Surgical Outcome of Blowout Fracture: Early Repair Without Implants and the Usefulness of Balloon Treatment

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Purpose: To determine the surgical intervention time, which is most likely to achieve a high success rate for blowout fracture repair without implants and the usefulness of treatment with an intramaxillary sinus balloon.

Methods: Two hundred patients with isolated fractures of the orbit were evaluated by the Hess screen test, the Hertel exophthalmometer, and coronal computed tomography of the orbit. Operative criteria included diplopia within 30 degrees and enophthalmos >3 mm. An inferior lid incision approach was used to expose the orbital floor for realignment of bone fragments. Eighty of the patients received a gingival incision, followed by an osteotomy to create a 10-mm opening into the maxillary sinus for placement of a silicon-Teflon-silicon balloon.

Results: The highest success rate, with diplopia completely improved in 66% of the patients, was observed when surgery was performed within 3 days after the injury. This success rate declined as surgical intervention was delayed. In 197 cases, enophthalmos was improved to <2 mm postoperatively for patients who had surgery within 14 days. The balloon treatment was well tolerated and caused no complications.

Conclusions: Surgery within 3 days is recommended in cases with diplopia and enophthalmos. An intramaxillary sinus balloon treatment was useful for the cases with large orbital floor fracture that could cause latent enophthalmos. **Jpn J Ophthalmol 2003;47:392–397** © 2003 Japanese Ophthalmological Society

Key Words: Balloon treatment, blowout fracture, diplopia, enophthalmia, orbital floor fracture.

Introduction

Patients with pure blowout fractures not involving the orbital rim or adjacent facial bones are usually free of preoperative ocular abnormalities.[1] However, multiple trauma carries a risk of postoperative complication from infection, implant rejection, anterior migration and prolapse of the eye, or posterior migration causing compression of the optic nerve with a net effect resulting in decreased visual acuity.[2–4] The timing of surgery is an important predictor of outcome, with most authors favoring a 7- to 14-day, or even a 21-day waiting period.[5–7] The Japanese literature suggests that immediate intervention results in improved prognosis.[8–11] These decisions depend mainly on the preoperative criteria used by the different surgical specialists who perform orbital repair. Following serious trauma to the orbit, restoration of the normal anatomy with implants is a common surgical intervention. Current articles describing implanted materials and surgical procedures for large patient populations have been published.[12–18] When orbital volume exceeds an 8% change as accessed by computed tomography (CT),[19–21] autogenous bone grafts, metals (titanium, vitallium), porous polyethylene, hydroxyapatite, methylmethacrylate, ceramic, or alloplastic materials like Teflon, Silastic, Medpor, Supramid, and Marlex,[22,23] or Vicryl (absorbable mesh; Ethicon, Sommerville, NJ, USA) are used for repair. Banked irradiated fascia lata and lyophilized dura are other alternatives.[24]

The objective of this study was to evaluate the surgical intervention time, which is expected to yield a high success rate for blowout fracture repair and to determine the

Received: November 6, 2001

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Jpn J Ophthalmol 47, 392–397 (2003)

Published by Elsevier Science Inc.

0021-5155/03/$–see front matter
doi:10.1016/S0021-5155(03)00057-1

Table 1. Age and Sex Distribution of Cases in the Study

Age (y)	Male	Female
0–9	14	6
10–14	25	2
15–19	37	2
20–24	35	4
25–29	26	4
30–39	8	4
40–49	15	8
50–59	5	2
60–69	0	2
70–79	0	1
Total	165	35

usefulness of an intramaxillary sinus balloon support procedure for cases with entrapment of orbital soft tissue.

Materials and Methods

The study was approved by the Showa University Institutional Review Board and informed consent was obtained from the patients. Two hundred patients with isolated fractures of the orbit were seen in the Ophthalmology Department over a 4-year period. Among these patients, 165 were men and 35 were women. The age range was 4–71 years (mean, 24 years; Table 1). The main cause of trauma in all age groups was alcohol-related assault (83 cases); followed by sports injuries, primarily due to baseball and soccer (38 cases); traffic accidents (33 cases); and other accidents (46 cases), such as falls, head-to-eye collisions, and domestic accident. All patients, initial or referred, had fractures of the orbital floor only. A single operation was performed within 3 days on 64 primary cases admitted directly to the Showa University Eye Hospital. One hundred and fourteen patients were referred for an initial operation and were treated for periods from 4 days to 2 months. The extent of injury in each group was essentially the same prior to surgery. Twenty-two other patients had been operated on at another location and referred here for a second corrective operation due to persistent diplopia (Table 2). The follow-up time ranged from 3 weeks to 5 years (mean, 20 months).

Table 2. Interval Between Fracture and Surgery

Interval Before Surgical Intervention (ds)	No. of Cases	
	First Operation	Re-Operation
0–3	64	0
4–7	33	1
8–14	35	0
>15	46	21
Total	178	22

Preoperative examination was performed to determine disturbance of ocular motility as evaluated using the Hess screen test,[25] enophthalmos was measured with the Hertel exophthalmometer. A simultaneous binocular field map was also prepared. Axial and coronal orbital CT were used to determine the type (linear or defect) and extent of fracture, associated soft tissue damage, and, in selected cases, orbital volume.[26] Operative criteria were (1) patient complaint of diplopia, (2) >3 mm of enophthalmos at time of examination, (3) a positive forced duction, and (4) CT evidence of entrapment of soft tissue. Diplopia in the vertical field of gaze was charted and graded on a scale of 1–4, after the operation; grade 1 = no diplopia, grade 2 = diplopia restricted to a small isolated area, grade 3 = diplopia beyond 30 degrees superior or inferior without inconvenience to daily living, grade 4 = diplopia within 30 degrees of primary position. These tests were repeated postoperatively for prognostic evaluation.

Surgical procedures were performed under local anesthesia (2% Lidocaine). With a Zeiss 6-C ophthalmic microscope, an inferior lid incision was made at 1 mm below the eyelash level, removal of orbital fatty tissue, the periorbita elevated to expose the orbital floor, extraocular muscle entrapment corrected and checked by forced duction, and bone fragments realigned along the defect.[27]

Eighty patients received an intramaxillary sinus balloon treatment.[28] When the surgeon observed evidence of orbital soft tissue entrapment after reintegration, an intramaxillary sinus balloon treatment was performed. A second 3–4-cm gingival incision extending from the incisor to first molar was made and a 10-mm hole opened into the maxillary sinus using a 5–6-mm Hass chisel and Kerrison ophthalmic rongeur. The balloon consisted of three alternating layers of silicon-Teflon-silicon (Medical Koken, Tokyo) attached to an 18-cm polyethylene tube (Figure 1). The balloon portion was guided into the sinus with a stylet and a volume appropriate for each patient ranging from 10–20 mL of 50% Urographine radio-opaque contrast medium (Schering AG, Berlin, Germany) was injected into the balloon until the orbital floor was raised and then the tube was stopped with a Teflon plug. The tube was brought out at the labial commissure and temporarily secured externally over the lateral aspect of the face to allow further adjustments in volume as determined by radiography the following day. Three days after the operation, the tube was reduced in length to fit inside the mouth. Patients received oral broad spectrum antibiotic therapy, a complete ophthalmological examination daily for visual function and evidence of complications, and were discharged on the third postoperative day. Two weeks later, the balloon was drained, the tube removed with contents, and the incision closed.

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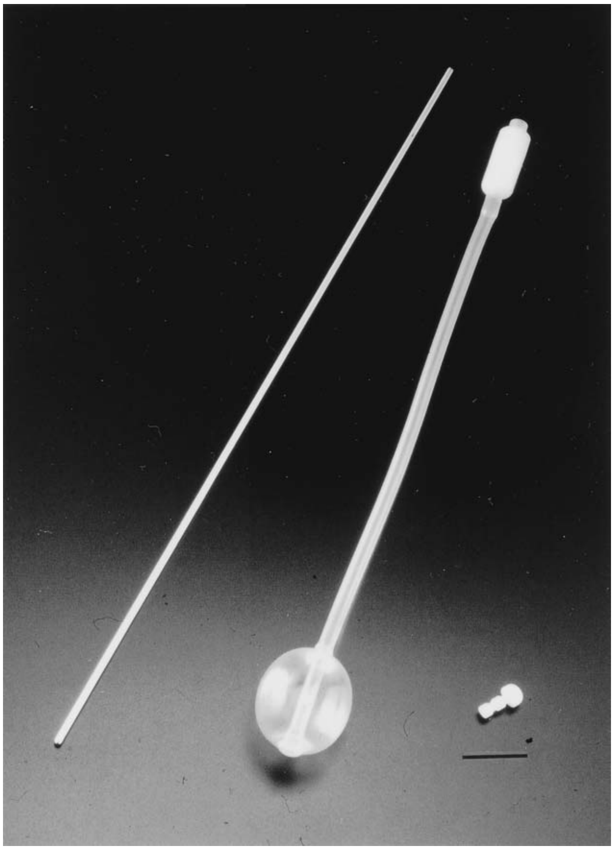

Figure 1. Figure shows from the left, stylet, balloon, and plug. The balloon consisted of three alternating layers of silicon-Teflon-silicon (Medical Koken, Tokyo) attached to an 18-cm polyethylene tube. Bar = 1 cm.

The criteria for success were that diplopia improved to lower than grade 3, and enophthalmos improved to <2 mm postoperatively.

Results

The age and sex distribution of the patient population is presented in Table 1.

The 64 patients who had single surgery were operated on within 3 days of the accident, 68 patients were operated on 4–14 days after the accident, and another subset of 46 patients were operated on between 15 days and 2 months after the accident (Table 3). Twenty-two patients had a second surgery. There was a definite relationship between the improvement in diplopia and a brief interval before surgery. Recovery was poor when the time until surgery was extended. For example, the percentage of patients with grade 1 diplopia (no diplopia) postoperatively was highest (66%) when surgery was performed within 3 days, and the percentage declined in a linear fashion thereafter in relation to interval time. Conversely, the percentage of patients with residual diplopia increased as a function of time. Only 1 patient had troublesome diplopia and that patient had been operated on 2 months after injury.

There were 118 cases who sustained bone defect fractures and 82 cases presented with a linear fracture (Table 4). Presurgical examination for restricted eye movements showed that 90–95% of the patients had deficits in vertical gaze (supraduction and/or infraduction). Upon admission, 159 cases (88 defect type and 71 linear type) had enophthalmos <2 mm, and 25 cases (17 defect type and 8 linear type) had enophthalmos between 2.0 and 2.9 mm. Of the 16 cases (13 defect type and 3 linear type) showing the most severe enophthalmos (>3 mm) prior to surgery, 13 cases (11 defect type and 2 linear type) of the 16 cases improved to <2 mm postoperatively and 3 cases retained enophthalmos of >3 mm. These 3 cases had received late surgical intervention, ie, between 15 days and 2 months. Other cases all improved to <2 mm enophthalmos postoperatively.

In the 200 cases reviewed in this study, 73 cases with defect type and 7 cases with linear type received balloon treatment during the initial surgery. Optimal positioning of the intramaxillary sinus balloon is shown in Figure 2 (A: anterior, B: lateral x-rays). The orbital floor was easily returned to its original location using this temporary implant procedure, which enabled the surgeon to produce a slight exophthalmos. Upon removal of the balloon, the eye was restored to the same height as the contralateral eye. Direct observation of the orbital floor, by endoscopy[29] through the original submaxillary surgical site,

Table 3. Relationship Between Surgical Intervention Time and Prognosis

	0–3 Days		4–7 Days		8–14 Days		≥15 Days	
	Patients	%	Patients	%	Patients	%	Patients	%
No diplopia	42/64	66	17/33	52	13/35	37	13/46	28
Residual diplopia								
Grade 2–3	22/64	35	16/33	48	22/35	63	32/46	70
Grade 4	0		0		0		1/46	2

Criteria of success rate: Diplopia improved to less than grade 3.

Table 4. Type of Blowout Fracture, Globe Position on Admission, and Success Rate

	Defect type		Linear type	
Preoperative enophthalmos (mm)	Patients (Balloon Cases)	Success Rate*	Patients (Balloon Cases)	Success Rate*
<2.0	88 (53)	100 (100)	71 (5)	100 (100)
2.0–2.9	17 (14)	100 (100)	8 (1)	100 (100)
≥3.0	13 (6)	85 (83)	3 (1)	67 (100)
Total	118 (73)		82 (7)	

*Criteria of success rate: Enophthalmos improved <2 mm postoperatively. Values are percentages.

showed no displacement of contents following balloon removal. Hypoesthesia of the infraorbital nerve distribution was always present until 3 months after surgery and then resolved. No postoperative complications were encountered in the surgery without balloon treatment. With the balloon procedure, leakage occurred in 8% of the cases due to puncture by sharp bone fragments. Sinusitis occurred in 2 cases (1.5%) and was resolved by antibiotics.

Discussion

Reports vary about the timing of surgical intervention for repair of blowout fracture.[30] Recently, Burnstine sug-

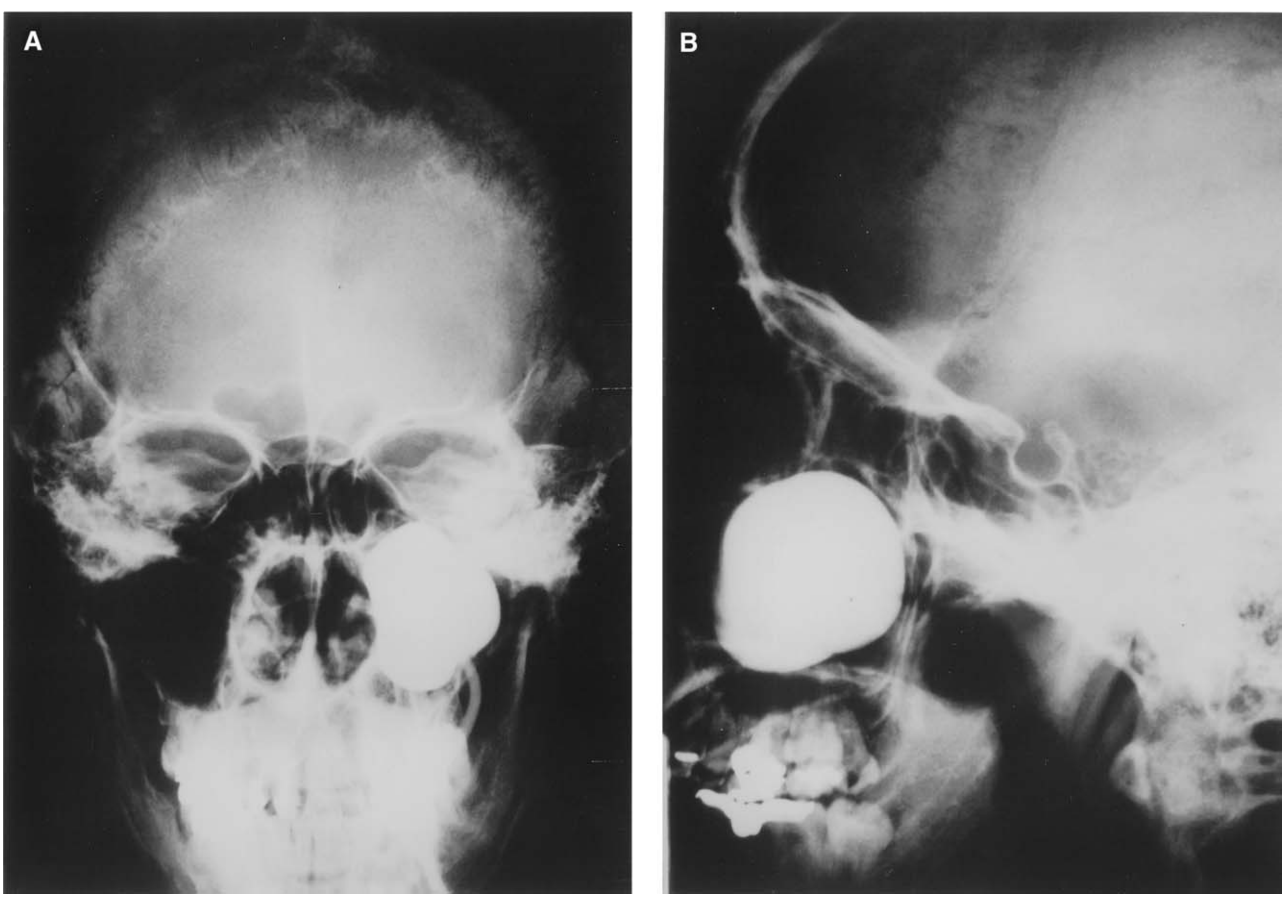

Figure 2. Anterior (**A**) and lateral (**B**) x-ray photographs of optimal positioning of the balloon at 1 day after surgery in a 17-year-old male patient with defect type of blowout fracture. Fifteen milliliters of 50% Urographine radio-opaque contrast medium was injected into the balloon.

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gested surgery within 2 weeks in a MEDLINE literature review,[29] but we recommend a very short period of less than 3 days, which, in our experience, provides a very satisfactory outcome. We consider grade 1 postoperative diplopia as an excellent outcome and 66% of our patients fell into that category. Of the remaining 34%, the outcomes were good (grade 2) or acceptable (grade 3). Thus, our success rate based on grade 3 or better as a measurement of morbidity was 100%. In recent reports where time to surgery was 13–23 days,[31] or up to several months,[18,21] more patients had diplopia remaining after surgery than we have observed. Troublesome grade 4 diplopia was encountered in only 1 case in our study, and that occurred when surgery was performed at 2 months after injury.

Enophthalmos markedly improved to $<$2 mm in 197 patients who received surgery within 14 days. In only 3 cases (2 defect type and 1 linear type) enophthalmos remained at 3 mm; in these cases surgical intervention had been more than 15 days after injury.

The results of this study indicate that with early intervention, especially within the first 3 days following post-traumatic injury, improvement in ocular mobility and reduction of enophthalmos can be expected. Our data agree with the results of Jones,[32] who recommended immediate referral of sports injuries to an ophthalmologist and early surgery.

Also, we report here for the first time that early removal of orbital fatty tissue before it becomes extensively damaged post trauma, reduces the extent of enophthalmos in the linear type of fracture. We think the structure of the trapdoor promotes ischemia of the extruded orbital tissues, and waiting longer than 3 days to perform surgery allows changes to develop that increase the degree of enophthalmos. Jordan et al.[33] also suggested that early surgery (within 2–4 days) is more appropriate than a wait-and-see period of 2–3 weeks in patients less than 18 years of age.

The balloon procedure is designed for use in a large defect or compound fractures and gives excellent results in these circumstances. It not only allows easy repositioning of displaced bones of the orbital floor, but is strong and flexible, biocompatible, and a temporary type of implant that, in contrast to the conventional types, can easily be removed. Shifting of orbital contents may be directly observed by endoscopy. These are important advantages. One disadvantage is that it involves a second invasive surgery. However, the additional surgery required for this procedure was well tolerated by our patients. Because the infection rate was extremely low in our patients, the procedure has merit. Including all of our earlier studies that began in 1985, we have performed this operation successfully on over 100 patients. With experience and improved technique, the number of patients with postoperative enophthalmos of $>$3 mm has decreased.[34] Therefore, we suggest that the balloon technique can be used effectively in place of rigid implants when repairing major ocular trauma. It is essentially free from postoperative complications.

The authors thank Donald Armstrong, PhD, DSc, for editorial assistance, James Reidy, MD, for reviewing the manuscript, and Takako Nakanishi-Ueda, PhD, for data analysis and graphics.

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