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Case Report Open Access

Awake Cranioplasty: A Case Series

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Abstract

Background: Cranioplasty restores the normal cranial architecture and protective functions of the skull and may play a role in normalizing cerebrospinal fluid dynamics in patients undergoing large craniectomies. It has a definitive impact on restoration of normal intracranial physiology and improvement of patient neurological condition. Anesthesia for awake neurosurgery procedure poses a unique challenge to anesthesiologists.

Objective: To present cases of awake cranioplasty and describe the principles of anesthetic management during this procedure.

Case description: 3 patients who have skull defect underwent cranioplasty procedure. Patients were managed with dexmedetomidine load of 1 mcg/kg over 10-15 min followed by infusion at rates of 0.2 mcg/kg/hr to 0.7 mcg/kg/hr and a local infiltration without airway instrumentation.

Discussion: Awake cranioplasty offers great advantages with respect to patient outcome. In this type of procedure, the anesthesiologist's goal is to make the operation safe and effective and reduce the psychophysical distress of the patient. Personal experience, careful planning, and attention to detail are the basis for obtaining good awake cranioplasty results. Dexmedetomidine is a highly specific α2 adrenoceptor agonist with sedative, analgesic, anesthetic sparing effect, awake if neither stimulated brain protection with no addiction effect nor suppress ventilation. Patients treated with dexmedetomidine will be sedated, comfortably but is easily aroused.

Conclusion: Awake cranioplasty procedures were successfully performed with stable hemodynamic intraoperative and no complications during procedure. Dexmedetomidine has been shown to provide sedation and analgesia without significant respiratory depression and has been used successfully in these settings.

Keywords: Analgesia; Awake cranioplasty; Dexmedetomidine; Sedative

Introduction

Craniectomy decompression is increasingly recognized as a valid and effective therapy in cases of increased intracranial pressure. The indications of this action are extensive, including post-traumatic brain swelling, intracranial hemorrhage, and postoperative complications [1,2]. Craniectomy essentially negates the Monroe-Kellie doctrine that regulates intracranial pressure, Cerebrospinal Fluid (CSF) dynamics, and ultimately cerebral blood flow and may cause some complications, including extra-axial fluid accumulation; Hydrocephalus, and sunken flap skin syndrome, also known as syndrome of the trephined. Various neurological symptoms are associated with hemispheric collapse such as headache, dizziness, fatigue, and psychiatric changes. Bone flap replacement has been shown to provide neurological improvement, mostly in motor function. Transcranial Doppler shows improvement in cerebral blood flow after cranioplasty [3].

Cranioplasty can protect the brain, and provide cosmetic results. But the most important thing is to improve the neurological deficit by decreasing local intracranial pressure and improving the dynamics of CSF changes. Cranioplasty can also affect postural blood regulation, cerebrovascular reserve capacity and glucose metabolism in the brain [4].

General anesthesia with endotracheal tube is an anesthetic technique that has been used in cranioplasty procedures. The goal of anesthesia management in cranioplasty is to maintain a slightly lower brain perfusion pressure to reduce blood loss and lower blood volume and intracranial tissue to help provide optimal surgery for surgeons [4].

Anesthesia for intracranial procedures requiring patients to remain conscious and cooperative is a challenge for anesthesiologists. Drugs administered during the course of action should be able to provide adequate levels of analgesia and sedation and do not affect the test for brain function and Electrocorticography (ECoG) [5,6]. Today the Awake Craniotomy procedure has been known. This procedure refers to surgery performed on the brain where the patient is in a conscious state and allows to cooperate during functional testing of the cerebral cortex [7]. This technique was originally introduced for surgical therapy in epilepsy patients by issuing epileptic focal and tumor

resection of the cerebral cortex that has a function (eloquent cortex) [8-10]. The advantage of the Awake Craniotomy procedure is the presence of a surgeon's chance to map the brain so that the route of operation more secure and able to reduce morbidity. In addition, it also has other advantages of avoiding general anesthesia and the use of invasive monitors that may decrease postoperative morbidity and shorten hospital length [5,8,11].

Anesthesia can be performed with a combination of droperidol and fat-soluble opioids called neurolept analgesia to indifference, immobilization and analgesia. Complications that often occur with these techniques are agitation, drowsiness, pain, and seizures. Further neurolept analgesia may lead to respiratory depression and sometimes $PaCO_2$ can reach 45-60 mmHg [5,12].

Some studies use propofol for awake craniotomy. The use of propofol reduces the occurrence of seizures and perioperative agitation, but frequent depression of the breath. More recently, the combination of propofol and remifentanil has been successful for brain mapping anesthesia. Both studies indicate the presence of episodes of respiratory depression, airway obstruction, and desaturation. In addition, large doses of propofol may increase glutamate exitotoxicity, have no brain-protective effect, and may cause more neuronal damage [11,12].

Dexmedetomidine is a α-2 agonist with the effects of sedation, analgesia and anesthetic sparring effect, wake-up when distimuli, not depressed breath, have a protective effect of the brain, and do not cause addiction so that the use of dexmedetomidine for awake craniotomy can be considered. The absence of a respiratory depression effect is the most important dexmedetomidine advantage compared to other anesthetic techniques for awake craniotomy. The recommended dosage is a dose of bolus 1 mcg/kg given within 10-15 min, then proceed with a maintenance dose of 0.2 mcg/kg/hr-0.7 mcg/kg/hr. Dexmedetomidine shows a decrease in blood pressure and heart rate in accordance with the magnitude of the dose but the changes are minimal [11,13,14].

This paper would like to report the procedure of cranioplasty by using the awake anesthesia technique as applied to the awake craniotomy procedure, as to date, no case reports have yet been discussed regarding awake cranioplasty.

Case Report

Case 1

A 59-year-old man weighing 70 kg and 165 cm in height was hospitalized for cranioplasty. Patient had a traffic accident history in October 2016 and was diagnosed with Severe Traumatic Brain Injury (TBI) Glasgow Coma Scale (GCS) 8 (E2M4V2) and intracerebral hematoma (ICH) reg temporoparietal dextra. Conducted ICH evacuation craniotomy at Undata Palu Hospital with general anesthesia (GA) without difficulties and complications.

Patients have no history of comorbid and allergic diseases. Physical examination is not found abnormalities. From the laboratory obtained WBC: 10.100/mm^3 without clinical manifestations. From a CT-Scan examination the head obtained an impression of skull defect the temporoparietal dextra region and the encephalomalacia of the dextra temporal region.

Patients with American Society of Anesthesiologists Physical status classification (ASA PS) 2 with Extended Glasgow Outcome Scale (GOSE) 8, diagnosed with cranial defect at right temporoparietal region scheduled for cranioplasty. Patients are planned to be anesthetized by the awake monitored anesthesia care method.

Preoperative preparation with premedication of Alprazolam 0.5 mg and Ranitidine 150 mg per oral night before surgery and patient was administered preoperative fasting for 8 h. Before undergoing the surgical procedure, an intravenous line was placed and given 1 gr ceftriaxone, 4 mg ondansetron, 50 mg ranitidine, 10 mg dexamethasone and 30 mg ketorolac intravenously one hour before surgery. The patient is taken to the operating room and positioned supine. Used standard ASA monitor, pulse oximetry, and noninvasive blood pressure. Installed binasal cannula with oxygen flow 2 ltr per min Urinary catheter was not inserted. Parameters of vital sign preoperative with blood pressure (BP) 130/80 mmHg, heart rate (HR) 52 times/min, spontaneous respiration 16 times/min with 99% saturation. Dexmedetomidine is administered at a loading dose of 1 mcg/kg intravenously for 15 min through a syringe pump. After loading, the dose of dexmedetomidine is reduced to 0.4 mcg/kg/hr. A local anesthetic injection was performed in the incision area using 25 mg Bupivacaine 0.25% + Epinephrine 1: 200.000. When infiltration, the patient complains of pain in the injection area. The dose of dexmedetomidine is titrated up to a dose of 0.65 mcg/kg/hr to obtain the desired analgesia sedation from dexmedetomidine administration. There is a significant decrease in pulse rate without any other vital signs changes. The operation lasted 60 min with a total bleeding of about 100 ml. Before the operation is completed, the dose of dexmedetomidine is reduced to 0.5 mcg/kg/h and titrated to 0.2 mcg/kg/h during recovery in post anesthesia care unit (PACU). Dexmedetomidine continued with a dose of 0.2 mcg/kg/hr and in tapering off until it is stopped. Patient was observed for about one hour and transferred to the treatment room with Aldrette score 10. Patient was given 50 mg Tramadol per 8 h and 500 mg Paracetamol per 6 h orally as postoperative analgesics. The patient was discharged from the hospital on the sixth day of treatment.

Case 2

A 37-year-old man weighing 43 kg and 160 cm in height was admitted to hospital in May 2017 with a defect on the head bone. Patient had a history of traffic accidents in February 2017 and was diagnosed with Mild TBI GCS 15 (E4M6V5) and Subdural Hematoma at right temporal region. It was performed craniotomy decompression with GA without difficulties and complications. Postoperatively, the patient was transferred to High Care with GCS 15 (E4M6V5).

When admitted the patient has no complaints. Patients also have no history of comorbid disease. Physical examination is not found abnormalities. From laboratory examination found WBC: 12.070/mm^3 without clinical manifestation. From a CT-Scan examination the head obtained an impression of skull defect the temporoparietal dextra region and the encephalomalacia of the dextra temporal region.

Patients ASA PS 2 GOSE 8, diagnosed with cranial defect at right temporal region scheduled for cranioplasty. Patients are planned to be anesthetized by the awake monitored anesthesia care method.

Prepared preoperative preparation with premedication of Alprazolam 0.5 mg and Ranitidine 150 mg per oral night before surgery and patient was administered preoperative fasting for eight hours. Before undergoing the surgical procedure, an intravenous line was placed and 1 gr ceftriaxone, 4 mg ondansetron, 50 mg ranitidine, 10 mg dexamethasone and 30 mg ketorolac intravenously one hour

before surgery. The patient is taken to the operating room and positioned supine. Use standard ASA monitor, pulse oximetry, and noninvasive blood pressure. Installed binasal cannula with oxygen flow 2 liters per minute. Urinary catheter was not inserted. Parameters of vital signs preoperative with BP 130/90 mmHg, HR 76 times/min, spontaneous respiration 16 times/min with 99% saturation. Prior to infiltration, dexmedetomidine was administered at a loading dose of 1 mcg/kg intravenously for 15 min by syringe pump. Later the dose of dexmedetomidine was reduced by 0.4 mcg/kg/hr and infiltration of local anesthesia in the incision area (Figure 1) using 25 mg of Bupivacaine 0.25% + Epinephrine 1: 200.000. Patients performed disinfection and drapping while waiting for onset of local anesthesia. 10 min after the infiltration, the incision starts. Hemodynamics is relatively stable during surgery. The dose of dexmedetomidine was raised to 0.5 mcg/kg/hr about 15 min after incision because the patient had complained uncomfortably. Side effects of dexmedetomidine such as decreased heart rate and blood pressure are not very significant in these patients. The dose of dexmedetomidine was again reduced to 0.4 mcg/kg 10 min before surgery was completed, and titrated to a dose of 0.2 mcg/kg/hr after the operation was completed. The operation lasted 60 min with a total bleeding of about 120 ml. During the operation, the patient is easily invited to communicate and understand the instructions given. After surgery, the patient is transferred to PACU. Dexmedetomidine continued with a dose of 0.2 mcg/kg/hr and in tapering off until it is stopped. Patient was observed for about 1 h and transferred to the treatment room with Aldrette score 10. Patient was given 50 mg Tramadol per 8 h and 500 mg Paracetamol per 6 h orally as postoperative analgesics. The third day of treatment, the patient is discharged.

Figure 1: Infiltration in the incision area.

Case 3

A 26-year-old man weighing 47 kg and 165 cm in height was hospitalized in August 2017 with a defect in the head bone. The patient was a history of a traffic accident in November 2016 and was diagnosed with Mild TBI GCS 12 (E3M5V4) and ICH of the left temporal region. It was performed craniotomy of hematoma evacuation with GA without complications and complications. Postoperatively, the patient is transferred to the ICU with GCS 12 (E3M5V4).

When admitted the patient has no complaints. Patients also have no history of comorbid disease. Physical and laboratory examinations are within normal limits and no abnormalities are found. From the examination of thorax photographs obtained the cast and pulmo features within normal limits. From the CT-Scan head obtained the impression skull defect parietal sinistra region.

Patient ASA PS 1, diagnosed with cranial defect at left temporal region planned for cranioplasty. Patients are planned to do anesthesia with awake technique also with the method of Monitored Anesthesia Care.

Prepared preoperative preparation with premedication of Alprazolam 0.5 mg and Ranitidine 150 mg per oral night before surgery and the patient was administered preoperative fasting for eight hours.

Prior to the surgical procedure, an intravenous line was placed and 1 gr ceftriaxone, 4 mg ondansetron, 50 mg ranitidine, 10 mg dexamethasone and 30 mg ketorolac intravenously 1 h before surgery. The patient is positioned supine. Use standard ASA monitor, pulse oximetry, and noninvasive blood pressure. Installed binasal cannula with oxygen flow 4 liters per minute. Urinary catheter was not inserted. Parameters of vital signs preoperative with BP 110/70 mmHg, HR 66 times/min, spontaneous respiration 16 times/min with 99% saturation. Dexmedetomidine is given a loading dose of 1 mcg/kg for 15 min by syringe pump. 15 min later the dose of dexmedetomidine was reduced by 0.4 mcg/kg/hr and local infiltration was performed in the incision area using 37.5 mg of Bupivacaine 0.25% + Epinephrine 1: 200.000. Patients performed disinfection and drapping while waiting for onset of local anesthesia. 15 min after infiltration, incision begins. Patients did not complain of pain during local anesthetic infiltration and during surgery. Hemodynamics is stable during surgery. The dose of dexmedetomidine was maintained at 0.4 mcg/kg/hr until the operation is complete. The operation lasted 50 min with a total bleeding of about 50 ml. During surgery, the patient is in a sleep state and no communication test was performed. After surgery, the patient is transferred to PACU. Dexmedetomidine continued with a dose of 0.2 mcg/kg/hr and in tapering off until it is stopped. Patient was observed for about two hours and transferred to the treatment room with Aldrette score 10. Patient was given 1 gr metamizole intravenous per 8 hours as postoperative analgesic. On the fourth day of treatment, the patient is discharged.

Discussion

The principle of anesthesia management and management of awake cranioplasty is based on the principle of anesthesia awake craniotomy. The patient is comfortable, does not move on the operating table during surgery and awakens when the operation is completed is the target of anesthesia management [15]. Ventilation must be adequate and the airway is safe, the patient does not move while operating but still feels comfortable and cooperative. The target can be achieved by adequate patient preparation; comfortable environment, appropriate sedative and analgesia, always communicate with patients and support patients, and prompt therapy in case of complications [12].

Preoperative patient selection is to find out if there are any contraindications. In awake craniotomy, there are contraindications to the awake procedure. Patients refused, inability to cooperate and communicate mental disorders and the inability to lie down for long periods are an absolute contraindication to this procedure. While relative contraindications are patients with OSA (Obstructive Sleep Apnea), obese, gastroesophageal reflux, cough, language difficulties, and patients under 14 years old [7,13,16]. For patient preparation, the primary key is the patient must be confident and agree to cooperate during the operation, and develop a good relationship with the patient

and his family is important. Communicate for what we expect from the patient and what the patient wants from us and its principles are committed, safe, and comfortable [7,16].

Anesthesia management is critical to the success of awake cranioplasty. In the awake procedure, there are two major anesthetic techniques used. The most commonly used technique is monitored anesthesia care, and the other way is the asleep-awake-asleep (AAA) technique. Analgesia may be given intravenously, local anesthesia, or scalp block. In monitored anesthesia care techniques, patients are preserved in conscious sedation or neurolept analgesia throughout the entire surgery. In the awake craniotomy procedure, sedation is stopped before the start of the stimulation testing. Generally there is no airway manipulation during the procedure. This method requires good planning and the ability to convert from sedation-analgesia to general anesthesia when necessary. Maintaining an optimal and adequate sedation level during airway operation and management is a key skill required in this technique. Preliminary management becomes the most crucial moment, because excessive sedation makes the patient uncooperative and depression may occur, whereas inadequate sedation can make the patient very uncomfortable, anxious, and anxious [5]. We use this kind of technique for the awake cranioplasty procedure.

The scalp block is mentioned as a key to awake technique because it inhibits the sensory branch of the trigeminal nerve and occipital nerve. The scalp block may also provide postoperative analgesics and reduce opioid intake [8,15]. In our cases, the scalp block was not performed and only infiltration of local anesthesia in the incision region. The addition of epinephrine is intended to increase the duration of action of local anesthetic agents and reduce bleeding when cutting scalp. The total safe dose of bupivacaine-epinephrine is 2.5 mg/kg. Generally can be given 40 ml-50 ml bupivacaine 0.25% + epinephrine 1: 200.000. It should be noted on the onset and duration of local anesthetic agents, from starting when injecting local anesthetic drugs [5].

Dexmedetomidine is an ideal sedative that is able to decrease CMRO2, decrease intracranial pressure without decreasing brain perfusion pressure, maintain cerebral autoregulation and vascular reactivity to CO_2, start fast and smooth, easy to control the depth and duration of sedation, at dose of therapeutic window can be evaluated neurological status and complications. Dexmedetomidine has properties: reversible sedation without respiratory depression, analgesia, anesthetic sparing effect, stable cardiovascular, minimal effect on intracranial pressure, neuroprotection effect, rapidly waking patient [5,14]. On the other hand, dexmedetomidine has hypotensive and bradycardia effects. But in our patients in particular, we found no change in pulse rate and blood pressure that could affect cerebral hemodynamics.

Induction of anesthesia begins when the patient's position on the operating table is comfortable. The act of injecting the local anesthetic may cause patient pain and anxiety, analgesia and sedatives should be given before injecting local anesthetic agents. One technique is that the patient is first given a dose of 1 mcg/kg dexmedetomidine bolus given for 10-15 min, after the patient has been dexmedetomidine deducted dose to 0.4 mcg/ kg/hr, if necessary, fentanyl 1 mcg/kg given slowly, then performed an injection of local anesthesia in the area to be installed graft. At the time of scalp infiltration, dexmedetomidine was also continued and the patient was sedated with midazolam 0.1 mg/kg [15]. All patients in all three cases were given only analgesic sedation of dexmedetomidine without the addition of midazolam and analgesics such as fentanyl. During the procedure, the dose of dexmedetomidine is titrated so that the patient does not complain of pain and is comfortable until the operation is complete.

Standard ASA monitors include ECG, noninvasive blood pressure, and pulse oximetry. Using invasive monitoring is not required. Urine catheters are also not necessary if the given intravenous fluid is minimal. Oxygen is given through face mask or binasal cannula, and it is preferable to use binasal cannula as it is more convenient for the patient and free to speak. Monitoring of end-tidal CO_2 and oxygen is supplied *via* nasal prong, but in the above cases it is not done due to the lack of equipment. The purpose of mounting a capnography is to detect respiration, breathing frequency monitoring, and not to look at end-tidal CO_2 [15]. Evaluation and monitoring of brain swelling is also very important because control of intracranial pressure is more difficult in patients with spontaneous ventilation compared with mechanical ventilation [16].

All possible complications should be considered before the onset of surgery. Preparation is needed for the treatment of these complications. The frequent intra-operative complications include airway obstruction due to oversedation, focal and brief or complete seizures, anxiety, nausea, vomiting, haemodynamic complications, local anesthetic toxicity, pain, uncooperative to general anesthesia [5,15]. In our case, no patients had complications.

Immediately after completion of the patient's operation is monitored for several hours in post anesthesia care unit (PACU). When stable and no neurological changes, the patient is transferred to the neurosurgical ward for observation and in the next morning, patient can be discharged. If antiepileptic drug seizures are to be given, however, they are not given as prophylaxis. Patients were not admitted to the ICU but were adequately observed in PACU at least 4 h postoperatively before being transferred to the room [5].

There are various analgesia medications that can be used as postoperative pain control, although none are free from side effects. Opioid can cause nausea, vomiting, and respiratory depression with consequent increased cerebral blood flow and intracranial pressure. NSAIDs are not often used in connection with the risk of increased intracranial bleeding [16].

Conclusion

The awake procedure in cranioplasty basically has the same principle as awake craniotomy. Procedures require good patient conditions where psychological support is more needed than pharmacological approaches [12]. The application of the awake technique has been greatly developed. Particular attention to each component, such as careful patient selection, preoperative psychological preparation, establishing solid relationships with patients, ensuring patients in a comfortable position, adequate regional anesthesia, selection of appropriate anesthetic techniques and agents, rapid crisis preparation and management, as well as ongoing team communication are key to the success of the awake procedure [11]. The choice of anesthesia techniques should be related to anesthesiologist's ability and experience. Dexmedetomidine is present to be the best remedy for analgesia sedation without impairing respiratory function [12,14].

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