Maxillofacial Trauma

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Disclosure

• None

Learning Objectives

• Review the anatomy and common fractures of the maxillofacial skeleton
• Understand the indications for intervention in bony maxillofacial trauma
• Overview the surgical approaches to the maxillofacial skeleton
Maxillofacial Trauma

- Mandible
- Maxilla
- Zygomaticomaxillary complex
- Orbital floor
- Nasal Bone

Initial Evaluation

- ABC's
  - Possible sublingual hematoma
- Cervical spine and other associated injuries
- Identify the mechanism of injury
- PMH: bony growth abnormalities, osteoporosis

Key Questions

1. Do you see “double?”
2. Are there any areas of numbness on your face?
3. Does your bite feel “normal?”
4. Which areas of your face hurt?
5. Does it hurt when you open your mouth?
Clinical Examination

1. Soft tissues
2. Nerves
3. Facial Skeleton
   - Inspection
   - Palpation
4. Dentition

Work-Up

• Maxillofacial CT without contrast

Mandible Anatomy
Anatomy

Mandible Fractures

Common etiologies: Mandible Fracture

- Motor Vehicle Accident
- Altercation
- Work related accidents
- Fall
Clinical Examination

- External skin lacerations, hematoma
- Oral mucosal lacerations, hematoma
- Deviation of the mouth
- Occlusion
- Palpate contour, TMJ
- Assess mobility
- Lip/Chin Numbness

Occlusion: Angle Classification

The mesiobuccal cusp of the upper first molar should align with the buccal groove of the mandibular first molar

Imaging

Panorex
CT maxillofacial s contrast
Surgical Indications: Mandible

- Surgical Goal: To maintain stability
  - Restoration of occlusion and facial contour
  - Prevent infection, osteomyelitis
- Malocclusion
- Open Fractures
- Coronoid fracture: No intervention needed

Closed Treatment: MMF

- Unilateral condyle fracture
- Severely comminuted fractures
- Children

ORIF Mandible

- Unfavorable fractures
- Fractures open to skin
- Multiple facial fractures
- Nonunion
- Malunion
Approach: Intraoral

Approach: External Risdon Incision

External Access

- Risdon Incision
- Retromandibular incision
ORIF Mandible: 2 Point Fixation

Two Point Fixation: Plate and Arch Bar

Mandible Fracture
Post-Operative CT

Gunshot wound to the Mandible
Maxilla Anatomy

Maxilla: Le Fort Fractures

Le Fort Fractures
Common etiologies: Maxilla Fracture

- Motor Vehicle Accident
- ATV Accidents
- Altercation: Usually with a weapon
- Work related accidents

Clinical Examination: Le FortFx

- Oral mucosal lacerations, hematoma
- Midface widening
- Occlusion
- Midface/Palate mobility
- Cheek or teeth numbness

Imaging
Le Fort I Fracture Patterns

Surgical Indications: Maxilla

- Surgical Goal: To maintain stability
  - Restoration of occlusion and facial contour
  - Prevent infection, osteomyelitis
- Prevent malocclusion and palate mobility

ORIF LeFort I: Intraoral Approach
Zygomaticomaxillary Complex (ZMC) Fractures

Four Fractures of ZMC
1. Zygomatic Frontal
2. Inferior Orbital Rim
3. Zygomatic Arch
4. Lateral Maxillary Buttress

Previously misnamed Tripod Fracture

Common etiologies: ZMC Fracture
- Altercation: Usually with a weapon
- Falls
Clinical Examination: ZMC Fx

- Trismus
- Facial Symmetry
- Cheek numbness
- Palpate orbital rims and zygomatic arch

Imaging

Zygomatic Arch Fracture
Surgical Indications: ZMC

- Surgical Goal:
  - Restoration of facial contour and symmetry
  - Trismus

ZMC: Multiple Approaches and Plating Options

ZMC: Multiple Approaches and Plating Options
Common etiologies: Orbital Fracture

- Falls
- Altercation
- Motor Vehicle accident
- Sports related accident

Clinical Examination: Orbital Fx

- Decreased Eye Motion
  - Entrapment
- Globe Injury
- Cheek numbness
- Visual Acuity
- Forced Duction Test

Imaging
Early Therapy

- Avoid Nose blowing
- Antibiotic Therapy
- Ice to face, Raise head of bed

Surgical Indications: Orbital Fracture

- Surgical Goal:
  - Prevent enophthalmos
  - Treat entrapment
- Orbital Floor Fracture
  - > 50% of the orbital floor with herniated orbital contents
  - Diplopia and Entrapment
- Medial Orbital Fracture
  - Repair in conjunction with orbital floor fracture if change in orbital volume
- Superior and Lateral Orbital fractures
  - Rarely require repair

Orbital Floor Approaches
Orbital Floor Repair

Nasal Bone Fractures

Common etiologies: Nasal Fracture

- Accidents
- Sports
- Altercation
- Falls
- Motor Vehicle Accident
Clinical Examination: Nasal Fx

- External Changes to the nose
- Septal Deviation
- Nasal obstruction
- Epistaxis
- Rhinorrhea

Septal Hematoma

Emergent Incision and Drainage to Prevent Septal Perforation

Imaging
Surgical Indications: Nasal bone Fx

- Surgical Goal:
  - Restoration of nasal appearance
  - Nasal congestion

Closed Reduction

Cerebrospinal Fluid Leaks

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Learning Objectives

- Review the etiology of cerebrospinal fluid (CSF) rhinorrhea
- Learn the evaluation and work-up for CSF leaks
- Understand the complications associated with CSF leaks
- Overview the management of CSF leaks

Congenital Encephalocele

Historical Classification of CSF leaks

- Traumatic
  - Accidental
  - Surgical
- Non-traumatic
  - High pressure
    - Tumors
  - Normal pressure
    - Tumors
    - Congenital
  - Spontaneous
- Accidental
  - Motor vehicle accident
  - Motorcycle/ATV
- Surgical
  - Endoscopic sinus surgery
  - Neurosurgery
  - Planned skull base surgery
Traumatic CSF Leak

- 18 year old male s/p ATV accident
- Continuous rhinorrhea and headache
- Cognitive changes

Post-FESS CSF Leak

- 57 yo male s/p FESS
- 3 days of severe headache
- Meningitis

Evaluation and Work-Up

- No age demographic
- History of Surgery or Trauma
- Confirm clear rhinorrhea with beta-2 transferrin
- High resolution CT of the skull base
Management

• Accidental
  – Lumbar drain, bedrest, stool softeners for 7 days
  – If persists, surgical repair is indicated
    • Debridement of bone fragments
    • Free graft or vascularized repair

• Post-surgical
  – Early repair of CSF leak to prevent meningitis
  – Free graft or vascularized flap repair

Post-FESS CSF Leak

Historical Classification of CSF leaks

• Traumatic
  – Accidental
  – Surgical

• Non-traumatic
  – High pressure
    • Tumors
  – Normal pressure
    • Tumors
    • Congenital
  • Spontaneous

• Spontaneous CSF rhinorrhea is a distinct clinical entity and occurs in the absence of any inciting event.
Why does it matter?
Spontaneous v. another etiology

- Endoscopic repair: 90-95% success rate
  - Standard of care
  - Excellent visualization
  - Avoid frontal craniotomy
- Spontaneous CSF leak: 13-75% success rate historically
- Increased ICP: negative risk factor for repair

Do spontaneous CSF leaks represent a distinct clinical entity and a variant of idiopathic intracranial hypertension?

Normal CSF Physiology

- Normal CSF pressure: 5-15 cm H₂O
- Total CSF volume: 90-150 mL
- CSF production: Choroid plexus 0.35 mL/min
- CSF absorption: Arachnoid villi acts as a one-way valve
  - Pressure gradient of 1.5 – 7 cm H₂O for antegrade flow
Clinical Presentation and Evaluation

- Obese, middle aged females with clear unilateral watery rhinorrhea
- β-2 transferrin or β-trace protein
- Localization
  - High resolution CT of skull base
  - MRI

Spontaneous CSF Leaks and IIH

<table>
<thead>
<tr>
<th>Spontaneous CSF leak</th>
<th>Idiopathic Intracranial Hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female sex (70-80%)</td>
<td>Female sex (90%)</td>
</tr>
<tr>
<td>Obesity (82-92%)</td>
<td>Obesity (94%)</td>
</tr>
<tr>
<td>Average BMI 35.4</td>
<td>Average BMI 33</td>
</tr>
<tr>
<td>Reproductive age (78%)</td>
<td>Reproductive age (70%)</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Symptoms</td>
</tr>
<tr>
<td>Pressure-like headache (91%)</td>
<td>Headache (98%)</td>
</tr>
<tr>
<td>Pulsatile tinnitus (45%)</td>
<td>Pulsatile tinnitus</td>
</tr>
<tr>
<td>Watery rhinorrhea</td>
<td>Visual changes (48%)</td>
</tr>
</tbody>
</table>

Wang Oto Clin North America 2011

70% of Spontaneous CSF Leak patient would have IIH by Dandy criteria

Obesity, Spontaneous CSF leaks and IIH

- BMI >30 ➞ 10-20 fold incidence of IIH
- Average BMI
  - Spontaneous CSF leak: 35.4
  - Traumatic CSF leak: 29.7

Radhakrishnan J Neurol Sci 1993, Banks OtoHNS 2009
CT: Spontaneous CSF Leaks

- Attenuated Skull Base
- Normal Skull Base

Common Sites of Spontaneous CSF Leaks

- Lateral Recess of Sphenoid
- Cribiform/Ethmoid Roof

MRI: Spontaneous CSF Leaks

1. Empty Sella Syndrome
2. Bilateral meningoceles
3. Dilated Optic Nerve Sheathes

Multiple meningoencephaloceles in spontaneous CSF leaks: up to 31%
Radiographic Findings of IIH

- Double Blinded Case Control Study
  1. Empty Sella Syndrome
  2. Abnormalities of the Optic Nerve
  3. Arachnoid Pits
  4. Flattening of the Posterior Globe/Skull Base

Empty Sella Syndrome

Herniation of meninges and CSF through weakened sellar diaphragm into sella turcica compresses pituitary

Association with ESS:
- Spontaneous CSF rhinorrhea: 76%
- Multiple spontaneous meningoceles: 100%
- Spontaneous CSF otorrhea: 80%
- IIH: 84%

Marker of successful treatment of depressed ICP?

Direct Evidence of Increased ICP in Spontaneous CSF Leaks

- IIH diagnosis requires ICP of 25 cm H₂O
- ICP after endoscopic repair in spontaneous CSF leak: 27 and 32.5 cm H₂O
- ICP after endoscopic repair in traumatic CSF leak: 14 cm H₂O
- Case series reporting development of classic IIH symptoms after repair of CSF leak
Evidence support Spontaneous CSF leaks as a variant of IIH

- Strikingly similar demographics and symptoms
  - Level 2B
- Overlap of radiographic findings
  - Level 2B
- Increased ICP after endoscopic repair
  - Level 2B

Can a reduction in CSF pressure alone be used to treat CSF leaks?

Reduction in CSF pressure

- Medications
  - Acetazolamide
  - Topiramate
- Shunting
  - Lumboperitoneal shunting
  - Ventriculoperitoneal shunting
- Weight loss
  - Gastric bypass reduced CSF pressure from 35.3 to 16.8 cm H2O
  - Sugerman, Ann Surg 1999
Case Reports

- Spontaneous CSF leak after VP shunt failure that resolved after shunt revision  

- 3 separate case reports of cessation of CSF leaks after gastric bypass surgery and weight loss for IIH  

Case Example

- 62 year old female with moderate obesity presents with the acute onset of left sided watery rhinorrhea two weeks ago.
Nasoseptal Flap Reconstruction

Spontaneous CSF Leak: Endoscopic Repair
- 53 yo obese female initially admitted for meningitis with pansinusitis
- After resolution of meningitis, she reports a history of right sided clear rhinorrhea for 3-4 years

Encephalocele of the Lateral Recess of the Sphenoid
Spontaneous CSF Leak: Endoscopic Repair

- 43 yo obese female who presents with watery rhinorrhea

Left trans-pterygoid approach to middle fossa
Does decreasing ICP improve outcomes of endoscopic repair of spontaneous CSF leaks?

Perioperative Concerns

- After repair and no further CSF diversion, ICP increase to 27-32.5 cm H₂O
- Possible stress on repair
- Lumbar drains?
- Medical therapy?
- Shunting?

No Randomized Controlled Trials

Lumbar Drains as Diagnostic Tools

- University of Pittsburgh [Caruso Laryngoscope 2005]
  - 19 Patients with increased ICP underwent endoscopic repair with diagnostic LD
  - If persistently elevated ICP, VP shunt
  - 100% success rate
- University of Pennsylvania [Woodworth OtoHNS 2008]
  - 77 Spontaneous CSF leak patients underwent endoscopic repair with diagnostic LD
  - If ICP > 15 cm H₂O, acetazolamide
  - If ICP > 35 cm H₂O, VP shunt
  - 95% success rate
A look at the failures out of Penn

- 6 failures
  - 3 at a second site, failure to control ICP
  - 3 failed after VP shunt malfunction

Acetazolamide and CSF leaks

- Carbonic anhydrase inhibitor
- Reduces CSF production by 48%
- Mean reduction of 10 cm H₂O
- Report decrease in tinnitus, headache
- No long term benefit demonstrated

Carbonic Anhydrase Inhibitors and IIH

- Acetazolamide: Conflicting evidence in vision
  - Visual fields: effective
  - Papilledema: ineffective
- Topiramate & Acetazolamide
  - Both effective for IIH: Headaches, Tinnitus, and visual fields
  - Topiramate: Weight Loss
- Cochrane review: insufficient data to recommend
Shunting

- Spontaneous CSF Leaks
  - Effective in 2 larger case series
- Empty sella syndrome
  - Neurological symptoms
  - Visual symptoms
  - Repair of CSF leaks
- IIH
  - Preventing visual loss

Why not shunt everyone?

- Shunt failure rate: 3-10%
- Infection (27%)
- Overdrainage issues
- Estimated 40-50% shunts are removed at 2 years

Evidence supporting Reduction in ICP after Repair of Spontaneous CSF leaks

- Medical reduction of ICP i.e acetazolamide
  - Level 4
- CSF diversion
  - Level 4
- Weight loss
  - Level 5
### Grade of Evidence Summary

<table>
<thead>
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<th>Evidence based Question</th>
<th>Grade of Evidence</th>
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<tbody>
<tr>
<td>Association between IIH and Spontaneous CSF leaks</td>
<td>B</td>
</tr>
<tr>
<td>Etiologic role of increased ICP in spontaneous CSF leak</td>
<td>B</td>
</tr>
<tr>
<td>Decreasing ICP alone for treatment of spontaneous CSF leak</td>
<td>D</td>
</tr>
<tr>
<td>Improving outcomes after endoscopic repair by decreasing ICP (medical or CSF diversion)</td>
<td>C</td>
</tr>
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### Conclusions

- Spontaneous CSF leaks are a distinct entity that is likely a variant of IIH
  - Demographic, Clinical and Radiographic

- Decreasing ICP may improve successful outcomes after endoscopic repair
  - Case series