Identifying Meningoceles, Meningoencephaloceles, and CSF Leaks and Their Clinical Significance

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Learning Objectives

1. Learning the importance of identifying meningoceles, meningoencephaloceles, and CSF leaks.

2. Identifying meningoceles, meningoencephaloceles, and CSF leaks on imaging.

3. Identifying imaging findings suggestive of idiopathic intracranial hypertension (IIH), which can be associated with meningoceles, meningoencephaloceles, and CSF leaks.
Introduction

- **CSF leak:** abnormal communication or fistula of the subarachnoid space with the sinonasal or tympanomastoid cavities
  - Presents with clear rhinorrhea or otorrhea
  - Increases risk of *meningitis* with persistent CSF rhinorrhea
- Mortality from bacterial meningitis is 33% with severe morbidity among survivors
- **Thus, important to diagnose CSF leaks early**
- **Meningocele:** meninges protruding through a skull base defect
- **Meningoencephalocele:** brain and meninges protruding through a skull base defect
Introduction

- Spontaneous CSF leaks account for 20 - 40% of all CSF leaks.
- Many spontaneous CSF leaks are thought to be due to underlying idiopathic intracranial hypertension (IIH).
- With spontaneous CSF leaks, up to 50 - 100% of patients can have coexisting meningoceles or meningoencephaloceles.

- IIH is proposed to cause increased pressure and dural tearing, resulting in CSF leaks.
- IIH, also, potentially predisposes patients to meningoceles or meningoencephaloceles due to associated skull base defects.
Idiopathic Intracranial Hypertension

- Diagnosing **IIH** as a potential cause of spontaneous CSF leaks or meningoceles/meningoencephaloceles is important, because these patients have an overall worse prognosis if their underlying IIH is not addressed.

- Recurrence rates after repair of CSF leaks in IIH range up to 87%.

- If an IIH patient has an active CSF leak, he or she may have pseudonormalized intracranial pressure, which can result in decreased utility of opening pressures for diagnosis.
  - Thus, it is important to identify **imaging findings** suggestive of IIH, if suspected.
  - While imaging can support the diagnosis of IIH and can rule out other causes of increased intracranial pressure, it is not diagnostic for IIH.
Imaging findings that can be associated with IIH

- Empty sella
- Prominent Meckel’s caves
- Posterior globe flattening
- Optic disc protrusion
- Enhancement of the optic disc
- CSF distension of the optic nerve sheaths
- Vertical tortuosity of the optic nerves
- Skull base defects with possible meningoceles, meningoencephaloceles, or CSF leaks
- Cerebellar tonsillar herniation
- Scalloping of the inner table of the calvarium
- Bilateral transverse dural venous sinus stenosis
Examples of Imaging Findings in Idiopathic Intracranial Hypertension

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Axial T2 MRI
Axial T2 MRI demonstrates vertically tortuous optic nerves (blue arrowhead), CSF distension of the optic nerve sheath (orange arrowhead), and optic disc protrusion (yellow arrowhead).

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Examples of Imaging Findings in Idiopathic Intracranial Hypertension

Sagittal T1 MRI

Axial T2 MRI
Examples of Imaging Findings in Idiopathic Intracranial Hypertension

- Sagittal T1 MRI shows an enlarged partially empty sella (purple arrowhead).
- Axial T2 MRI illustrating prominent Meckel’s caves (i.e., CSF spaces) (blue arrowheads).
Diagnosing CSF leaks, meningoceles, and meningoencephaloceles

Test otorrhea or rhinorrhea for beta 2-transferrin, a protein specific to CSF.

High-resolution CT of the paranasal sinuses and temporal bones to identify osseous defect(s)

- 1 defect
  - No additional imaging, and proceed to surgical repair
- 2+ defects
  - CT cisternogram to identify site of leak

- Possible meningocele or meningoencephalocele
  - Magnetic resonance cisternography to identify possible meningocele or meningoencephalocele

No imaging indicated because unlikely to be a CSF leak

Adapted from Reddy and Baugnon
Non-contrast CT Findings

- **CSF leaks**
  - Osseous defect(s) in the skull base
  - Dependent material within or adjacent to the skull base defect in the sinonasal cavity or temporal bone
  - In IIH, most common sites are ethmoid roof/cribiform plate and lateral recess of the sphenoid sinus

- **Meningocele/meningoencephalocele**
  - Osseous defect(s) in the skull base
  - Nondependent polypoid tissue in the sinonasal cavity or temporal bone adjacent to a skull base defect

- **Special cases**
  - Single opacificied ethmoid air cell
  - Olfactory recess opacification
CT Cisternogram Findings in CSF Leak

- Increased attenuation or contrast pooling near skull base defect
- Washout of intracranial contrast near skull base defect
- Change in location of contrast with change in patient position
- Increasing dependent contrast attenuation
MRI Findings

• CSF leak:
  ○ Dependent fluid near an osseous defect
  ○ Continuous **T2 hyperintense** signal extending from the subarachnoid space into the sinonasal cavity or temporal bone through an osseous defect

• Meningocele/meningoencephalocele
  ○ Meninges and/or brain parenchyma extending through an osseous defect
Identify abnormalities

Non-contrast CT

Magnetic resonance cisternography
Meningoencephalocele of the geniculate ganglion

Noncontrast CT demonstrates tegmen tympani defect (yellow arrowhead) adjacent to the geniculate ganglion (pink arrowhead) with nondependent material adjacent to the skull base defect (blue arrowhead).

FIESTA MRI reveals brain parenchyma and meninges (orange arrowhead) extending through the tegmen tympani defect identified on CT, representing a meningoencephalocele of the geniculate ganglion.
Identify abnormalities

Non-contrast CT

T2 fat saturated MRI
Noncontrast CT demonstrates a skull base defect along the lateral recess of the right sphenoid sinus (green arrowhead) and material adjacent to skull base defect in the right sphenoid sinus (yellow arrowhead).

T2 fat saturated MRI reveals gliotic brain parenchyma (green arrowhead) and meninges/CSF space (yellow arrowhead) extending through the skull base defect into the right sphenoid sinus.

**Imaging Findings**

Skull base defect

Material in the sphenoid sinus adjacent to the defect

Brain parenchyma and meninges protruding through the skull base defect
Identify abnormalities

Non-contrast CT

T2 MRI
CSF Leak

Noncontrast CT demonstrates layering material (yellow arrowhead) in the left sphenoid sinus adjacent to a lateral recess skull base defect (green arrowhead).

Imaging Findings

Skull base defect
Dependent fluid near the defect

T2 MRI reveals dependent T2 hyperintense material in the left sphenoid sinus (yellow arrowhead) near the skull base defect identified on CT.
Differential Diagnoses of CSF leak or Meningocele/Meningoencephalocele

**CSF leak**
- Rhinorrhea or otorrhea due to other benign inflammatory causes
- *Important to confirm leak with beta 2-transferrin testing*

**Meningocele/meningoencephalocele**
- Sinonasal polyposis
- Cholesteatoma
- Skull base, sinonasal, or temporal bone tumors/masses

- **MR imaging** is necessary to differentiate between diagnoses.
  - Absence of central enhancement, isointensity to CSF on all sequences, and tethering and/or gliosis of adjacent brain parenchyma, when present, suggest a meningocele or meningoencephalocele
  - Also, useful to identify imaging findings suggestive of IIH
Take home points

- **CSF leaks** can predispose patients to meningitis, which has an associated high morbidity and mortality
- **IIH** can potentially predispose patients to **CSF leaks, meningoceles, and meningoencephaloceles**
- Important to recognize **imaging findings** suggestive of **IIH** to alert reading radiologist to possibility of **CSF leak, meningocele, or meningoencephalocele** and to make the referring clinician aware of the possible underlying diagnosis
- Important to follow algorithm to correctly diagnose **CSF leaks, meningoceles, or meningoencephaloceles** and to rule out other pathologies, in order to make sure patient receives appropriate treatment and avoids possible adverse outcomes from incorrect or delayed diagnosis
References