Surgical Technique for the Prevention of Cerebrospinal Fluid Leakage After Bifrontal Craniotomy

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Key words
- Cerebrospinal fluid
- Frontal sinus
- Rhinorrhea
- Skull base

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
FS: Frontal sinus

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BACKGROUND: **Cerebrospinal fluid leakage and meningitis caused by frontal sinus (FS) exposure are characteristic complications of bifrontal craniotomy used for treating skull base tumors and anterior communicating artery aneurysms. Prevention of these complications is of utmost importance. We describe in detail our procedure for sealing exposed FSs during bifrontal craniotomy and present the results and outcomes of the procedure.**

METHODS: **A total of 51 consecutive patients who had undergone bifrontal craniotomy for tuberculum sellae meningiomas, craniopharyngiomas, anterior cerebral artery aneurysms, or other frontal skull base lesions at our institute were selected for the study. Our technique for sealing exposed FSs is described below. The mucosa was sterilized using surgical cotton dipped in iodine. After craniotomy, the exposed mucosa was sealed using 7-0 nylon sutures, whereas Gelfoam with fibrin glue was used to ensure watertight closure. The exposed portions of the FSs were covered by bone covers made of internal table bone and sealed. As a final layer, frontal periosteal flaps were sutured to the frontal base dura mater.**

RESULTS: **Postoperative cerebrospinal fluid leakage or meningitis did not occur in any of our patients.**

CONCLUSION: **Our results indicate the effectiveness of our technique in the prevention of FS-related postoperative complications.**

INTRODUCTION

Bifrontal craniotomy is effective for the treatment of anterior skull base tumors (11) and anterior cerebral artery aneurysms (5, 9, 18). However, complications particular to this approach include cerebrospinal fluid (CSF) leakage and meningitis caused by exposure of frontal sinuses (FSs) as a result of opening of the covering bone and underlying mucosa during surgery (14, 17, 24, 33, 36). Previous reports (20, 22, 32) have proposed various methods for preventing these complications, including the use of frontal periosteal flaps, fibrin glue, and artificial bone. Sealing of the dura mater and FS mucosa and sealing of FSs using bone are necessary to prevent CSF leakage and meningitis (20-22, 28, 29, 33, 36). In this paper, we present our technique for performing the above-mentioned procedures and report the results and outcomes. A presentation of our techniques and a representative case are available in the video.

SUBJECTS AND METHODS

Fifty-one consecutive patients (age, 15–71 years; mean age, 48.3 years; 26 males) who had undergone bifrontal craniotomy with FS exposure for frontal base lesions during the last 6 years at this hospital were initially selected for this study (Table 1). Patients without exposure of bony FS or the mucous membranes of FS were not included in this study. Lesions included tuberculum sellae meningioma (n = 8), craniopharyngioma (n = 7), anterior cerebral artery aneurysm (n = 27), and other frontal skull base lesions (3 patients with pituitary adenomas and 1 each with germinoma, fibrous dysplasia, ependymoma, mucocele, and frontal falx meningioma). Antibiotics (sulbactam/ampicillin, 3 g/day) were administered for 6 days prior to craniotomy.

We retrospectively investigated the postoperative frequency of CSF leakage and meningitis. CSF leakage was defined as persistent postoperative leakage of a glucose-containing serous liquid from the nasal cavities. Patients with postoperative meningeal signs and fever of ≥38°C were required to undergo CSF examination, and a patient was considered to have meningitis if this examination showed increased cell count.

Video available at WORLDNEUROSURGERY.org

SURGICAL APPROACH AND METHODS

Craniotomy

Bilaterally symmetrical skin incisions that covered the forehead were placed behind the hairline, and the frontal periosteal flap was separated from the frontal dermal flap. An advantage of this surgical approach is that the temporal muscles do not have to be cut, and this reduces postoperative pain at the wound site. Therefore, the

Table 1. Characteristics of Frontal Skull Base Legions

Cases	51
Diagnosis	
Anterior cerebral artery aneurysm	27
Meningioma	
Tuberculum sellae	8
Anterior falx	1
Craniopharyngioma	7
Pituitary adenoma	3
Anterior cranial fossa dural arteriovenous malformation	1
Germinoma	1
Fibrous dysplasia	1
Third ventricle ependymoma	1
Mucocele	1
Sex	
Male/Female	26/25
Age (years)	15–71 (mean 48.3)
Follow-up (months)	1–84 (mean 36.8)

frontal periosteal flap was raised medially on the temporal line in an "H" shape (Figure 1). The frontal base side of the flap was used to seal the exposed portions of FS, whereas the parietal side of the flap was used to cover the titanium plates used for bone fixation (Figure 2).

Three burr holes were made. The first burr hole was made in the midline approximately 6 cm above the nasion. The other two burr holes were bilaterally symmetrical and placed on the supraorbital border adjacent to the frontal nerve.

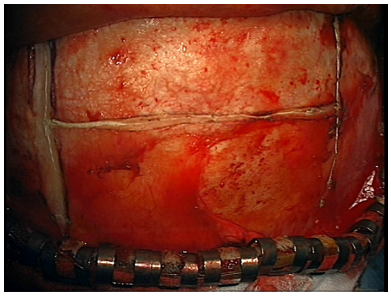

Figure 1. Photograph showing the H-shaped periosteal flap incision.

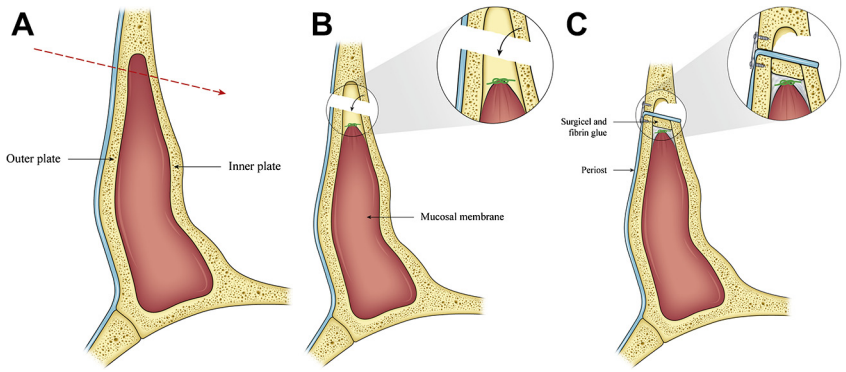

Figure 2. (**A**–**C**) Schematic diagram illustrating the technique of reconstruction of the mucosal membrane and bony frontal sinus. Sagittal view showing the relationships between the mucosal suturing and bony cap of the frontal sinus using an inner plate.

Craniotomies were performed after the most prominent FS was measured preoperatively on cranial X-ray images or predicted from intraoperative findings that revealed a swelling of the frontal bone. During craniotomy, bone incision should be placed in the frontal base side exactly toward the center and should begin from two lateral areas. If a bone pillar existed between the anterior and posterior walls of FS, it was eliminated using a micro drill, leaving only two layers of bone, that is, the anterior and posterior walls. The anterior wall was used to seal the remaining craniotomy line, whereas the posterior wall was used as a bone cover for the exposed FS. The FS mucosa was separated from the bone components and pushed into the ostium of the frontonasal duct. Next, surgical cotton soaked in 10% povidone iodine was placed in the wound.

CLOSURE

The FS mucosa is extremely thin and fragile for craniotomy. However, mucosal edema occurs if the mucosa is separated from the bone of FS and pushed down in the deep FS using the surgical cotton soaked in antiseptic solution (Figure 3A). Therefore, plication closure can be easily performed for sealing the exposed area (Figure 3B). We used continuous 7-0 Prolene sutures and then attached two layers of Gelfoam sponge soaked in fibrin glue to the sutured area (Figure 3C). Thrombin solution was sprayed to achieve equal adherence. Bone caps for the exposed FS were created using the inner table of FS and fixed. The periosteal flap, which covered the bone cap, was then sutured to the dura mater in the frontal base. This caused the four coating layers of periosteum, bone cap, fibrin glue, and mucous membrane to separate from the subdural space within FS, thereby preventing CSF leakage.

RESULTS

Postoperative CSF leakage and meningitis did not occur in any patient. Three patients with tuberculum sellae meningioma in whom a bifrontal interhemispheric approach was used developed postoperative olfactory nerve disorders. Postoperative symptomatic epilepsy occurred in one patient. Neurological and magnetic resonance imaging findings, including postoperative diffusion-weighted imaging findings, did not indicate ischemic complications. CSF leakage did not occur as a postoperative complication in any patient. One patient excreted serous fluid from the nasal cavity; however, this fluid contained no glucose. We therefore presumed that the physiological salt solution used for cleaning the operative field during surgery may have accumulated in the paranasal sinuses and excreted. No patients exhibited symptoms of meningitis, such as fever or meningeal signs. No patient required lumbar subarachnoid CSF drainage. The postoperative follow-up period was 1–84 months (mean, 36.8 months).