Sitting Position in Neuro Anesthesia – Current Perspective and The Way Forward

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Introduction

The sitting position has been used in neurosurgical procedures for over a century.[1]In this position, the patient is seated upright with head and neck flexed to allow access to the posterior fossa.[2] Despite its longstanding use, controversy still exists regarding the safety and efficacy of the sitting position.[3] In this review, we will discuss the history of the sitting position in neuro anaesthesia, physiological changes, the current perspective on its use, and future directions for research.

History of the Sitting Position in Neuro Anesthesia

The sitting position was first described in 1908 by Krause and Rosenthal[1]. They used this position for a patient undergoing posterior fossa surgery and reported improved surgical access and reduced bleeding.[1] In the following years, the sitting position was used sporadically but fell out of favor due to concerns about the risk of venous air embolism.[4] The position was reintroduced in the 1960s when new safety measures, such as continuous end-tidal CO2 and central venous pressure monitoring, were introduced.[4]

Surgical indications may vary according to the preferences of the surgeon and their enthusiasm. Most believe that high midline and posterior fossa surgeries are dealt with best in the sitting position.[5] Central venous decompression, lower intracranial pressure, cleaner operating field due to less blood and cerebral spinal fluid, needing less cerebral retraction for surgical exposure are advantages of this position. Ultimately leading to superior surgical access and reduced bleeding. It also provides greater access to the chest and face for the Anesthetist and improves ventilation with lower airway pressures. It is noted that post-operative cranial nerve function is too improved in this position compared to the other[5] positions.

Current Perspective on the Use of the Sitting Position

The use of the sitting position in neuro anaesthesia remains controversial. Proponents argue that the sitting position provides superior surgical access and reduces bleeding.[5] In addition, the sitting position allows for more extensive removal of tumour in the posterior fossa.[6] Opponents of the sitting position argue that it carries a high risk of venous air embolism (VAE), which can lead to catastrophic consequences, such as stroke and death.[3] In addition to VAE, increased incidents of hypotension and bradycardia, pneumocephalus, lingual and laryngeal trauma, and quadriplegia due to excessive flexion, pressure point and sustaining

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of peripheral nerve injuries support their argument.[5]

The physiological changes that take place lead to both advantages and disadvantages. One of the significant consequences of the seated position is a decrease in functional residual capacity (FRC).[6] FRC is the air that remains in the lungs after a normal expiration. The seated position leads to a decrease in FRC because of the reduction of the diaphragm's movement and a decrease in lower rib cage movement.[14] A reduction in FRC can result in atelectasis, the collapse of a portion of the lung due to decreased airway pressure.[6] To mitigate the risk of atelectasis, measures such as positive end-expiratory pressure (PEEP) and recruitment maneuvers can be employed.[15]

The seated position can also lead to changes in cardiovascular function. In the seated position, the central venous pressure (CVP) decreases, which can reduce venous return and cardiac output. This reduction in CVP can increase the risk of venous air embolism, which occurs when the air enters the venous circulation.[16] To mitigate the risk of venous air embolism, prophylactic anticoagulation may be employed, and the patient should be carefully monitored.[17]

In addition to the decrease in FRC and changes in cardiovascular function, the seated position during anaesthesia can also lead to a reduction in lung compliance, an increase in airway resistance, and a decrease in arterial oxygenation saturation.[6] Patients may experience a drop in respiratory system compliance and an increase in airway resistance due to the increased intrathoracic pressure in the seated position. The decreased oxygenation saturation can result in hypoxia, which may cause damage to the vital organs and, in severe cases, result in irreversible tissue injury.[7]

The use of the seated position in anaesthesia can also lead to changes in blood pressure and heart rate[8]. The seated position can lead to a decrease in blood pressure due to reduced CVP and an increase in heart rate due to the sympathetic nervous system's activation. These changes can increase the risk of adverse cardiovascular events, such as myocardial ischemia, arrhythmias, and pulmonary edema.[8]

The incidence of venous air embolism during neurosurgical procedures in the sitting position is difficult to determine due to the lack of standardized reporting.[9] The paths taken by the air determine the pathophysiology of air embolism sucked into the venous system. They could be classic venous air embolisms, where the air goes through the right ventricle into the pulmonary circulation, which is known as classic venous embolism. Paradoxical air embolism being the other, is due to air passing through the right and left atrium barrier which is functionally closed but open in certain situations.[5]

However, several studies have reported an incidence of up to 40%. [10] The risk of a venous air embolism can be minimized using several safety measures, such as extended monitoring, volume loading, use of neck tourniquet, positioning air aspiration etc. [11] Extended monitoring includes the use of precordial dopplers, ECG, end-tidal CO2 monitoring, central venous pressure, pulmonary artery pressure monitoring, Transesophageal Echocardiography (TOE), Pulse Oximetry, and an arterial blood gas analysis.

In addition to the risk of venous air embolism, the sitting position can also lead to other complications, such as hypotension and bradycardia.[12] These complications are thought to be due to reduced venous return and increased sympathetic tone associated with the sitting position.[12] Hypotension and bradycardia can be minimized by maintaining adequate intravascular volume, using vasopressors, and careful titration of anaesthetic agents.[13]

The Way Forward

Despite the controversy surrounding the sitting position, it remains a valuable tool in the neurosurgeon's armamentarium. Several strategies can be employed to maximize the benefits of the sitting position while minimizing the risks. These include using safety measures, such as continuous monitoring of end-tidal CO_2 and central venous pressure and careful titration of anaesthetic agents.[11]

Extended neuromonitoring is a prerequisite for detecting complications of sitting position in Anesthesiology. Despite the importance of extended monitoring in detecting critical incidents, there is limited evidence regarding the sensitivity of monitoring modalities in detecting critical incidents in the sitting position. However, several studies have shown that extended monitoring, including invasive monitoring and advanced imaging, can improve the detection of critical incidents and reduce the incidents of complications in the sitting position. [22, 23]

Some specialists in anesthesiology have recommended modifications to the anaesthetic practice for the sitting position beyond the standard ones found in textbooks.

A modification recommended by some specialists is the use of neuromuscular blocking agents. While these agents are not typically used in the sitting position, they may be necessary to ensure patient safety. By relaxing the muscles, the anesthesiologist can better monitor the patient's blood pressure and heart rate, especially during procedures that require more invasive monitoring, such as those that involve the brain or neck. Using neuromuscular blocking agents also allows for improved surgical access, possibly reducing the risk of neurologic injury. [14.]

The second modification to anaesthesia practice for the sitting position is the use of ultrasonography. Ultrasonography can provide real-time images of blood flow and tissue perfusion in the brain, helping the anesthesiologist monitor blood pressure and identify early signs of hypoperfusion. The use of ultrasonography can also help identify complications such as air embolism or pneumocephalus, which are more likely to occur in the sitting position.[15]

The author's experience over the past 20 years has shown that patient selection, pre-operative echocardiograms to identify PFOs, fluid loading, adopting a modified sitting position with extended monitoring with central venous catheters, continuous end-tidal $C0_2$ monitoring and special care for pressure and nerve injuries minimized most of the popularly documented complications.

In his experience, post-operative lingual and facial oedema and difficult airway noted in the first few cases were attributed to over-flection of the neck, causing cerebral venous congestion. Preventing over-flexion and identifying the appropriate degree of flexion preoperatively minimized this complication thereafter.

Future directions for research include the development of new safety measures, such as the use of transcranial Doppler to detect venous air embolism in real-time.[5] In addition, the use of neurophysiological monitoring, such as somatosensory evoked potentials and motor evoked potentials, may help to detect early signs of neurological injury during surgery in the sitting position.

Conclusion

The sitting position has a long and controversial history in neuro anaesthesia. While it provides superior surgical access and reduced bleeding, it carries a high risk of venous air embolism and other complications. But the future of the sitting position in anaesthesia practice is still promising. Advances in monitoring technologies, anaesthetic techniques, and imaging techniques may make the sitting position safer for patients undergoing surgical procedures. However, careful patient selection, monitoring, and anaesthetic management will continue to be essential for ensuring patient safety.

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