The Transpalatal Approach to Repair of Congenital Basal Skull Base Cephaloceles

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Abstract

Basal skull base herniations, including meningoceles and encephaloceles, are rare and may present with characteristic facial and neurologic features. The traditional craniotomy approach has known morbidity, and nasal endoscopy may not allow for control of large posterior basal defects, especially in newborns. We present two cases of successful repair of basal transsphenoidal meningoceles using an oral-transpalatal approach. The first patient with an intact palate presented with respiratory distress, and a palatectomy was performed for access to the skull base. The second patient had a large basal herniation that was reduced through a congenital midline cleft palate, and a calvarial bone graft was used to repair the defect. A literature search revealed 10 previous successful cases using the transpalatal repair, which allows for excellent access, low morbidity, and a team-oriented method to skull base surgery.

Keywords

- transpalatal
- encephalocele
- congenital
- endonasal

Introduction

Basal skull base defects resulting in meningoceles or meningoencephaloceles are rare, and have been estimated to occur in 1 in 35,000 live births.¹

Basal herniations are further divided into sphenoorbital, transthemoidal, sphenoethmoidal, and transsphenoidal, with the latter representing only 5% of basal developmental defects and occurring in an estimated 1 in 700,000 births.^{2–4} Although the exact pathogenesis remains unknown, it is thought that the disruption of the basal skull base occurs early, prior to the 10th week of gestation.⁴ Theories of development include failure of fusion of ossification centers,

failure of separation of ectodermal elements from the neural crest, and persistence of the craniopharyngeal canal with subsequent herniation of intracranial contents.¹

Approaches to repair of basal skull base meningoceles and encephaloceles include the transfrontal open craniotomy, endoscopic transnasal, and transpalatal. Open craniotomy historically has known risks, including frontal lobe retraction and difficulty controlling the “stalk,” resulting in a high rate of cerebrospinal fluid (CSF) leakage.^{7,8} Transnasal endoscopic approaches have been rapidly evolving over the past decade and are considered first-line approaches for most lesions. However, this is not feasible in neonatal patients, particularly with a large posterior skull base defect. The transpalatal

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Fig. 1 (A) Characteristic facial appearance of patient with trans-sphenoidal basal herniation, hypertelorism, and midline cleft lip (patient 2). (B) Open-mouth view showing midline tongue hamartoma, midline cleft palate, and basal meningocele.

approach has only been reported a handful of times, but it carries several advantages over open craniotomy and nasal endoscopy including better visualization, decreased morbidity, and a team approach.^{4,8–10}

We present two cases of basisphenoid meningocele that were successfully managed via the transpalatal approach and spared the patient an open craniotomy. One patient had an intact palate, and the other presented with a congenital cleft palate with herniation of a basal meningocele into the oral cavity (►Fig. 1). The presentation, management, and outcomes are discussed, along with a historical review of this rare congenital anomaly.

Methods

Two cases of basal transsphenoidal meningoceles were identified, and the charts were reviewed for clinical presentation, radiologic imaging, techniques of surgical repair, and outcomes of surgery. Clinical photographs, surgical illustrations, and intraoperative surgical videos were reviewed. In addition, a comprehensive literature search on the transpalatal repair of basal skull base herniations was performed including English and non-English languages.

Case Reports

Case 1

A full-term 2-week-old male infant was admitted to the neonatal intensive care unit for intermittent respiratory distress, which improved with crying, much like a child with choanal atresia. The pediatric otolaryngology service was consulted, and a fiberoptic nasal endoscopy revealed a 1-cm pulsating nasopharyngeal mass causing complete obstruction. A computed tomography (CT) confirmed a meningocele, connected to the brain via a basisphenoid defect (►Fig. 2). Given the severity of the respiratory distress, a choice needed to be made between performing a tracheotomy or repairing the defect via a transpalatal approach. An entirely endoscopic approach would not be possible in a neonatal patient with a large posterior lesion. Our team favored the transpalatal approach.

Surgical Technique

The patient was placed in the supine position and intubated orotracheally. The lower jaw was retracted with a neonatal Crowe-Davis mouth gag exposing the palate. Indirect mirror examination showed the cephalocele arising from the basisphenoid and with obstruction of the choana (►Fig. 3). A U-shaped incision was made in the palate, 5 mm away from the maxillary alveolus to spare the greater palatine artery (►Fig. 4). This was extended laterally and posteriorly to the anterior tonsillar pillar to give the flap adequate length. The flap was raised in the subperiosteal plane and reflected forward, with the soft palate centrally detached, exposing the edge of the hard palate and giving access to the nasopharynx. The posterior edge of the bony palate was “back bitten” and shortened with a rongeur, as with a transpalatal repair of choanal atresia, providing circumferential control of the meningocele stalk (►Fig. 5). The mucosa of the meningocele was confluent with the mucosa of the nasopharynx. An incision was made around the neck of the meningocele at the bony skull base. The bony defect in the skull base was noted to be funnel shaped, with the stalk of the meningocele

Fig. 2 Preoperative imaging of patient 1, showing the basal skull base defect. (A) Coronal computed tomography (CT). (B) Axial CT.

Fig. 3 Medical illustration representation of the indirect mirror examination of the nasopharynx and choanae in patient 1, at the time of surgery. Note the intact palate and skull base herniation seen in the mirror.

passing through the inverted cone of bone. A bipolar cautery was used to shrink the size of the meningocele successfully, and the narrowed stalk was then ligated with a silk suture. The palatal flap was replaced and sutured into its original position.

Postoperatively, the patient did well and was extubated on the second postoperative day. Oral feeds were started the

following day. A flexible nasal endoscopy 6 months postoperative showed healed mucosa with no evidence of recurrence.

Case 2

During routine prenatal ultrasound at 20 weeks, a fetus was diagnosed with a basal skull defect with herniation of cranial contents. Subsequent prenatal magnetic resonance imaging (MRI) confirmed the diagnosis of a large basal meningocele with associated hypertelorism and cleft palate. Due to concerns for immediate respiratory distress at birth, a cesarian delivery was performed at 39 weeks with the pediatric otolaryngology team present for delivery, anticipating the necessity of airway control. Fortunately, the child did not have respiratory issues after birth because of the cleft palate, which allowed for nasal respiration around the large meningocele.

Examination and radiologic workup (CT and MRI) revealed the following congenital anomalies: basal transsphenoidal meningocele (which expanded when crying) with herniation through a wide U-shaped cleft palate into the oral cavity, hypertelorism, agenesis of the corpus callosum, optic nerve coloboma, midline cleft lip, and a midline dorsal tongue hamartoma (►Figs. 1 and 6). The midline cleft lip extended within 3 mm of the columella. These findings were consistent with the Sakoda complex, which includes basisphenoidal meningocele/encephalocele, agenesis of the corpus callosum, and midline cleft lip and palate. An endocrinologic work-up of the hypothalamic/pituitary axis was normal in our patient.

Because he did not have respiratory symptoms, the decision was made to allow for growth and development prior to

Fig. 4 Illustrations demonstrating sequence of surgical technique for the transpalatal approach with an intact palate (patient 1) by P.J. Koltai. (A) Exposure of the palate with a mouth gag. (B) U-shaped incision of the palate, avoiding the greater palatine arteries. (C) Exposure of the posterior bony hard palate and meningocele.

Fig. 5 Continued from Fig. 4: Illustrations demonstrating sequence of surgical technique for the transpalatal approach with an intact palate (patient 1) by P.J. Koltai. (D) Removal of the posterior palatal bone to enhance exposure. (E) Retraction of the herniation with exposure of the stalk and skull base defect. (F) Ligation of the stalk.

surgery. He was fed with a pigeon nipple due to his cleft palate and to prevent increased negative intraoral pressure that might increase the size of the meningocele. At 7.5 months of age, the transoral transpalatal approach was performed through his existing cleft palate by the neurosurgery and otolaryngology services.

Surgical Technique

The patient was anesthetized and orotracheally intubated, and then placed into a Mayfield clamp. A lumbar CSF drain was placed but left closed. A split-calvarial bone graft was harvested from the left parietal region and placed aside. A Dingman mouth gag was then used to retract the mandible and oral commissure, with identical exposure as for a cleft palate repair. The operative microscope was positioned over the oral cavity, and excellent visualization of the entire oral cavity, cleft palate, meningocele, and skull base was achieved (► Fig. 7). The mucosa overlying the meningocele was contiguous with the primary hard palate anteriorly, and there was a midline hair-bearing segment along the palate. After injection with lidocaine/epinephrine, the palatal mucosa was incised to separate the meningocele, and the mucosa along the stalk of the meningocele was incised at the skull base, exposing the bony skull base defect. This patient also had an inverted funnel-shaped defect with the stalk of the meningocele within the funnel. Using bipolar cautery, the meningocele was cauterized circumferentially and reduced in size. Attempts to elevate mucosa off the lesion resulted in a CSF leak that was controlled with bipolar cautery and sutures. Abandoning the attempt to further elevate the mucosa, we reduced the size of the meningocele with the bipolar cautery

until the lesion retracted deep to the skull base defect at the level of the surrounding dura of the intracranial cavity. Polyethylene glycol/trilysine solution (DuraSeal, Covidien) was placed over the meningocele remnant. The calvarial bone graft was trimmed to size and placed snugly into the bony skull base defect. Two pedicled nasopharyngeal mucosal flaps were then rotated and sutured into place to cover the bone graft, and then an additional layer of DuraSeal was applied over the flaps (► Video 1).

Postoperatively, the patient was extubated, and the lumbar drain was removed on the postoperative day 3 without complication. He was fed with an nasogastric tube for 1 month to allow for healing of the nasopharynx. His postoperative course was benign, and he was discharged home without complication. Six months postoperatively, at age 13 months, his cleft palate was repaired, and the nasopharynx was noted to be completely healed at the time of surgery (► Fig. 8).

He is currently 24 months postoperative, with no recurrence of his meningocele, closure of his cleft palate, and repair of his lip defect. The MRI 2 years postoperative showed complete bony closure of his skull base defect, with refilling of the meningocele remnant with CSF but no herniation (► Fig. 9).

Video 1

Operative sequence of patient 2.

Fig. 6 Preoperative imaging of patient 2. (A) Axial computed tomography (CT). (B) Coronal CT. (C) Sagittal T2-weighted magnetic resonance imaging (MRI). (D) Coronal T2-weighted MRI. Note basal transsphenoidal meningocele herniating into the oral cavity and tongue hamartoma.

Discussion

The transpalatal approach for successful repair of a congenital skull base meningocele or encephalocele has only been reported in 10 patients previously, and we present two additional cases. This approach to repair of a congenital skull base herniation allows for consistently reliable access. This is especially relevant in neonatal patients who are obligate nasal breathers, in whom a basal herniation causes airway distress. The nasal cavity and size of the lesion may severely limit the endoscopic options, and the transpalatal approach offers a viable alternative.

Transsphenoidal basal herniations are often associated with characteristic facial features including hypertelorism, broad nasal dorsum, bifid nose, and central clefting of the lip and palate.^{1,11,12} Midline dorsal tongue hamartoma has also been described and was present in our second patient. Large herniations interfere with the medial closure of the secondary palate and result in a wide U-shaped cleft palate with protrusion of the meningocele/encephalocele into the oral cavity. Neonates are obligate nasal breathers, and therefore a basal herniation without a cleft palate may present with nasal obstruction and respiratory distress relieved by crying, as seen in our first case. Several reports discuss older children

with chronic noisy breathing and snorting sounds that may be a clue to diagnosis.^{12–14} In the absence of cleft palate and grossly abnormal facial features, the diagnosis may be delayed until adolescence or adulthood. In these cases, nasal

Fig. 7 Intraoperative view of patient 2, with Dingman mouth gag in place, showing wide U-shaped cleft palate, with contiguous mucosa over palate and meningocele. Note the midline hair-bearing strip along the palate.

Fig. 8 Six-month postoperative view of nasopharyngeal closure of patient 2, with complete mucosalization. View through the (A) palate and (B) posterior choanae. Photograph was obtained at the time of cleft palate closure.

obstruction or a nasal mass is a common presenting symptom, and it may be confused with nasal polyposis. In fact, early case descriptions from the 19th century and prior to modern imaging and endoscopes even state that “it will probably always be difficult, if not impossible, to state at the outset whether a nasal polypus is or is not a hernia of the cerebrum.”¹⁵

The location of the skull base defect and the timing of development prior to the 10th week also explains the associated optic, endocrinologic, and neurologic abnormalities.¹ These include microphthalmia, anophthalmia, optic coloboma (seen in the optic nerve in our second case), abnormalities of the optic chiasm, absence or decreased function of the hypothalamic/pituitary axis, and absence of the corpus callosum.^{16,17} A thorough work-up including MRI, CT, endocrinologic, and ophthalmologic consultations is appropriate when a basal skull base defect is seen or suspected based on phenotypic appearance or clinical presentation.

The open approach to repair of a basal hernia was first successfully performed by Fenger in 1895 via a superior maxillectomy and subsequently using the transfrontal craniotomy route.^{13,18} The transcranial approach has been reported to have a morbidity and mortality as high as 70% and 50%, respectively, as well as increased incidence of hypothalamic and local neurovascular lesions.^{8,12,14} These are related to retraction of the olfactory bulbs and frontal lobe, disturbance to the pituitary, and reduction of the herniated sac into the cranium. Separation of the sac from the nasal mucosa is extremely difficult, and amputation of the neck of the herniation can result in CSF leakage, respiratory failure, and endocrine disturbances.^{4,9,19,20} Kai et al, in 1996, reported a successful open repair using the transbasal intra- and extradural approach.²¹ A combined transcranial and transpalatal approach has been described, but in general intracranial approaches have decreased with the development of advanced endoscopic techniques.²²

Transnasal endoscopic techniques have rapidly evolved, and the expanded endonasal approach is now advocated for benign and malignant tumors as well as congenital and acquired defects of the skull base. Repair of CSF leak is routinely performed endonasally, and the use of local pedicled flaps, particularly the nasoseptal flap, has drastically decreased recurrence rates.²³ Advantages of the transnasal endoscopic approach over the open technique include

Fig. 9 (A) Immediate postoperative and (B) 8-month postoperative T2-weighted sagittal magnetic resonance imaging of patient 2. Note the calvarial bone graft in place separating the intracranial cavity from the nasopharynx (arrow). The meningocele has refilled with cerebrospinal fluid at 8 months without herniation or clinical significance.

improved visualization and decreased morbidity. Indeed, meningoceles and encephaloceles are often completely repaired via endoscopic techniques. However, most reports focus on either anterior transcribiform/transethmoidal herniations or smaller posterior transsphenoidal herniations, and rarely in newborns and infants who will inherently have a much smaller nasal cavity and more difficult access.^{24–27} For infants and neonates with large posterior basal herniations, particularly with a preexisting cleft palate, the transpalatal approach may be a superior approach.

Historically, the first reported attempt at the transoral transpalatal approach was by Oldfield in 1936, who used manual compression followed by ligation of the encephalocele neck under light anesthesia.²⁸ Unfortunately, this patient became cyanotic and died after 24 hours. The first successful case was reported by Lewin and Shuster in 1965, in which a 3-month-old with a midline cleft lip and palate underwent transpalatal opening of a meningocele sac with ligation of the stalk using catgut, and the bony defect was filled with a tibial graft.²⁹ Lewin went on to report a second similar case in 1983, again in a patient with midline cleft lip and palate, using a rib graft to repair the bony defect after transpalatal meningocele reduction.⁹

Gerhart et al, in 1979, presented a 5-year-old boy with a large sphenoethmoidal meningocele with a median cleft palate and agenesis of the corpus callosum. Transfrontal intracranial occlusion of the skull base was attempted twice and failed. The transpalatal approach was then used successfully, with closure of the bony defect with a perforated tantalum plate.²

Kennedy et al, in 1997, report four cases repaired transpalatally (two meningoceles and two encephaloceles).¹⁰ Two of the patients had midline facial clefting with nasal obstruction, whereas one patient had an episode of meningitis that led to the diagnosis and the fourth patient's encephalocele was found incidentally during a seizure work-up. All patients were repaired via the transpalatal approach, using titanium or palatal bone to reconstruct three of the four patients.

Formica et al reported an 8-month-old girl with breathing difficulties, hypertelorism, and cleft lip and palate. The meningocele was reduced with a ventricular drain into the cranial cavity, and the defect was repaired with a parietal bone graft.⁴

Acherman et al reported a similar patient with midline cleft lip and palate and hypertelorism who presented with whitish discharge from the nose at 3 months of age.¹² She was noted to have "snoring-like" breath sounds and a 1-cm white mass protruding from the cleft palate into the oral cavity. Via a transpalatal approach, in which the bony palate was opened further for exposure, the meningocele was coagulated and reduced. The skull base defect was repaired using a temporal bone graft, temporalis fascia, and fibrin glue. She developed meningitis postoperatively and was successfully treated with vancomycin and rifampin.

In 2006, Monteiro et al described a patient with a basal transsphenoidal meningoencephalocele with hypertelorism, agenesis of the corpus callosum, and cleft palate. At 7 years of age, he underwent a transpalatal repair with a parietal bone graft

and buccinator oral cavity pedicle graft. The repair was successful, although he had diabetes insipidus postoperatively.¹⁴

Our two cases emphasize that the transpalatal approach allows for direct access through the oral cavity, with wide exposure of the basal skull base herniation and defect. An operative microscope can easily be positioned over the patient for microsurgical techniques, and we found this to be particularly important with a large meningocele, as in our second case. The transpalatal approach provides the surgeon with an advantage in dividing the contiguous mucosa from the palate and meningocele, and isolating the herniation at the skull base. For a large lesion, separation of the herniated sac from the nasal mucosa may be difficult via the transnasal route in a neonatal patient. The patient is spared the morbidity of a transcranial surgery including scar, retraction of the olfactory bulbs and frontal lobe, and difficulty controlling the neck of the herniation. By approaching the skull base defect from below, there is also less risk to the optic chiasm and pituitary, although it is important to be cognizant of these structures at all times.

Even if a cleft palate is not present, a palatal flap and palatotomy can be performed providing wide access to the herniation. It is important to emphasize that the goal of the transpalatal approach is not to entirely remove the meningocele/encephalocele, but to reduce the herniation into the intracranial cavity and close the bony defect into the nasopharynx. If the sac refills with CSF, seen in the postoperative MRI from our second case, this will not be of significance as long as the connection into the nasopharynx is closed. Although one case in the literature developed meningitis postoperatively, recent evidence suggests that the endonasal and oral cavity routes to the skull base do not carry increased risk of intracranial infection.^{12,30}

Finally, the transpalatal approach allows for a combined team approach with neurosurgery and otolaryngology, which has become one of the main principles of modern skull base surgery. Although transnasal endoscopic techniques will continue to evolve and will be appropriate for most cases of basal herniations and skull base lesions, in neonates and young infants the transpalatal approach allows for wide access to safely repair congenital basal skull base defects.

Note

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References

- 1 Yokota A, Matsukado Y, Fuwa I, Moroki K, Nagahiro S. Anterior basal encephalocele of the neonatal and infantile period. *Neurosurgery* 1986;19(3):468–478
- 2 Gerhardt HJ, Mühler G, Szdzyd D, Biedermann F. Therapy problems in sphenoethmoidal meningoceles [in German]. *Zentralbl Neurochir* 1979;40(1):85–94
- 3 French BN. Midline fusion defects and defects of formation. In: Youmans JR, ed. *Neurological Surgery*. Philadelphia, PA: WB Saunders; 1982:1236–1380

- 4 Formica F, Iannelli A, Paludetti G, Di Rocco C. Transsphenoidal meningoencephalocele. *Childs Nerv Syst* 2002;18(6-7):295-298
- 5 Lemire R, Loeser J, Leech R, Alvord E. *Normal and Abnormal Development of the Human Nervous System*. Hagerstown, MD: Harper & Row; 1975
- 6 David DJ. Cephaloceles: classification, pathology, and management—a review. *J Craniofac Surg* 1993;4(4):192-202
- 7 Abe T, Lüdecke DK, Wada A, Matsumoto K. Transsphenoidal cephaloceles in adults. A report of two cases and review of the literature. *Acta Neurochir (Wien)* 2000;142(4):397-400
- 8 Franco D, Alonso N, Ruas R, da Silva Freitas R, Franco T. Transsphenoidal meningoencephalocele associated with cleft lip and palate: challenges for diagnosis and surgical treatment. *Childs Nerv Syst* 2009;25(11):1455-1458
- 9 Lewin ML. Sphenoethmoidal cephalocele with cleft palate: transpalatal versus transcranial repair. Report of two cases. *J Neurosurg* 1983;58(6):924-931
- 10 Kennedy EM, Gruber DP, Billmire DA, Crone KR. Transpalatal approach for the extracranial surgical repair of transsphenoidal cephaloceles in children. *J Neurosurg* 1997;87(5):677-681
- 11 Hayashi T, Utsunomiya H, Hashimoto T. Transethmoidal encephalomeningocele. *Surg Neurol* 1985;24(6):651-655
- 12 Acherman DS, Bosman DK, van der Horst CM. Sphenoethmoidal encephalocele: a case report. *Cleft Palate Craniofac J* 2003;40(3):329-333
- 13 Mylanus EA, Marres HA, Vlietman J, et al. Transalar sphenoidal encephalocele and respiratory distress in a neonate: a case report. *Pediatrics* 1999;103(1):E12
- 14 Monteiro M, de Albuquerque AC, Nobre MC, et al. Transsphenoidal transpalatal meningoencephalocele. [in Portuguese]. *Arq Neuropsiquiatr* 2006;64(3A):624-627
- 15 Fenger C. Basal hernias of the brain. *Am J Med Sci* 1895;109(1):1-19
- 16 Larsen JL, Bassøe HH. Transsphenoidal meningocele with hypothalamic insufficiency. *Neuroradiology* 1979;18(4):205-209
- 17 Liebllich JM, Rosen SE, Guyda H, Reardan J, Schaaf M. The syndrome of basal encephalocele and hypothalamic-pituitary dysfunction. *Ann Intern Med* 1978;89(6):910-916
- 18 Macfarlane R, Rutka JT, Armstrong D, et al. Encephaloceles of the anterior cranial fossa. *Pediatr Neurosurg* 1995;23(3):148-158
- 19 Modesti LM, Glasauer FE, Terplan KL. Sphenoethmoidal encephalocele: a case report with review of the literature. *Childs Brain* 1977;3(3):140-153
- 20 Moore MH, Lodge ML, David DJ. Basal encephalocele: imaging and exposing the hernia. *Br J Plast Surg* 1993;46(6):497-502
- 21 Kai Y, Nagahiro S, Yoshioka S, Ushio Y. Application of the skull base technique to the repair of transsphenoidal meningoencephaloceles. *Pediatr Neurosurg* 1996;25(1):54-56
- 22 Lesavoy MA, Nguyen DT, Yosur G, Dickinson BP. Nasopharyngeal encephalocele: report of transcranial and transpalatal repair with a 25-year follow-up. *J Craniofac Surg* 2009;20(6):2251-2256
- 23 Kassam AB, Prevedello DM, Carrau RL, et al. Endoscopic endonasal skull base surgery: analysis of complications in the authors' initial 800 patients. *J Neurosurg* 2011;114(6):1544-1568
- 24 González-García JA, García-Berrolcal JR, Trinidad A, Verdaguier JM, Sanz R, Ramirez-Camacho R. Endonasal endoscopic management of a large meningoencephalocele in a patient with concomitant middle skull base defect. *Minim Invasive Neurosurg* 2006;49(5):309-311
- 25 Tabaei A, Anand VK, Cappabianca P, Stamm A, Esposito F, Schwartz TH. Endoscopic management of spontaneous meningoencephalocele of the lateral sphenoid sinus. *J Neurosurg* 2010;112(5):1070-1077
- 26 Nogueira JF Jr, Stamm AC, Vellutini E, Santos FP. Endoscopic management of congenital meningo-encephalocele with nasal flaps. *Int J Pediatr Otorhinolaryngol* 2009;73(1):133-137
- 27 Shah RN, Surowitz JB, Patel MR, et al. Endoscopic pedicled nasoseptal flap reconstruction for pediatric skull base defects. *Laryngoscope* 2009;119(6):1067-1075
- 28 Oldfield M. An encephalocele associated with hypertelorism and cleft palate. *Br J Surg* 1937;25:757-764
- 29 Lewin ML, Shuster MM. Transpalatal correction of basilar meningocele with cleft palate. *Arch Surg* 1965;90:687-693
- 30 Kono Y, Prevedello DM, Snyderman CH, et al. One thousand endoscopic skull base surgical procedures demystifying the infection potential: incidence and description of postoperative meningitis and brain abscesses. *Infect Control Hosp Epidemiol* 2011;32(1):77-83