Association between preoperative inferior rectus muscle swelling and outcomes in orbital blowout fracture

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1. Introduction

In orbital blowout fracture, impairment of eye movements often persists after surgery. One of the possible causes may be extraocular muscle injury (Smith et al., 1984; Gilbard et al., 1985; Lisman et al., 1987; Watanabe et al., 2000; Oba et al., 2001; Kase, 2007). We (Matsunaga et al., 2009) previously evaluated outcomes 1 year after the surgery in patients with orbital blowout fracture who underwent reconstruction using a bone autograft, and reported marked swelling of the extraocular muscle close to the fracture site on preoperative CT images as a finding common to patients in whom impaired eye movements remained.

However, there have been no studies on objective preoperative evaluation methods for prediction of the postoperative impairment of eye movements. Therefore, we objectively evaluated inferior rectus muscle swelling on the injured side in comparison with that on the non-injured side on preoperative CT images in 18 patients with blowout fracture of the orbital floor who underwent reconstruction using a bone autograft, and analyzed the association of this swelling and remaining double vision or impaired eye movements after the surgery.

2. Material and methods

2.1. Subjects

Among orbital blowout fractures, those showing punched out type bone defects with a maximum width \( \geq 20 \) mm are treated by reconstruction using a bone autograft in principle at our department. We performed operations employing a previously reported technique (Matsunaga et al., 2009). Fig. 1 summarizes the surgical methods. At first, we performed a subciliary incision and determined the fracture site in the orbital floor. We removed bone fragments and repaired the orbital tissue (Fig. 1a), inferior rectus
muscle injury was not evaluated by an ophthalmologist during surgery. We confirmed the extent of the bone defect and then, we formed a bone autograft that was the same thickness as so that it was the orbital floor. With regard to the size of the bone autograft, we trimmed the bone autograft slightly larger than the bone defect in order to achieve graft support. The bone autograft was fixed to the front of the orbital floor wall with an absorbable screw (Fig. 1c). We confirmed that the position of the eyeballs was symmetrical and that there was no oculomotor disorder at the surgical site by traction test after fixation of the bone autograft. Fig. 1b and d presents pre and postoperative CT images, respectively. Fig. 1d shows that orbital tissue on the injured side was restored to the normal position.

To exclude the influences of surgical manipulation and reduction materials, one surgeon (K.M) performed all operations, and cases were limited to those treated using a bone autograft. The subjects consisted of 18 patients with orbital blowout fracture who underwent reconstruction using a bone autograft between January 2006 and March 2009 (Table 1). There were 14 males and 4 females aged 13–68 years (mean, 35.6 years). Fracture was observed on the left side in 11 patients and the right side in 7, and the fracture site was the orbital floor in all 18 patients. The cause of injury was the act of a third party in 8 patients, sports in 4, traffic accidents in 4, and falling in 2.

The interval from injury to surgery was between 4–21 days (mean, 13.3 days). The interval from injury to initial examination affected the interval from injury to surgery.

The bone autograft used for reduction was the iliac bone in 15 patients and mandibular bone in 3 (Table 1). The bone autograft used for reduction had been obtained from mandibular bone in early 2006 (Kosaka et al., 2004). However, patients in which mandibular bone was used showed postoperative complications that included marked swelling of the submandibular area, hematoma formation or infection of the donor site. Therefore, the autograft used for reduction has been obtained from iliac bone since the middle of 2006. Table 2 presents preoperative findings on Hess test and the maximal width of fracture on coronal CT images. The Hess test was evaluated by an ophthalmologist. The preoperative maximal width of fracture on coronal CT images ranged from 17 to 22 mm (Table 2). The intraoperative maximal width of fracture was more than 20 mm in all patients.

2.2. Classification of postoperative outcomes

The patients were classified according to the postoperative outcome into four groups (Table 3): Group A without double vision...
showing normal eye movements in the HESS test, Group B with double vision showing normal eye movements in the HESS test, Group C with double vision showing improvement in eye movements (below the normal range) after the operation in the HESS test, and Group D with double vision showing no changes in eye movements after the operation in the HESS test.

### 2.3. Evaluation of inferior rectus muscle swelling on CT images

Evaluation was performed by preoperative CT on the day of the initial visit to our hospital within 12 days after injury in all 18 patients. Coronal CT images obtained with a 2-mm slice width from the anterior toward the posterior area of the eye were used. The slice image showing the most marked swelling of the inferior rectus muscle on the injured side was selected. On slice images, the cross-sectional areas of the inferior rectus muscles on the fracture and non-injured sides were measured using a computer (Fig. 2). Subsequently, the inferior rectus muscle swelling rate on the injured side was calculated using the cross-sectional area of this muscle (injured/non-injured side).

![Fig. 2. Maximal preoperative area of the section of inferior muscles between the injured side and the non-injured side.](image)

### 3. Results

#### 3.1. Classification of postoperative outcomes

Table 4 presents findings on HESS tests and outcomes 1 year after surgery in each patient. According to the outcome 1 year after the surgery, 12 cases (66.7%) were classified as Group A, 2 (11.1%) as Group B, and 4 (22.2%) as Group C, with no case in Group D. In Group A, the interval until double vision disappeared was varied with individual and ranged from 1 month to 1 year postoperatively.

#### 3.2. Evaluation of inferior rectus muscle swelling by preoperative CT

Figs. 3a, 4a and 5a present slice images showing the most marked swelling of the inferior rectus muscle on the injured side. Figs. 3b, 4b and 5b present findings of the HESS test before the surgery and Figs. 3c, 4c and 5c present findings of the HESS test 1 year after the surgery. Case 13 (Group A) showed no extraocular muscle swelling on the injured compared with the non-injured side and an inferior rectus muscle swelling rate of 1.1 (Fig. 3a). In case 6 (Group B), marked inferior rectus muscle swelling was observed on the injured compared with the non-injured side, and the inferior rectus muscle swelling rate on the injured side was 2.2 (Fig. 4a). Case 9 (Group C) showed marked inferior rectus muscle swelling on the injured compared with the non-injured side and an inferior rectus muscle swelling rate of 2.0 (Fig. 5a).
4. Discussion

The reported factors associated with a poor prognosis in surgically treated patients with orbital fracture include: (1) extraocular muscle injury (Smith et al., 1984; Gibbard et al., 1985; Lisman et al., 1987; Watanabe et al., 2000; Oba et al., 2001; Kase, 2007), (2) preoperative severe double vision (Kase, 2000; Watanabe et al., 2000; Lee et al., 2005), and (3) young patients (de Man et al., 1991; Watanabe et al., 2000; Burnstine, 2002; Kamijo et al., 2005; Kwon et al., 2005). Concerning extraocular muscle injury, Kase (2000) reported that extraocular muscle swelling and deviation are factors associated with a poor prognosis. We (Matsunaga et al., 2009) also evaluated outcomes 1 year after surgery in patients with orbital blowout fracture who underwent reconstruction using a bone autograft, and reported remaining double vision or slight impairment of eye movements after the operation in patients showing marked swelling of the extraocular muscle close to the fracture site on preoperative CT images. However, there have been no studies on the methods of objective preoperative evaluation of the degree of extraocular muscle swelling for the prediction of postoperative outcomes. Therefore, we objectively evaluated inferior rectus muscle swelling on the injured compared with the non-injured side to determine the degree of its swelling associated with remaining postoperative double vision and impaired eye movements in 18 patients with orbital blowout fracture who underwent reconstruction using a bone autograft. As an objective method for the evaluation of inferior rectus muscle swelling, the rectus muscle swelling rate on the injured compared with the non-injured side was calculated, and its association with the outcome 1 year after the operation was evaluated.

As a result, in the group without postoperative double vision or impairment of eye movements, the inferior rectus muscle swelling rate on the injured side was ≤1.2, showing no marked swelling of this muscle on preoperative CT images. In the groups with remaining double vision or impaired eye movements after the operation, the swelling rate of this muscle was ≥1.6, showing clear inferior rectus muscle swelling on the injured side.

To determine whether the degree of orbital floor fracture influenced the inferior rectus muscle damage, we evaluated the association between the preoperative maximal width of fracture on coronal CT and outcomes. The maximal width of fracture in the group without postoperative double vision or impairment of eye movements and those in the groups with persistent double vision or impaired eye movements after surgery showed the same mean value, of 19.7 mm. There was no association between preoperative fracture size and postoperative outcomes.

Therefore, whether the preoperative inferior rectus muscle swelling rate is ≥1.6 or not may be a useful indicator in the prediction of the postoperative outcome.
Fig. 4. Group B (case 6). (a) Findings of preoperative inferior muscles (arrow: the injured side). Swelling rate of the inferior muscle: the injured side/the non-injured side = 2.2. (b) HESS test before surgery. (c) HESS test 1 year after surgery.

Fig. 5. Group C (case 9). (a) Findings of preoperative inferior muscles (arrow: the injured side) Swelling rate of the inferior muscle: the injured side/the non-injured side = 2.0. (b) HESS test before surgery. (c) HESS test 1 year after surgery.
5. Conclusion

In 18 patients with orbital blowout fracture who underwent reconstruction using a bone autograft, the association between preoperative inferior muscle swelling and the outcome 1 year after surgery was evaluated. In patients in whom the preoperative cross-sectional area of the inferior rectus muscle on the injured was \( \geq 1.6 \) times that on the non-injured side, double vision or slightly impaired eye movements may remain after surgery.

References


