Challenges in Pediatric Neuroanesthesia

Awake Craniotomy, Intraoperative Magnetic Resonance Imaging, and Interventional Neuroradiology

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KEYWORDS

• Pediatric • Intraoperative magnetic resonance imaging • Awake craniotomy
• Neurointerventional • Neuroendovascular • Pediatric neuroanesthesia

KEY POINTS

- There are many complexities to the care of children undergoing awake craniotomies.
- The anesthesiologist must be prepared to deal with a variety of urgent and emergent intraoperative scenarios.
- When the techniques of cortical mapping are combined with an awake, responsive patient, optimal outcomes can be realized.
- Intraoperative magnetic resonance imaging offers high-resolution intraoperative images that can assess the extent of resection in pseudoreal time.
- Angiography and embolization are frequent procedures performed in the neurointerventional suite to address a variety of pediatric neurovascular lesions.

INTRODUCTION

Anesthesiologists involved in caring for children undergoing neurosurgical procedures are required to have an intimate understanding of normal neurocognitive development, the effects of anesthetics on the developing nervous system, the fundamental differences between children and adults, and the implications of these surgical approaches to children. Several surgical approaches such as image-guided procedures and awake craniotomies add to the complex environment faced by the anesthesiologist. In addition, the neurointerventional suite has become increasingly used as

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children with a variety of neurovascular lesions present for often lengthy and complicated procedures for definitive diagnosis or treatment. Planning and executing safe, age-appropriate perioperative care in these environments is challenging. This article offers some insight into the complexities of care of children undergoing awake craniotomies as well as procedures in intraoperative magnetic resonance imaging (iMRI) suites and neurointerventional radiology.

AWAKE CRANIOTOMY

History of Awake Craniotomy

Evidence of craniotomy predates the invention of surgical anesthesia by several millennia. There is evidence of trepanation (creating a hole through the skull and dura) in human skulls unearthed in France from approximately 6500 BC.[1] In addition, it is clear that several pre-Columbian societies in Mesoamerica practiced trepanation, most notably, the Incas.[2,3] During the Middle Ages and Renaissance in western Europe, trepanation was performed to alleviate headaches and seizures.[4] Dutch painter Hieronymus Bosch famously captured this practice in his painting, *The Extraction of the Stone of Madness*, from the late fifteenth century.

The modern use of awake craniotomy (AC) began in the second half of the nineteenth century, when local anesthetics became widely available. With good local anesthesia, Horsley was able to perform ACs.[5] However, the modern understanding of the benefit of AC began in 1951, when Wilder Penfield, the first director of the famous Montreal Neurologic Institute, published his landmark monograph, *Epilepsy and the Functional Anatomy of the Human Brain*.[6] Penfield described the use of craniotomy performed under local anesthesia only to facilitate resection of epileptogenic foci. Before resection, Penfield stimulated various locations of the cortex and observed the responses in the awake patient. This practice allowed him to generate cortical maps of motor and sensory areas, which result in cortical homunculus.

The 1960s brought the advent of neuroleptic anesthetic techniques, which continued to provide a responsive patient but offered some degree of analgesia and sedation in order to tolerate prolonged awkward positions.[7] A combination of drugs such as droperidol and fentanyl were commonly used to facilitate a patient who was drowsy and comfortable, yet still able to arouse to stimulation and follow commands. The downside of prolonged use of dopaminergic drugs became apparent when the occurrence of side effects, including extrapyramidal effects and dysphoria, was noted.

AC as a method of treating seizure foci and tumors became popular again in the 1990s and early 2000s, with the widespread use of shorter-acting hypnotic agents and opioids, such as propofol and remifentanil.[8,9] Current anesthetic techniques use a wide range of agents. Dexmedetomidine, an α_2 agonist with sedating and analgesic properties, is a relatively newer drug that offers some distinct advantages over other techniques using sedative hypnotics and opioids.[10,11] One of the most advantageous aspects of dexmedetomidine is its ability to offer mild analgesia and good sedation without compromising the airway.

AC in Children

Equipment

No special equipment is needed for the performance of AC. The anesthesiologist should have the operating room (OR) prepared for the same problems that may be encountered during a craniotomy under general anesthesia. Invasive blood pressure monitoring is useful. The anesthesiologist should be prepared to convert to a general anesthetic if needed. Airway management while the patient is in head pins can be