Eyes wide open: The awake craniotomy for tumour resection: A review

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Abstract

The awake craniotomy procedure has become the gold standard for tumour resection in eligible patients. In this paper, the awake craniotomy procedure is reviewed, including the advantages of the procedure over the standard craniotomy procedure. The role of the neuroscience nurse in awake craniotomies is highlighted.

Introduction

The use of the awake craniotomy procedure for brain mapping began in the 1950s at the Montreal Neurological Institute by the Canadian pioneer, Dr. Wilder Penfield. His work, in mapping the brain, led to understanding the function of the areas of the cerebral cortex, known today as the Somatosensory Map (Bulsara, Johnson, & Villavicencio, 2005). Today, awake craniotomy is used for tumour resection, allowing patients a faster recovery, a shortened length of hospital stay, a decline in post-operative complications, and a higher satisfaction rate (Bernstein, 2001; Berkenstadt, 2001; Bhardwaj, 2002). In this paper, the awake craniotomy procedure is described. A detailed account of the operative phase will be given and the nursing care of the patient undergoing the awake craniotomy will be discussed. Very little information currently exists in the literature regarding nursing care during and after this procedure.

Review of the literature

Penfield’s work with intractable epilepsy led him to the discovery of the “asleep-awake-asleep” technique (Berkenstadt, 2001; Blanshard, 2001; Meyers, 2001; Taylor & Bernstein, 1999) that is now used in anesthesia to enable the surgeon to speak with an alert patient during cortical mapping. It was essential that Penfield’s patients be alert so that, as an electrical stimulant was applied to specific areas on the cerebral cortex, he could elicit a reaction or aura in his patients. This response indicated the area of the cortex responsible for the seizure and, thus, it could be removed or destroyed. Penfield used this simple technique to map the brain into its corresponding body parts. A diagrammatical figure or homunculus was created to demonstrate that the face, lips, tongue and hands have far more innervation on the cerebral cortex than any other parts of the body. Penfield also discovered that the human brain’s surface cortex corresponds to physical anatomy and is influenced by the motor and sensory experiences of the individual (Bulsara, Johnson, & Villavicencio, 2005). For example, an artist’s motor cortex would be highly evolved and reorganized to reflect the practices of a musician, painter, or dancer. The eloquent areas of the cortex such as the motor strip, Broca’s area (receptive speech) in the dominant hemisphere, and Wernicke’s area (expressive speech) were also defined and could be avoided during surgery in order to prevent impairment of these functions.

With a trend in health care towards a shorter length of stay (LOS), use of less-invasive treatments, and the evolution of imaging technology, the awake craniotomy procedure has gained favour not only in epilepsy treatment, but also brain tumour resection from eloquent areas, Parkinson’s dystonia, and even heroin addiction (Bernstein, 2001; Bhardwaj, 2002).

The basic advantage of keeping a patient awake while performing intricate neurosurgery is obvious. Mapping prior to cutting can prevent unnecessary damage to the functionally important or eloquent areas of the brain. When compared to the standard craniotomy procedure, the awake procedure also reduces the intensive care unit (ICU) stay and shortens total LOS to about two to three days (Bhardwaj, 2002; Bernstein, 2001; Blanshard, 2001; Meyers, 2001; Taylor & Bernstein, 1999). During an awake craniotomy, patients do not require intubation or ventilation and are free of an indwelling urinary catheter.

In contrast, the standard craniotomy procedure requires a longer LOS of about five to seven days, and patients require monitoring in the ICU because of the risk of developing a post-operative hematoma. A longer ICU stay was often necessary as patients had to be weaned from the ventilator or were intubated to protect their airway or manage secretions. A longer ICU stay was characterized by a decreased level of consciousness (LOC), increased intracranial pressure (ICP), and greater incidence of motor deficits, seizures, and infection (Sarkissian, 1995). In addition, patients with an indwelling urinary catheter were more likely to suffer a urinary tract infection (UTI), with risk of infection rising as much as 10% each day. UTIs are associated with prolonged hospital stay, use of antibiotics, increased mortality, and increased costs associated with hospital stay (Kuinin, 2001; Saint & Lipsky, 1999; Parkin & Keeley, 2003). Intravascular devices such as intravenous (IV), or central venous pressure lines (CVP) placed patients at risk for infections and colonization with resistant micro-organisms (Struelens, 1998). Immobility coupled with malignancy potentiates hypercoagulability and the development of deep vein thrombosis (DVT) and pulmonary embolus for the post-operative brain tumour patients (Goldhaber, 2002; Warbel, 1999). Early mobility and discharge reduces the incidence of these nosocomial complications (Bernstein, 2001).

It is, however, important to note that not every brain tumour patient is eligible for an awake craniotomy. Bosek (2004) and Taylor and Bernstein (1999) described patients with acute increases in ICP, sleep apnea, obesity, emotional instability, decreased LOC, or a difficult airway as ineligible for this procedure. Tumours in the low occiput also were excluded as operative positioning limited patient interaction. Additionally, patients who were dysphasic or had a language barrier could not be properly assessed during the mapping and were also ineligible.
Pre-operative preparation
While informed consent requires the neurosurgeon to psychologically prepare the patient for this procedure, anesthesiology’s challenge is to provide suitable conditions for surgery by keeping the patient calm and cooperative without jeopardizing their safety and comfort during surgery. A pre-operative meeting between patient and anesthesiologist allows a degree of rapport to evolve. Nurses’ contributions to the pre-operative preparation of the patient, including allaying anxiety and providing useful discharge information, are not yet widely utilized in the pre-admission education or screening of eligible patients (Zanchetta & Bernstein, 2004). Since the LOS for patients is greatly shortened, a supportive and attentive family member was needed to supervise the patient after discharge following an awake craniotomy.

A stealth magnetic resonance imaging (MRI) is a necessity immediately before the surgical resection (Bernstein, 2001; Blanshard, 2001; Meyers, 2001; Taylor & Bernstein, 1999). Stealth technology allows the surgeon a three-dimensional view of the lesion using MRI imaging and intra-operative cameras. Fiducial markers are placed on the patient’s head prior to imaging. After the MRI imaging is obtained, the fiducial points are registered with an intra-operative camera and then automatically calibrated by stealth technology to produce the 3-D image coordinates for the surgeon (Bosek, 2004).

Intra-operative care
The surgical procedure of an awake craniotomy lasts from three to six hours, somewhat longer than a standard craniotomy. However, as the surgeon’s expertise develops, this time may be reduced (Taylor & Bernstein, 1999). Patients are positioned in a “beach chair” position, which allows them to be supine and lateral, with head of the bed at 20 degrees and facing the anesthesiologist. Elevation of the head promotes gravitational drainage of blood and cerebrospinal fluid (CSF) while minimizing bleeding. This position also provides excellent operative access for the surgeon (Bosek, 2004; Taylor & Bernstein, 1999). Draping of operative linen is done such a way as to allow for eye contact between patient and anesthesiologist. This allows for constant communication between the two, so that the patient is aware of the progress of the surgery and to allow reactions to stimulation of the cortex to be observed.

The anesthesiologist’s role with a patient undergoing an awake craniotomy is to advocate for the patient, as well as administering all medications, monitoring vital signs and assessing patient comfort throughout the procedure. Antibiotics, antiemetics and steroids are given at the start of the surgery. The asleep-awake-asleep anesthesia technique (Huncke, 1998) is used to begin the process of opening the skull. Additionally, local anesthesia may be injected along the incision lines and into the dura leaflets. Soft music may lend to a more relaxed atmosphere for the patient and operating room staff. In most cases, no indwelling urinary catheter is used during the procedure and the patient is encouraged to void before surgery (Taylor & Bernstein, 1999). In other cases, the indwelling catheter is inserted immediately before surgery and removed in the recovery room (Meyer, 2001). The catheter is conjectured to cause irritation and restlessness in patients who are awake. The patient may be offered sips of water during the procedure and male patients can be offered a urinal for voiding for comfort. A full bladder may necessitate catheterization in a female patient. Further comfort measures for the patient, such as warm blankets, decreasing conversation between staff and reduction of noise in the operating room, results in a less stressful experience for the patient (Berkenstadt & Ram, 2001).

Asleep-awake-asleep anesthesia
Prior to surgery, the patient is commonly given propofol, Versed, and remifentanil through an intravenous line. This sedates the patient to allow the surgeon to begin the supraorbital nerve blocks, which are very painful, and the application of the Mayfield pins and frame that will hold the head in position throughout the procedure. The patient is first awakened by adjusting the propofol infusion. The skull is then opened. Although this procedure is somewhat noisy, it is painless. The dura is sensitive in some patients and opening the dura may require increased propofol to delicately balance comfort, sedation and responsiveness. Brain mapping and tumour resection is performed while the patient is awake since the brain itself has no nociceptors for pain. The patient is then put back to sleep with neurolept, propofol and opioid sedation while closure of the dura and skull is undertaken (Huncke, van der Wiele, Fried & Rubinstein, 1998; Bernstein, 2001; Blanshard, 2001; Meyers & Bates, 2001, Berkenstadt & Ram, 2001; Taylor & Bernstein, 1999).

Anticipating intra-operative complications
Various problems can be encountered during the awake craniotomy procedure. Anticipating the complications allows the anesthesiologist, the neurosurgeon, and the neuroscience nurse to manage the intra-operative phase of this procedure smoothly, and provide comfort and safety for the patient (Bosek, 2004). The provision of antiemetics on induction prevents nausea and vomiting. Propofol, given intravenously, allows a restless patient to be given more sedation easily. While an intra-operative focal seizure is a possibility given the cortical stimulation that occurs during the procedure, cold water applied to the cortex has been shown to alleviate seizures. Cerebral edema or a “tight brain” can be treated with hyperventilation or diuretics. Airway difficulties are always a possibility with an unprotected airway, supine patient and heavy sedation with increasing ICP. An awake patient poses another challenge to the surgical team, as the need for conversion to general anesthesia could arise. Venous air embolism is a potentially fatal complication. Venous air embolism may occur when the head is above the heart, creating negative pressure in the dural venous sinuses and veins draining the brain. Air is then quickly carried to the heart, resulting in cyanosis, respiratory distress, tachycardia or circulatory shock (AANN, 2006; Balki, 2003). A sitting position has been associated with increased risk of venous air embolism. Venous air embolism can be managed by immediately flooding the cerebral cortex with normal saline and placing the patient in a Trendelenburg position (Balki, 2003; Blanshard, 2001; Berkenstadt, 2001).

Disadvantages of the awake craniotomy
To summarize, an awake craniotomy may take longer to perform and is associated with a higher incidence of seizures, nausea or vomiting and emotional distress. Additionally,
although rare, venous air embolism due to positioning has also been reported (Taylor & Bernstein, 1999; Bernstein, 2001; Bosek, 1999).

**Post-operative management**

Bhardwaj and Bernstein (2002) effectively demonstrated that clinically and radiographically significant complications occur within the first four hours or after 24 hours post-stereotactic brain biopsy. This finding lays the groundwork for a same-day discharge for the awake craniotomy as described by Zanchetta and Bernstein (2004), Blanshard (2001) and Bernstein (2001), who routinely discharge patients as early as six hours post-operatively. Despite the evidence their reports provide, to this author’s knowledge, Toronto’s University Health Network, Toronto Western Hospital site, is the only hospital in the world following this practice of early discharge. Most sites, including this author’s, employ conservative post-operative care, with patients usually managed in the ICU for 24 hours to observe for any neurological deterioration due to cerebral edema, intracranial hemorrhage, hematoma or seizures. Nausea and vomiting occur less often in the awake craniotomy population when compared to the standard craniotomy procedure, especially so in the first four hours (Manninen, 2002; Verchere, 2002). Observation for changes in blood pressure and pain control is also important. Typically, patients spend 24 to 48 hours in hospital prior to discharge.

**Implications for nursing care**

The brevity of the length of stay for awake craniotomy patients requires nursing assessment for changes in level of consciousness, development of hematoma, intra-cerebral hemorrhage or seizures in the post-operative phase so that patients are safely discharged with the least risk for developing complications at home. Pain at the surgical site and headache can be managed successfully following the awake craniotomy with oral analgesics. Zanchetta and Bernstein (2004) established that nursing played an integral role in this patient group’s successful recovery. They identified nursing’s role in explaining, interpreting and reinforcing information for patients. Health teaching is a necessary prelude to discharge, effective pre-procedure and pre-discharge teaching, decreased complication rates and re-admission. Post-operative care should include written material and, for the same-day discharge group, access to after-hour resources.

Care of the surgical wound and signs and symptoms of infection and medications are key areas of discharge teaching. Staples are used in the standard closure of craniotomy wounds and are typically removed seven to 10 days post-operatively by the patient’s family doctor. If a subgaleal drain is used to collect CSF located under the skin near the craniotomy flap, it is generally removed on the first to second day post-operatively by the surgeon. Incision sites are assessed for the development of complications by observations of drainage, subgaleal fluid characteristics and incisional redness, swelling and warmth, as well as patient’s temperature.

Additionally, if medications upon discharge include the steroid dexamethasone, warn patients that this drug must not be stopped suddenly and to follow the tapering regimen if it is to be discontinued. Ensure that follow-up appointments with
neuro-oncology or radiation oncology (as necessary) and their neurosurgeon (six to eight weeks post-operatively) are in place as this demographical group may move on to further treatment with radiation and/or chemotherapy. In many cases, a post-operative film (CT or MRI) will be booked prior to the neurosurgeon’s follow-up appointment. Other patient concerns regarding driving, return to work and travelling following craniotomy may be addressed at this time. Generally, patients who have experienced a seizure may not drive for up to one year following the last seizure. The surgeon makes this determination and is required to report the patient’s medical condition to the Ministry of Transportation (CMA, 2000).

Referral to support groups and resources should include the Brain Tumor Foundation of Canada (www.btfc.org), the Canadian Cancer Society, WellSpring, local support groups and American counterparts (e.g. American Brain Tumour Association) as necessary.

References


In summary

The advent of ultra-short-acting hypnotic agents allowed anesthesiologists to monitor patients’ pain and sedation more effectively, thus allowing them to rapidly return patients to consciousness. This has brought the awake craniotomy procedure into favour over the last 15 years. The awake craniotomy procedure has been shown to be efficacious in reducing length of stay, complications and costs, and promoting a faster recovery, especially in the same-day discharge patient group. The nurse’s role in the peri-operative preparation has not been previously well-described in the literature. Patient satisfaction with the awake craniotomy procedure will be addressed in a future publication.

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