ABSTRACT

Objective: The incidence of air embolism is still high with low mortality and morbidity if preventive measures and proper monitoring were taken. This will make management quick and effective.

Methods: Forty patients underwent neurosurgical procedure in the sitting position for posterior fossa tumors, pineal tumor, foramen magnum decompression and cervical disc between January 2003 and January 2004. Gender and age distribution, venous air embolism, hypotension, postoperative ventilation and other complications were studied.

Results: Venous air embolism was found in 10% of patients who had a drop in their end tidal carbon dioxide by 5mmHg. Hypotension with a 20% drop of the baseline blood pressure developed in 5% of patients in the absence of hypovolemia. Patients who developed combined venous air embolism and severe hypotension were resuscitated by intravenous fluid and ventilated electively.

Conclusion: Sitting position is safe if done with preventive measures and strict monitoring. Prompt management of complication is essential to reduce morbidity

Key word: Neurosurgery, Sitting position, Venous air embolism

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Introduction

There has been debate about advantages and disadvantages of sitting position in comparison with horizontal position in neurosurgery\(^1\). The advantages are: Optimum access to posterior midline lesions, improved cerebral venous decompression, lower intracranial pressure, promotion of gravity drainages of blood and spinal fluid access to bleeding points, minimization of cerebral retraction and good access to the face during facial nerve stimulation\(^3\). Disadvantages include homodynamic instability, venous air embolism (VAE) with the possibility of paradoxical air embolism, pneumocephalus, quadriplegia, and compressive peripheral neuropathy\(^3\).

The high prevalence of complications due to sitting position was evaluated over the last century. In 1928 the sitting position was first used by Frazer & Gartner\(^4\). Black and colleagues reported major change in sitting position over 4 years from 1981-1984\(^1\). The use of sitting position remains controversial and variable due to its complications. Campkin reported that 53% of posterior fossa procedures were done in sitting position in the year 1981\(^5\). Elton and Howel claimed a reduction of sitting position in neurosurgery in survey between years 1981-1991 to 50%\(^6\). Harrison and colleagues also reported a VAE prevalence of 9.3% among 40 children who underwent neurosurgical procedures using the sitting position. This is quite small in comparison with other studies in adults ranging between 25-76% depending on the technique of detection\(^7-9\). The sitting position was fully reviewed physiologically and clinically by Porter and colleagues\(^10\).

Methods

Between January 2003 and January 2004 we followed...
40 patients who underwent a neurosurgical procedure in sitting position for one of the following: Posterior fossa acoustic neuroma, pineal gland tumor, cervical disc and foramen magnum decompression.

The patients were not premedicated but were hydrated by giving them 10 ml/kg colloid, after inserting the main monitors: oxymetry, electrocardiography and sphygmomanometer. Anesthesia was induced intravenously by Thiopentone 5mg/kg, Vecuronium 0.15/kg, Fentanyl 2mcg/kg or inhalation by Sevoflurane, Nitrous Oxide and oxygen in children. Maintenance was with Nitrous Oxide and oxygen+1.5% Sevoflurane. We kept end tidal carbon dioxide around 30mmHg. An arterial line was inserted through the left radial artery for adults and femoral artery for children. A Central line was inserted through the right internal jugular vein except in children below five years of age who got two peripheral lines. Legs were wrapped by bandages and PEEP was kept around 30mmHg.

In our study we followed the frequency of venous air embolism, hypotension and postoperative ventilation. Monitoring during the surgery consisted of electrocardiogram, oxymetry, central venous pressure, intra arterial blood pressure, end tidal carbon dioxide, blood loss and urine out put.

Intraoperative venous air embolism was considered if there was a sustained drop in end tidal carbon dioxide of more than 5mmHg in the absence of a change in ventilation. General therapeutic measures included: switching off Nitrous Oxide, giving 100% oxygen, pressure on jugulars, Valsalva’s maneuver and aspiration through the central line. The surgeon was usually asked to flush the area with saline or soaked swab with saline, coagulate visible vessels and smear the bone edges with bone wax. Drop of the blood pressure below 20% of base line was managed by crystalloid infusion at faster rate but in a severe drop it was managed by giving Ephedrine 6 mg intermittently with slight head down position.

Pathology included metastatic tumors, astrocytoma, and acoustic neuroma. Certain patients were ventilated postoperatively.

**Results**

Among the 40 patients who were enrolled in the study, 75% were adults and 25% were children as shown in (Fig. 1). There were 55% males and 45% females as shown in (Fig. 2). Venous air embolism was detected in four patients (10%); one of them was a child as shown in (Fig. 3). Most of the cases occurred during opening the dura (n=3) 75%, only one patient during bone drilling (n=1) 25%.

Hypotension was detected in two patients (5%). Both of them had venous air embolism without hypovolemia. Moderate hypotension was managed by rapid infusion of crystalloid and intermittent doses of Ephedrine 6mg but stable patients were not given any support.

Postoperative ventilation was elective in two patients (5%) who got venous air embolism with hypotension as shown in (Fig. 3). (P<0.05 if blood pressure dropped below 90 mmHg).
Regarding the lesions’ pathology, 30% were metastatic tumors, 20% astrocytomas, 17.5% acoustic neuromas, 15% cervical discs, 10% medulloblastomas, 5% foramen magnum decompressions (FMD), and 2.5% were due to other pathologies (Fig. 4).

Discussion

Our study sample was homogenous regarding sex, with wide variability regarding the age between one year and 70 years. There was no increase in venous air embolism with increasing age and it was less frequent in children.

We found a 10% frequency of VAE among our patients which is less than the internationally published rate, probably because we used end tidal CO\(_2\) as indicator which is less sensitive than other monitors such as Transesophageal echo (TEE) and Doppler ultrasound which were used in other studies. Albin and Papadopoulos reported an incidence between 7-50% detected by Doppler ultrasound\(^{(8-9)}\). Matasko and Young reported high incidence of air embolism in children (62%) which is quite high compared with this study\(^{(10-21)}\). The Mayo clinic showed a lower incidence of VAE in children (30%) and in adults (45%) by Transesophageal echo\(^{(13)}\). Some tried to aspirate air through central line under Transesophageal echo\(^{(21)}\). Meyer reported incidence of VAE of 26% by end tidal carbon dioxide\(^{(14)}\). Fuch reported incidence of 37% in children by Doppler ultrasound\(^{(15)}\). The only explanation of low incidence in children is high dural sinus pressure in children and good hydration in this study.

Our study using capnography as monitor is supported by Mammoto who found end tidal carbon dioxide is satisfactory in clinical situations\(^{(16)}\). He used capnography and TEE comparatively and he graded VAE according to number of bubbles detected by TEE (Grade 1 = less than 5micro bubbles, grade 2 = 5-10 micro bubbles, grade 3 = >10 bubbles). He found that above grade 2 could be detected by end tidal CO\(_2\) monitoring and most importantly that end tidal CO\(_2\) monitoring can detect VAE before any changes occur.

Hypotension among our patients was found in 5% of the cases which is less, in comparison with other studies such as that reported by Mayo clinic which is 36%\(^{(18)}\). The possible explanation for this is that our patients were well hydrated preoperatively by crystalloid.

Some studies tried to find a relation between site of air embolism such as dura or bone and severity of hemodynamic changes\(^{(19)}\). Some tried to reduce venous air embolism by applying positive end expiratory pressure\(^{(20)}\). There was no difference in prevalence of complication between our study using sitting position and others using horizontal position\(^{(21)}\).

There is still a controversy about sitting position; this is supported by Leonard\(^{(17)}\). Some studies paid attention to pneumocephalus\(^{(18)}\), which was not a problem in our study. In general, no serious complications with permanent sequelae were detected in our series.

Conclusion

Sitting position is safe in neurosurgical procedures with many advantages over horizontal position despite the high prevalence of VAE.

Venous air embolism is a frequent complication in sitting position in neurosurgery but usually without serious sequelae if preventive measures with strict monitoring of hemodynamic and venous air embolism are taken.

References

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