The Management of the Fronto-basal injured Patient: The Point of View of the ENT-Surgeon

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Introduction and classification

Fronto-basal traumas include fractures of the anterior and posterior wall of the frontal sinus, the skull base of the ethmoidal and sphenoidal region, the posterior wall of the sphenoidal and the orbital roof. There are typical fracture lines affecting the anterior cranial fossa.
For clinical documentation and preoperative consideration a variety of classifications have been presented in the past. From our point of view any classification must respect the needs of daily clinical practice (2, 10). Therefore, we prefer a differentiation into central, centrolateral and lateral fractures of the midfacial skeleton with or without fronto-basal involvement and CSF-leakage.
Over the last five years we observed in 75 cases out of 173 midfacial injuries that have been treated in the ENT-Department of the University Hospital of Münster, involvement of the frontal base. This type of traumatization affected in 47 % a central and 43 % a centrolateral part of the facial skeleton; in contrast the main part of the group without fronto-basal involvement (50 %) was located laterally.
This kind of classification as well as the description of Escher type I-IV lack detailed documentation of the fronto-basal traumatization itself (2). Therefore, we support our clinical report with the following considerations with respect to the anatomy and the pathological intraoperative findings.

FB I: *fracture of the frontal sinus (right/left),* affecting anterior and/or posterior wall with or without CSF leakage

FB II: *fracture of the ethmoidal region,* affecting anterior and posterior ethmoidal cells, cribriform plate with or without CSF-leakage

FB III: *fracture of the sphenoidal region,* affecting upper-, posterior-, anterior and lateral wall with or without CSF-lesion

FB IV: *fracture of the orbital roof,* affecting orbital part of the frontal bone, floor of the frontal sinus neighbouring ethmoidal cells with or without CSF-leakage

The "Grading" of the trauma is described by addition of the symbols. For example: "FB I + FB II r + CSF" describes a fronto-basal injury affecting the frontal sinus and the right ethmoidal region with CSF-leakage (13).

Timing of treatment

Immediately after stabilization of the vital functions an interdisciplinary consultation is demanded.

1. *Immediate intervention - emergency surgery*

- Life-threatening bleeding from the sinuses, nasopharynx, skull base.

- Life-threatening increase of intracranial pressure due to intracranial bleeding or edema

2. *As soon as possible - early surgical intervention*
   - Open brain injury
   - Impacted foreign body (Fig. 2a + b)
   - Extensive soft tissue defects
   - Optic nerve lesion
   - Amaurosis of the only seeing eye
   - Intracranial complications such as meningitis, extradural or subdural abscess.
3. *Whithin 1-week*
   - Various fractures without functional problems
   - Evidence of dural tear such as CSF-rhinorrhea or pneumoencephalocele
   - Severe interdisciplinary reconstructions in one or more sessions
   - Combination of fronto-basal and severe intracranial problems
4. *Wait and see*
   - Fractures without dislocated fragments
   - Trauma without functional or esthetic defects
   - Small projectiles
   - Isolated orbital emphysema

General remarks

Before surgery the localization of fronto-basal defects with or without CSF leakage has to be determined thoroughly. Therefore, modern imaging techniques, especially CT-equipment, is required. These techniques provide improved resolution of osseous fractures and can delineate fractures of even very thin bony plates. Nevertheless, 15 % of the bony defects remain undetected. Concerning the choice of reconstruction technique the healing process along the skull base includes a replacement of the fracture lines by scar tissue only. Reossification of bony defects do not occur in these areas. Therefore, infection of the nose and paranasal sinuses can ascend if the cranial cavity is not sealed. They

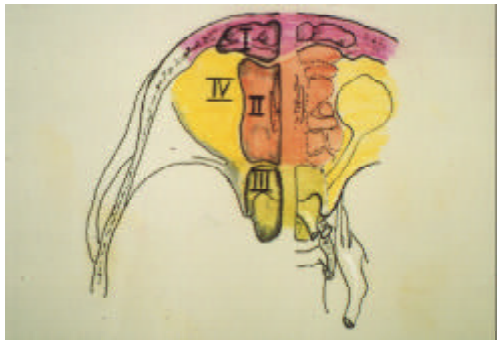

Fig. 1. The four areas of the anterior cranial fossa which could be affected in fronto-basal injuries

cause meningitis, encephalitis or abscesses even years later unless the leaks are sealed by appropriate duraplasty primarily (1, 9).
In rare cases cerebrospinal fluid runs from a defect in the petrous bone through the middle ear and the Eustachian tube into the nose, when the tympanic membrane is intact otherwise through the external auditory canal (= otorhinoliquorrhea).

Choice of the approach

A great variety of approaches for the reconstruction of fronto-basal injuries has been recommended. Only the best ones provide wide exposure of the dural defect and preserve olfactory sensation as long as the trauma has not destroyed the fila olfactoria.
In ENT-surgery the fronto-orbital approach via Killians's incision is well established for reconstruction of bony and dural defects involving the posterior wall of the frontal sinus and areas of the skull base bordering the sphenoidal and ethmoidal sinuses (15).
The transnasal endo- or microscopic approach is only suitable for defects along the rhinobase of limited size (16). The transfrontal extra- or intradural approach via coronal incision is mainly indicated for communicating fractures of the anterior skull base with extensive dural tearing and cerebrale prolap (14).

Figs. 2a + b. Direct fronto-basal injury by impacted foreign body

Principles of duraplasty

Dural defects in the region of the frontal sinuses

Our figures demonstrate a combination of fractures of the posterior wall in combination with fractures of other regions in 46,6%, pneumatoceles or cephaloceles in 25 - 30 % and additional rhinoliquorrhoe in 30 %.

In those cases we use an external approach combined with Killian- and eyebrow-incision. The anterior wall is temporarily removed as a bone fragment or by the osteoplastic on bloc-incision. Then, the posterior wall defect is inspected using a microscope in areas where visualization is difficult. In contrast to early literature, the bony fragments should remain in situ, but exposure of the dural lesion has to be enlarged as far as necessary. The dura is securely closed by direct sutures. Any residual defect is covered with lyophilized dura, gelita and fibrin glue (Fig. 3). Gelita tampon is a spongy haemostatic, made from hardened gelatin of porcine origin, that is completely biologically degradable. The reconstruction should be supported by an intranasal antibiotic-containing ointment pack for the following 12 days (7, 8).

Reconstruction in the ethmoidal region

A similar technique is used for the closure of circumscribed defect. Mostly, a direct suture is impossible in this area. Therefore, we recommend sealing the defect intradurally with a layer of gelita, fat or fascia lata. Extradurally, the plasty should be covered with a nasal mucoperiosteal flap following complete exenteration of the ethmoidal cells (Fig. 4).

Fig. 3. Duraplasty and drainage of the FB I-trauma with CSF-leakage

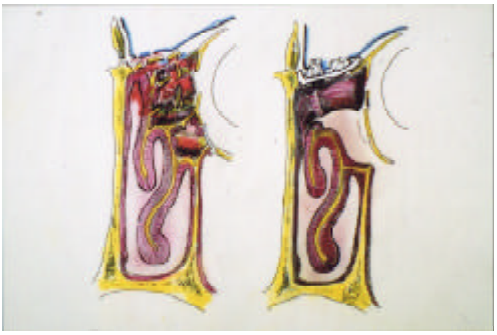

Fig. 4. Duraplasty and drainage of FB II-trauma

The mucoperiosteal flap can be secured with fibrin adhesive and a 12 day ointment-packing over a silicon plate to support the plasty. Bilateral traumas can be repaired in the same manner or without mucosal flaps based on the septum. These may include the surface of the middle turbinates.
The majority of CSF-leakage result from dural injuries at the ethmoid roof which is attributed to the firm attachment of the very thin dura to the bone, the little holes of the lamina cribrosa and the shell-like stucture of the bone. Most leaks do not occur in the cibriform plate but in the adjacent ethmoid roof.

Reconstruction of the sphenoidal region

CSF-leakage into the sphenoid sinuses is a challenge to diagnosis and treatment. Small circumscribed defects are closed with patches of fat, muscle, soft tissue, fascia lata or gelita including tissue glue. A transnasal endoscopic manoeuvre is appropriate in special cases. But larger defects should be treated by a transfrontal-transethmoidal approach. The same technique as used for the frontal sinus defect is useful in many cases.
In extreme situations only the technique of obliteration can be successful. Then, the sphenoid sinus, mono- or bilaterally, is filled with fat, fascia lata and muscle tissue. Before the obliteration, the mucose has to be removed completely. If possible the tissue-package can be covered by a mucosal flap. An ointment-pack over a silicon plate has to support the plastic for 10 -12 days. In some cases a CSF-drainage is indicated.

Paranasal sinus drainages

The principle of paranasal drainage is the enlargement of the normal routes. Concerning the frontal sinus and ethmoidal region we prefer a modification of Uffenorde's technique. The three-flap technique helps to enlarge the infundibulum and can be combined with the contralateral transseptal drainage described by O. Mayer (1940). These procedures are combined with enlargement of the hiatus semilunaris joining into the middle etage of the nasal cavity (6, 14).

Fig. 5a. Immediate loss of visual acuity due to impression of the optic canal
Fig. 5b. One week after surgical decompression. The visual acuity increased to 0.5

Decompression of the optic nerve

With regard to the impairment of vision a surgical optic nerve decompression has to be considered. Defined ophthalmological indications are:

- immediate decrease or loss of visual acuity
- afferent pupillary defect
- increasing restriction of the visual field

- optic disc swelling or papillary edema due to lesions of the optic nerve
- CT findings with impression of the optic canal or with bony fragments
- Amaurosis of the only seeing eye

The prognosis is controversial and depends on the severity of the trauma and the time past between trauma and surgical management. In our experience, the rate of success is more than 50 % in patients without fronto-basal complications and less when the frontal base is affected.

As soon as the diagnosis is considered, high dose steroids should be administered. If vision improves, no further treatment is necessary. Otherwise, surgical intervention is the last resort. Before surgical intervention contraindications such as lesions of the chiasma, injury of the globe, avulsion of the optic nerve or life-threatening complications have to be excluded (3, 4, 5, 11).

The procedure of decompression can be performed through the midface along the skull base. This direct approach will avoid craniotomy. Exposure is through an osteoplastic frontonasal approach with resection of the ethmoidal cells and the medial orbital wall. Using a microscope and long cutting burrs, the posterior ethmoidal and sphenoidal region is identified as well as the optic ridge along the superior wall of the spenoidal sinus. The wall in front of the optic ridge, which means the medial wall of the optic canal is ground off until the nerve is shining through a thin shell. Finally, the lamella is removed using a small bone elevator (12, 13) (Fig. 5a + b).

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