Outcomes Following Severe Venous Air Embolism in Neurosurgical Patients in the Sitting Position

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Background

- Venous air embolism (VAE) is a known complication of procedures performed in the sitting position.
- Perioperative sequelae following VAE varies. Mild VAE events may be transient—without the need of clinical intervention. However, severe VAE may lead to hemodynamic collapse, respiratory failure, or neurologic deficits.
- The incidence of, and outcome following, severe VAE is not well described.

Objectives

Objective 1:

- Identify and characterize incidents of severe venous air embolism within patients
- Describe outcomes following severe VAE

Objective 2:

- Characterize the use and utility of long-arm central venous catheters in the management of severe VAE

Methods

- After Institutional Review Board approval, the medical records of patients having neurosurgical procedures performed in the sitting position at Mayo Clinic Rochester between January 2000 and October 2013 were identified.
- From these records, both the corresponding neurosurgical operative reports and anesthetic records were searched for VAE using the Mayo Clinic Anesthesia Data Mart
- Patient records were then manually reviewed for the occurrence of VAE, as well as severity of the event. **Severe VAE** were classified as a VAE causing (1) significant hemodynamic compromise (i.e. requiring vasopressors to maintain blood pressures within 20% of baseline) (2) necessitating emergent surgical closure and (3) return to supine positioning.

Figure 1: Sitting Positions

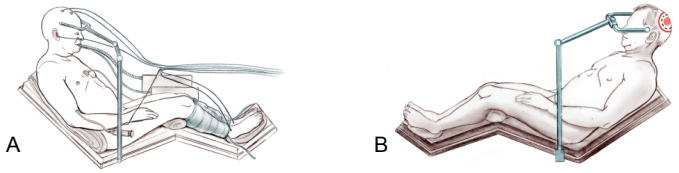

Figure 1. Images depicting sitting position at our institution. (A) Sitting position for patients undergoing deep brain stimulator placement or exchange. **(B)** Sitting position for undergoing craniotomy or cervical laminectomy

Results

- Overall, 1889 patients underwent neurosurgical procedures in the sitting position.
- A total of: 336, 1027, and 526 patients underwent deep brain stimulator (DBS) lead implantation, cervical spine, and craniotomy procedures in the sitting position, respectively.
- Of these, 5 patients were placed in the supine position intraoperatively due to severe and continued VAE (see Table 1)

Table 1. Outcomes following severe venous air embolism in neurosurgical patients in the sitting position

	Surgical Procedure			Postoperative Outcomes			
		Intervention					
Patient, Sex, Age (yr)	Operation	Surgical	Anesthesia	New Neurologic Deficit	Attributed to VAE?	In-Hospital complications	Hospital Discharge (days)
Male, 68	Cerebellar tumor resection	Irrigation, Bone Wax; Emergent closure &	4 cc air aspirated from CVP; N2O off; Jugular pressure; PFO diagnosed on TEE; supine positioning	Seizure POD 2	No	None	POD 18
Female, 43	Suboccipital angioma resection	Irrigation & packing of surgical field; supine positioning	CVP aspirated but no air removed; Jugular pressure; ACLS resuscitation	None	No	None	POD 4
Female, 53	Chiari malformation correction	None documented	CVP aspirated but no air removed; PEEP increased; Supine + Trendelenberg	None	No	None	POD 3
Female, 35	Cerebellar tumor resection	Bone wax; soaked sponges; Emergent closure.	Emergent supine positioning	None	No	Patient completed procedure POD 2	POD 5
Female, 74	Deep brain stimulator placement	Removal of equipment; wound stapled	Pressors given; Supine positioning + Trendelenburg	None	No	None	POD 2

Table 1. Case series describing patients who met Severe VAE criteria from January 2000 to October 2013. CVP = Central Venous Pressure monitor. N2O = Nitrous Oxide. PFO = Patent foramen ovale. TEE = transesophageal echocardiogram. ACLS = Advanced Cardiac Life Support. PEEP = positive end expiratory pressure. POD = Post Operatve day

Discussion

- This is the largest retrospective studies examining the intraoperative and postoperative outcomes of patients undergoing a neurosurgical procedure in the sitting position.
- The incidence of severe VAE in any neurosurgical procedure in the sitting position was overall rare, at approximately 0.30%. Most VAE events were mild, and of no clinical significance.
- No severe VAE occurred in patients undergoing cervical laminectomies in the sitting position.
- Patients in this cohort experienced no long-term neurologic consequences and were uneventfully discharged from hospital.
- Due to the small cohort of patients who fit this category, it is difficult to predict prognosis.
- The use of a long-arm central line in a severe VAE may not affect outcomes in the intraoperative or postoperative setting.

Conclusions

- The incidence of severe VAE during neurosurgical procedures in the sitting position is rare.
- With appropriate expectant management, the risk of long-term sequelae following severe VAE is exceedingly low

References

1. Jadik S, Wissing H, Friedrich K, Beck J, Seifert V, Raabe A. A standardized protocol for the prevention of clinically relevant venous air embolism during neurosurgical interventions in the semisitting position. *Neurosurg*. 2009 Mar, 64(3): 533-8.
2. Matjasko J, Petrozza P, Cohen M, Steinberg P. Anesthesia and surgery in the seated position: analysis of 554 cases. *Neurosurg.* 1985 Nov; 17(5): 695-702.