INTRODUCTION
Proper positioning during neurosurgical procedures is almost as important as the operation itself. Of the many positions used during neurosurgery, the semi-sitting position has generated the most controversy (Siddiqi et al., 1998). Although the semi-sitting position seems to be superior to the supine position or prone position in terms of less intraoperative venous bleeding and free bimanual dissection, a higher risk of venous air embolism (VAE) exists in the position (Kida et al., 2000).

The semi-sitting position of the patient offers a number of advantages for the neurosurgeon, including the lax brain, clean operating field, possibility of bimanual dissection, and reduced venous pressure creating an optimal environment for surgery, many complications other than venous air embolism (VAE) also have been ascribed to the semi-sitting position in neurosurgery as hypotension, tension pneumocephalus, quadriplegia, macroglossia and peripheral nerve injuries are some of the complications that have been reported in the literature. (Schaffranietz et al., 2000).

HISTORY
The adoption of the semi-sitting position in neurosurgery practice was highlighted by Albin and colleagues (Albin et al., 1976). The first use of this position for brain tumors located in posterior fossa or dorsally located parietal lesions was reported in 1913; it was performed under local anesthesia. Frazier and Gardner (1928) reported use of this position for surgery on Gasserian ganglion in the USA. Although the semi-sitting position is not commonly used in North America, it is quite popular in Europe and was the preferred position for surgery of the posterior fossa. In Japan, this position is used only in small numbers of institutions, and by a few neurosurgeons who use it constantly (Schaffranietz and Günther, 1997).

In the late 1980s, mostly because of reservations by anesthesiologist, the semi-sitting position was no longer used. More recently, neurosurgeons have reintroduced the semi-sitting position for posterior fossa surgery operated on hundreds of cerebellopontine angle and posterior fossa tumors in the recumbent position (Misra, 2000 and Misra et al., 2009). The advantages were more significant in large and giant cerebellopontine angle tumors. The cerebellum was lax, and the foramen magnum did not need to be opened in most cases. The operating time was considerably shorter, and dissection of the tumor capsule for cranial nerves VII and VIII was easier. The tumor fell over the anteriorly displaced cranial nerves VII and VIII in the lateral and supine positions, whereas the tumor fell away from the nerves in the semi-sitting position.

The advancement of the operating microscope in neurological practice, new inhalation anesthetic agents and neuromuscular blocking drugs, and sophisticated monitoring equipment facilitated the development of more complicated and technically challenging procedures performed in the semi-sitting position (Yasargil MG. (1969).

ADVANTAGES
There are undisputable advantages of the sitting position for posterior fossa and dorsal cervical spine procedures. Gravitational drainage of venous blood and cerebrospinal fluid (CSF) from the surgical site improves orientation and surgical access to midline structures. In particular, the significant reduction of cerebellar swelling is a key feature of the sitting position. Reduced surgical time and reduction of blood loss can also contribute to a potential better outcome of patients.
operated in the sitting position (Irene and Monica 2007).

In the semi-sitting position, blood drains out of and away from the operative site. This allows easy access to bleeding points, a cleaner surgical field than in the prone position. In addition, the semi-sitting position provides an unobstructed view of the patient's face, permitting intraoperative neurophysiological monitoring. In some approaches, notably supracerebellar, infratentorial approach to the pineal region, the semi-sitting position minimizes the amount of cerebellar retraction needed to gain access to deeper structures (Geevarghese, 1977).

POSITIONING OF THE PATIENT

First, the initial positioning of the patient with the toes above the heart is critical with flexion of the hips, elevation of the knees to the level of the heart and wrapping of the lower extremities from toes to the groin. Careful coagulation of all the bleeding veins, waxing the drilled bone, careful craniotomy leaving the exposure of sinuses to the end, liberal use of fibrin glue, and frequent manual compression of both jugular veins are important preventive measures against VAE. Although positive end expiratory pressure is routinely employed during anesthesia in the semi-sitting position, it is contraindicated in patients with PFO (Siddiqi et al., 1998).

Figure: (A): Modified semi-sitting position.

COMPLICATIONS

1-Venous Air Embolism (VAE):

Mechanism of VAE includes negative venous pressure and exposure of veins as well as bony venous sinuses to air. When the site of surgery is exposed to air and located above the level of the heart, air may be entrained in the veins and bony venous sinuses, then air may enter the pulmonary circulation. A large VAE may decrease cardiac output by creating an airlock and decreasing left ventricular output.

Incidence of VAE in sitting position may approximate 20–50% when precordial Doppler monitoring is used for detection and 76% with transesophageal echocardiography (TEE) (Papadopoulos et al., 1994). Although TEE is more sensitive in detecting VAE, precordial Doppler is inexpensive, readily available, easy to use, and noninvasive. Optimal placement of the precordial probe should be guided by the recognizing the highest pitch over the right upper sternal border with the intravenous injection of agitated saline. When precordial Doppler or TEE are unavailable, VAE should be considered when end tidal CO2 suddenly decreases in the presence of hypotension, not explained by other causes. An atrial catheter (multi orifice or single orifice) placed at the high level of the right atrium may be helpful for air aspiration (Standefor et al., 1984).

An oesophageal stethoscope was previously used to detect VAE but a significant volume of air has to be entrained before the classic ‘mill-wheel’ murmur is heard, and this is usually already associated with signs of cardiovascular collapse. With the availability of more sensitive non-invasive monitors to detect VAE, the oesophageal stethoscope is of little clinical use (Duffy 2000).

Patent foramen ovale (PFO) should be excluded before every case as it is a source of paradoxical air embolism. Therefore, preoperative “bubble test” in awake patients using TEE or transthoracic echocardiography is advocated by some authors if the semi-sitting position is considered (Porter et a, 1999).

Correct positioning may be verified using intravenous electrocardiography, chest radiography, or TEE. However, the therapeutic value of the right atrial catheter may be limited. The most important treatment for VAE include irrigation of the surgical site with saline, rescue head down tilt or left lateral positioning, and cardiovascular support with administration of inotropes (Irene and Monica 2007).

Catheterization and aspiration of the right auricle considered as a treatment for VAE, the first fatality as a result of VAE in association with surgery in the sitting position was recorded as early as 1830. Fifty years later, Dr N. senn drew attention of readers to VAE. He concluded that VAE produces death by “mechanical over distention of the right ventricle of the heart and asphyxia from obstruction to the pulmonary circulation consequent upon embolism of the pulmonary artery”; he proposed catheterization and aspiration of the right auricle as a treatment (Papadopoulos et al., 1994).

2- Postural hypotesion:
The classic semi-sitting position causes postural hypotension in about 1/3 of patients, and 2–5% of patients suffer severe hypotension (decrease in blood pressure more than by half from baseline) (Black, and Cucchiara, 1998).

The major hemodynamic consequence is decrease in venous return, leading to decrease in cardiac output and hypotension. Therefore, hemodynamic instability and cardiac disease are relative contraindications for prone positioning. Wrapping of the legs with elastic bandages (e.g. ACE bandage) prevents pooling of blood in the lower extremities and should be applied in every case.

The modified semi-sitting position provides better venous return and less hemodynamic instability. (Figure A) With head-up tilt venous drainage via internal jugular veins is improved which results in decreased intracranial pressure. However, jugular veins may also collapse in sitting position and careful head positioning to avoid hyperflexion and hyperextension is required to prevent stretching or obstruction of the vertebral venous outflow (Cirovic et al., 2003).

PNEUMOCEPHALUS

This complication has been described with posterior fossa surgeries in semi-sitting position with an incidence of about 3%. Air entry into the epidural or dural spaces could be sufficient to exert a mass effect with the potential for life-threatening brain herniation; suggestive clinical features include confusion, headache, convulsions, neurological deficit and failure to regain consciousness. Early CT scan enables diagnosis and localization of intracranial air or other mass lesions (Toung et al., 1983).

This complication has been attributed to diminution of brain volume secondary to removal of space occupying mass, intraoperative drainage of CSF either via ventriculostomy or, ventricular incision or subarachnoid drainage as well as mannitol administration, hyperventilation and contraction of intravascular blood volume associated with acute hemorrhage. The gravitational effect of the sitting position may increase the likelihood of airway entry into the subdural space as CSF leaks through the incision site. Lunsford et al., 1979 has proposed the inverted pop bottle analogy to describe this phenomenon. As fluid (CSF) pours out, air bubbles to the top of the container (cranium). Occurrence of tension pneumocephalus is a serious and life threatening emergency (Lunsford et al., 1979).

A variety of strategies have been adopted to reduce the potential for pneumocephalus after surgical procedures in the semi-sitting position. Flushing the subdural space with normal saline has been recommended but may be impractical suggestion (Findler et al., 1980).

Life-threatening tension pneumocephalus is rare (3%), untreated tension pneumocephalus may result in brain herniation and death, and therefore rapid therapeutic intervention is warranted. Cardiac arrest has been reported in association with this complication. Immediate twist drill aspiration of air through burr holes on either side of the vertex is indicated if a tension pneumocephalus is diagnosed. Rapid evacuation of air should ensure prompt recovery (Toung et al., 1983).

QUADRIPLEGIA

Quadriplegia is a rare but devastating complication and results from cervical spine ischemia with neck and head hyperflexion. Elderly patients with cervical spine deformities and vascular pathologies have higher risk. Acute flexion of the neck in the anaesthetized patient in the sitting position may stretch the cord at the level of the fifth cervical vertebra. Regional cord perfusion may be compromised especially if mean arterial pressure is reduced. Somatosensory evoked potential monitoring has been proposed as an indicator of the adequacy of regional spinal cord perfusion in these cases.

During positioning, sufficient distance between chin and neck (at least 2 finger-breadth) is recommended to avoid neck hyperflexion (Porter et al., 1999).

MACROGLOSSIA

Extreme flexion of the head with the chin resting on the chest and the prolonged presence of an oral airway may promote obstruction of venous and lymphatic drainage of the tongue after procedures performed in the sitting position. Postoperative macroGLOSSIA has the potential to produce airway obstruction, hypoxemia and hypercapnia. Infants may be at particular risk because of the high anterior larynx, small tracheal diameter and relatively large tongue (Rath et al., 2007).

Reports of macroGLOSSIA after procedures performed in the sitting position highlight swelling of other pharyngeal structures, including the soft palate, posterior pharyngeal wall and tongue. Sustained neck flexion, the use
of oral airways and long duration of surgery have all been associated with this condition. Several strategies have been advocated to reduce the possibility of this complication. The oropharyngeal airway may be withdrawn until the tip functions as a bite block when the patient has been positioned. Small diameter transoesophageal echocardiographic probes have been recommended when this monitoring modality is used to avoid trauma to pharyngeal and peri-laryngeal structures (Porter et al., 1999).

PERIPHERAL NERVE INJURIES

Incidence of this complication is less than 1%. Reported cases of peripheral nerve injuries in association with semi-sitting position resulted in footdrop and less commonly, recurrent laryngeal nerve injury (Porter et al., 1999).

CONTRAINDICATIONS

Black and Cucchiara 1998 note several conditions which may warrant avoidance of the operative semi-sitting position. Certain pre-existing conditions may place patients at increased risk of vascular air embolism (i.e. presence of a patent ventriculo-atrial shunt, demonstrable pressure gradient from the right to the left heart or presence of a patent foramen ovale). Patients who experience cerebral ischaemia' whenever they assume the upright position as a result of cardiovascular and/or cerebrovascular disease are at increased risk of inadequate cerebral perfusion under anaesthesia in the operative sitting position. Relative contraindications may include extremes of age, uncontrolled hypertension or chronic obstructive airways disease.

ANAESTHETIC CONSIDERATIONS

The main goals of anaesthetic management are to avoid significant increase in ICP, maintain cerebral perfusion pressure, avoid haemodynamic instability, enable intraoperative neuro-monitoring and ensure the early detection and management of complications (Domaingue 2005).

Haemodynamic instability during induction and positioning should be avoided and interruptions in monitoring during positioning minimized. Remifentanil can be used in patients with elevated ICP to reduce the stress response to intubation. Either an inhalation or an i.v. technique can be used for the maintenance of anaesthesia, but nitrous oxide should be avoided, particularly in patients with a high risk of VAE or pneumocephalus. Any unexpected haemodynamic change or instability should be notified to the surgeon immediately because it may indicate close surgical proximity to vital centres. Normothermia should be maintained throughout. Careful observation of blood loss and volume status of the patient should be ensured.

CONCLUSION

In conclusion, although supporters and opponents of the semi-sitting position during neurosurgery are equally passionate in their argument for their preferred approach, the semi-sitting position in posterior fossa surgery makes the surgical field optimal for surgery. Although the experience is limited, even patients with PFO can be operated on safely in the semi-sitting position. However, it is crucial that an experienced team institute appropriate preventive and remedial measures by while using this approach lest catastrophe occurs.

REFERENCES


