contractures. Stimulation of the orbicularis oculi muscle can provide a reliable trend for monitoring neuromuscular paralysis, but may underestimate the degree of neuromuscular blockade of other muscles.\textsuperscript{10}

This patient presented with both an airway that appeared difficult to manage and a history of gastroesophageal reflux. General anesthesia or sedation prior to endotracheal intubation might have resulted in inability to ventilate the lungs or in aspiration of gastric contents. An awake intubation with local anesthesia was planned. Physical restraint was not necessary because of marked immobility due to the patient's disease. Several reports have described unique methods to establish and maintain a patent airway in pediatric patients.\textsuperscript{8-10} The need to inspect her larynx for tissue hyperplasia made tracheal intubation assisted by fiberoptic visualization ideal. A 3.2-mm pediatric fiberoptic bronchoscope can be inserted through tracheal tubes with an internal diameter of 4.5 mm and larger.\textsuperscript{9,10} A 4.5-mm tracheal tube was too large for our patient and likely would have caused laryngeal trauma. We inserted a soft-tipped guide wire through the suction port of the bronchoscope to use as a guide for the tracheal tube. The technique allowed laryngeal visualization to confirm correct tube placement and could be used to pass any size endotracheal tube.\textsuperscript{10}

In summary, juvenile hyaline fibromatosis is an unusual disease with profound anesthetic implications. Assessment of multiple organ involvement, uneventful tracheal intubation assisted by placing a guide wire through a pediatric bronchoscope, care in positioning, and appropriate neuromuscular monitoring all led to an uneventful outcome.

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Venous Air Embolism in the Recovery Room Producing Unexplained Cardiac Dysrhythmias: A Case Report

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Venous air embolism is a well-known complication of neurosurgical procedures performed upon patients who are in the sitting position but has also been reported during head and neck surgery, total hip replacement, cesarean section, and other surgical procedures.\textsuperscript{1-3} The authors are unaware of any previous report of this complication occurring in a patient in the recovery room. We report a case of venous air embolism in the recovery room initially manifest as unexplained cardiac dysrhythmias in a patient recovering from general anesthesia for posterior cervical fusion.

REPORT OF A CASE

A 14-yr-old female sustained an odontoid fracture without neurologic damage in a motor vehicle accident. Despite immobilization in a halo vest since the time of injury, the fracture did not heal. Four months after sustaining the injury, the patient was admitted to the hospital for elective C1-C2 fusion. The patient's past medical history was unremarkable with the following exception: while being observed in the intensive care unit at the time of the initial injury, unifocal PVCs were noted. Antidysrhythmics were not required, and the ectopy resolved

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seemed greatest during inspiration. After placing betadine-coated gauze pads over the original screw sites, Doppler sounds of venous air embolism were no longer heard. The frequency of ectopic beats decreased dramatically, but a rare PVC, less than 1 beat per min was still observed. Three of the four original screw sites were covered with betadine ointment and a bandage. The muscle and soft tissue overlying the old left anterior screw site was closed with suture; during removal from the site intraoperatively, this screw was noted to be inserted deeper than normal and had likely perforated the inner table of the skull.

Despite venous air embolism and dysrhythmias, the patient at no time became hypotensive. Chest x-ray was unremarkable and 12-lead ECG showed no evidence of myocardial ischemia. The trachea was extubated and the remainder of the recovery room stay was uneventful. The patient was observed in the intensive care unit overnight. Rare unifocal PVCs were observed while in the ICU but resolved by the next morning. ECG, serial cardiac enzymes, and echocardiogram obtained on the first postoperative day were normal.

**DISCUSSION**

Venous air embolism can occur whenever a noncollapsible venous channel is open to the atmosphere and a negative pressure gradient exists between the vessel opening and the right atrium. Neurosurgical patients operated upon while in the sitting position are at risk for venous air embolism intraoperatively because the surgical site is located above the level of the heart. Most commonly, air entrainment occurs from a site within the operative field. However, sites remote from the operative field such as burr holes and pinion sites of neurosurgical head holders have been identified as the source of air entrainment during sitting neurosurgical procedures. Air entrainment from screw sites of a halo frame might be expected if this patient had experienced VAE in the sitting position.

What is most significant in this case is the occurrence of VAE with the patient in the supine position and manifest initially in the recovery room as cardiac dysrhythmias.

With the patient supine, the hydrostatic pressure gradient between the original anterior screw sites and the right atrium must have been close to zero. We postulate that a negative pressure gradient was created between the screw site(s) and right atrium as a result of negative intrathoracic pressure generated during inspiration. In spontaneously breathing subjects, during inspiration a negative pressure gradient is created between intrathoracic and extrathoracic structures. It is likely that this same pressure gradient that is necessary for airflow into the lung during inspiration was responsible for air entrainment into open venous channels at the original screw sites. This phenomenon has been demonstrated in experimental animals. In supine, spontaneously breathing dogs with a catheter in the external jugular vein and left open to the atmosphere, air entrainment was observed during inspiration.

This mechanism of air entrainment helps to explain why VAE and the associated dysrhythmias were not manifest until arrival in the recovery room. Neuromuscular
blockade was not reversed until just prior to transfer to the recovery room. With conversion from controlled ventilation, during which intrathoracic pressure is never less than atmospheric, to spontaneous ventilation, in which intrathoracic pressure is less than atmospheric during inspiration, the problem of venous air entrainment developed. Because the patient was transported to the recovery room without ECG monitoring, cardiac dysrhythmias were unrecognized until ECG monitoring was resumed in the recovery room.

Common causes of cardiac dysrhythmias such as hypoxia, hypercarbia, anemia, hypo- or hyperkalemia, and myocardial ischemia were immediately ruled out after arrival in the recovery room. Michenfelder has reported that common dysrhythmias associated with VAE are PVCs and bigeminy, both of which occurred in our patient. However, only after excluding the common causes of dysrhythmias did we consider the possibility of VAE. The diagnosis of VAE was confirmed using a precordial Doppler. The precordial Doppler has been shown to be one of the most sensitive monitors for VAE. Doppler sounds were most intense during inspiration and gradually cleared during expiration and between breaths. Although air was most likely being entrained by the patient during inspiration, changes in the intensity of Doppler sounds during the respiratory cycle may also have been due, at least in part, to positional changes of the Doppler relative to cardiac structures. Because air was no longer heard on the Doppler and the cardiac dysrhythmias resolved after the left anterior screw site was occluded, suggests that air entrainment occurred from scalp veins or diploic veins in this area.

This case demonstrates several important points. Episodes of venous air embolism are not restricted to the intraoperative period and can occur during spontaneous respiration in patients in the supine position. Also, one should consider VAE in the differential diagnosis of cardiac dysrhythmias in patients with exposed venous channels when other more likely etiologies have been ruled out. Finally, the importance of patient monitoring during transport is reemphasized.

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Fiberoptic Intubation Complicated by Pulmonary Edema in a 12-Year-Old Child with Hurler Syndrome

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Hurler syndrome (mucopolysaccharidosis storage disease, Type I-H) is an inherited progressive metabolic disorder. The tongue, tonsils, adenoids, and nasopharyngeal tissues are hypertrophic in these children and may cause upper airway obstruction. Micrognathia, a very short neck, and restricted motion at the temporomandibular

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