# Defying Gravity- Overcoming Repeated Venous Air Embolism in a Sitting Neurosurgical Procedure

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# 44 YEAR, FEMALE WITH SPACE OCCUPYING LESION OF MIDBRAIN POSTED FOR EXCISION OF THE LESION IN SITTING POSITION .

# CHIEF COMPLAINTS

- A 44 year old female, resident of Pimpri came with chief complaint of headache since 1 month

# HISTORY OF PRESENT ILLNESS

- Patient was apparently alright 1 month back when she developed headache, which was progressively increasing in nature, dull aching in character, not relieved with medications.

- Predominantly in frontal and occipital region

- Associated with nausea and vomiting in early mornings.

- No complaints of blurring of vision and diplopia.

- No complaints of cough / cold / fever .

# PAST HISTORY

- No h/o similar complaints in the past
- Not a k/c/o DM/HTN/BA/TB/epilepsy/IHD/stroke
- No h/o previous hospitalization /blood transfusion/radiation exposure.
- No h/o any surgical procedure
- No h/o any allergy

# PERSONAL HISTORY

- Diet – mixed
- Appetite - normal
- Sleep - normal
- Bowel – normal
- Bladder – normal
- No history of addictions

# FAMILY HISTORY

⓾ Not significant

# DRUG HISTORY

- No ongoing medications

# GENERAL EXAMINATION

- Patient was afebrile, conscious, cooperative, well oriented to time, place and person.
- Weight: 72 kg, Height: 170 cm, BMI – 24.9 $kg/m^2$
- No pallor, icterus, cyanosis, clubbing, lymphadenopathy or oedema
- Pulse: 80 bpm in right radial artery, regular in rhythm, good volume, equal on both sides
- Bp: 110/70 mmHg recorded over the right brachial artery, sitting position
- RR: 17 /min
- SPO2:100% on RA .
- Spine – normal

# AIRWAY EXAMINATION

- Mouth opening - adequate
- MPC – II
- TMJ mobility - normal
- Neck extension –adequate.

# SYSTEMIC EXAMINATION

## CENTRAL NERVOUS SYSTEM

- Higher functions – conscious, cooperative and oriented to time place and person.
- Tone –Normal in all 4 limbs
- Reflexes – normal (deep and superficial)
- Motor – Power 5/5 in all 4 limbs
- Sensory – no tingling, numbness
- Touch, proprioception and temperature- normal
- Gait – normal
- No involuntary movement

## RESPIRATORY SYSTEM

- Respiratory Rate-17/min,
- On auscultation – Bilateral air entry equal , No added sounds.

## •CARDIOVASCULAR SYSTEM

- Auscultation – S1 S2 heard , no murmurs .

## ABDOMINAL EXAMINATION

- Soft, non tender, no rigidity/guarding, no distension
- Bowel sounds + , no organomegaly

# INVESTIGATIONS

- Hb: 9.7gm/dl, TLC : 9400, Platelets : 4.3 lakh
- PT/INR : 12.2/1.03
- Urea : 33, Creatinine: 0.87
- Na/K/Cl : 139/4.5/107
- LFTs : Total bilirubin : 0.86, (direct: 0.45, indirect : 0.41)
- SGOT: 20,
- SGPT: 22,
- ALP: 78,
- RBS : 94
- Blood group: B +ve
- Serology – nonreactive.

# CHEST XRAY

No abnormality detected

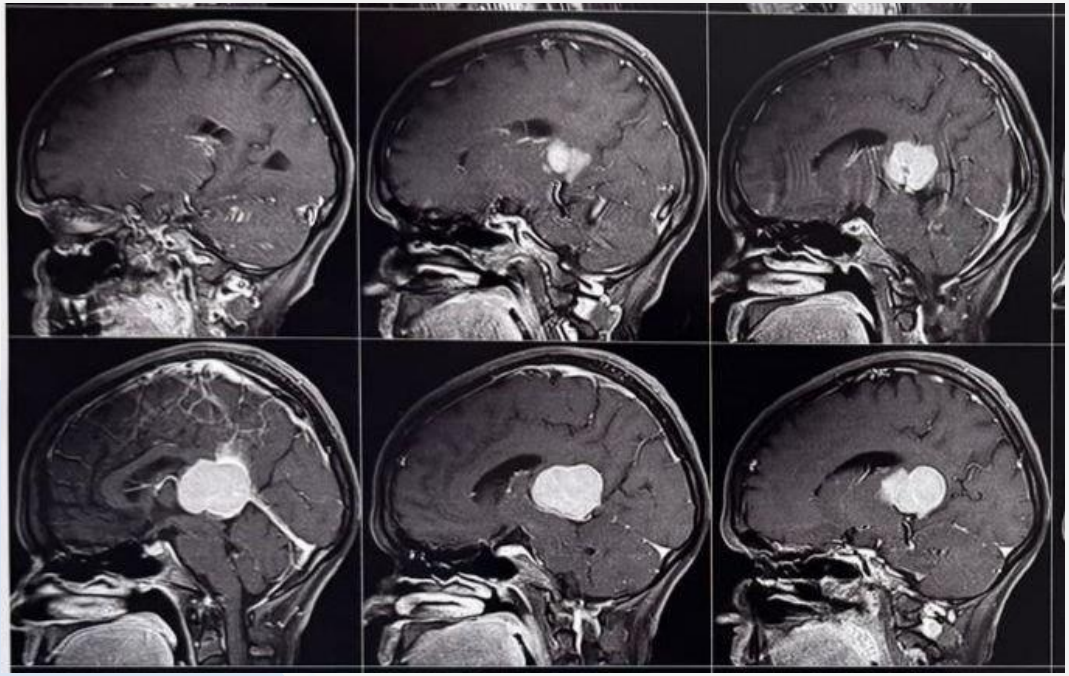
# ECG

Normal sinus rhythm

# 2D ECHO

Normal LV size and function EF- 60%
No regional wall motion abnormality
Normal diastolic function.
IAS and IVS intact
No clot or vegetation

# MRI BRAIN



A well defined large, lobulated, solid, intensely homogeneously enhancing mass lesion - **31x39x41mm** (CCxAPxTR) likely **meningioma in pineal region** .

## ⑩MR Brain Venography

The lesion is seen causing **mass effect** on straight sinus and inferior sagittal sinus,  displacement of bilateral internal cerebral veins and vein of Galen.

# ANAESTHESIA MANAGEMENT

- Anaesthesia Plan: General Anesthesia
- Patient was shifted to OT, standard ASA monitors- pulse oximetry, NIBP and ECG were attached as per protocol
- Baseline vitals recorded- HR-84/min, BP- 117/80mmHg, SpO2- 100% on room air
- IV fluids – RL was started through a wide bore iv cannula
- Patient was preoxygenated with 100% O2 for 3 minutes

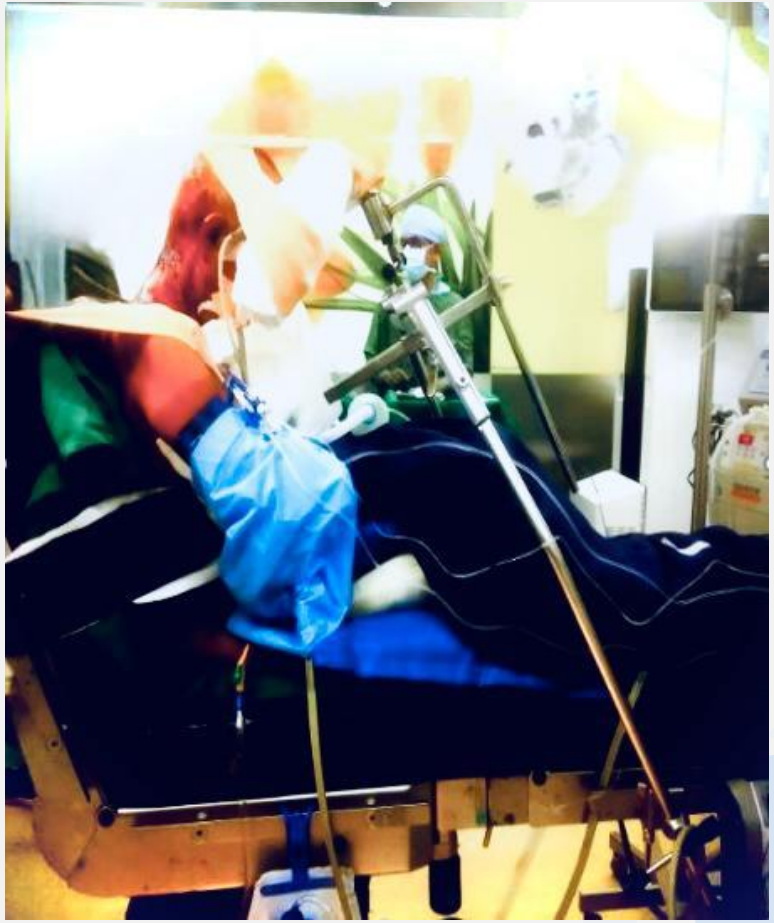
- She was premedicated with Injection midazolam 0.2mg/kg IV and Inj Fentanyl at 2mcg/kg iv

- Induction-
- Inj Propofol at 2mg/kg
- Inj Vecuronium 0.1mg/kg, after confirming adequate ventilation
- Intubated with a 7.0 mm cuffed Flexo-metallic endotracheal tube, followed by throat packing.

- Ultrasound guided triple lumen central line catheter was secured in the Right Subclavian vein.

- An arterial line was secured in the right radial artery for invasive blood pressure monitoring after positive modified Allens test.

- On a standard OT table, head part was removed
- back was positioned vertically to 60 degrees
- head was fixated by Mayfield pin fixator mounted on frame across table
- Adequate padding of all the pressure points - elbows, ischial spine, heels, forehead was ensured.



- Compression stockings were used for DVT prophylaxis.

- Ventilator settings-

Tidal volume: 6-8ml/kg
Respiratory rate: 14/min
EtCO2- 30-35mmHg

- Anesthesia maintained- 50%O2 + 50% air + 1-1.5% sevoflurane with Inj. Vecuronium as required

- Hemodynamic stability was ensured throughout the procedure

- During the procedure after 2 hours of induction, **sudden drastic fall in the end tidal CO2 from 30 to 16 mmHg** was noted, associated with hypotension and tachycardia.

- Keeping in mind the nature of the procedure and the position of the patient- **air embolism was suspected**

- Surgeons were informed of the findings, they proceeded by closing the open venous sinuses by placing saline soaked gauze and bone wax .

- Blood and air bubbles were aspirated through the central venous catheter.

- Improvement in hemodynamics was observed after aspiration of air.

- 2 additional episodes of sudden drop in etCO2 were seen, accompanied by hemodynamic instability- tachycardia and hypotension.

- Air was aspirated from the central line after every such episode, after which gradual stabilisation of hemodynamic parameters was observed


EPISODE 1- DROP IN ETCO2 FROM 29 TO 16
100ml of air aspirated


EPISODE 2- DROP IN ETCO2 FROM 29 TO 18
50ml of air aspirated

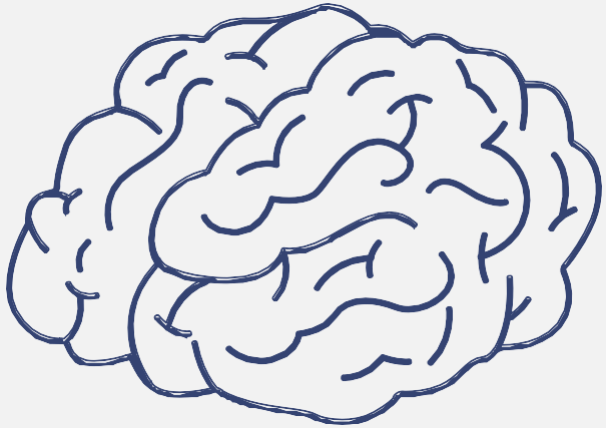

EPISODE 3- DROP IN ETCO2 FROM 32 TO 15
120 ml air aspirated

# Changes in hemodynamics during an episode of air embolism

| Time | HR/min | | BP (mmHg) | | EtCO2 (mmHg) | |
|---|---|---|---|---|---|---|
| 12:32 hrs | 79 | 98 | 140/90 | 100/80 | 29 | 16 |
| 13:00 hrs | 90 | 94 | 160/100 | 130/90 | 29 | 18 |
| 14:18 hrs | 80 | 82 | 118/85 | 49/39 | 32 | 15 |

# AFTER EVENTS

- After aspiration of air from the central venous catheter, patient got stabilised hemodynamically and the surgery was continued.
- The surgery lasted for 5 hours
- She was extubated uneventfully after the surgery and shifted to SICU for postoperative observation. And shifted to ward on POD- 7
- Patient recovered well postoperatively and was discharged on POD- 15



# DISCUSSION

# VENOUS AIR EMBOLISM

- Venous air embolism is a rare complication seen in neurosurgery, laparoscopic and cardiac procedures.
- It occurs when air is entrained into the venous system through open venous sinuses and moves to the right heart and pulmonary circulation.
- In the sitting position, the head is elevated relative to the heart, which can result in a significant decrease in central venous pressure.
- This pressure gradient makes it easier for air to enter the venous system in the presence of an open or compromised blood vessel.

# CLASSICAL FEATURES OF AIR EMBOLISM

- Sudden drop in end tidal $CO_2$
- Tachycardia
- Acute hypotension
- Hypoxia
- Air aspiration from CVC

Not diagnostic of venous embolism, but highly specific markers for the same

# DETECTION OF AIR EMBOLISM

- Transesophageal Echo- 0.02ml/kg of air
- Computed Tomography- 0.5-1.0 ml of air
- Doppler ultrasound- can detect microbubbles in circulation
- Millwheel murmur
- ECG Changes- S1Q3T3 pattern, ST-T changes, followed by supraventricular and ventricular tachyarrythmias

➓A minimum amount of 5ml/kg of air when introduced into the venous system can present with symptoms.

➓1 to 2 milliliters of air into the cerebral circulation can occasionally be lethal.

➓Furthermore, ventricular fibrillation can be brought on by as little as 0.5 ml of air being injected into the coronary arteries.

➓The risk of problems increases with the proximity of the air injection to the right heart.

# CLINICAL CONSEQUENCES

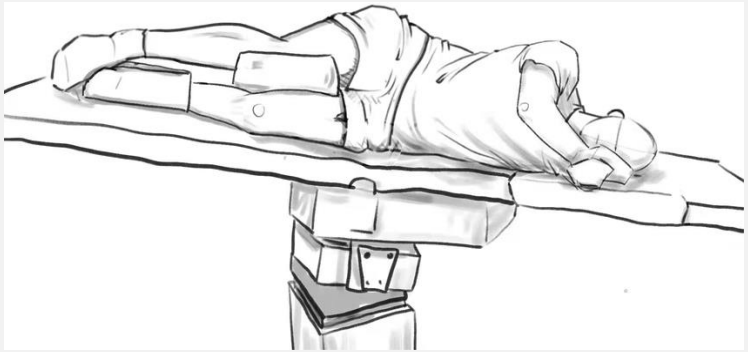
- Neurological- Stroke, transient ischemic attack (TIA), seizures.
- Cardiac- Myocardial infarction, arrhythmias.
- Peripheral- Limb ischemia, end-organ damage.

# PREVENTION

- Patient positioning: alternate positions- prone, park bench
- Use of DVT stockings
- Avoid nitrous oxide: may expand existing air bubbles
- Hydration: increases central venous pressure
- Prevention of further air entrapment

# MANAGEMENT

- High-flow oxygen
- Durant's maneuver: Trendelenburg + left lateral decubitus position
- Flooding of open sinuses with soaked gauze/ bone wax
- Aspiration of air from CVC if air embolism suspected
- Inotropic support if required
- Hyperbaric oxygen therapy



# TAKE HOME MESSAGE

Vigilant observation, prompt diagnosis and resuscitation is vital for a successful outcome

# REFERENCES


- Miller's anaesthesia- 9th edition
- https://pmc.ncbi.nlm.nih.gov/articles/PMC5323025/
- Acute management of vascular air embolism- J Emerg Trauma Shock 2009 Sep-Dec;2(3):180–185. doi: 10.4103/0974-2700.55330

# THANK YOU