

ORBITAL ROOF FRACTURES IN CHILDREN FROM THE POINT OF VIEW OF A NEUROSURGEON

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Abstract

Childhood is a highly risky age group in terms of orbital injuries. Injuries of the forehead in the presence of orbital ecchymosis, swelling and haematoma of the eyelids, infiltration and swelling of the surrounding tissues and the face must be carefully examined for a high level of suspicion of the presence of orbital fracture and exclusion of intracranial complications which may accompany orbital fractures (impressive fracture of the skull, epidural haematoma, pneumocephalus, dilaceration of dura mater, contusion or dilaceration of the brain, liquorrhoea, fronto-orbital encephalocele). An examination must be conducted by a traumatologist (surgeon, neurosurgeon), neurologist, and ophthalmologist. In the case of acute injuries, the most efficient radiological examination is CT, i.e. brain, orbit (with coronary projections as a minimum) and 3-D reconstruction of the skeleton. MR is performed when there is a suspicion of liquorrhoea and orbital encephalocele, and in very small children. The most frequent place of orbital trauma is the orbital roof. Orbital fractures without displaced bone fragments and with exclusion of intracranial complications are treated conservatively. Displaced fragments either in the orbit or the intracranial space indicate an operation. The aim of the operation is to remove displaced bone fragments, stop bleeding and evacuate blood clots, and to reconstruct the damaged bone cover. In the orbit, increased attention must be paid to complete liberation of the optic nerve, ophthalmogyrus muscles, and other potential compressed structures. Parallel neurosurgical treatment of the intracranial trauma is obvious and, in many cases, of priority. The timing of the operation is within 24 hours after the injury unless the condition requires urgent operation (open injuries, epidural bleeding).

Key words

Orbital fractures, Child age, Neurosurgical operation

INTRODUCTION

Orbital roof fractures rarely occur as isolated fractures, but rather as part of more extensive or less extensive craniocerebral injuries or face injuries. In most cases, they accompany fractures of the os frontale leading to the frontobasal cranial cavity. In the case of a simple fissure or undisplaced fracture of one of the orbital walls, it is generally not necessary to perform surgical examination.

However, if the injury is followed by dislocation of bone fragments from the fracture into the orbits or the intracranial space, surgical examination is necessary.

At the Children's Hospital of the Faculty Hospital in Brno, the operations are performed either by neurosurgeons or otorhinolaryngologists; if the face skeleton is injured, co-operation is provided by a stomatologist surgeon. Craniocerebral injuries with orbital roof structures, their lateral wall, and sometimes the medial wall are treated by a neurosurgeon. Fractures of the lower and medial walls of the orbit are treated by an otorhinolaryngologist. In certain cases it is then necessary to perform operations requiring both these specialists together. The aim of the operations is to reposition and remove displaced bone fragments and stop possible bleeding with evacuation of the blood clots. In the intracranial space it is also necessary to evacuate haematoma and stop the sources of bleeding, and treat potential intracerebral injury and provide a watertight suture or plastic operation of the frequently torn dura mater. In the orbit it is mainly necessary to remove any pressure acting on the optic nerve, being the only cranial nerve that is not peripheral, but is a part of the central nervous system. Even its potential suturing would not lead to subsequent regeneration, as is the case with other cranial and peripheral nerves, and permanent blindness caused by interruption or long-term compression of the optic nerve on the affected side is definite. What is also very important is to relieve compression or to suture the partially or completely interrupted ophthalmogyric muscles (whose early treatment can recover its full functions), or other structures compressed in the orbit.

MATERIAL AND METHODS

Between 1998 and 2002, a total of 22 patients with orbital fractures were hospitalised at the Department of Paediatric Surgery, Orthopaedics, and Traumatology of the Children's Hospital of the Faculty Hospital in Brno. Eleven patients with these diagnoses were treated conservatively, 11 patients were operated on.

Of these patients, 12 were boys and 10 were girls at the age of 4–15. The average age was 10 years, only two children were of pre-school age. As regards the children that were not operated on, their diagnoses were simple fissures or fractures of some of the orbital walls without dislocation of bone fragments. As regards the second group, with 11 children undergoing operations, 8 patients were operated on for orbital fractures, in the other 3 cases the orbital fracture was identified only during the operation of a more serious intracranial injury with a fracture of the skull and intracranial bleeding. In 3 patients, some of the adjacent parts of the facial skeletons were also injured.

All patients were hospitalised immediately after the injuries. The injuries occurred most often during sporting activities (football, cycling, gymnastics, sledging), during children's games (falls from lofts), and car accidents. One boy was hurt by a drop side of a factory train.

After admission, each of the patients underwent neurological examination, ophthalmological and radiological examinations.

During the ophthalmological examination, swelling and haematoma of the lids and adjacent surroundings of the injured orbit were observed, along with pain of the eye, diplopia, failure of movability of the eyeball, sometimes enophthalmus, in one case significant limitation of vision and, in the case of one boy, blindness with mydriatic non-reacting pupil.

The neurological examinations showed signs depending on the seriousness of the intracranial injuries. Ten patients experienced problems with consciousness disorders. The unconsciousness was prevailingly short, being a consequence of commotion, but in one case it was longer due to cerebral contusion with dilaceration, subdural and intracerebral haematoma. A gradually growing conscious-

ness disorder was observed in two patients with epidural bleeding. In two cases, leakage of liquor from an open wound was found.

Radiological examinations always indicated CT examination of the brain with a skeletal window and sagittal and coronary cuts and then targeted CT orbit in the sagittal and coronary projections with specific aiming at the optic canal, or possibly 3-D reconstruction of the bone skeleton. Simple X-ray pictures of the skull and orbits were not performed in all patients due to the utilisation percentage of the CT examinations, but mostly in the case of lighter injuries where operations were not indicated.

All operations were performed within 24 hours after admission to the Children's Hospital.

In all operations, fronto-orbital osteoplastic craniotomy according to R. Johnson (*Fig. 1*) was performed with various modifications based on the type and extent of the injury (*Fig. 2, 3*).

All patients who were operated on were provided with totally administered broad-spectrum antibiotics.

Bone fragments were fixed using non-absorbable suturing material. The plastic operation of the dura was made using suture and grafts from the periosteum; in the case of three patients the defect of the dura was covered using a Dura Guard patch.

Following the operation, checking ophthalmological and neurological examinations were made until the clinic conditions of the patients improved or got stabilised.

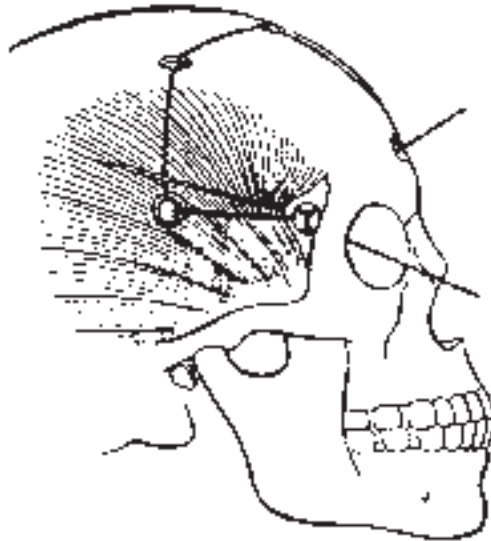


Fig. 1

Johnson's combined fronto-orbital osteoplastic craniotomy



Fig. 2
Our modified fronto-orbital osteoplastic craniotomy

RESULTS

Patients who were not operated on and who suffered from simple fissures of the orbital walls did not show signs of diplopia, defects of movability of the eyeball or defects of vision and, during hospitalisation, no health troubles occurred in long-term monitoring.

As regards the patients who were operated on, the movability of the eyeball fully recovered within 14 days, but in one patient with persisting paralysis of downward look the situation improved only after 3 months. The signs of diplopia disappeared within a week, but took longer in two patients. In one patient, the diplopia disappeared in 3 weeks and in another patient in 14 weeks.

In a patient with a bone fragment straining an optic nerve in the orbital apex, who was absolutely blind when admitted to the hospital with a non-reacting mydriatic pupil, the operation slightly decreased the pupil's mydriasis and improved the

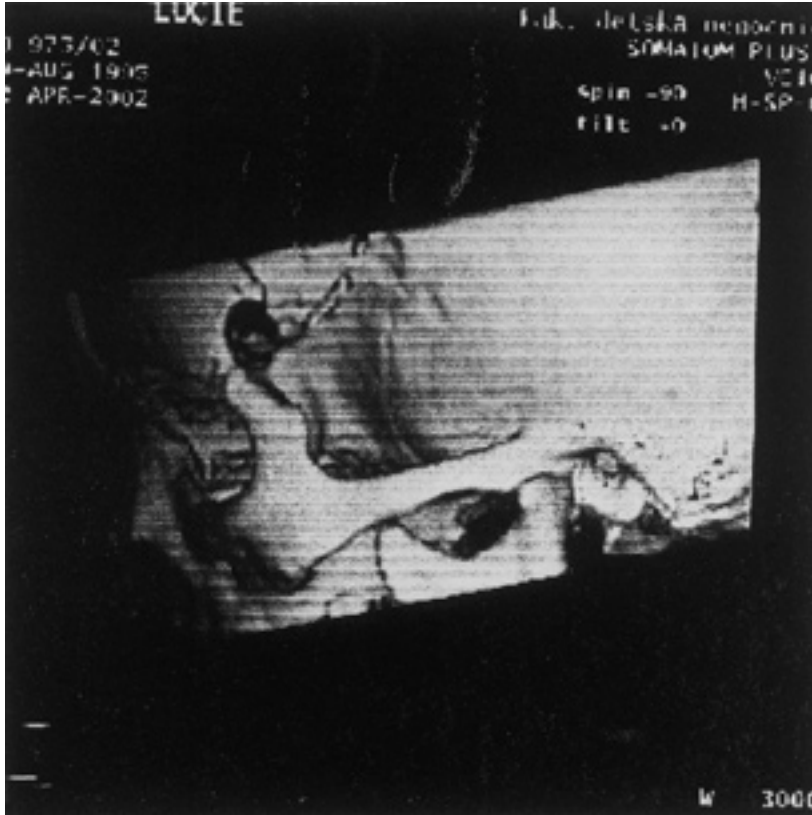


Fig. 3
Our modified fronto-orbital osteoplastic craniotomy

movement of eyeballs with impossibility of nasal look. Within a week, the patient could recognise movement 1 m in front of the eye. Optic examination performed 2 months after the operation showed that he could read the fingers at a distance of 1 m; the pupil was still wider with a minimum reaction to light exposure. Four months after the injury (during the last examination so far), the right pupil was only slightly wider and reacted to light exposure and the boy started distinguishing objects at a distance of up to 2 meters. He does not suffer from diplopia. The movement of eyeballs in the nasal direction has stabilised.

None of the patients experienced post-operation complications with wound healing, the replacement of Dura Guard did not cause any reaction to heterogeneous material in any of the patients.

None of the patients died, not even in the cases of more extensive craniocerebral injuries (*Figs 4-15*).

DISCUSSION

In the literature there are many studies proving the fact that orbital fractures are not only treated by neurosurgeons (3, 4, 7, 13), but also by specialists in the field of maxillofacial surgery (19), traumatology (24), ophthalmology (9, 10, 17, 23), otorhinolaryngology (5, 16, 22), and plastic and reconstruction surgery (1, 6, 11, 14, 18, 25).

In the Children's Hospital of the Faculty Hospital in Brno, patients with orbital fractures are treated at our department as well as at the ENT department, where a total of 8 patients with a diagnosis of blow-out orbital fractures were treated, of which 6 were operated on between 1994 and 1999. The operations were performed in the case of medial wall fractures and orbital bone base. Injury of the facial

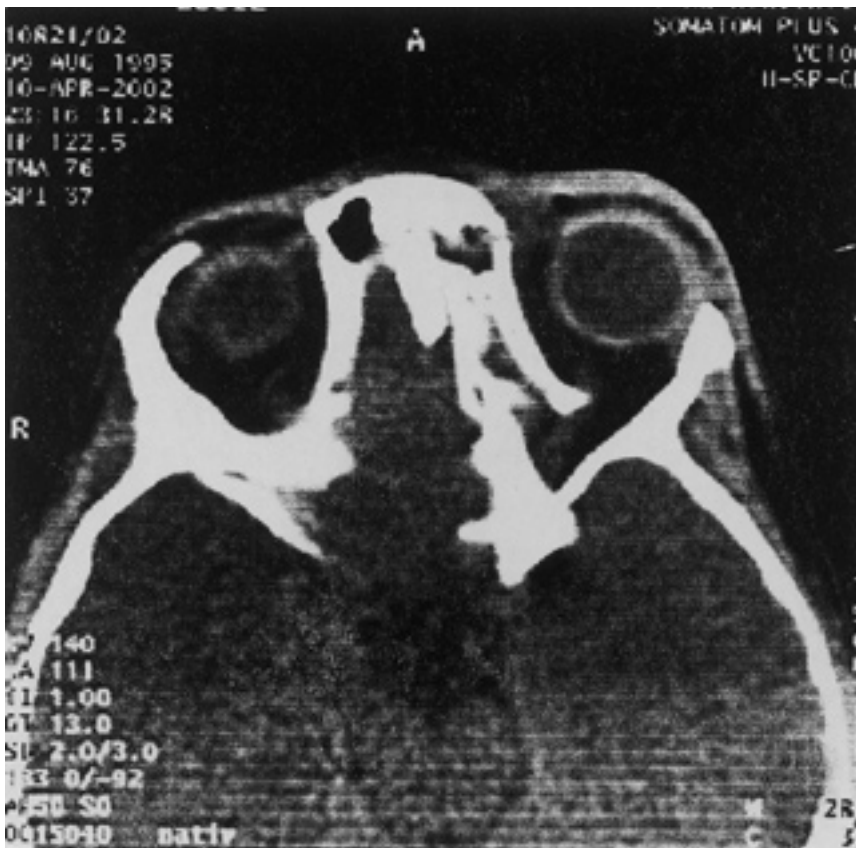
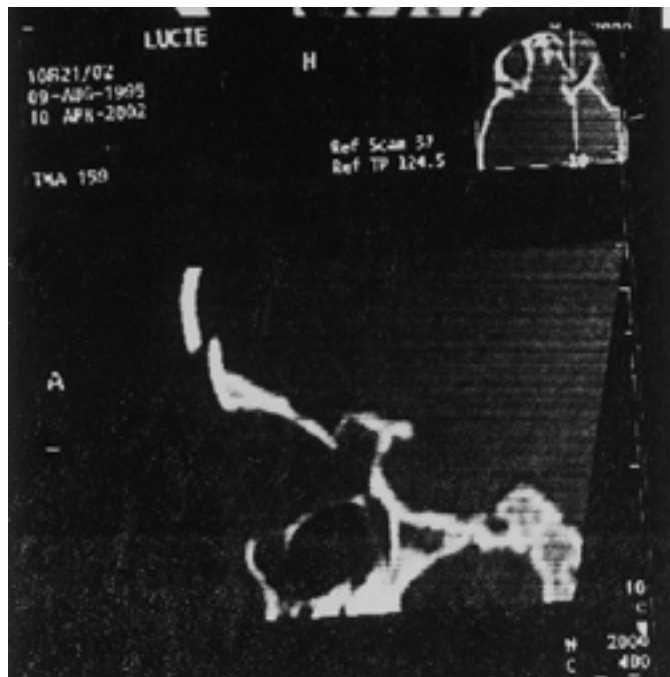
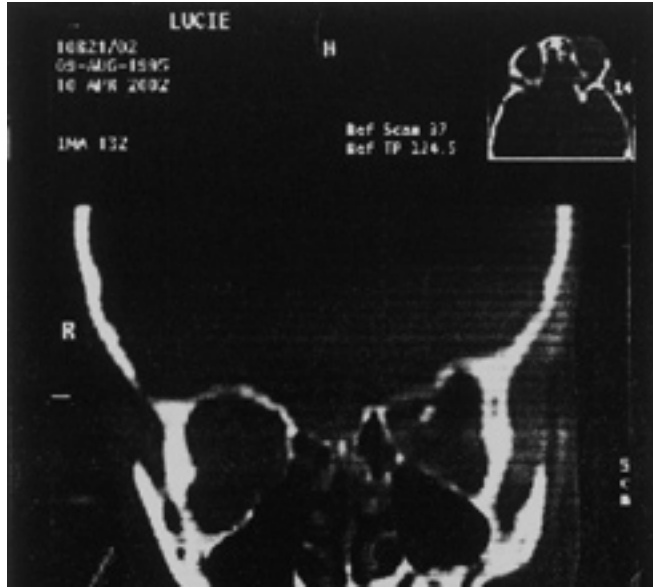


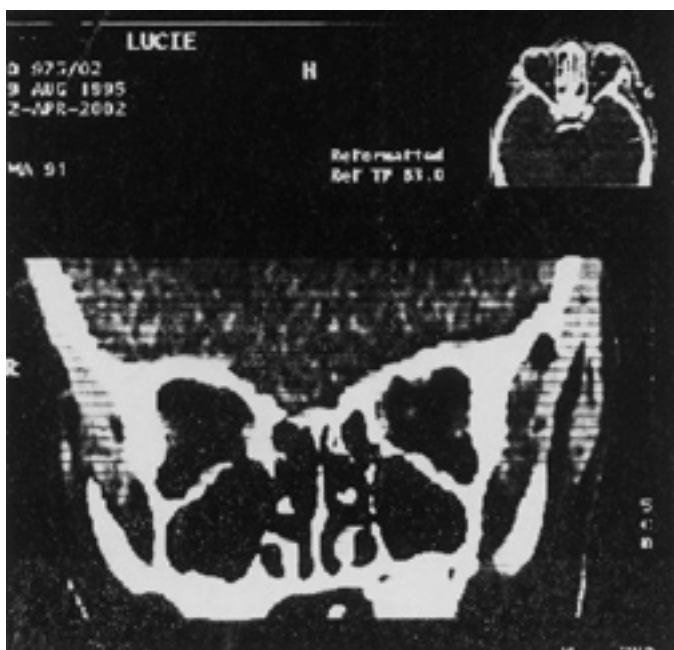
Fig. 4

Pre-operative CT orbital roof fracture and medial wall of the orbit with compressed optic nerve



Figs. 5, 6

Pre-operative CT orbital roof fracture and medial wall of the orbit with compressed optic nerve



Figs. 7, 8
Post-operative CT orbit of the same patient

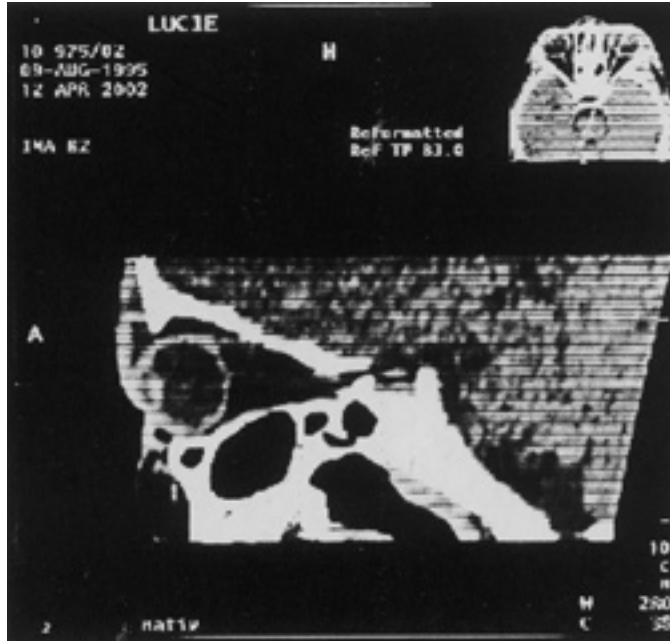


Fig. 9
 Post-operative CT orbit of the same patient



Fig. 10
 Pre-operative fronto-orbital roof fracture compressing ophthalmogryic muscles and eye ball

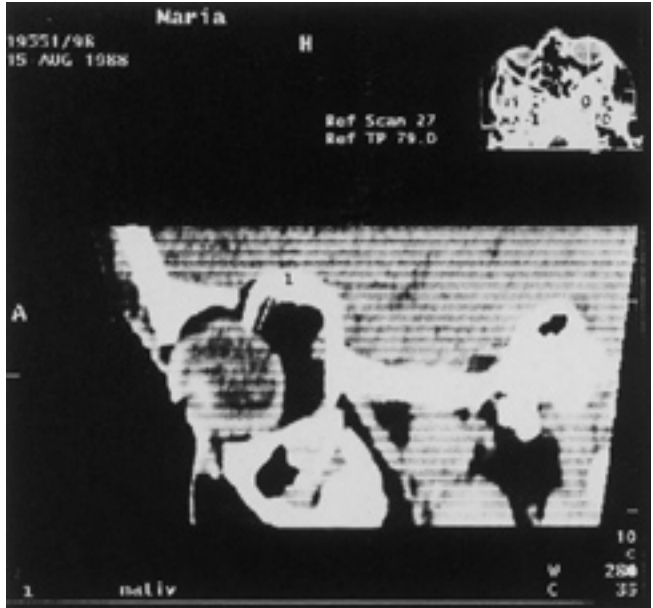


Fig. 11

Pre-operative fronto-orbital roof fracture compressing ophthalmogryic muscles and eye ball

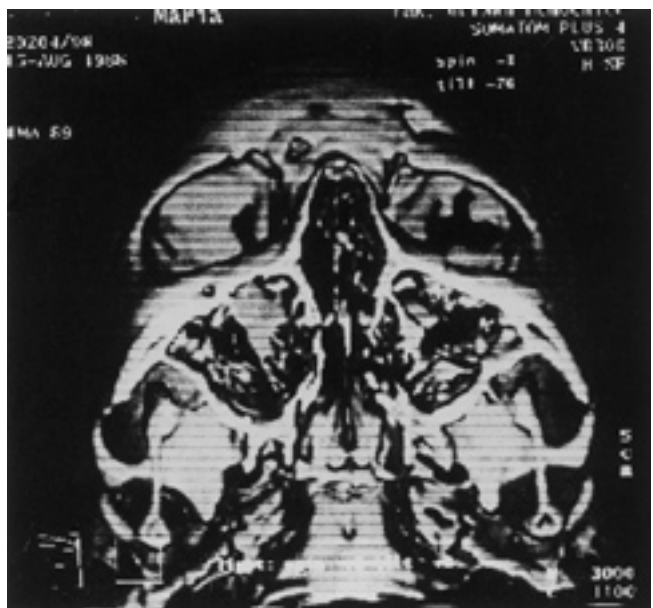


Fig. 12

Post-operative pictures of the same patient

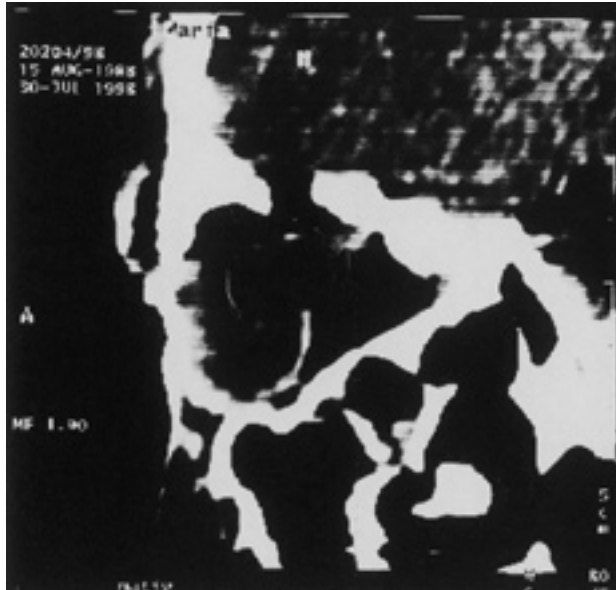


Fig. 13
Post-operative pictures of the same patient



Fig. 14
Pre-operative CT image of impressed bone fragment at the orbit apex, which caused complete blindness of the affected eye before the operation (with mydriatic pupil without photoreaction)



Fig. 15
Post-operative CT of the same patient

skeleton usually requires co-operation of a maxillofacial surgeon from another department of the Faculty Hospital in Brno.

Patients with craniofacial injuries usually experience intracranial injuries, too. Older children and adolescents often experience orbital traumas caused by strong impacts, whereas in small children the fractures of orbital roof, in particular, may appear even after minor traumas (9, 24). The orbital roof fractures are often related to injuries of the forehead, which is generally one of the most frequent injuries in childhood (12). The reason for a relatively frequent relation between forehead injuries and orbital roof fractures in small children is their relatively big cranium, prominent foreheads, fragile orbital roofs, and missing pneumatization of the not fully developed frontal bone sinus (9). Frontal impacts on a small or only outlined frontal sinus are transferred directly to the orbital roofs and are not absorbed by “collapsing” of the fronto-ethmoidal complex, as we see in adolescents and adults (6, 18).

The frequency of maxillofacial fractures affecting the upper third of the face drops with the growing age (5, 16). *McGraw and Cole* (16) state that younger patients with maxillofacial fractures, even if in the central part of the face only, are exposed to a higher probability of intracranial injuries than the adults.

The most noticeable sign of the orbital fracture is periorbital ecchymosis with the so-called “dark violet eye” with massive infiltration and swelling of the face. A torn eyebrow or upper lid is a clear sign of suspicion of a facial fracture or an

orbital fracture. The facial swelling itself is not specific and may accompany simple contusion of the facial soft tissues or a massive intracerebral trauma. Orbital injuries may also be accompanied by rhinorrhagia.

However, the clinical examination alone cannot often recognise intracranial injuries. Orbital roof fractures are often accompanied by frontal bone fractures, torn dura on the frontal lobe base with epidural (8) and subdural haematoma.

Cerebral contusions and sometimes dilaceration of brain tissues and intracerebral haematoma are not exceptional. These fractures may also be complicated by liquor-rhoea (2) and pneumocephalus (17). Older children and adults with medial fractures of the orbital roof often experience injuries to the pneumatized frontal sinus, whereas in children under 7 years of age, when the frontal sinus is not developed yet, an impact without a sinus fracture is transferred directly to the orbital roof.

Injuries of the anterior skull base cavity with an orbital roof fracture with a torn dura bring about a risk of the occurrence of orbital encephalocele (18, 20), and "chronic" transorbital herniation of brain tissues with the so-called "growing skull" fracture (14, 15, 22) may be manifested by proptosis (3, 9, 10).

Orbital roof fractures with fragments at the orbit apex are marked by a higher probability of the optic nerve damage (8), which can be easily hurt by a bone fragment, and it is often necessary to release the bone compression as well as to open the optic canal and liberate the ophthalmic artery (4, 26).

Fractures of the orbital base occur more frequently in adults and adolescents, most often as "blow-out" orbital fractures, when the orbital soft tissues are pressed into the maxillary sinus (22). In children, the maxillary sinus is less developed than in adults, and therefore the fractures are less frequent in small children. In their study of 71 children with maxillofacial traumas, *McGraw and Cole* (16) present a high incidence of accompanying intracranial injuries to toddlers and small children compared to children over 12 years of age, and therefore they recommend that in the case of these traumas in children under 7 years of age, a neurosurgeon should be consulted.

The most useful examination of the orbit in relation to acute traumas is the coronary examination by CT (9, 19, 25). For the examination of CSF-orbital fistula or transorbital herniation of the frontal lobe of the brain it is suitable to use CT cisternography (10) or MR. *Shevach et al.* (21) clearly demonstrated cerebral herniation in children in MR 6 months after a penetrating trauma of the orbital roof.

CONCLUSION

Between 1998 and 2002, the Department of Paediatric Surgery, Orthopaedics, and Traumatology of the Children's Hospital of the Faculty Hospital in Brno hospitalised 22 patients with orbital fractures. A total of 11 patients were treated conservatively, and 11 patients were operated on. Of these patients there were 12 girls and 10 boys at the age of 4-15, with an average age of 10. Patients with fractures

without displacement of bone fragments were not operated on. Eight out of ten operated patients had a fragment impressed in the orbit, in two cases the operation was performed for epidural bleeding in the intracranium and impressed fracture of the frontal bone and open injury with liquorrhoea. In 3 patients, these injuries were accompanied by an injury of one of the adjacent parts of the facial skeleton. One of the patients undergoing surgery suffered from polytrauma. The operations were performed within 24 hours after the injuries. The access during the operation was ensured by modified fronto-orbital craniotomy. The condition of all the patients improved after the operation; in 9 cases the condition fully normalised, one patient with pre-operative complete amaurosis shows significant improvement of vision half a year after the operation. No post-operative complications were observed in the patients undergoing surgery.

Ventruba J.

ZLOMENINY OČNICE U DĚTÍ Z POHLEDU NEUROCHIRURGA

Souhrn

Dětský věk je vysoce rizikovou věkovou skupinou pro poranění očníce. Rány na čele s přítomností orbitální ekchymózy, otoku a hematomu víček, s prosáknutím a otokem okolních tkání a obličej je nutno pečlivě došetřit pro vysoké podezření na přítomnost fraktury očníce a k vyloučení intrakraniálních komplikací, které fraktury očníce mohou provázet (impresivní fraktury lebky, epidurální hematom, pneumocephalus, dilacerace dury, kontuze či dilacerace mozku, likvoreu, frontoorbitální encephalokéla). Je nutné vyšetření traumatologem (chirurgem, neurochirurgem), neurologem a očním specialistou. U akutních úrazů je nejdůležitějším radiologickým vyšetřením CT, a to mozku, orbit (minimálně s koronárními projekcemi) a 3D rekonstrukcemi skeletu. MR se provádí jen při podezření na likvoreu a orbitální encephalokélu a u velmi malých dětí. Nejčastějším místem poranění očníce je její strop. Při zlomeninách očníce bez dislokace kostních fragmentů a při vyloučení nitrolebních komplikací je na místě konzervativní postup. Při dislokaci úlomků až do orbity či intrakraniálního prostoru je indikována operace. Cílem operace je odstranění vpáčených kostních fragmentů, stavění případného krvácení a rekonstrukce porušeného kostního krytu. V orbitě je nutno věnovat zvýšenou pozornost úplně deliberaci očního nervu, okohybných svalů a dalších případně tísňených struktur. Současné neurochirurgické ošetření nitrolebního poranění je samozřejmě a v mnohých případech prioritní. Timing operace je do 24 hodin po úraze, pokud stav přímo nevyžaduje urgentní operaci (otevřená poranění, epidurální krvácení).

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