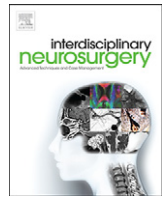




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Technical Notes &amp; Surgical Techniques

## Toward a more rationalized use of a special technique for repair of frontal air sinus after cerebral aneurysm surgery: The most effective technique



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### ABSTRACT

A craniotomy that passes through the frontal air sinus (FAS) often results in postoperative complications such as infection, cerebrospinal fluid leakage or mucocele formation. A good understanding of FAS reconstruction can decrease the morbidity rate of complications. This study describes the outcomes of treatment and establishes the most effective technique for FAS reconstruction in our institution. We enrolled 107 patients who had a bifrontal craniotomy which exposed the FAS during the operation for an anterior communicating artery (ACoA) aneurysm. Demographic data including the follow-up information were collected and analyzed. The complications after surgery were observed and described in the treatment procedure. The patency of the nasofrontal outflow tract (NFOT) was proved by removal of blood clots and bone dust by irrigation and by direct inspection under a microscope before closure of the frontal sinus mucosa with a monofilament non-absorbable 7/0 material suture. The dura was closed in a watertight fashion and an abdominal fat graft was packed into the FAS cavity. There were 33 male and 74 female patients and the mean age (range) was 64 years (32–90 years). The mean follow-up time was 13 months (1–35 months) and complications were found in only 2 patients. One patient suffered from dislocation of the fat graft and the other patient developed a surgical wound infection. At post-operation the first patient sneezed several times and the second patient suffered from trauma in the nasal area after discharge to home. Both patients were surgically treated and cured. In conclusion, FAS reconstruction from our technique is very effective for the prevention of complications after bifrontal craniotomy. Direct suturing of the frontal sinus mucosa and proving the patency of the NFOT are keys to successful treatment.

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### 1. Introduction

Nowadays, the surgical approach to pass through the frontal air sinus (FAS) is a serious procedure for neurosurgeons to perform as the surgery increases the possibility of complications related to the procedures such as infection, cerebrospinal fluid (CSF) leakage or mucocele formation. The clues for an effective procedure to decrease these problems are: 1) maintain the patency of the nasofrontal outflow tract (NFOT) and 2) disconnect the space between the intracranial and air sinus compartments. Obstruction of the NFOT can cause an infection and mucocele formation at post-operation due to insufficient drainage

of secretions via the primary ostium, hence the complication rates were reported as 0–10% [2,4,6,12]. The authors reported several effective methods for FAS reconstruction by using either artificial or autologous materials to obliterate the FAS or exenterate the frontal sinus mucosa and then use an autologous flap to close the space with fibrin glue. These procedures were reported to be safe and effective especially in FAS fracture from trauma [2,11,12]. However, only a few papers mentioned non-traumatic patients who had a craniotomy that involved the FAS such as anterior cerebral artery aneurysms or anterior skull base tumor surgeries [15,18]. Dealing with the complications requires aggressive treatment for repair or to rid the patient of an infection both of which require long hospitalization.

The technique of FAS reconstruction by closing the frontal mucosa after proving the patent status of the NFOT and then packing with abdominal fat has been established in a few reports [8,14]. Our series is the largest series that studied the results of FAS reconstruction in

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non-traumatic patients after we performed the anterior interhemispheric approach for every anterior communicating artery (ACoA) aneurysm. Data of both ruptured and unruptured aneurysms of the patients were collected and the effective technique of frontal sinus reconstruction was described.

## 2. Methods

### 2.1. Study design

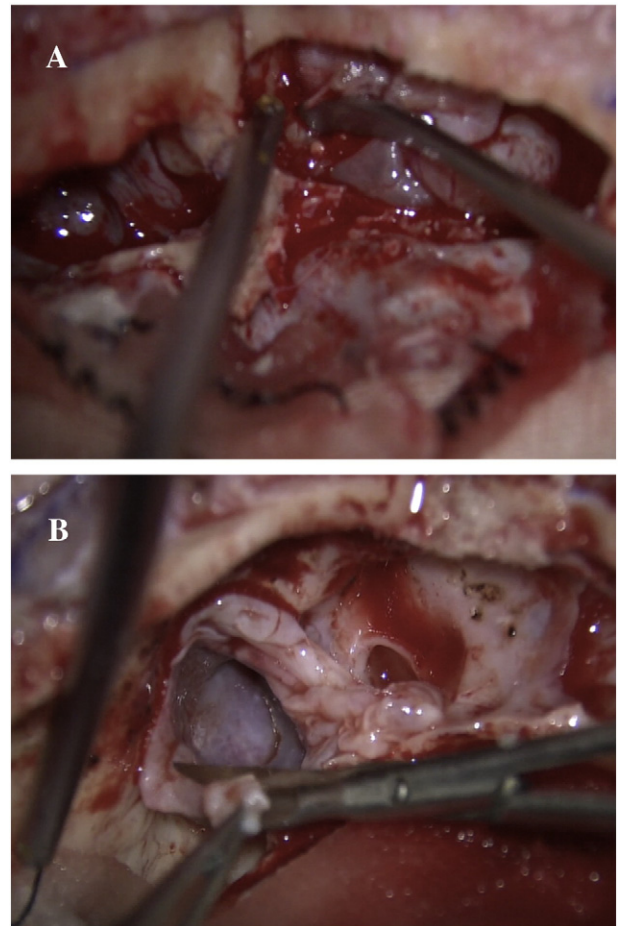
The retrospective cohort review was collected from April 2012 to April 2015 in Teishinkai Hospital, Sapporo, Japan. All of the patients signed a completed informed consent form before the operation. The inclusion criteria were the patients who underwent interhemispheric approach for ACoA aneurysm and had a bifrontal craniotomy performed that exposed the FAS. In patients who were diagnosed as ACoA aneurysm with a simultaneous aneurysm at another site, such as middle cerebral artery or posterior communicating artery aneurysm, we chose the fronto-temporal approach instead of the interhemispheric approach and these patients were excluded from the study. The patient demographic data, follow-up times, and complications from the treatment were collected and analyzed after a review of the ethical issues and approval by the institutional review board committee. All patients were post-operatively followed up.

### 2.2. Surgical techniques

After the informed consents were signed by the patients but before undergoing surgery, preoperative information was obtained in each patient from fusion images (MRA and CTA scans of the brain) for the characteristics of aneurysms, superficial veins related to the anterior segment of the superior sagittal sinus, and the morphology of the frontal sinus. A routine intravenous antibiotic of first generation cephalosporin was administered before the operation and until the third day post-operation for prophylaxis treatment. After the neutral position and head elevation above the heart to decrease intracranial pressure were arranged, the standard bicoronal skin incision was made. The bifrontal craniotomy was performed until the FAS was exposed (Fig. 1). The frontal mucosa was stripped from the table of sinus in all directions (Fig. 2A). Afterwards the mucosal edge was trimmed to the appropriate shape of the sac (Fig. 2B). A survey of the NFOT patency was proved by using the irrigation-suction device designed by Kamiyama et al. [7] to remove blood clots and small bone dust that can result in obstruction of the NFOT before closing the frontal mucosa. Patency was verified under microscope. This step is necessary to decrease the incidence of recurrent infection or mucocele formation in the long-term. Additional



**Fig. 1.** The bone flap was done by the bifrontal craniotomy approach for an ACoA aneurysm.



**Fig. 2.** A: The mucosa was stripped from the anterior and posterior wall of the frontal air sinus by small dissector. B: Frontal mucosa was exposed and the edge was trimmed to reshape the closure.

removal of the inner table of the FAS was performed to make a wider space for reconstruction of the FAS. Pyoktanin was used to mark the edge of the mucosa for easier closure with monofilament non-absorbable 7/0 suture material by continuous technique under microscope (Fig. 3A–B). After this process was finished, saline-soaked cottonoid was used to temporarily pack the mucosal space. Then the crista galli was removed. The dura was opened in the next step and the aneurysm was clipped. The dura was closed in a watertight fashion after clipping the aneurysm to prevent CSF leakage. Abdominal fat was harvested to pack the FAS space and then sealed with fibrin glue (Fig. 4A). Cranialization of the mucosa and removal of the posterior table of the frontal sinus from the bone flap was done before closure. After that the bone flap was closed for cosmetic reconstruction (Fig. 4B). The pericranial flap that included the skin was closed layer by layer. The patient needed to stay in the hospital for post-operative care for 2 weeks and was advised to avoid certain activities for at least 3 months that would cause the fat graft to be blown away such as sneezing or the Valsalva maneuver to allow complete epithelialization of the FAS [17]. An MRI scan of the brain was performed post-operatively before discharge and at follow-up times of 3 and 6 months and then once a year if the clinical condition was stable. Complications such as infection were determined by a clinical presentation according to the following criteria: nasal discharge related to the clinical symptoms of sinusitis, fever with nuchal rigidity or headache (meningitis), and headache and fever with deterioration of neurological signs (brain abscess). Imaging was also used to confirm this condition. CSF leakage was detected by clinical rhinorrhea and CSF rhinorrhea was proved by a fluid profile. Mucocele formation was confirmed by revealing the

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