INCIDENCE AND COMPLICATIONS OF VENOUS AIR EMBOLISM IN PATIENTS UNDERGOING ELECTIVE INTRACRANIAL SURGERIES BY USING TRANSESOPHAGEAL ECHOCARDIOGRAPHY

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DM (Neuroanaesthesia)

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DECLARATION

I hereby declare that this thesis titled **'Incidence and complications of venous air embolism in patients undergoing elective intracranial surgeries by using Transesophageal echocardiography'** has been prepared by me under the capable supervision and guidance of Dr.Smita V., Associate Professor, Department of Anaesthesiology (Neuroanaesthesia division), Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram and Dr. Manikandan.S, Professor, Department of Anaesthesiology, Head of Neuroanaesthesia division, Sree Chitra Tirunal Institute for Medical Sciences & Technology, Thiruvananthapuram.

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TABLE OF CONTENTS

ABBREVIATIONS

ABP: Arterial blood pressure

ASA: American Society of Anaesthesiology

BMI: Body Mass Index

CT: Computed Tomography

EF: Ejection Fraction

ECG: Electrocardiogram

ETCO2: End tidal carbon dioxide

ETN2: End tidal Nitrogen

HR: Heart Rate

ICU: Intensive Care Unit

LVIDD: Left ventricular internal diameter in diastole

LVIDS: Left ventricular internal diameter in Systole

MAP: Mean Arterial Pressure

MAP: Mean Airway Pressure

NIBP: Non invasive blood pressure

NPO: Nil Per Oral

NSICU: Neuro-surgical Intensive Care Unit

PEEP: Positive End Expiratory Pressure

PAP: Peak Airway Pressure

PAP: Pulmonary Artery Pressure

PW: Pulsed Wave

PFO:Patent Foramen Ovale:

RVIDD:Right ventricular internal diameter in diastole

RVIDS: Right ventricular internal diameter in Systole

RR: Respiratory Rate

RWMA: Regional Wall Motion Abnormality

RA: Right Atrium

RV: Right Ventricle

SAH: Subarachnoid Haemorrhage

SD: Standard Deviation

SBP: Systolic blood pressure

TEE: Transesophageal Echocardiography

TAPSE: Tricuspid Annular Plane Systolic Excursion

TV: Tidal Volume

VAE: Venous Air Embolism

INTRODUCTION

INTRODUCTION

Venous air embolism (VAE) is the entrainment of air from the surgical site into the venous system producing a broad range of symptoms and outcomes. The venous air embolism can happen in all type of surgeries. However in neurosurgical patients venous air embolism is clinically more relevant due to possibility of severe hemodynamic disturbance it can produce in these patients. While VAE most probably occurs much more frequently than is recognized clinically, with significant air entrainment the syndrome can produce hemodynamic collapse and death. The studies addressing VAE have reported different incidences within a wide range of 7%–76%.[1]

Sitting position in neurosurgery has the advantages of good surgical exposure and less blood loss. However the sitting position was associated with more incidence of venous air embolism.[2] So majority of studies on venous air embolism were carried out in sitting position.

Neurosurgical operations performed in the lateral, supine, or prone positions have an incidence ranging from 15% to 25%.[3] Although it was reported to occur more commonly in sitting positions, air embolism may occur in any surgical position, including prone, as long as a gradient develops between the operation site and the heart.[3,4]

Papadopoulos et al[2] studied the incidence of venous paradoxical air embolism in the sitting position. He found to have venous air embolism in 76% of all posterior fossa operation and 25% of cervical laminectomies. Similarly Schwatz et al detected in 27.4% venous air embolism in sitting position by using the transesophageal echocardiography[5].

Mammoto et al[6] used transesophageal echocardiography to find the incidence of venous and paradoxical air embolism in neurosurgical patients in the sitting position. He detected venous air embolism in all the patients undergoing surgeries in sitting position by using TEE but paradoxical air embolism only occurred following the most severe grade of venous air embolism.

However no study was done to find the relationship between the gradient of height of surgical field from the right heart with the incidence of venous air embolism. Therefore we proposed this observational study to find the cut off height of the surgical field from the right heart to predict the venous air embolism. Our study was also designed to find the incidence rates and complications rates of venous air embolism in different positions in neurosurgeries involving various neurological conditions.

AIMS AND OBJECTIVES

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Our study is a prospective observational study which was performed with following aims:

1. Incidence of venous air embolism in different patient positions in neurosurgery (supine, lateral, semi-sitting and sitting position) by using Transesophageal Echocardiography and its grading according its severity.
2. Incidence of venous air embolism in their relation with the vertical gradient of the operating field from the right atrium and the angle of the position from the ground level.
3. Comparison of the incidence of venous air embolism detected with Transesophageal Echocardiography with that detected by End Tidal Carbon dioxide.
4. Incidence of immediate and late complications as a consequence of venous air embolism.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Venous air embolism (VAE) is defined as entry of air into the central venous system producing an embolism in the right heart or pulmonary artery. Any gas can result in remobilization if present in the vasculature. Its characteristics, mainly its solubility and volume will determine the clinical sequelae. Air is the commonest cause for this predominantly iatrogenic complication. . Also medical gases such as carbon dioxide[11, 12], nitrous oxide [13,14], nitrogen[15,16], and helium [17] can also cause this condition.

Air embolism was first reported in 19th century, both in the paediatric and adult surgical practice[18]. The main site of entrance of air was described in procedures involving the neck and upper chest. Approximately 160 years ago, Magendie[21] described the first reported case of a death due to air aspiration. Erichsen[19] described different changes in heart sounds resulting from entrance of air into right side of heart 134 years before . More than 30 cases were published regarding venous air aspiration by 1835 in various Europe and American journals[21]. These early reports were occurred in non neurosurgical spontaneous breathing patients of which many were operated in sitting position. The incidence ranges between 16% and 86%, depending on the literature model studied; however, in most cases, it has no relevant clinical manifestations[22,23]. Traditionally associated with neurosurgical procedures performed in the sitting position, VAE has also been observed to occur in non-sitting surgical procedures. This is because of improved methods of detection and to the increasing complexity of surgical procedures and use of laparoscopic surgical techniques. While VAE occurs much more frequently than is recognized clinically, with significant air entrainment, the syndrome can produce hemodynamic collapse and death.

This wide range in the incidence on VAE is probably due to the different variety of surgical and anaesthetic techniques reported and also due to the different diagnostic methods used. VAE-related mortality in neurosurgery is unclear, but there are some case reports of fatal outcomes following the occurrence of a massive air embolism.[24]The risk of developing a VAE exists for all kinds of neurosurgical procedures. Its incidence is higher for procedures requiring the patient to be in a sitting[25]or semi-sitting position. [1,26] The incidence of air embolism in the sitting position is variable but has been described in up to 45% of the cases.[27]

It also occur with the patient in lateral decubitus, supine or prone position.[28]The procedures more commonly associated with VAE are craniotomy in the sitting position, surgery of the posterior fossa, and craniosynostosis repair.[29,30] In paediatric neurosurgery the incidence reported has ranged between 9.8 and 42%.[31,32] The incidence reported in neuroendoscopic procedures is low, but can occur.[33] Three cases of fatal VAE have also been reported in patients during lumbar laminectomy performed in the prone position[34]. The frames used during spine surgery to reduce epidural bleeding by suspending the abdomen reduces inferior vena caval (IVC) pressure.[35] This reduction in IVC pressure results in a relative increase in the negative pressure gradient between the epidural veins and the right atrium. The greater the gradient between surgical site and right atrial pressure (RAP), the greater the potential for air entrainment. The critical gradient has been reported to be as low as 5 cm.[36] When this physical gradient is combined with inadequate intravascular volume replacement (producing decreased venous return and thereby, reduced RAP), the stage is set for the entrainment of air into the venous circulation.

Incidence-

Traditionally neurosurgical procedures and surgical procedures of the head and neck are associated with the greatest incidence of venous air embolism but there are other types of surgeries associate with it. During hip replacement surgery, the incidence is reported to be approximately 30%.[38] Using a precordial ultrasound Doppler, Malinow et al[39] reported the incidence of VAE to be 40% in women undergoing caesarean section.

Various studies on VAE have been reported in medical or surgical procedures and trauma. During laparoscopic cholecystectomy, the incidence is reported to be 69% [45]. Also, VAE cases associated with central venous catheters [46], endoscopic procedures [47], or inadvertent injection of air as contrast media [48] have been recently reported. Lung[49] or abdominal trauma [50] can also induce VAE.

Neurosurgical procedures which are performed in the sitting position have the highest rate of VAE, with an incidence of approximately 10% for cervical laminectomy and an incidence as high as 80% for seated posterior fossa surgery[37,2]. Neurosurgical operations performed in the lateral, supine, or prone positions have an incidence ranging from 15% to 25% .[3]

Though higher superior sagittal sinus pressure were noted in upright children under 6 years of age, the incidence of VAE during seated neurosurgical procedures is practically identical to that of the adult.[40,41]Surgery to correct craniosynostosis is one of the procedures with the highest incidence of VAE and represents an important cause of morbidity and mortality in the paediatric population.[42] Children suffer greater hemodynamic derangements from VAE than adults.[43]This is believed to be because the volume of air entrained in children is larger relative to their cardiac volume.

Recently, surgery for deep brain stimulation with the patient awake for the treatment of Parkinson and other motion disorders has been noted to be associated with a greater risk of developing VAE. Chang et al[1], found an incidence of 1.3% of VAE in a retrospective series of 467 patients undergoing deep brain stimulation. Other recently published trials have reported an incidence of VAE of 3.2% for deep stimulation surgery in a retrospective series of 287 cases, and an incidence of 4.5% in a prospective series with 22 cases.[51]

Air embolism has also been reported in stereotactic surgery.[52]A Series with 36 stereotactic surgeries reported 3 cases of symptomatic air embolism (8.3%) and in 5 cases there was radiographic evidence of air embolism in postoperative CT scan(13.8%). This study showed a relationship between the elevated head position and the occurrence of air embolism, although the air volume did not affect the patient's hemodynamic stability. There have been reports of occurrence of venous air embolism with neuro endoscopic surgeries, but the incidence is low.[33] The pin site can also be a source of venous air embolism but it is very rare.[70]

Pathophysiology-

The major air emboli often originates from non-collapsible cerebral venous sinuses, mostly the transverse, sigmoid, and the posterior half of sagittal sinus and the venous channels in the diploic space within the cancellous bone of skull (which may occur during craniotomy and also pin fixation). The diploic space is not actually a bleeding site and provides a one-way passage for air to enter the circulation.[52] However, any vein opened during a surgical procedure may become a source for air entrance. Air may enter via emissary veins, which can be opened to atmosphere at their point of entry to the occipital bone, during procedures requiring dissection of suboccipital muscle.[6,53] The veins within or below the duramater may also become an entrance site. The intradural venous channels are frequently opened which may not be coagulated effectively due to the confined space of burr holes.[1] Air under pressure in the ventricles or subdural space may also enter the venous system, probably through the egress route of cerebrospinal fluid via arachnoid granulations.[53]

VAE may cause significant morbidity including lung injury, neurologic injury, cardiovascular compromise, and mortality due to cardiovascular collapse caused by obstruction to blood flow from the right heart.[7,54,55] The LD50 of bolus air is estimated to be 200–300 mL in humans. When a *large volume of air* is entrained in the venous system, it moves to the right atrium (RA) and ventricle and interferes with the flow of blood through tricuspid and pulmonary valves, which results in "air lock" of the right heart, reducing the stroke volume and cardiac output.[54,55] The decrease in cardiac output eventually causes hypotension, tachycardia or bradycardia, reduction in pulmonary arterial pressure, and a rise in central venous pressure (CVP).

VAE may also occur as slow passage of air to the venous system in a longer period of time. VAE during sitting craniotomy occurs more in this slow way. The pathophysiologic consequence of slow air infusion is different from that of large air emboli, because small air bubbles pass through the right heart to lodge in the pulmonary vasculature, resulting in mechanical obstruction to pulmonary blood flow. This obstruction causes a progressive right ventricular (RV) overload that eventually leads to cardiovascular collapse. In contrast to large volume of air emboli, the pulmonary arterial pressure and CVP gradually rise, while cardiac output gradually decreases.

The consequences of the effects of air emboli most commonly depend on volume and rate of accumulation.[54,56] In a study addressing the hemodynamic effects of volume of air emboli in dogs, it was reported that the effects begin at an infusion rate of 0.5 mL/kg/min and severe cardiovascular impairment occurs at >1.5 mL/kg/min.[54] VAE has been classified by using different grading scales according to its severity. Most of the detected VAE events were reported to reveal no clinical alterations.[57,58,59]

Grading scales of venous air embolism-

Venous air embolism is graded to know the severity of the air embolism. It is graded differently by different authors. Girard[57] scale takes into account precordial Doppler signal along with hemodynamic alteration and decrease in End tidal Carbon dioxide ($ETCO_2$).

Grade 1 -include precordial Doppler signal positive without any hemodynamic alteration.

Grade 2 include positive Doppler signal along with decrease of etco2 more than 3 mm of Hg/ increase in SPAP by 5 mm of hg.

Grade 3 includes positive Doppler signal along with decrease in ABP by 20% or increase in HR by more than 20% and at least one positive grade 2 criteria. Grade 4 include abrupt decrease in ABP by ≥40% or increase in HR by 40% and at least one positive grade 2 criteria.

Grade 5 consists of cardio circulatory collapse with at least one positive grade 2 criterion.

Next grading scale is Tubigen scale by Feigl[58] where,

Grade 1 contain TEE air bubbles,

Grade 2 has TEE bubbles with decrease in etco2 by >3 mm of Hg.

Grade 3 has TEE air bubbles and decrease ETCO2 >3 mm of Hg,

Grade 4 has TEE bubbles and decrease ETCO2 >3 mm of Hg and decrease in MAP by≥20% and/or increase in HR by≥40%.

Grade 5 patients have arrhythmia with hemodynamic instability requiring CPR.

Another grading is Jadik scale[59] where he included TEE finding, $ETCO_2$ decrease along with hemodynamic instability.

Grade 1 includes TEE positive with decrease ETCO2 >3 mm of Hg,

Grade 2 includes TEE positive findings and decrease in MAP by≥20% and/or increase in HR by≥40% including CPR.

Grade 3 is the most severe form of Jadik score.

Another grading is by Schmandra T C [60]grading which is based on only TEE findings.

Grade 1 includes single air bubble in right atrium, RV,RVOT, Grade 2 includes air bubble filling less than half diameter of RA, RV,RVOT. Grade 3 includes air bubble filling more than half diameter of RA, RV,RVOT. Grade 4 , air completely fills whole of RA,RV and RVOT.

This is the grading system we had used in our study.

Clinical manifestations-

When the patient is awake during the surgical procedure, the VAE may manifest as a coughing episode associated with arterial oxygen desaturation, arterial hypotension,[66] dyspnoea, chest pain and nausea. Furthermore, a de novo heart murmur may be identified at auscultation.[55,67]During the postoperative period patients may develop neurological impairment ranging from focal neurological lesions to coma.[68]Cardiovascular disorders may also develop, including acute right heart failure, pulmonary hypertension, myocardial ischemia, associated pulmonary edema,[69]and cardiovascular collapse.[70]The presence of coagulopathy and reduced platelet count have also been reported following a VAE, apparently triggered by the effect of air bubbles on the pulmonary microvasculature that causes the release of inflammatory factors and plateletactivation.[67]However, Duda et al in his trial found no evidence of inflammatory markers when comparing patients in the sitting position versus supine position in neurosurgery.[71]

The major cause of death from massive air embolism is due to circulatory obstruction and ultimately arrest resulting from air trapped in the right ventricular outflow tract.[72] Large emboli may cause paradoxical embolization by acutely increasing RAP, facilitating a right to left shunting through a patent foramen ovale or across the pulmonary capillary bed. [73] Micro air emboli can lodge in pulmonary vessels and either produce gradual obstruction to blood flow or undergo spontaneous resorption depending on the rate and volume of air entrained.[74] In addition, the air-blood interaction may induce the production of fibrin clots or thrombosis and further obstruct right ventricular outflow or pulmonary blood flow.[75]The severity of hypoxemia associated with VAE is variable and depends on the significance of the episode. The mechanism of this hypoxemia is the result of ventilation-perfusion (V/Q) maldistribution.[76]

Prevention of venous air embolism-

The sitting position is the preferred position for 45% of posterior fossa surgeries and 39% of cervical spinal surgeries.[7] This position reduces bleeding

and intracranial pressure by improved blood drainage and allows lesser cerebellar retraction. These effects leads to a clear surgical field. Apart from the beneficial effects, this position has some major risks including hemodynamic instability, VAE, and pneumocephalus. It was previously suggested by Jadik et al.[59] that these risks of the sitting position can be reduced by some modifications. The aim of this modification is simply to provide a positive venous pressure at the operation site to decrease the gradient between this site and the RA. Despite this modified semi-sitting position, these patients require specific monitoring to provide a safer surgery.[77] A central venous catheter with its tip localized in the superior vena caval–RA junction is recommended to be placed in all patients scheduled for an operation in the sitting position. Hence, the air in the RA can be aspirated in case of major embolic events.[57] The Trendelenburg position should be used when placing or removing CVCs.[54] A controlled fluid load before positioning the patient according to the intravascular volume status may be considered for these procedures.[56]

The degree of the head-up position to facilitate the surgical procedure should be the most important factor for the decision to use a right heart catheter. It was suggested that a multi-orifice catheter should be advanced up to 2 cm below the superior vena caval–RA junction and a single-orifice catheter with its tip 3 cm above the superior vena caval–RA junction. These locations may well serve for optimal recovery from small volumes of air emboli when cardiac output is well maintained. However, any location in the RA will be sufficient for massive air emboli, resulting in cardiovascular collapse. The right heart placement can be verified by either radiography or intravascular electrocardiography. The catheter, via the right internal jugular vein, may be advanced up to a distance to the second or third right intercostal space to have a sufficient placement in the RA, which can easily be confirmed radio graphically. The electrocardiogram (ECG) electrode placed in the RA will initially reflect an increasing positivity as the P-wave vector approaches it, then an increasing negativity as the depolarization wave passes and moves away from the electrode, resulting in the typical biphasic P wave reflected by the electrode placed in the atrium. The catheter should be withdrawn until P waves become inverted.[53,54]

Diagnosis-

In general, the monitoring devices that are used should be sensitive, easy to use, and non invasive. The selection of monitoring device should be decided by the surgery performed, the position of the patient, the expertise of the anaesthesiologist in using the device, and the overall medical condition of the patient. The detection of an on- going episode of VAE is a clinical diagnosis, taking into consideration the circumstances under which clinical alterations occur. There are specific circumstances where the diagnosis of VAE should be considered immediately in the differential diagnosis: Any unexplained hypotension or decrease in ETCO2 intra operatively in cases that are performed in the reverse Trendelenburg position. Patients undergoing insertion or removal of a central venous catheter who report shortness of breath during or shortly after completion of the procedure should also be suspected for air embolism.

Transesophageal Echocardiography

This instrument is currently the most sensitive monitoring device for VAE, detecting as little as 0.02 ml/kg of air administered by bolus injection.[78,79] It permits detection not only of venous macroemboli and microemboli but also paradoxical arterial embolization that may result in ischemic cerebral complications. Notwithstanding, transesophageal echocardiography (TEE) has been said to be almost too sensitive, detecting virtually any amount of air in the circulation, most leading to no adverse sequelae. The other advantage is that the presence of any volume of air should alert the anaesthesiologist to institute prophylactic measures, reducing the risk of further entrainment. The major deterrents to TEE are that it is invasive, is expensive, and requires expertise and constant vigilance that may limit its use by a non cardiac anesthesiologist. A report by Himmelseher *et al.*[80] noted the use of TEE as standard of practice in 38% of patients undergoing intracranial procedures.

Precordial Doppler Ultrasound

The precordial Doppler is the most sensitive of the non invasive monitors, capable of detecting as little as 0.25 ml of air (0.05 ml/kg).[81] The Doppler probe (typically a 2- to 5-mHz device) can be placed on either the right or the left sternal border (second to fourth intercostal spaces) or alternatively, between the right scapula and the spine.[82] The probe is placed along the right heart border, to pick up signals from the right ventricular outflow tract. The bubble test is helpful in positioning the Doppler probe in obese patients. The first evidence of VAE is a change in the character and intensity of the emitted sound. The “washing machine” turbulent resonance of normal blood flow passing through the right cardiac chambers abruptly is superimposed by an erratic high-pitched swishing roar.

Major impediments in the use of this device include sound artifacts during concurrent use of electrocautery, prone and lateral patient positioning, and morbid obesity. The combination use of a precordial Doppler probe along with a two-dimensional echo image may improve detection.

Transcranial Doppler Ultrasound

Contrast-enhanced transcranial Doppler has been shown to be highly sensitive in the detection of a patent foramen ovale and has been used as a screening tool for patients undergoing high-risk procedures. The sensitivity of this method has been shown to increase with the use of the Valsalva maneuver.[83] In comparison with TEE, contrast-enhanced transcranial Doppler has shown a sensitivity of 91.3%, a specificity of 93.8%, and an overall accuracy of 92.8%.[84]

Pulmonary Artery Catheter

A pulmonary artery catheter is a relatively insensitive monitor of air entrainment (0.25 ml/kg),[85,81] being inferior to the precordial Doppler and is invasive for a patient who has no other comorbidities requiring its use. The pulmonary artery catheter is of limited ability to withdraw air from its small calibre lumen. The use of the pulmonary artery catheter is thus restricted to those patients who have significant comorbidities that may benefit from its use as a monitoring tool for cardiac output or mixed venous saturation. Volk *et al*[86] have demonstrated the utility of an 8-MHz probe introduced through the central venous catheter in pig studies to improve upon VAE detection .

End-tidal Nitrogen

Not routinely available on all anesthesia monitors, ETN2 is the most sensitive gas-sensing VAE detection method, measuring increases in ETN2 as low as 0.04%.[85,88] It has been shown that changes in ETN2 occur 30–90 s earlier than changes in ETCO2.[88] The sensitivity compares to or exceeds that of ETCO2 during large-bolus VAE but may be less sensitive during slower entrained volumes.[52] Unfortunately, this method is not useful if air is used as a carrier gas. The presence of ETN2 may also indicate air clearance from the pulmonary circulation prematurely, and the method is limited by hypotension.

End-tidal Carbon Dioxide

The ETCO2 monitor is the most convenient and practical American Society of Anesthesiologists monitor used in the operating room. A change of 2 mmHg ETCO2 can be an indicator of VAE. So the "low"-level alarm should be adjusted to detect even this small decrement, especially in high-risk procedures.[89] But ETCO2 monitoring is not very specific, and its reliability in the event of systemic hypotension is difficult to assess. In addition, in spontaneously breathing patients, this monitor may become unreliable during periods of upper airway obstruction, mouth breathing, and variations in respiratory rate or obstruction of the gas analyzer port by mucus or condensation.

Esophageal Stethoscope

The sensitivity of the esophageal stethoscope has been shown to be very low in detecting a mill wheel murmur (1.7 ml /kg/ min).[90]

Electrocardiographic Changes

Alterations in the electrocardiogram rank low in sensitivity for VAE detection. Changes are seen early only with rapid entrainment of air, and generally reflect an already compromised cardiac status. Peaked P waves are the first change seen on a 12-lead electrocardiogram in animal studies. In humans, ST–T changes are noted first, followed by supraventricular and ventricular tachyarrythmias.[90]

Treatment-

Acute management in VAE includes several measures to be taken simultaneously: aspiration of air from RA, waxing the open venous channels of the bone, flooding the operation site with saline, lowering the patient head, discontinuing N_2O, raising FiO_2 to 1and increasing cerebral venous pressure.[7] Controlled fluid load and direct compression of jugular veins raises cerebral venous pressure to prevent further air entrance.[91] This manoeuvre also helps surgeon to identify open vessels. However, the efficacy of manual compression may not be sufficient to increase the pressure and may cause adverse events such as decrease in cerebral blood flow due to direct compression of carotid arteries. In a study on swine intra-jugular balloon catheters have recently been proposed to be used as a safe and effective alternative.[91] PEEP and the Valsalva manoeuvre are not used anymore because they increase the risk of PAE and the superiority of direct compression on jugular veins to raise the cerebral venous pressure has been confirmed. PEEP >5 cmH2O has been shown to raise the hazard of VAE.[56,66] Similarly, in a large prospective study, PEEP of 10 cmH_2O has been shown to cause adverse cardiopulmonary effects without any change in the incidence of VAE.[92] In the presence of cardiovascular dysfunction caused by VAE, a sudden application of PEEP may further cause deterioration by impairing the systemic venous return.[15] Besides the avoidance of PEEP and the Valsalva manoeuvre, it should be kept in mind that bilateral jugular vein compression may not help identify the source of air entrance in cervical spinal procedures even as high as C2 because they have different routes for drainage. When VAE causes sustained hemodynamic derangement, the patient should be placed in a lateral position with the right side up. This position allows the air in the RA to remain attainable by right atrial catheter and prevents the development of an air lock in the right ventricle. However, this position is impossible with a patient in a pin head holder. Additionally, enough data are not available to prove the efficacy of this maneuver in terms of hemodynamic benefit. A right-heart catheter provides immediate evacuation of air, which makes it indispensable in patients operated on in a sitting position. The management of VAE in awake patients undergoing surgery for DBS is similar to the patients under general anaesthesia. A major concern is that the risk of a VAE event occuring in these patients is often underestimated, leading to a delay in recognition. In a study undertaken by Chang et al[1] an algorithm for VAE management in awake patients was presented. This algorithm defines the probability of the development of a VAE according to the severity of symptoms and signs, which begin with coughing. If a VAE event reveals transient symptoms or signs and there is no suspicion for further air entrance, the procedure can be continued safely If inotropic support and aspiration of air from RA become imperative, then the incision should be closed as soon as possible and the procedure should not proceed**.**

To summarize the review of literature vascular air embolism is a potentially life-threatening event that is increasingly more common in situations other than surgery performed in the classic sitting position. Anaesthetists must be aware of this silent but dangerous entity that can occur during many seemingly routine operative procedures and interventions. Vascular air embolism may be detected by

TEE and precordial Doppler ultrasound should be used in moderate to high-risk patients undergoing high risk procedures. Emphasis should be given to the prevention (hydration, positioning) and prompt recognition of this event and to the use of all available tools (fluids, positive ionotropic agents) in the management of cardiovascular complications. The use of invasive monitoring devices such as TEE and central venous catheters should be dictated by the presence of comorbidities, rather than as a primary tool to manage VAE.

MATERIAL AND METHODS

MATERIAL AND METHODS

This study was a prospective observational study. After the approval of Technical advisory committee and Institutional Ethics Committee (Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum) and with signed informed consent (in English and Malayalam), 100 adult patients were included in our observational study. Data was collected from August 2016 to August 2017.

Rational for the sample size-

The number of subjects was calculated by accepting an expected incidence of 50% with 95% confidence interval having width of 20%. Hence we included 100 patients from neurosurgery department undergoing intracranial neurosurgical procedures involving craniotomy or craniectomy.

Sampling method-

Patients posted for routine neurosurgical procedures were included in our study after they satisfy our inclusion criteria, until the sample size is reached.

The following were the inclusion criteria of patients-

1. Age above 18yrs
2. Patients undergoing elective intracranial craniotomy or craniectomy in supine, lateral, semisitting or sitting position.

Exclusion criteria were-

1. Refusal by the patient or patient relatives

2. Emergency surgeries

3. Pregnant and Nursing mothers

4. Age less than 18 years

5. Abnormal neck flexion and abnormal neck rotation which can increase the possibility of postoperative airway oedema (< 2 finger breadths between mentum and upper end of sternum and < 2 finger breadth between lower border of body of mandible and ipsilateral clavicle)

6. Any contraindication for applying TEE probe (oral pathology, H/O dysphagia, odynophagea, history of active upper gastro intestinal bleed, documented cases of esophageal stricture, esophageal mass, tracheoesophageal fistula, perforated bowel, history of esophageal surgery, abnormal coagulation parameters, cervical spine disease)

Patients who met the inclusion criteria were explained about the study and study protocol. Informed consent was obtained from patient who were willing to participate in the study.

Patients were kept fasting according to Nil per oral guidelines and routine premedication were given as per the orders of concerned neuroanaesthesia team. The study was carried out in neurosurgery operation theatre. After shifting the patients to the operating table, all the standard ASA monitors were attached, which included ECG, pulse oximetry and a non invasive blood pressure cuff(PHILLIPS intellivue MX700).Intravenous access were obtained. Patients were induced as per the discretion of the anaesthesia team and appropriate sized endotracheal tube were used for intubation. ETCO2 was used to titrate the ventilatory parameters and to assess hemodynamic events during surgery. Radial artery was cannulated with a 20G cannula in all the patients. These were connected to a pressure transducer and invasive blood pressure was monitored. Central venous catheters were inserted under ultrasound guidance under aseptic precautions.

Adult transesophageal probe was inserted into the esophagus through the oral cavity after lubricating the probe and kept at 35-40 cm from the lips. In our study TEE (GE Vivid 7, GE Healthcare) was used to detect the incidence of VAE along with other monitors like ETCO2. All the patients were positioned in final operating position with the help of a Mayfield clamp, neck flexion and any vessel compression were checked. Then the height from the right atrium to the surgical field was noted by measuring the distance from second right intercostal space to the surgical field. The angle of elevation of the head end of the table from the horizontal line parallel to the floor was also noted. Positions of the patients were classified as,

Supine - if angle$<15^0$,

semisitting -if angle was 15-45^0,

sitting position- if angle was $>45^0$.

TEE Measurements

Transesophageal Doppler measurements: Transesophageal echo measurements for the right and left ventricular function were done at baseline and after positioning. Continuous monitoring of venous air embolism were done in all patients throughout surgical procedures. Measurements for right and left ventricular function were also carried out after positioning, during the craniotomy, dural opening and handling of dural sinuses, closure of duramater and whenever venous air embolism was detected.

LEFT VENTRICULAR FUNCTION:

a) Systolic function- We measured the LVIDD(Left ventricular internal diameter in `diastole), LVIDS(left ventricular internal diameter in systole), ejection fraction(EF), stroke volume(SV) in ml, Regional Wall motion abnormality were calculated at the four chamber and the two chamber mid esophageal views averaged two times.

b) Diastolic dysfunction was measured by E/A, E'/A' and Deceleration time which differentiated normal and pseudo normal pattern. These parameters were taken in the mid esophageal 4-Chamber view and LV inflow out flow view across the mitral valve. The pulsed wave Doppler was put over the mitral valve opening area and mitral flow was measured. The **E/A ratio** represents the ratio of peak velocity flow in early diastole (the E wave) to peak velocity flow in late diastole caused by atrial contraction (the A wave). Similarly the E'/A' is measured by tissue Doppler in the annulus of mitral valve.The motion of the mitral valve annulus mirrors systolic as well as diastolic events. During systole the annulus moves caudally towards the apex, and during diastole it moves cranially towards the atrium. The motion of the annulus can be recorded with the help of PW tissue Doppler (TDI) at the medial (septal) as well as the lateral ring (in a four chamber view). To measure the velocity of mitral annular motion we used tissue Doppler (TDI) in the septal wall of mitral valve and placed the tissue doppler approximately 1 cm within the insertion of the mitral valve leaflets.

2. RIGHT VENTRICULAR FUNCTION was measured by Tricuspid Annular Plane Systolic Excursion, Right Ventricular Internal Diameter in Diastole, Right Ventricular Internal Diameter in Systole. These parameters were recorded in the mid esophageal 4 chamber view. The TAPSE was measured in the apical four-chamber view. The right ventricle contracts largely along its length. M-mode imaging through the lateral tricuspid valve plane captures this longitudinal motion, a simple, reproducible measure with low inter observer variability. Values of tricuspid annular plane systolic excursion (TAPSE)< 16 mm indicate RV dysfunction.

3. Presence of any intracardiac shunts or patent foramen ovale was also looked for during baseline monitoring in the bicaval view.

4. Occurrence of venous air embolism was seen in the bicaval view and grading was done in RV inflow outflow view in all patients.

We defined hemodynamic instability as

- bradycardia defined as heart rate less than 50 beats/ minute or tachycardia as more than 110 beats/minute.
- arrythmias as new onset rhythm changes.
- systolic blood pressure ± 20% from baseline as hypertension and hypotension respectively.
- myocardial Ischaemic changes as new onset ST-T changes in ECG, new onset Regional Wall Motion Abnormality (RWMA)
- stroke as an infarct corresponding to a vascular territory in the postoperative period from the CT scan taken in postoperative period which was not be due to primary disease process or due to surgical complication.

Grading of venous air embolism-

VAE was graded in four grades:

Grade I - single gas bubble in either RA, RV, and RVOT;

Grade II - gas bubbles filling less than half the diameter of RA, RV, and RVOT;

Grade III - gas bubbles filling more than half the diameter of RA,RV and RVOT;

Grade IV - gas bubbles completely filling the diameter of RA, RV, and RVOT.

Observations: Following parameters were monitored in all the patients.

Patient demographic factors like

- Age

- Gender

- Weight, height and Body surface area

- Primary disease and the proposed surgical intervention

- Height of the surgical field from the right atrium

- Angle of inclination of the patient from the horizontal plane

- Ventilatory settings- modes of ventilation, tidal volume, Respiratory Rate, Positive End Expiratory Pressure, Peak Airway Pressure and Mean Airway pressure was measured.

- Hemodynamic factors

  Heart rate (HR)

  Mean Blood pressure (mean BP)

  End Tidal CO_2

  Transesophageal echo parameters as described above were also measured.

After the completion of the skin closure and removal of the pins, the TEE probe is removed slowly and the patients were extubated and /or shifted to the neurosurgery ICU. In the neurosurgery ICU, patients were monitored for any new onset stroke or myocardial ischaemia in the first six hours and their occurrence were noted.

STATISTICAL ANALYSIS

STATISTICAL ANALYSIS

Statistical software, namely SPSS 17.0(Chicago, SPSS inc.) were used for analysis of data, Microsoft word and Excel were used to generate the graphs, tables.

The number of subjects were calculated by accepting an expected incidence of 50% with 95% confidence interval having width of 20%. Hence we included 100 patients from neurosurgery department undergoing intracranial neurosurgical procedures involving craniotomy or craniectomy.

All the data were expressed as mean±standard deviation(SD) for quantitative data and number (%) for categorical data type. Incidence of VAE in all neurosurgeries and in different positions are described as percentage. The incidence of complications are also described as percentage.

Statistical analysis was done with chi square test or Fischer exact test for descriptive and nominal data. Mann whitney test was used to compare non contiguous data and non normally distributed data. For correlation Spearman Rank Correlation was used. The level of significance was accepted as $p<0.05$. The relation between height of operating field to the right atrium and angle of positioning with incidence of venous air embolism was analysed by correlation coefficient and drawing the ROC curve. The area under the ROC curve (AUC) is a measure of how well a parameter can distinguish between two diagnostic groups. The area of > 0.9 was accepted to have excellent significance.

RESULTS

RESULTS

Based on previous studies we had taken a sample size of 100 patients for an prospective observational study to determine the incidence of venous air embolism. We selected our patients from the routine neurosurgical procedures in our institute. The number of subjects were calculated by accepting an expected incidence of 50% with 95% confidence interval having width of 20%.

Table 1 shows the age distributions of the patients. The maximum number of patients belong to the 51-60 years having 26% of study population. The minimum number of patients belong to the 21-30 years of age having 10% of the total patients. There were 13% patients below 20 years of age, 23% of patients between 31-40 years of age, 14% of total number of patients in 41-50 years of age. There were 14 patients who were above 60 years of age.

Table 1- shows the age distribution of the 100 patients in our study population-

AGE IN YEARS	NUMBER OF PATIENTS	PERCENTAGE
≤20	13	13.0
21 - 30	10	10.0
31 - 40	23	23.0
41 - 50	14	14.0
51 - 60	26	26.0
>60	14	14.0
Total	100	100.0

The above study group has mean age of 43.28years±SD 15.47 years. Total number of patients were 100 in number.

Figure 1: bar diagram shows the age distribution of the study population-

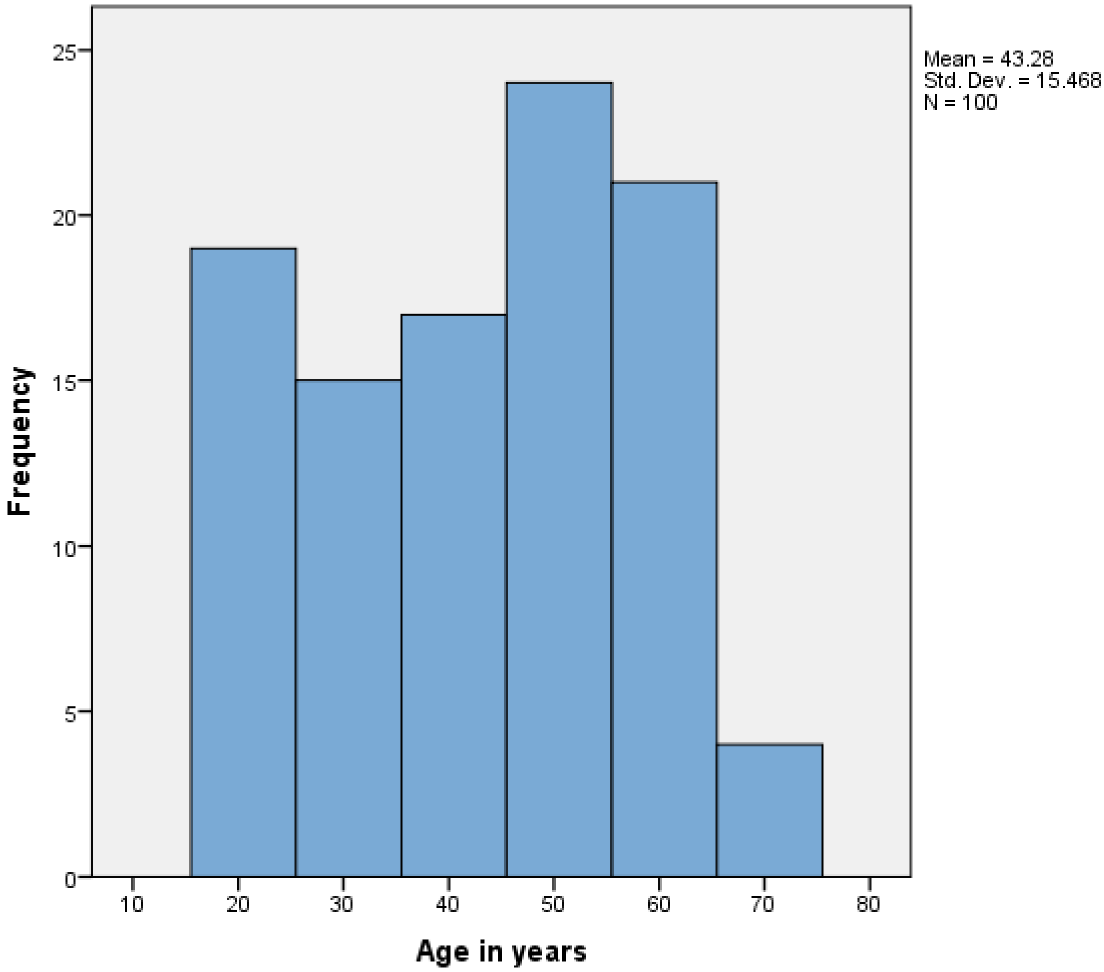
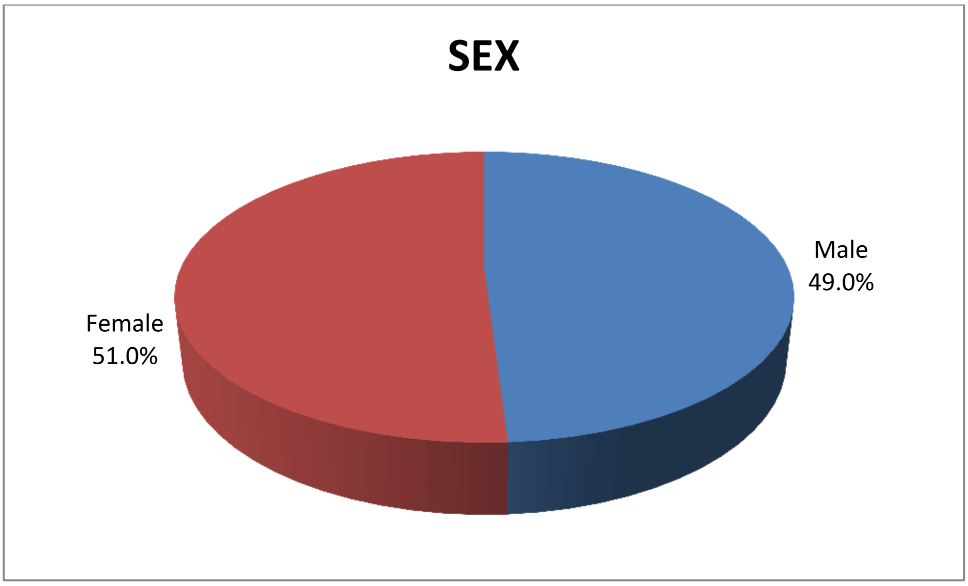


Table 2- shows the sex distribution of the patients in our study population

SEX	Frequency	Percent
Male	49	49.0
Female	51	51.0
Total	100	100.0

Fig 2- shows the sex distribution of the 100 study patients-

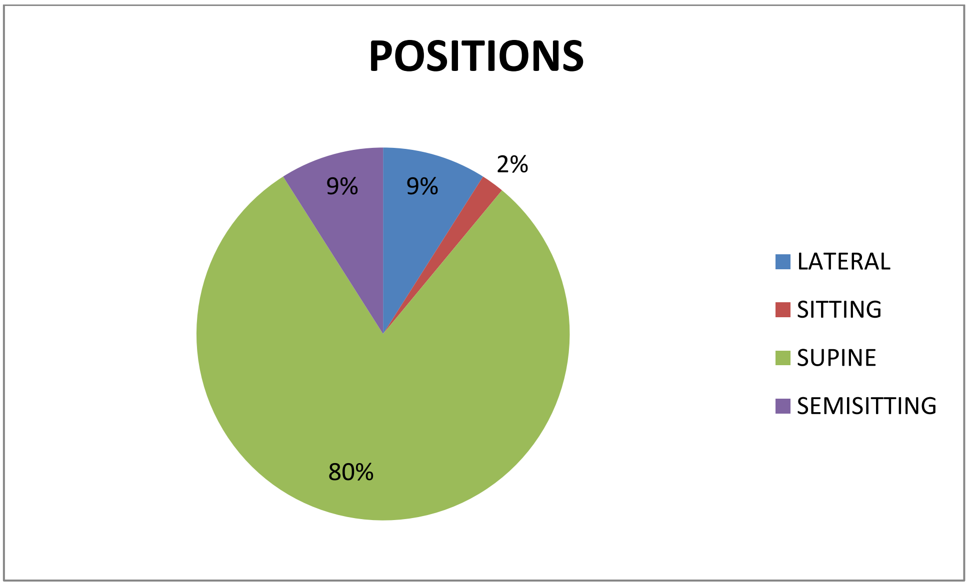


Out of 100 patients 51 patients were female and 49 patients were male.

Table 3- shows the percentage of different positions of the patients in study population-

POSITIONS OF PATIENTS	NUMBER OF PATIENTS	PERCENTAGE
LATERAL	9	9.0
SITTING	2	2.0
SUPINE	80	80.0
SEMISITTING	9	9.0
Total	100	100.0

Fig 3- shows the percentage of positions of different patients in study population-



The above table and figure shows the percentage of various positions of the patients undergoing neurosurgical procedures in our study population. The maximum number of patients were operated in supine position (80/100), followed by lateral and semi sitting position, each having 9% (9/100) of patients. Only 2%(2/100) patients were operated in the sitting position.

Table 4- shows the number of patients having venous air embolism in the 100 study population.

VENOUS AIR EMBOLISM	NO OF PATIENTS	PERCENTAGE
Present	45	45.0
Absent	55	55.0
Total	100	100.0

Fig 4- shows the incidence of venous air embolism in the study population

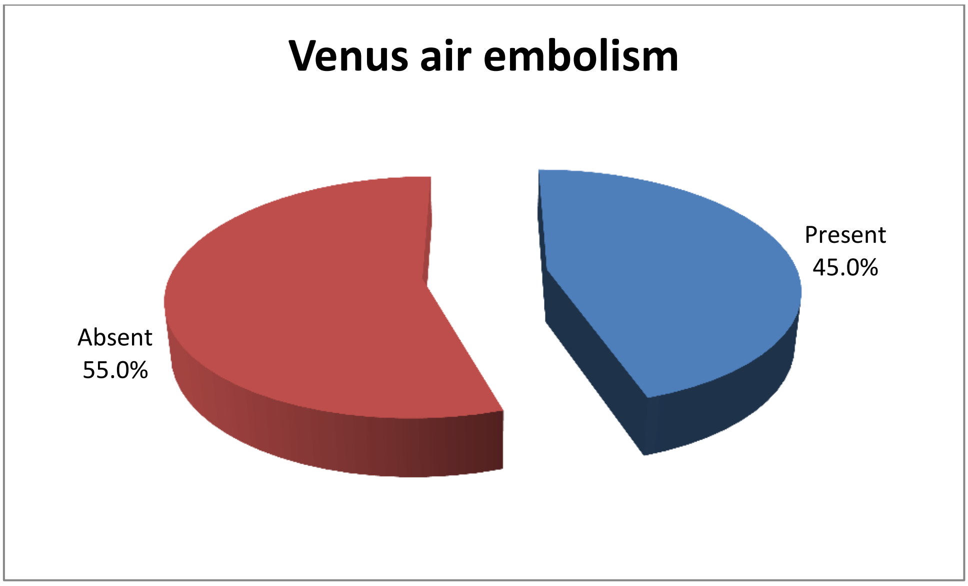


Table 4 and figure 4 shows that 45 patients had venous air embolism out of 100 patients and 55 patients did not have any venous air embolism.

Table 5- shows the incidence of venous air embolism in different positions of the patients undergoing neurosurgical procedures-

Position	Venus air embolism				Total	
	Present		Absent			
	N	%	N	%	N	%
LATERAL	6	66.7	3	33.3	9	100.0
SITTING	2	100.0	0	0.0	2	100.0
SUPINE	33	41.3	47	58.8	80	100.0
SEMISITTING	4	44.4	5	55.6	9	100.0
Total	45	45.0	55	55.0	100	100.0

N- number of patients

The above table shows 66.7% (6/9) patients had venous air embolism in lateral position. In sitting position both the patients (100%) had venous air embolism. In supine position 33 patients out of 80 patients(41.3%) had venous air embolism. In semisitting position 4 patients out of 9 (44.4%) had episodes of venous air embolism.

Table 6- shows the incidence of venous air embolism in different neurological conditions-

NEUROSURGICAL CONDITIONS	TOTAL NO OF CASES	GRADE 1 VAE	GRADE 2 VAE
GLIOMA	21	6	1
MENINGIOMA	16	7	2
ANEURYSM	21	9	2
PITUITARY ADENOMA	5	3	0
EPILEPSY	7	2	0
SCHWANNOMA	3	1	0
MISCELLANEOUS	27	12	0
TOTAL	100	40	5

TABLE 6 shows the number of meningioma are 16 in number, glioma were 21 in number, various aneurysms were 21 in number. Others were vestibular schwannoma (3%), epilepsy (7%), pituitary adenoma (5%). Rest 27% were miscellaneous in nature. In glioma, out of 21 patients 6 patients developed grade 1 venous air embolism,1 patient had grade 2 venous air embolism. In aneurysms 9 patients out of 21 patients developed grade 1 VAE and 2 patients developed grade 2 VAE. The meningioma were 16% in number, 7 patients were found to have grade 1 venous air embolism, 2 patients out of 16 were having grade 2 air embolism and

7 patients were not detected to have venous air embolism. In pituitary adenoma 3 patients out of 5 patients developed grade 1 VAE, no patients had grade 2 VAE.

Table 7- shows different stages of surgery at which venous air embolism occurred.

Venus air embolism in various stages of surgery	No of patients	Percent
ABSENCE OF EMBOLISM	55	55.0
HANDLING OF DURAL SINUSES	1	1.0
DURAL OPENING	2	2.0
CRANIOTOMY	34	34.0
CRANIOTOMY+ SINUS HANDLING	2	2.0
CRANIOTOMY+DURAL OPENING	4	4.0
CRANIOTOMY+DURAL OPENING +HANDLING OF DURAL SINUSES	1	1.0
DURAL OPENING + HANDLING OF DURAL SINUSES	1	1.0
Total	100	100.0

Table 7 showed 34 patients had venous air embolism during the craniotomy period, 2 patients had air embolism during dural opening, 4 patients had embolism in both craniotomy and dural opening. One patient was having air embolism multiple times during craniotomy, dural opening and handling of sinuses and 1 more patient was having embolism during dural opening and manipulation of dural sinuses.

Table 8- shows incidence of different grades of venous air embolism -

Venus air embolism grade	No of patients	Percent
Absent	55	55.0
Grade 1	40	40.0
Grade 2	5	5.0
Total	100	100.0

Fig 5- shows bar diagram of incidence of different grades of venous air embolism-

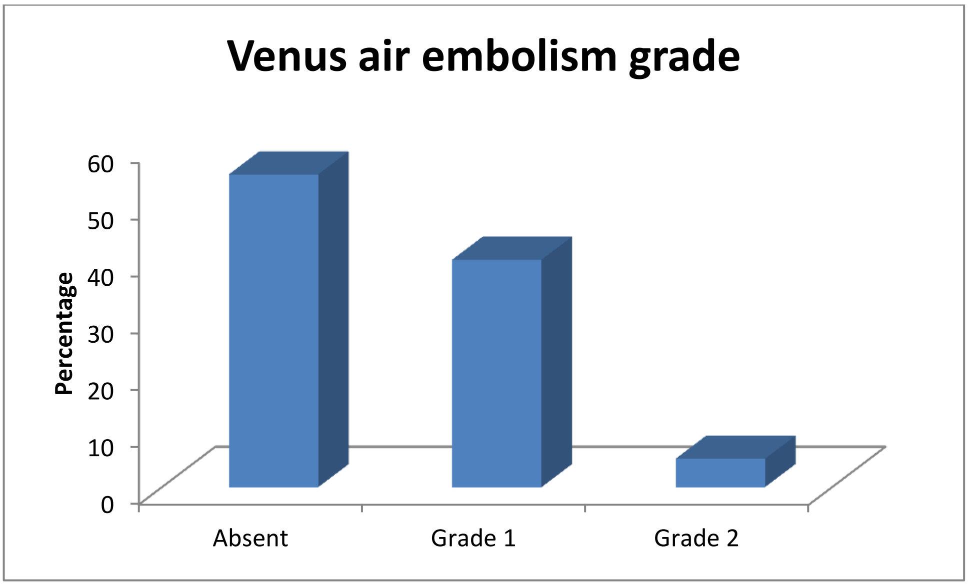


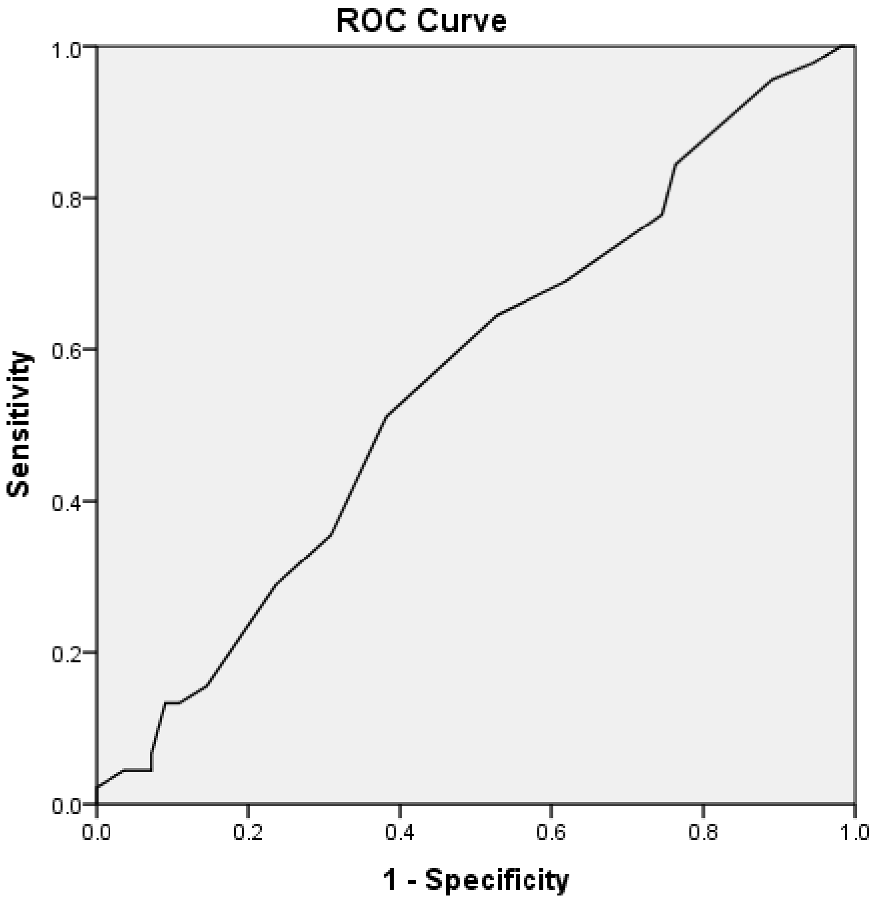
Table 8 and figure 5 shows the incidence of different grades of venous air embolism. Out of 100 patients 40 patients(40%) had grade 1 venous air embolism and 5 patients(5%) had grade 2 venous air embolism.

Table 9- shows comparison of mean height of the surgical field from the right atrium level of the patients with venous air embolism and patients without air embolism.

Venus air embolism	N	**Height in cm**		t	p
		Mean	sd		
Present	45	14.3	5.1	.836	.405
Absent	55	13.4	5.0		

The mean height of the surgical field of the patients from right atrium with venous air embolism was found to be 14.3 cm± SD 5.1 cm. The corresponding height of patients without venous air embolism is 13.4 cm± 5.0 cm. But the difference between the two heights was statistically insignificant with p value of 0.405.

Figure 6- shows ROC curve for finding optimum cut off value of Height to predict Venus air embolism



Diagonal segments are produced by ties.

Area Under the Curve

Test Result Variable(s): HEIGHT

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.562	.058	.291	.449	.675

A value of height >12cm has sensitivity 64.4% and specificity 47.3% to predict the Venus air embolism.

Table 10- shows the cut off height ≥12.5 cm to predict venous air embolism with sensitivity of 64.4% and specificity of 47.3%.

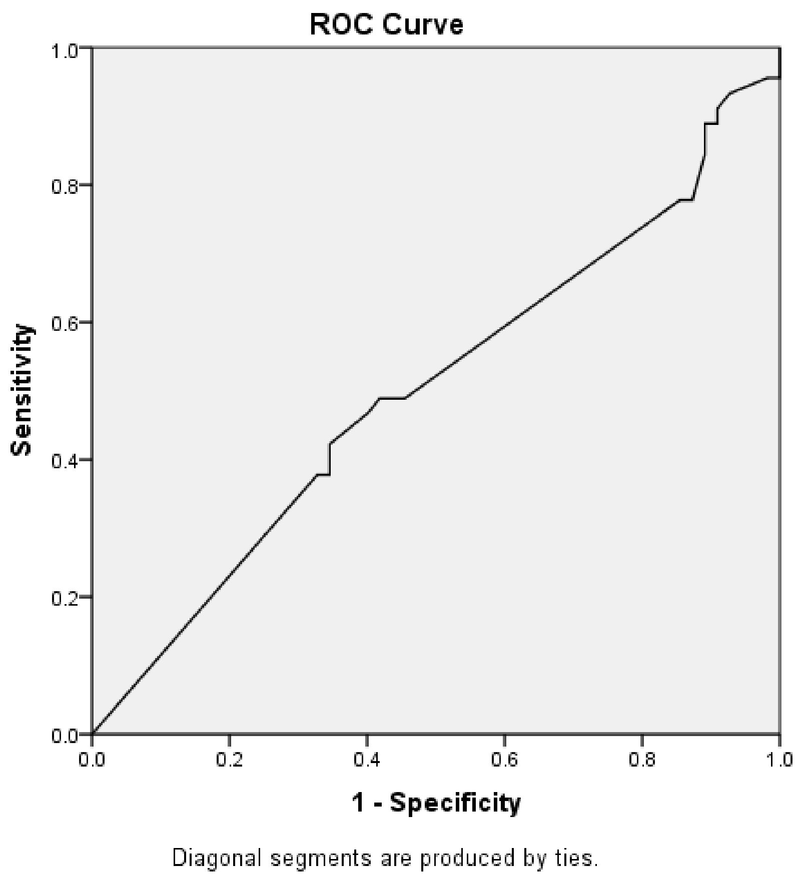
Height in cm	Venus air embolism				Total		p
	Present		Absent				
	N	%	N	%	N	%	
≥12.5	29	64.4	29	52.7	58	58.0	0.238
<12.5	16	35.6	26	47.3	42	42.0	
Total	45	100.0	55	100.0	100	100.0	

Table 11- shows the comparison of mean of angle of inclination of patients with venous air embolism and without venous air embolism.

Venus air embolism	N	**Angle in degrees**		t	p
		Mean	sd		
Present	45	13.91	11.56	.284	.777
Absent	55	13.35	8.32		

The mean angle of inclination of patients with venous air embolism was 13.91^0± SD of 11.56^0 . The mean angle of inclination of patients without venous air embolism was 13.35^0± SD of 8.32^0 . But the mean difference of angle of inclination between the two groups was found to be statistically insignificant with p value of 0.77.

Fig 7- shows the ROC curve for finding the optimum cut off value of angle to predict VAE-



Area Under the Curve

Test Result Variable(s): ANGLE

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.503	.059	.953	.388	.619

A value of Angle ≥14.5^0 has sensitivity 51.1% and specificity 45.5 % to predict the Venous air embolism. But the area under the curve is 0.503 showing the power of the study is less.

Table 12- shows the cut off angle ≥14.5^0 to predict the venous air embolism with sensitivity of 51.1% and specificity of 45.5% -

Angle in degrees	Venus air embolism				Total		p
	Present		Absent				
	N	%	N	%	N	%	
<14.5	22	48.9	25	45.5	47	47.0	0.732
≥14.5	23	51.1	30	54.5	53	53.0	
Total	45	100.0	55	100.0	100	100.0	

Table 13- comparison between mean height of grade 1 venous air embolism patients with the height of grade 2 venous air embolism patients-

Venus air embolism	N	Height in cm		p
		Mean	sd	
No	55	10.35	9.640	.279
Grade 1	40	10.23	9.825	
Grade 2	5	18.40	17.024	
Total	100	10.70	11.017	

Figure 8- shows the mean height of the grade 1 and grade 2 patients along with SD.

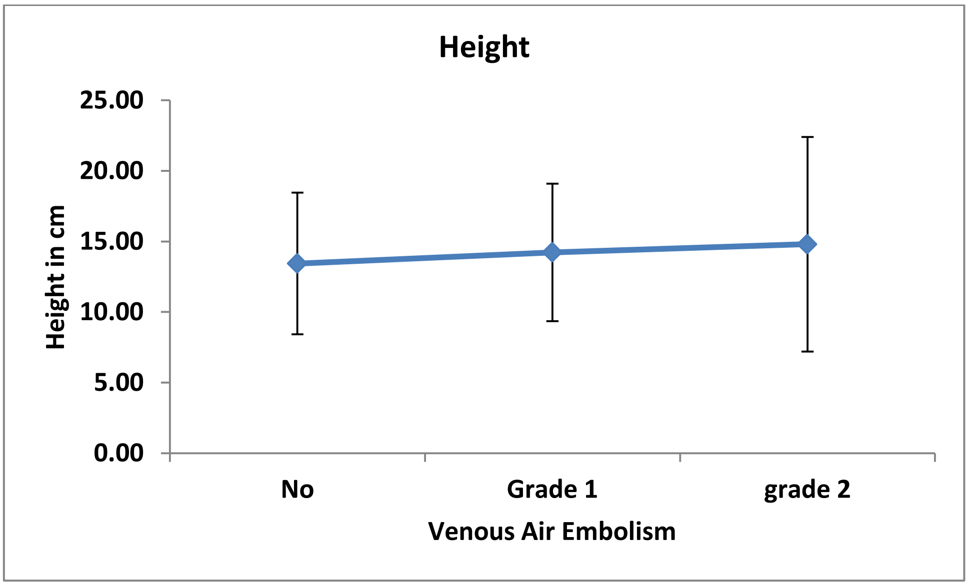


TABLE 13 and figure 8 shows the mean gradient height of the surgical field from the right atrium to be 10.23 cm± SD 9.82cm in grade 1 venous air embolism. The mean height of that of grade 2 venous air embolism is 18.4 cm± SD 17.02cm. But the difference of gradient of height in grade 2 and grade 1 venous air embolism is not statistically significant with p value of 0.279.

Table 14-Shows comparison between mean angle of inclination of grade 1 venous air embolism patients with the angle of inclination of grade 2 venous air embolism patients-

Venus air embolism	N	**Angle in degrees**		p
		Mean	sd	
ABSENT	55	13.44	5.021	.689
Grade 1	40	14.23	4.875	
Grade 2	5	14.80	7.596	
Total	100	13.82	5.064	

FIG-9 shows the mean angle of the grade 1 and grade 2 patients along with SD-

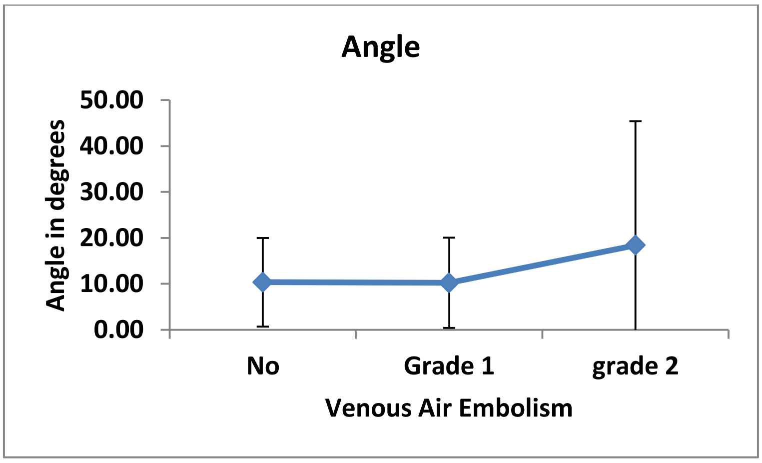


TABLE 14 and figure 9 shows the mean angle of inclination is 14.23 ^{0}± SD 4.87^0 in grade 1 venous air embolism. The mean angle of inclination in grade 2 venous air embolism is 14.80 ^{0}± SD 7.59^0. But the difference of angle of inclination in grade 2 and grade 1 venous air embolism is not statistically significant with p value of 0.689.

Table 15- shows comparison between change in end tidal CO_2 between patients with venous air embolism and patients without venous air embolism.

change in ETCO2 from baseline	Venus air embolism				Total		P
	Present		Absent				
	N	%	N	%	N	%	
>2	3	6.7	4	7.3	7	7.0	0.906
≤2	42	93.3	51	92.7	93	93.0	
Total	45	100.0	55	100.0	100	100.0	

N is the number of patients.

Table 15 shows that total 45 patients had venous air embolism, out of which only 3 patients had decrease of ETCO2 >2 mm of Hg, 42 patients(93%) did not have decrease in $ETCO_2$ more than 2 mm of Hg. Again 7% (4/55 patients) of patients without any air embolism reported >2 mm of Hg change in ETCO2. However the results were insignificant as p value was 0.906 .

Table 16- shows the comparison between the change in RVIDD in patients with venous air embolism and change in RVIDD in patients without venous air embolism.

Venus air embolism	N	**Change in RVIDD**		t	p
		Mean	sd		
Present	45	.40	2.17	.704	.483
Absent	55	.07	2.43		

RVIDD- Right ventricular internal diameter in diastole

N- no of patients

Table 16 shows the mean of change in RVIDD in patients with venous air embolism is 0.4mm± SD 2.17 mm. The mean of change in RVIDD in patients without venous air embolism is 0.07mm± SD 2.43 mm with p value of 0.483. The result showed that RV strain was not recorded during venous air embolism possibly due to lower grades of venous air embolism.

Table 17- shows the comparison between the change in RVIDS in patients with venous air embolism and change in RVIDS in patients without venous air embolism.

Venus air embolism	N	**Change in RVIDS**		t	p
		Mean	sd		
Present	45	-.38	2.48	-1.103	.273
Absent	55	.16	2.41		

Table 17 shows the mean of change in RVIDS in patients with venous air embolism is- 0.38mm± SD 2.48 mm. The mean of change in RVIDS in patients without venous air embolism is 0.16mm± SD 2.41 mm with p value of 0.273. The result also showed that RV strain was not recorded during venous air embolism possibly due to lower grades of venous air embolism.

Table 18- shows the comparison between the change in TAPSE in patients with venous air embolism and change in TAPSE in patients without venous air embolism.

Venus air embolism	N	**Change in** TAPSE (In mm)		t	p
		Mean	sd		
Present	45	-.44	2.04	-1.642	.104
Absent	55	.05	.87		

TAPSE- Tricuspid annular plane systolic excursion

The above table showed there is no statistical significant change in TAPSE due to presence of venous air embolism as the p value was 0.104.

TABLE 19- Shows the comparison of PEEP in gade 1 VAE, in grade 2 VAE and in patients without any venous air embolism.

Venous air embolism	N	**PEEP in cm of H2O**		p
		Mean	SD	
ABSENT	55	3.00	2.32	.316
Grade 1	40	2.33	2.38	
Grade 2	5	2.00	2.74	
Total	100	2.68	2.37	

N- number of patients

Figure 10- shows the mean PEEP in cm of H2O in different grades of air embolism

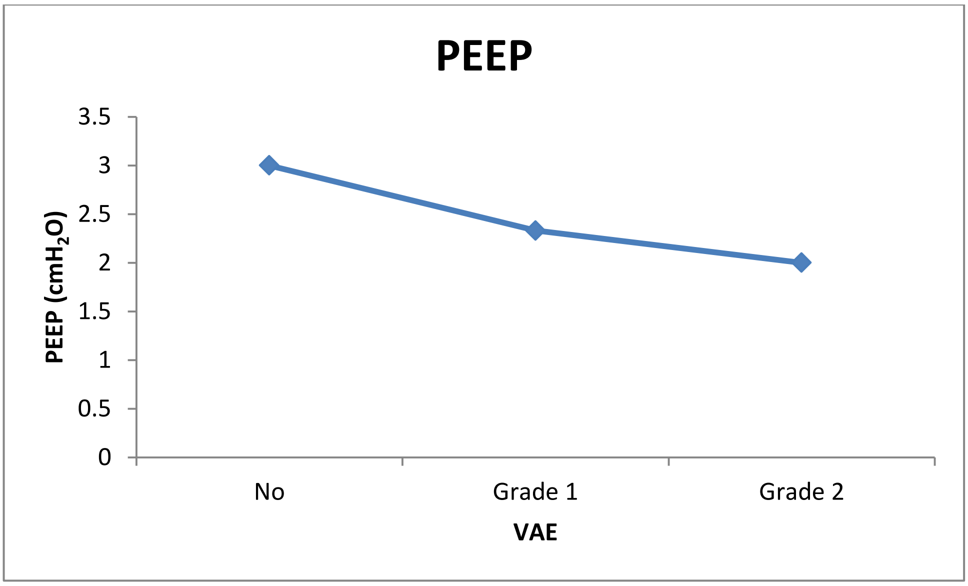


Table 19 and figure 10 shows that the mean PEEP in patients without venous air embolism was 3 cm of H_2O ± SD 2.32cm of H_2O. The mean PEEP in grade 1 venous air embolism was 2.33 cm of H_2O ± SD 2.38cm of H_2O and the mean PEEP in grade 2 venous air embolism was 2.68 cm of H_2O ± SD 2.37cm of H_2O . The difference between the PEEP value in different grade of venous air embolism was statistically insignificant suggesting that the PEEP value was constant

Table 20- shows the complication rates of the patients in the post operative period-

TOTAL NUMBER OF PATIENTS WITH VAE	POST OP STROKE (N)	POSTOP MYOCARDIAL INFARCTION(N)	PARADOXICAL EMBOLISM
45	0	0	0

N- no of patients

The above table shows no patients developed any post operative complications like post operative stroke and post operative myocardial infarction. It may be due to absence of higher grades of embolism(grade 3 and grade 4) in our study population. We also did not get any patients with paradoxical air embolism.

DISCUSSION

DISCUSSION

Our study was a prospective observational study to find the incidence and complications of venous air embolism in patients who were posted for undergoing elective intracranial surgeries by using transesophageal echocardiocardiography. Both supratentorial and infratentorial surgeries were included in our study in supine, lateral, semi sitting and sitting positions. These specific positions were standardized according to angle of inclinations. Supine was accepted as angle≤ 15 degrees, semi sitting as angle ranging from 15-45 degrees and sitting position was taken as angle ≥ 45 degrees. The severity of the venous air embolism was graded according to Schamandra grading. The incidence of different grades of venous air embolism was measured in different neurosurgical conditions. The primary outcome also calculated the relationship between height of operating field from the right atrium and the angle of positioning with the incidence of venous air embolism. The secondary outcome was to measure the complications arising out of venous air embolism and change in echo parameters like RVIDS, RVIDD and TAPSE which measures the RV strain. The change in end tidal carbon dioxide due to venous air embolism was also measured by calculating sudden change in ETCO2 of more than 2 mm of Hg in presence of echocardiographic evidence of presence of air inside RA, RV and RVOT.

In our study total number of patients were 100 out of which 49 were male and 51 were females. All age group of adult patients were included in the study. We used the transesophageal echocardiography to detect the air in right side of the heart. The current study showed the incidence of venous air embolism to be 45% of the patients. Total 45 patients out of 100 patients who had undergone craniotomies in different positions was found to have venous air embolism in different stages of surgery.

The incidence of venous air embolism were reported in the literature varied from 7% to 76% of patients. Albin et al[3] in 1978 used Doppler ultrasonography to detect the incidence of the venous air embolism and he found 100 patients had venous air embolism out of 400 patients in sitting position (25%) , 5 patients had venous air embolism in lateral position out of 60 patients, 7 patients had venous air embolism out of 48 patients in supine position and 1 patient out of 10 prone positioned patients had venous air embolism.

Papadopoulos G et al[2] used a prospective randomised study to find out the incidence of venous air embolism and paradoxical air embolism by transesophageal echocardiography in neurosurgical patients undergoing surgery in sitting positions. Sixty-two patients were divided into two groups, 22 patients were studied in group 1 (posterior fossa surgery) and group 2 (cervical surgery) contained 40 patients. Two further patients of this group (12% of 17 patients), in whom a patent foramen ovale had been excluded pre-operatively by the authors. Three morphological types of VAE with different haemodynamic and ventilation changes were demonstrated. VAE was observed in 76% of all posterior fossa operations and in 25% of cervical laminectomies.

Mammato et al[6] studied to analyse incidence of the degree of venous air embolism quantitatively and to assess the incidence of pulmonary air embolism according to the severity of venous air embolism during neurosurgery in the sitting position. He also used the TEE to measure the incidence of air embolism as it is the most sensitive method to detect the venous air embolism. They detected microbubbles in the right atrium appeared in all patients and the number of patients involved in grades 0, 1, 2 and 3 of VAE was 0, 10, 3 and 8 respectively. Pulmonary air embolism occurred in 3 patients and only followed grade 3 of venous air embolism.

Bithal et al[66] studied the incidence of air embolism in sitting position in neurosurgical procedures. They reported venous air embolism of 28% (93/334 patients) incidence rate in adults and 22% (21/96 patients) in children by using sudden decrease of end tidal CO_2 of more than 0.7kpa.

Our results coincided with the percentage of patients that developed venous air embolism in craniotomies in different positions. We reported 45% of patients had venous air embolism by TEE. We had used the transesophageal echocardiography to detect the air embolism as it is presently the most sensitive method to detect it. The TEE was also used by Mammato et al[6] to detect the air embolism. However Albin et al[3] used Doppler ultrasound to detect the air embolism and Bithal et al[66] used change in end tidal CO_2 to detect the air embolism.

2)INCIDENCE OF VENOUS AIR EMBOLISM IN DIFFERENT POSITIONS- In our study we had 80% of patients (80/100) undergone craniotomies in supine position, 9% of patients (9/100) in lateral position, only 2% (2/100) of cases in sitting position and 9% (9/100) of patients in semi sitting position. In supine position, out of 80 patients 33 patients developed (41.3%) venous air embolism detected by TEE. Out of 9 patients who were operated in lateral positon,6 patients (66.7%) had venous air embolism. 2 patients who were operated in the sitting position both developed venous air embolism with incidence of 100%. Four patients out of 9 patients in semi sitting(44.4%) position had venous air embolism.

Albin et al[3] reported 25% of patients operated in sitting position had developed venous air embolism. In lateral position 60 patients were operated out of which only 5 patients (8.3%) developed venous air embolism. In supine position 14.6% of patients (7 patients out of 48 operated patients) developed venous air embolism.

Young et al[27] documented venous air embolism incidence of 66% of patients in sitting positions when precordial Doppler applied as monitoring tool. They have reviewed 255 patients in sitting position for venous air embolism. It was a retrospective study where they had reviewed to determine the anaesthetic and surgical complications in neurosurgical patients having venous air embolism in sitting position.

Similarly Papadopoulos et al[2] found venous air embolism in 76% of cases of all posterior fossa operations when done in sitting positions. Here also they have used transesophageal echocardiography to detect the air embolism which was similar to our study. But they had included the cervical surgery group containing 40 patients in their study. But we had included only craniotomies in our study cohort which might have changed our results.

Bithal et al[66] reported venous air embolism of 28% in sitting position in patients of neurosurgical procedures. They detected embolism in 93 patients out of 334 patients in adult groups. The incidence was 22% of patients in children group(22/96). Here the authors used decrease in end tidal CO2 of more than 0.7 kpa as one of clinical indicator of venous air embolism.

Derek et al[94] in a retrospective study compared the incidence of venous air embolism in between sitting and supine position. All the patients were operated for vestibular schwannoma via retrosigmoid approach. In sitting position 28% of cases developed venous air embolism and in supine position 5% of patients had venous air embolism($p<0.001$). As it was retrospective study the method of detection was different in different patients. Venous air embolism detection was done by ETCO2, precordial Doppler echocardiography, transesophageal echocardiography and right arterial catheterisation. But if only TEE detection was taken into account 20% of patients in supine position and 28% of patients have venous air embolism in sitting position.

There is a variation between the incidence rates of venous air embolism in different neurosurgical positions in our study and incident rates found in the previous studies. It may be due to different parameters taken by different authors in detecting the venous air embolism. We only used the transesophageal echocardiography to detect the venous air embolism. Albin etal[3] used precordial Doppler to detect the venous air embolism which is less sensitive than TEE to detect the VAE. It may be the cause why 14.6% of supine patients developed venous air embolism while our study showed 41.3% patients had venous air embolism in supine position. We found 100% of patients developed venous air embolism in sitting position. But total number of patients who had undergone surgery in sitting position was two in number and both developed venous air embolism. But Bithal et al[66] found venous air embolism in 28% of sitting positioned patients of neurosurgical procedures. They had used capnography to detect the VAE. As end tidal CO2 is a less sensitive method to detect the venous air embolism, the above study may not have detected the air embolism in many patients undergoing neurosurgical procedures in sitting position.

3)Incidence of different grades of venous air embolism-

Our prospective study showed an incidence of 45% of venous air embolism. Out of total 100 patients who had undergone craniotomies for different neurosurgical conditions, 40 patients were found to have grade 1 venous air embolism. Grade 2 venous air embolism were found in 5 patients. No patients were having grade 3 and grade 4 venous air embolism out of total 100 patients. We used grading used by Schmandra TC et al[60] for grading venous air embolism.

Mammato et al[6] detected venous air embolism in all the patients by transesophageal echocardiography. He graded the venous air embolism as grade

0,1, 2and 3 as per micro bubble score. Grade 0 has no microbubbles, grade 1 contain 5 microbubbles per frame, grade 2 contain 10-25 microbubbles per frame and grade 3 as too many microbubbles per frame to be counted. No patients had grade 0, 48% of patients had grade 1, 14% of patients had grade 2 and 38% of patients had grade 3 embolism.

Schmitt et al[95] also studied the incidence of different grades of venous air embolism. He reported venous air embolism of grade 1, grade 2 and grade 3 in 7,2,1 patients respectively. They had studied 18 consecutive neurosurgical patients posted for surgery in sitting position. Transesophageal echocardiography was used for detection of the air embolism. Here also the grading system was different with grade 1 as only microbubbles, grade 2 as microbubbles plus sudden decrease in ETCO2 more than 1.5 mm of Hg. Grade 3 includes microbubbles plus sudden decrease in ETCO2 of 1.5 mm of Hg and sudden decrease of mean arterial pressure of 20mm of Hg.

The above findings of incidence of different grades of venous air embolism are different from our results. It may be due to different grading system of the venous air embolism in different studies.

4)Incidence of venous air embolism in different neurosurgical conditions-

In our study we had taken 100 patients out of which meningioma are 16(16%) in number, glioma were 21(21%) in number, various aneurysms were 21(21%) in number. Rest consisted of vestibular schwannoma(3%), epilepsy(7%), pituitary adenoma(5%). Rest 20% were miscellaneous in nature. The meningioma were 16 in number, 7 patients were found to have grade 1 venous air embolism, 2 patients out of 16 were having grade 2 air embolism and 7 patients were not detected to have venous air embolism. The parasagittal meningioma were 12 in number, 2 had frontoparietal meningioma and 2 were patients of sphenoid wing meningioma. The 5 patients with parasagittal meningioma were having grade 1 venous air embolism, 1 patient was having grade 2 venous air embolism and 6 patients did not have any air embolism. Another study was carried out by Raza SM et al[96] where they had reported 1.5% of patients of parasagittal meningioma had venous air embolism as intraoperative complication. But the method of detection of venous air embolism was not described in the study.

There were 21 subarachnoid haemorrhage patients with aneurysm were included in my study. 9 cases out 21 had developed grade 1 air embolism, 3 patients had grade 2 air embolism and 9 patients were not having any venous air embolism. Similarly there were 21 glioma patients who were included in the study. Out of 21 glioma patients, 6 patients developed grade 1 venous air embolism, 1 patient developed grade 2 venous air embolism and 14 patients did not have any venous air embolism.

Our study compared the incidence of venous air embolism in various neurosurgical conditions. Vestibular schwanomma patients had incidence of 33% (1/3), glioma patients had also incidence of 33% air embolism (7/21), SAH patients had incidence of air embolism in intraoperative period in 57.14% (12/21). The meningioma patients showed 42.8% incidence of venous air embolism (9/21), and the parasagittal meningioma had incidence of 50% (6/12) venous air embolism in intraoperative period. During meningioma decompression, surgeon may have taken extra vigilance to prevent venous air embolism which may explain the slightly lower incidence of venous air embolism in meningioma than aneurysms.

5) Relationship between venous air embolism and height of surgical field, angle of inclination of the table-

In our study we have tried to find out the optimum height of the operating site from the right atrium below which the chance of venous air embolism decreases. That is why we collected the data of gradient of height of operating site from right atrium of all patients. The mean height at which embolism is present is 14.3 cm ± SD 5.1cm, the mean height of patients who did not have the venous air embolism was 13.4cm ± SD 5.0cm. The mean height of patients having venous air embolism is 1.3 cm more than the mean height of patients who did not have air embolism. But the p value was 0.405 which was statistically insignificant. The exact height of more than 12.5 cm has sensitivity of 64.4% and specificity of 47.3% to predict the venous air embolism. But area under the curve is 0.562 which showed power of study to be low. Again we tried to compare the height of patients in grade1 and grade 2 patients. The mean height of grade 2 patients was 18.4 cm and mean height of patients in grade 1 was 10.23 cm. There was a mean height difference of 8.2 cm between grade 2 and grade 1 patients. But the p value was again 0.279 which was not significant.

Similarly we measured the angle of inclination of patients to find out the angle above which the chance of venous air embolism is increased. The mean angle of patients with grade 1 venous air embolism was 14.23^0 ± SD of 4.8^0 and the mean angle in grade 2 venous air embolism is 14.8^0 ± SD of 7.59^0. The mean angle of inclination in grade 2 patients is more than the mean angle of inclination in grade 1 patients. But the p value was 0.689 which was again statistically insignificant. The optimum cut off angle to predict the venous air embolism was 14.5 degrees which has a sensitivity of 51.1% and specificity of 45.5% to predict the venous air embolism. But again the area under the curve was less (0.503).

Albin et al[3] reported that gravitational gradient from venous portal of entrance to right side of heart were as small as 5cm was sufficient to aspirate 200 ml of air. Harris et al[31] studied venous air embolism in children to find out the incidence of it. They had also used both precordial Doppler and sub xiphoid transthoracic echo with continuous four chamber real time video recorder. They had found venous air embolism in 66% of infants undergoing craniectomies. They also reported that children in study had large head which laid 5-10 cm above the level of heart. We found a mean height of 14.3 cm in our cohort group. We had not included the pediatric group who are more prone to develop VAE in our study. Our study is unique that it tried to find out the cut off height of operating site from right heart and angle of inclination of the patient to predict the venous air embolism.

6) **Change in echo parameters like RVIDD, RVIDS, AND TAPSE due to venous air embolism –**

Our study was devised to study the right heart strain parameters due to venous air embolism in different positions of patients undergoing neurosurgical procedures. We had total 45 patients who developed venous air embolism. There were 40 patients who developed grade 1 venous air embolism, 5 patients developed grade 2 venous air embolism but no patients developed grade 3 and grade 4 venous air embolism. We measured the change in RVIDS, RVIDD,TAPSE at the time of venous air embolism from the baseline values. The change in RVIDS, RVIDD, TAPSE was statistically insignificant with p value of 0.273, 0.483, 0.104 respectively. It may be due to absence of higher grades of venous air embolism in our study group. It is also clear that smaller grades of air embolism though common, do not produce any significant hemodynamic changes or complications. We also could not get any patient having post operative stroke and post operative myocardial infarction in the neurosurgical ICU. This finding might be due to the presence of only lower grades of venous air embolism during intra operative period.

7) **Comparison of change in End tidal CO2 with incidence of venous air embolism-**

In our study we accepted sudden change in the end tidal CO2 more than 2 mm of Hg to be significant for venous air embolism. We found 3 patients among 45 patients of venous air embolism have end tidal CO2 of more than 2 mm of Hg. But 42 patients did not have end tidal CO2 of more than 2 mm of Hg despite having venous air embolism. The change in $ETCO_2$ due to venous air embolism was statistically insignificant.

Bithal et al[66] reported venous air embolism of 28% in sitting position in patients of neurosurgical procedures. They used decrease in end tidal CO2 of more than 0.7 kpa as one of clinical indicator of venous air embolism. They detected embolism in 93 patients out of 334 patients in adult groups. The incidence was 22% of patients in children group(22/96). We did not find any statistically significant difference in change of end tidal CO_2 which may be attributed to venous air embolism. But the sensitivity of ETCO2 to detect VAE is much lower when compared with the TEE. Also, the lower grades of venous air embolism might not change the end tidal CO2 parameters.

8) Advantages of our study-

The major advantages of our study is that we tried to find the cut off height of the operating site and the angle of inclination of the patients who developed the venous air embolism in different neurosurgical conditions. Previous studies was carried out to find the incidence of venous air embolism and very few of them calculated the relation of height and angle of inclination of the patient with incidence of the venous air embolism.

The other advantage of our study is that we standardized the various positions like supine, semi sitting and sitting positions as specific range of angles.

We had tried to find out the relationship of incidence of venous air embolism with specific positions.

We also used the TEE which is the most sensitive method available to detect the venous air embolism. It can detect as little as 0.02ml/kg of air, and also it can detect passage of air into the left side of the heart.

Lastly we had tried to quantitatively assess the right ventricular strain by measuring the transesophageal echo parameters like RVIDS, RVIDD, TAPSE (tricuspid annular plane systolic excursion). But we could not detect any higher grades of venous air embolism (grade 3 and grade 4) for which we could not quantify the change in these parameters.

9) Limitations of our study-

Like all scientific studies, our study also had some limitations. Our study did not standardize the number of patients in each group. That is why we got very few patients in the sitting position. Due to very less number of patients we could not get statistically significant results in sitting position. Secondly we found only grade 1 and grade 2 venous air embolism in our study group. It may be due to early detection of venous air embolism and hence surgeon was informed to take precaution to stop the air embolism. Due to this we could not get higher grades of air embolism. It would have been unethical not to inform the operating surgeon. Another limitation of our study was the angle of inclination was not constant throughout the study. But we had accepted the baseline angle after positioning to be the angle of inclination for the whole surgery. Lastly we did not include the prone position due to practical difficulties in manipulating the probe in prone position.

However despite some limitation we were able to find the incidence of venous air embolism in different positions of patient and we compared the incidence of VAE in different neurosurgical conditions.

CONCLUSION

CONCLUSION

In our prospective observational study, we found that the incidence of VAE in neurosurgical patients undergoing surgery in various positions was 45% as detected by using TEE. The sitting postion has the maximum risk, followed by semisitting and lateral positions.

Our study revealed that the cut off height of the operative site to that of right atrium was 12.5 cm, having sensitivity 64.4% and specificity 47.3% to predict the occurrence of venous air embolism. Also, the angle of $\geq 14.5^0$ had 50.1% sensitivity and 45.5% specificity to predict the venous air embolism.

Lastly we found that change in End tidal CO2 parameters is not a reliable method of detecting lower grades of venous air embolism. Also we found that lower grade venous air embolism do not produce any significant change in right ventricular strain parameters in Echo and also did not cause any major intraoperative hemodynamic complications.

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ANNEXURES

श्री चित्रा तिरुनाल आयुर्विज्ञान और प्रौद्योगिकी संस्थान, त्रिवेन्द्रम
तिरुवनन्तपुरम - ६९५०११, केरल, इंडिया
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY, TRIVANDRUM
Thiruvananthapuram - 695 011, Kerala, India
(An Institute of National Importance under Govt. of India)
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Institutional Ethics Committee
(IEC Regn No. ECR/189/Inst/KL/2013)

SCT/IEC/882/APRIL-2016

16.07.2016

Dr. Bimal Kumar Sahoo
Senior Resident
Department of Anaesthesiology
SCTIMST, Thiruvananthapuram

Dear Dr. Bimal Kumar Sahoo,

The Institutional Ethics Committee reviewed and discussed your application to conduct the study entitled "INCIDENCE OF VENOUS AIR EMBOLISM IN PATIENTS UNDERGOING INTRACRANIAL SURGERIES BY USING TRANSESOPHAGEAL ECHOCARDIOGRAPHY" (IEC/882) on 16th April, 2016.

The following documents were reviewed:

1. *Covering letter addressed to the Chairman, IEC, SCTIMST, with check list*
2. *Letter addressed to the Chairman, IEC, SCTIMST, dated 22.03.2016 received from Dr. Manikandan, Additional Professor, Department of Anaesthesiology, SCTIMST*
3. *TAC Approval Letter*
4. *IEC Application Form*
5. *Project Proposal*
6. *Proforma*
7. *Patient Information Sheet and Consent Form in English and Malayalam*
8. *CV of Principal Investigator and Co- Investigators*

Revised submission

1. *Covering letter addressed to the Chairman, IEC, SCTIMST dated 13.07.2016 with check list*
2. *Copy of IEC Recommendation Letter dated 03.05.2016*
3. *TAC Approval Letter*
4. *IEC Application Form*
5. *Project Proposal*
6. *Proforma*
7. *Undertaking regarding payment of processing fee*
8. *Patient Information Sheet and Informed Consent Form in English and Malayalam*
9. *CV of Principal Investigator and Co- Investigators*

The following members of the Ethics Committee were present at the meeting held on 16th April, 2016 at G. Parthasarathi Board Room, AMCHSS, SCTIMST

SL. No.	Member Name	Highest Degree	Gender	Scientific /Non Scientific	Affiliation with Institution(s)
1.	Justice Gopinathan. P.S	BSc. LLB	Male	Legal Expert (Chairperson)	No
2.	Dr. Asha Kishore	MD, DM	Female	Clinician (Neurologist)	Yes
3.	Shri. O.S. Neelakantan Nair	BE	Male	Engineer	Yes
4.	Dr. Meenu Hariharan	DM	Female	Clinician (Gastro-Enterologist)	No
5	Dr. Rema M. N	MD	Female	Pharmacologist	No
6.	Dr. V. Raman Kutty	MPH(Harvard) MPhil, MD	Male	Public Health	Yes
7.	Dr. K R S Krishnan	ME, PhD	Male	Biomedical Scientist/Engineer	No
8.	Dr. Kala Kesavan. P	MD	Female	Pharmacologist	No
9.	Smt. Sathi Nair	MA	Female	Lay Person	No
10.	Dr. Christina George	MD	Female	Psychiatrist	No
11.	Dr. Mala Ramanathan	MSc, PhD, MA	Female	Ethicist/Social Scientist (Member Secretary)	Yes

IEC Decision

The IEC approved the conduct of the study in the present form.

Remarks:
The Institutional Ethics Committee expects to be informed about the progress of the study, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent and asks to be provided a copy of the final report.

There was no member of the study team who participated in voting / decision making process. The ethics committee is organized and operated according to the requirements of Good Clinical Practice and the requirements of the Indian Council of Medical Research (ICMR).

Sincerely,

MRamanathan

Mala Ramanathan
Member Secretary, IEC

PATIENT CONSENT FORM

Title of the study: **Incidence of venous air embolism in patients undergoing intracranial surgeries by using Transesophageal echocardiography.**

Name of the Investigators:
Dr Bimal kumar Sahoo, Dr Smita V, Dr.Manikandan.S,

Venous air embolism can occur during neurosurgical procedures. You are being requested to participate in this study which will detect changes in hemodynamics during your surgery. . This study will require placement of invasive arterial cannula and use of transesophageal echocardiography. Both these tools are used as part of Anaesthesia monitoring in this institute and worldwide. We have planned to include about 100 people from this hospital in this study.

.

What is TEE?

TEE is an ultrasound imaging of your heart. During TEE, a ultrasound probe is inserted through your mouth into the esophagus (food pipe).The ultrasound shows the structure and functions of the heart muscles and valves from different angles.This tool has been used all over the world in neurosurgical patients undergoing major surgeries and found to be safe.

What is invasive arterial BP?

Invasive arterial BP is the monitoring of blood pressure of the patient after placing an arterial cannula in the peripheral artery of your hand/leg. This method of BP monitoring is a part of standard anesthesia monitoring and has been used all over the world in neurosurgical patients and found to be safe.

If you take part what will you have to do?

On the day of surgery you will be taken inside the Operation Theatre. Monitors to check your heart beat, blood pressure and oxygen saturation level will be attached. A small venous cannula will be inserted under local anesthesia in the hand for fluid and drug administration. Arterial cannula also will be inserted under local anesthesia for monitoring the blood pressure. General Anaesthesia will be induced and maintained as per the routine anesthesia practice in the hospital. Arterial canula will be inserted for monitoring blood pressure continuously and a central venous catheter will be put in the big vessel of the neck. Then TEE probe will be inserted through the mouth into the esophagus. Both the tools will be used to monitor the hemodynamic changes throughout the surgery as per routine. At the end of surgery TEE probe will be removed. Arterial line will be retained for post operative monitoring in ICU.

Does TEE use have any side effects?

The majority of people have no side effects. The reported side effects are sore throat and numbness of throat when used in awake patients but the incidence of this complication in our study will be remote as the patient is in general anesthesia. Other reported complications are very rare and include injuries to teeth and esophagus. Esophageal intubation can induce vagal and sympathetic reflexes such as hypertension or hypotension, tachy arrhythmias or bradycardia.These complications are very rare in patients under general anesthesia as they are in deep sedation and paralysed and anesthesia mostly blunts the hemodynamic effects of TEE.Futhermore the patients with risk of getting injured are excluded by the exclusion criteria.

Does invasive arterial line use have any side effects?

The majority of people have not had side effects. The reported side effects are hemorrhage, infection, vascular insufficiency, ischemia, thrombosis, embolization, and neuronal or adjacent structure injury. These are very rare complications and are prevented by preoperative testing for good collateral circulation and avoiding long term canulation.

Does use of central venous catheter use has any side effect?

The complications of central venous catheter is accidental injury to the artery, other structures of the neck and pneumothorax. These complications will be minimized by use of ultrasound guided catheterization.

.

Can you withdraw from this study after it starts?

Your participation in this study is entirely voluntary and you are also free to decide to withdraw permission to participate in this study. If you do so, this will not affect your usual treatment at this hospital in any way.

What will happen if you develop any study related injury?

We do not expect any injury to happen to you since the anaesthesia technique and monitoring tools would be same even if you were not part of the study. But if you do develop any side effects or problems due to the study, these will be treated at no cost to you. We are unable to provide any monetary compensation, however.

Will you have to pay for the cost of using the devices?

Arterial BP monitoring and TEE are used as a part of routine anaesthesia procedures for surgery. No extra charge for monitoring purpose will be extracted from you.

What happens after the study is over?

Arterial BP, Transesophageal Echocardiography is a routinely used tool for monitoring heart and circulation during major neurosurgery. They will be used to monitor hemodynamics throughout the length of the surgery. After surgery is over the TEE probe will be removed before shifting the patient to ICU.

Will your personal details be kept confidential?

The results of this study will be used for thesis submission as a part of academic research and will be submitted to a medical journal for publication, but you will not be identified by name in any publication or presentation of results. However, your medical notes may be reviewed by people associated with the study, without your additional permission, should you decide to participate in this study.

If you have any further questions, please ask Dr Bimal Kumar Sahoo (Principal investigator) mobile number9746438536.. Email: bimalkusahoo@sctimst.ac.in

Participant's name: **Date of Birth / Age (in years)**:

I_________________________, son/daughter of

____

Declare that (Please tick boxes)

- I have read the above information provided to me regarding the study: Incidence of venous air embolism in patients undergoing intracranial surgeries by using Transesophageal echocardiography.

- I have clarified any doubts that I had. [ ]
- I also understand that my participation in this study is entirely voluntary and that I am free to withdraw permission to continue to participate at any time without affecting my usual treatment or my legal rights [ ]
- I understand that the study staff and institutional ethics committee members will not need my permission to look at my health records even if I withdraw from the trial. I agree to this access [ ]
- I understand that my identity will not be revealed in any information released to third parties or published [ ]
- I voluntarily agree to take part in this study [ ]
- I have been provided with the contact numbers of the principle investigator, in case I want to know more about the study and participants rights [ ].
- I received a copy of this signed consent form [ ]

Name:
Signature:
Date:

Name of witness:
Relation to participant:
Signature:

Person Obtaining Consent

I attest that the requirements for informed consent for the medical research project described in this form have been satisfied. I have discussed the research project with the participant and explained to him or her in nontechnical terms all of the information contained in this informed consent form, including any risks and adverse reactions that may reasonably be expected to occur. I further certify that I encouraged the participant to ask questions and that all questions asked were answered.

Name:

Signature: Date:

PROFORMA

TRANSESOPHAGEAL ECHOCARDIOGRAPHIC (TEE) ASSESSMENT OF VENOUS AIR EMBOLISM WITH HEMODYNAMIC CHANGES IN THE INTRAOPERATIVE PERIOD DURING NEUROSURGERY

Case no- Age Gender M/F Hosp.No
Weight(KG) Height BSA

Diagnosis Surgery Position: SUPINE /LATERAL/ SEMISITTING/SITTING

baseline TEE (Before positioning)

LV FUNCTION (SYSTOLIC)	LVIDD LVIDS SV EF RWMA
DIASTOLIC FUNCTION	E/A E′/A′ DT E/E′
PFO/ SHUNTS	
MITRAL/TRICUSPID/ AORTIC/PULMONARY VALVE	
RV FUNCTION	RVIDS RVIDD TAPSE

VENTILATION BASELINE SETTINGS

MODE	
TIDAL VOLUME	
PEEP	
PAW	
RR	
MEAN AWP	

SL NO	STEP SURGERY	TIME	HR	IBP	ETCO2	LVIDD(mm)	LVIDS (mm)	EF%	SV	RWMA	E/A	E'/A'	TR /PR	RVIDS	RVIDD	TAPSE	Right to left shunt	VAE (Y/N) grade
1	After positioning																	
2	craniotomy																	
3.	Dural opening																	
4.	Handling of dural sinuses																	
5.	Closure of duramater																	
6.																		
7.																		
8.																		
9.																		
10.																		
11.																		
12.																		

PERI OPERATIVE COMPLICATIONS -YES/ NO

IF YES

PRESENCE OF ST CHANGES

AMI/RWMA

STROKE- CT CHANGES- TERRITORY OF INFARCT

SL NO	HOS NO	AGE	SEX	WT	HT	BSA	DIAGNOSIS	SURGERY	POSITION	HEIGHT	ANGLE	LVIDD	LVIDS	SV	EF	RWMA	E/A	E'/A'	DT
1	353219	62	2	58	1.48	26.48	RT VESTIBULAR S	CRANIOTOMY AN	LATERAL	13	8	30	21	46	57	2	0.97	1.45	212
2	409766	20	1	73	1.66	26.49	OPTICO CHIASMA	SEPTOSTOMY, VP	SUPINE	9	5	34	28	52	58	2	1.82	1.46	165
3	430636	19	2	62	1.64	23.05	RT TRIGEMINAL S	CRANIOTOMY AN	SUPINE	16	14	40	30	50	58	2	1.2	1.63	165
4	433027	48	1	82	1.73	27.40	ICA BIFURCATION	CRANIOTOMY AN	SUPINE	9	5	40	28	46	68	2	1.48	1.68	215
5	326888	58	1	58	1.62	22.10	RT PARIETO OCCI	CRANIOTOMY AN	LATERAL	16	17	42	34	59	62	2	1.62	1.78	169
6	433729	62	2	56	1.42	27.77	RT FRONTAL GLIC	CRANIOTOMY AN	SEMISITTING	28	35	34	29	39	55	APICAL,LAT	0.89	1.05	135
7	435710	55	1	62	1.52	26.84	RT PCOM ANEUR	CRANIOTOMY AN	SUPINE	15	14	39	32	48	52	2	1.26	1.12	170
8	435405	23	1	55	1.62	20.96	RT FRONTAL GLIC	CRANIOTOMY AN	SUPINE	8	5	38	32	59	58	2	1.42	1.38	136
9	433182	64	2	55	1.44	26.52	LEFT PARASAGITT	CRANIOTOMY AN	SUPINE	12	11	40	31	48	56	2	1.44	1.52	165
10	432211	38	1	52	1.52	22.51	RT TEMPORAL GL	CRANIOTOMY AN	SUPINE	9	5	35	24	58	62	2	1.91	1.89	170
11	430451	68	2	68	1.65	24.98	LT FRONTAL GLIC	CRANIOTOMY AN	SUPINE	9	5	39	30	46	58	2	1.68	1.92	176
12	433870	37	2	65	1.46	30.49	DIFFUSE SPLENIA	CRANIOTOMY AN	SUPINE	11	14	38	26	46	52	2	1.92	1.35	202
13	418839	19	1	69	1.72	23.32	LT TEMPORAL DN	CRANIOTOMY AN	SUPINE	11	15	43	38	56	66	2	2.02	2.9	163
14	434630	62	1	65	1.53	27.77	RT FRONTO PARII	CRANIOTOMY AN	SUPINE	10	5	39	27	57	58	2	1.13	1.39	195
15	426936	19	1	68	1.72	22.99	RT TEMPORAL DN	CRANIOTOMY AN	SUPINE	11	15	41	32	68	72	2	1.68	1.76	100
16	344184	22	1	52	1.69	18.21	LT MTS	ATL AH	SUPINE	9	5	44	38	62	5	2	1.21	1.39	140
17	435043	35	2	55	1.49	24.77	COLLOID CYST	CRANIOTOMY AN	SUPINE	8	5	38	30	48	55	2	1.62	1.78	165
18	427337	47	1	82	1.70	28.37	RECURRENT PARA	CRANIOTOMY AN	SEMISITTING	22	28	34	24	59	72	2	1.81	1.75	181
19	434417	49	2	65	1.53	27.77	LT MCA ANEURYS	CRANIOTOMY AN	SUPINE	13	9	49	38	58	61	2	1.58	1.86	190
20	434549	21	1	55	1.67	19.72	LT FRONTAL ABS(	CRANIOTOMY AN	SUPINE	8	5	41	32	55	58	SEPTAL WA	2.23	2.1	178
21	429397	35	1	65	1.56	26.71	LT PARASAGITTAI	CRANIOTOMY AN	SEMISITTING	18	27	39	31	62	58	2	1.28	1.36	138
22	425389	34	1	67	1.62	25.53	RT TEMPORAL LE	CRANIOTOMY AN	SUPINE	6	5	41	33	48	52	2	1.82	1.19	181
23	216151	58	1	78	1.74	25.76	LT MCA STROKE	DECOMPRESSIVE	SUPINE	14	15	46	41	25	27	SEPTAL AN	0.6	1.6	111
24	431863	36	2	65	1.42	32.24	PITUITARY ADEN(	CRANIOTOMY AN	SUPINE	7	5	46	37	62	64	2	1.68	1.74	157
25	434586	19	1	48	1.42	23.80	THIRD VENTRICUI	CRANIOTOMY AN	SUPINE	9	5	44	32	62	72	2	1.73	1.71	144
26	970876	53	2	65	1.52	28.13	RT PARASAGITTA	CRANIOTOMY AN	SUPINE	22	15	46	38	48	66	2	1.94	2.27	192
27	356121	34	1	76	1.86	21.97	LT PARASAGITTAI	CRANIOTOMY AN	SEMISITTING	24	35	47	35	49	72	2	1.64	1.75	184
28	380559	37	1	88	1.78	27.77	RT MTS	RT ATL AH	SUPINE	11	15	41	27	62	76	2	1.71	1.86	145
29	422960	40	2	45	1.61	17.36	RT DACA ANEURY	CRANIOTOMY AN	SUPINE	9	5	42	35	68	52	2	1.14	1.28	176
30	400130	18	1	58	1.72	19.61	LT MTS	ATL AH	SUPINE	11	5	39	32	49	59	2	1.26	1.38	128
31	422541	53	1	55	1.65	20.20	LT FP GLIOMA	CRANIOTOMY AN	SEMISITTING	28	35	38	32	52	65	2	1.37	1.58	145
32	380588	30	1	62	1.72	20.96	LT FRONTAL GLIC	CRANIOTOMY AN	SUPINE	13	15	44	36	68	62	2	1.65	1.9	165
33	434252	34	2	55	1.47	25.45	LT FRONTAL GLIC	CRANIOTOMY AN	SUPINE	8	5	41	31	56	34	2	1.65	1.97	196
34	279193	31	1	58	1.63	21.83	RECURRENT PITU	CRANIOTOMY AN	SUPINE	14	15	42	33	61	65	2	1.29	1.52	136
35	329726	19	1	55	1.59	21.76	COLLOID CYST	CRANIOTOMY AN	SUPINE	7	5	38	24	65	62	2	1.38	1.49	128
36	415630	38	2	62	1.56	25.48	FRONTAL GLIOMA	CRANIOTOMY AN	SUPINE	10	5	46	36	58	66	2	1.82	2.66	202
37	425320	50	1	85	1.57	34.48	RT PARASAGITTA	CRANIOTOMY AN	SUPINE	18	14	48	31	50	55	2	3.04	3.87	262
38	401747	55	2	55	1.48	25.11	LT MTS	LT ATL AH	SUPINE	15	13	33	29	45	43	2	1.85	1.4	178
39	294503	55	1	55	1.38	28.88	RECURRENT CRAI	CRANIOTOMY AN	SUPINE	14	12	38	28	69	7	2	2.69	1.3	257
40	419879	65	1	65	1.78	20.52	RT ICA ANEURYSI	CRANIOTOMY AN	SUPINE	14	12	37	16	55	62	2	2.67	1.69	148
41	382126	53	2	62	1.65	22.77	LT PARASAGITTAI	CRANIOTOMY AN	SUPINE	16	15	32	20	56	57	2	2.36	2.52	261
42	423535	51	2	68	1.54	28.67	TUBERCULUM SE	CRANIOTOMY AN	SUPINE	12	15	49	32	68	62	2	1.28	1.39	134
43	420583	38	2	65	1.52	28.13	LT PARIETAL LESI(	CRANIOTOMY AN	LATERAL	27	15	48	21	68	71	2	1.16	1.23	132
44	421583	69	2	67	1.62	25.53	RT FRONTAL GLIC	CRANIOTOMY AN	SEMISITTING	22	28	40	32	40	69	2	2.4	1.5	193
45	419814	55	1	55	1.64	20.45	LT PARIETAL MEN	CRANIOTOMY AN	SUPINE	15	15	44	23	63	72	GLOBAL	1.24	1.17	172
46	437377	56	2	56	1.43	27.39	LEFT PARIETAL H(	CRANIOTOMY AN	SUPINE	11	5	41	32	46	53	2	2.27	1.66	150
47	265423	28	1	85	1.68	30.12	LT TP GLIOMA	CRANIOTOMY AN	SEMISITTING	19	38	32	21	35	68	2	2.4	2.27	189
48	424234	70	2	50	1.38	26.25	A COM ANEURYS	CRANIOTOMY AN	SUPINE	13	15	45	36	35	53	2	2.47	2.35	208
49	419437	53	2	63	1.53	26.91	LT ICA ANEURYSI	CRANIOTOMY AN	SUPINE	15	15	31	20	52	0	2	1.81	2.39	191

PFO	MV/TV/AV	RVIDS	RVIDD	TAPSE	TIME AP	HR AP	IBP AP	ETCO2 AP	LVIDD AP	LVIDS AP	EF AP	SV AP	RWMA AP	E/A AP	E'/A' AP	TR/PR AP	RVIDS AP	RVIDD AP	TAPSE AP	RTL SHUNT	VAE (Y/N) /
2	2	22	28	9	9.35	83	96/58	25	29	20	57	44	2	1.58	2.1	2	22	30	10	2	2
2	2	22	28	8	10	100	110/65	28	32	24	58	52	2	1.82	1.46	2	22	28	9	2	2
2	2	23	32	9	10.05	75	129/62	28	40	29	58	50	2	1.2	1.3	2	22	32	10	2	2
2	MR	21	33	9	14.15	56	91/59	28	40	28	70	52	2	1.68	2.1	2	21	33	9	2	2
2	2	28	33	9	8.55	99	122/67	32	42	34	60	59	2	1.62	1.78	2	28	33	9	2	2
2	2	31	40	7	13.56	76	105/65	29	41	33	56	48	YES	1.92	2.1	2	30	38	7	2	2
2	2	26	33	12	9.4	46	106/57	27	39	32	52	48	2	1.26	1.12	2	26	33	11	2	2
2	2	22	28	9	9.15	82	108/65	32	38	32	58	59	2	1.42	1.38	2	22	28	9	2	2
2	2	27	33	9	9.3	87	118/63	26	40	31	56	48	2	1.44	1.52	2	27	33	9	2	2
2	TR++	26	36	10	9.25	58	103/66	28	35	24	62	58	2	1.91	1.89	TR++	26	36	10	2	2
2	2	28	36	9	9.35	86	107/45	29	39	30	56	46	2	1.62	1.92	2	28	36	10	2	2
2	2	21	29	7	9.01	63	105/58	31	38	26	55	48	2	1.89	1.38	2	22	29	8	2	2
2	MR+	25	40	9	8.55	71	108/68	28	42	32	62	59	2	1.92	2.3	2	29	40	9	2	2
2	2	31	38	9	8.25	61	118/58	29	40	30	65	63	2	1.16	1.58	2	30	39	9	2	2
2	2	24	32	9	9	68	114/62	29	40	32	70	64	2	1.68	1.72	2	25	32	9	2	2
2	2	28	36	9	14.09	72	125/75	30	44	38	66	65	2	1.24	1.39	2	28	36	9	2	2
2	2	22	33	9	10	78	132/65	29	38	30	55	48	2	1.62	1.73	2	22	33	9	2	2
2	2	26	38	10	14.15	78	137/75	28	35	24	70	59	2	1.11	1.75	2	26	38	10	2	2
2	2	28	36	9	17.15	65	108/68	28	48	38	61	59	2	1.42	1.98	2	28	36	10	2	2
2	MR+	19	28	7	13.15	78	90/49	29	41	32	57	55	SEPTAL	2.23	2.1	2	19	28	7	2	2
2	2	24	32	10	8.35	82	139/86	27	39	31	58	62	2	1.28	1.36	2	24	32	10	2	2
2	2	26	35	11	11.5	71	103/62	27	41	34	52	48	2	1.12	1.19	2	26	35	11	2	2
2	MR+	21	33	7	14.51	86	117/65	34	46	42	27	25	SEPTAL API	0.6	1.1	2	21	33	7	2	2
2	TR++	24	33	10	9.1	80	118/82	28	46	35	65	58	2	1.86	2.36	TR++	24	32	10	2	2
2	2	30	36	9	8.3	81	111/68	26	42	30	72	68	2	1.68	1.92	2	30	35	9	2	2
2	MR+,TR+	27	36	7	10.2	60	106/63	30	46	38	63	45	2	1.92	1.86	TR++	27	33	10	2	2
2	2	35	46	11	9.4	86	89/56	29	47	35	75	49	2	2.46	2.08	2	35	47	11	2	2
2	MR+	34	40	13	15.1	82	92/49	28	37	28	65	42	2	2.24	2.3	2	28	36	14	2	2
2	TR+	24	36	9	8.5	75	102/64	28	42	35	68	52	2	1.14	1.28	TR+	24	36	9	2	2
2	2	32	38	9	14.05	69	130/65	29	39	30	62	58	2	1.18	1.26	2	32	38	10	2	2
2	MR+	26	35	9	10.2	59	142/67	28	46	32	60	59	2	1.36	1.58	2	26	35	9	2	2
2	2	32	38	9	8.45	58	106/68	26	44	36	62	67	2	1.65	2.12	2	31	38	9	2	2
2	2	21	28	8	10.16	67	107/60	26	41	33	56	48	2	1.62	1.53	2	26	31	9	2	2
2	2	28	36	10	8.55	79	128/79	30	42	33	65	61	2	1.29	1.52	2	28	36	9	2	2
2	2	28	36	9	8.25	77	108/49	29	38	24	62	65	2	1.38	1.48	2	28	36	9	2	2
2	MR+,TR+	32	36	10	9.2	68	98/59	30	46	36	66	58	2	1.82	2.66	TR+	32	36	9	2	2
2	2	47	52	12	9.25	64	116/65	29	48	31	55	52	2	3.04	3.8	2	47	52	12	2	2
2	2	35	42	9	1.55	68	93/55	26	39	28	43	46	2	1.84	1.92	2	35	42	9	2	2
2	2	26	38	8	8.55	60	106/59	28	38	28	69	67	2	2.69	1.3	2	26	38	8	2	2
2	MR+	18	32	10	10.45	55	138/47	30	37	22	68	52	2	2.67	1.67	2	20	32	11	2	2
2	2	29	38	11	8.45	68	108/58	27	36	22	65	66	2	2.12	2.36	2	28	36	11	2	2
2	2	29	38	11	8.36	87	126/89	30	48	30	62	65	2	1.28	1.39	2	29	38	11	2	2
2	2	22	32	10	13.55	69	108/65	30	48	21	71	68	2	1.16	1.23	2	21	32	10	2	2
2	MS+,MR+,T	35	44	10	14.35	62	105/58	26	46	31	67	52	2	1.28	1.46	TR+	35	44	10	2	2
2	MR+	32	44	9	9.06	46	108/58	32	43	24	71	62	2	1.12	1.32	2	32	44	9	2	2
2	TR+	27	35	11	9.06	82	116/79	26	41	32	53	48	2	2.27	1.66	TR+	27	35	11	2	2
2	TR+	31	42	13	9.35	60	111/61	29	32	21	68	39	2	2.4	2.2	TR+	31	42	13	2	2
2	MR+	25	37	10	8.47	89	160/89	30	45	36	54	55	2	2.48	2.37	2	25	37	10	2	2
2	2	25	29	9	8.45	74	106/59	28	31	20	60	52	2	1.81	2.31	2	25	29	9	2	2

TIME CR	HR CR	IBP CR	ETCO2 CR	LVIDD CR	LVIDS CR	EF CR	SV CR	RWMA CR	E/A CR	E'/A' CR	TR/PR CR	RVIDS CR	RVIDD CR	TAPSE CR	RTL SHUNT	VAE (Y/N) CI	TIME DO	HR DO	IBP DO	ETCO2 DO
10.3	83	124/75	26	29	20	57	43	2	1.52	2.2	2	20	31	9	2	2	11.04	81	113/73	26
10.55	112	128/69	27	35	25	59	53	2	1.75	1.48	2	21	29	9	2	2	11.4	108	108/58	27
10.55	75	128/62	27	39	30	58	50	2	1.1	1.15	2	22	32	10	2	GRADE 1	11.01	74	122/62	25
15.18	58	116/58	28	39	28	69	50	2	1.75	2.08	2	20	32	9	2	2	15.38	55	108/57	27
9.38	106	142/73	33	44	34	63	62	2	1.72	1.79	2	28	34	9	2	GRADE 1	10.22	96	116/65	32
14.5	87	118/65	28	40	32	56	47	YES	1.91	1.96	2	28	38	7	2	2	15.1	73	102/52	27
10.18	43	122/62	25	39	31	50	49	2	1.28	1.18	2	26	32	12	2	2	10.55	53	118/58	26
10.18	96	119/75	30	38	33	59	62	2	1.52	1.46	2	21	28	9	2	2	10.55	78	105/61	30
11.1	72	107/62	25	40	30	58	56	2	1.53	1.72	2	28	33	9	2	GRADE 1	11.55	76	105/58	24
10.15	53	104/64	28	35	24	62	58	2	1.89	1.93	TR++	26	36	10	2	2	10.42	55	119/73	29
10.16	78	119/55	29	39	30	58	46	2	1.58	2.01	2	29	36	9	2	GRADE 1	10.55	80	109/54	28
10.15	64	103/54	30	39	27	56	46	2	1.88	1.45	2	23	29	8	2	2	10.35	64	101/53	29
9.45	68	121/70	28	43	29	66	62	2	2.02	2.4	2	30	38	9	2	2	10.16	63	106/58	28
10.31	57	117/71	26	39	28	58	59	2	1.14	1.26	2	30	39	9	2	GRADE 1	10.45	57	113/71	26
9.48	53	109/58	29	41	32	70	65	2	1.65	1.76	2	24	32	9	2	2	10.05	56	108/57	29
14.55	89	165/82	32	42	36	66	62	2	1.38	1.27	2	29	37	9	2	2	15.18	70	116/68	30
11	87	146/68	30	38	29	58	48	2	1.65	1.78	2	22	34	9	2	2	11.2	72	116/56	29
14.5	68	121/69	26	35	25	68	59	2	1.12	1.69	2	28	36	10	2	2	15.03	58	134/78	27
18.45	78	148/96	26	46	38	58	56	2	1.46	2.01	2	27	36	9	2	GRADE 1	19.28	79	118/76	27
13.38	70	98/56	28	41	32	57	56	SEPTAL	2.31	2.02	2	20	27	8	2	2	13.45	70	99/56	28
9.51	99	165/98	28	40	30	57	60	2	1.29	1.42	2	26	33	10	2	GRADE 1	10.35	76	121/66	27
13.1	67	120/68	27	42	33	52	49	2	1.18	1.26	2	24	33	10	2	2	13.46	73	98/55	27
15.21	77	94/56	31	47	44	26	24	SEPTAL API	0.7	0.9	2	22	34	6	2	2	15.52	89	114/59	32
10.38	76	124/90	28	46	36	68	65	2	1.73	2.08	TR++	24	32	9	2	GRADE 1	10.56	72	122/87	27
9.15	82	125/75	26	41	31	70	64	2	1.71	1.96	2	32	36	10	2	2	9.33	81	108/75	26
11.01	71	98/54	29	47	38	64	46	2	2.11	2.19	TR++	26	32	10	2	GRADE 1	11.15	70	109/57	28
10.23	73	147/81	26	48	32	72	48	2	2.12	2.16	2	36	47	12	2	GRADE 1	10.55	73	107/48	26
15.4	82	111/60	26	38	29	65	52	2	2.3	2.34	2	30	36	12	2	2	16.1	70	93/48	26
10.1	69	110/67	26	41	33	69	56	2	1.12	1.21	TR+	24	35	9	2	2	11	64	87/66	25
15.13	86	142/86	29	40	30	62	59	2	1.16	1.32	2	31	36	10	2	2	16.08	65	108/52	28
11.28	56	136/62	27	44	28	65	62	2	1.38	1.42	2	27	35	9	2	2	12.28	56	108/65	25
9.27	65	118/64	25	43	34	63	69	2	1.68	1.92	2	32	38	9	2	GRADE 1	10.53	56	97/51	21
10.44	69	127/70	25	40	33	54	47	2	1.58	1.63	2	27	31	9	2	GRADE 1	11.25	76	123/76	27
9.35	92	146/92	31	43	32	66	62	2	1.32	1.58	2	29	37	9	2	2	10.55	78	136/86	30
8.55	68	135/65	29	38	22	63	67	2	1.28	1.41	2	29	35	9	2	2	9.16	66	108/68	29
10.18	86	106/65	29	42	33	62	57	2	1.68	2.42	TR+	33	37	9	2	2	10.57	78	92/58	27
10.15	61	107/58	28	46	33	56	54	2	2.9	3.2	2	42	51	12	2	2	11.05	64	95/53	26
14.35	79	124/79	26	40	29	47	52	2	1.68	1.84	2	36	43	10	2	2	15.03	80	120/77	26
9.28	64	108/54	28	40	32	72	69	2	2.46	1.39	2	29	37	8	2	2	10.05	67	109/54	28
12	53	120/50	30	39	24	68	55	2	2.72	1.69	2	21	30	11	2	GRADE 1	12.26	52	117/47	28
9.38	85	119/86	26	37	21	65	66	2	2.02	2.19	2	29	36	10	2	2	10.28	61	99/65	28
9.18	89	142/90	29	49	31	64	67	2	1.24	1.31	2	28	39	11	2	2	10.05	76	122/86	28
14.45	86	138/92	27	46	22	70	66	2	1.08	1.16	2	21	33	10	2	2	15.55	65	103/62	27
15.32	78	178/96	25	46	32	66	52	2	1.21	1.38	TR+	35	44	10	2	GRADE 1	16.1	68	99/76	25
9.55	56	118/62	30	42	26	70	60	2	1.19	1.28	2	32	44	9	2	GRADE 1	10.25	66	123/65	28
10.15	74	104/63	28	40	30	56	49	2	2.12	1.52	TR+	26	35	11	2	2	10.55	76	106/68	28
10	55	104/50	29	34	21	66	38	2	2.3	2.02	TR+	32	42	12	2	2	10.2	57	92/44	28
9.51	108	159/80	32	48	34	57	58	2	2.39	2.35	2	24	35	10	2	GRADE 1	10.33	91	131/76	30
9.25	91	125/73	27	36	22	64	59	2	1.92	2.1	2	27	31	10	2	GRADE 1	9.55	80	90/48	26

LVIDD DO	LVIDS DO	EF DO	SV DO	RWMA DO	E/A DO	E'/A' DO	TR/PR DO	RVIDS DO	RVIDD DO	TAPSE DO	RTL SHUNT	VAE DO	TIME HDS	HR HDS	IBP HDS	ETCO2 HDS	LVIDD HDS	LVIDS HDS	EF HDS	SV HDS	RWMA HD
29	21	58	44	2	1.54	2.11	2	20	31	9	2	2	12.07	75	126/72	26	30	21	58	44	2
33	22	56	50	2	1.65	1.39	2	21	28	9	2	2									
40	30	60	52	2	1.15	1.3	2	23	32	10	2	GRADE 1									
38	29	68	51	2	1.69	2.05	2	21	32	9	2	2	16.28	59	121/62	29	39	27	65	50	2
41	34	1	60	2	1.61	1.7	2	29	33	9	2	2	10.33	98	115/65	32	42	35	60	59	2
42	33	59	46	YES	1.85	1.98	2	29	39	7	2	2	15.42	70	92/48	27	39	31	58	43	YES
35	26	62	34	2	1.75	1.51	2	28	38	11	2	2	11.3	48	129/57	26	38	27	58	38	2
39	32	59	58	2	1.45	1.42	2	22	29	9	2	2									
42	29	59	46	2	1.58	1.69	2	30	34	9	2	2	12.53	69	112/67	24	40	29	59	58	2
33	24	60	54	2	1.93	1.96	TR++	26	36	10	2	2									
40	30	58	49	2	1.61	1.86	2	27	34	10	2	2	11.5	70	114/54	28	39	30	58	51	2
40	29	57	50	2	1.86	1.61	2	24	30	8	2	2	11.12	68	106/56	28	39	28	55	46	2
43	31	63	60	2	1.86	2.1	2	29	41	9	2	2									
37	29	58	58	2	1.12	1.23	2	31	38	9	2	2	11.41	58	123/75	26	38	29	57	57	2
41	33	69	68	2	1.66	1.78	2	25	33	9	2	2									
43	36	65	60	2	1.26	1.31	2	28	36	9	2	2									
38	30	55	49	2	1.58	1.7	2	25	32	10	2	2	12.25	68	108/65	29	39	32	59	40	2
34	24	68	58	2	1.34	1.78	2	26	37	10	2	2	15.31	105	78/44	30	36	27	69	59	2
48	39	65	61	2	1.58	1.86	2	26	35	10	2	2									
41	32	57	55	SEPTAL	2.25	2.58	2	20	28	7	2	2									
41	29	58	63	2	1.2	1.32	2	25	32	10	2	2	11.28	69	108/59	28	40	30	58	62	2
42	33	52	46	2	1.26	1.35	2	26	33	11	2	2	14.35	76	126/71	27	41	33	55	53	2
47	44	26	24	SEPTAL API	0.58	1.12	2	21	33	7	2	2	16.35	76	109/61	31	46	43	25	22	SEPTAL+AF
42	34	68	65	2	2.26	2.46	TR++	24	31	11	2	2	11.4	75	101/85	27	44	34	67	59	2
42	31	69	65	2	1.62	1.91	2	30	36	9	2	2	10.05	82	125/76	27	40	32	68	65	2
44	36	62	44	2	2.1	2.16	TR++	21	33	11	2	2	11.35	69	104/55	26	44	37	62	47	2
47	31	72	48	2	2.28	2.31	2	35	47	11	2	2	11.1	74	103/44	25	48	35	70	49	2
38	29	62	48	2	2.1	2.24	2	32	38	12	2	2	16.55	63	95/48	25	39	28	67	43	2
43	33	70	57	2	1.21	1.34	TR+	22	33	9	2	GRADE 1	11.55	81	127/69	30	46	31	73	64	2
41	32	63	60	2	1.21	1.36	2	30	36	10	2	2	16.58	76	104/58	29	40	32	60	59	2
43	31	65	61	2	1.41	1.46	2	26	35	9	2	2	13.58	59	118/62	25	44	28	64	66	2
46	28	65	72	2	1.72	2.16	2	31	38	10	2	2	11.41	58	96/53	22	44	34	60	62	2
39	32	53	49	2	1.69	1.58	2	25	30	9	2	2	12.3	78	130/78	27	41	32	56	48	2
41	32	65	60	2	1.28	1.56	2	28	36	9	2	2	11.26	68	107/65	29	42	33	65	61	2
39	24	61	62	2	1.28	1.36	2	28	35	9	2	2	9.33	69	106/75	29	40	25	67	68	2
44	28	69	64	2	1.58	2.01	TR+	32	37	10	2	2	11.28	79	116/68	28	46	32	5	62	2
45	32	56	54	2	2.86	3.36	2	46	52	12	2	2	12.02	63	96/52	24	46	31	57	52	2
41	30	44	48	2	1.92	1.98	2	35	42	10	2	2	15.52	81	128/82	27	40	28	48	53	2
39	29	70	68	2	2.44	1.38	2	29	38	8	2	2	10.59	69	110/56	28	41	32	72	69	2
39	26	67	54	2	2.36	1.72	2	20	32	11	2	2	13.16	58	108/58	29	40	22	70	59	2
37	22	64	65	2	2.31	2.28	2	28	36	11	2	2	11.2	66	108/59	27	36	24	68	66	2
47	28	63	64	2	1.37	1.42	2	28	38	11	2	2	10.52	79	130/78	28	48	31	62	65	2
48	20	72	65	2	1.13	1.21	2	20	31	10	2	2	16.28	62	92/61	27	48	21	70	66	2
47	33	5	53	2	1.24	1.38	TR+	36	42	10	2	GRADE 1	16.23	67	105/77	25	46	33	66	52	2
42	28	69	58	2	1.16	1.31	2	31	42	9	2	2	11.06	86	108/61	27	43	22	70	59	2
44	29	62	55	2	2.2	1.62	TR+	27	34	10	2	GRADE 1	11.35	78	118/69	28	42	30	54	48	2
36	26	65	38	2	2.1	2.05	TR+	36	42	12	2	2									
44	36	55	57	2	2.19	2.26	2	25	35	10	2	2									
35	22	63	60	2	1.86	2.08	2	26	31	10	2	2	11.41	81	89/49	26	36	21	62	60	2

E/A HDS	E'/A' HDS	TR/PR HDS	RVIDS HDS	RVIDD HDS	TAPSE HDS	RTL SHUNT	VAE HDS	TIME CLOD	HR CLOD	IBP CLOD	ETCO2 CLO	LVIDD CLO	LVIDS CLO	EF CLOD	SV CLOD	RWMA CLO	E/A CLOD	E'/A' CLOD	TR/PR CLO	RVIDS CLO	RVIDD CLO
1.58	2.01	2	22	31	9	2	2	15.07	76	128/80	26	30	20	58	46	2	1.56	2.11	2	20	31
								13.15	110	106/56	27	31	23	57	51	2	1.63	1.39	2	20	28
								17.3	89	108/66	26	41	32	60	52	2	1.15	1.3	2	21	33
1.78	1.96	2	20	31	9	2	2	17.55	56	139/65	27	39	29	62	51	2	1.68	1.92	2	20	32
1.73	1.68	2	28	33	9	2	2	12.55	92	118/60	32	40	32	58	56	2	1.68	1.65	2	28	33
1.75	2.02	2	28	38	7	2	2	17.35	86	123/86	29	40	32	59	48	YES	1.78	2.36	2	28	37
1.72	1.38	2	29	37	11	2	2	12.45	61	138/65	27	39	27	58	46	2	1.38	1.52	2	28	39
								13.12	98	138/92	31	38	31	60	65	2	1.48	1.39	2	21	28
1.02	1.19	2	25	32	8	2	2	13.55	76	113/82	25	41	30	58	56	2	1.43	1.21	2	28	33
								13.17	61	114/72	30	33	24	60	53	2	1.78	1.86	TR++	28	36
1.68	1.85	2	25	33	10	2	2	12.46	86	106/65	27	41	32	62	58	2	1.73	1.69	2	28	34
1.83	1.62	2	25	31	8	2	2	11.35	67	111/56	28	40	28	56	48	2	1.86	1.61	2	26	32
								11.32	86	129/78	29	44	31	64	61	2	1.92	2.06	2	31	40
1.16	1.28	2	30	38	9	2	2	13.3	59	124/76	27	39	29	58	57	2	1.13	1.27	2	30	38
								12.13	69	132/65	30	40	31	66	65	2	1.68	1.76	2	26	33
								17.16	68	109/65	30	41	36	62	61	2	1.29	1.38	2	28	37
1.48	1.92	2	25	34	9	2	2	13.35	75	135/67	29	37	29	52	39	2	1.65	1.83	2	25	35
1.29	1.69	2	27	38	10	2	2	16.06	90	97/58	33	34	24	68	59	2	1.34	1.82	2	29	38
								21.35	76	139/79	27	48	38	65	63	2	1.38	1.78	2	28	37
								15.35	78	97/54	29	40	32	58	59	SEPTAL	2.36	2.18	2	21	28
1.19	1.28	2	26	33	10	2	GRADE1	13.08	86	121/68	28	40	30	60	64	2	1.36	1.38	2	24	32
1.32	1.29	2	25	32	11	2	2	15.55	82	136/78	27	42	33	56	49	2	1.28	1.36	2	26	33
0.76	1.16	2	21	33	7	2	2	17.2	78	110/65	32	46	44	24	22	SEPTAL+AF	0.69	0.93	2	21	31
2.03	1.86	TR++	24	31	11	2	2	14.45	82	109/86	28	46	32	68	59	2	2.03	1.96	TR++	24	30
1.68	1.98	2	30	35	9	2	2	12	86	135/86	28	40	32	65	62	2	1.63	1.86	2	30	35
1.92	2.14	TR++	27	36	9	2	2	12.55	86	118/69	27	46	37	64	49	2	1.86	2.12	TR++	27	36
2.23	2.26	2	36	47	10	2	GRADE1	12.53	86	112/68	26	48	35	71	46	2	2.12	2.38	2	35	47
2.41	2.79	2	26	33	13	2	2	18.1	70	107/54	27	38	29	62	48	2	2.24	2.36	2	30	37
1.36	1.43	TR+	26	36	10	2	2	13.15	69	110/54	26	44	32	72	59	2	1.26	1.42	TR+	26	34
1.13	1.28	2	30	36	10	2	2	17.35	78	132/69	30	41	32	60	58	2	1.21	1.36	2	31	36
1.29	1.36	2	25	34	9	2	2	14.55	65	132/89	25	42	21	65	72	2	1.58	1.38	2	26	35
1.69	2.13	2	32	38	9	2	2	12.35	62	106/59	28	44	35	61	65	2	1.68	2.12	2	31	38
1.38	1.63	2	26	31	9	2	2	13.25	89	134/79	27	40	33	56	49	2	1.56	1.38	2	28	32
1.29	1.56	2	29	36	9	2	2	12.38	76	118/72	29	41	33	66	61	2	1.32	1.58	2	28	36
1.31	1.42	2	27	33	9	2	2	10.21	74	118/63	29	38	24	60	59	2	1.38	1.36	2	28	38
1.89	2.58	TR+	32	38	9	2	2	12.5	92	129/79	28	45	33	66	59	2	1.82	2.39	TR+	32	38
2.91	3.2	2	45	51	11	2	2	13.35	69	108/69	26	45	33	55	51	2	3.01	3.5	2	46	52
1.86	1.92	2	35	43	9	2	2	16.47	76	125/78	27	40	27	48	53	2	1.78	1.88	2	36	44
2.42	1.43	2	29	37	8	2	2	12.36	82	118/62	28	38	29	68	66	2	2.41	1.48	2	29	37
2.38	1.76	2	20	32	10	2	2	14.05	54	132/55	29	40	22	70	59	2	2.52	1.89	2	21	30
2.19	2.36	2	28	36	11	2	2	12.46	78	109/59	27	38	21	69	67	2	2.05	2.25	2	28	36
1.39	1.45	2	28	37	10	2	2	12.58	98	136/96	28	47	32	63	65	2	1.28	1.36	2	28	38
1.18	1.36	2	21	30	10	2	2	17.45	68	116/65	27	46	21	71	65	2	1.19	1.32	2	20	30
1.28	1.42	TR+	36	43	10	2	GRADE1	17.55	71	134/67	26	45	30	65	52	2	1.31	1.42	TR+	35	43
1.21	1.39	2	32	42	9	2	2	12.28	89	132/65	27	42	28	70	59	2	1.22	1.36	2	31	41
2.08	1.42	TR+	28	34	11	2	2	13.25	86	108/65	28	40	33	54	49	2	2.16	1.44	TR+	28	34
								12.25	58	106/58	28	32	22	66	38	2	2.12	2.16	TR+	35	42
								12.15	89	139/69	31	48	33	59	61	2	2.2	2.32	2	26	36
1.89	2.1	2	25	30	10	2	2	12.39	88	90/52	26	36	21	64	59	2	1.86	2.18	2	26	30

TAPSE CLO	RTL SHUNT	VAE CLOD	TV	RR	MAP	PAP	PEEP	PERIOP CO	ST CHANGI	AMI/RWM.	STROKE
9	2	2	375	10	11	19	0	2	2	2	2
9	2	2	500	12	9	13	0	2	2	2	2
10	2	2	450	14	10	17	0	2	2	2	2
9	2	2	525	12	9	15	4	2	2	2	2
9	2	2	450	12	9	13	4	2	2	2	2
7	2	2	375	12	8	14	0	2	2	YES	2
11	2	2	400	10	9	18	0	2	2	2	2
9	2	2	475	13	14	21	4	2	2	2	2
8	2	2	475	12	8	16	5	2	2	2	2
10	2	2	425	14	7	19	0	2	2	2	2
9	2	2	400	13	10	20	0	2	2	2	2
8	2	2	500	12	11	21	5	2	2	2	2
9	2	2	500	12	7	16	5	2	2	2	2
9	2	2	550	13	9	17	5	2	2	2	2
9	2	2	550	14	16	24	5	2	2	2	2
9	2	2	600	14	10	16	5	2	2	2	2
9	2	2	475	12	8	14	4	2	2	2	2
10	2	2	500	12	7	17	0	2	2	2	2
10	2	2	450	14	7	13	0	2	2	2	2
7	2	2	475	12	9	19	4	2	2	2	2
10	2	2	450	12	8	16	5	2	2	2	2
11	2	2	475	10	9	17	5	2	2	2	2
7	2	2	475	10	10	15	4	1	1	1	1
10	2	2	475	18	8	16	4	2	2	2	2
9	2	2	450	12	16	26	5	2	2	2	2
9	2	2	500	12	12	18	5	2	2	2	2
11	2	2	550	12	12	20	5	2	2	2	2
12	2	2	550	14	11	19	5	2	2	2	2
9	2	2	500	12	8	16	4	2	2	2	2
10	2	2	450	12	9	17	4	2	2	2	2
9	2	2	550	12	10	16	5	2	2	2	2
9	2	2	525	12	7	19	5	2	2	2	2
9	2	2	500	11	11	23	4	2	2	2	2
9	2	2	400	15	7	15	5	2	2	2	2
9	2	2	400	12	8	17	5	2	2	2	2
9	2	2	500	12	9	16	5	2	2	2	2
12	2	2	475	12	8	14	5	2	2	2	2
9	2	2	400	12	6	17	0	2	2	2	2
8	2	2	450	14	7	18	5	2	2	2	2
11	2	2	450	12	8	12	4	2	2	2	2
11	2	2	425	12	6	20	0	2	2	2	2
11	2	2	425	12	9	21	0	2	2	2	2
10	2	2	450	12	8	21	5	2	2	2	2
10	2	2	400	12	12	16	0	2	2	2	2
9	2	2	525	14	12	22	4	2	2	2	2
11	2	2	450	12	8	23	0	2	2	2	2
12	2	2	500	13	9	19	0	2	2	2	2
10	2	2	350	12	12	21	0	2	2	2	2
10	2	2	475	12	9	16	5	2	2	2	2

50	431870	26	1	65	1.73	21.72	RT CHOROID PLEX	CRANIOTOMY AN	LATERAL	16	5	31	24	54	52	2	1.66	1.85	193
51	405810	25	2	50	1.48	22.83	LT MTS	LT ATL AH	SUPINE	9	5	38	30	52	65	2	2.23	2.03	193
52	330664	18	2	45	1.40	22.96	LT FRONTAL CORT	CRANIOTOMTY AN	SUPINE	11	15	42	31	68	67	2	1.9	2.1	203
53	432104	65	2	65	1.60	25.39	A COM ANEURYS	CRANIOTOMY AN	SUPINE	13	12	39	28	50	65	2	1.94	1.99	190
54	262080	42	1	65	1.72	21.97	LT FRONTAL GLIO	CRANIOTOMY AN	SUPINE	16	15	43	38	56	65	2	1.55	1.48	142
55	427150	60	1	68	1.65	24.98	PITUITARY ADENO	CRANIOTOMY AN	SUPINE	13	5	39	32	59	62	2	1.69	1.97	230
56	420257	46	1	68	1.65	24.98	RT TRIGEMINAL N	CRANIOTOMY AN	LATERAL	16	5	39	23	47	62	2	2.63	2.19	146
57	432940	47	2	40	1.54	16.87	RT VERTEBRAL AF	CRANIOTOMY AN	LATERAL	18	5	41	30	42	72	2	2.06	1.91	114
58	416983	65	2	58	1.42	28.76	LT VESTIBULAR SC	CRANIOTOMY AN	LATERAL	14	5	50	36	52	64	2	2.42	2.36	202
59	428855	19	1	62	1.68	21.97	THIRD VENTRICLE	CRANIOTOMY AN	SUPINE	14	13	38	30	52	65	2	2.02	1.98	192
60	413961	18	1	49	1.46	22.99	FRONTAL GLIOMA	CRANIOTOMY AN	SUPINE	10	5	42	21	64	71	2	2.86	2.78	212
61	432349	65	1	65	1.71	22.23	LT TEMPORAL GL	CRANIOTOMY AN	SUPINE	7	5	42	30	52	62	2	1.58	1.32	132
62	419291	57	2	67	1.52	29.00	PARASAGITTAL M	CRANIOTOMY AN	SUPINE	16	14	47	26	77	75	2	1.18	1.26	226
63	424143	35	2	62	1.52	26.84	LT CP EPIDERMOI	CRANIOTOMY AN	LATERAL	13	12	46	31	65	58	2	2.06	3.83	131
64	421496	39	2	59	1.48	26.94	FRONTAL METAST	CRANIOTOMY AN	SUPINE	9	5	46	33	53	54	2	1.89	1.76	202
65	427125	29	2	58	1.36	31.36	RT FRONTAL LESI	CRANIOTOMY AN	SUPINE	14	15	44	35	62	58	2	1.6	1.8	152
66	425729	42	2	61	1.52	26.40	LT FRONTAL GLIO	CRANIOTOMY AN	SUPINE	16	15	47	36	42	52	2	1.39	1.51	151
67	421561	33	2	59	1.56	24.24	LT CP EPIDERMOI	CRANIOTOMY AN	LATERAL	16	15	46	19	76	78	2	2.32	2.19	212
68	423023	48	1	65	1.65	23.88	PARAFALCINE ME	CRANIOTOMY AN	SEMISITTING	25	35	38	22	49	56	2	1.62	1.59	137
69	434252	34	2	60	1.56	24.65	LT FRONTAL GLIO	CRANIOTOMY AN	SUPINE	12	5	39	28	59	64	2	1.48	1.62	158
70	419053	44	1	69	1.68	24.45	LT GANGLIO CAPS	DECOMPRESSIVE	SUPINE	11	5	48	37	46	43	SEPTAL	1.12	0.98	108
71	306682	19	2	50	1.53	21.36	LT FRONTAL DYSF	CRANIOTOMY AN	SUPINE	11	5	47	39	43	65	2	2.09	2.26	177
72	359316	61	2	63	1.56	25.89	PITUITARY ADENO	CRANIOTOMY AN	SUPINE	13	15	42	33	34	43	2	2.16	2.32	208
73	9800591	59	1	65	1.68	23.03	RECURRENT PARA	CRANIOTOMY AN	SITTING	28	65	40	22	73	53	SEPTAL, IN	1.43	1.68	230
74	423349	56	1	67	1.63	25.22	LT FRONTAL GLIO	CRANIOTOMY AN	SUPINE	14	15	39	19	54	68	2	1.46	1.38	178
75	344184	22	1	82	1.69	28.71	LT MTS	LT ATL AH	SUPINE	9	5	46	38	62	65	2	1.42	1.36	140
76	423546	40	1	72	1.69	25.21	RT FRONTAL GLIO	CRANIOTOMY AN	SUPINE	13	15	42	27	51	65	2	1.92	2.12	210
77	265423	34	1	85	1.82	25.66	LT FRONTAL LESIO	CRANIOTOMY AN	SUPINE	13	15	35	19	58	68	2	2.89	2.02	212
78	426904	60	1	69	1.72	23.32	SPHENOID WING	CRANIOTOMY AN	SUPINE	16	14	49	34	65	57	2	1.36	1.28	225
79	423775	38	2	45	1.49	20.27	A COM ANEURYS	CRANIOTOMY AN	SUPINE	14	14	54	46	35	56	SEPTAL,API	2.52	2.38	340
80	430146	58	2	60	1.53	25.63	RT ICA ANEURYSN	CRANIOTOMY AN	SUPINE	11	15	38	27	35	56	2	0.86	0.88	102
81	434746	51	2	64	1.61	24.69	B/L P COM ANEU	RT CRANIOTOMY	SUPINE	13	15	42	31	40	51	2	1.53	1.49	208
82	421018	55	2	68	1.62	25.91	RT P COM ANEUR	CRANIOTOMY AN	SUPINE	14	15	48	31	68	64	2	1.52	1.48	165
83	395816	54	2	65	1.53	27.77	RT PCOM ANEUR	CRANIOTOMY AN	SUPINE	12	15	37	28	52	56	2	1.98	1.69	240
84	425914	52	1	75	1.69	26.26	RT A1 ANEURYSM	CRANIOTOMY AN	SUPINE	9	5	42	31	40	51	2	1.18	1.26	158
85	422939	40	2	40	1.39	20.70	RT FRONTAL GLIO	CRANIOTOMY AN	SUPINE	11	5	32	18	35	64	2	3.76	2.22	240
86	421856	55	2	50	1.47	23.14	LT A1 ANEURYSM	CRANIOTOMY AN	SUPINE	10	5	46	32	56	57	2	1.48	1.36	205
87	424993	18	2	45	1.48	20.54	LT FRONTAL AVM	CRANIOTOMY AN	SUPINE	14	15	47	32	56	69	2	1.92	1.96	162
88	422161	48	2	50	1.49	22.52	RT P COM ANEUR	CRANIOTOMY AN	SUPINE	13	13	38	19	50	73	2	1.63	1.58	178
89	435796	18	1	52	1.58	20.83	PITUITARY ADENO	CRANIOTOMY AN	SUPINE	13	14	38	28	58	56	2	1.82	1.96	165
90	437940	47	2	58	1.56	23.83	RT MCA BIFURCA	CRANIOTOMY AN	SUPINE	12	15	46	34	49	51	2	1.16	1.28	148
91	422541	42	1	68	1.65	24.98	METASTATIC FRO	CRANIOTOMY AN	SUPINE	13	15	46	21	46	62	2	1.63	1.72	176
92	268392	45	2	65	1.56	26.71	RT FRONTAL GLIO	CRANIOTOMY AN	SUPINE	15	15	37	15	62	76	2	2.9	2.87	323
93	429808	69	1	69	1.64	25.65	RECURRENT MID	CRANIOTOMY AN	SEMISITTING	22	17	39	28	41	70	2	1.11	0.67	249
94	437664	55	2	55	1.42	27.28	RT SUPRACLINOII	CRANIOTOMY AN	SUPINE	12	15	40	27	46	55	APICAL, LA	1.52	1.91	164
95	387563	23	2	45	1.46	21.11	B/L MTS	B/L HIPPOCAMPA	SITTING	32	48	33	19	42	56	2	1.85	1.94	204
96	9409204	58	2	68	1.51	29.82	RECURRENT P CO	CRANIOTOMY AN	SUPINE	9	5	38	25	52	42	2	1.11	1.47	210
97	432825	59	2	62	1.52	26.84	TUBERCULUM SE	CRANIOTOMY AN	SUPINE	12	12	52	40	61	60	2	2.85	2.01	141
98	362900	40	1	94	1.78	29.67	RT FRONTAL LYM	CRANIOTOMY AN	SUPINE	15	14	57	37	60	63	2	1.85	2.14	158
99	390357	35	1	74	1.73	24.73	RT FRONTAL GLIO	CRANIOTOMY AN	SUPINE	16	15	52	41	63	61	2	2.12	1.86	200
100	438300	65	2	66	1.56	27.12	RT DACA ANEURY	CRANIOTOMY AN	SUPINE	15	15	53	42	56	71	2	0.98	1.22	258

2	MR+	17	28	8	9.3	62	100/54	30	31	24	52	54	2	1.66	1.85	2	17	28	8	2	2
2	2	23	34	9	9.45	67	95/55	30	38	30	65	52	2	2.23	2.03	2	23	34	9	2	2
2	2	28	36	10	14.4	76	106/72	27	42	31	68	67	2	1.9	14.4	2	28	36	10	2	2
2	MR+	33	40	9	9.3	79	94/56	30	36	28	65	56	2	1.94	1.99	2	33	40	9	2	2
2	2	29	38	9	8.55	76	118/87	27	43	38	5	56	2	1.55	1.48	2	29	38	9	2	2
2	2	28	35	12	9.09	90	165/90	33	39	29	65	56	2	1.8	1.69	2	28	34	12	2	2
2	2	22	31	14	8.55	69	136/78	28	39	23	62	47	2	2.3	2.19	2	22	31	14	2	2
2	2	28	38	9	12.3	78	131/78	32	41	30	72	42	2	2.06	1.91	2	28	38	9	2	2
2	2	28	36	14	9.5	69	139/65	28	50	31	63	66	2	2.42	2.36	2	28	36	14	2	2
2	2	21	28	8	9.2	73	111/64	26	38	30	65	52	2	2.02	1.98	2	21	28	8	2	2
2	TR+	28	36	14	8.52	92	116/72	26	42	21	64	71	2	2.86	2.78	TR+	28	36	14	2	2
2	MR+	29	38	10	10.35	68	106/65	27	42	30	62	52	2	1.58	1.32	2	29	38	10	2	2
2	TR+	24	33	15	9.28	68	116/68	28	47	26	75	77	2	1.18	1.26	TR+	24	33	15	2	2
2	MR+	21	28	8	9.25	108	132/65	30	46	31	58	65	2	2.08	3.83	2	21	28	8	2	2
2	2	21	32	16	8.46	86	115/69	29	46	33	54	53	2	1.89	1.76	2	21	32	16	2	2
2	2	28	33	9	14.35	86	92/58	29	44	35	65	62	2	1.6	1.8	2	28	33	12	2	2
2	2	27	32	9	8.38	75	90/51	27	47	36	52	42	2	1.39	1.51	2	27	32	9	2	2
2	TR+	26	35	16	9.38	68	98/65	27	48	22	74	86	2	2.32	2.14	TR+	26	35	16	2	2
2	2	29	38	10	8.25	90	105/65	29	38	22	56	49	2	1.62	1.59	2	29	38	10	2	2
2	2	28	37	11	8.48	86	128/68	26	39	28	64	59	2	1.48	1.62	2	28	37	11	2	2
2	TR+,MR+	29	36	13	17.25	62	99/58	33	48	37	43	46	SEPTAL	1.12	0.98	TR+	29	36	14	2	2
2	2	24	28	9	8.58	60	106/62	28	47	39	65	55	2	2.09	2.26	2	24	28	9	2	2
2	2	26	33	15	9.25	86	129/68	30	42	33	43	34	2	2.16	2.32	2	26	33	15	2	2
2	2	25	37	14	8.35	55	140/80	30	40	23	53	72	SEPTAL,INF	1.43	1.68	2	25	37	14	2	2
2	TR+	26	32	14	13.15	69	136/70	28	39	19	68	54	2	1.46	1.38	2	26	32	14	2	2
2	2	28	36	13	14.25	72	125/75	32	46	38	65	62	2	1.18	1.26	2	28	36	14	2	2
2	2	28	33	14	8.55	88	128/76	29	42	27	65	51	2	1.92	2.12	2	28	33	14	2	2
2	2	28	36	13	15.06	82	136/82	30	35	19	68	58	2	2.89	2.02	2	28	36	13	2	2
2	TR+	25	33	14	9.22	69	139/76	29	49	34	57	65	2	1.36	1.28	TR+	24	35	14	2	2
2	TR++	26	34	15	9.25	62	136/82	89	54	46	56	38	APICAL,SEF	2.52	2.28	TR++	26	34	15	2	2
2	MR+	32	39	16	8.45	65	108/68	27	38	27	56	35	2	0.8	0.89	2	32	39	16	2	2
2	2	29	34	16	8.45	67	125/69	30	43	32	50	42	2	1.44	1.52	2	28	34	16	2	2
2	TR+	32	39	16	9.15	61	108/58	26	48	31	64	69	2	1.52	1.48	TR+	32	39	16	2	2
2	2	26	33	14	9.15	86	128/65	28	37	29	56	52	2	1.98	1.69	2	26	33	14	2	2
2	TR+	32	38	14	9.05	65	96/68	27	42	31	51	40	2	1.18	1.26	TR+	32	38	14	2	2
2	2	25	39	15	9.11	48	105/57	27	33	19	63	38	2	2.65	2.48	2	25	39	15	2	2
2	TR+	28	36	14	8.55	86	146/86	27	46	32	57	56	2	1.48	1.36	TR+	28	36	14	2	2
2	2	22	32	14	9.38	74	108/51	30	45	32	69	65	2	1.92	1.96	2	22	33	14	2	2
2	TR+	22	34	16	9.35	85	132/59	26	38	19	73	50	2	1.63	1.58	TR+	22	34	14	2	2
2	2	26	35	14	9.18	86	108/65	29	38	28	56	58	2	1.28	1.46	2	26	35	14	2	2
2	2	28	36	15	9.35	88	140/76	28	46	34	51	49	2	1.16	1.28	2	28	36	15	2	2
2	2	28	37	14	15.13	89	108/65	32	46	21	62	48	2	1.38	1.26	2	32	39	14	2	2
2	2	20	32	14	9.38	84	92/60	28	37	15	76	62	2	2.19	1.57	2	20	26	14	2	2
2	MR++,TR+	21	28	8	14.06	56	93/57	27	39	28	70	41	2	0.94	0.98	TR+	21	28	8	2	2
2	MR++,TR+	21	32	7	10.05	88	106/54	33	42	26	58	53	APICAL,LAT	1.36	1.48	TR+	21	32	8	2	2
2	MR++	16	32	14	9.25	67	118/59	29	33	19	56	42	2	1.85	1.94	2	16	32	14	2	2
2	TR++,MR+	23	29	12	9.25	62	117/59	28	37	30	61	51	2	1.05	1.19	TR++	23	29	12	2	2
2	TR+	24	35	10	9.55	69	138/58	33	51	40	60	60	2	2.28	2.01	TR+	26	35	10	2	2
2	2	32	42	14	9.38	69	108/65	34	56	36	64	61	2	2.48	2.19	2	32	42	14	2	2
2	2	27	40	12	9.56	56	118/65	32	54	43	52	38	2	1.75	0.97	2	28	40	13	2	2
2	TR+	30	35	15	14.42	59	96/58	26	53	41	51	61	2	0.96	1.21	TR+	30	35	15	2	2

10.2	78	96/52	28	35	26	54	56	2	1.48	1.69	2	18	29	9	2	GRADE 1	10.45	76	96/54	28
10.15	79	136/85	31	39	30	66	54	2	2.21	2.19	2	23	34	9	2	GRADE 1	11.05	80	128/86	30
15.35	73	84/57	26	41	31	66	65	2	1.8	2	2	28	37	10	2	GRADE 1	16.1	76	96/52	26
10.45	73	132/72	32	37	29	66	59	2	1.95	1.92	2	32	40	9	2	2	11.15	73	129/73	31
9.47	86	148/92	26	42	39	65	56	2	1.52	1.46	2	29	38	9	2	2	10.38	75	108/75	26
9.57	59	137/95	28	40	29	68	52	2	1.63	1.78	2	27	34	13	2	GRADE 1	10.12	58	118/67	28
9.38	67	129/82	27	38	21	62	47	2	2.28	2.26	2	22	31	14	2	2	10.26	77	118/68	28
14.45	74	126/79	29	42	30	71	42	2	2.08	1.94	2	28	38	9	2	2	16.19	72	126/74	28
11.25	72	146/59	27	48	29	66	70	2	1.52	1.38	2	27	36	12	2	GRADE1	11.48	61	116/62	27
9.5	79	146/84	27	39	31	65	52	2	2.06	1.99	2	22	28	9	2	GRADE1	10.2	73	116/76	27
10.05	88	117/69	27	44	22	66	74	2	2.73	2.38	TR+	29	37	14	2	GRADE1	10.26	78	108/65	27
11.38	89	148/98	28	40	31	60	50	2	1.62	1.46	2	29	37	10	2	2	12.15	76	112/65	27
10.21	76	136/65	27	44	26	71	63	2	1.28	1.21	TR+	25	33	14	2	2	10.47	61	129/76	27
9.58	121	148/66	29	44	32	56	62	2	2.08	3.83	2	21	28	8	2	GRADE1	10.45	110	108/65	27
9.18	87	136/72	28	44	32	53	46	2	1.76	1.72	2	22	32	16	2	2	9.52	76	105/69	27
15.2	108	136/92	28	42	33	62	60	2	1.61	1.82	2	27	32	13	2	2	16.08	81	99/65	28
9.35	87	108/58	28	46	36	51	42	2	1.38	1.52	2	28	33	9	2	2	10.25	89	118/59	28
10.55	79	121/76	26	46	21	73	80	2	2.38	2.28	TR+	27	35	16	2	GRADE1	11.26	59	118/65	27
9.11	86	109/68	28	40	24	55	42	2	1.58	1.62	2	30	38	10	2	2	9.55	88	112/73	28
9.55	88	135/82	27	40	28	65	60	2	1.52	1.48	2	29	37	10	2	2	10.38	76	112/78	26
18.23	61	108/62	32	46	37	40	39	SEPTAL	1.13	0.96	TR+	28	36	14	2	GRADE1	19.21	60	98/56	33
9.55	62	89/56	25	46	40	65	53	2	2.12	2.36	2	22	28	10	2	2	10.25	65	86/52	25
10.18	82	136/76	30	44	34	45	40	2	2.18	2.18	2	27	33	15	2	GRADE1	10.38	80	118/62	29
9.5	56	147/86	31	41	26	51	66	SEPTAL,INF	1.41	1.69	2	26	37	14	2	2	10.15	52	120/68	21
14.2	68	150/86	29	38	20	63	49	2	1.37	1.32	2	25	33	14	2	GRADE1	14.46	66	122/76	28
14.55	76	116/76	31	44	37	63	60	2	1.16	1.21	2	28	37	14	2	2	15.3	68	108/72	30
9.25	76	121/69	28	43	23	66	59	2	1.68	1.92	2	28	33	14	2	2	10.5	82	116/68	29
15.38	89	130/80	29	36	20	67	56	2	2.63	2.08	2	27	36	13	2	2	15.55	76	121/68	29
9.58	76	128/69	28	48	33	58	63	2	1.38	1.26	TR+	25	35	14	2	GRADE1	10.21	68	133/66	28
10.05	69	149/84	96	55	44	55	37	APICAL,SEF	2.96	2.89	TR++	30	32	7	2	GRADE2	10.38	60	130/82	86
9.48	66	128/72	27	36	28	45	26	2	0.91	0.88	2	32	38	16	2	2	10.15	63	129/73	27
9.35	67	125/69	30	43	32	50	42	2	1.44	1.52	2	28	34	16	2	2	10.18	63	126/69	28
10.18	63	118/61	27	47	31	62	64	2	1.56	1.46	TR+	33	40	16	2	GRADE1	10.5	66	126/70	27
9.47	92	89/58	26	38	30	55	52	2	2.16	2.13	2	30	33	8	2	GRADE2	10.2	88	105/52	24
9.55	78	128/76	27	43	31	54	45	2	1.21	1.12	TR+	32	38	14	2	GRADE1	10.18	63	131/79	27
9.5	54	129/76	27	34	21	62	38	2	2.85	2.63	2	30	36	9	2	GRADE2	10.3	54	92/50	28
9.48	65	152/89	27	45	31	56	54	2	1.52	1.35	TR+	27	36	14	2	GRADE1	10.28	62	116/65	28
10.17	75	119/58	29	47	32	68	60	2	2.1	2	2	22	32	14	2	GRADE1	10.55	84	127/58	31
10.25	82	136/65	27	36	21	70	40	2	1.48	1.52	TR+	23	34	14	2	2	10.39	80	130/58	26
10.15	92	118/68	28	37	28	56	58	2	1.36	1.48	2	27	35	14	2	2	11.05	80	106/58	30
10.35	82	136/68	28	47	34	53	54	2	1.12	1.29	2	27	36	15	2	2	11.1	85	131/68	28
15.48	88	112/69	30	45	20	63	48	2	1.46	1.38	2	30	37	15	2	2	16.22	82	107/62	30
10.25	88	123/61	28	40	21	72	64	2	2.25	1.59	2	21	27	13	2	2	10.39	77	131/66	27
15.45	65	92/49	28	40	28	71	42	2	1.03	0.96	TR+	20	29	7	2	GRADE 1	16.2	66	105/57	27
10.55	83	135/65	36	41	27	56	49	APICAL,LAT	1.33	1.4	TR+	20	32	7	2	2	11.04	81	135/64	35
10.28	83	132/65	30	36	21	55	42	2	1.89	2.08	2	24	31	10	2	GRADE1	10.44	69	108/58	30
10.12	63	111/57	27	37	29	63	53	2	1.15	1.25	TR++	24	30	8	2	GRADE2	10.29	65	109/54	2
10.5	67	106/49	32	50	41	61	60	2	2.38	2.02	TR+	24	35	11	2	2	11.25	71	113/51	30
10.29	54	112/72	33	56	37	63	60	2	1.98	2.49	2	33	42	14	2	2	10.46	57	117/72	33
10.28	57	98/58	32	55	43	51	38	2	2.24	0.83	2	29	41	13	2	2	10.52	54	119/61	31
15.13	65	108/59	27	52	40	50	60	2	0.92	1.28	TR+	30	36	15	2	GRADE1	15.34	63	132/72	25

35	25	55	56	2	1.59	1.68	2	18	29	9	2	2									
39	30	66	54	2	2.26	2.08	2	24	34	9	2	2									
43	30	69	68	2	1.8	2.1	2	28	36	10	2	2	16.55	69	108/72	26	41	30	68	67	2
37	29	65	58	2	1.84	1.91	2	32	40	9	2	2									
43	39	66	57	2	1.61	1.39	2	28	39	10	2	2									
39	30	64	53	2	1.68	1.76	2	27	35	12	2	2	11.25	62	108/68	28	40	31	66	58	2
39	22	65	49	2	2.48	2.19	2	22	31	14	2	2	11.35	68	112/66	27	38	23	60	43	2
40	31	70	42	2	1.86	1.94	2	28	38	9	2	2	16.45	70	132/70	28	40	30	71	43	2
52	36	58	62	2	1.38	1.42	2	28	37	14	2	2	12.35	60	131/71	27	51	28	69	73	2
40	30	67	55	2	2.12	1.89	2	21	28	8	2	2	10.5	72	129/71	27	39	32	64	52	2
43	28	64	53	2	2.39	2.12	TR+	28	37	14	2	2	11.25	68	113/69	28	49	26	79	78	2
41	30	60	52	2	1.57	1.38	2	29	38	10	2	2	13.53	87	130/82	28	40	32	59	50	2
46	24	76	77	2	1.13	1.26	TR+	24	33	14	2	2	11.35	62	136/68	26	48	21	82	81	2
45	32	56	62	2	2.18	3.15	2	23	29	9	2	2	11.25	132	158/92	28	44	31	57	64	2
48	31	64	69	2	1.92	1.78	2	21	33	16	2	2									
40	32	58	59	2	1.58	1.76	2	28	32	10	2	2	16.55	95	108/65	29	41	34	56	57	2
47	36	52	42	2	1.42	1.59	2	27	32	9	2	2	1.15	78	102/59	28	45	35	51	41	2
44	19	75	83	2	2.52	2.26	TR+	26	34	16	2	2	13.38	60	128/71	27	48	24	76	81	2
41	26	54	43	2	1.61	1.58	2	28	38	11	2	2	10.35	89	118/76	27	42	24	58	52	2
40	29	65	60	2	1.46	1.65	2	28	37	10	2	2									
47	39	35	36	SEPTAL	1.08	0.86	TR+	29	36	14	2	2									
46	39	64	55	2	2.14	2.38	2	24	30	10	2	2									
43	31	54	45	2	2.38	2.41	2	27	33	15	2	2	11.05	69	108/58	29	42	33	43	34	2
40	24	52	68	SEPTAL,INF	1.52	1.79	TR++	35	42	8	2	GRADE2	10.35	56	95/44	22	42	26	52	69	SEPTAL,INF
38	21	61	47	2	1.36	1.38	2	25	32	14	2	2	15.3	58	138/72	28	40	20	69	57	2
43	37	62	59	2	1.28	1.32	2	27	37	15	2	2									
42	26	68	53	2	1.76	1.88	2	28	34	14	2	2	10.5	82	116/68	29	42	26	68	53	2
39	20	67	55	2	2.49	2.12	2	28	36	13	2	2									
48	34	55	60	2	1.41	1.29	TR+	24	36	15	2	2	11.39	58	135/65	27	47	32	59	61	2
46	39	50	34	APICAL,SEF	3.28	3.17	TR+++	31	36	7	2	GRADE2									
38	27	56	35	2	1.1	0.96	2	33	39	16	2	2	11.2	61	132/76	27	37	30	40	29	2
43	32	50	42	2	1.46	1.53	2	28	33	16	2	2	10.5	64	130/69	28	42	32	47	37	2
49	33	60	62	2	1.65	1.52	TR+	32	38	15	2	2	11.48	62	128/71	27	47	30	65	67	2
39	29	58	53	2	2.39	2.08	PR+	31	34	7	2	GRADE2	11.25	89	106/58	26	37	30	56	53	2
43	30	57	48	2	1.21	1.28	TR+	32	38	14	2	2	11.15	62	136/80	27	42	30	55	43	2
35	24	58	32	2	3.76	2.93	TR+	31	38	10	2	GRADE2	11.2	60	88/62	29	34	25	55	30	2
48	32	61	62	2	1.29	1.18	TR+	28	36	14	2	2	11.46	69	119/66	27	46	33	54	53	2
46	32	66	59	2	1.96	1.94	2	21	34	14	2	2									
39	20	75	53	2	1.61	1.56	TR+	22	33	15	2	2	11.45	76	127/55	26	41	21	77	59	2
37	29	55	56	2	1.21	1.35	2	22	33	13	2	2	11.55	78	108/59	29	39	29	57	56	2
46	33	54	53	2	1.26	1.21	2	28	35	15	2	2	11.48	80	130/72	28	45	33	52	48	2
44	24	57	40	2	1.29	1.36	2	30	38	15	2	2									
41	22	73	66	2	2.28	1.6	2	22	27	13	2	2									
37	26	69	46	2	1.11	1.29	TR+	22	31	9	2	2	17.28	61	118/59	26	39	27	68	47	2
41	25	57	53	APICAL,LAT	1.3	1.46	TR+	20	31	9	2	2									
37	21	57	46	2	1.86	1.97	2	21	31	12	2	2									
35	29	58	49	2	1.06	1.64	TR++	26	32	9	2	2	11.3	63	108/56	26	36	29	58	48	2
52	38	63	65	2	2.12	2.47	TR+	23	34	10	2	2	12.16	73	124/58	30	50	40	60	60	2
57	34	69	68	2	2.47	2.25	2	34	41	15	2	2									
51	40	55	42	2	1.81	1.92	2	28	41	15	2	2	11.55	58	121/62	31	50	41	52	39	2
52	41	42	55	2	0.94	0.92	TR+	31	35	15	2	2	16.15	64	129/78	24	51	39	46	57	2

								13.16	88	115/62	29	36	25	56	56	2	1.48	1.59	2	18	29
								12.42	85	132/86	30	38	28	66	55	2	2.08	2.13	2	24	34
1.8	2.12	2	28	37	10	2	2	18.1	88	118/76	27	42	31	68	67	2	1.91	2.02	2	28	37
								13.35	76	148/79	32	38	28	67	57	2	1.84	1.86	2	34	40
								12.29	78	128/69	26	44	38	65	55	2	1.65	1.32	2	29	38
1.69	1.82	2	28	35	12	2	2	13.21	58	116/72	28	41	30	66	58	2	1.63	1.75	2	27	34
2.36	2.2	2	22	32	15	2	GRADE1	16.21	66	126/72	27	38	21	62	47	2	2.08	2.15	2	23	31
1.89	1.92	2	27	38	9	2	2	19.25	71	119/65	27	42	31	73	44	2	2.16	1.82	2	27	38
1.58	1.46	2	27	37	13	2	2	17.25	67	136/79	27	50	32	66	69	2	1.45	1.52	2	28	36
2.19	1.92	2	21	28	8	2	2	12.1	76	138/76	28	40	31	65	55	2	2.28	1.86	2	20	29
2.69	2.63	TR+	29	37	13	2	2	13.38	88	132/68	30	45	26	63	67	2	2.52	2.39	TR+	28	37
1.61	1.48	2	29	38	10	2	2	14.55	89	138/86	29	42	32	60	51	2	1.58	1.49	2	29	37
1.19	1.29	TR+	25	33	15	2	2	12.55	72	119/59	26	49	22	83	84	2	1.08	1.07	TR+	24	34
2.28	3.18	2	23	28	8	2	2	12.1	97	124/62	28	45	31	57	62	2	2.18	3.08	2	22	28
								11.38	79	118/61	28	46	30	64	62	2	1.89	1.69	2	22	32
1.38	1.52	2	27	31	9	2	2	17.1	82	116/68	29	45	36	62	60	2	1.62	1.81	2	28	32
1.36	1.48	2	27	33	9	2	2	12.25	82	108/65	30	44	33	50	40	2	1.49	1.59	2	27	33
2.37	2.39	TR+	27	35	15	2	2	17.28	62	136/72	27	46	24	73	74	2	2.51	2.46	TR+	26	35
1.56	1.61	2	29	37	11	2	2	12.15	108	139/79	28	40	24	55	42	2	1.38	1.66	2	28	37
								11.58	86	136/89	27	41	28	66	65	2	1.38	1.49	2	29	37
								21.1	61	105/58	33	48	36	49	53	SEPTAL	0.98	0.87	TR+	28	36
								12.55	69	98/65	26	44	37	62	52	2	2.36	2.52	2	24	29
2.26	2.48	2	26	32	15	2	2	15.38	76	121/65	29	43	31	54	45	2	2.29	2.48	2	27	33
1.58	1.67	TR++	36	43	6	2	GRADE2	11.56	58	122/82	30	43	27	52	68	SEPTAL,INF	1.48	1.59	TR+	33	41
1.28	1.39	2	25	33	14	2	2	17.17	69	147/58	28	40	19	72	58	2	1.18	1.26	2	24	32
								17.1	66	107/68	30	46	37	64	60	2	1.18	1.21	2	28	38
1.76	1.88	2	28	34	14	2	2	12.46	83	123/69	29	42	24	70	58	2	1.86	1.89	2	28	33
								18.48	89	139/92	29	40	21	68	58	2	2.28	1.92	2	27	37
1.26	1.38	TR+	24	34	14	2	2	15.55	61	121/61	27	49	33	60	66	2	1.29	1.42	TR+	25	35
								13.38	66	154/92	88	52	41	51	36	APICAL,SEF	2.58	2.39	TR++	29	34
1.12	0.98	2	33	38	16	2	2	13.45	60	148/86	27	38	27	56	35	2	1.16	0.99	2	32	38
1.42	1.52	2	28	33	16	2	2	12.55	66	148/76	29	44	31	56	49	2	1.38	1.48	2	27	33
1.58	1.5	TR+	32	39	16	2	2	14.15	68	148/79	27	47	31	62	64	2	1.61	1.55	TR+	32	39
1.92	1.78	2	30	35	12	2	2	13.3	86	118/69	26	39	30	56	53	2	1.68	1.73	2	28	34
1.08	1.16	TR+	32	38	14	2	2	13.5	61	149/82	28	43	31	54	45	2	1.16	1.19	TR+	32	38
2.63	2.38	2	27	39	11	2	2	12.58	62	96/58	28	35	23	57	31	2	2.13	2.02	2	26	39
1.22	1.28	TR+	28	35	14	2	2	13.35	76	148/76	27	45	30	62	57	2	1.38	1.41	TR+	28	36
								13.35	86	132/62	29	45	31	69	66	2	1.86	1.92	2	22	32
1.52	1.57	TR+	22	34	14	2	2	14.25	75	148/88	27	37	20	71	45	2	1.61	1.58	TR+	23	34
1.25	1.42	2	26	35	14	2	2	14.5	86	116/6	29	40	28	59	58	2	1.31	1.45	2	27	35
1.29	1.38	2	27	36	15	2	2	15.15	86	138/76	28	47	32	61	56	2	1.26	1.34	2	28	36
								17.55	86	112/65	30	46	28	55	39	2	1.21	1.32	2	32	38
								12.54	78	118/67	28	40	22	72	62	2	2.35	1.69	2	23	28
1.13	1.01	TR+	22	33	9	2	2	18.35	52	96/53	25	36	29	66	53	2	1.19	0.98	TR+	21	36
								14.15	83	116/54	35	38	28	48	42	APICAL,LAT	1.21	1.29	TR+	20	30
								11.58	65	107/57	30	35	20	55	41	2	1.88	1.93	2	19	31
1.42	1.68	TR++	27	32	9	2	2	16.35	69	118/62	27	37	28	59	48	2	1.38	1.46	TR++	26	32
2.39	2.48	TR+	23	33	10	2	2	16.05	76	118/52	32	52	40	61	62	2	2.24	2.55	2	24	33
								13.55	67	128/68	33	58	34	69	67	2	2.35	2.26	2	35	41
1.92	1.31	2	28	42	15	2	2	13.07	60	118/63	31	53	40	63	46	2	1.97	1.16	2	26	38
0.96	0.98	TR+	31	35	15	2	2	17.45	68	139/89	25	50	39	49	52	2	0.92	1.16	TR+	30	35

9	2	2	500	12	9	20	0	2	2	2	2
9	2	2	500	12	8	19	0	2	2	2	2
10	2	2	350	11	11	14	0	2	2	2	2
10	2	2	400	10	7	17	4	2	2	2	2
9	2	2	500	12	11	19	4	2	2	2	2
12	2	2	450	14	8	23	0	2	2	2	2
14	2	2	450	12	8	18	0	2	2	2	2
9	2	2	350	12	12	21	4	2	2	2	2
14	2	2	375	12	12	16	0	2	2	2	1
8	2	2	450	12	11	18	5	2	2	2	2
14	2	2	400	14	8	18	5	2	2	2	2
10	2	2	525	12	6	17	0	2	2	2	2
15	2	2	550	14	11	22	0	2	2	2	2
8	2	2	475	12	9	19	0	2	2	2	2
16	2	2	450	12	7	16	0	2	2	2	2
10	2	2	500	12	8	21	5	2	2	2	2
9	2	2	450	12	10	22	0	2	2	2	2
16	2	2	475	10	7	18	0	2	2	2	2
11	2	2	475	12	11	22	5	2	2	2	2
10	2	2	500	12	11	21	5	2	2	2	2
15	2	2	400	12	15	22	0	1	1	1	1
10	2	2	425	12	7	19	5	2	2	2	2
15	2	2	450	14	14	23	5	2	2	2	2
8	2	2	475	10	5	15	0	2	2	2	2
15	2	2	475	12	16	23	5	2	2	2	2
14	2	2	550	14	6	16	0	2	2	2	2
14	2	2	500	12	8	18	5	2	2	2	2
13	2	2	550	14	8	18	5	2	2	2	2
14	2	2	475	13	14	24	5	2	2	2	2
12	2	2	425	12	13	21	5	2	2	2	2
16	2	2	450	12	8	16	0	2	2	2	2
16	2	2	450	11	12	21	0	2	2	2	2
16	2	2	500	11	8	18	0	2	2	2	2
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14	2	2	500	14	9	18	0	2	2	2	2
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15	2	2	450	10	8	19	0	2	2	2	2
14	2	2	475	12	6	18	5	2	2	2	2
13	2	2	450	12	16	20	5	2	2	2	2
8	2	2	500	12	8	17	0	2	2	2	2
10	2	2	450	13	8	19	4	2	2	1	1
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14	2	2	530	12	8	18	5	2	2	2	2
14	2	2	500	12	6	16	0	2	2	2	2
14	2	2	375	10	6	19	0	2	2	2	2