

# Anterior skull base fracture

Anterior [skull base fractures](#) are relatively common traumas but surgical indications are still discussed.

Subcranial approach seemed successful in the management of all frontobasilar fractures with reasonably low complication rate <sup>1)</sup>.

[Endoscopic surgery](#) for any type of skull base defect is the gold standard. The size of the defects does not seem to play a significant role in the success rate. Fascia lata and mucoperiosteum of the turbinate allow a two-layer reconstruction of small and midsized defects. For larger skull base defects, a combination of fat, fascia lata, and nasoseptal pedicled flaps provides a successful reconstruction <sup>2)</sup>.

## Case series

### 2016

Retrospective chart review identified patients treated surgically between January 2004 and May 2014 for anterior skull base fractures with [cerebrospinal fluid fistulas](#). All patients were treated with [bifrontal craniotomy](#) and received [pedicle flaps](#). Cases were classified according to the extent of fracture: Class I (frontal bone/sinus involvement only); Class II (extent of involvement to ethmoid cribriform plate); and Class III (extent of involvement to sphenoid bone/sinus). Surgical repair techniques were tailored to the types of fractures. Patients were assessed for CSF leak at follow-up. The Fisher exact test was applied to investigate whether the repair techniques were associated with persistent postoperative CSF leak.

Forty-three patients were identified in this series. Thirty-seven (86%) were male. The patients' mean age was 33 years (range 11-79 years). The mean overall length of follow-up was 14 months (range 5-45 months). Six fractures were classified as Class I, 8 as Class II, and 29 as Class III. The anterior pericranial flap alone was used in 33 patients (77%). Multiple flaps were used in 10 patients (3 salvage) (28%)-1 with Class II and 9 with Class III fractures. Five (17%) of the 30 patients with Class II or III fractures who received only a single anterior pericranial flap had persistent CSF leak ( $p < 0.31$ ). No CSF leak was found in patients who received multiple flaps. Although postoperative CSF leak occurred only in high-grade fractures with single anterior flap repair, this finding was not significant.

Extensive anterior skull base fractures often require aggressive treatment to provide the greatest long-term functional and cosmetic benefits. Several vascularized tissue flaps can be used, either alone or in combination. Vascularized flaps are an ideal substrate for cranial base repair. Dual and triple flap techniques that combine the use of various anterior, lateral, and [nasoseptal flaps](#) allow for a comprehensive arsenal in multilayered skull base repair and salvage therapy for extensive and severe fractures <sup>3)</sup>.

### 2015

Retrospective chart review identified patients treated surgically between January 2004 and May 2014 for anterior skull base fractures with CSF fistulas. All patients were treated with bifrontal craniotomy and received pedicled tissue flaps. Cases were classified according to the extent of fracture: Class I

(frontal bone/sinus involvement only); Class II (extent of involvement to ethmoid cribriform plate); and Class III (extent of involvement to sphenoid bone/sinus). Surgical repair techniques were tailored to the types of fractures. Patients were assessed for CSF leak at follow-up. The Fisher exact test was applied to investigate whether the repair techniques were associated with persistent postoperative CSF leak. RESULTS Forty-three patients were identified in this series. Thirty-seven (86%) were male. The patients' mean age was 33 years (range 11-79 years). The mean overall length of follow-up was 14 months (range 5-45 months). Six fractures were classified as Class I, 8 as Class II, and 29 as Class III. The anterior pericranial flap alone was used in 33 patients (77%). Multiple flaps were used in 10 patients (3 salvage) (28%)-1 with Class II and 9 with Class III fractures. Five (17%) of the 30 patients with Class II or III fractures who received only a single anterior pericranial flap had persistent CSF leak ( $p < 0.31$ ). No CSF leak was found in patients who received multiple flaps. Although postoperative CSF leak occurred only in high-grade fractures with single anterior flap repair, this finding was not significant. CONCLUSIONS Extensive anterior skull base fractures often require aggressive treatment to provide the greatest long-term functional and cosmetic benefits. Several vascularized tissue flaps can be used, either alone or in combination. Vascularized flaps are an ideal substrate for cranial base repair. Dual and triple flap techniques that combine the use of various anterior, lateral, and nasoseptal flaps allow for a comprehensive arsenal in multilayered skull base repair and salvage therapy for extensive and severe fractures <sup>4)</sup>.

## 2014

A retrospective analysis of 48 patients (45 males, mean age 38,5 years; range 16-82 years) who had a subcranial approach for frontal base fracture correction between April 1996 and April 2011 at a tertiary care academic hospital in Turku, Finland.

Sixteen (33%) patients had fractures including all frontobasilar fracture types (Type I-IV) i.e. fractures that involved frontal sinuses, orbital roofs, ethmoidal region, cribriform plate and sphenoidal region. Twenty-seven (56%) patients were considered to have had brain damage at presentation. Forty percent of patients were suffering from synchronous trauma. Peroperatively, 31 (65%) patients had exposure or defect of the dura due to bone dehiscence but only two patients suffered from cerebrospinal fluid (CSF) fistula following surgery. CSF fistulae were covered by pericranium in most of the cases (68%). There was no postoperative meningitis. Thirty-eight percent of the patients needed further operation with a subcranial craniotomy following primary reconstruction. At the last follow-up visit 35% were suffering from permanent neurological problems following brain injury.

Subcranial approach seemed successful in the management of all frontobasilar fractures in this series with reasonably low complication rate. Therefore, we would recommend it as the technique of choice in multiple and even in the most complicated frontal base fractures <sup>5)</sup>.

## 2012

Piccirilli et al. report their results on patients showing anterior cranial fossa fractures; clinical data, surgical indications, and results are reported and critically analyzed.

From 1991 to 2010, 223 patients were admitted with diagnosis of anterior cranial fossa fracture. Fractures were classified as type A-fracture of the anterior wall of the frontal sinus; type B-fracture of the posterior wall of the frontal sinus; and type C-frontobasal traumas without involvement of the frontal sinus. All patients entered a follow-up program consisting in periodic controls.

A total of 105 patients were conservatively treated, while 118 patients underwent surgical intervention. The presence of pneumocephalus ( $p < 0.0001$ ) and rhinoliquorrhea ( $p = 0.001$ ) were the factors influencing the surgical indication. In the fractures of group B with signs of pneumocephalus and or rhinoliquorrhea, full sinus cranialization represents the variable mainly influencing the outcome ( $p < 0.001$ ). Conclusion Patients with frontobasal traumas should be carefully evaluated to choose the best treatment option. Clinical and radiological data suggest that patients with frontobasal fractures with massive pneumocephalus and/or rhinoliquorrhea should be always surgically treated <sup>6)</sup>.

## 2006

55 patients with severe frontobasal trauma, who were operated between 1/1999 and 11/2003. The subfrontal approach according to Raveh we had chosen in 20 patients which were operated by an interdisciplinary team together with the neurosurgeons. With an average follow up of 36 month we report about early and late complications.

19/20 patients showed sufficient coverage of the CSF leakage, once a revision surgery was necessary. Finally this patient had also an unobjectionable coverage of the CSF leakage. We saw no major complication like meningitis or brain abscess, intracerebral haematoma or surgical injury of the orbital wall. The most important complication was an anosmia, which depending on the extension of the approach results in any patients.

The results show that the subfrontal approach is a reliable method to explore extensive frontal dural defects and to reconstruct fractures of the frontal skull base without additional trauma to the frontal lobe <sup>7)</sup>.

## 2000

148 patients who sustained traumatic frontobasal injuries and were treated between 1986 and 1999. Included in this study are 74 of 148 patients with acute injuries and complex frontobasal lesions involving the frontal sinus, the cribriform/ethmoid roof complex, one or both orbital roofs, and the planum sphenoidale.

Surgery was delayed for up to 4 weeks postinjury in most patients (67 cases), whereas 17 with space-occupying hematomas and perforating injuries required early surgery. In 30 patients additional surgery was required to treat maxillofacial fractures, which was performed as a one-stage procedure together with the neurosurgical operation. The author performed a standard bifrontal craniotomy in which an intradural or combined intradural-extradural approach was used in all cases. Four patients developed ascending meningitis in the preoperative period. As a result of surgical treatment one patient died, another two patients suffered from permanent defects, and three suffered from transitory neurological worsening. In two patients recurrence of a cerebrospinal fluid fistula occurred within a 3-month period posttreatment but was successfully obliterated during reoperation. In the author's experience the intradural approach is comparable in terms of the morbidity, mortality, and success rates with extracranial approaches; additionally the intradural approach provides full visualization of the intracranial lesion. Useful olfactory nerve function can only be preserved if both olfactory nerves are left intact and not crushed during initial injury; this occurred in only five patients in this series.

If possible, surgical treatment of more complex lesions should be delayed until the 2nd or 3rd week following traumatic injury. With antibiotic prophylaxis the risk that ascending meningitis will occur

prior to surgery is low. If the patient is systemically stable and brain swelling has resolved, even extensive one-stage neurosurgical/maxillofacial procedures are well tolerated <sup>8)</sup>.

Reiss et al. examined 133 patients retrospectively who had a fracture. Altogether we considered with the classical x-ray diagnosis 111 and with the CT 250 regions of the frontobasis. In all, one third of fractures in the regions could not be detected preoperatively by CT and not the half by classical x-ray-diagnosis. CT allows a direct detection of brain hernias and far better imaging of osseous lesions, also of fine structures, such as a better appraisal of paranasal sinus pathology. Classical radiology is, however, still indispensable for imaging certain fracture types and localization of a pneumocranium. Except in case of special demands, conventional x-ray diagnosis is important for the routine diagnostics of the facial skull as a primary method supplying an answer to the most important questions at a lower cost and in a shorter time. Altogether, CT allows an improvement of postoperative results, influencing indication, timing of operation, such as surgical approach <sup>9)</sup>.

## 1993

The classification of anterior fossa fractures with their sequelae: cerebrospinal fluid (CSF) rhinorrhea, pneumocephalus, or meningitis is presented. This classification is based on five selection criteria which are discussed in this paper. This classification resulted in the table of indications for operative treatment, according to which the appropriate time for operation in urgent cases is immediately, in cases with absolute indication 5 to 6 days after the injury, in long-lasting CSF rhinorrhea or pneumocephalus 10 days after the onset, in intermittent or delayed rhinorrhea and/or pneumocephalus as soon as these signs occur, and in cases of meningitis soon after recovery. This study is based on the analysis of 52 consecutive surgically treated cases, collected from 1984 up to December 1989 <sup>10)</sup>.

## 1986

Over a period of 15 years the Probst operated on 205 patients with traumatic frontobasal CSF fistulas. In one third of these cases, exploration had to take place within 24 hours because of cerebral compression or a direct open injury. Craniotomy enables the surgeon to repair the concomitant neurosurgical lesions frequently found (57%) as well as the often multiple (56%) or bilateral (35.3%) fistulas. As regards surgical technique, the important points are: protection of the brain thanks to the use of magnification, the best possible approach, lumbar puncture during surgery to relieve pressure, sufficient cerebral debridement and in the paranasal sinuses, reliable closure of the fistula (duraplasty and sometimes additional plastic closure of the bony defect), and consideration of the latest findings of neuroanaesthesia, endocrinology etc. Nearly two-thirds of the patients operated were able to resume work completely <sup>11)</sup>.

1)

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Archer JB, Sun H, Bonney PA, Zhao YD, Hiebert JC, Sanclement JA, Little AS, Sughrue ME, Theodore N, James J, Safavi-Abbasi S. Extensive traumatic anterior skull base fractures with cerebrospinal fluid leak: classification and repair techniques using combined vascularized tissue flaps. *J Neurosurg*. 2015 Oct 16:1-10. [Epub ahead of print] PubMed PMID: 26473788.

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Perheentupa U, Mäkitie AA, Kinnunen I. Subcranial craniotomy approach for frontobasal fracture correction. *J Craniomaxillofac Surg*. 2014 Oct;42(7):1371-7. doi: 10.1016/j.jcms.2014.03.028. Epub 2014 Apr 3. PubMed PMID: 24780354.

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11)

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