



Case Report

Draf Type III Surgery for Delayed Formation of Lateral Frontal Sinus Mucocele with Repeated Inflammation Following Frontal Craniotomy: Case Report and Literature Review

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Citation: Kuruma T, Iwami K, Arimoto M, Yo K, Kawade Y, et al (2022) Draf Type III Surgery for Delayed Formation of Lateral Frontal Sinus Mucocele with Repeated Inflammation Following Frontal Craniotomy: Case Report and Literature Review. Ann Case Report 7: 909. DOI: 10.29011/2574-7754.100909

Received: 09 August 2022, **Accepted:** 13 August 2022, **Published:** 17 August 2022

Abstract

The complication of frontal sinus mucocele can occur long after craniotomy. We experienced a 77-year-old woman who developed recurring sinusitis due to delayed formation of a mucocele in the right frontal sinus at 20 years after frontal craniotomy. Following right frontal sinus surgery performed through a Killian incision, the frontal sinusitis recurred, but showed improvement after endoscopic modified Lothrop procedure (Draf type III surgery). Frontal sinus mucocele can occur due to residual mucosa in the frontal sinus or as an inflammatory reaction due to filling material in the frontal sinus. Prior to operating on a frontal sinus mucocele after craniotomy, it is necessary to discuss the surgical approach thoroughly with the neurosurgeon to confirm whether the primary site of inflammation is in the frontal sinus, and to decide whether the endoscopic modified Lothrop procedure (Draf type III) should be used alone or in combination with frontal sinus surgery via a coronal incision on the scalp as the surgical approach. Preoperative image-based simulation was very effective in the present case. Draf type III, using a navigation system and a frontal sinus punch, is considered a very safe surgical technique for frontal sinus mucocele that is unlikely to cause closure of the nasofrontal canal.

Keywords: Frontal sinus mucocoele; Endoscopic sinus surgery; Endoscopic modified Lothrop procedure (Draf type III); Frontal sinus punch

Introduction

The frontal sinus is frequently a troublesome anatomical obstacle to gaining access to the medial anterior cranial base. In the setting of craniotomy, complications after traversing the frontal sinus can lead to mucocoele formation and frontal sinusitis. Violation of the frontal sinus during craniotomy can result in mucocoele formation as an early or late sequela. Image guidance may help avoid unnecessary frontal sinus violation. As mucocoeles may develop decades after the initial frontal sinus violation, long-term follow-up with imaging is recommended. The endoscopic endonasal approach is generally preferred for treating these lesions; however, it may be necessary to perform obliteration or cranialization in certain situations [1]. Delayed onset of frontal sinusitis after craniotomy is often refractory. In cases where the cause of infection was bone wax, endoscopic modified Lothrop procedure (EMLP/Draf type III, hereafter termed Draf type III) has been reported to result in remission [2]. In contrast, several reports have indicated that control of infection is difficult by Draf type III alone in the case of combined infection of artificial materials such as titanium plates, artificial bones, and bone valves in addition to bone wax infection. In these studies, frontal sinus surgery via a coronal scalp incision or coronal incision of the forehead was also necessary [3,4]. We report a case of recurrent frontal sinusitis caused by a delayed frontal sinus mucocoele that had first occurred as frontal sinusitis immediately following craniotomy, which was eventually cured by the Draf type III procedure.

Case Presentation

A 77-year-old woman had undergone anterior craniotomy to remove an olfactory fossa meningioma 31 years ago at the Department of Neurosurgery at municipal general hospital. Bone wax was used to fill the frontal sinus during craniotomy. Thereafter, she developed recurrent abscesses in the right frontal sinus that resolved following surgical removal of the bone wax in the frontal sinus at one year after surgery. Bacteriological examination of the frontal sinus at the time of surgery revealed resistant *Pseudomonas aeruginosa*. Twenty years after the surgery, the patient once again suffered recurring abscesses due to a right frontal sinus

mucocoele and underwent radical surgery of the right frontal sinus through a Killian incision, which was performed at the Otolaryngology Department of the same general hospital. An exostomy was performed on the right frontal skin and frontal sinus to prevent repeated abscesses after closure of the nasofrontal canal. However, the right frontal exostosis closed, and frontal sinus abscesses reappeared soon afterwards, as well as downward displacement of the right eyeball due to the mucocoele. The patient was referred to another hospital for consultation due to recurrence of a frontal skull base tumor; however, she was hospitalized following acute worsening of the right frontal sinus abscess, which was punctured and drained from a closed fistula in the right frontal region, followed by treatment with antibiotics. Acute exacerbation of frontal sinusitis had occurred approximately three times per year for the past several years. She was then referred to our otolaryngology department for treatment of the right frontal sinus mucocoele, which was necessary prior to surgery for recurrence of the anterior skull base tumor. She had a 30-year history of diabetes mellitus, for which she received insulin therapy. One year ago, she had an infarction in the pons and midbrain and was taking bay-aspirin. On initial examination, the right frontal area was not swollen. The skin of the right forehead was strongly depressed. The right eyeball was displaced downward and slightly outward (Figure 1a). The right nasal cavity was difficult to see clearly even with an endoscope because the olfactory cleft was quite narrow. Computed tomography (CT) scan of the paranasal sinuses revealed soft-tissue shadow on the lateral aspect of the right frontal sinus that was suggestive of cyst formation (Figure 1b). Although the cyst was located laterally, an imaging simulation confirmed that it could be opened by removing the upper nasal septum, using curved forceps from the opposite nasal cavity (Figure 2a, b). Surgery was scheduled for two months later, but the cyst became infected two weeks before surgery, with pus exuding from the right frontal sinus fistula. The fistula was punctured and frontal sinus lavage was performed with saline solution. Bacteriological examination revealed *Pseudomonas aeruginosa*. Two days before surgery, the patient was admitted to the hospital and started on an intravenous infusion of susceptible antibiotics. Surgery was performed under general anesthesia. The left anterior ethmoid sinus, maxillary sinus, and frontal sinus were opened. The nasal septum and perpendicular plate of ethmoid bone were resected superiorly and anteriorly so that both nasal cavities could be seen. The left frontal sinus

foramen was drilled while checking the left frontal sinus foramen, and the left agger nasi and nasal bones were also cut open. The mucosa of the nasal septum was pushed down between the nasal septum and the middle nasal meatus to check the first olfactory threads on both sides and confirm the position of the cranial floor. The frontal septum was then scraped open from the left frontal sinus, and the right frontal sinus (specifically, the internal sinus septum cell) was also opened. The cyst on the outer side of the right frontal sinus was punctured with the tip of the seeker through the membranous closure of the cyst, after searching for the location of the cyst with the seeker of the navigation system (Stealth Station S7®, Medtronic, Minneapolis, MA, USA) (Figure 3a). The surrounding frontal bone, including the base of both frontal sinuses with strong bone thickening, was also scraped open to reveal the right frontal sinus mucocoele under clear view. The bone around the cyst could not be forceped with a regular curette or other means, including by drilling. Hosemann frontal sinus punches (Karl Storz Slender model, HOSEMANN Frontal Sinus / Recess Punches, 3.5 mm dia. Punch Head, 2.5 mm dia. Sheath, 13 cm Working Length) were inserted through the left nasal cavity and the bone around the right frontal sinus mucocoele was cleanly removed and opened (Figure 3b, c). Pus exuding from the inside of the right frontal sinus was repeatedly swabbed. There was no evidence of bone wax inside the frontal sinus. Postoperatively, intranasal *Pseudomonas aeruginosa* infection occurred that resolved with the administration of antibiotics. At one year after surgery, there is no obstruction of the open mucocoele in the right frontal sinus (Figure 4a, b) and no recurrence of inflammation in the right frontal sinus. Long-term follow-up is scheduled to continue.

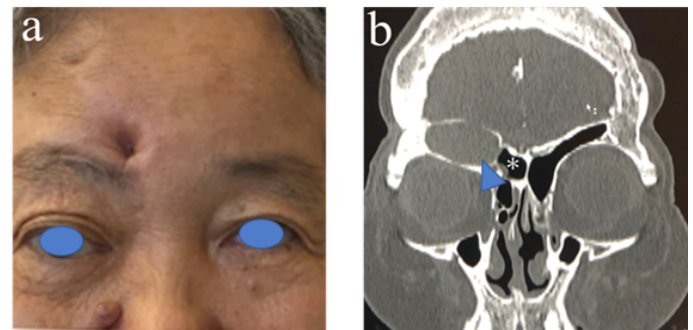


Figure 1: Initial findings. a) Photograph of the forehead. The external fistula is located in the depression in the right forehead. b) CT coronal section of the sinuses. A frontal sinus mucocoele (arrowhead) is seen lateral to an internal septal cell (ISSC) (*) located to the right of the midline.

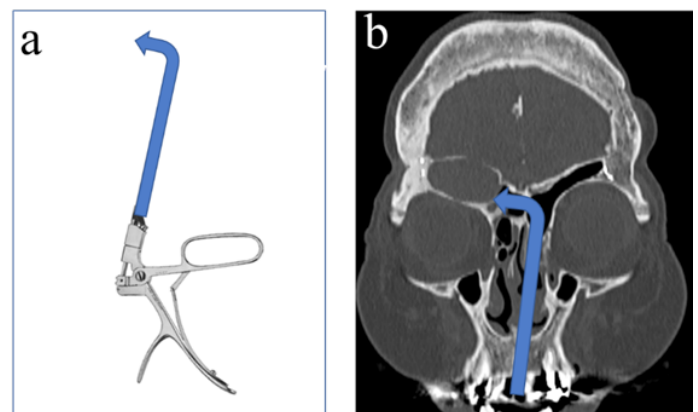


Figure 2: Preoperative CT image simulation. a, Direction and tip of the frontal sinus punch. b, Simulation of frontal sinus punch using a CT image of the sinuses.

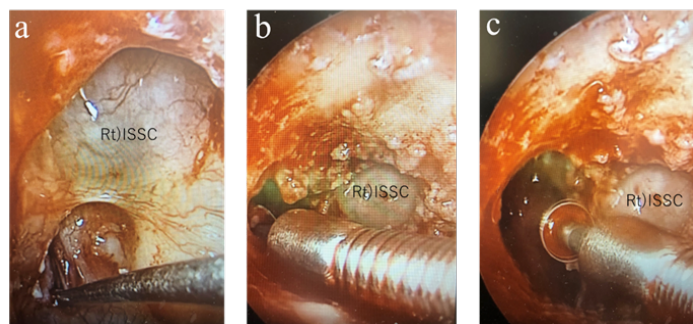


Figure 3: Intraoperative findings. a, Right frontal sinus mucocoele on the lateral side is perforated with a seeker. b, Bone anterior to the cyst is removed using a frontal sinus punch. c, Bone above and behind the cyst is removed with a frontal sinus punch. Rt) ISSC: right internal septal sinus cell.

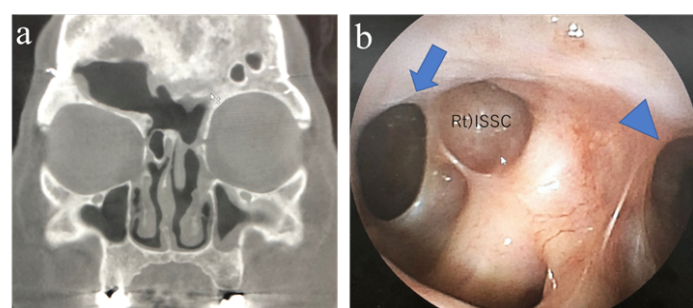


Figure 4: Findings at 1 year after surgery. a, CT coronal section of the paranasal sinuses shows a wide opening between the right frontal sinus mucocoele and the nose. b, Nasal endoscopic findings also show a wide opening between the right frontal sinus mucocoele and the nose (arrow). Open area of the left frontal sinus (arrowhead).

Discussion

Complications that may occur when the frontal sinus is opened during craniotomy include frontal sinus mucocoele, CSF leakage, meningitis, osteomyelitis, brain abscess, cavernous sinus thrombosis, and facial disfiguration [5]. To prevent these complications, it is important that no mucosa remains on the cranial side and that the space between the cranial side and the nasal cavity is completely blocked. In particular, mucocoele can develop in the frontal sinus early in the postoperative period or even decades later, requiring careful long-term follow-up. Farag et al. reviewed 36 cases of frontal sinus mucocoele after craniotomy, including 9 cases at their institution. They reported that frontal sinus

mucocoele occurred in the range of 3 months to 36 years (mean: 14.5 years) after craniotomy [1]. Yoshioka confirmed that in all reoperations for delayed mucocoele formation in the frontal sinus, the frontal sinus recess had been blocked due to incomplete removal of frontal sinus mucosa during the initial craniotomy [6]. Hydroxyapatite and bone wax are artificial materials that are frequently used to fill the frontal sinus during craniotomy. In particular, bone wax is a non-absorbable material that is prone to infection, granulation, and allergic reactions, including abscess formation, and it has been reported that inflammatory reactions due to foreign body reactions may progress in the short and long term, resulting in delayed mucocoele formation [7]. In the present case, there was a 20-year interval between the first and second episodes of frontal sinusitis. Therefore, we hypothesized that the right frontal sinus abscess that occurred soon after craniotomy was caused by early inflammation of the frontal sinus in response to bone wax or to bacterial infection of the bone wax. The recent bacteriological examination revealed the presence of resistant *Pseudomonas aeruginosa*, suggesting the possibility of recurrent frontal sinusitis. The early frontal sinus abscess had resolved following the removal of bone wax in the frontal sinus in the early postoperative period. We considered the possibility that the remaining mucosa within the frontal sinus was the cause of the delayed frontal sinus mucocoele. Right frontal sinus surgery was performed using the Killian incision technique accordingly, and we speculated that postoperative changes had caused nasofrontal duct obstruction and formation of a mucocoele outside the right frontal sinus. The bony valve of the frontal bone itself may also have become infected. There are two methods of otorhinolaryngological surgical treatment for frontal sinus mucocoele: 1) opening the frontal sinus through an intranasal or extranasal skin incision and then providing an excretory channel, and 2) removing the diseased mucosa and filling the sinus with fat or other material. Since Draf established endonasal frontal sinus surgery for frontal sinus lesions in 1991[8], the standard procedure for frontal sinus cysts has shifted to endoscopic endonasal surgery. More recently, the widespread use of navigation systems has made it relatively safe to perform endonasal surgery for bony obstructed frontal sinus lesions [9]. Draf classified nasal endonasal sinus surgery into three types [8]. Type I, enlargement of the normal frontal sinus drainage tract (Draf type I method, simple drainage); type II, enlargement of the base of the frontal sinus anterior to the frontal sinus opening

(Draf type II method, extended drainage); and Draf type III, bilateral expansion of the bottom of the frontal sinus (Draf type III, median drainage) in which the upper nasal septum and frontal septum are removed and the enlarged openings of the left and right frontal sinuses are connected.

In the present case, based on the preoperative sinus CT findings, we considered that a frontal sinus mucocoele existed externally, but the space inside it was an inter sinus septal cell (ICCS). Therefore, the cyst formed due to obstruction of the nasofrontal duct, which was originally located outside of the ICCS. Although a bony obstruction blocked the nasofrontal duct, the bone was not thick. When we opened the frontal sinus mucocoele, the bone was easily punctured with a thin-tipped instrument (the seeker), suggesting that membranous closure of the nasofrontal canal had occurred, followed by thickening of the bony part of the surrounding frontal sinus septum and closure.

The bony part of the nasofrontal sinus canal was also easily removed and opened wide with Hosemann frontal sinus punches. The small head of the frontal sinus punch allowed us to open the nasofrontal canal while keeping a close eye on the manipulated part, even in the narrow perioperative field around the frontal sinus located on the outside. In the Draf type III procedure in particular, restenosis due to damage to the mucosa around the nasofrontal canal from drilling is a major postoperative problem. The frontal sinus punch used in this case can open the nasofrontal canal to its maximum extent, enabling preservation of the mucosa surrounding the nasofrontal canal, which is thought to reduce the risk of postoperative closure due to scar formation or bone growth in the frontal sinus canal [10]. In the present case, the nasofrontal canal remained wide open and no stenosis was observed at one year after surgery. Preoperative imaging simulation was very useful in the present case. By removing the upper nasal septum and creating a single frontal sinus using the Draf type III procedure, we were able to visualize and confirm before surgery that the frontal sinus punch would reach the lesion site from the contralateral nasal cavity. Several factors have been cited as causes of frontal sinus mucocoele, including bone wax, hydroxyapatite, artificial bone, or titanium plates used to fill the frontal sinus during craniotomy, as well as infection of the bone valve [3,7]. Hirai et al. reviewed 10 cases of frontal sinus mucocoele after craniotomy and found that Draf type III was performed in 3 cases of frontal sinus mucocoele caused by

bone wax, all of which showed improvement [7]. In addition, 7 cases of combined infection with artificial material lower than the canopy of the frontal sinus were treated with Draf type III, of which 5 cases showed improvement [7]. Hirai et al. noted that if there is a primary site of inflammation in the frontal sinus, opening the frontal sinus with Draf type III may improve ventilation in the frontal sinus, which may secondarily control infection of the artificial material and bone valves. If the artificial material is higher than the canopy of the frontal sinus, however, the authors state that the Draf type III procedure is insufficient and that frontal sinus surgery through a coronal scalp incision is necessary [7]. In the present patient, we discussed the case with the neurosurgeon prior to surgery and confirmed that the inflammation was mainly located in the frontal sinus before performing intranasal Draf type III surgery, which improved the inflammation in the frontal sinus.

Conclusion

Frontal sinus mucocoele after craniotomy is a complication that can occur long after surgery. In the present patient, right frontal sinusitis developed after frontal craniotomy, followed 20 years later by frequent frontal sinusitis caused by delayed formation of a right frontal sinus mucocoele. A frontal sinus mucocoele may be caused by residual mucosa in the frontal sinus or by an inflammatory reaction due to filling material in the frontal sinus. Prior to performing surgery for a frontal sinus mucocoele after craniotomy, it is necessary to confirm with the neurosurgeon whether the inflammation is located mainly in the frontal sinus, and to decide whether intranasal surgery (Draf type III) alone or combined with frontal sinus surgery through a coronal scalp incision should be performed. The Draf type III procedure for frontal sinus mucocoele using the navigation system and frontal sinus punch is considered a very safe surgical technique that is unlikely to cause closure of the nasofrontal canal.

References

1. Farag A, Rosen MR, Ziegler N, Rimmer RA, Evans JJ (2020) Management and Surveillance of Frontal Sinus Violation following Craniotomy. *J Neurol Surg B Skull Base* 81: 1-7.
2. Kanowitz SJ, Batra PS, Citardi MJ (2008) Comprehensive management of failed frontal sinus obliteration. *Am J Rhinol* 22: 263-270.
3. Kuboki A, Asaka D, Nakayama T, Okusi T, Otori N (2011) Modified Lothrop Procedure of Refractory Frontal Sinusitis. *Oto-Rhino-Laryngology* 54: 151-156.

4. Akiyama K, Karaki M, Takeda J, Mori N (2011) Two Cases Report of Pott's Puffy Tumor and Pott's Puffy Like Tumor. *Japanese Journal of Rhinology* 50: 143-150.
5. Meetze K, Palmer JN, Schlosser RJ (2004) Frontal sinus complications after frontal craniotomy. *Laryngoscope* 114: 945-948.
6. Yoshioka N (2014) Modified cranialization and secondary cranioplasty for frontal sinus infection after craniotomy: Technical Note. *Neurol Med Chir* 54: 768-773.
7. Hirai T, Fukushima N, Go K, Sera T, Fujita R, et al (2021) Surgical Strategy for Delayed-onset Frontal Sinusitis After Craniotomy. *Journal of Otolaryngology of Japan* 124: 876-883.
8. Draf W, Minovi A (1991) Endonasal micro-endoscopic frontal sinus surgery: The fulda concept. *Operative Techn Otolaryngol Head Neck Surg* 2: 234-240.
9. Kuhn FA, Javer AR, Nagpal K, Citardi MJ (2000) The frontal sinus rescue procedure: Early experience and three-year follow-up. *Am J Rhinol* 14: 211-216.
10. Dubin MG, Kuhn FA (2005) Endoscopic modified Lothrop (Draf III) with frontal sinus punches. *Laryngoscope* 115: 1702-1703.