subarachnoid monitoring**: Under normal circumstances, subarachnoid pressure is virtually identical to intraventricular pressure. The prototype devices designed for insertion in the subarachnoid space are the subarachnoid catheter or bolt. There are two types of bolts: (i) "Leeds bolt," which has lateral openings and, (ii) "Richmond bolt," which has an end opening. A protruding tip is designed to enter the subarachnoid space and establish a fluid chamber that is contiguous with the subarachnoid space, pressure tubing, and the pressure transducer. Generally, the transducers have been piezoelectric or strain gauge types. More recently fibre-optic systems have been used. These systems are reusable, easily sterilized, and available in disposable forms. However, the lumen of hollow bolt may be occluded by haemorrhage or brain tissue. The attractiveness of the bolt system lies in the

simplicity of the concept and the ability to leave cerebral parenchyma untouched, even though studies have found that the subarachnoid catheter is often not in the correct position.

FIGURE 7: RICHMOND BOLT

• **Epidural monitoring**: The epidural monitor is perhaps the least well-understood invasive ICP monitoring device. The premise of epidural monitors is that the dura mater functions as the deformable membrane and epidural pressure can be monitored by the placement of transducer directly in contact with its surface. Placement of transducer within the cranial vault minimizes the problem of obstruction, leaks, and infection. Various devices used are in clinical practice includes "Ladd, Gaeltec and Camino monitor." This technique looks attractive because of being least invasive and reduced risk of infection and hemorrhage. However, epidural monitoring is inaccurate because the stiff, inelastic dura prevents the transmission of ICP from the intracranial cavity to the sensor system.

• **Subdural monitoring**: The subdural pressure is virtually identical to the subarachnoid and intraventricular pressures. Because of its accessibility, the subdural space is particularly useful for monitoring ICP after craniotomy by leaving an infant feeding tube (5–8 F) or other catheter in the subdural space. A subdural catheter entails the risk of waveform dampening. Underestimation of ICP is frequent (50–90%) when intracranial pressure is high and when the subdural catheter-external transducer is used. Subdural air can distort fiberoptic subdural catheter readings.

• **Intraparenchymal monitoring**: Currently, two types of intraparenchymal devices are available: (i) fiberoptic and (ii) wire. Fiberoptic catheter is made up of thin fiberoptic cables with a pressure transducer at the tip that requires a dedicated microprocessor to interpret the signal. It is expensive, nonflexible, and liable to breakage. The wire system contains a micro transducer at the tip of a flexible wire. In both types, the tip is introduced into parenchyma through a 4 mm hallow screw inserted into the skull. Infection and hemorrhage rates are quite low. However, they do not allow CSF drainage. The accuracy of reading is optimal, second only to intraventricular monitoring. The devices need to be calibrated once before insertion regardless of head level used.

• **Lumbar subarachnoid monitoring**: Indwelling lumbar subarachnoid catheters are placed mainly for use as CSF drainage device after surgery, to aid in the prevention of CSF leaks, or as a method of achieving brain relaxation. Measurement of pressure is used in these contexts chiefly to confirm that the device is functioning in the desired fashion. However, in circumstances where herniation is not a risk (meningitis, communicating hydrocephalus etc.) lumbar CSF pressure measurement via percutaneous lumbar puncture continues to be a method of ICP estimation. However, long-term monitoring at this site is seldom used.

• **Micro transducer-tipped intracranial pressure monitoring devices:** They may be divided as fiberoptic devices (e.g., Camino catheter), strain gauge devices (e.g., Codman microsensor), and pneumatic sensors (Spiegelberg transducers). In the current practice, "Camino monitor" has gained a wide usage allowing intraparenchymal pressure monitoring and is equally suitable for intraventricular use. Such devices have an excellent accuracy in their measurements and a low zero drift over a prolonged period. These devices use a monitor that incorporates both tunnelled and bolted advanced monitoring technologies allowing versatility in CSF draining as well as monitoring the patient. Mean pressure is then displayed digitally on the monitor. Camino and Codman devices do not need to have a hydrostatic zero level, as normal ventricular catheters do, because the transducer is in the tip and, there is no concern about the level of the transducer. It allows for continuous measurement, and it gives accurate pressure reading and allows for the analysis of waveform in the compartment.

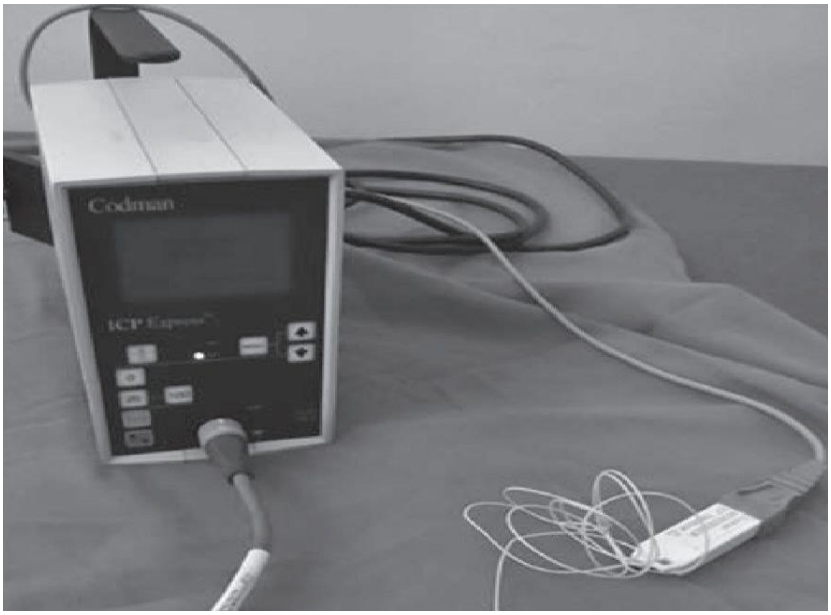


FIGURE 8: CODMAN DEVICE

Non-invasive techniques :

• **Palpation of fontanelle**: Palpation of the patent fontanelle of the infants has long been used clinically to estimate intracranial pressure. Fiberoptic pneumatic sensor (Ladd) placed directly on the fontanelle gives a reasonable correlation between fontanelle pressure and intraventricular pressure. Standard strain gauge transducers have been connected to the fontanelle through a saline-filled chamber sealed to the infant's scalp. They effectively measure the pulsation of the fontanelle. The primary disadvantage of the technique is that the transducer must be placed precisely; it must be perpendicular and coplanar to the fontanelle and underlying dura. The application force must be controlled and constant. The ICP readings increase linearly with application force.

• **Transcranial Doppler:** Transcranial doppler (TcD) allows insonation of basal cerebral vessels through the skull to assess flow velocity patterns. It is a bedside examination and many critical care centres routinely use this monitor. Transcranial doppler demonstrates characteristic changes with raised intracranial presure as it begins to attenuate cerebral perfusion pressure. The pulsatility index represents the relationship between systolic flow (influenced by blood pressure) and diastolic flow (influenced by cerebrovascular resistance, mainly ICP), and provides TcD correlate of ICP. At the extreme end of the spectrum, raised intracranial pressure can lead to cerebral circulatory arrest and brain death. Transcranial Doppler can provide objective verification of cerebral circulatory arrest. Several TcD based methods have been described to estimate cerebral perfusion pressure, which in turn can be used to estimate intracranial pressure.

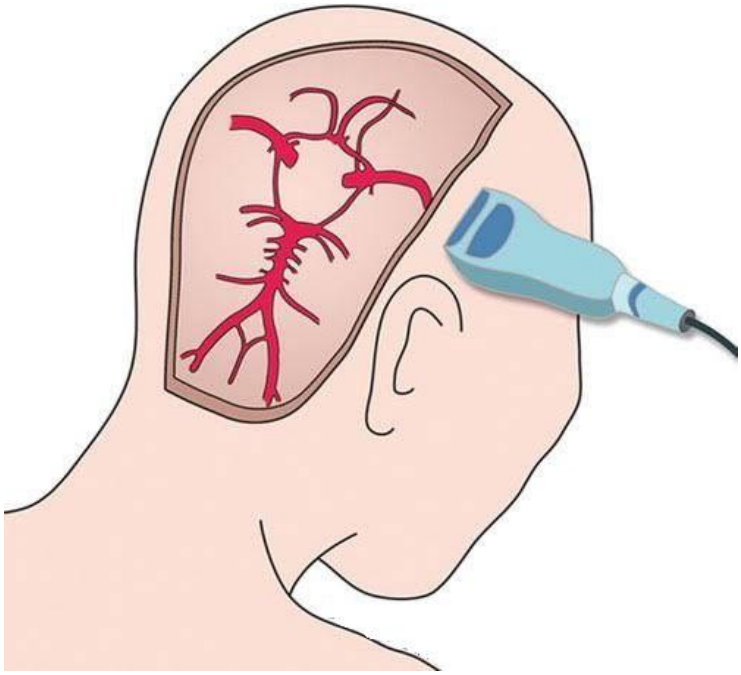


FIGURE 9: TRANSCRANIAL DOPPLER

• **Ultrasonographic measurement of optic nerve sheath diameter:** It correlates with direct measurement of intracranial pressure. The optic nerve is a part of the central nervous system and the space between the optic nerve and its sheath is a continuation of the subarachnoid space, whose pressure is equal to ICP. When intracranial pressure rises, the diameter of the optic sheath also increases, which can be measured using trans-ocular ultrasound. This method has the potential as a screening test for elevated intracranial tension in traumatic brain injury even though the correlation of optic nerve sheath diameter with intraventricular pressure monitoring has not been widely established. In general, multiple studies support the correlation between ONSD and ICP.

The problems of this technique include inter and intra observer variation and the lack of a uniform cut off value of optic nerve sheath diameter for predicting intracranial pressure, ranging from 4.8 to 6.0 mm in different studies. Also, its

measurement may be unreliable in orbital and optic nerve pathologies, sarcoidosis, Grave's disease, and orbital inflammation.

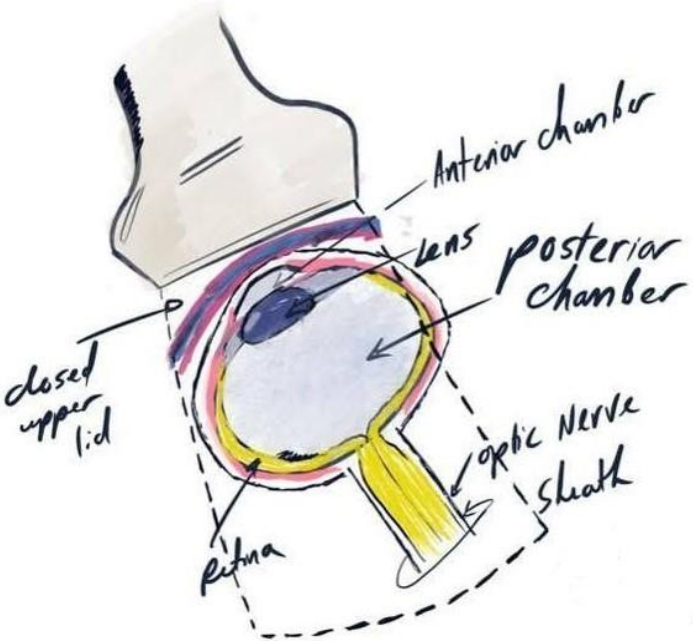


FIGURE 10: ULTRASOUND OF EYE DIAGRAM

• **Tissue resonance analysis:** When the heart beats, various compartments of the brain exhibit characteristic vibration and mechanical resonant responses that radiate through the organs and tissue of the body. A small portable computerized tissue resonance analysis (TRA) device has been developed to obtain qualitative and quantitative monitoring of intracranial pressure in a non-invasive manner. The function of the device is based on the analysis of the relationship between frequencies produced by reflected ultrasound signal from the third ventricle. In a preliminary clinical trial, there was a highly significant correlation between standard invasive methods and TRA.

• **Tympanic membrane displacement:** This method is broadly based on the principle that raised ICP affects the acoustic reflex, which is the reflex contraction of the stapedius and tensor tympani muscles in response to sound. The cochlear aqueduct communicates the CSF with the perilymph; any increase in intracranial pressure is directly transmitted to stapes footplate, which alters the direction and magnitude of its displacement when a sound stimulus is given. Although numerous studies demonstrate a strong linear relationship between tympanic membrane displacement and invasive methods, its utility in estimating actual ICP values is questionable. Nevertheless, this technique is promising in detecting serial changes in intracranial pressure over a period of several days.

• **Serial CT scan:** Increased intracranial pressure is associated with CT scans findings such as abnormal or compressed cisterns, cerebral edema, loss of grey-white differentiation, loss of normal gyri and sulci pattern, and midline shift. Associated intracranial pathology such as intracranial bleed, mass lesions, and hydrocephalus can also be simultaneously detected. However, problems of logistics and radiation hazards make repetitive CT scans difficult for real-time ICP estimation.

The disadvantages and advantages for each system suggest that the ideal system will be different in different circumstances. However, when cost, overall utility, the ability to rezero and calibrate, and flexibility of use are considered, the external piezoelectric transducer connected to one of the intracranial compartments through saline-filled tubing is the most useful. Fiberoptic and miniature piezoelectric systems are the only practical systems for monitoring intraparenchymal pressure, although questions exist, about the interpretation of tissue pressure under pathological conditions. Epidural monitors are less accurate and require experience for their use. They are most useful for monitoring patients with coagulopathy. Newer, non-invasive techniques for

continuous brain monitoring like transcutaneous oximetry, Transcranial doppler, assessment of CPP, and optic nerve sheath diameter will provide new impetus for intracranial pressure monitoring in the future.

ULTRASONOGRAPHY: [29,30,31]

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

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

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

TRANSDUCER:

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

It comprises 5 major components:

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

Linear Transducer:

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

- ❖ Measuring body fat thickness,
- ❖ Ultrasonic velocity change imaging.

FIGURE 11: LINEAR USG PROBE

Curvilinear Transducer:

- The Piezoelectric crystals – curvilinear arrangement.
- They produce convex ultrasound beam.
- Used to image deeper tissues.
- As depth of imaging increases, image resolution decreases.
- Footprint is wide with central frequency being, 2.5 – 7.5MHz for 2D imaging and 3.5 – 6.5MHz for 3D imaging.

- Applications:
  - ❖ Abdominal examinations,
  - ❖ Transvaginal and transrectal examinations,
  - ❖ Diagnosis of' organs

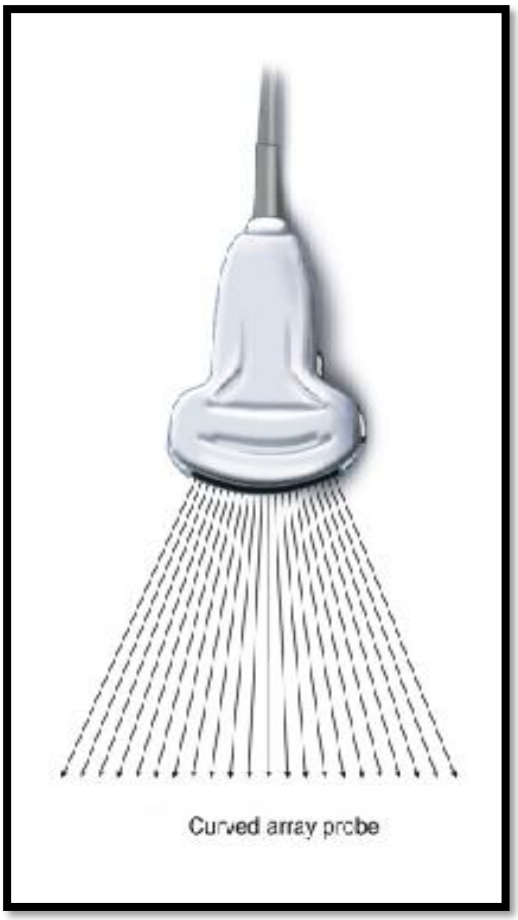


FIGURE 12: CURVILINEAR USG PROBE

MODES OF IMAGING :

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

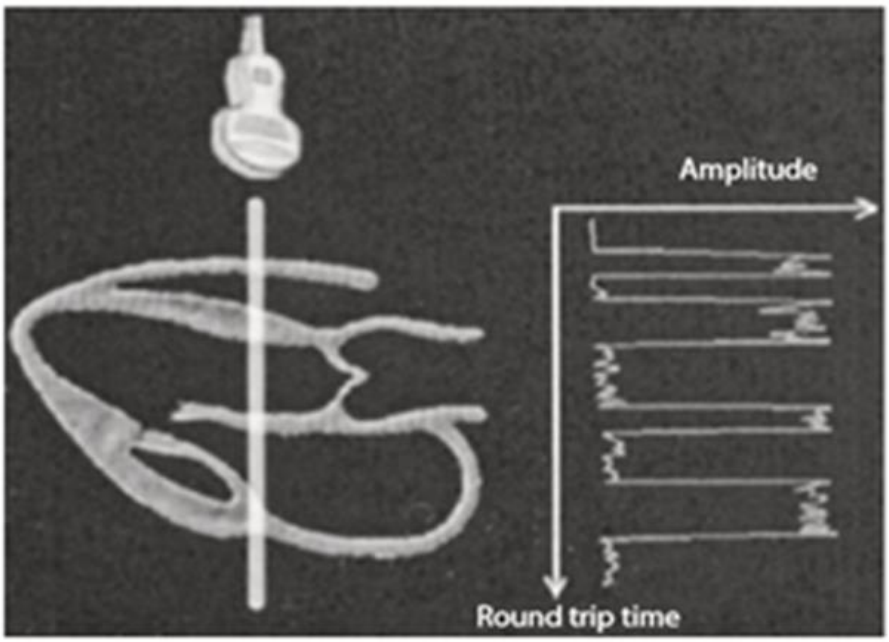


FIGURE 13: A MODE SCANNING

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

emitted. When all the emitted waves reach the transducer back, the 2D ultrasound image (B mode) is formed.

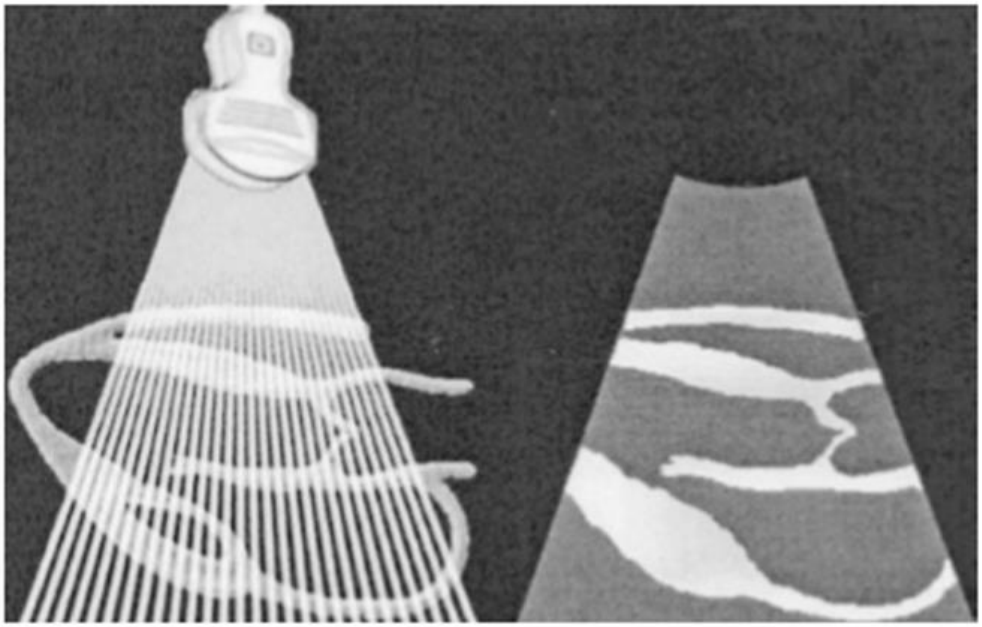


FIGURE 14: B MODE SCANNING

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

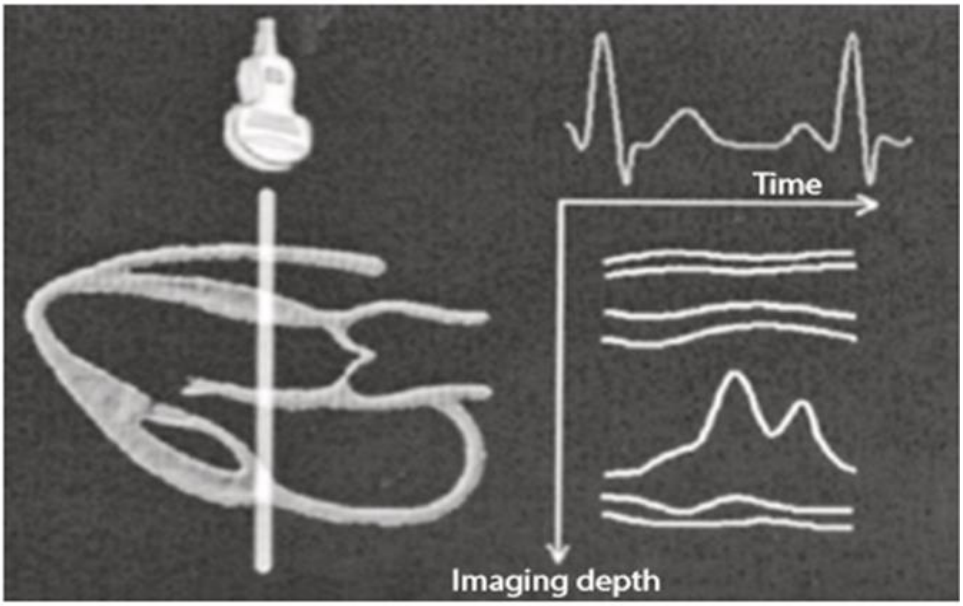


FIGURE 15: M MODE SCANNING

ANATOMY OF OPTIC NERVE:[32,18,27]

The optic nerve is the second cranial nerve. It is a purely sensory nerve that conveys visual information from the eye to the brain. The nerve arises from the back of the globe exiting the orbit via the optic canal. It joins the contralateral optic nerve at the optic chiasm where medial fibers decussate before continuing as the optic tracts.

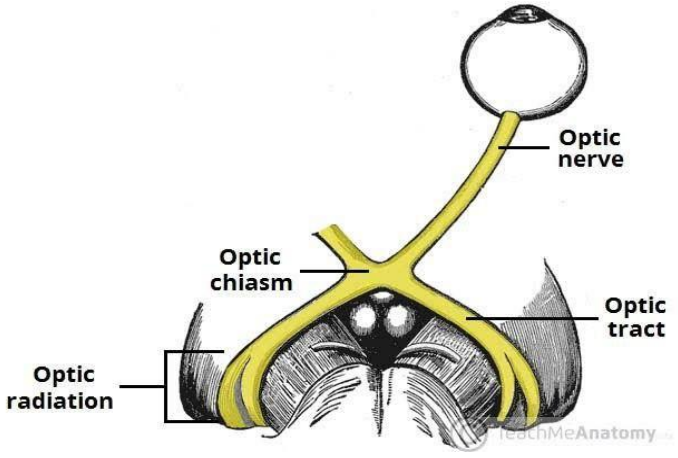


FIGURE 16: OPTIC CHIASM

The cells of origin consist of the ganglion cells of the retina with the main central connections consisting of the lateral geniculate nucleus of the thalamus, and the pretectal area of the midbrain. Similar to the olfactory nerve, the optic nerve is really an extension of the central nervous system. It is not surrounded by Schwann cells with the first sensory bipolar cell body located peripherally in the retina. Their central processes synapse on ganglion cells on the vitreous surface of the retina and their central processes pass via the optic disc out of the globe and form the optic nerve proper.

The optic nerve runs from the eyeball to the chiasm and can be divided into four parts, that is, an intraocular part (1 mm long), intra-orbital part (30 mm long), intracanalicular part (6-10 mm long), and intracranial part (10-16 mm long).

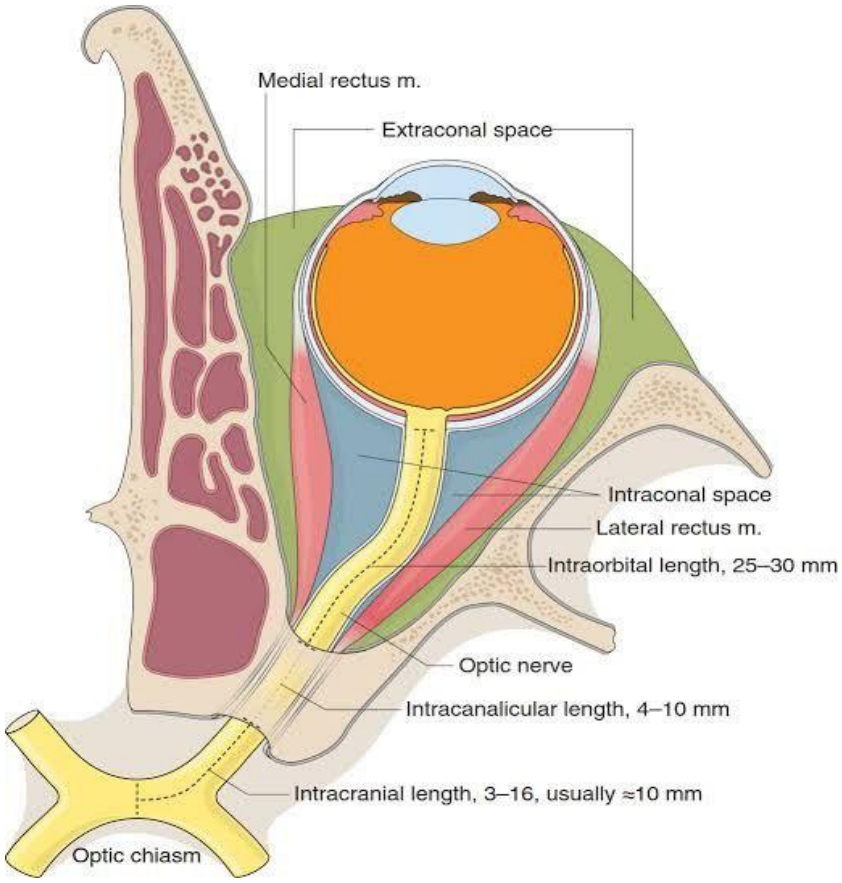


FIGURE 17: COURSE OF OPTIC NERVE

Nerve fibers originate from the retinal ganglion cells and join at the optic disc, which is commonly referred to as “the blind spot.” From here, the bundled unmyelinated optic nerve fibers run approximately 1mm through the globe before penetrating the sclera through the lamina cribrosa. Once the optic nerve enters the intra-orbital space, it is surrounded by the optic nerve sheath. Besides the optic nerve and its sheath, the region immediately behind the globe also contains extraocular muscles and fat tissue.

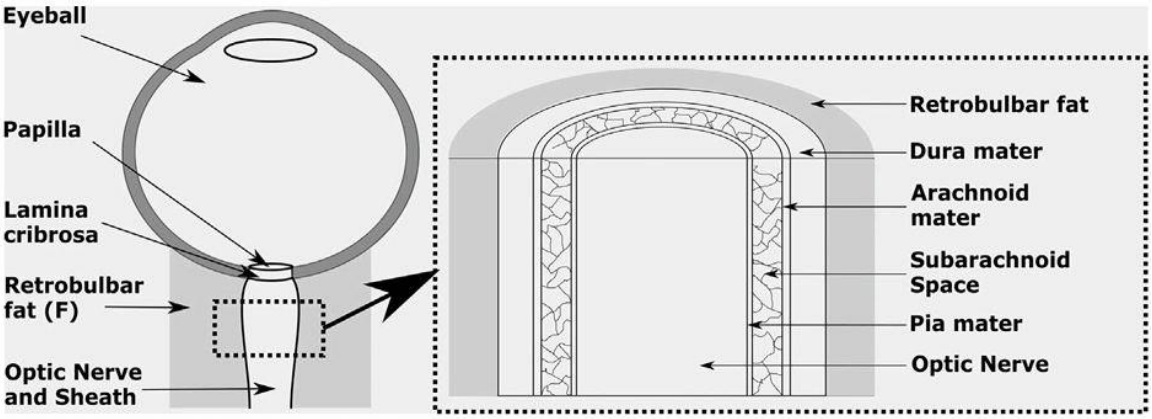


FIGURE 18: OPTIC NERVE SHEMATIC REPRESENTATION

The optic nerve itself has a diameter of approximately 3 mm, whereas the optic nerve sheath has a thickness of approximately 1 mm. From in to out, the sheath consists of the pia mater, the subarachnoid space, the arachnoid mater, and the dura mater. The pia mater and the arachnoid mater have a thickness of 0.09-0.15 mm, whereas the subarachnoid space and the dura have a thickness of 0.1-0.29 and 0.3-0.5 mm respectively.

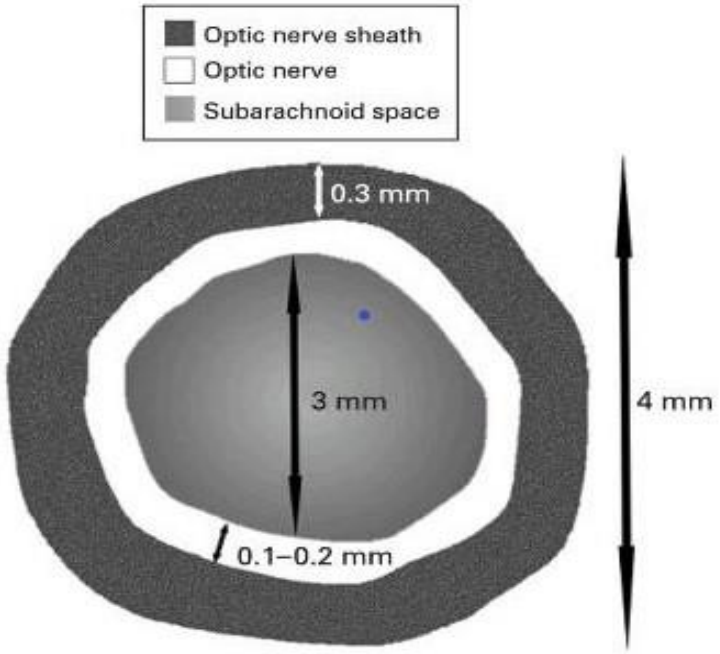


FIGURE 19: TRANSVERSE SECTION OF OPTIC NERVE AND SHEATH

The subarachnoid space features a complex structure formed by arachnoidal trabeculae, septa, and pillars immersed in the cerebral spinal fluid. The composition of these structures within the subarachnoid space changes along the nerve. The anterior part of the subarachnoid space mainly contains trabeculae, which are 5–7 μm in diameter. The midsection of the sheath displays both septa that divide this space into small communicating chambers, as well as pillars with a diameter of 10–30 μm. In the posterior part, where the sheath crosses the optic canal, both pillars and trabeculae are present.

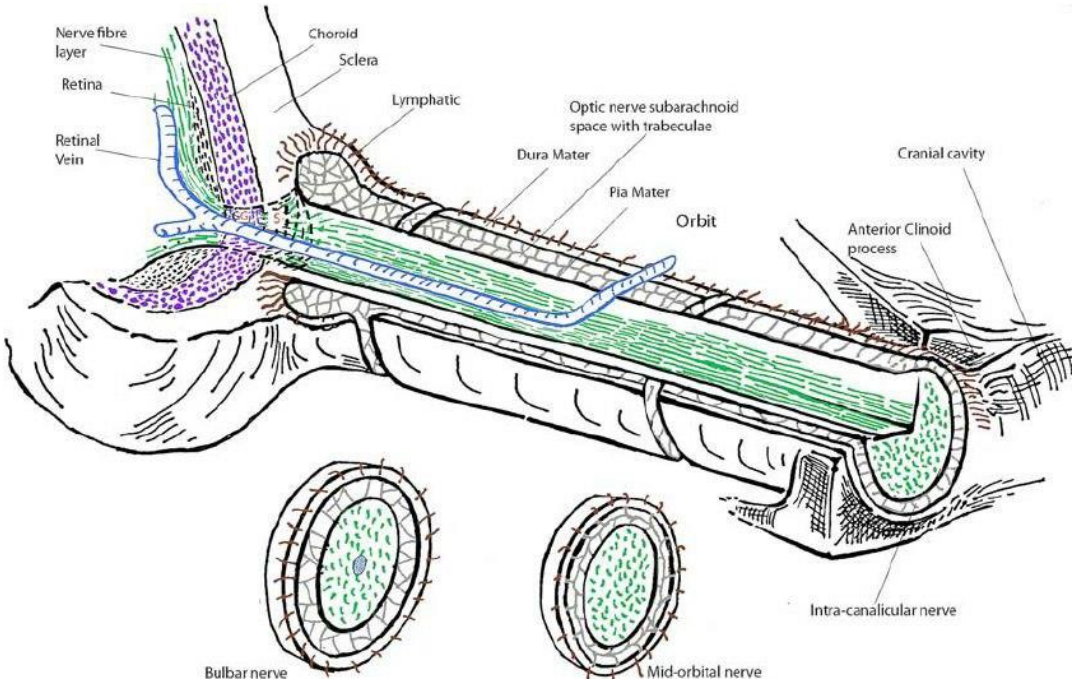


FIGURE 20: TRABECULAE AROUND OPTIC NERVE

Under normal conditions, perioptic subarachnoid space holds approximately 0.1–0.2 mL of cerebrospinal fluid. The perioptic subarachnoid space is a prolongation of the intracranial subarachnoid space, specifically, the chiasmal cistern. It has been hypothesized that the perioptic cerebrospinal fluid slowly percolates toward the bulbar portion of the nerve and that reversal flow occurs with eye movements squeezing the retrobulbar optic nerve sheath (ONS).

As the optic nerve sheath is distensible, ONSD changes rapidly with changing cerebrospinal fluid pressure. The optic nerve sheath diameter is constant as long as the intracranial pressure remains within normal ranges. When intracranial pressure rises, maximum optic nerve sheath diameter fluctuations occur in the anterior subarachnoid compartment, 3 mm behind the globe, rather than in the posterior perineural one. It has been suggested that this non-uniform enlargement may be the result of the

asymmetrical distribution of the arachnoidal trabeculae, with lower density in the retrobulbar optic nerve sheath. Moreover, the anterior compartment of the optic nerve sheath is the thinnest of the entire segment and, therefore, the most distensible.

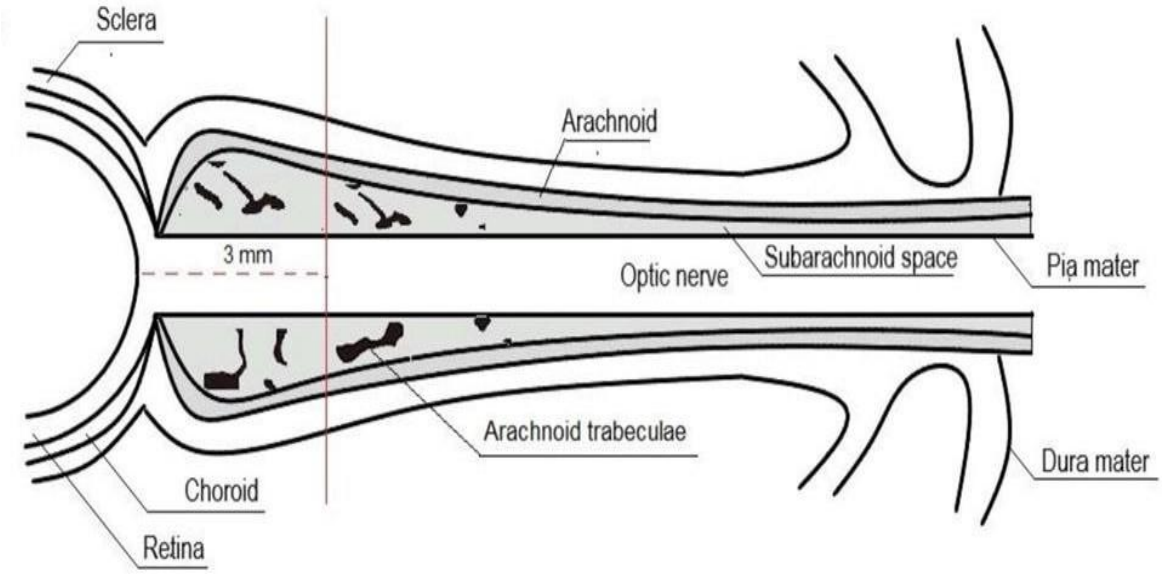


FIGURE 21: LONGITUDINAL SECTION OF OPTIC NERVE

OCULAR ULTRASOUND AND ONSD MEASUREMENT:[33,34,35]

The eye's superficial location and fluid-filled constitution are ideal for bedside diagnostic ultrasound evaluation. The well-defined borders of the globe and deeper ocular structures, including the optic nerve, retinal artery, and retinal vein, can be easily imaged with ultrasound. Although the use of ocular ultrasound has appeared in ophthalmology literature since the late 1950s, we have only begun to appreciate the diagnostic potential of point-of-care ocular ultrasound over the past decade. Minimal training is required to acquire the skills to perform precise and accurate point-of-care ultrasound examinations of the eye for specific findings. Bedside ultrasound of the eye can provide valuable diagnostic information, especially when physical examination is limited by bright lighting, facial swelling, or pain due to trauma.

Ocular ultrasound allows rapid assessment for potentially vision-*threatening* conditions when evaluation by an ophthalmologist or with computerized tomography (CT) or magnetic resonance imaging (MRI) may be unavailable or delayed. Furthermore, ocular ultrasound enables providers to evaluate the posterior chamber of the eye when direct visualization through the lens is limited by hyphema, hypopyon, or cataracts. Noninvasive assessment for elevated intracranial pressure can also be performed using ocular ultrasound.

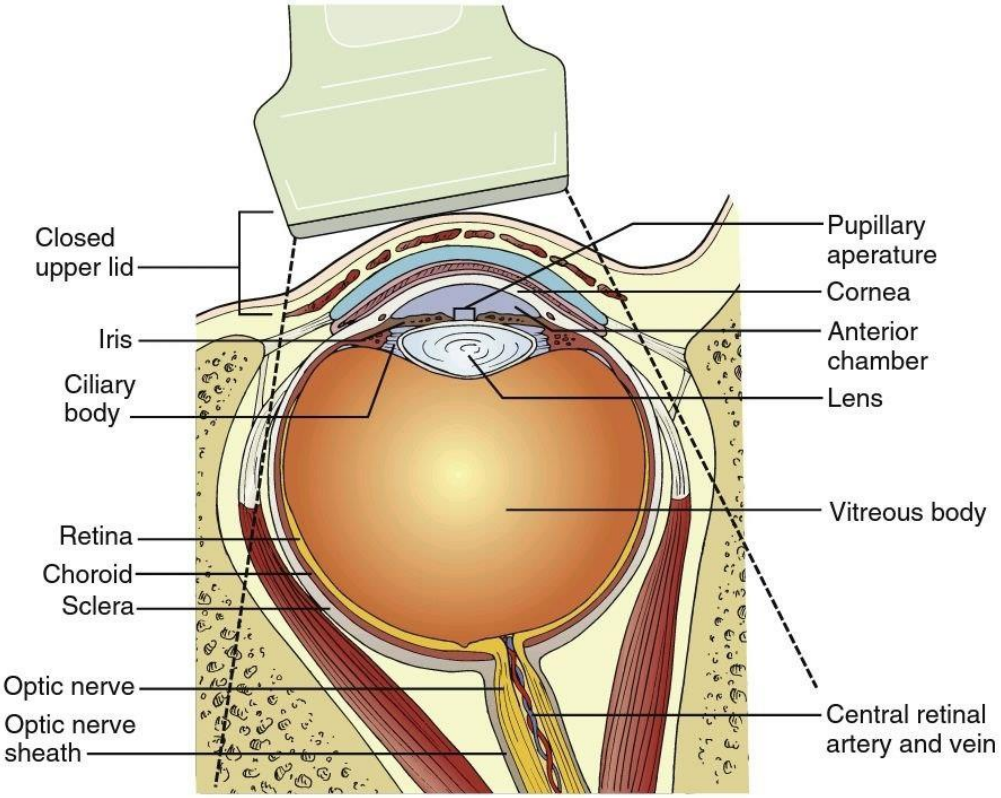


FIGURE 22: TECHNIQUE OF OCULAR ULTRASOUND

The five primary indications to perform an ocular ultrasound exam are:

□ Loss of vision (partial or complete)

□ Ocular trauma

□ Atraumatic eye pain

□ Intraocular foreign body

□ Elevated intracranial pressure

NORMAL SONO ANATOMY OF EYE :

The eye normally appears as a circular, well circumscribed, hypoechoic structure on ultrasound. The human eye is 24–25 mm in anteroposterior diameter, with minimal variation from person to person. The cornea appears as a thin, arch-shaped, hyperechoic layer parallel to the overlying eyelid and is contiguous with the sclera. The anterior chamber lies beneath the cornea and is filled with aqueous humor, thus appearing anechoic by ultrasound. The iris and anterior reflection of the lens constitute the posterior wall of the anterior chamber and appear as a hyperechoic line that abuts the pupillary aperture.The lens appears as a biconvex structure with distinct anterior and posterior borders and an anechoic center. Posterior to the lens is a large, anechoic space that is the vitreous body. In younger patients, the vitreous body appears black (anechoic), but in older patients, small, low-intensity echoes are scattered in the vitreous body (“floaters”) due to vitreous syneresis, or liquefaction of vitreous gel. The retina, choroid, and sclera form the posterior border of the globe, and these layers cannot be normally differentiated by ultrasound, except when pathologic findings such as retinal detachment are present.

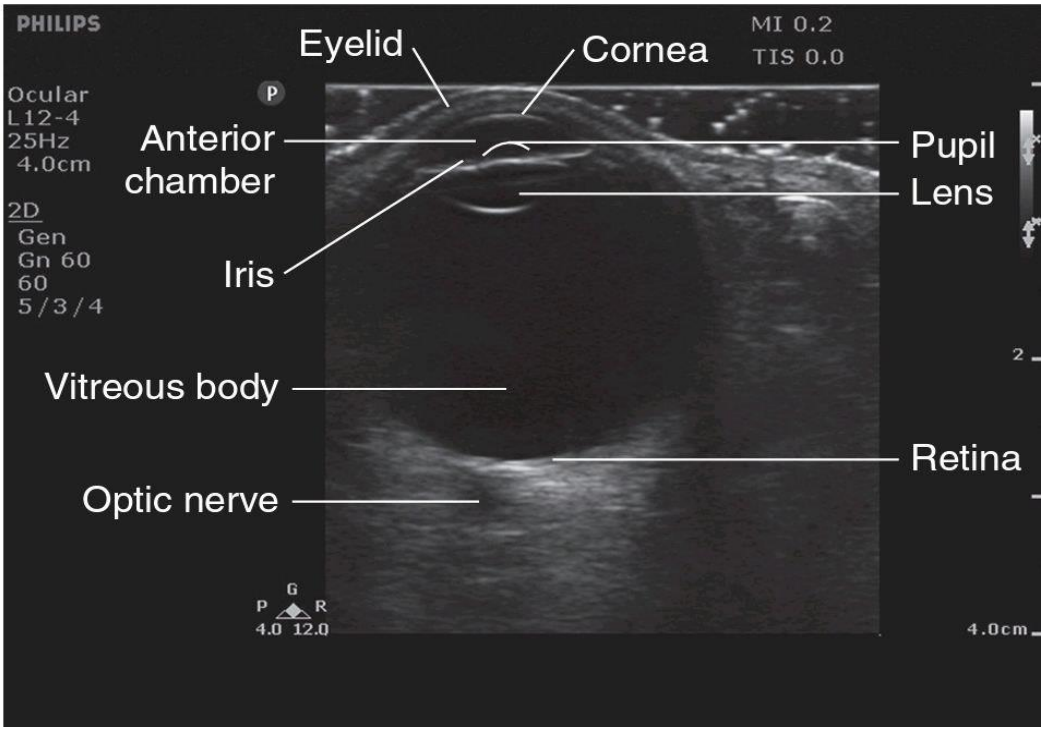


FIGURE 23: SONOANATOMY OF EYE

Posterior to the globe, the optic nerve and surrounding echogenic retro-orbital fat can be visualized. The optic nerve extends posteriorly and appears as an echogenic, linear structure perpendicular to the retina. A hyperechoic sheath surrounds the optic nerve. The optic nerve enters the eye slightly inferior and medial to the posterior pole of the globe. With subtle adjustment of the transducer angle, the optic nerve can be visualized longitudinally in the center of the screen. The central retinal artery and vein are within the center of the optic nerve and can be identified using color flow doppler over the distal optic nerve. The central artery and vein can be distinguished from one another by evaluating the waveforms using pulsed-wave Doppler. In both transverse and sagittal imaging planes, dense orbital bones create acoustic shadows that form the lateral borders of the globe.

IMAGE ACQUISITION :

Because the eye is superficial and requires high-resolution images to be evaluated, a highfrequency linear array transducer (7.5 MHz or greater) is used. Ophthalmologists often use transducers with higher-than-average frequencies (20–50 MHz) to maximize resolution, but these specialized transducers are not available with most portable ultrasound machines.

A two-dimensional (B-mode) ultrasound mode should be selected, and most ultrasound machines include an “ocular” preset. Optimizing near-field gain settings should be

performed. The patient should be positioned lying supine. The head of the bed may be elevated if the patient cannot tolerate lying completely flat.The exam is performed with the patient's eyelids closed. As with any ultrasound application, an acoustic coupling medium, usually water-soluble ultrasound gel, is used to eliminate the air interface between the transducer and skin. A copious amount of ultrasound gel should cover the entire eyelid to allow adequate imaging, with the transducer placed on the gel without applying any pressure to the eye. Chilling the ultrasound gel results in increased viscosity and allows the gel to stack easily.

Ultrasound gel is safe if it comes into contact with the eye, but it is recommended to use a transparent film dressing, such as a Tegaderm, over the eyelid to prevent contamination of the conjunctiva. Also, a transparent film may improve patient comfort and should be carefully removed without pulling eyebrow hair or eyelashes.

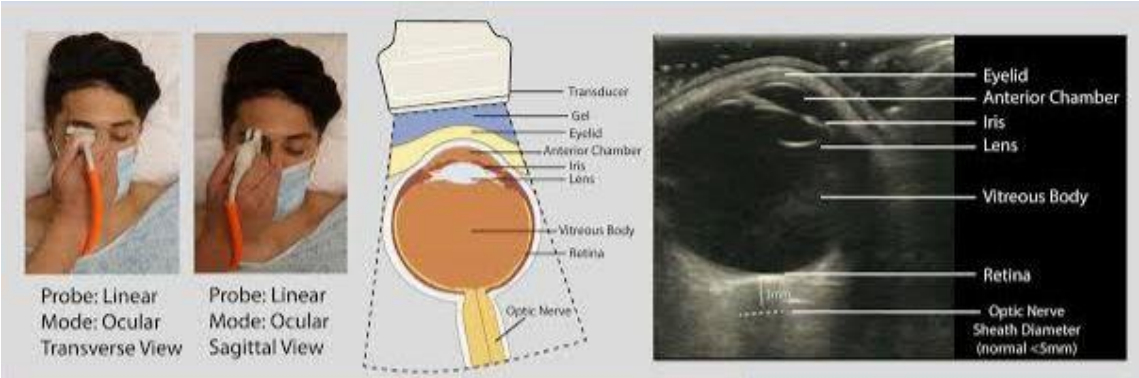


FIGURE 24: PROBE ORIENTATION FOR ONSD

While standing to the patient's side, begin scanning in a transverse plane by placing the transducer across the eyelid with the transducer marker pointing to the patient's right. The provider's wrist can be stabilized against the patient's zygomatic arch or nose bridge to steady the image. Instruct the patient to look straight ahead, and identify the cornea, iris, lens, vitreous body, retina, and optic nerve. The transducer may need to be positioned slightly laterally and angled inferomedially to capture a true longitudinal view of the eye, including the optic nerve. Adjust the depth of the image to visualize 1–2 cm beyond the entrance of the optic nerve into the globe. Tilt or fan the transducer systematically to thoroughly visualize the entire eye throughout the globe. Return to the initial mid-eye image and, while holding the transducer steady, ask the patient to slowly look in all four directions and evaluate the eye for any abnormalities. Objects that disappear as the eye is moved are most likely artifacts, rather than true pathology. After imaging in a transverse plane, turn the transducer 90 degrees to a sagittal plane with the transducer marker pointing toward the patient's head. Obtain a mid-eye view including the cornea, iris, lens, vitreous body, retina, and optic nerve. Repeatthe process of tilting or fanning the transducer while having the patient maintain a static gaze. Scan the entire orbit from its medial to lateral edges, noting any abnormalities and correlating findings with those seen on transverse

images. After returning to the initial mid-eye view, hold the transducer steady and have the patient slowly look in all four directions. After imaging the entire globe, the ONSD should be measured from a mid-eye transverse view, and the central retinal artery and vein can be evaluated with color flow and pulsed-wave Doppler. Repeat the same procedure to evaluate the contralateral eye. It may be helpful to scan the unaffected eye first and compare the appearance of the normal eye to any abnormal findings in the affected eye.

OPTIC NERVE SHEATH DIAMETER :

The optic nerve is considered part of the central nervous system, as opposed to the peripheral nervous system, because it is an extension of the brain. The optic nerve sheath encircles the optic nerve and is composed of three layers of meninges.

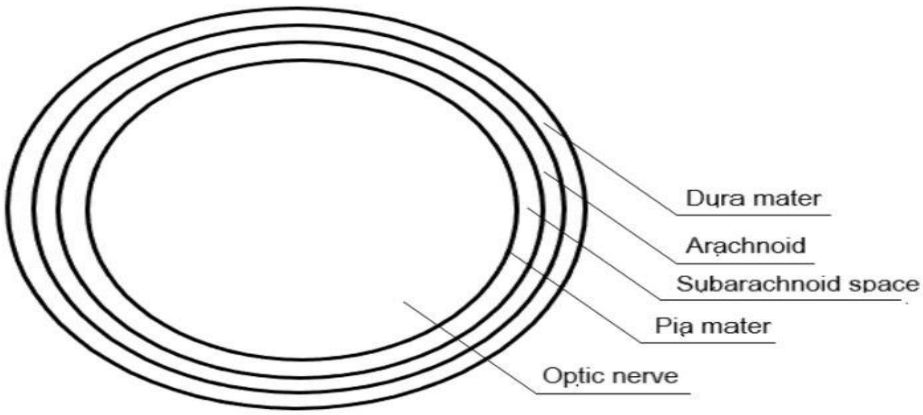


FIGURE 25: LAYERS OF OPTIC NERVE SHEATH

The subarachnoid space surrounding the optic nerve sheath is contiguous with that of the brain and spinal cord, and the same cerebrospinal fluid circulates in the subarachnoid space around the brain, spinal cord, and optic nerve. Increases in intracranial pressure are transmitted to the CSF in the optic nerve sheath and result in dilation of the optic nerve sheath.

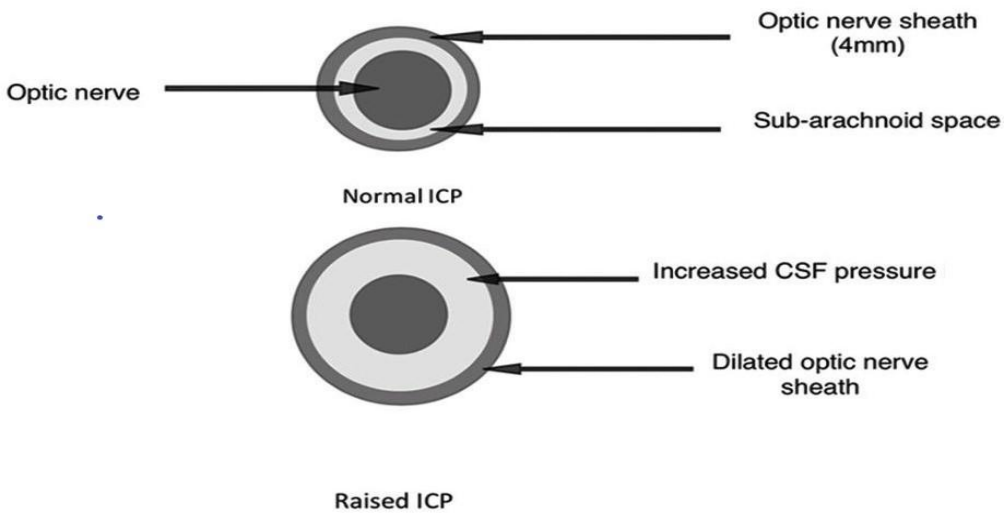


FIGURE 26: ICP AND ONSD RELATION

The optic nerve sheath diameter can be measured with ocular ultrasound, and a growing body of literature has demonstrated a correlation between increased ONSD and elevated intracranial pressure when compared to intraventricular pressure monitoring or evidence of increased intracranial pressure on CT scan.

To measure the optic nerve sheath diameter accurately, an on-axis, longitudinal cross-sectional view of the optic nerve sheath must be obtained. The borders of the sheath appear sharply demarcated and are parallel to one another. Because the optic nerve enters the globe slightly inferior and medial to the posterior pole, the ideal view of the optic nerve will show an off-axis view of the anterior chamber, iris, and lens. It is imperative to acquire a true on-axis, longitudinal cross section of the optic nerve sheath because off-axis imaging results in erroneous measurement of the optic nerve sheath diameter.

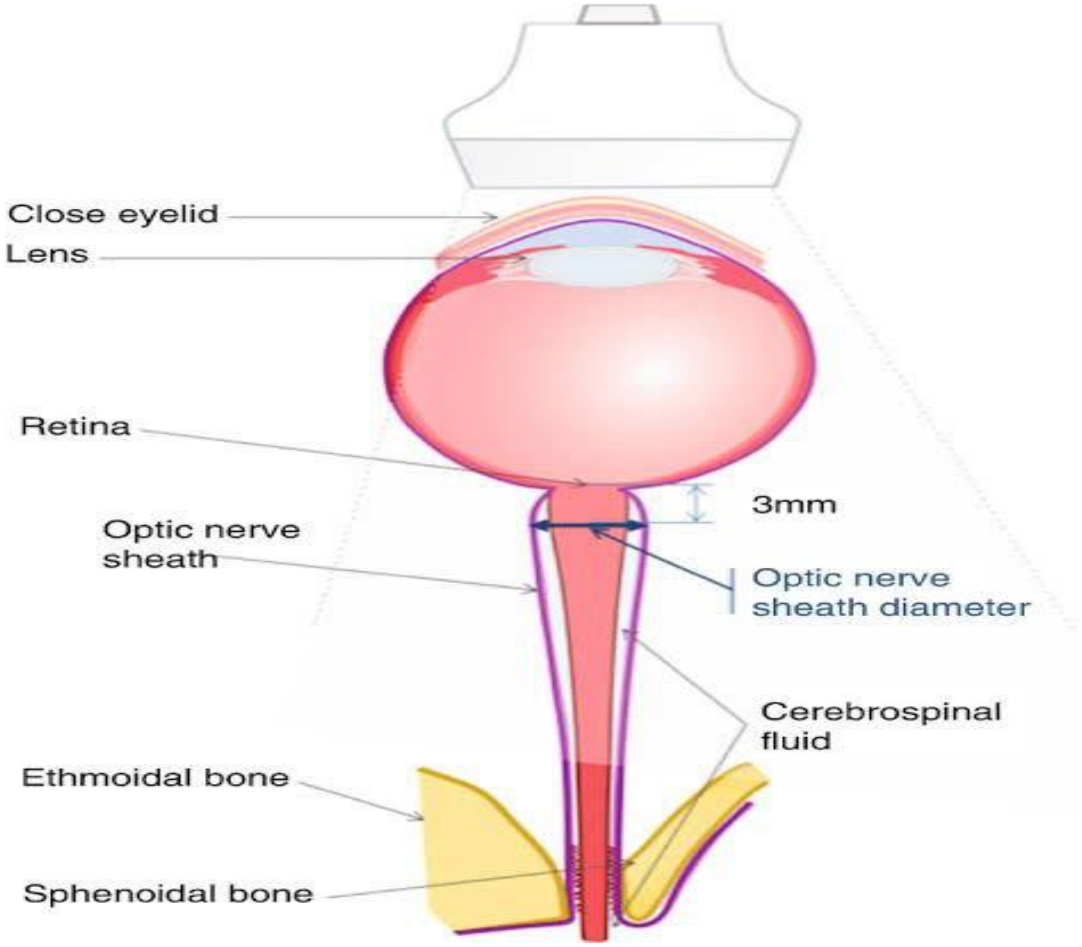


FIGURE 27: SCHEMATIC ONSD MEASUREMENT

The optic nerve sheath diameter should be measured 3 mm posterior to where the optic nerve sheath engages the retina. The subarachnoid space in the optic nerve sheath does not dilate uniformly, and the greatest variability and most pronounced response to increased fluid in the subarachnoid space occurs 3 mm posterior to the optic nerve sheath–retina junction.

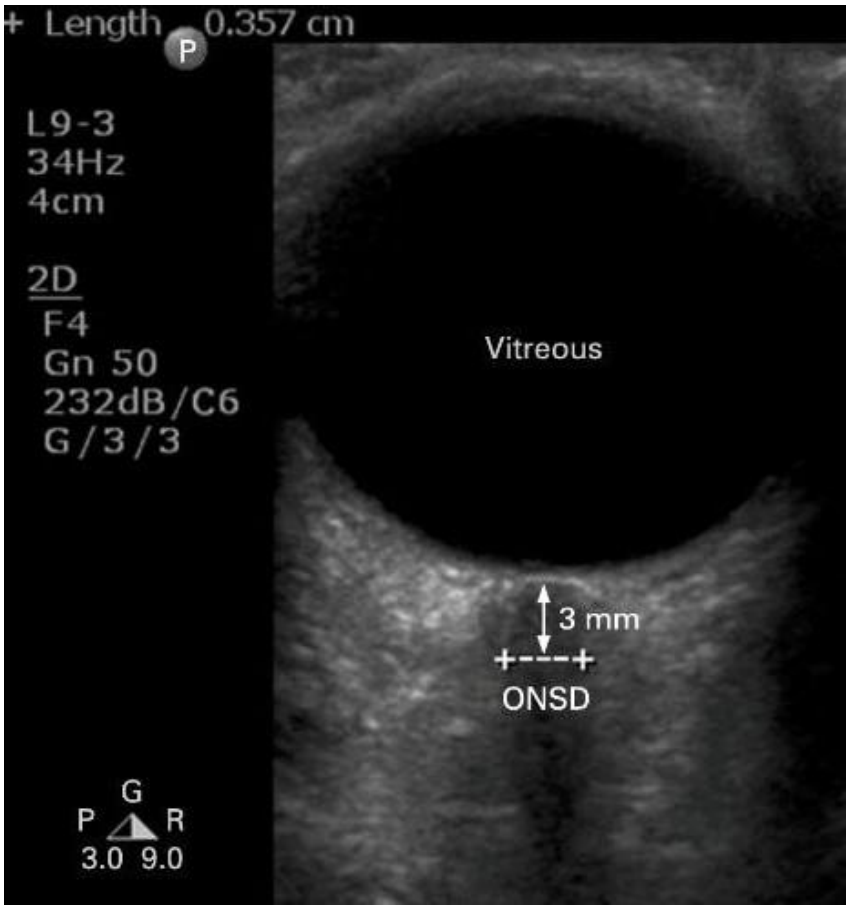


FIGURE 28: OPTIC NERVE AND ONSD

Starting in a transverse plane, measure the width of the optic nerve sheath 3 mm posterior to the retina and then rotate the transducer clockwise to measure the optic nerve sheath diameter in a sagittal plane, perpendicular to your first measurement. Repeat these steps in the contralateral eye to obtain transverse and sagittal measurements of the optic nerve sheath diameter. The ONSD is reported as the average of these four values. Any intracranial process causing elevated intracranial pressure should affect optic nerve sheath diameter of both eyes equally. The presence of unilateral increased optic nerve sheath diameter suggests a lateralizing process, such as optic neuritis or compressive optic neuropathy. Papilledema may also be noted as optic disc bulging into the retina and protruding into the vitreous body.

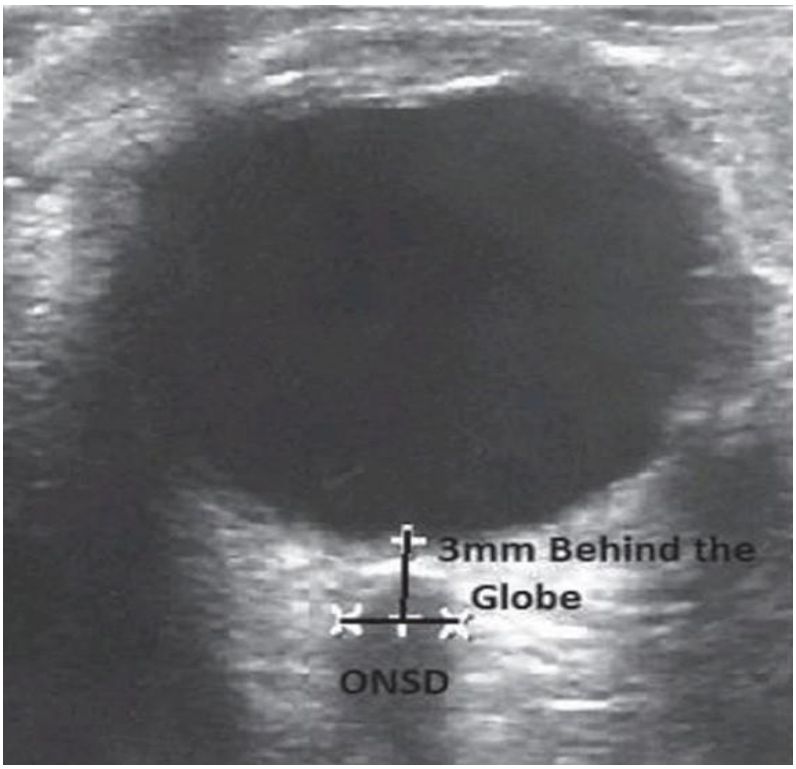


FIGURE 29: ONSD MEASUREMENT ON USG

The cutoff value for increased optic nerve sheath diameter correlating with increased intracranial pressure has been debatable. Based on the initial study of ultrasound measurement of optic nerve sheath diameter, many authors cite a diameter >5 mm as elevated in patients older than age four. Two recent meta-analyses of six studies evaluated the correlation between optic nerve sheath diameter and intracranial pressure >20 cm H_2O and calculated a pooled sensitivity and specificity of 87–90% and 79–85%, respectively; however, the cutoff for abnormal optic nerve sheath diameter varied from 5.0 to 5.9 mm in these studies, with half of the studies utilizing a cutoff of ≥ 5.7 mm. It is recommended to use an ONSD >5 mm as abnormal in patients with clinical concern for elevated intracranial pressure based on the current body of literature. Even though animal studies suggest that prolonged high-frequency ocular ultrasound is safe, these studies are limited. The eye is considered a

particularly sensitive organ to the potential risks of mechanical and thermal effects of ultrasound energy. Using an ocular preset limits the mechanical and thermal output of the transducer to relatively safer levels; however, ocular ultrasound should still be performed in concordance with the ALARA principle (As Low As Reasonably Achievable principle). Limiting the duration of an ocular ultrasound exam, especially the amount of time spent with the transducer in a single position, and minimizing the use of color flow and spectral doppler ultrasound, modes with higher thermal output than standard two-dimensional imaging, will lessen the potential risk for damage to the sensitive tissues of the eye.

CLINOMETER:[36]

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

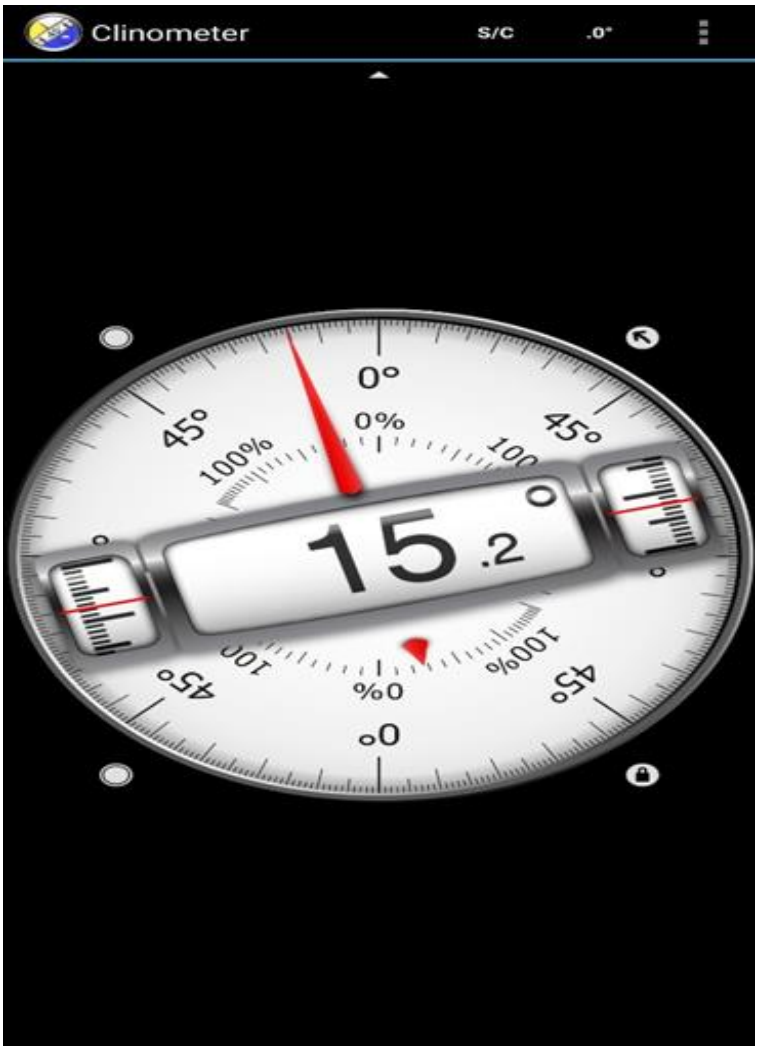


FIGURE 30: DIGITAL CLINOMETER

MATERIAL AND METHODS

Study design: A one year hospital based prospective observational study.

Study period: One year (March 2021 – February 2022).

Place: "Department of Anaesthesiology, KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, KAHER, Belagavi".

Source of data: Patients aged 18 to 60, of both female and male sex, belonging to ASA (American Society of Anaesthesiologists) class I & II, posted for elective laparoscopic surgery under general anesthesia requiring trendelenburg and reverse trendelenburg positioning at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre & KLES Dr. Prabhakar Kore Charitable Hospital, Nehru Nagar, Belagavi -10.

Sample size: A total of 60 patients.

Sampling procedure: Sample size was calculated using the results of previous similar studies and substituting them in the formula as below:

Sample size calculation:

Based on mean and standard deviation, the formula for the minimal sample size calculation is $n = \frac{(z_\alpha + z_\beta)^2(s_1^2 + s_2^2)}{(\bar{X}_1 - \bar{X}_2)^2}$

where Zα is associated with the level of significance of the test and Zβ is associated with the power of the test. Zα is taken as 1.96 for 5% significance level and for 80% power of the test Zβ is taken as 0.84.

$\bar{X}_1$ denotes the average of group A (0.5226) whereas $\bar{X}_2$ denotes the average of group B (0.4852).

S1 refers to standard deviation (S.D) for group A (0.05261) whereas S2 refers to standard deviation for group B (0.04652). Using these parameters, size of the sample achieved is 28.

For ease of calculations and sake of consistent results, sample size was raised to 30. There were two groups of size 30 each.

Inclusion criteria:

1. Age 18 – 60 years.

2. Either sex.

3. ASA physical status I & II.

4. Patients willing to give informed consent.

5. Patients undergoing laparoscopic surgeries requiring trendelenburg and reverse trendelenburg positioning.

Exclusion criteria:

1. Emergency and trauma patients.

2. Patients with ophthalmic diseases, neurological diseases, thyroid disorders neuro developmental defects.

3. Patients with history of ocular and neurosurgery.

4. Patients who are not willing to give consent.

Ethical clearance:

The approval by the institutional Ethical and Research Committee, Jawaharlal Nehru Medical College, Belagavi, was taken before starting the study.

Informed consent:

All the patients who fulfilled the selection criteria were explained about the nature of the study and intervention being done. A written informed consent was obtained from all patients before enrolment in their vernacular language.

Method of collection of data: After obtaining approval from institutional ethics committee, a total of 60 patients undergoing elective laparoscopic surgery were included in the study.

Patients were divided into two groups based on the type of laparoscopic surgery to be done. This segregation was done after patients having met the inclusion criteria and exclusion criteria.

Group A: Patients undergoing laparoscopic surgeries requiring trendelenburg positioning.

Group B: Patients undergoing laparoscopic surgeries requiring reverse trendelenburg positioning.

A careful preanesthetic check was performed at least one day prior to surgery. Patients were explained about the study to be conducted in brief and informed consent was taken. On the day of surgery, intravenous (IV) access was secured using 18G or 20G cannula and IV fluid was started.

In the operation theatre, standard monitoring devices which include triple-leaded electrocardiogram (ECG), pulse oximeter (SpO_2) and non-invasive blood pressure (NIBP) were connected and initial readings of oxygen saturation, heart ratean d blood pressure were recorded and documented.

Patients were premedicated with Inj. Glycopyrrolate 0.005mg/kg, Inj. Midazolam 0.05mg/kg, Inj. Fentanyl 2mcg/kg and preoxygenated with 100% oxygen for 5minutes. Patients were induced with Inj. Thiopentone 5-7 mg/kg and Inj. Vecuronium 0.1mg/kg. Tracheal intubation was done with endotracheal tube of adequate size and patients were connected to mechanical ventilator and ventilated on volume control mode to achieve a tidal volume of 6-8ml/kg and respiratory rate adjusted to maintain an end tidal carbon dioxide concentration of 35-40 mm Hg.

Patients were maintained with 50% oxygen-air mixture, isoflurane and Inj. Vecuronium 0.02 mg/kg.

A multiport laparoscopic access and pneumoperitoneum of 12 -14 mmHg was established. All patients received intravenous ondansetron 4 mg preoperatively and intravenous paracetamol 15mg/kg before extubation to prevent the potential postoperative nausea vomiting and postoperative pain/headache respectively.

Optic nerve sheath diameter measurement:

After placing the patients in supine position, their eyes were covered with a sterile transparent adhesive (tegaderm^{R}) making sure that there were no air bubbles in between. A layer of sterile gel was applied over the tegaderm, and the probe was positioned carefully on the supero-lateral aspect of the upper eyelid without applying any force on the eyeball.

All ultrasonographic measurements were taken with a portable Sonosite M-Turbo ultrasound machine's 6-13 MHz linear-array probe.

The probe was oriented until an axial image of the orbit was acquired, revealing the optic nerve's entry into the globe. Depth and gain were adjusted as per the need. The image acquired was frozen, and the cursors of electronic calliper were placed on the outer margins of the optic nerve sheath at a distance of 3 mm behind the eyeball and perpendicular to the axis of optic nerve. This horizontal distance between the electronic callipers corresponds to optic nerve sheath diameter.

Optic nerve sheath diameter was measured separately in both transverse and sagittal axis of the right globe at four points of time during intraoperative period. The mean of these two values at each point was taken as average optic nerve sheath diameter.

Study protocol:

When hemodynamically stable conditions were achieved, optic nerve sheath diameter was measured 4 times during the surgery as follows

1) T0 [In supine position 5 minutes after anesthesia induction]

2) T1 [5 minutes after establishing pneumoperitoneum]

3) T2 [5 minutes after position change combined with pneumoperitoneum]

4) T3 [5 minutes after desufflation of pneumoperitoneum in supine position].

Parameters measured at each point of time include,

A) Optic nerve sheath diameter (ONSD)

B) Heart rate (HR)

C) Respiratory rate (RR)

D) Oxygen saturation (SpO_2)

E) Noninvasive blood pressure (NIBP)

F) Mean arterial pressure (MAP)

G) End tidal CO_2 concentration ($EtCO_2$)

H) Airway peak pressure (P_{peak})

I) Airway plateau pressure ($P_{plateau}$)

The angle of inclination of operating table during laparoscopic surgery for achieving position change was measured using a digital inclinometer.[36]

The data obtained was recorded and tabulated as follows

Parameters	T0	T1	T2	T3
ONSD (sagittal)				
ONSD (transverse)				
Avg ONSD				
Heart rate				
Respiratory rate				
SpO_2				
NIBP				
MAP				
EtCO2				
P_{PEAK}				
$P_{PLATEAU}$				

At the end of the procedure, patients were reversed with Inj.Glycopyrrolate 0.01mg/kg and Inj.Neostigmine 0.05mg/kg and extubated.

Patients were monitored in the postoperative recovery room for 3 hours for any incidence of postoperative nausea vomiting (PONV) and postoperative headache (POHA).

Statistical analysis:

Because the current study was an observational one, the following analysis plan was used.

This study focussed on comparison between two groups. The mean and Standard Deviation for the continuous quantitative variables were computed. Between the two groups continuous variables were compared using suitable statistical techniques like student's unpaired t test. To compare the quantitative variables within each group with respect to the base line value, student's paired t test was used.

Median was used to represent discrete variables. The categorical data was expressed in terms of ratios, rates, and percentages. The Chi-square test was used to examine the relationship between the result, clinical, and demographic factors.

For the discrete variables, nonparametric tests were utilised. The comparison was represented using the suitable graphs. For all tests, p less than 5% (0.05) was considered significant.

RESULTS

A total of 60 patients, belonging to ASA I & ASA II undergoing elective laparoscopic surgeries under general anaesthesia requiring endotracheal intubation were included in the study.

Using ultrasound optic nerve sheath diameter was measured on right eye in sagittal and transverse plane during the surgery at 4 different points of time which are

1) T0 [5 minutes after anaesthesia induction in supine position]

2) T1 [5 minutes after establishing pneumoperitoneum]

3) T2 [5 minutes after position change combined with pneumoperitoneum]

4) T3 [5 minutes after desufflation of pneumoperitoneum in supine position].

Any occurrence of postoperative nausea vomiting and postoperative headache during 1st 3 hours of postoperative period was taken into consideration and correlated with optic nerve sheath diameter. Data obtained was entered in Microsoft excel spread sheet. Data was analysed and results were tabulated as follows

TABLE 1: GENDER DISTRIBUTION

	GROUP A (TP)		GROUP B (RTP)	
GENDER	**NUMBER**	**%**	**NUMBER**	**%**
FEMALE	19	63.33	14	46.67
MALE	11	36.67	16	53.33
TOTAL	30	100.00	30	100.00

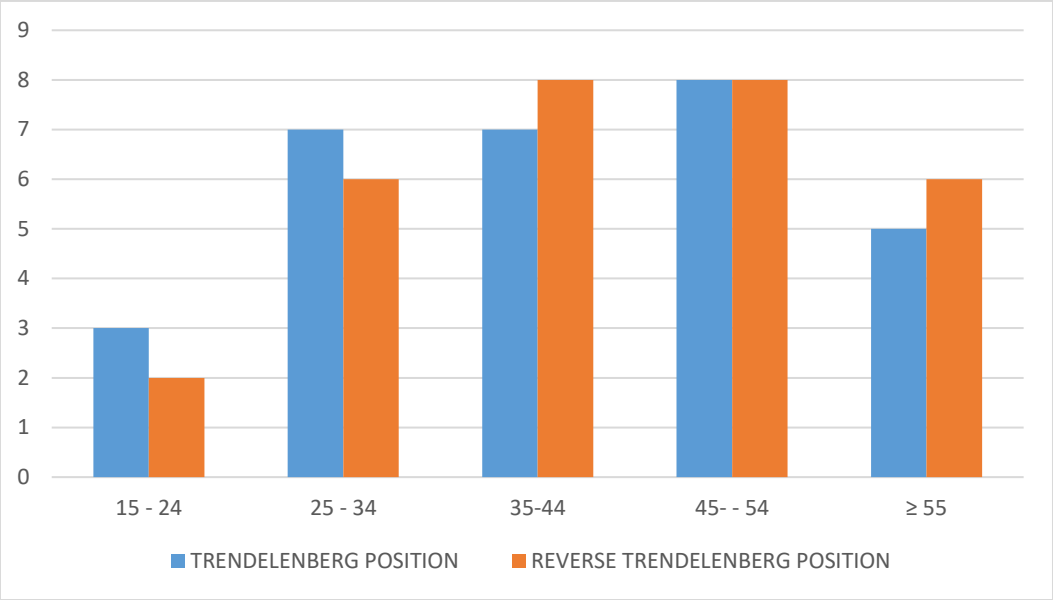
GRAPH 1: GENDER DISTRIBUTION

In this study, 63.33% of patients are females in Group A compared to 46.67% in Group B, 36.67% of patients are males in Group A compared to 53.33% in Group B.

TABLE 2: AGE DISTRIBUTION

	GROUP A		GROUP B	
AGE	**NUMBER**	**%**	**NUMBER**	**%**
15 - 24	3	10	2	6.67
25 - 34	7	23.33	6	20.00
35 - 44	7	23.33	8	26.67
45 - 54	8	26.66	8	26.67
≥ 55	5	16.66	6	20.00
TOTAL	30	100.00	30	100.00

GRAPH 2: AGE DISTRIBUTION



From the above table, age distribution is found to be comparable between both the groups.

TABLE 3: ASA DISTRIBUTION

	GROUP A		**GRUP B**	
ASA	**NUMBER**	**%**	**NUMBER**	**%**
1	25	83.33	20	66.67
2	5	16.67	10	33.33
TOTAL	30	100.00	30	100.00

In this study, group A have 83.33% of participants belonging to ASA I and 16.67% to ASA II and group B have 66.67% of participants belonging to ASA I and 33.33% to ASA II.

TABLE 4: COMPARISION OF MEAN ONSD BETWEEN 2 GROUPS

	GROUP A				GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	0.33	0.05	0.275	0.48	0.32	0.04	0.25	0.41	0.1147	NS
T1	0.43	0.05	0.335	0.51	0.41	0.04	0.35	0.535	0.0996	NS
T2	0.52	0.05	0.405	0.66	0.44	0.04	0.39	0.585	< 0.0001	HS
T3	0.41	0.04	0.315	0.52	0.36	0.03	0.295	0.435	< 0.0001	HS

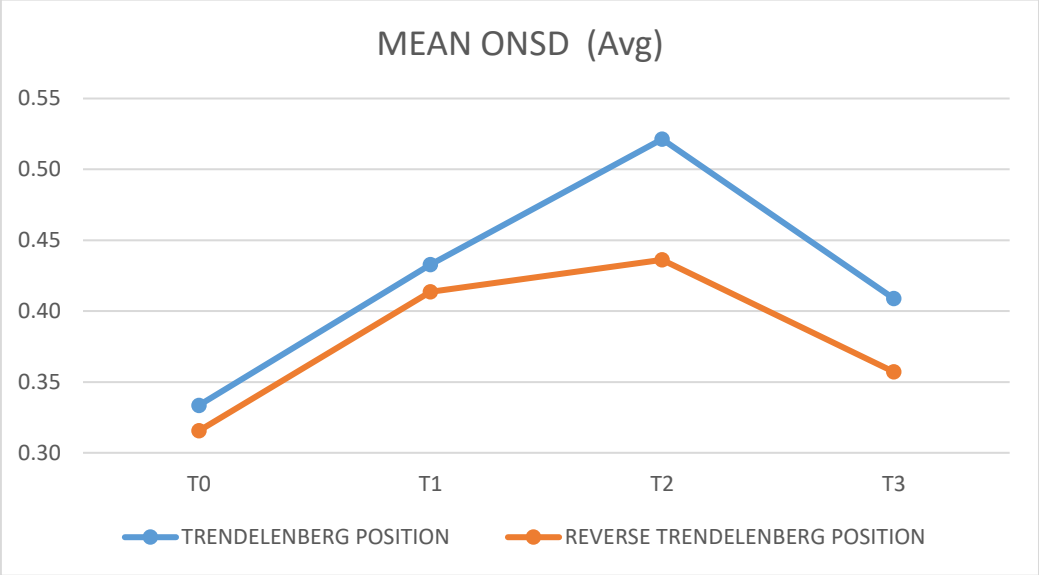
TABLE 5: COMPARISION OF MEAN ONSD WITHIN THE GROUP A

	GROUP A					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	0.33	0.05	0.275	0.48	--	--
T1	0.43	0.05	0.335	0.51	< 0.0001	HS
T2	0.52	0.05	0.405	0.66	< 0.0001	HS
T3	0.41	0.04	0.315	0.52	< 0.0001	HS

TABLE 6: COMPARISION OF ONSD WITHIN THE GROUP B

	GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	0.32	0.04	0.25	0.41	--	--
T1	0.41	0.04	0.35	0.535	< 0.0001	HS
T2	0.44	0.04	0.39	0.585	< 0.0001	HS
T3	0.36	0.03	0.295	0.435	< 0.0001	HS

GRAPH 3: THE MEAN OF ONSD(Avg) IN BOTH GROUPS



On comparison between two groups there is no significant difference in mean optic nerve sheath diameter at T0 and T1 where as in T2 and T3 the change in mean optic nerve sheath diameter between 2 groups is highly significant($p<0.0001$). Within both groups there is a significant difference in mean optic nerve sheath diameter at T1, T2and T3 when compared with baseline T0 ($p<0.0001$).

TABLE 7: COMPARISION OF MEAN HR BETWEEN 2 GROUPS

	GROUP A				GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	86.27	6.82	75	100	85.27	11.56	60	112	0.1074	NS
T1	100.47	7.66	87	116	94.90	10.94	72	115	0.0261	S
T2	102.33	11.47	70	118	98.40	10.72	76	118	0.1752	NS
T3	85.93	7.81	62	98	80.20	8.66	60	92	0.0092	VS

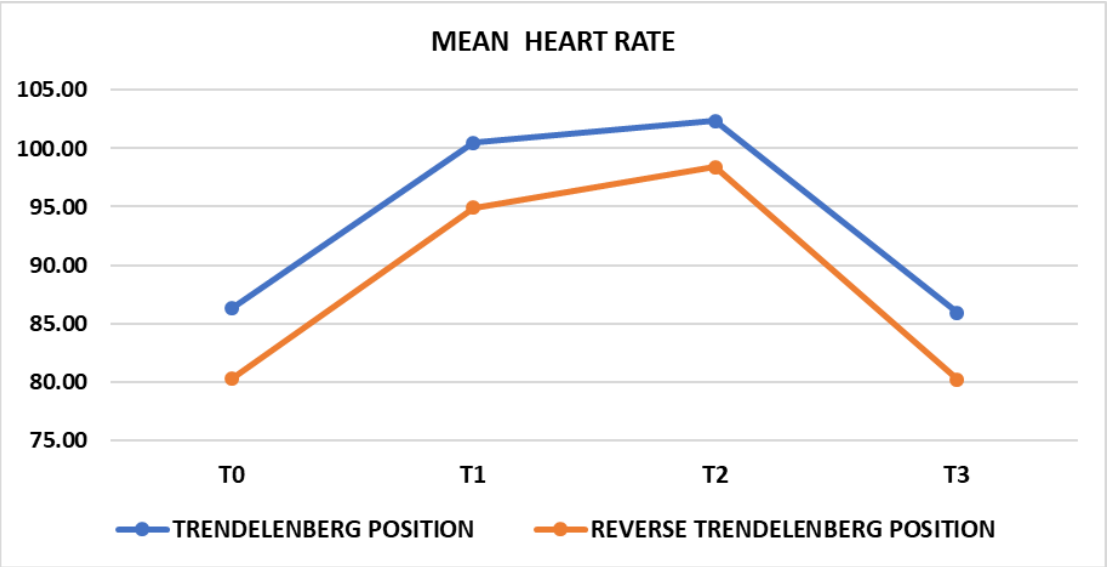
TABLE 8: COMPARISION OF MEAN HR WITHIN THE GROUP A

	GROUP A					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	86.27	6.82	75	100	--	--
T1	100.47	7.66	87	116	< 0.0001	HS
T2	102.33	11.47	70	118	< 0.0001	HS
T3	85.93	7.81	62	98	0.4304	NS

TABLE 9: COMPARISION OF MEAN HR WITHIN THE GROUP B

	GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	80.27	11.56	60	112	--	--
T1	94.90	10.94	72	115	< 0.0001	HS
T2	98.40	10.72	76	118	< 0.0001	HS
T3	80.20	8.66	60	92	0.4900	NS

GRAPH 4: THE MEAN OF HR IN BOTH GROUPS



On comparison between two groups there is significant difference in mean heart rate at T0 and T1 whereas at T2 the change in mean heart rate between 2 groups is not significant. At T3 the mean heart rate was found to be very significantly increased in group A compared to group B ($p=0.0092$).

Within both groups there is a significant difference in mean heart rate at T1 and T2 when compared with baseline T0 ($p<0.0001$) whereas the mean heart rate at T3 was found to be comparable to T0.

TABLE 10: COMPARISION OF MEAN MAP BETWEEN 2 GROUPS

	GROUP A				GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	79.63	12.47	30	110	77.73	10.12	45	93	0.5196	NS
T1	91.73	9.75	56	112	93.63	8.52	71	107	0.4248	NS
T2	92.33	6.42	75	103	92.50	5.40	77	98	0.9137	NS
T3	84.00	6.36	65	97	79.27	6.19	66	88	0.0050	VS

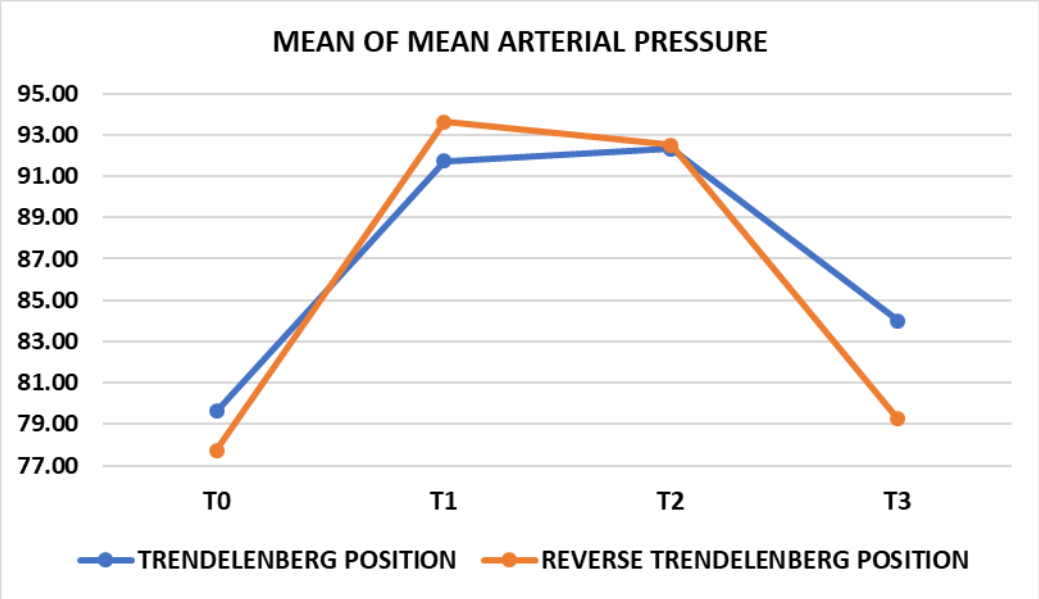
TABLE 11: COMPARISION OF MEAN MAP WITHIN THE GROUP A

	GROUP A					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	79.63	12.47	30	110	--	--
T1	91.73	9.75	56	112	< 0.0001	HS
T2	92.33	6.42	75	103	< 0.0001	HS
T3	84.00	6.36	65	97	0.0465	S

TABLE 12: COMPARISION OF MEAN MAP WITHIN THE GROUP B

	GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	77.73	10.12	45	93	--	--
T1	93.63	8.52	71	107	< 0.0001	HS
T2	92.50	5.40	77	98	< 0.0001	HS
T3	79.27	6.19	66	88	0.2409	NS

GRAPH 5: THE MEAN OF MAP IN BOTH GROUPS



On comparison between two groups there is no significant difference in the mean of mean arterial pressure at T0, T1 and T2 whereas at T3 the mean MAP was found to be very significantly increased in group A compared to group B (p=0.005). Within both groups there is a significant difference in mean MAP at T1 and T2 when compared with baseline T0 (P<0.0001).

TABLE 13: COMPARISION OF MEAN ETCO2 BETWEEN 2 GROUPS

	GROUP A				GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	28.80	1.94	24	33	28.07	2.30	20	32	0.1872	NS
T1	33.97	2.93	25	38	35.23	3.05	26	40	0.1062	NS
T2	32.97	2.47	24	36	32.63	2.91	24	41	0.6340	NS
T3	29.53	1.98	22	33	29.17	2.93	20	34	0.5717	NS

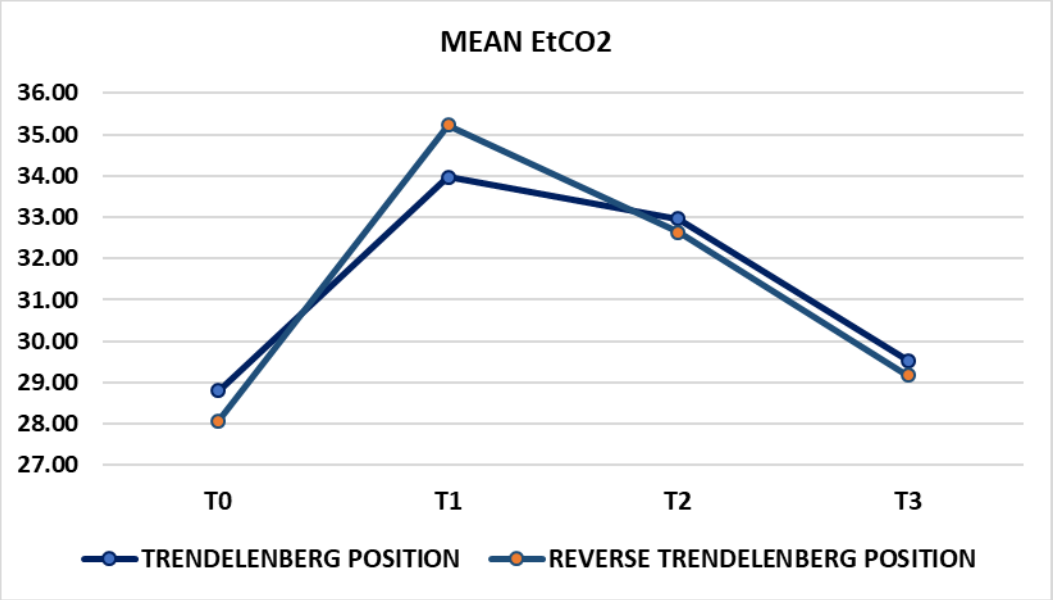
TABLE 14: COMPARISION OF MEAN ETCO2 WITHIN THE GROUP A

	GROUP A					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	28.80	1.94	24	33	--	--
T1	33.97	2.93	25	38	< 0.0001	HS
T2	32.97	2.47	24	36	< 0.0001	HS
T3	29.53	1.98	22	33	0.0761	NS

TABLE 15: COMPARISION OF MEAN ETCO2 WITHIN THE GROUP B

	GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	28.07	2.30	20	32	--	--
T1	35.23	3.05	26	40	< 0.0001	HS
T2	32.63	2.91	24	41	< 0.0001	HS
T3	29.17	2.93	20	34	0.0555	NS

GRAPH 6: THE MEAN OF EtCO2 IN BOTH GROUPS



On comparison between two groups the mean $EtCO_2$ levels at T0, T1, T2 and T3 were found to be comparable with no statistical significance between them. Within both groups there is a significant difference in mean $EtCO_2$ at T1 and T2 when compared with baseline T0($p<0.0001$) however at T3 mean $EtCO_2$ was found to be comparable to T0.

TABLE 16: COMPARISION OF MEAN Ppeak BETWEEN 2 GROUPS

	GROUP A				GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	13.87	1.91	11	19	13.67	2.17	10	18	0.7060	NS
T1	20.00	2.63	15	26	19.57	2.28	14	24	0.4980	NS
T2	20.83	2.63	15	26	20.00	2.53	15	25	0.2160	NS
T3	14.73	2.03	12	20	14.40	2.14	10	18	0.5390	NS

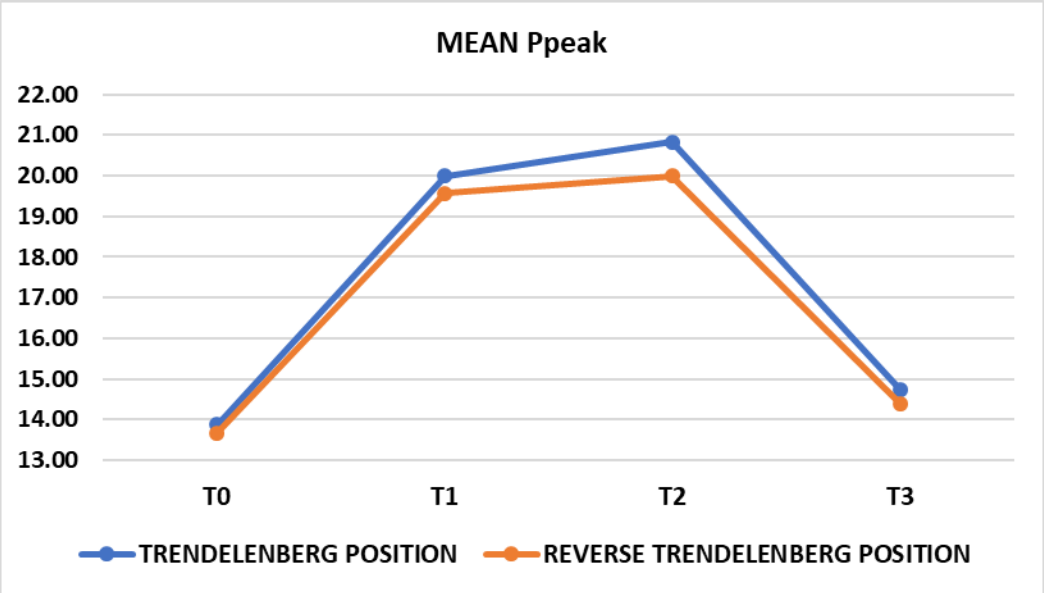
TABLE 17: COMPARISION OF MEAN P peak WITHIN THE GROUP A

	GROUP A					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	13.87	1.91	11	19	--	--
T1	20.00	2.63	15	26	< 0.0001	HS
T2	20.83	2.63	15	26	< 0.0001	HS
T3	14.73	2.03	12	20	0.0470	S

TABLE 18: COMPARISION OF MEAN Ppeak WITHIN THE GROUP B

	GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	13.67	2.17	10	18	--	--
T1	19.57	2.28	14	24	< 0.0001	HS
T2	20.00	2.53	15	25	< 0.0001	HS
T3	14.40	2.14	10	18	0.0966	NS

GRAPH 7: THE MEAN OF Ppeak IN BOTH GROUPS



On comparison between two groups the mean P_{peak} values at T0, T1, T2 and T3 were found to be comparable with no statistical significance between them. Within both groups there is a significant difference in mean P_{peak} at T1 and T2 when compared with baseline T0 ($P<0.0001$).

TABLE 19: COMPARISION OF MEAN Pplateau BETWEEN 2 GROUPS

	GROUP A				GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	12.87	1.96	10	18	12.57	2.10	10	17	0.5691	NS
T1	18.60	2.31	14	24	18.33	2.25	13	23	0.6524	NS
T2	19.33	2.54	14	25	18.47	2.34	13	24	0.1747	NS
T3	13.53	2.13	10	19	13.30	2.09	10	18	0.6698	NS

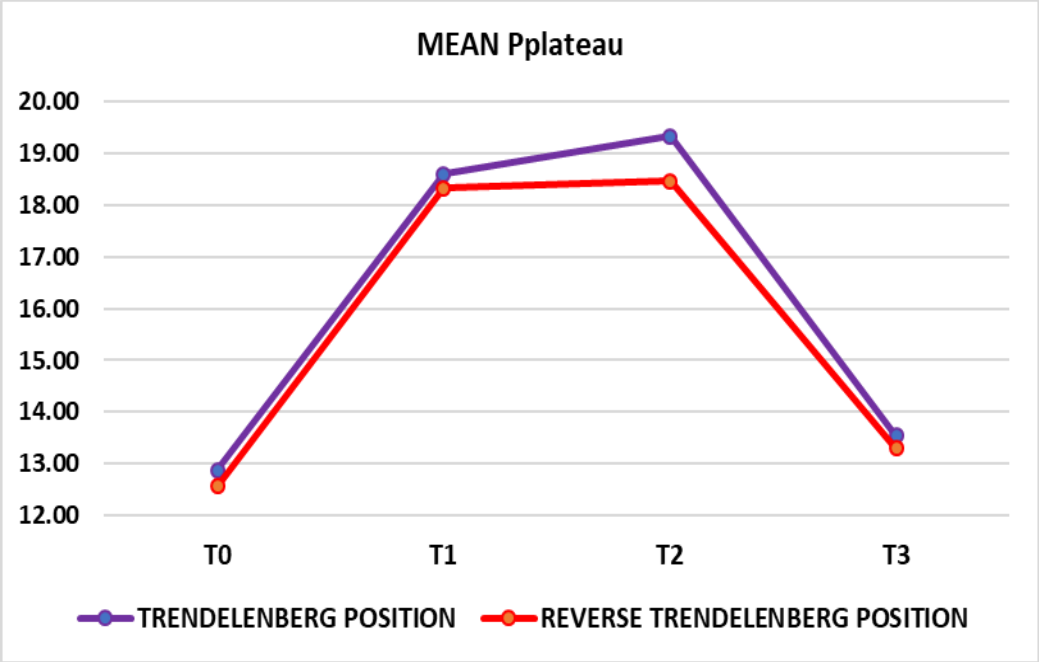
TABLE 20: COMPARISION OF MEAN Pplateau WITHIN THE GROUP A

	GROUP A					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	12.87	1.96	10	18	--	--
T1	18.60	2.31	14	24	< 0.0001	HS
T2	19.33	2.54	14	25	< 0.0001	HS
T3	13.53	2.13	10	19	0.1061	NS

TABLE 21: COMPARISION OF MEAN Pplateau WITHIN THE GROUP B

	GROUP B					
	MEAN	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T0	12.57	2.10	10	17	--	--
T1	18.33	2.25	13	23	< 0.0001	HS
T2	18.47	2.34	13	24	< 0.0001	HS
T3	13.30	2.09	10	18	0.0898	NS

GRAPH 8: THE MEAN OF Pplateau IN BOTH GROUPS



On comparison between two groups the mean $P_{plateau}$ levels at T0, T1, T2 and T3 were found to be comparable with no statistical significance between them. Within both groups there is a significant difference in mean $P_{plateau}$ at T1 and T2 when compared with baseline T0 ($p<0.0001$).

TABLE 22: INCIDENCE OF PONV IN BOTH GROUPS

	GROUP A		GROUP B	
PONV	**NUMBER**	**%**	**NUMBER**	**%**
YES	8	26.67	5	16.67
NO	22	73.33	25	83.33
TOTAL	30	100.00	30	100.00

The incidence of Postoperative Nausea Vomiting was found to be 26% in group A and 16.67% in group B.

TABLE 23: RELATION BETWEEN CHANGE IN ONSD AND PONV IN GROUP A

	GROUP A									
	PONV ABSENT				PONV PRESENT					
Δ ONSD	**MEAN**	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T1 - T0	0.09	0.04	0.015	0.155	0.13	0.05	0.06	0.195	0.0342	S
T2 - T0	0.16	0.05	0.05	0.245	0.25	0.05	0.195	0.32	0.0001	HS

TABLE 24: RELATION BETWEEN CHANGE IN ONSD AND PONV IN GROUP B

	GROUP B									
	PONV ABSENT				PONV PRESENT					
Δ ONSD	**MEAN**	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T1 - T0	0.09	0.03	0.04	0.14	0.13	0.02	0.115	0.155	0.0140	S
T2 - T0	0.11	0.03	0.07	0.165	0.15	0.04	0.105	0.205	0.0241	S

In both the groups the patients who experienced postoperative nausea vomiting showed significantly higher deviation in ONSD from baseline to T1 and from baseline to T2.

TABLE 25: INCIDENCE OF POHA IN BOTH GROUPS

	GROUP A		**GROUP B**	
POHA	**NUMBER**	**%**	**NUMBER**	**%**
YES	4	13.33	2	6.67
NO	26	86.67	28	93.33
TOTAL	30	100.00	30	100.00

The incidence of Postoperative Headache was 13.33% in group A and 6.67% in group B.

TABLE 26: RELATION BETWEEN CHANGE IN ONSD AND POHA IN GROUP A

	GROUP A									
	POHA ABSENT				**POHA PRESENT**					
Δ ONSD	**MEAN**	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T1 - T0	0.10	0.04	0.015	0.195	0.11	0.04	0.06	0.155	0.7854	NS
T2 - T0	0.18	0.06	0.05	0.32	0.25	0.05	0.195	0.3	0.0402	S

TABLE 27: RELATION BETWEEN CHANGE IN ONSD AND POHA IN GROUP B

	GROUP B									
	POHA ABSENT				**POHA PRESENT**					
Δ ONSD	**MEAN**	**S.D.**	**MIN**	**MAX**	**MEAN**	**S.D.**	**MIN**	**MAX**	**p VALUE**	**INFERENCE**
T1 - T0	0.10	0.03	0.04	0.14	0.14	0.03	0.115	0.155	0.1102	NS
T2 - T0	0.12	0.03	0.07	0.165	0.16	0.07	0.105	0.205	0.1236	NS

In group A the patients who experienced postoperative headache showed significantly higher change in optic nerve sheath diameter from baseline to T2 (p=0.04) but not from baseline to T1. In group B the change in optic nerve sheath diameter from baseline to T1 and T2 were comparable in all patients irrespective of presence of postoperative headache.

DISCUSSION

The increase in intracranial pressure can be seen post pneumoperitoneum, and this increase is further exaggerated with concomitant trendelenberg position during laparoscopy. This elevation in intracranial pressure during laparoscopy is well tolerated by most of the individuals but it can be harmful in certain individuals with unevaluated intracranial lesions and are at increased risk of complications due to raised intracranial pressure.[1,2,3]

Cerebral perfusion depends on intracranial pressure and mean arterial pressure. Sudden increase in intracranial pressure leads to decreased cerebral perfusion pressure, compromising the blood supply to brain tissue.[26,27,28]

There are several non-invasive methods available for the measurement of intracranial pressure. Ultrasonography guided measurement of optic nerve sheath diameter is a simple, relatively easy, reproducible, bedside method for evaluating intracranial pressure.[4,7,26]

This present study is an observational study which demonstrates the effects of pneumoperitoneum and positional change during laparoscopy on intracranial pressure of the patients and its associated complications such as postoperative nausea vomiting and postoperative headache.

We have evaluated the usefulness of ultrasonography in predicting raised intracranial pressure by measuring ONSD on a single eye (right) in both transverse and sagittal axis at 4 different points of time during the surgery which was conducted in Indian population.

We enrolled a total of 60 ASA 1 and 2 patients aged 18-60 posted for elective laparoscopic surgeries under general anaesthesia with endotracheal intubation.

Amongst the 30 patients enrolled, in group A there are 11 male (37%) and 19 female patients (63%), and in group B out of 30 patients enrolled there are 16 male (53%) and 14 female (47%) patients.

In our study in group A, 83% patients belonged to ASA1 and 17% belonged to ASA 2 whereas in group B, 67% patients belonged to ASA1 and 33% belonged to ASA2.

Out of the 60 patients included in the study, there was no significant difference between the two groups with respect to age distribution.

In the present study the mean optic nerve sheath diameter was found to be comparable between group A (Trendelenburg position) and group B (Reverse trendelenburg position) at T0 ($p = 0.11$) and T1 ($p = 0.09$). However, there was significant difference between mean optic nerve sheath diameter between group A and B at T2 ($p < 0.0001$) and at T3 ($p < 0.0001$). Within the group comparison has concluded that there is significant increase in optic nerve sheath diameter at T1, T2 and T3 when compared with baseline T0 in both the groups with p values < 0.0001.

The results in our study correlated with the study conducted by Nishanth Sahay et al who concluded that there is significant increase in optic nerve sheath diameter post pneumoperitoneum ($p<0.0001$ in head down group and $p<0.0011$ in head up group) and also post positional change ($p<0.0001$ in both groups) when compared to baseline value. They also concluded that post desufflation the optic nerve sheath diameter values did not fall back to baseline level but were comparable between both groups,[1] whereas in our study there was significant difference in optic nerve sheath diameter between 2 groups post desufflation ($p < 0.0001$).

Verdonck et al conducted a study on 20 ASA 1 & 2 male patients posted for RARLP and came to conclusion that there is no effect of pneumoperitoneum and

trendelenberg positioning on optic nerve sheath diameter which contrasts with the inference obtained in our study and also in several other studies. In the same study Verdonck and his colleagues confirmed the increasing trend of mean arterial pressure and $EtCO_2$ in relation to pnemoperitoneum.[37]

Robba et al conducted a study on 40 patients who underwent laparoscopic surgery requiring trendelenburg position and concluded that optic nerve sheath diameter measurement is a reliable tool for measuring intracranial pressure when compared to other non-invasive methods of measuring intracranial pressure.[38] In the same study, Robba and his colleagues concluded that the elevation in intracranial pressure based on optic nerve sheath diameter and Transcranial Doppler (TcD) methods was rarely above 20mmHg, indicating that patients without neurological disorders are not likely to manifest any clinical features due to raised intracranial pressure.[38]

Hamilton et al studied intracranial pressure variations in an animal model (porcine) and proposed that optic nerve sheath diameter may reflect sudden variations in intracranial pressure over 1 hour, and that this technique can be proved in humans.[39]

Kimberly et al in a study established that readings of intracranial pressure by invasive methods were comparable with optic nerve sheath diameter values obtained in adults. They proposed that ONSD > 5 mm can correlate with ICP > 20 cm H_2O, which may need intervention. However, they did not define a standard cut off value.[40]

In our study the mean heart rate, mean of mean arterial pressure, mean $EtCO_2$, mean P_{peak} and mean $P_{plateau}$ in group A (trendelenberg position) and in group B (reverse trendelenberg position) were found to be significantly elevated at T1 and T2

with respect to T0. In both the groups they were found to be either comparable or slightly significant (MAP, P_{peak}) at T3 with respect to T0.

Ji Young Min et al in a study conducted on 25 paediatric patients below 9 years of age undergoing laparoscopic procedure investigated the effects of pneumoperitoneum on optic nerve sheath diameter, hemodynamic parameters, airway pressures, and $EtCO_2$ at T0 (Baseline), T1 (post pneumoperitoneum) and T2 (post desufflation).[41] The results obtained by these authors correlate with the results derived in our study even though they employed a lower intraabdominal pressure of 8-10 mmHg during pneumoperitoneum in contrast to 12-14 mmHg of intraabdominal pressure employed by us.

In our study the occurrence of postoperative nausea vomiting, and postoperative headache were evaluated post procedure for 3 hours. The group A has higher incidence of PONV (26%) when compared to group B (16%). The incidence of POHA was observed to be 13% in group A and 6% in group B.

Cooke et al in a study compared laparoscopic surgeries and open surgeries and found that there is significant increase in postoperative nausea vomiting ($p<0.02$) and postoperative headache ($p<0.05$) when compared to open surgeries.[42]

Yilmaz et al conducted a study which included 61 patients undergoing laparoscopic surgery who were investigated for optic nerve sheath diameter changes, postoperative nausea vomiting, and postoperative headache. The study revealed that postoperative nausea vomiting, and postoperative headache showed significant association with the change in optic nerve sheath diameter from baseline to pneumoperitoneum and from baseline to pneumoperitoneum plus trendelenburg position.[2]

In our study we noticed that in both the groups there was a significant increase in optic nerve sheath diameter from baseline to T1 and from baseline to T2 in those patients who had postoperative nausea vomiting however this change in optic nerve sheath diameter was more prominent in group A than group B.

We also noticed that in group A there was significant rise in ONSD from baseline to T2 in those patients who reported headache during postoperative period whereas in group B even though there was increase in optic nerve sheath diameter from baseline to T1 and from baseline to T2, this change in optic nerve sheath diameter was found to be comparable in all patients whether they had headache postoperatively or not.

LIMITATIONS AND SCOPE

There are some limitations pertaining to our study. The sample size of our study was relatively small. In our study optic nerve sheath diameter was measured in only right eye instead of both eyes because of time constraint. The number of measurements in each axis were restricted to one however a greater number of measurements could be taken to obtain an ideal average value. In our study, we have not performed optic nerve sheath diameter examination and fundoscopy preoperatively to detect pre-existing cases of raised intracranial pressure. In our study invasive monitoring was not done simultaneously to correlate with ONSD measurements.

The time after desufflation at which optic nerve sheath diameter returns to baseline was not measured in our study. This limitation can be addressed in future studies by performing serial optic nerve sheath diameter measurements during the postoperative phase and comparing it with initial value.

Further studies with larger sample size need to be carried out to compare the effectiveness of optic nerve sheath diameter in predicting raised intracranial pressure with other non-invasive and invasive techniques of intracranial pressure monitoring.

CONCLUSION

From our study, we conclude that pneumoperitoneum causes a significant increase in optic nerve sheath diameter, a surrogate marker of raised intracranial pressure in patients who are undergoing laparoscopy assisted surgeries. Furthermore, this increase in optic nerve sheath diameter is further elevated when combined with trendelenburg position than with reverse trendelenburg position. However, the optic nerve sheath diameter does not come back to baseline value immediately after pneumoperitoneum desufflation, indicating that more time may be needed for optic nerve sheath diameter to return to normal value.

In our study we also conclude that the extent of change in optic nerve sheath diameter from baseline during the surgery correlates with postoperative nausea vomiting and postoperative headache in the postoperative period.

Hence, we conclude that intraoperative optic nerve sheath diameter measurement is useful in detecting raised intracranial pressure which may be clinically significant in patients at risk, and it can also be used to predict postoperative nausea vomiting and postoperative headache which are more commonly seen post laparoscopic surgery.

SUMMARY

In this study titled " ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBURG POSITION AND REVERSE TRENDELENBURG POSITION – A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY **"** we have measured and compared the optic nerve sheath diameter of right eye in transverse and sagittal planes at four different points of time intraoperatively which are, after anaesthesia induction in supine position, after pneumoperitoneum, after positional change and in supine after pneumoperitoneum desufflation.

In this study 60 patients aged between 18 and 60 years belonging to ASA category I and II posted for laparoscopic surgery were included after having met the inclusion criteria. Imaging and measurements of optic nerve sheath diameter for all the patients were documented and tabulated separately.

The optic nerve sheath diameter increased significantly from the baseline value with the instillation of pneumoperitoneum, and further increase was noted with change in position of patient. The increase in optic nerve sheath diameter was maximum when the position was changed to trendelenburg than in reverse trendelenburg position. However, the optic nerve sheath diameter values did not revert to initial level even after 5 minutes of removal of pneumoperitoneum.

It is concluded that intraoperative optic nerve sheath diameter measurement is useful in detecting raised intracranial pressure which may be clinically significant in patients at risk, and it can also be used to predict postoperative nausea vomiting and postoperative headache which are more commonly seen post laparoscopic surgery.

BIBLIOGRAPHY

1) Sahay N, Sharma S, Bhadani UK, Singh A, Sinha C, Sahay A, et al. Effect of pneumoperitoneum and patient positioning on intracranial pressures during laparoscopy: A prospective comparative study. Journal of Minimally Invasive Gynecology. 2018;25(1):147–52.
2) Yilmaz G, Akca A, Kiyak H, Salihoglu Z. Elevation in optic nerve sheath diameter due to the pneumoperitoneum and Trendelenburg is associated to postoperative nausea, vomiting and headache in patients undergoing laparoscopic hysterectomy [Internet]. Minerva anestesiologica. U.S. National Library of Medicine; [cited 2022Dec20]. Available from: https://pubmed.ncbi.nlm.nih.gov/31680498/.
3) Robba C, Bacigaluppi S, Cardim D, Donnelly J, Sekhon MS, Aries MJ, et al. Intraoperative non-invasive intracranial pressure monitoring during pneumoperitoneum: A case report and a review of the published cases and Case report series. Journal of Clinical Monitoring and Computing. 2015;30(5):527–38.
4) Samuel AJ. [Internet] [thesis]. Diagnostic utility and accuracy of optic nerve sheath diameter in detecting raised intracranial tension. 2016 [cited 2022]. Available from: http://repository-tnmgrmu.ac.in/id/eprint/10485.
5) Robba C, Bacigaluppi S, Cardim D, Donnelly J, Sekhon MS, Aries MJ, et al. Intraoperative non-invasive intracranial pressure monitoring during pneumoperitoneum: A case report and a review of the published cases and Case report series. Journal of Clinical Monitoring and Computing. 2015;30(5):527–38.
6) Hylkema C. Optic nerve sheath diameter ultrasound and the diagnosis of increased intracranial pressure. Critical Care Nursing Clinics of North America. 2016;28(1):95–9.

7) Kim J-Y, Min H-G, Ha S-I, Jeong H-W, Seo H, Kim J-U. Dynamic optic nerve sheath diameter responses to short-term hyperventilation measured with sonography in patients under general anesthesia. Korean Journal of Anesthesiology. 2014;67(4):240.

8) Dip F, Nguyen D, Rosales A, Sasson M, Menzo EL, Szomstein S, et al. Impact of controlled intraabdominal pressure on the optic nerve sheath diameter during laparoscopic procedures. Surgical Endoscopy. 2015;30(1):44–9.

9) Raffiz M, Abdullah JM. Optic nerve sheath diameter measurement: A means of detecting raised ICP in adult traumatic and non-traumatic neurosurgical patients. The American Journal of Emergency Medicine. 2017;35(1):150–3.

10) Romagnuolo L, Tayal V, Tomaszewski C, Saunders T, Norton HJ. Optic nerve sheath diameter does not change with patient position. Am J Emerg Med. 2005 Sep;23(5):686–8.

11) Chen H, Ding G-S, Zhao Y-C, Yu R-G, Zhou J-X. Ultrasound measurement of optic nerve diameter and optic nerve sheath diameter in healthy Chinese adults. BMC Neurology. 2015;15(1).

12) Chan PYN, Mok KL. Transorbital sonographic evaluation of optic nerve sheath diameter in normal Hong Kong Chinese adults. Hong Kong Journal of Emergency Medicine. 2008;15(4):197–204.

13) Yashwashi T, Kaman L, Kajal K, Dahiya D, Gupta A, Meena SC, et al. Effects of low- and high-pressure carbon dioxide pneumoperitoneum on intracranial pressure during laparoscopic cholecystectomy. Surgical Endoscopy. 2019;34(10):4369–73.

14) Kim EJ, Koo B-N, Choi SH, Park K, Kim M-S. Ultrasonographic optic nerve sheath diameter for predicting elevated intracranial pressure during laparoscopic

surgery: A systematic review and meta-analysis. Surgical Endoscopy. 2017;32(1):175–82.

15) Kim M-S, Bai S-J, Lee J-R, Choi YD, Kim YJ, Choi SH. Increase in intracranial pressure during carbon dioxide pneumoperitoneum with steep Trendelenburg positioning proven by ultrasonographic measurement of optic nerve sheath diameter. Journal of Endourology. 2014;28(7):801–6.

16) Chin J-H, Seo H, Lee E-H, Lee J, Hong JH, Hwang J-H, et al. Sonographic optic nerve sheath diameter as a surrogate measure for intracranial pressure in anesthetized patients in the Trendelenburg position. BMC Anesthesiology. 2015;15(1).

17) Chen K, Wang L, Wang Q, Liu X, Lu Y, Li Y, et al. Effects of pneumoperitoneum and steep Trendelenburg position on cerebral hemodynamics during robotic-assisted laparoscopic radical prostatectomy. Medicine. 2019;98(21).

18) Stevens RR, Gommer ED, Aries MJH, Ertl M, Mess WH, Huberts W, et al. Optic nerve sheath diameter assessment by neurosonology: A review of methodologic discrepancies. Journal of Neuroimaging. 2021;31(5):814–25.

19) Robba C, Cardim D, Donnelly J, Bertuccio A, Bacigaluppi S, Bragazzi N, et al. Effects of pneumoperitoneum and Trendelenburg position on intracranial pressure assessed using different non-invasive methods. British Journal of Anaesthesia. 2016;117(6):783–91.

20) Munawar K, Khan MT, Hussain SW, Qadeer A, Shad ZS, Bano S, et al. Optic nerve sheath diameter correlation with elevated intracranial pressure determined via ultrasound. Cureus. 2019.

21) You AH, Song Y, Kim D-H, Suh J, Baek JW, Han DW. Effects of positive end-expiratory pressure on intraocular pressure and optic nerve sheath diameter in robot-assisted laparoscopic radical prostatectomy. Medicine. 2019;98(14).

22) Perrin M, Fletcher A. Laparoscopic abdominal surgery. Continuing Education in Anaesthesia Critical Care & Pain. 2004;4(4):107–10.

23) Mishra DRK. Physiological Changes during Laparoscopic Surgery [Internet]. Physiological changes during laparoscopic surgery. 2020 [cited 2022Dec21]. Available from: https://www.laparoscopyhospital.com/physiological-changes-laparoscopy.html.

24) Sood J, Jain AK, Jolly AS, Jain A. Effect of Carboperitoneum on CNS Physiology. In: Anaesthesia in laparoscopic surgery. New Delhi, India: Jaypee Bros. Medical Publishers; 2007. p. 37–40.

25) Duke J. CHAPTER 20 - Patient Positioning. In: Duke J, ed. Anesthesia Secrets (Fourth Edition). Fourth Edi. Mosby; 2011:142-148. doi:

26) https://doi.org/10.1016/B978-0-323-06524-5.00020-9.

27) Trikha A, Rath GP, Lamsal R. Intracranial Pressure Monitoring. In: Monitoring in anesthesia and critical care. New Delhi, India: Jaypee Brothers Medical Publishers; 2018. p. 224–31.

28) Cannata G, Pezzato S, Esposito S, Moscatelli A. Optic nerve sheath diameter ultrasound: A non-invasive approach to evaluate increased intracranial pressure in critically ill pediatric patients. Diagnostics. 2022;12(3):767.

29) Abraham M, Singhal V. Intracranial Pressure Monitoring. Journal of Neuroanaesthesiology and Critical Care. 2015;02(03):193–203.

30) Bushberg JT, Boone JM. The Essential Physics of Medical Imaging. Wolters Kluwer Health; 2011. https://books.google.co.uk/books?id=tqM8IG3f8bsC.

31) Heggie JCP, Liddell NA, Maher KP, st. Vincent's Hospital (Melbourne Vic). Applied Imaging Technology. St. Vincent's Hospital; 2001. https://books.google.co.uk/books?id=7A38PAAACAAJ.

32) Schäberle W, Dauzat M. Ultrasonography in Vascular Diagnosis. Vol 87.; 2006. doi:10.1016/s0221-0363(06)74044-6.

33) Bell DJ. Optic nerve: Radiology reference article [Internet]. Radiopaedia Blog RSS. Radiopaedia.org; 2022 [cited 2022Dec21]. Available from: https://radiopaedia.org/articles/optic-nerve.

34) Soni NJ, Arntfield R, Kory P, Chesney GL, Mohabir PK. Ocular Ultrasound. In: Point-of-care ultrasound. Philadelphia, Pennsylvania: Elsevier/Saunders; 2015. p. 245–53.

35) Lumb PD, Karakitsos D, Sargsyan AE, Blaivas M, Geeraerts T. Ocular Ultrasound in the Intensive Care Unit. In: Critical care ultrasound. Philadelphia, Pennsylvania: Elsevier Saunders; 2015. p. 45–9.

36) Killu K, Dulchavsky S, Coba V, Xu peng, Geng zhi long, Yuan hong bin, et al. Optic Nerve Exam. In: Icu Chao Sheng Shou Ce = the ICU ultrasound pocketbook. Beijing, (Peking): Ren min wei sheng chu ban she; 2016. p. 183–7.

37) Dixit RB, Neema MM. Use of an Android application "clinometer" for measurement of head down tilt given during subarachnoid block. Saudi journal of anaesthesia. 2016;10(1):29-32. doi:10.4103/1658-354X.169471.

38) Verdonck P, Kalmar AF, Suy K, Geeraerts T, Vercauteren M, Mottrie A, et al. Optic nerve sheath diameter remains constant during robot assisted laparoscopic radical prostatectomy. PLoS ONE. 2014;9(11).

39) Robba C, Cardim D, Tajsic T, Pietersen J, Bulman M, Donnelly J, et al. Ultrasound non-invasive measurement of intracranial pressure in neurointensive care: A prospective observational study. PLOS Medicine. 2017;14(7).

40) Hamilton DR, Sargsyan AE, Melton SL, et al. Sonography for determining the optic nerve sheath diameter with increasing intracranial pressure in a porcine model. J Ultrasound Med. 2011; 30:651–659.

41) Kimberly HH, Shah S, Marill K, Noble V. Correlation of optic nerve sheath diameter with direct measurement of intracranial pressure. Acad Emerg Med. 2008; 15:201-204.

42) Min JY, Lee J-R, Oh J-T, Kim M-S, Jun E-K, An J. Ultrasonographic assessment of optic nerve sheath diameter during pediatric laparoscopy. Ultrasound in Medicine & Biology. 2015;41(5):1241–6.

43) Cooke SJ, Patterson Browne S. Association between laparoscopic abdominal surgery and postoperative symptoms of raised intracranial pressure. Surg Endosc. 2001; 15:723–725.

ANNEXURE I

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH STUDY

Mr. /Mrs. /Miss._____ we are requesting you to enroll yourself in study titled "ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBURG POSITION AND REVERSE TRENDELENBURG POSITION – A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY" conducted by REG NO. BA0120016, Post Graduate in M.D. Anaesthesiology under the guidance of Dr. _____ Department of Anaesthesiology, J.N. Medical College, under K.A.H.E.R, Belagavi.

Respected Sir/Madam We request you to participate in our study as you are eligible for participating in the study. 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 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 this study is to evaluate the extent of change in optic nerve sheath diameter as a marker for elevated intracranial pressure in patients undergoing laparoscopic surgery.

Procedure Involved:

If you agree to enroll in my study, I will ask you the present, past and family medical history. Then you will be clinically examined in detail. After having satisfied the inclusion and exclusion criteria you will be assigned to either of the two groups, A and B depending on the type of surgery to be performed. You will be premedicated, induced with anesthetic drugs and intubated as per standard institutional protocols. A multiport laparoscopic access and pneumoperitoneum will be established as required for the surgery. You will be investigated using ultrasonography for optic nerve sheath diameter measurement during laparoscopic surgery.

Risks:

There is no known risk involved with ultrasonography.

Benefits:

Using ultrasonography, we can predict intraoperative elevation of intracranial pressure during the laparoscopic surgery and take necessary measures to avoid any unwanted outcome.

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 present or future health care services offered to you or your ward at K.L.E.S Hospital and MRC & KLES Dr. Prabhakar Kore Charitable Hospital.

Alternatives:

Even if you decline the participation in the study, you will get the routine line of management.

Privacy and Confidentiality:

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

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

Authorization to Publish Results:

When the results of the research are published or discussed, in a conference, no information will be displayed that would disclose your identity. Any information that is obtained in connection with this study and that can be identified with your identity remains 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 & KLES Dr. Prabhakar Kore Charitable Hospital, Belagavi. There is no compensation or payment for such medical treatment by law.

Questions:

In case you have any questions related to the study in future or in case of study related injury or illness, you can contact REG NO. BA0120016, postgraduate student, Department of Anaesthesiology, J.N. Medical College, KLES Hospital and MRC, Belagavi at Department Phone number _____, mobile number: _____or you can contact Dr_____, Dept. of Anaesthesiology, J.N. Medical College, KLES Hospital and MRC, 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, Belagavi. Phone number-9480422500.

INFORMED CONSENT FOR PARTICIPATION IN RESEARCH TRIAL

"ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBURG POSITION AND REVERSE TRENDELENBURG POSITION – A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY."

I, Mr./Mrs._____

voluntarily agree for the participation as a subject of study. By signing this consent form, I am not giving up any of my legal rights, I may withdraw myself from the study anytime. I am signing the consent form after having read or been read for me in my 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

Title: "ULTRASONOGRAPHIC MEASUREMENT OF OPTIC NERVE SHEATH DIAMETER FOR ASSESSING INTRACRANIAL PRESSURE DURING LAPAROSCOPIC SURGERY IN TRENDELENBURG POSITION AND REVERSE TRENDELENBURG POSITION– A ONE YEAR PROSPECTIVE OBSERVATIONAL STUDY."

Patient Name: IP No.:

Age: Gender:

Date: Occupation:

Address: Anaesthesiologist:

Preanesthetic Evaluation:

1. Chief Complaints:
2. Past History: H/o HTN / DM / Asthma / Epilepsy

   H/o Previous postoperative nausea vomiting

   H/o Motion sickness

   H/o Migraine / chronic headache

   Any other relevant history
3. History of Treatment / Drug intake:

   a) Current drug history

   b) Any H/o drug allergy

   c) H/o opioid drug use
4. History of previous surgeries and anaesthetic exposure:
5. H/o smoking/alcohol/drug abuse:
6. Family history:

General physical examination

Pallor / Icterus / Clubbing / Cyanosis / Lymphadenopathy / Edema

Pulse Rate: BP:

Respiratory Rate: Temperature:

Systemic Examination

RS: CNS:

CVS: GIT:

Airway examination:

Jaw movements: Teeth:

Airway assessment: Spine:

Investigations

Hb: Total Leucocyte Count:

Platelet count: Serum Urea:

Serum Creatinine: RBS:

ECG: Others:

COVID -19 Test:

CHEST XRAY/HRCT:

ASA GRADE: I / II

Diagnosis:

Proposed Surgery:

Preoperative baseline values:

Pulse rate: BP:

Respiratory rate: SpO_2:

Group of study belongs to:

Position given:

Angle of inclination of OT table:

POST OPERATIVE NAUSEA VOMITING (PONV):

1) Nausea yes no

2) Vomiting yes no

3) No of times and dose of antiemetics given:

4) Preop antiemetic prophylaxis given yes no

POST OPERATIVE HEADACHE (POHA): Yes/ No

PARAMETERS	T0	T1	T2	T3
ONSD (sagittal view)				
ONSD (transverse view)				
Avg ONSD				
Heart rate (HR)				
Respiratory rate (RR)				
Oxygen saturation (SpO_2)				
Non-Invasive Blood Pressure (NIBP)				
Mean Arterial Pressure (MAP)				
End tidal CO_2 concentration ($EtCO_2$)				
Airway peak pressure (P_{peak})				
Airway plateau pressure ($P_{plateau}$)				

SIGNATURE OF THE ANAESTHESIOLOGIST: _____

SIGNATURE OF THE GUIDE: _____

SIGNATURE OF THE PRINCIPAL INVESTIGATOR: _____

ANNEXURE III

PHOTOGRAPHS

PHOTOGRAPH 1: USG MACHINE WITH LINEAR PROBE

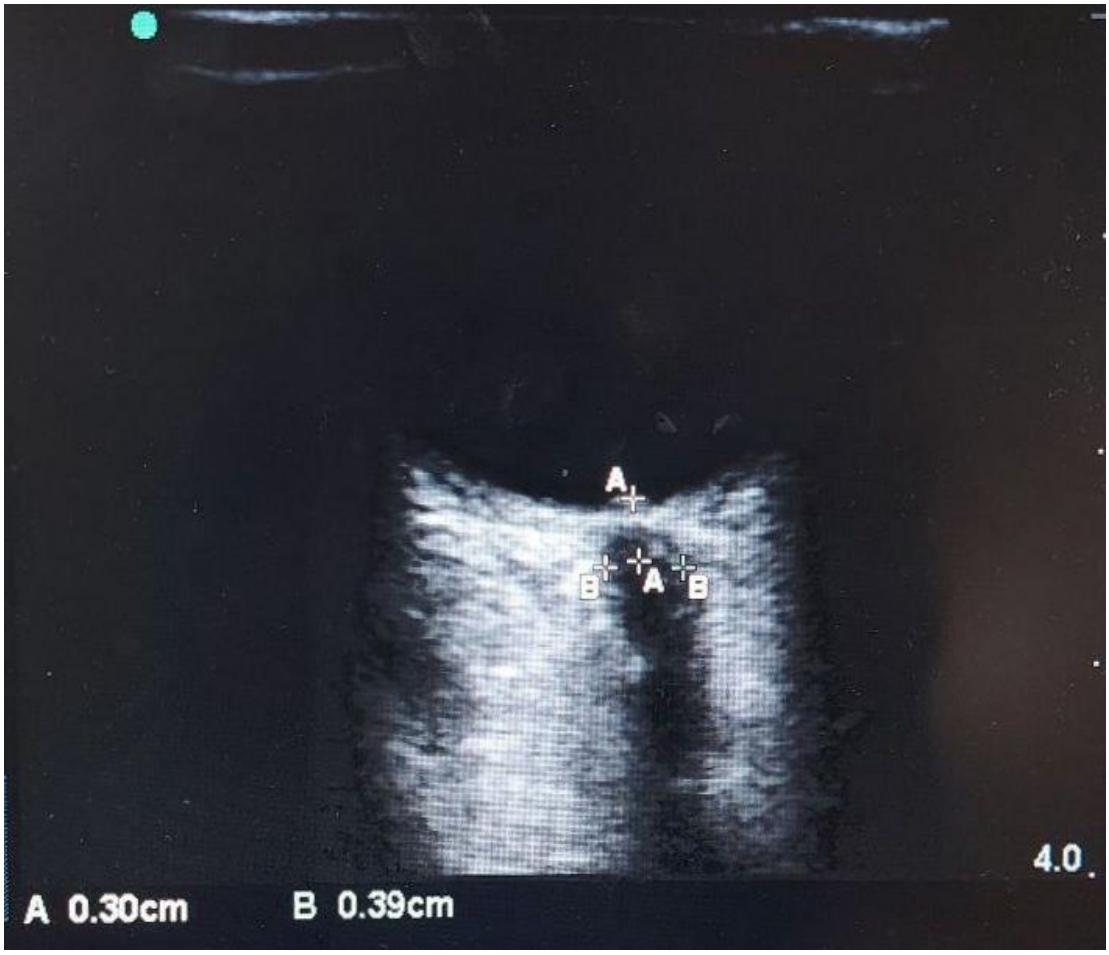
PHOTOGRAPH 2: HIGH FREQUENCY LINEAR USG PROBE

PHOTOGRAPH 3: STERILE LIGNOCAINE JELLY

PHOTOGRAPH 4: TEGADERM

PHOTOGRAPH 5: PROBE PLACEMENT FOR SAGITTAL ONSD MEASUREMENT

PHOTOGRAPH 6: PROBE PLACEMENT FOR TRANSVERSE ONSD MEASUREMENT



PHOTOGRAPH 7: ONSD MEASUREMENT

ANNEXURE IV

KEY TO MASTER CHART

ASA : American Society of Anaesthesiologists

ONSD : Optic Nerve Sheath Diameter

HR : Heart Rate

SBP : Systolic Blood Pressure

DBP : Diastolic Blood Pressure

MAP : Mean Arterial Pressure

$EtCO_2$: End Tidal Carbon Dioxide

P_{peak} : Peak Airway Pressure

$P_{plateau}$: Plateau Airway Pressure

PONV : Post Operative Nausea Vomiting

POHA : Post Operative Headache

T0 : 5 minutes after anesthesia induction in supine position

T1 : 5 minutes after establishing pneumoperitoneum

T2 : 5 minutes after position change combined with pneumoperitoneum

T3 : 5 minutes after desufflation of pneumoperitoneum in supine position.

S. No.	NAME	IP No	AGE (Yrs)	SEX	ASA	Angle of inclination	T0										T1										T2										T3										Postoperative complications		Δ ONSD	Δ ONSD
							ONSD (Saggital)	ONSD (Transvers)	ONSD (Avg)	HR	SBP	DBP	MAP	EtCO2	Ppeak	Pplateau	ONSD (Saggital)	ONSD (Transvers)	ONSD (Avg)	HR	SBP	DBP	MAP	EtCO2	Ppeak	Pplateau	ONSD (Saggital)	ONSD (Transvers)	ONSD (Avg)	HR	SBP	DBP	MAP	EtCO2	Ppeak	Pplateau	ONSD (Saggital)	ONSD (Transvers)	ONSD (Avg)	HR	SBP	DBP	MAP	EtCO2	Ppeak	Pplateau	PONV	POHA	T1 - T0	T2 - T0
1	SANIKA MULLENI	1055842	32	F	1	15	0.47	0.49	0.48	75	114	78	90	33	15	13	0.52	0.50	0.51	88	109	56	74	30	22	20	0.52	0.54	0.53	88	116	75	89	32	18	16	0.48	0.47	0.48	62	112	80	91	29	14	13	NO	NO	0.03	0.05
2	SHWETHA PATIL	1082694	33	F	1	20	0.31	0.32	0.32	98	118	86	97	26	12	11	0.44	0.45	0.45	110	136	92	107	35	18	17	0.50	0.48	0.49	106	145	90	108	32	20	19	0.37	0.39	0.38	84	128	88	101	30	13	12	NO	NO	0.13	0.18
3	DATTATREYA J	1067130	24	M	1	15	0.29	0.32	0.31	87	113	77	89	24	13	11	0.36	0.36	0.36	88	132	89	103	25	21	19	0.52	0.58	0.55	82	127	85	99	27	20	18	0.48	0.46	0.47	63	117	77	90	25	15	14	NO	NO	0.06	0.25
4	MAHADEVI	1072110	49	F	1	15	0.39	0.4	0.40	83	132	92	105	30	16	15	0.49	0.47	0.48	87	151	99	116	33	22	19	0.60	0.58	0.59	87	152	103	119	35	21	19	0.52	0.52	0.52	82	145	92	110	30	18	17	YES	YES	0.09	0.20
5	ANWAR	1044752	29	M	1	20	0.45	0.43	0.44	82	112	89	97	28	15	14	0.49	0.51	0.50	92	136	90	105	32	19	19	0.65	0.67	0.66	99	145	95	112	34	22	21	0.42	0.48	0.45	90	128	86	100	29	15	14	YES	YES	0.06	0.22
6	GANESH B	1045919	19	M	1	25	0.36	0.29	0.33	96	118	72	87	26	12	12	0.47	0.45	0.46	112	145	80	102	30	20	18	0.52	0.48	0.50	110	147	92	110	33	22	21	0.39	0.42	0.41	89	128	84	99	29	14	13	NO	NO	0.14	0.18
7	BASAVARAJ D	1084230	47	M	1	22	0.33	0.32	0.33	88	126	80	95	28	12	11	0.39	0.40	0.40	106	142	98	113	34	19	18	0.48	0.51	0.50	110	139	100	113	32	20	19	0.42	0.40	0.41	92	130	90	103	32	16	14	NO	NO	0.07	0.17
8	SATISH	1083574	24	M	1	25	0.36	0.39	0.38	88	112	76	88	28	14	12	0.42	0.45	0.44	99	139	89	106	36	22	21	0.44	0.49	0.47	98	142	92	109	31	20	19	0.39	0.40	0.40	90	126	80	95	30	12	11	NO	NO	0.06	0.09
9	DHULU GARADE	1084264	60	M	1	20	0.33	0.32	0.33	86	126	84	98	30	14	13	0.40	0.45	0.43	102	146	92	110	33	20	19	0.50	0.49	0.50	98	138	88	105	32	22	21	0.41	0.42	0.42	86	124	80	95	30	15	14	NO	NO	0.10	0.17
10	SUNITA J		26	F	1	20	0.32	0.30	0.31	84	128	83	98	30	15	14	0.39	0.42	0.41	104	145	103	117	35	22	19	0.52	0.49	0.51	98	140	90	107	32	23	22	0.40	0.42	0.41	78	124	80	95	30	14	12	NO	NO	0.10	0.20
11	PRAGATHI K	1084212	23	F	1	20	0.38	0.40	0.39	90	128	83	98	30	15	14	0.45	0.51	0.48	102	145	103	117	36	19	17	0.55	0.55	0.55	98	145	95	112	34	18	15	0.48	0.50	0.49	76	124	84	97	32	17	16	NO	NO	0.09	0.16
12	ANITHA	1079298	49	F	2	45	0.28	0.29	0.29	86	118	72	87	28	14	13	0.39	0.42	0.41	102	142	90	107	33	18	17	0.55	0.56	0.56	108	132	92	105	32	22	20	0.42	0.40	0.41	88	126	84	98	30	15	14	YES	YES	0.12	0.27
13	SAHYADHRI PATIL	1082082	21	F	1	20	0.37	0.39	0.38	100	128	85	99	26	14	12	0.40	0.39	0.40	102	136	93	107	29	20	19	0.44	0.45	0.45	100	153	98	116	24	20	19	0.44	0.42	0.43	80	132	80	97	22	14	13	NO	NO	0.02	0.07
14	RAJESHWARI	1044492	38	F	1	15	0.28	0.32	0.30	76	119	80	93	28	15	15	0.33	0.34	0.34	92	145	99	114	37	22	21	0.53	0.49	0.51	70	127	88	101	31	20	19	0.40	0.42	0.41	86	132	86	101	30	16	15	NO	NO	0.04	0.21
15	AYRAPPA K	1086176	22	M	1	15	0.35	0.38	0.37	96	130	90	103	28	16	15	0.47	0.45	0.46	105	146	96	113	32	22	21	0.52	0.49	0.51	102	149	102	118	34	24	22	0.42	0.39	0.41	86	128	96	107	30	14	14	NO	NO	0.10	0.14
16	SUNITHA M	1086690	32	F	1	15	0.38	0.42	0.40	82	126	80	95	29	16	15	0.47	0.52	0.50	97	138	92	107	36	21	20	0.59	0.61	0.60	102	142	80	101	34	22	20	0.42	0.40	0.41	88	120	77	91	28	15	14	YES	NO	0.10	0.20
17	BASAYYA K	1086686	34	M	1	20	0.29	0.32	0.31	96	120	80	93	29	19	18	0.35	0.35	0.35	116	150	112	125	36	26	24	0.42	0.39	0.41	118	138	90	106	34	26	25	0.40	0.39	0.40	92	132	80	97	30	20	19	NO	NO	0.05	0.10
18	SHWETHA B	1085536	26	F	1	18	0.27	0.30	0.29	82	118	76	90	29	12	11	0.46	0.48	0.47	100	138	90	106	36	20	19	0.59	0.62	0.61	112	142	98	113	34	22	19	0.42	0.44	0.43	92	126	80	95	28	14	13	YES	NO	0.19	0.32
19	KANCHANA J	1072052	18	F	1	20	0.30	0.34	0.32	83	132	92	105	28	16	15	0.42	0.44	0.43	87	151	91	111	33	22	19	0.55	0.50	0.53	87	152	103	119	35	21	19	0.39	0.40	0.40	93	105	65	78	31	18	16	NO	NO	0.11	0.21
20	AISHWARYA	1095845	19	F	1	20	0.30	0.29	0.30	80	128	30	63	29	14	14	0.36	0.36	0.36	96	132	78	96	34	24	22	0.45	0.46	0.46	98	142	90	107	36	23	22	0.41	0.40	0.41	92	127	97	107	33	16	15	NO	NO	0.07	0.16
21	NEHA DHARADI	1084916	19	F	1	15	0.29	0.28	0.29	84	112	80	91	28	12	11	0.47	0.49	0.48	102	136	90	105	36	18	16	0.52	0.57	0.55	96	142	90	107	34	19	18	0.32	0.34	0.33	90	130	86	101	30	14	13	YES	NO	0.20	0.26
22	ROOPA C	1096245	26	F	1	15	0.33	0.34	0.34	77	120	72	88	30	11	10	0.45	0.47	0.46	106	142	88	106	36	16	14	0.52	0.54	0.53	118	132	92	105	34	18	17	0.29	0.34	0.32	88	126	82	97	30	12	11	NO	NO	0.13	0.20
23	ALAMSAHEB	1043072	42	M	2	15	0.27	0.28	0.28	91	140	110	120	28	12	11	0.41	0.45	0.43	101	127	86	100	30	15	15	0.52	0.48	0.50	102	126	89	101	32	15	14	0.47	0.46	0.47	88	124	82	96	30	12	11	NO	NO	0.16	0.23
24	CHANDRIKA	1095611	19	F	1	20	0.29	0.30	0.30	86	118	72	87	29	14	14	0.40	0.43	0.42	104	142	90	107	34	18	17	0.54	0.57	0.56	106	132	92	105	33	23	21	0.41	0.39	0.40	88	126	84	98	30	16	15	YES	NO	0.12	0.26
25	MAREPPA	1096463	33	M	2	25	0.28	0.31	0.30	96	132	86	101	32	16	15	0.39	0.39	0.39	104	156	102	120	36	22	21	0.46	0.49	0.48	116	146	90	109	35	23	20	0.36	0.34	0.35	84	124	84	97	29	14	13	NO	NO	0.10	0.18
26	SUJATA K	1096418	29	F	1	20	0.33	0.34	0.34	82	122	76	91	28	12	11	0.42	0.44	0.43	92	142	96	111	38	20	19	0.49	0.54	0.52	116	146	100	115	34	22	20	0.36	0.34	0.35	90	130	90	103	30	14	11	NO	NO	0.10	0.18
27	RANJANA PATIL	1090139	33	F	1	20	0.27	0.28	0.28	82	140	86	104	28	12	11	0.41	0.45	0.43	98	152	101	118	34	15	15	0.56	0.59	0.58	107	136	90	105	36	15	14	0.40	0.39	0.40	87	130	92	105	30	12	10	YES	YES	0.16	0.30
28	GURUPADAPPA	1084972	48	M	1	15	0.32	0.35	0.34	78	120	70	87	32	11	10	0.44	0.45	0.45	107	138	88	105	36	16	15	0.49	0.52	0.51	118	130	90	103	35	18	18	0.39	0.37	0.38	88	128	84	99	30	12	11	NO	NO	0.11	0.17
29	LAXMIBAI	1093972	42	F	2	20	0.30	0.34	0.32	92	126	80	95	31	15	14	0.47	0.45	0.46	112	147	92	110	38	23	21	0.51	0.49	0.50	108	156	101	119	34	26	24	0.37	0.40	0.39	98	130	90	103	29	18	17	NO	NO	0.14	0.18
30	NILAVVA	1091915	24	F	2	15	0.33	0.34	0.34	82	126	72	90	31	12	11	0.44	0.46	0.45	101	137	87	104	36	18	17	0.49	0.52	0.51	112	130	90	103	34	20	19	0.37	0.40	0.39	88	129	80	96	30	13	11	NO	NO	0.12	0.17

TRENDELENBERG POSITION (GROUP A)

S. No.	NAME	IP No	AGE (Yrs)	SEX	ASA	Angle of inclination	T0										T1										T2										T3										Postoperative complications		Δ ONSD	Δ ONSD
							ONSD (Saggital)	ONSD (Transvers)	ONSD (Avg)	HR	SBP	DBP	MAP	EtCO2	Ppeak	Pplateau	ONSD (Saggital)	ONSD (Transvers)	ONSD (Avg)	HR	SBP	DBP	MAP	EtCO2	Ppeak	Pplateau	ONSD (Saggital)	ONSD (Transvers)	ONSD (Avg)	HR	SBP	DBP	MAP	EtCO2	Ppeak	Pplateau	ONSD (Saggital)	ONSD (Transvers)	ONSD (Avg)	HR	SBP	DBP	MAP	EtCO2	Ppeak	Pplateau	PONV	POHA	T1 - T0	T2 - T0
1	KAUSAR M	1081865	21	F	1	30	0.32	0.30	0.31	81	101	72	82	25	14	14	0.35	0.36	0.36	78	118	81	93	29	18	16	0.40	0.39	0.40	90	122	86	98	29	19	16	0.36	0.36	0.36	78	118	81	93	27	18	16	NO	NO	0.05	0.09
2	SHASHIKALA PATIL	1081379	37	F	1	25	0.37	0.39	0.38	96	136	93	107	20	15	14	0.45	0.42	0.44	102	142	90	107	26	20	19	0.46	0.45	0.46	106	153	98	116	24	22	19	0.38	0.40	0.39	80	118	80	93	22	14	13	NO	NO	0.06	0.08
3	SHOBA PATIL	1081281	34	F	1	25	0.33	0.35	0.34	79	118	72	87	30	11	10	0.39	0.40	0.40	102	142	90	107	36	18	16	0.42	0.40	0.41	118	132	92	105	34	15	14	0.39	0.37	0.38	86	126	84	98	32	11	11	NO	NO	0.06	0.07
4	PAVITRA H	1080957	25	F	1	20	0.37	0.35	0.36	112	131	93	106	26	11	10	0.40	0.40	0.40	115	136	92	107	35	14	13	0.43	0.44	0.44	113	151	87	108	30	15	13	0.39	0.37	0.38	92	128	74	92	29	12	11	NO	NO	0.04	0.08
5	GANGAPPA	1083614	60	M	2	20	0.42	0.40	0.41	78	142	90	107	29	14	12	0.54	0.51	0.53	96	154	102	119	34	17	16	0.56	0.55	0.56	108	150	98	115	30	19	17	0.40	0.39	0.40	90	138	84	102	20	14	13	YES	NO	0.12	0.15
6	RAJESAB NADAF	1084933	50	M	2	18	0.30	0.29	0.30	78	129	80	96	30	14	12	0.42	0.45	0.44	102	146	104	118	34	20	20	0.44	0.48	0.46	116	152	98	116	32	19	18	0.39	0.37	0.38	89	137	77	97	29	15	15	NO	NO	0.14	0.17
7	BASAVARAJ K	1083994	46	M	1	20	0.27	0.29	0.28	70	132	78	96	29	11	10	0.38	0.39	0.39	88	147	71	96	36	19	18	0.44	0.44	0.44	96	140	90	107	35	19	17	0.32	0.35	0.34	74	117	85	96	29	14	13	NO	NO	0.11	0.16
8	SUNANDA K	1085096	58	F	1	18	0.31	0.33	0.32	68	118	80	93	29	14	13	0.39	0.39	0.39	77	124	94	104	37	20	19	0.38	0.41	0.40	89	130	94	106	33	19	19	0.30	0.29	0.30	70	107	77	87	30	14	12	NO	NO	0.07	0.08
9	MOHAMMED R	1085799	38	M	1	20	0.29	0.27	0.28	88	122	84	97	26	12	12	0.40	0.41	0.41	99	136	100	112	33	20	19	0.42	0.40	0.41	104	128	98	108	30	18	18	0.34	0.36	0.35	80	117	74	88	28	14	13	NO	NO	0.13	0.13
10	RENUKA G		38	F	1	15	0.33	0.34	0.34	80	118	88	98	29	16	15	0.42	0.39	0.41	102	132	75	94	38	22	20	0.44	0.45	0.45	98	135	92	106	33	21	20	0.37	0.35	0.36	75	124	77	93	32	14	12	NO	NO	0.07	0.11
11	PRAMILA	1085155	21	F	1	20	0.30	0.31	0.31	80	124	88	100	29	13	12	0.44	0.42	0.43	102	136	92	107	36	17	16	0.45	0.44	0.45	98	134	77	96	32	19	19	0.32	0.30	0.31	84	128	86	100	30	11	10	NO	NO	0.13	0.14
12	ALLASAHEB B	1084980	55	M	2	20	0.29	0.31	0.30	89	132	72	92	27	11	10	0.37	0.39	0.38	104	148	89	109	35	16	15	0.38	0.40	0.39	107	134	80	98	34	15	14	0.36	0.33	0.35	78	128	80	96	28	10	10	NO	NO	0.08	0.09
13	SHANKAR JADAV	1042885	50	M	1	15	0.25	0.25	0.25	97	111	81	91	28	15	16	0.36	0.35	0.36	80	140	90	107	39	20	19	0.40	0.38	0.39	85	140	98	112	41	20	19	0.39	0.39	0.39	80	118	73	88	30	18	18	NO	NO	0.11	0.14
14	RESHMA H	1083864	33	F	1	26	0.32	0.36	0.34	88	128	64	85	28	12	11	0.40	0.41	0.41	102	142	90	107	36	19	18	0.40	0.43	0.42	98	136	88	104	32	20	19	0.38	0.39	0.39	90	130	78	95	31	14	12	NO	NO	0.07	0.08
15	RAJESH	1083522	54	M	2	30	0.29	0.30	0.30	78	104	67	79	30	14	12	0.38	0.36	0.37	72	130	100	110	32	20	19	0.42	0.40	0.41	79	131	94	106	33	23	20	0.35	0.39	0.37	68	101	66	78	31	18	17	NO	NO	0.08	0.12
16	SHAINAZ	1083274	40	F	1	28	0.32	0.30	0.31	78	104	67	79	30	18	16	0.36	0.34	0.35	72	137	102	114	37	20	18	0.39	0.40	0.40	76	131	94	106	33	23	20	0.37	0.39	0.38	60	101	66	78	32	16	14	NO	NO	0.04	0.09
17	ARCHANA B	1085360	31	F	1	20	0.27	0.29	0.28	88	132	82	99	29	15	13	0.34	0.36	0.35	102	140	92	108	36	18	17	0.39	0.41	0.40	98	138	98	111	33	19	18	0.34	0.33	0.34	90	118	74	89	29	16	15	NO	NO	0.07	0.12
18	MALLAVVA B	1083619	60	F	2	15	0.30	0.29	0.30	72	120	80	93	28	12	11	0.42	0.44	0.43	92	132	91	105	36	18	18	0.44	0.42	0.43	98	128	87	101	32	20	19	0.30	0.33	0.32	68	116	78	91	29	14	13	NO	NO	0.14	0.14
19	SANA GOUDA PA	1078112	48	M	1	25	0.33	0.35	0.34	79	118	72	87	30	11	10	0.42	0.44	0.43	102	142	90	107	36	18	16	0.44	0.46	0.45	118	132	92	105	34	19	18	0.39	0.37	0.38	86	130	86	101	32	11	10	NO	NO	0.09	0.11
20	IRSHAD B	1080329	50	M	2	30	0.35	0.35	0.35	65	77	45	56	26	14	11	0.44	0.45	0.45	85	157	107	124	29	20	18	0.47	0.46	0.47	91	140	96	111	29	19	16	0.39	0.37	0.38	80	126	86	99	26	14	12	NO	NO	0.10	0.12
21	FAHED MULLA	1054217	30	M	1	30	0.37	0.39	0.38	102	90	72	78	26	12	11	0.52	0.55	0.54	92	121	86	98	37	20	19	0.57	0.60	0.59	97	138	97	111	33	19	18	0.45	0.42	0.44	91	108	80	89	34	15	13	YES	YES	0.16	0.21
22	SALIM SHAIK	1094849	58	M	1	20	0.30	0.32	0.31	68	116	76	89	29	13	11	0.44	0.46	0.45	102	132	88	103	35	21	20	0.45	0.46	0.46	96	139	90	106	32	22	20	0.32	0.35	0.34	77	124	85	98	30	16	15	NO	NO	0.14	0.15
23	S D'SOUZA	1091387	43	M	2	18	0.29	0.30	0.30	64	122	80	94	25	17	16	0.42	0.43	0.43	98	148	104	119	36	24	23	0.45	0.43	0.44	92	144	98	113	36	25	24	0.33	0.33	0.33	78	130	88	102	29	18	16	YES	NO	0.13	0.15
24	BHIRAPPA	1089250	52	M	1	20	0.33	0.34	0.34	78	134	90	105	30	12	12	0.45	0.42	0.44	104	142	98	113	36	19	17	0.46	0.44	0.45	98	146	90	109	34	19	18	0.37	0.39	0.38	86	130	85	100	29	14	13	NO	NO	0.10	0.12
25	GANGUBHAI	1090934	41	F	1	15	0.32	0.30	0.31	83	112	89	97	29	15	14	0.41	0.44	0.43	102	138	100	113	38	19	18	0.40	0.43	0.42	112	134	92	106	33	21	20	0.34	0.34	0.34	80	125	87	100	30	15	15	YES	YES	0.12	0.11
26	RAZAK DESAI	1093070	60	M	2	20	0.27	0.29	0.28	72	142	80	101	29	14	14	0.38	0.39	0.39	98	155	103	120	38	23	22	0.42	0.42	0.42	95	148	92	111	36	22	20	0.30	0.34	0.32	68	130	85	100	32	16	15	NO	NO	0.11	0.14
27	FARZANA H	1094138	36	F	1	18	0.31	0.31	0.31	83	117	71	86	27	16	14	0.39	0.43	0.41	107	142	103	116	36	22	21	0.44	0.42	0.43	98	135	90	105	35	23	20	0.35	0.34	0.35	92	127	73	91	30	14	12	NO	NO	0.10	0.12
28	AIMAAN MANIYAR	1092609	27	M	2	22	0.34	0.30	0.32	60	120	76	91	30	18	17	0.44	0.45	0.45	84	128	93	105	40	24	22	0.43	0.47	0.45	92	132	95	107	34	25	23	0.32	0.35	0.34	68	113	70	84	31	16	15	NO	NO	0.13	0.13
29	PRAKASH K		53	M	2	15	0.27	0.25	0.26	70	120	70	87	32	10	10	0.39	0.40	0.40	88	136	92	107	38	18	17	0.42	0.40	0.41	84	138	96	110	33	19	18	0.30	0.34	0.32	78	127	84	98	29	12	11	NO	NO	0.14	0.15
30	ASHIDA KANAPUR	1087806	37	F	1	20	0.30	0.28	0.29	84	126	80	95	27	16	14	0.42	0.44	0.43	98	139	100	113	33	23	21	0.43	0.45	0.44	102	140	98	112	30	22	20	0.35	0.37	0.36	90	118	75	89	25	14	14	YES	NO	0.14	0.15

REVERSE TRENDELENBERG POSITION (GROUP B)