Sitting Position for Removal of Pineal Region Lesions: The Helsinki Experience

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Key words
- Air embolism
- Craniotomy
- Hemodynamics
- Pineal tumors
- Position

Abbreviations and Acronyms
CT: Computed tomography
$ETCO_2$: End-tidal carbon dioxide
HES: Hydroxyethyl starch
ITSC: Infratentorial supracerebellar route
PEEP: Positive end-expiratory pressure
SAP: Systolic arterial pressure
SD: Standard deviation
SpO_2: Arterial saturation of oxygen
VAE: Venous air embolism

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OBJECTIVE: **To present a summary of anesthetic considerations for use of the sitting position in procedures to remove lesions of the occipital and suboccipital regions, with a special reference to the Helsinki experience with more than 300 operations in 1997–2007, and a retrospective study evaluating the incidence of venous air embolism (VAE) and hemodynamic stability in patients operated in the steep sitting position.**

METHODS: **Anesthesiology reports of 72 patients with a mean (± standard deviation [SD]) age of 33 years ± 18 treated by the senior author (J.H.) for pineal region tumors using the infratentorial supracerebellar approach in the sitting position during an 11-year period were retrospectively reviewed for the incidence of VAE and hemodynamic stability.**

RESULTS: **In the sitting position, median systolic blood pressure changed −8 (−95 to +50) mm Hg without alteration in heart rate. Based on patient records, the incidence of VAE was 19% (14 of 72 patients). In five patients, end-tidal carbon dioxide ($ETCO_2$) decreased more than 0.7 kPa (5.25 mm Hg), possibly indicating VAE. Comparing patients with and without VAE, no differences in change of blood pressure, heart rate, or amount of administered vasoactive agents were observed. Postoperative duration of ventilator treatment and hospital stay were similar in patients with and without VAE. No signs of arterial embolization were seen postoperatively.**

CONCLUSIONS: **The sitting position is associated with risk for hypotension. The same surgical approach and procedure does not exclude the occurrence of VAE. In this study, the unaltered hemodynamics in patients during VAE indicates relatively small VAE. Possible explanations for this are early recognition of air leakage and good cooperation between the surgical and anesthesia teams.**

INTRODUCTION

The sitting position provides good surgical conditions for suboccipital craniotomy (17), but because of the potential for complications, such as venous air embolism (VAE), hemodynamic instability, facial and tongue edema, nerve damage, quadriparesis, and pneumocephalus (37), use of the sitting position has declined over the years (13, 31). The advantages of the sitting position are obvious, however: The intracranial pressure is lower than in other positions, the risk of bleeding decreases, and a clean surgical field produced by outflow of the fluids provides the neurosurgeon with a straightforward access to deeply located lesions, such as those of the pineal region.

Hemodynamic instability and VAE with a risk for paradoxic air embolism are the major concerns related to the sitting position. VAE, diagnosed by precordial Doppler ultrasound monitoring, has been reported to occur in 25%–50% of patients undergoing craniotomy in a sitting position (8, 14, 31). An incidence of VAE of 76% has been shown using transesophageal echocardiography (30).

The hemodynamic changes during VAE vary and are related to the amount and the rate of air entering the circulation (20). VAE has been reported to increase pulmonary artery pressure, but only a large volume of air (1 mL/kg or 2 mL/kg) decreases systemic arterial pressure as shown in experimental studies (20, 21). The results of the effect of VAE on the arterial blood pressure are controversial: Bithal et al. (4) showed hypotension in association with VAE in one third of adult and pediatric patients, but in a study by Leslie et al. (22), patients with VAE were not more at risk for hemodynamic instability than patients without VAE. Also, the sitting position itself may cause hypotension, but as reported by Rath et al. (33), hypotension occurred similarly in patients undergoing posterior fossa surgery in a lateral position. Hypotension induced by the upright position during anesthesia with concomitant decrease in cardiac output may compromise cerebral and myocardial perfusion (6, 24), and VAE may disturb the hemodynamic status further. VAE can pass into the systemic arterial circulation resulting in ischemia of vital organs (16, 23, 28).

Careful surgical technique and observa-

tion of the surgical site are of utmost importance in the prevention of VAE, although the effect of surgical technique per se on the incidence of VAE is unknown. We present a summary of anesthetic considerations for the sitting position, with a special reference to the Helsinki experience with more than 300 operations in 1997–2007. The technical report is complemented by a retrospective study evaluating the incidence of VAE and hemodynamic stability in patients operated in the steep sitting position. We excluded the possible impact of various surgical indications and approaches for craniotomy by selecting patients with pineal tumor operated on by one surgeon (J.H.) by the infratentorial supracerebellar route (ITSC) (17). We hypothesized that the incidence of VAE with hemodynamic alterations is lower than reported previously in heterogeneous patient groups. The surgical considerations have been published earlier (17).

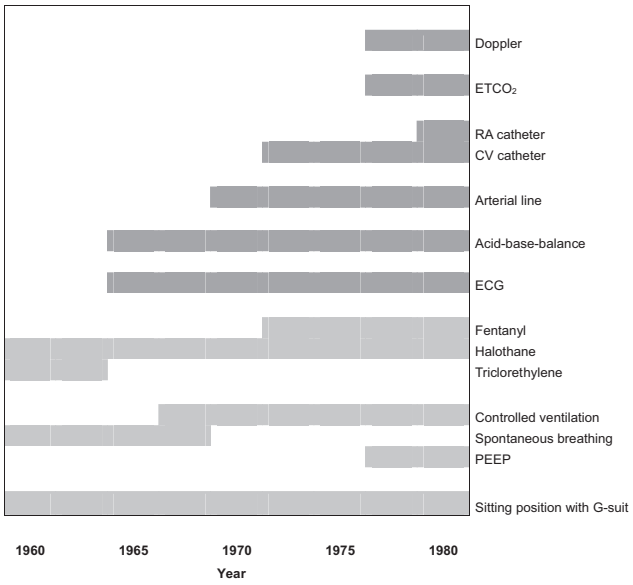

Figure 1. Evolution of management of patients operated on in the sitting position in Helsinki University Hospital. CV, central venous; ECG, electrocardiography; G-suit, antigravity suit; PEEP, positive end-expiratory pressure; RA, right atrial.

METHODS

Patient Selection

The sitting position has been used in the Helsinki Neurosurgical Department in selected cases of posterior fossa surgery since the 1930s. All acoustic neurinomas were operated on in an upright position from the early 1960s to the end of the 1980s (**Figure 1**). The general perioperative anesthesiology principles in the management of patients undergoing posterior fossa surgery in the sitting position in our hospital were revised according to recommendations in the literature and available monitoring techniques (**Figure 1**) but have been unchanged since the early 1990s. In 1997, the sitting position was changed to a steeper sitting position with the patient's back elevated to approximately 90 degrees to provide better surgical conditions compared with the earlier position. The feet-up positioning with a pillow under the patient's knees is used to increase central venous pressure. Also, a protocol for the sitting position was implemented so that surgical and anesthesia teams are aware of the requirements for the sitting position (**Figure 2**). Intermittent jugular venous compression on a suspicion of VAE was implemented to facilitate the localization of the leak. Even before 1997, our standard care for a patient in the sitting position included intraoperative monitoring with end-tidal carbon dioxide ($ETCO_2$) and precordial Doppler, fluid loading, and use of an antigravity suit to avoid VAE and avoiding nitrous oxide and hyperventilation to diminish the complications of VAE. The use of central venous and right atrial catheters was abandoned before 1997.

The general contraindications and our exclusion criteria for the sitting position are ventriculoatrial shunt, severe congestive heart failure, uncontrolled hypertension, cerebral ischemia when upright and awake, extreme ages (<6 months or >80 years), known open foramen ovale, and right atrial pressure greater than left atrial pressure. Also, the neurosurgeon and the anesthesiologist discuss selected individual cases to optimize the surgical conditions without compromising the patient's medical status because of improper positioning.

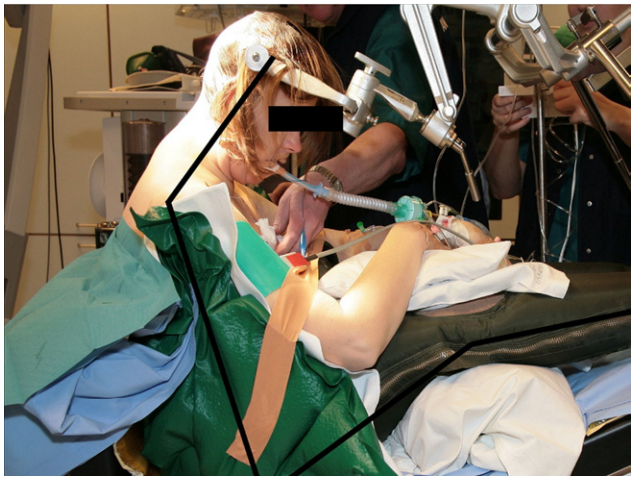

Figure 2. Patient in the steep sitting position with end-tidal carbon dioxide ($ETCO_2$) monitoring, precordial Doppler, and antigravity suit.