Pure "blow-out" fractures of the orbital floor

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The true blow-out fracture of the orbital floor

As early as 1889, Lang conceived the existence and probable mechanism of the blow-out fracture. For many decades after this no mention is made of this type of injury in the literature until an accurate description was given in 1943 by Pfeiffer. Smith and Regan (1957) clarified the mechanism by which the internal or blow-out fracture is produced, by experiments on the cadaver. In recent years there has been an increasing interest in the study of these fractures, the accumulated evidence emphasizing the importance of their early diagnosis and prompt treatment.

This report gives an account of ten cases of pure blow-out fractures diagnosed and treated at the ENT clinic at the Central Hospital, Falun, Sweden, during the period 1964-1970.

Definition

"Pure blow-out fracture" is a term denoting downward displacement of the orbital floor of traumatic origin, which is not accompanied by an orbital rim fracture (Converse, Smith, Regan, 1957). It is caused by a sudden increase in intraorbital pressure, produced by blunt trauma. By contrast, a secondary or impure blow-out fracture is a fracture of the orbital floor, associated with other facial fractures.

Mechanism

The orbit is a quadrilateral, pyramidal bony cavity with a reinforced anterior rim. The vertical diameter of the orbit is about 35 mm, the horizontal diameter about 40 mm, and the depth about 50 mm. The weakest part is the floor, which measures no more than 0.5 to 1.0 mm in thickness. The floor forms the roof of almost the entire maxillary sinus, its weakest part being the anterior part. The orbit is filled with fat, blood-vessels and nerves, lachrymal gland, extraocular muscles, and the eyeball.

The pure blow-out fracture results from a force applied directly to the orbital contents from in front, the striking object having a diameter greater than the orbital opening. An isolated rupture of the eye is more likely when the injury object is smaller in diameter than the orbital aperture, for example, a golf ball. The force is transmitted through the orbital contents to all portions of the bony walls, resulting in a fracture of the weakest portion of the floor, causing extrusion of more or less of orbital soft tissues into the maxillary sinus (Fig. l).

Classification

From the point of view of surgical pure blow-out fractures can be subdivided into two groups (Whyte, 1969).

I. The depressed type, where a segment of the floor has been driven down into the antrum, and the orbital contents have become herniated into the defect.

II. The linear or trapdoor type, where the same mechanism has produced a linear fracture - the tissue herniates briefly into the fissure and is nipped firmly as the bone plates spring back into position.

Diagnosis

Early diagnosis of a blow-out fracture is very important as early repair is technically easier and gives better results than delayed operation.

Blow-out fractures occur at all ages. The youngest patient reported was a 4-year-old boy (Wolter, Chamichian, 1970), and the oldest more than 70 years old. The greatest incidence is in the age group 15-35 years, and it is much more common in men than in women.

Reliance on the classical signs enophthalmos, diplopia and limitation of upward gaze alone leaves about 50 per cent of cases undiagnosed (Altiyeh, May, Gildersleeve, 1966). It is therefore important to use more adequate methods to increase the diagnostic accuracy.

The following clinical features are helpful:

History

A history of blunt trauma to the face, an object with a diameter larger than the orbital entrance striking the region of the eye from in front. The most common types of violence are automobile accidents, where the forwards-moving head hits the dashboard, a blow with the clenched fist, the elbow or the knee. Conversely, objects smaller than the orbital entrance usually result in an isolated injury to the eyeball.

Periorbital ecchymosis

The extent of the "black-eye" - depends on the size and type of fracture, and is found in most cases, followed by edema of the lids. The initial physical examination may reveal this sign only, but it is not present in every single case.

Restriction of eye motion

Limitation of motion of the eyeball in the vertical axis is a rather common finding, restriction of upward gaze probably being most frequent, and is explained by incarceration of orbital fat and extraocular muscles in the torn floor of the orbit, or it is caused by indirect trauma to the inferior muscles and/or their nerve supply.

Zizmor and associates (1962) attribute the limitation of upward gaze to four possible causes:

I. Incarcerated muscles at the fracture site.

II. Indirect trauma to the muscles.

III. Injury to the nerve supplying the muscles.

IV. Herniation.

Limitation of downward gaze and fixed or semifixed globe must have a similar cause (Figs. 2, 3 and 4). It is, however, important to remember that retrobulbar haemorrhage can result in nonspecific and variable signs of extraocular muscle imbalance.

Diplopia

The extent of diplopia depends on the size and location of the fracture. This is a subjective symptom and difficult to evaluate. The majority of patients present with swelling of the eyelids, making the diplopia test uncertain. The patients often confuse diplopia with fuzzy vision. Day-to-day change of this symptom is common. The diplopia is often over after two to three days.

Infraorbital nerve anaesthesia

This nerve passes through the roof of the antrum, where it gives off the anterior superior dental nerve, before it goes through the foramen infraorbitale to supply the upper lip, the distal one-half of the nasal skin, and lower eyelid. Because of this anatomy, the nerve can easily be injured at any point of its course through the roof of the antrum. Routine X-rays do not always show this fracture and therefore anaesthesia of the infraorbital nerve often is the only reliable clinical finding in a true blow-put fracture.

Radiography

Radiological examination is of course essential, but the thin small bony fragments of the orbital floor may be very difficult or impossible to see on routine X-ray examination of the face. The downward herniation of soft tissues from the orbit into the antrum may be very difficult to perceive because of the absence of air in the antrum in the case of bleeding or the effusion of sinusitis or even because of allergic or infectious thickening of the antral mucosa. Tomography is thus indicated as an additional study in any patients with a clinical suspicion of a blow-out fracture, especially with clouding of the antrum on the injured side as seen on routine X-rays. It is much more efficient means of detecting small bony fragments and the only method for accurately determining the exact site and extent of the injury. A third method of X-ray examination in blow-out fractures is contrast orbitography, which has been found to be 100 per cent accurate (Saviano, Alonso, 1970). The contrast material passes through the traumatic defect in the orbital floor and is easily visualized roentgenographically in the antrum.

Treatment

Treatment is directed toward freeing the orbital contents from the fracture site and the restoration of the orbital floor, and this must be carried out within the first seven to ten days before irreversible changes occur. Fibrous adhesions of soft tissue to bone may become so dense that breaking of the adhesions and restoration of the orbital content to a normal position becomes increasingly difficult as well as hazardous to the involved muscle, bone and vascular tissue. Furthermore, the cosmetic result is poorer in cases of late floor restoration and the patient may need more than one operation.

The objects of surgical repair are therefore: (a) Reconstruct the orbital floor; (b) Replace the prolapsed tissues in the orbit; (c) Free the trapped muscles in order to insure normal mobility of the eye; and (d) Maintain the fracture reduction until sufficient healing and fixation of the fracture has occurred.

One of the four following methods can be used in the treatment of pure blow-out fracture:

(1) Maxillary sinus route (Caldwell-Luc approach).

(2) Infraorbital, subperiosteal approach.

(3) A combination of (1) and (2).

(4) A blind, intranasal antrostomy.

The variations and complexities of blow-out fractures demand that the approach be selected according to the findings in the individual case. Rigidity of management invites a number of failures.

When relying on the Caldwell-Luc approach, alone the antrotomy opening should be large enough to allow a finger to palpate the fracture site, and reduce the fracture (Aiello, Myers, 1965; Atiyeh, May, Gildersleeve, 1966).

Slight over-correction is always attempted to compensate for possible mild atrophy of the periorbital fat that seems to occur eventually in most cases. The mobility of the globe is always tested at operations in order to detect incarceration of the inferior ocular muscles in spite of the reduction. To provide support to the floor of the orbit many types of packing in antrum have been used, gauze pack, penrose drains pack, Anthony-Fisher jackscrew and Shea-Anthony rubber balloon (Anthony, 1952), Ivalon sponge and silastic sponge pack (Aiello, Myers, 1965), and even a Foley balloon catheter. The packing is left in the antrum for ten to fifteen days, depending on the extent of the fracture and its stability at the time of operation. Direct orbital exposure of the floor and the reinforcement of it with a piece of inert material to cover the defect is by many authors the method of choice (Lerman, 1970; Whyte, 1968 and 1969; Piddie, 1968). Different materials have been used for this purpose such as bone from the iliac crest (Converse, Smith, 1950), bone from the anterior maxillary wall, autogenous costal cartilage (Kazanjian, Converse, 1959), methyl methacrylic stents (Anderson, Teague, 1963), acrylic wedges (Sherman, 1952), polyethylene plates (Browning, Walter, 1961), silicon rubber (Lipshutz, Ardizone, 1963; Bowers, 1964; Lerman, 1970; Whyte, 1968 and 1969; Piddie, 1968, Aiello, Myers, 1965; Weiss, 1969), collagen, Dacron Velour (Wolter, Chamichian, 1970).

When using orbital exposure the incision is made over the infraorbital margin at the junction of the lower lid with cheek skin (Lerman, 1970; Whyte, 1968). It allows an easy and quick exposure, and generally avoids injuring the orbital septum, which, if penetrated, may cause a baggy eyelid by herniation of periorbital fat. The incision must not extend too far laterally lest the lymphatics be damaged with consequent persistent oedema of the lower lid, and neither may the incision extend too far medially because then it might disturb the action of the lachrymal pump (Whyte, 1968).

The orbicularis muscle fibers are separated to expose the orbital rim, and the periosteum is incised at the upper surface enabling a wide subperiosteal dissection in the orbit. This is necessary in order to see the fracture and the herniated tissue. The herniated tissues are dissected carefully from the infraorbital nerve. Any loose bone fragments should be removed, and then the implant, approximately 1 mm in thickness and shaped to fit over the defect, is placed over the floor of the orbit under the periosteum. The implant should not be too large because then it may impinge on the extraocular muscles or to the orbital nerve, and a horse hoof-shape seems to be suitable. The choice of orbital alloplasts is wide, but the perfect one is not yet to be discovered. Ideally, it should be soft enough to shape easily, yet firm enough to support the globe and it must also be well tolerated. We have used silicone rubber implant 1 mm in thickness and found that to be satisfactory. Early reduction of postero-medial small "trap-door" blow-out fractures might require only a infraorbital approach, with freeing of entrapped tissue and elevating the hinged segments, with or without an implant. Larger or older fractures require a combined infraorbital and maxillary sinus approach. In these antral support in conjunction with an orbital implant is required.

The intranasal approach with insertion of Foley catheter as the only form of treatment should be used only in unusual circumstances, and is mentioned here only for the sake of completeness.

Discussion

Blow-out fractures are not uncommon result of a blunt trauma to the eye. The diagnosis of these fractures increases with awareness. In my opinion the orbital approach alone is not sufficient in the repair of such fractures. Both orbital and Caldwell-Luc approaches at the same time are necessary for the best results, with very few exceptions. The close association of the otolaryngologist and the ophthalmologist in the diagnosis and treatment of blow-out fractures of the orbital floor is of great importance.

The success of the operation, particularly when undertaken at an early stage is high, and therefore a delay of operation reduces the chances of a good result from both functional and cosmetic points of view. In my opinion it is better to do a careful exploration of the fracture when clinical evidence is not conclusive, than to miss a fracture and be left with the sequelae.

Summary

The pathogenesis of pure blow-out fractures, clinical and radiological diagnosis and surgical correction are discussed. Emphasis is placed on the need for early diagnosis and treatment, and a close association of the otolaryngologist and the ophthalmologist for that purpose. The use of silicone rubber implants is described. The results of ten operated cases are analyzed.