SUMMARY: Blow-out fractures of the orbit may be masked by a 'black' eye. The essential characteristics are:


The pathogenesis and clinical details of this condition is considered together with relevant case histories.

Introduction

Black eyes (Fig. 1) are a common sight particularly in military life. Indeed one is susceptible from childhood days due to the fists and elbows of friend or foe at sport and play, whilst in later life due to the increasing frequency of road traffic accidents, accounting for over 50 per cent of all orbital fractures (Rowe and Killey 1968).

The wide and various injuries resulting in a black eye and the apparent absence of any sequelaes, reinforces the view that these are trivial injuries to be treated with a cold compress and dark glasses. This is true in the majority of cases but over the past decade or so, an awareness of the potential complications of black eyes with particular reference to blow-out fractures of the orbit has occurred. It is now recognised that delay in the diagnosis and treatment of these cases may have permanent consequences for the individual in respect to Binocular Single Vision (BSV) and cosmetic appearance. One must remember that Diplopia if it occurs, is a most distressing symptom to the individual and may produce severe limitations on military career prospects.

A black eye is a descriptive term resulting from the extravasation of blood into the subcutaneous tissues of the eyelids. As a rule this follows the initial injury but obviously when of delayed onset more serious complications such as intercranial bleeding may be suspected; indeed in a road traffic accident, the black eye may be one feature of a multiplicity of problems.
This paper deals exclusively with the minor 'blunt' injury to the orbit such as a fist or tennis-ball, producing a black eye which may mask a blow-out fracture of the medial wall or orbital floor. Damage to the eyeball or adnexae has been excluded but would take priority in treatment.

Illustrated are the basic mechanisms resulting in this injury together with relevant details from clinical cases examined and treated at the Cambridge Military Hospital, Aldershot, and the British Military Hospital, Rinteln.

**Structural anatomy of the orbit**

The primary function of the orbit is a protective shell for the eye yet allowing full mobility. Examination on the dry skull reveals the efficient design in structure and function to this end. The orbital rims are thick for protection whilst the walls and floors are thin bone, merely 0.2 to 0.5 mm thick in parts where strength is of lesser importance. This construction is similar to the remainder of the skull where the delicate balance of weight to function is maintained.

*Transillumination* demonstrates the paper thinness of the orbital roof, which may show the impression of the frontal lobe gyri, the medial wall called the lamina papyracea related to the ethmoid bone cells, and the orbital floor which forms part of the roof of the Maxillary Antrum.

There are a number of potential weaknesses in the orbit; the lateral wall is deficient below making the globe particularly vulnerable to direct injury from this direction. Also the numerous suture-lines, foramina, and fissures reduce its mechanical strength to a direct blow.

The shape of the orbit is likened to a pear, with the stalk in the optic canal and the maximum diameter 1.5 cm behind the orbital rim to house the widest diameter of the eyeball. One can visualise how the orbit develops embryologically around the eyeball in a protective manner.

You will note that the orbit forms part of the skull and facial configuration. It is closely related to the para-nasal sinuses, nasal cavity, anterior cranial fossa and acts as anchorage for the Temporalis muscle. It is thus apparent that many disciplines may be involved in orbital fractures and a 'team' of Maxillo-facial, E.N.T. Ophthalmologists and less frequently Plastic and Neurosurgeons is required in overall management of these patients.

**Blow-out orbital fractures**

The association of orbital trauma with enophthalmos due to orbital floor defects has been recognised for almost a century (Lang 1889). However a scientific explanation on the pathogenesis of this condition was not forthcoming until Pfeiffer (1943) which culminated in the first orbital floor repair (King and Samuel 1944).

The term 'blow-out' fracture was introduced by Converse and Smith (1950, 1957) in the United States of America to describe indirect orbital floor fractures following trauma in which the orbit rim remained intact (Duke-Elder 1970).

It is rather surprising the slow progress in our knowledge and interest of this condition, for only in the past twenty years has the diagnosis been in vogue. This great
upsurge in interest has corresponded with improved diagnostic techniques, particularly in radiological and orthoptist assessment.

Pathogenesis

When a blunt object such as a fist or tennis-ball strikes the orbital margin a rise in intra-orbital pressure is produced (Morton 1967). This pressure is transmitted through the globe and orbital contents to the walls of the orbit; over 95 per cent of these fractures occur in the orbital floor where it covers the Maxillary Sinus (Bleeker et al 1972) and only rarely is the medial wall overlying the ethmoid air cells involved (Fig. 2 (a) and (b)).

It is easy to understand why the orbital floor is most vulnerable due to the thinness of bone and also the curved posterior part of the floor lies closest to the globe thus receiving the maximum hydraulic pressure; additionally the fracture is beneath the geometric optic axis along which the eyeball is pushed as a result of a direct frontal blow (Jones and Evans 1967, Whyte 1968).

Surgical pathology

There are two basic types of blow-out orbital fractures as follows:—

Depressed. Part of the orbital floor is driven into the underlying Maxillary antrum with consequent prolapse of the orbital fat and the inferior extra-ocular muscles. This may result in considerable enophthalmos, displacement of the globe and diplopia.

Trap-door. A similar mechanism occurs as before when the orbital contents are forced through the bony fractures. As the pressure within the orbit reduces to normal, the bone ‘springs’ back trapping the herniating tissues. This is most likely to produce diplopia rather than enophthalmos or displacement of the globe.

Trap-door fractures occur more frequently in young persons due to the elastic nature of the bones (Bleeker et al 1972) and owing to the minimum bony defect, routine radiological techniques may not reveal any fracture.
Clinical features

These are apparent from the nature and pathogenesis of the injury (Figs. 3 and 4).

Fig. 3. This officer sustained a blunt injury to Left orbit from a knee during sport, sustaining a medial wall orbital fracture. Four hours later he blew his nose and described a 'tearing' sensation with gross swelling of the eyelids and proptosis of the globe.

Clinical and radiological examination revealed peri-orbital emphysema, which resolved on conservative treatment, with no sequelae.

A 'Blow-out fracture of the medial orbital wall' may result in a 'retraction syndrome' due to involvement of the medial rectus.

Figs 4 (a), (b) and (c). This 21 year old officer cadet sustained a blunt injury by an elbow during a rugger game four months prior to seeking medical advice for persistent diplopia.

Note the considerable Left Enophthalmos and 2 mm inferior displacement of the globe. He has developed a marked AHP to minimise the diplopia.

Slide (a) shows the gross limitation of elevation and (b) primary position of gaze.

Corrective muscle surgery will be required in this patient.

**Black eye.** Clinical features are demonstrated in Figure 1.

**Enophthalmos** resulting from the herniation of orbital contents into the underlying maxillary antrum (Fig. 4 (b)).

**Diplopia due to muscle involvement** of either the Inferior Rectus, Inferior Oblique or both. This symptom is exhibited chiefly on attempted elevation and depression (Fig. 4 (a)).

**Infra-orbital sensory changes** due to involvement of the nerve in its boney canal on the floor of the orbit on direct injury on the face at the time of the original incident.
Orbital emphysema indicating a communication between the orbit and nasal sinuses (Fig. 3). It is most frequently found in medial wall fractures involving the Ethmoid air-cells. The onset of Orbital Emphysema may be delayed occurring with a rise in pressure in the respiratory passages typically after nose blowing. The crepitant feeling on palpation of the tissues or lids on orbit is pathognomonic of this condition, which usually resolves on conservative treatment with no sequelae (Murphy 1970).

Radiological findings. Over 70 per cent of blow-out fractures are visible on routine facial bone views; both antero-posterior and 30° occipito-mental views are required (Fig. 5 (a) and (b)).

![Fig. 5 (a)](image1)
![Fig. 5 (b)](image2)

Fig. 5 (a) and (b). (a) demonstrates a depressed (L) blow-out orbital floor fracture. The ‘Hanging drop’ appearance of the herniating tissues into the underlying maxillary antrum is well shown, with a relatively opaque maxillary antrum.

(b) A Tomogram (30° occipito-mental) at 7 cm of the same case shows clearly the herniating tissues.

Suggestive signs are (a) Unilateral Maxillary sinus on Ethmoid cell opacification. (b) ‘Hanging-drop’ shadow from the orbital floor clearly visible if the sinus is not cloudy. (c) Discontinuity of orbital floor seen at the edge.

Specialized radiological techniques of Tomography may be required to show the position and size of the bony defect.

Treatment

Before embarking on any form of treatment a full and accurate assessment of the patient is essential and this is best performed in a fully equipped ophthalmological department with orthoptist and specialised facilities available.

Not all patients require surgical intervention; indeed the only indications are: — Diplopia due to muscle incarceration. Enophthalmos of significant cosmetic embarrassment.

In the absence of these clear-cut clinical features, irrespective of radiological findings, these patients are better treated conservatively as iatrogenic diplopia may result from unnecessary manipulation (Whyte 1969). Surgery if indicated, should be
undertaken as soon as possible before troublesome fibrosis in the healing phase takes place.

Surgical techniques

All surgery must be preceded by a Forced Duction Test which is performed by grasping the inferior rectus muscle through the conjunctiva with a pair of toothed forceps to demonstrate tethering of the globe. This may be facilitated by making a small conjunctival incision and inserting a squint hook or traction suture under the inferior muscle belly; the technique has the added advantage of allowing the eye to be 'lifted' whilst inserting an implant along the orbital floor, thereby minimising the risk of trapping the inferior rectus muscle whilst performing this procedure.

Orbital. This approach is utilised in all cases of muscle tethering; where there is a large floor defect, it may be combined with the trans-antral approach. The incision is made along the inferior orbital margin followed by blunt dissection of the orbicularis muscle fibres until the periosteum is reached.

The periostium is incised 2 to 3 mm below the inferior orbital margin and 4" 0" catgut sutures are placed on the cut edges to aid in identification and suturing when closing the layer.

The periostium is then elevated from the bone by blunt dissection along the floor of the orbit until the fracture is found. The herniating tissues are free from the fracture site and an alloplast of silicone or teflon is cut to shape and inserted over the bony defect. The wound is closed in layers and antibiotic cover given in the postoperative phase (Fig. 6 (a) and (b)).

Fig. 6 (a) and (b). This 22 year old soldier was kicked in the face and presented with a swollen face and left 'black eye'. Examination revealed orbital emphysema, infra-orbital anaesthesia and evidence of muscle incarceration substantiated by orthoptist examination and field of BSV.

Surgical treatment by the orbital approach was undertaken and a 3 mm silicone alloplast inserted to cover the bony defect. Photograph (b) was taken on the fifth postoperative day. Note the considerable oedema, which is not unusual. On review at 3 weeks he was asymptomatic having a full field of BSV. He has a mechanical hypertropia within 2 prism dioptre, which is of little significance.
Trans-antral. The maxillary antrum is opened by a Caldwell-Luc procedure and the orbital floor is elevated from below. The antrum is packed usually with an inflated Foley’s catheter, which is inserted through a separate nasal antrostomy and strapped to the face; the buccal mucosa can then be sutured.

This approach is utilised in cases with large bony defects resulting in marked enophthalmos in the absence of muscle incarceration. It may be necessary when difficulty is experienced in the orbital approach (Fig. 7 (a) and (b)).

Fig. 7 (a) and (b). This 26 year old soldier fell down a 'hole' and presented on the second day with a 'black eye'. Examination revealed marked enophthalmos and inferior displacement of the globe. Note the pseudoptosis due to lack of support for the 'sling' ligament and the widening of the supra-tarsal sulcus. There was no evidence of muscle involvement, the patient having basically a full field of BSV, with no diplopia.

A trans-antral orbital repair was performed; the orbital floor was elevated from 'below' and the maxillary antrum packed. Photograph (b) was taken on the third postoperative day, the gauze pack emerging through a nasal antrostomy and strapped to the face. On review at 3 weeks he was asymptomatic and cosmetically very satisfactory. Infra-orbital neuralgia and hypoesthesia persisted for six months before resolution.

Conclusion

Blunt orbital trauma is a common feature of twentieth century life. Diplopia may be the result, which is extremely distressing to patient and doctor alike.

A blow-out fracture of the orbit is a commonly missed diagnosis chiefly due to the difficulty in examination of a bruised swollen black eye and also the initial assessment falls on the unit medical officers who may be unaware of this potential fracture. Fortunately, this condition is relatively benign for it is highly likely that the majority of these cases are undiagnosed and untreated with few sequelae noted by the individual. However, it is recommended that all patients with a 'black eye' are carefully assessed and if there is a suspicion of a blow-out orbital fracture then referral for specialist opinion undertaken.

Without doubt in selected patients, surgical treatment offers the greatest hope of maintaining the maximum field of Binocular Single Vision and cosmetic appearance.
Acknowledgements

I would like to thank Colonel K. P. Milne, Consultant Ophthalmologist at the Cambridge Military Hospital, Aldershot, and Lieutenant-Colonel J. Dowson, F.R.C.S., Command Advisor in Ophthalmology B.A.O.R. for allowing me access to these patients. Additionally my colleagues in Maxillo-Facial and E.N.T. Surgery Lieutenant-Colonel R. A. Smart, B.D.S., F.D.S., D.Orth., R.C.S. and Major A. Burge, F.R.C.S., D.L.O., for their help and co-operation. Finally the invaluable assistance of Miss A. Jones, D.L.O., Senior Orthoptist in the department, Mrs. B. Brand for the typing and illustrations by Mrs. G. Leeson. Major 'Bill' De Bass is responsible for the excellent photographs.

REFERENCES
