A novel technique for placing titanium mesh with porous polyethylene via the endoscopic transnasal approach into the orbit for medial orbital wall fractures

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Background The endoscopic transnasal approach is widely used for reconstructing the medial orbital wall by filling it with a silicone sheet or Merocel, but this technique has the disadvantage of retaining the packing for a long time. To overcome this drawback, a method of positioning an absorbable plate in the orbit has been introduced, but there is a risk of defect recurrence after the plate is absorbed. Here, the authors report the results of a novel surgical technique of placing a nonabsorbable titanium mesh with porous polyethylene into the orbit through the endoscopic transnasal approach.

Methods Fourteen patients underwent surgery using the endoscopic transnasal approach. Preoperative computed tomography (CT) was used to calculate the size of the bone defect due to the fracture, and the titanium mesh was designed to be shorter than the anteroposterior length of the defect and longer than its height. The titanium mesh was inserted into the orbit under an endoscopic view. The authors then confirmed that the titanium mesh supported the orbital contents by pressing the eyeball and finished the operation. Immediately after surgery, CT results were evaluated.

Results Postoperative CT scans confirmed that the titanium mesh was well-inserted and in the correct position. All patients were discharged without any complications.

Conclusions We obtained satisfactory results by inserting a titanium mesh with porous polyethylene into the orbit via the transnasal approach endoscopically.

Keywords Wound and injuries / Endoscopy / Orbit / General surgery / Titanium

INTRODUCTION

Blowout fractures account for 13.3% of all facial fractures, and medial orbital wall fractures alone account for 0% to 55% of cases [1-3]. Although the incidence of medial orbital wall fractures is not very low, there is currently less consensus regarding the
treatment of medial orbital wall fractures than there is for orbital floor fractures [4]. A medial orbital wall fracture that is not treated correctly can cause late enophthalmos and facial asymmetry [5]. Therefore, more research is needed on the optimal treatment of this condition.

Various approaches have been used for the surgical treatment of medial orbital wall fractures. Some of these approaches have disadvantages, such as difficulty in securing sufficient vision for the operation and scarring in the facial area. The endoscopic transnasal approach introduced by Yamaguchi et al. [6] in 1991 is widely used to overcome these shortcomings [7-11].

The endoscopic transnasal approach is often used to fill the nasal cavity with a silicone sheet and Merocel to reconstruct the medial orbital wall. However, this technique has several problems; for instance, the patient must endure considerable discomfort and the risk of surgical site infection increases because the filling materials must be maintained for a long time. To overcome these drawbacks, a method of positioning an absorbable plate in the orbit through the endoscopic transnasal approach has been introduced [12]. However, it is difficult to identify absorbable plates because they are radiolucent, and they also may induce a foreign body reaction [13]. Furthermore, although this is somewhat controversial, it is likely that late enophthalmos can occur after absorption of the plate [14-16].

To overcome these disadvantages, the authors devised a new surgical technique to place a nonabsorbable plate of titanium mesh with porous polyethylene into the orbit endoscopically via the transnasal approach. Here, we report the results of applying this surgical technique in a series of cases.

**METHODS**

**Study patients**
From July 2017 to July 2018, 14 patients who were diagnosed with pure medial orbital wall fractures were operated on using the endoscopic transnasal approach. The causes of the fractures were falls in five patients, assaults in three patients, traffic accidents in five patients, and exercise injury in one patient. There were nine males and five females. Three patients complained of diplopia at the time of admission, and six patients complained of gaze limitation. All patients underwent surgery within 2 weeks of the injury (Table 1).

**Surgical procedure**
All patients underwent orbital wall reconstruction surgery using the endoscopic transnasal approach under general anesthesia. First, cottonoids soaked with diluted epinephrine (1:100,000) were filled in the middle meatus using a 0° 4-mm-diameter endoscope (Tricam NTSC; Storz, Tuttinglen, Germany) to induce atrophy and vasoconstriction of the nasal mucosa. A solution of 1:100,000 epinephrine and 2% lidocaine was injected into the anterior border of the middle turbinate, around the uncinate process, and into the adjacent septum and lateral wall of the middle turbinate. When needed for a sufficient visual field, the anterior part of the middle turbinate was partially resected. An incision was made in the uncinate process using a sickle knife, and the ethmoidal sinus was opened. After identifying the site of the medial orbital wall fracture, the herniated orbital contents were pushed into the orbit. Preoperative computed tomography (CT) images were used to calculate the size of the bone defect due to fracture. The size of the bone defect was calculated by multiplying the width by the height of the defect. The titanium mesh with porous polyethylene (Medpor Titan Barrier sheet; Stryker, Kalamazoo, MI, USA) was trimmed to be shorter than the anteroposterior length of the defect and longer than its height (Fig. 1). A 30° endoscope was used to insert a titanium mesh into the bone defect. We placed the implant so that it could be fixed to the uninjured border of the defect (Fig. 2). After pressing the eyeball, we confirmed that the titanium mesh supported the orbital contents. Immediately after the operation, the forced duction test was performed, and the operation was terminated.

**Radiologic examinations**
Before and after surgery, CT was performed using the same protocol (120 kV, 280 mAs, 1.0-mm section thickness). Preoperative CT scans were taken within 1 week from the date of injury, and postoperative CT was performed immediately after surgery (Figs. 3-5).

| Patient | Sex | Age (yr) | Cause     | Defect size (cm²) | Problem                              |
|---------|-----|----------|------------|-------------------|--------------------------------------|
| 1       | Female | 35      | Traffic accident | 1.7               | Gaze limitation                      |
| 2       | Female | 70      | Traffic accident | 3.4               | None                                 |
| 3       | Male   | 39      | Assault    | 2.5               | None                                 |
| 4       | Male   | 29      | Traffic accident | 2.3               | None                                 |
| 5       | Female | 59      | Fall       | 3.2               | Diplopia, gaze limitation            |
| 6       | Male   | 17      | Fall       | 4.2               | None                                 |
| 7       | Male   | 27      | Assault    | 3.9               | None                                 |
| 8       | Male   | 52      | Traffic accident | 2.3               | None                                 |
| 9       | Male   | 67      | Assault    | 3.4               | None                                 |
| 10      | Male   | 43      | Exercise   | 2.7               | Diplopia, gaze limitation            |
| 11      | Male   | 56      | Traffic accident | 4.8               | None                                 |
| 12      | Female | 37      | Fall       | 4.0               | Diplopia, gaze limitation            |
| 13      | Female | 58      | Fall       | 2.2               | None                                 |
| 14      | Male   | 56      | Fall       | 2.9               | Gaze limitation                      |
Follow-up of patients
All patients underwent follow-up at 2 weeks after surgery. The authors assessed patients for the presence of symptoms such as diplopia and gaze limitation.

RESULTS
The postoperative CT images showed that the titanium mesh was well-inserted and in the proper position, and that the orbital contents were kept in the orbit. We also confirmed that the symptoms that patients complained of before surgery had resolved after surgery. All patients were discharged within 1 week after surgery without any complications.

DISCUSSION
In 1991, Yamaguchi et al. [6] introduced the endoscopic transnasal approach for reconstruction of medial orbital wall fractures; since then, it has been widely used due to its various advantages, including a wide visual field during the operation and the lack of a subsequent scar on the facial area [7-11]. However, the choice of the implant to be inserted is also important, as well as the approach to the reduction of medial orbital wall fractures. The implant should be determined considering the defect size, associated injuries, age, and donor site morbidity [17]. The ide-
A novel technique for blowout fractures

A nonabsorbable plate is harder and difficult to handle than an absorbable plate, so it was trimmed to be shorter than the anteroposterior length of the defect and longer than its height so that the implant could be inserted through the bone defect site. It could be possible to trim the plate to be shorter than the height and longer than the anteroposterior length of the defect. However, when the plate is inserted, the tissue around the bone defect could be damaged by the plate, and we were afraid of damage to the optic nerve. Therefore, the authors chose the former strategy. This allowed the implant to be fixed in proper position by the intact bone around the defect. This method does not require nasal packing, and therefore reduces the risk of complications such as infection and patient discomfort. Additionally, titanium mesh with porous polyethylene has the advantage of being able to maintain its load-bearing capacity permanently, and its position can be identified on postoperative radiological examinations. However, the limitations of this technique are that it is difficult to perform, the operating time is relatively long, and it is likely to be influenced by the skill of the operator. It may also be expected that the mesh will be difficult to remove after insertion. In this study, we confirmed that excellent results were obtained from CT examinations performed immediately after surgery. However, a disadvantage is that no follow-up for more than 6 months was carried out, and no study has explored subsequent complications. The small number of cases is also a limitation of this study. Further research on these issues will be needed in the future, but this surgical technique is expected to be able to overcome the problems of other surgical techniques. The authors have developed a surgical method of inserting a nonabsorbable titanium mesh with porous polyethylene into the orbit through a transnasal endoscopic approach, and obtained good results, as confirmed by postoperative CT scans. Although additional study is needed, this technique is expected to be another surgical option for medial orbital wall fractures.

NOTES

Conflict of interest
No potential conflict of interest relevant to this article was reported.

Ethical approval
This study was approved by the Institutional Review Board of Pusan National University Hospital (IRB No. H-1907-003-080) and was performed in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained.

Patient consent
The patients provided written informed consent for the publication and the use of their images.

Author contribution
Conceptualization: Bae SH, Jeong DK. Data curation: Go JY, Park H. Formal analysis: Kim JH. Methodology: Lee JW. Project administration: Kang T. Writing - original draft: Jeong DK. Writing - review & editing: Bae SH. Approval of final manuscript: all authors.

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