

VENOUS AIR EMBOLISM (VAE) DURING CRANIOTOMY OF SUPRATENTORIAL MENINGIOMA IN SUPINE POSITION

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Submission date: 16-Jun-2022 07:51AM (UTC+0700)

Submission ID: 1857609666

File name: G_CRANIOTOMY_OF_SUPRATENTORIAL_MENINGIOMA_IN_SUPINE_POSITION.pdf (1.26M)

Word count: 3077

Character count: 16394

CASE REPORT

Bali Journal of Anesthesiology (BJOA) 2017, Volume 1, Number 3: 60-63
E-ISSN: 2549-2276



Published by DiscoverSys

Venous Air Embolism (VAE) during craniotomy of supratentorial meningioma in supine position



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ABSTRACT

Venous Air Embolism (VAE) is one of the most serious complications in neuroanesthesia case. The highest number of VAE incident is during neurosurgery procedure with sitting position, even though VAE may occur during craniotomy of supratentorial tumor in the supine position. VAE occurs due to the pressure differential between open vein in the surgical field and right atrium. A 46 years old woman underwent craniotomy for supratentorial meningioma in the supine position. Intraoperative, the patient was experiencing

a decrease in end-tidal CO₂ pressure about 6 mmHg in 5 minutes. Therefore, management of acute VAE was proceed to the patient, such as informed the surgeon immediately, discontinued N₂O and increased flow of O₂, modified the anesthesia technique, asked the surgeon to irrigate the surgical field with fluids, gave compression on jugular vein, aspirated the right atrial catheter, prepared drugs to support the hemodynamic, and changed the patient's position if possible.

Keyword: Craniotomy, Supine Position, Venous Air Embolism, VAE, Neuroanesthesia

Cite This Article: Sutawan, I.B.K.J., Bisri, T., Rahardjo, S., Lalenoh, D. 2017. Venous Air Embolism (VAE) during craniotomy of supratentorial meningioma in supine position. *Bali Journal of Anesthesiology* 1(3): 60-63. DOI:10.15562/bjoo.v1i3.26

INTRODUCTION

Venous Air Embolism (VAE) is a condition where the air is trapped on venous blood. VAE is a serious complication in neurosurgery.¹ It usually occurs when there is an open vein which its position is higher than right atrium during surgery. Thus forming negative pressure that has a suction effect. The greater the pressure difference, the stronger the suction effect.²

The highest incidence rates of VAE occurs in neurosurgery with sitting position. However, it also can occur at other positions, even in supine position. It only needs 5 cm H₂O pressure difference to create suction effect in the open vein.¹

In 2002, a severe intraoperative complication VAE in patients with convexity meningioma who underwent surgery with supine position was reported.³ Then, in Malaysia (2013) also reported an intraoperative VAE complications in elective craniotomy surgery of parasagittal meningioma which was operated in the supine position with head position up 30 degrees.⁴ Even though it did not give a fatal effect, There was a VAE intraoperative events in Canada happened on a patient underwent supine position awake craniotomy with different clinical signs.⁵ Hence the incidence of VAE in patients with the supine position is rare but still likely to occur.

Understanding VAE and its management are important in all kinds of positions for neurosurgery procedure because the risk for the occurrence of

VAE with catastrophic symptoms can be minimized with fast and accurate prevention and management of VAE intraoperatively.²

In this case report, we will discuss the preparation, prevention and initial management of VAE performed on a 46 years old female. The patient was diagnosed with meningioma in the right parietal region and underwent surgery with supine and 45° head up. Monitoring that used during anesthesia was invasive hemodynamic monitoring with an arterial line, central venous catheter (CVC), end tidal CO₂, ECG, oxygen saturation and urinary catheter. Intraoperative, end tidal CO₂ decreased from 31 mmHg to 24 mmHg, which was suspected because of the VAE. Therefore, notification to the operator, provided 100% oxygen, jugular vein compression and lowered the patient position with approval from the operator, and aspirated right atrial catheter (RAC) was done subsequently.

CASE REPORT

A 46 years old woman was diagnosed with meningioma in right parietal and planned to undergo tumor resection with supine 45° head up position. The patient came with an intermittent headache since 2.5 years ago and worsened about 4 weeks before admission. A brain tumor was found from head magnetic resonance imaging (MRI). There were no other symptoms reported by the patient such as nauseous, vomiting, seizure, and loss of

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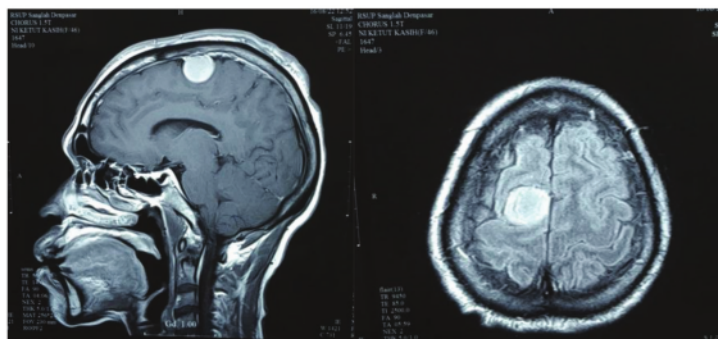


Figure 1 T2W1 FLAIR Head MRI



Figure 2 Patient's position

consciousness. On physical examination revealed patient had weight 45 kg, height 150 cm (BMI 25 kg/m²), blood pressure 130/80 mmHg, pulse rate 78 times/min, respiratory rate 12 times/min. There were no neurologic deficits found and another physical examination was normal. All laboratory results were normal, no abnormalities were found either on ECG or chest x-ray. Head MRI examination found hypointense, well demarcated with smooth border lesion on right parietal in T1WI that become hyperintense in T2WI and flair with enhancement after contrast was injected. From the MRI, the patient was diagnosed with a meningioma.

The anesthesia procedure was started by giving premedication with midazolam 1.5 mg, and then 50 mg tramadol and 50 mg fentanyl that slowly administered in operating theater before surgery. The patient was sedated with TCI propofol (Schneider mode), the 5th Ramsay achieved with CE 0.5 ug/dl. While keeping the airway secure, an artery line installation with lidocaine as local anesthesia was performed, then induction was given by increasing TCI propofol to Ce 2-2.5 mg/

dl, 100 micrograms fentanyl IV, 60 mg rocuronium IV, and 60 mg lidocaine IV. Stable vital sign after intubation was achieved and after that, Certodyn and ultrasound guided CVC installation on the right jugular were done.

The patient was positioned with 45° head up with 2 fingers distance between chin to surrounding bone. The operation was started under anesthesia maintenance using 1.5-2 microgram/dl TCI propofol, 40% oxygen, 0.8-1 vol%, sevoflurane, 20 mg/hour rocuronium and intermittent fentanyl (total of fentanyl during surgery was 200 micrograms).

The patient had relatively stable hemodynamics intraoperatively. On the 1.5 hours since the surgery was started there was a bleeding around the sinus after the tumor was resected. While the surgeon is trying to control the bleeding, there was a sudden decrease of end tidal CO₂ from 31 to 24 mmHg in less than 5 minutes with normal vital signs. Then, the patient was suspected having a Venous Air Embolism (VAE), the operator subsequently informed and advised to take action in accordance with VAE such as water irrigation in the surgical field, bone wax if necessary and stopped bleeding as soon as possible. With the approval of the operator, the patient's head was lowered to approximately 30° so the operator still could stop the bleeding. Simultaneously compression on both internal jugular vein and gave 100% oxygen were done. During suctioning in right atrial catheter (RAC), blood with enough amount of air was found. While preparing the drugs for hemodynamic support, close monitoring on end tidal CO₂ was performed and in approximately 2 minutes afterward, end tidal CO₂ increased slowly from 24 back to 30 mmHg in less than 5 minutes.

There was no VAE event recurrence until the operation was completed, all hemodynamics status and oxygen saturation were stable. After 3 hours of surgery, the extubation was proceeded after patient gained consciousness. The patient was admitted to HCU for 24 hours and transferred to a regular ward since there was no complication recorded during observation in HCU.

DISCUSSION

In this case, a right parietal meningioma located nearby the sagittal sinus which is one of the largest sinuses in the brain. The risk of laceration of the sinus was big, hence massive bleeding and opened sinus were the consequences known of this surgery. When the opened vein is failed to collapse and it usually happens with large sinus, the risk of VAE is increased.⁶ Therefore a supine position with 45° head up approach was offered to simplify the surgical approach.

CASE REPORT

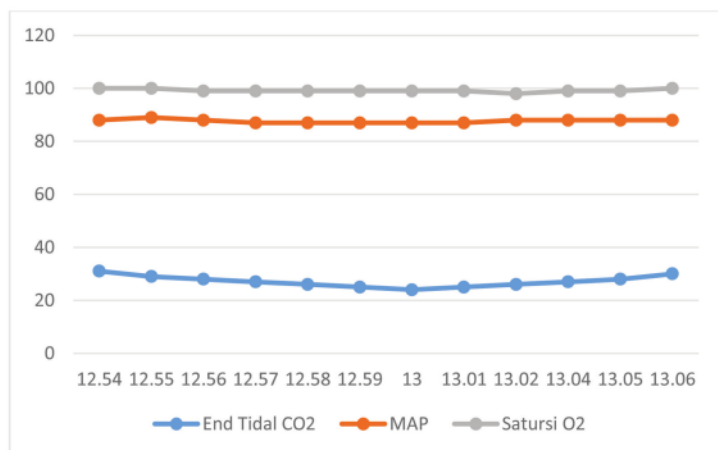


Figure 3 A record of sudden decrease of end-tidal CO₂



Figure 4 Picture show that tip of RAC was 1-3 cm above the SA node

45° head-up position will certainly cause more than 5 cm height difference of the surgical field compared to the right atrium¹³ using more than 5 cmH₂O pressure difference between the opened veins and the right atrium, therefore the hole of the G14 needle in blood vessels can suck the air approximately 100 ml/minutes.⁷ Therefore other invasive monitoring such as arterial line, CVC, and end tidal CO₂ were used in addition to the standard monitoring.

Beside headache caused by the tumor, this patient had no history of other illness. The patient was alert before surgery, with a pinch amount of anxiety observed before surgery. Therefore, 0.5 mg Alprazolam was given in ward orally and 1.5 mg midazolam IV was given in preparation room. In operating theater, 50 mcg Fentanyl and 50 mg tramadol were given to alleviate the pain during insertion of an arterial line. Slow bolus administration of fentanyl and tramadol was given to avoid cough and thoracic muscle spasm.⁸

Sedation with propofol TCI Schneider, until 5th Ramsay achieved, was done prior to the installation of artery line, and it was achieved with Ce 0.5 ug/

ml. During sedation and insertion of artery line, the patient's airway was secured. This patient is a young patient with a BMI of 25 kg/m², so both models TCI propofol commercially available can be used. However, Schneider was chosen due to our familiarity. Furthermore, the TCI experts also suggested that when using Schneider, target effect (Ce) must be used, just like what we did on this patient.⁹ Once artery line was inserted with lidocaine subcutaneous injection before the insertion to reduce pain, induction with ABCDE neuroanesthesia's rules was started.⁸ In this patient, additional 100 microgram fentanyl, 60 mg rocuronium and 60 mg lidocaine were administered intravenously and the target effect of TCI propofol increased to 2.5 g / dl. Intubation was done without significant hemodynamic fluctuation.

Subsequently, an ultrasound-guided CVC in the right internal jugular vein was done to avoid insertion into carotid artery, thus reducing the number of miss-insertion and its complications.¹⁰ After right arterial catheter (RAC) was installed, intravascular electrocardiography was used to get the right position. In these patients, Certodyn universal adapter was used. The best proper location for tip of catheter is 2 cm below the sinoatrial node to perform aspiration of air in case of VAE.² But based on modeling studies, RAC with tilt 80° of right atrium, the tip of catheter should be 1- 3 centimeters above sinoatrial node.² If using intravascular electrocardiography, the position will be seen when the tip of intravascular ECG give an overview of the P wave slightly smaller than the QRS complex.

After RAC was installed properly and appropriately, the patient was put in supine position with 45 degrees head up. Until 1.5 hours of surgery, the patient's hemodynamic relatively stable, with the anesthesia maintenance using 1.5-2 micrograms/dl TCI propofol, 40% oxygen, 0.8-1 vol% sevoflurane, continuous rocuronium of 20 mg/h and intermittent fentanyl.

Approximately 1.5 hours since the operation was begun, when the operator tried to stop the bleeding around the sinus, a sudden decrease of end tidal CO₂ happened rapidly from 31 mmHg to 24 mmHg in less than 5 minutes. Based on studies that were conducted on patient underwent surgery with sitting position in Australia, VAE is suspected if there is a decrease of end-tidal pressure CO₂ 5 mmHg or more within 5 minutes.¹¹

Three minutes after a decrease of end-tidal, VAE was suspected. Therefore, VAE management was done simultaneously, such as gave notification to the operator, saline irrigation in surgical field by the operator, bone wax if necessary. After the operator gave the consent, the patient's head was lowered until 30 degrees. Oxygen was increased from 40% to

100%, there was no change in anesthesia technique performed since TCI was already used at first. The pressure was applied on the jugular vein, aspiration was done through RAC and air emboli within the blood was found in a small amount. Neither increase PEEP nor Valsalva maneuver, were done in this patient, because it could increase the incidence of arterial paradoxical embolism (PAE).² Hyperventilation was not suggested because it was not particularly helpful in VAE management, based on prior studies conducted on porcine models of cerebral air embolism.² Close observation on end tidal CO₂ gave result the increasing of end tidal CO₂ from 24 mmHg to 30 mmHg approximately in 5 minutes, without any manipulation of tidal volume and respiration.

Once the patient was extubated at the end of the operation, the patient was observed in HCU for 24 hours. Postoperative monitoring is required in patients with intraoperative VAE, to prevent the occurrence of hypoxemia and other respiratory limitations, early detection and management of myocardial ischemia and PAE if it happens.² Supporting examination that can be done when PAE is suspected clinically is fundoscopy if emboli is suspected in retina's blood vessel and CT-Scan if there is a suspicion of emboli travel to the brain.² After 24 hours observation, the patient did not show any symptoms of the PAE, myocardial ischemia and respiratory disorders, the patient was transferred to the inpatient unit.

CONCLUSION

VAE can occur at any neurosurgery procedure, although the incidence was highest on neurosurgery with sitting position, patients with supine position can also experience VAE. VAE incidence risk increases when the surgical field is 5 cm higher than the right atrium and if the surgical site is close to the major veins which are difficult to collapse such as sinuses, bridging veins and epidural vein. In patients suspected with a high risk of VAE, close monitoring with the installation of the arterial line to evaluate hemodynamic fluctuation, CVC in the right atrium to aspirate the emboli and end tidal CO₂ installation were required. Installation of CVC should be guided by ultrasound to reduce the complications. The placement of tip should also be guided by the intravenous ECG, so the tip of the catheter is exactly 1-3 centimeters above the sinoatrial node. VAE is suspected when there is a decrease of pressure 5 mmHg or more within 5 minutes that is recorded with end tidal CO₂. Several things that should be done in case of VAE happened intraoperatively, such as notify the operator, discontinue N₂O and increase O₂ flow, modify the anesthesia technique, ask the operator

to irrigate the surgical field with a water, jugular vein compression, aspiration through RAC, prepare drugs for hemodynamic support and reposition the patient if possible. Postoperative observation is needed in patients with intraoperative VAE, to observe the possibility of hypoxemia, myocardial ischemia, and PAE closely.

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