FRONTAL SINUS FRACTURES

M OH A M M E D A L S U K A Y T
R2

20 April 2016
INTRODUCTION

- Absent at birth
- Radiographically evident @ 8 years
- Adult size by 15 years
- 15% with unilateral sinus
- 4% with no sinus
- Anterior table 2-12 mm thick
- Posterior table 0.1 to 4.8 mm thick
- 5-12% of facial fractures
- 50-70% caused by MVA

ASSOCIATED INJURIES

- Loss of consciousness ➔ 72%
- Obtunded/intubated ➔ 21%
- Intracranial injuries
  - Pneumocephalus 26%
  - Cerebral contusion 18%
  - Dural tear 14%
  - CSF leak 11-33%
  - 5% with persistent CSF leaks
  - Epidural hematoma 8%
<table>
<thead>
<tr>
<th></th>
<th>Anterior</th>
<th>Posterior</th>
<th>Ant/Post</th>
<th>Frontal recess</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wallis et al 1974-1986</td>
<td>13 (18%)</td>
<td>2 (3%)</td>
<td>55 (79%)</td>
<td>2</td>
<td>70</td>
</tr>
<tr>
<td>Strong et al 1987-2002</td>
<td>35 (28%)</td>
<td>4 (3%)</td>
<td>88 (69%)</td>
<td>3</td>
<td>127</td>
</tr>
<tr>
<td>Gossman et al 1990-2003</td>
<td>48 (50%)</td>
<td>0</td>
<td>48 (50%)</td>
<td>n/a</td>
<td>96</td>
</tr>
<tr>
<td>Chen et al 1994-2002</td>
<td>22 (28%)</td>
<td>0</td>
<td>56 (72%)</td>
<td>n/a</td>
<td>78</td>
</tr>
</tbody>
</table>
GOALS

• Goals of treatment:
  • Protection of intracranial structures and control of CSF leakage
  • Prevention of late complications
  • Correction of aesthetic deformity.
APPROACH TO FRONTAL SINUS FRACTURES
ALGORITHM FOR FRONTAL SINUS FRACTURE MANAGEMENT

CT SCAN (2-3 mm cuts coronal/axial)

ANTERIOR WALL FRACTURE
- NON-DISPLACED
- MINIMALLY-DISPLACED
- COSMETICALLY ACCEPTABLE

DISPLACED
- EXPLORATION
  - OBSERVE

FND PATENT
- NO BONE LOSS
- ORIF, ELEVATION ± FSO IF FND DAMAGED

FND DAMAGE
- BONE SALVAGE
- CRANIOPLASTY

OPEN-COMMINUTED FRACTURE
- WOUND DEBRIDEMENT DURA REPAIR

POSTERIOR WALL FRACTURE
- NON-DISPLACED
- NO CSF LEAK

TREPHINE ENDOCOSCOPY
- RELIABLE FOLLOW UP
- UNRELIABLE FOLLOW UP

FSO
- CRANIALIZATION
  (the greater the amount of bone loss the stronger the indication for cranialization)

? FND TRAUMA
- Sinus floor or nasoethmoid fracture

TREATMENT OPTIONS
- STENTING
- FSO

MOD. BONE LOSS
- CRANIALIZATION

MAJOR BONE LOSS
- CRANIALIZATION
<table>
<thead>
<tr>
<th>ANTERIOR TABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Non-displaced</td>
</tr>
<tr>
<td>• Observation</td>
</tr>
<tr>
<td>• Displaced</td>
</tr>
<tr>
<td>• Needs to be reduced for acceptable cosmetic outcome</td>
</tr>
<tr>
<td>• Access: bicoronal; supraorbital brow; extension of overlying laceration</td>
</tr>
<tr>
<td>• In non-fragmented or minimally fragmented cases</td>
</tr>
<tr>
<td>• Fixate with wires or mini-plates</td>
</tr>
<tr>
<td>• Comminuted fractures</td>
</tr>
<tr>
<td>• ORIF (mesh vs miniplates)</td>
</tr>
<tr>
<td>• Ensure no mucosa trapped between fragments</td>
</tr>
<tr>
<td><strong>ANTERIOR TABLE</strong></td>
</tr>
<tr>
<td>---------------------</td>
</tr>
</tbody>
</table>
| 1. Nondisplaced or minimally displaced:  
  • Observation  
  2. Displaced  
  • Open reduction and internal fixation for cosmesis  
  3. Involvement of the *nasofrontal outflow* tract:  
  • (a) ORIF of anterior table and osteoplastic flap with obliteration  
  • (b) Outflow tract reconstruction (not highly recommended)  
  • (c) Observation and medical management with future endoscopic ventilation if necessary  
  4. Comminuted fractures  
  • ORIF (titanium mesh vs miniplates)  
    • Ensure no mucosa trapped between fragments |
**FAT OBLITERATION**

Weber, R, Draf: 59 Patients with fat obliteration

<table>
<thead>
<tr>
<th>Late Complications</th>
<th>N (%)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbness N V₁</td>
<td>5 (8.5%)</td>
<td></td>
</tr>
<tr>
<td>Mucocele</td>
<td>4 (6.8%)</td>
<td>11, 34, 49, 106, 130 months after surgery. One case with two recurrences of a mucocele and two revisions</td>
</tr>
<tr>
<td>Persistent pain without a mucocele or infection within the frontal sinus</td>
<td>2 (3.4%)</td>
<td></td>
</tr>
<tr>
<td>Frontal embossment</td>
<td>2 (3.4%)</td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>4 (6.8%)</td>
<td>Revision with split calvarial bone in one case performed</td>
</tr>
<tr>
<td>Extrusion of ionomeric cement</td>
<td>2 (3.4%)</td>
<td>Revision with removal of ionomeric cement necessary</td>
</tr>
<tr>
<td>Insufficient esthetic result (patients’ view)</td>
<td>3 (5.1%)</td>
<td>Depression (2), hypertrophic scar after removal of ionomeric cement (1)</td>
</tr>
</tbody>
</table>

POSTERIOR TABLE

- **Nondisplaced** without CSF leak:
  - observation

- **Nondisplaced** with CSF leak:
  - conservative management of CSF leak with progression to sinus exploration if no resolution in 4–7 days

- **Displaced** (more than one table width):
  - Sinus exploration, repair of dura, obliteration or cranialization depending on involvement of the posterior table

- Involvement of the *nasofrontal outflow* tract:
  - obliteration or cranialization
• Endoscopic Management of Fractures
  • This approach is generally reserved for management of depressed anterior wall fractures.

• Two approaches have been advocated:
  • Endoscopic fracture reduction with percutaneous repair
  • Endoscopic camouflage.
Figure 2  Trephination approach for endoscopic assessment of the posterior wall. (A) Incision. (B) Exposure of fracture. (C) Exposure of sinus. (D) Exposure of posterior wall of frontal sinus. (E) Repair.
Figure 3  (A) Axial computed tomographic image showing depression related to an anterior table fracture. (B-E) Intraoperative photographs showing repair of frontal depression related to an anterior table fracture. (B) After making an incision, (C) an endoscope is used to dissect in the subperiosteal plane and expose the depression. (D) Hydroxyapatite cement is then injected and gentle pressure is used to smooth the cement to restore the appropriate contour. (F) Axial postoperative image showing excellent restoration of the frontal contour after placement of bone cement.
Managing the Frontal Sinus in the Endoscopic Age: Has the Endoscope Changed the Algorithm?

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However, the endoscope does offer new options for smaller defects and posterior wall encephaloceles and CSF leaks. For medial posterior defects, the Draf III actually provides access through the nose. If the area of encephalocele and/or CSF leak can be visualized and instrumented, it can generally be repaired. For more lateral defects, a trephination can be performed either through the anterior wall or through the floor. Encephaloceles that have protruded into the sinus in this area can generally be shrunken with bipolar cautery. Repair can be performed using various graft materials, including fascia, cartilage, bone, and mucosa. In recent years, the vascularized nasoseptal flap has gained popularity for endoscopic reconstruction of skull base defects, and this flap can be useful in the management of some posterior table defects. The goal is to obtain a watertight repair of the defect at the time of surgery if a satisfactory postoperative outcome is to be dependably anticipated.
Figure 7  (A) Axial computed tomographic showing fractures of the posterior aspect of the right frontal sinus and the intersinus septum. A frontal sinus trephination approach was used to manage this defect. (B) Intraoperative picture showing a drill being used to perform the trephination and expose the frontal sinus lumen. (C) Endoscopic view of the frontal sinus lumen through the trephination shows a small area of brain herniation (black arrow) into the frontal sinus through the posterior table defect. Endoscopic visualization also shows a patent frontal sinus outflow tract (white arrow). (D) After encephalocele cauterization, repair was performed using a bone graft and mucosal graft. Image shows mucosal graft in place (black arrow) and that the frontal sinus outflow tract remains patent (white arrow).
<table>
<thead>
<tr>
<th>Author</th>
<th>Number of patients</th>
<th>Summary</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith et al(^{19})</td>
<td>7</td>
<td>Patients with frontal sinus fractures suspected of outflow tract injury were managed medically with antibiotics and follow-up imaging studies.</td>
<td>5 of 7 patients had aerated frontal sinuses on follow-up. 2 patients with obstruction underwent endoscopic sinus surgery and had restoration of frontal sinus patency on follow-up.</td>
</tr>
<tr>
<td>Chen et al(^{25})</td>
<td>7</td>
<td>Patients with depressed anterior table fractures were treated with endoscopic browlift approach and microplate fixation of the fractures.</td>
<td>All patients underwent successful reduction and fixation with microplates.</td>
</tr>
<tr>
<td>Steiger et al(^{16})</td>
<td>5</td>
<td>Fractures with depression of anterior table were treated with reduction by way of frontal sinusostomy or frontal sinus trephination.</td>
<td>All had good cosmetic outcomes and all had patent and functional frontal sinuses based on CTs performed 2 months after surgery.</td>
</tr>
<tr>
<td>Hueman and Eller(^{26})</td>
<td>1</td>
<td>Endoscopic balloon sinuplasty was performed to reduce an anterior table fracture with involvement of the frontal outflow tract.</td>
<td>Successful reduction was performed. Follow-up imaging showed good reduction and aeration of the frontal sinus.</td>
</tr>
<tr>
<td>Chaaban et al(^{27})</td>
<td>13</td>
<td>12 patients with skull base defects from posterior table fractures were managed with Draf 2B (1 with concurrent trephination). One patient was managed with Draf 3.</td>
<td>All patients were repaired successfully with septal flap and/or free tissue grafts. One required revision frontal sinusostomy.</td>
</tr>
<tr>
<td>Crozier et al(^{14})</td>
<td>2</td>
<td>2 patients with skull base defects from posterior table fractures were managed using an endoscopic assisted trephination technique.</td>
<td>Both patients underwent successful repair using bone and/or mucosal grafts.</td>
</tr>
</tbody>
</table>
**Floor/FSOT Damage**

- Observe then sinus surgery if problem develops or sinus fails to clear on F/U CT (no later than 6 months). Close F/U mandatory.
- Explore
  - Trephine
    - Eval outflow tract with endoscope
  - Observe if FSOT is open
    - Obliterate if outflow tract is damaged

**Delayed Complications**

- Sinusitis
  - Sinus surgery/Draf III
  - Obliteration
- Mucocoele
  - Sinus surgery/Draf III
  - Obliteration

**CSF Leak/Encephalocele**

- Medial
  - Draf III
    - Repair
      - Obliterate
  - Lateral
    - Trephine & Repair
      - Obliterate
REFERENCES
