

전두동 골절에서 내시경적 치료의 확대 적용

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Extended Application of Endoscopic Repair for Frontal Sinus Fractures

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Purpose: The coronal approach for repair of frontal sinus fractures is associated with significant adverse sequelae including a long scar, alopecia, paresthesias, and, uncommonly, facial nerve injury. To minimize these complications, an endoscopic approach for repair of frontal sinus fractures was developed. The authors now present the results of an endoscopy-assisted approach for the treatment of frontal sinus fractures.

Methods: From 2002 to 2009, five patients with frontal sinus fracture underwent endoscopic repair. Two slit incisions were placed in the scalp, and one or two stab incisions directly over the fractures were placed in the forehead. After subperiosteal dissection, fracture segments were reduced under direct vision and fixed with microplates or fibrin glue.

Results: All patients had good cosmetic results and remained free of sinus complaints. There were no perioperative complications reported.

Conclusion: Endoscopic repair of frontal sinus fractures is an efficacious technique that significantly reduces patient morbidity. A relatively wide range of anterior table fractures can be reduced using an endoscope. In cases of complicated comminuted fractures, fibrin glue helps to achieve satisfactory endoscopic reduction. Endoscopic repair is an alternative treatment for various anterior table fractures of the frontal sinus.

Key Words: Endoscopic repair, Frontal sinus fracture

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I. INTRODUCTION

Frontal sinus fractures constitute 5 to 15 percent of maxillofacial fractures.¹ Usually, the trauma is caused by high velocity injuries such as motor vehicle accidents, assaults, and sporting events. The frontal sinus fracture is not the most pressing immediate concern during resuscitation and stabilization. Nevertheless, it assumes a prominent position in the management algorithm of craniofacial trauma, because of the complications of delayed or improper management: persistent cerebrospinal fluid (CSF) leakage, mucocele, mucopyocele, encephalitis and brain abscess.²

The treatment algorithm for a complex frontal sinus fracture involving the frontal recess or posterior table is controversial due to associated complications. But, mild to moderately displaced anterior table fractures carry a relatively low risk of long-term morbidity and are generally treated as aesthetic deformities.¹ Traditionally, a coronal approach was widely used to achieve bony reduction and rigid fixation. Unfortunately, the coronal approach for repair is associated with significant adverse sequelae including a long scar, alopecia, paresthesias, and, uncommonly, facial nerve injury. Consequently, an endoscopic approach to these injuries was recently developed.³

The advantages of endoscopic surgery include more accurate visualization, a minimal number of external incisions, and reduced soft tissue dissection. Hence, endoscopy is widely used nowadays in plastic surgery for facial contouring and rejuvenation procedures. Similarly, traumatic facial fractures, particularly zygomatic complex fractures and selective mandibular fractures, have been repaired with this minimally invasive approach.^{4,6} Until now, a few case reports have described endoscopic procedures to manage frontal sinus fractures, and mostly fractures with a limited extent of damage have been treated.³ We applied endoscopic techniques to more extensive and comminuted fractures. This article presents the authors' experiences regarding endoscopic

Table I. Patient Demographics

Case No.	Sex/Age	Cause	Severity	Fracture extent (mm)	Associated injury	Timing of repair after injury (days)	Follow-up (months)	Fixation
1	M/28	Assault	Simple depressed	32 × 25	Orbital roof fracture	9	13	Microplate
2	M/18	Assault	Simple depressed	31 × 30	Orbital roof fracture	7	14	Microplate
3	M/16	Assault	Comminuted	35 × 30	Orbital roof fracture	14	15	Microplate
4	M/20	Slip down injury	Comminuted	55 × 30	No	17	8	Fibrin glue
5	M/23	Sports injury	Comminuted	40 × 25	No	17	4	Fibrin glue

approaches to treatment of a depressed anterior table of the frontal sinus with extended application in various sized fractures.

II. MATERIALS AND METHODS

From 2002 to 2009, five patients with displaced anterior table frontal sinus fractures were selected for repair using endoscopy (Table I). All were men and their average age was 21 years (ranged from 16 to 28 years). The mechanisms of injury included assaults (n=3), sport injuries (n=1), and slip down injuries (n=1). All patients presented obvious forehead depressions on physical examination. Preoperative facial skeleton computed tomography (CT) scans demonstrated anterior, simple, depressed or comminuted fractures. Three of the patients had associated orbital roof fractures. No nasofrontal duct injuries or posterior table fractures were identified. There were no other associated injuries such as neurosurgical, ocular, or extremity injuries. Three of the five patients underwent surgery within 2 weeks of the fracture. The other two were referred from another institution and underwent surgery in 3 weeks after the injury.

All operations were done under general anesthesia. Two 2-cm longitudinal incisions were made behind the anterior hairline (Fig. 1). The incisions were deepened into the subperiosteal layer and an endoscope (5 mm, 30 degree) was introduced through the left incision. With the aid of the endoscope, further downward subperiosteal dissection was performed to the fracture site using a periosteal elevator. The boundary of the frontal sinus fracture was clearly defined under direct vision (Fig. 2).

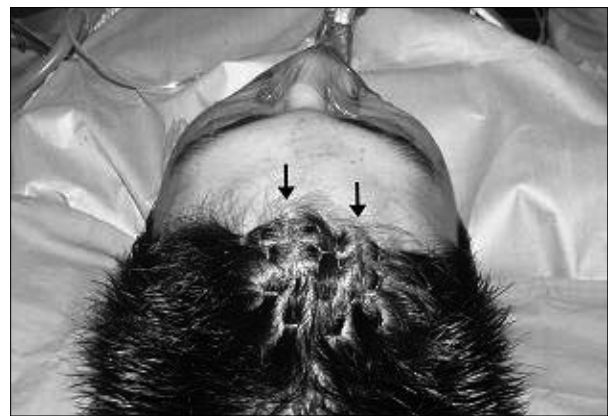


Fig. 1. Two 2-cm longitudinal incisions (arrows) were placed behind the anterior hairline.



Fig. 2. Endoscopic view showing depressed fractures.

One or two stab incisions were made on the forehead skin just above the fracture sites. Through these incisions, a handling screw was inserted when possible and a bone

hook was inserted to reduce the number of fractured fragments. With gentle retraction, the fragments were elevated into a reduced position. When comminution was not severe, internal fixation was done, which was possible in three patients. Drilling and plating were performed in situ when possible. In one case, fragments were assembled and fixed with microplates on the side table and reinserted with further fixation to the adjacent frontal bone (Fig. 3). In another two cases, the fragments were too small with extensive comminution. So, fibrin glue was applied over the surface of the reduced fragments instead of attempting rigid fixation. Finally, the operative field was irrigated with sterile saline and a silastic drain was inserted into the scalp wound. The frontal sinus area was protected from all compressive forces for several weeks.

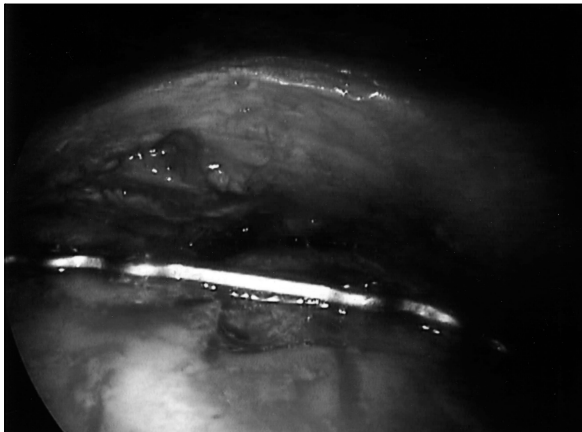


Fig. 3. Fragment fixed with a microplate to the adjacent frontal bone.

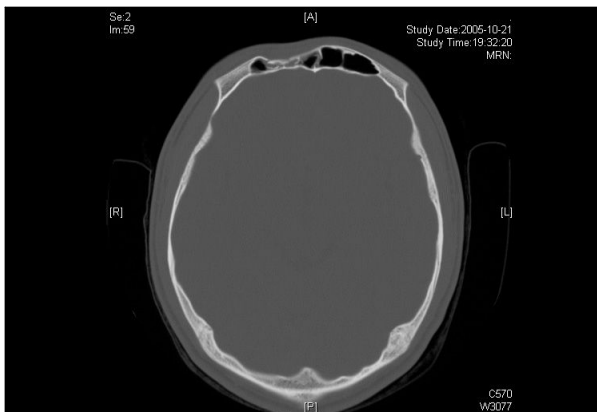


Fig. 4. Case 1 (Left) Depressed deformity (arrows) over the right frontal area caused by an assault injury. (Right) Preoperative computed tomography.

III. RESULTS

None of the patients needed to undergo conversion to traditional bicoronal incisions. After surgery, all patients were discharged uneventfully within 1 week. Follow-up periods ranged from 4 to 15 months (mean, 11 months). All had good cosmetic results and remained free of sinus complaints. Computed tomography (CT) scans revealed patent frontal sinuses and acceptable fracture reduction in all patients. No perioperative complications were reported.

Case 1 (Case No. 3 in Table I)

An otherwise healthy 16-year-old patient presented following an assault injury in which he sustained a displaced anterior table frontal sinus fracture. The patient had an obvious depression in his right forehead contour (Fig. 4) and an area of hypoesthesia in the territory of the right supraorbital nerve. CT scans showed large pneumatized frontal sinuses with an isolated, comminuted fracture of the anterior table of the right frontal sinus (Fig. 4). No pneumocephalus or involvement of the nasofrontal duct was noted.

The frontal sinus fracture was corrected under endoscopic control and fixed with a microplate using stab incisions. In 15 months after the surgery, the right previously depressed frontal area was well recontoured (Fig. 5). The follow-up CT showed complete anatomic reduction of the fracture sites and bone healing (Fig. 5). No evidence of mucocele or mucopyocele was found until 16 months postoperatively.

Case 2 (Case No. 4 in Table I)

A 20-year-old patient presented with a slip down fall-related, injury directly to his left frontal area (Fig. 6). The fracture was corrected under endoscopic control using two

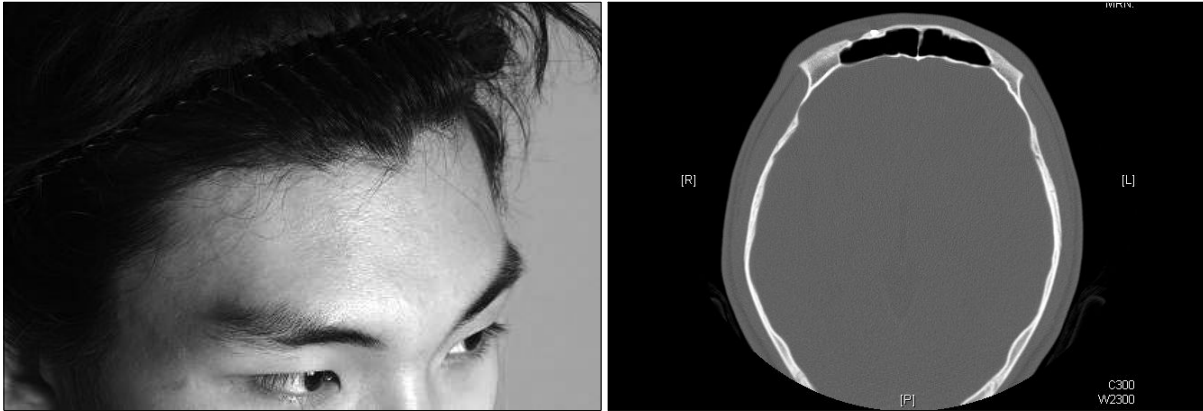


Fig. 5. Case 1 (Left) Good contour of the right forehead 16 months after the surgery. (Right) Postoperative computed tomography showing a well-reduced frontal fracture.

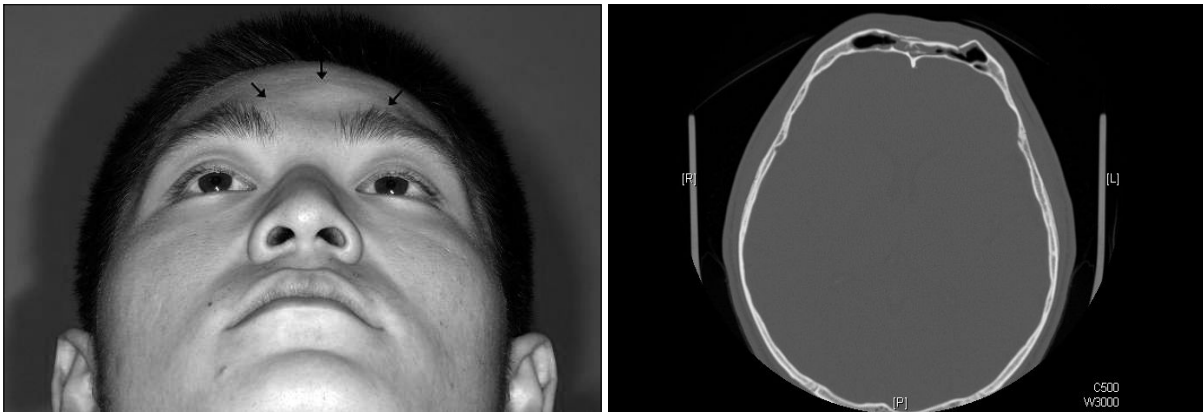


Fig. 6. Case 2 (Left) Wide depressed deformity (arrows) over the left frontal area caused by a fall-related injury. (Right) Preoperative computed tomography shows an extensive fracture size with severe comminution.

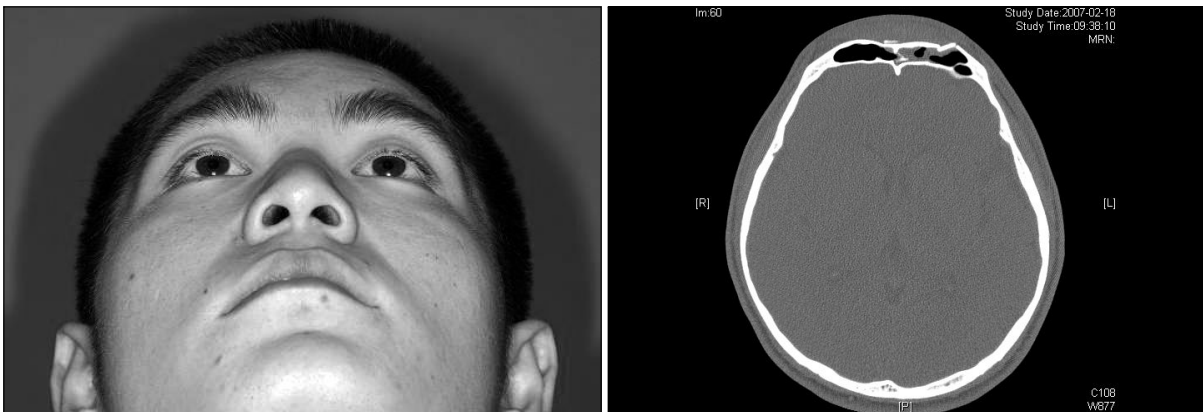


Fig. 7. Case 2 (Left) Good contour of the forehead was achieved with fibrin glue fixation only after reduction. (Right) 4 months after the surgery, computed tomography showing acceptable contour of the frontal bone.

stab incisions. The size of the fracture was so extensive with severe comminution that fibrin glue was applied over the surface of the reduced fragments instead of rigid fixation. The

follow-up CT showed adequate reduction of the fracture site (Fig. 7).

IV. DISCUSSION

The appropriate management for a frontal sinus fracture is a matter of debate because of the associated risks of brain injury, meningitis, cerebrospinal fluid fistula, and mucocele formation. But, the consensus is that surgical operative exploration is necessary for anterior table displacement with aesthetic forehead deformity, nasofrontal duct involvement or obstruction, and displacement of the posterior table with dura tear and CSF leakage.⁷

Although coronal incision is a widely accepted method of approach to a frontal sinus fracture, it has some disadvantages. An endoscopic approach is suitable for displaced anterior table fractures. Surgeons can achieve the same results that bicoronal incisions give with only one or two percutaneous incisions. Several authors have published case reports detailing successful management of anterior wall fractures of the frontal sinus using endoscopy.⁸ Initial reports have dealt with eggshell fractures of the anterior wall that are simply “popped” back into position and allowed to heal without rigid fixation. Onishi et al.⁹ reported endoscopic reduction and rigid fixation using microplate and microscrews in 1998. They used an endoscopic approach in cases of minimal and non-comminuted fractures. Strong³ used camouflage techniques with 0.85 mm thick porous polyethylene implants to treat isolated, moderate displacement (2 to 6 mm) fractures of the anterior table. The fracture camouflage technique involves an observation period to allow resolution of facial edema, followed by recontouring of the defect with an alloplastic implant. Authors of these previous reports used an endoscopic approach in fractures of limited extent.

On the other hand, we applied an endoscopic technique in more extensive and comminuted fractures. When the extent of fracture was wide, one or two stab incisions were used on the forehead skin just above the fracture sites for drilling and rigid fixation. In cases of extensively comminuted fractures, alignment and fixation of plates were often difficult to do accurately. If the comminuted fragments were not suitable for rigid fixation, fibrin glue was applied to keep them in reduced position. When there is some stability of fractured fragments provided by hanging them on surrounding stable bony structures, fibrin glue is helpful for maintaining the reduced position.¹⁰

Although the stability of reduced fragments with fibrin

glue is weaker than that with a microplate, the anterior table of the frontal sinus is not an area [[to resist strength?]]. Furthermore, partial under-correction of fractured fragments is not noticeable externally because of soft tissue thickness in the glabellar region. Fibrin glue helps to achieve safe, accurate, and rapid open reduction by avoiding the difficult steps of inserting and affixing plates to bone fragments. Fibrin glue also reduces the problems attendant to relatively long surgical times and surgeons' inexperience with complicated surgical techniques. We can achieve satisfactory results in extensive and comminuted fractures using fibrin glue.

Nevertheless, not all frontal sinus fractures are suitable for endoscopic repair. Displaced posterior table fracture with CSF leakage or nasofrontal duct injury require open reduction or even frontal sinus obliteration.¹ Thus, preoperative evaluation is important for selection of the treatment method.

V. CONCLUSION

Endoscopic repair of frontal sinus fractures is an efficacious technique that significantly reduces patient morbidity. A relatively wide range of anterior table fractures can be reduced using endoscopy. In cases of complicated comminuted fractures, fibrin glue helps to achieve satisfactory endoscopic reduction. Endoscopic repair is an alternative treatment for variously sized anterior table fractures of the frontal sinus.

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