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ANESTHETIC CONSIDERATIONS FOR ENDOVASCULAR REPAIR OF INTRACRANIAL ANEURYSMS

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Anesthesiologists play a vital role in the management of intracranial aneurysms (IAs). The goal of endovascular repair of IAs is the occlusion of the proximal feeding arteries or obliteration of the aneurismal sac. Destruction of the sac while sparing the parent artery can be difficult, and can lead to distal embolism and rupture. The anesthesiologist must always be prepared for potential complications. This article provides a brief description of the principles of anesthesia for endovascular repair of intracranial aneurysms, as well as the relevant epidemiological, pathophysiological, diagnostic and therapeutic points. The goal of anesthesia in endovascular IA repair is to maintain an adequate hemodynamic profile and avoid decreases in cerebral perfusion pressure. Cerebral ischemia, increased intracranial pressure (ICP), and hemodynamic instability are intraoperative concerns.

Key words: *anesthesia, intracranial aneurysms, endovascular repair*

Epidemiology

The incidence of intracranial aneurysms (IA) in the general population is 0.2 to 9.9%. Although most cases of IA are sporadic, certain disease states are associated with the development of IAs including polycystic kidney disease, neurofibromatosis type I, Marfan syndrome, and Ehlers-Danlos syndrome type IV [1, 2]. Some people have a genetic predisposition to developing IAs, and the risk is increased in first-degree relatives. 20 to 30% of patients diagnosed with an aneurysm have more than one. Risk factors for multiple aneurysms include cigarette smoking, female gender, and hypertension. IAs typically exists at branch points in the cerebral vasculature, the most common site being the junction of the anterior communicating artery and middle cerebral artery.

IA rupture is a major cause of morbidity and mortality, though fortunately, not all aneurysms rupture. However, 85% of all cases of subarachnoid hemorrhage (SAH) result from a ruptured IA, which has 25 to 50% mortality. Many people that survive a SAH are severely debilitated [3, 4]. Other presenting symptoms of IAs are caused by cranial nerve palsies, hydrocephalus, and cerebral compression. Rarely, an IA can present with seizures. Most IAs does not rupture and are completely asymptomatic; some are discovered incidentally with brain imaging. IAs that is found incidentally has an annual rupture rate of 0.5-2%.

Interventional neuroradiology (INR) procedures are performed for a number of CNS pathologies, and endovascular treatment IAs is an option for many patients. The goal of endovascular repair of IAs is the occlusion of the proximal feeding arteries or obliteration of the aneurysmal sac. Destruction of the sac while sparing the parent artery can be difficult, and can lead to distal embolism and rupture. Therefore, the anesthesiologist must always be prepared for potential rupture [5].

Ruptured IAs can be safely treated with endovascular coiling in the first hours after rupture, with a low probability of aneurysm perforation. Success is determined largely by the size and anatomy of the aneurysm. 57-85% of ruptured aneurysms less than 4mm in diameter can be completely occluded by endovascular coiling, while only 15-35% of aneurysms more than 4mm can be successfully coiled [6].

Preoperative considerations

The importance of pre-anesthetic assessment can be overstated. The anesthesiologist must understand the patient's pathology and presenting symptoms. A careful neurological exam is necessary for a comparison with the patient's post-procedure state. As with all anesthetic plans, patients' comorbid conditions, particularly relating to the patients' blood pressure, renal function, and cardiovascular status, should be investigated prior to the procedure. Because anticoagulation is usually used, the presence of coagulopathic conditions should be known, and evaluation of hemostatic function should be considered. Patients' allergies should be known, especially with regards to contrast dye, protamine, shellfish, and iodine. Previous experience with angiography should be inquired, as well as recent steroid use. Patients who will undergo the procedure with intravenous sedation should be capable of lying supine on a hard, flat surface for

a several hours, and risk factors for aspiration should be inquired. The possibility of pregnancy should be investigated in young female patients. In general, premedication with anxiolytics should be avoided.

Anesthetic technique

The choice of anesthetic technique is determined by the anesthesiologist, and there is little data to support that general anesthesia or sedation is preferred. Most anesthesiologists and neuroradiologists prefer a general anesthetic for several reasons: this approach is more comfortable for the patient, there airway is protected, the patient's immobility will provide a better image for the radiologist, and there is tighter control of respiratory and hemodynamic profile. However, this must be weighed against the risks of potential hypertension and subsequent increased intracranial pressure (ICP) in response to intubation and extubation. Additionally, a general anesthetic technique prevents the ability to assess the patient's intraoperative neurological status.

For general anesthesia, propofol is often the agent of choice for induction. Maintenance can be achieved with either sevoflurane or isoflurane. Desflurane has been associated with increased cerebral blood flow, loss of autoregulation, and more cerebral vasodilation in animal studies. Nitrous oxide is generally avoided because of risk of enlargement of micro air bubbles during injection of contrast or irrigation fluid. For airway management, either a laryngeal mask airway (LMA) or endotracheal tube (ETT) intubation is appropriate.

If conscious sedation is used, the patient should be comfortably positioned on the table. A propofol infusion (10-20 μg/kg/min) is preferred by many anesthesiologists because it offers some degree of control when rapid return to consciousness and neurological assessment is needed. The relatively high rate of upper airway obstruction with propofol use, however, must be considered and a nasopharyngeal airway should be immediately available. Alternatively, other agents, including dexmedetomidine, fentanyl, and midazolam, can be administered and titrated to effect. Oxygen should be administered continuously via nasal cannula, and oxygen saturation should be continuously monitored.

The INR suite should be prepared like any operating room, and should be equipped for general anesthesia and intubation. Emergency equipment for cardiopulmonary resuscitation should be immediately available.

Intraoperative monitoring and considerations

Regardless of the anesthetic technique used, the monitors used in the INR suite are the same as those used in the operating room. In additional to standard monitors, an arterial line can be useful in achieving tight hemodynamic control. Contrast medium can produce an osmotic load and lead to diuresis, thus bladder catheterization is generally used to guide fluid management as well as for patient comfort. Core body temperature should be closely monitored, and hypothermia should be avoided. This is especially important when conscious sedation is used, as shivering results in imaging degradation. Intravascular access should be established, and extension tubing should be used to maximize the distance between the anesthesiologist and the fluoroscopy unit.

The goal of anesthesia in endovascular IA repair is to maintain an adequate hemodynamic profile and avoid decreases in cerebral perfusion pressure. Cerebral ischemia, increased intracranial pressure (ICP), and hemodynamic instability are intraoperative concerns. Thus, blood pressure should be monitored closely and maintained with tight pharmacologic control.

After the initial angiogram is obtained via the femoral artery, a baseline activated clotting time (ACT) is obtained and heparin (70 units/kg) is administered intravenously for a target ACT of two to three times the baseline level. Before embolization, the anatomy of the aneurysm sac is carefully examined with advanced 3-dimensional imaging, and decisions are made with regards to the safety and feasibility of coiling the aneurysm.

Intraoperative complications

The two most frequent and devastating complications that occur during endovascular treatment of IAs is hemorrhage (2.4%) and thromboembolism to distant vessels (3.5%). The anesthesiologist's first priority should be immediate securing of the airway and communication with the interventional radiologist. If the problem is hemorrhage, heparin must be immediately discontinued and reversal with protamine should be administered intravenously (1mg protamine for each 100 units of heparin used, with an ACT afterward used for fine-tuning the dose). A ventriculostomy is usually performed to decrease ICP. In the setting of vascular occlusion, the anesthesiologist's goal is to increase perfusion by augmenting blood pressure with or without thrombolysis.

Post-operative care

Postoperatively, patients with successful embolization should be monitored for neurological complications and hemodynamic instability. Prompt recognition of SAH and neurological complications are vital in providing immediate intervention and preventing additional morbidity. Only rarely is emergent craniotomy necessary.

Recanalization of coiled aneurysms is a significant postoperative problem. Surface active and bioactive coils have been developed, but their efficacy has yet to be determined. Thus, follow-up angiography is recommended for all coiled aneurysms, usually at 6 months and 2 years.

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ТҰЖЫРЫМ

Бассүйекішілік аневризманы емдеу кезінде анестезиологтың рөлі аса маңызды. Бас сүйек ішілік аневризманы эндоваскулярлы қалпына келтірудің мақсаты: аневризманы қамтамасыз ететін артерияны бітеп тастау немесе аневризма қапшығын бітеу. Аневризма қапшығын бітеу кезінде, сол жерді қамтамасыз етуші артерияны зақымдаусыз жүргізу өте күрделі. Ол аневризманың жарылып кетуі немесе шеткі артериялардың бітеліп қалуына әкелуі мүмкін. Анестезиолог әрқашан осы аталған асқынуларға дайын тұруы керек. Осы мақала эндоваскулярлық емшара кезінде жансыздандыру (анестезия) талаптарын- эпидемиологиялық, патофизиологиялық, диагностикалық емдеу ерекшеліктеріне сәйкес қысқаша түсіндіріп береді. Бас сүйек ішілік аневризмаға байланысты емшара үшін жансыздандырудың негізгі мақсаты: гемодинамикалық көрсеткішті бірқалыпты ұстап, мидың перфузиялық қысымын төмендетпеу. Ми ишемиясы, бассүйекішілік қысымның жоғарылауы және гемодинамиканың тұрақсыздығы анестезиологтың басты назарында болады.

Негізгі сөздер: Жансыздандыру (анестезия), бассүйекішілік аневризмалар, эндоваскулярлы қалпына келтіру.

РЕЗЮМЕ

Анестезиологи играют исключительно важную роль в лечении внутричерепных аневризм (ВА). Целью эндоваскулярного восстановления ВА является окклюзия приносящих артерий, питающих аневризму, или облитерация мешка аневризмы. Облитерация мешка аневризмы без повреждения приносящей артерии может быть исключительно сложной и может привести к разрыву аневризмы или окклюзии дистальной артерии. Анестезиолог всегда должен быть готовым к описанным осложнениям. Данный обзор вкратце описывает принципы анестезии для эндоваскулярных процедур так же, как соответствующие эпидемиологические, патофизиологические, диагностические и терапевтические особенности. Целями анестезии для эндоваскулярных процедур, связанных с ВА являются поддержание адекватных гемодинамических показателей и избегание снижения перфузионного давления мозга. Ишемия мозга, повышенное внутричерепное давление и гемодинамическая нестабильность являются значительным интересом для анестезиолога.

Ключевые слова: анестезия, внутричерепные аневризмы, эндоваскулярное восстановление.