

Evaluating CSF Leak Risk in Traumatic Frontal Sinus Fracture Based on Degree and Morphology of Radiographic Pneumocephalus

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Introduction

Skull fractures from blunt or penetrating trauma can lead to numerous life-threatening complications. Fractures through bones containing hollow spaces, known as pneumatized bone, can offer a communication between the cranium and the external environment. These communications can allow for:

- Cerebrospinal Fluid (CSF) Leak: the passage of CSF out of the skull and into the external environment
- Pneumocephalus: a radiologic finding of air in the skull after entering from the outside environment

The frontal sinuses are an example of a pneumatized bone in which fractures are commonly associated with the development of both pneumocephalus and CSF leak. While pneumocephalus itself can be relatively benign, CSF leaks left untreated pose numerous risks to the health of the patient. Neurosurgeons often perform a Frontal Sinus Cranialization procedure to seal the leak, reconstruct the frontal bone to close the skull.

Importance

Neurosurgeons have often associated pneumocephalus with later development of a CSF leak and the possible need for frontal sinus cranialization. Previous case studies have documented CSF leaks in patients with pneumocephalus, however there is a lack of large scale studies to more broadly evaluate the correlation of the two findings, including its clinical implications. Evidence supporting or disputing the predictive power of pneumocephalus for later development of a CSF leak is needed to identify patients who would need surgical repair of a frontal sinus fracture compared to those who may not develop a leak and could heal with non-operative management.

Methods

Medical records of 3,690 patients who presented with skull fractures to a Level 1 Trauma Center is being evaluated. Patients with a fracture involving the Anterior and/or Posterior tables of the frontal sinuses were identified for an extensive chart review for the following metrics:

- Type of fracture (Comminuted, Linear)
- Displacement of fracture
- Presence of pneumocephalus
- Class of Pneumocephalus (Banu MA et al classification criteria)
- Progression (stable, resolves, or worsens on later imaging)
- Development of CSF leak (yes, no)
- Days to CSF leak development
- Surgical repair of Frontal sinuses needed (yes or no)
- Other injuries sustained
- Development of any intracranial infection
- Placement of a lumbar drain or intraventricular drain

With a completed data set and after establishing patient criteria, a statistical analysis is to be performed to evaluate the development of a CSF leak based on the presence and class of pneumocephalus.

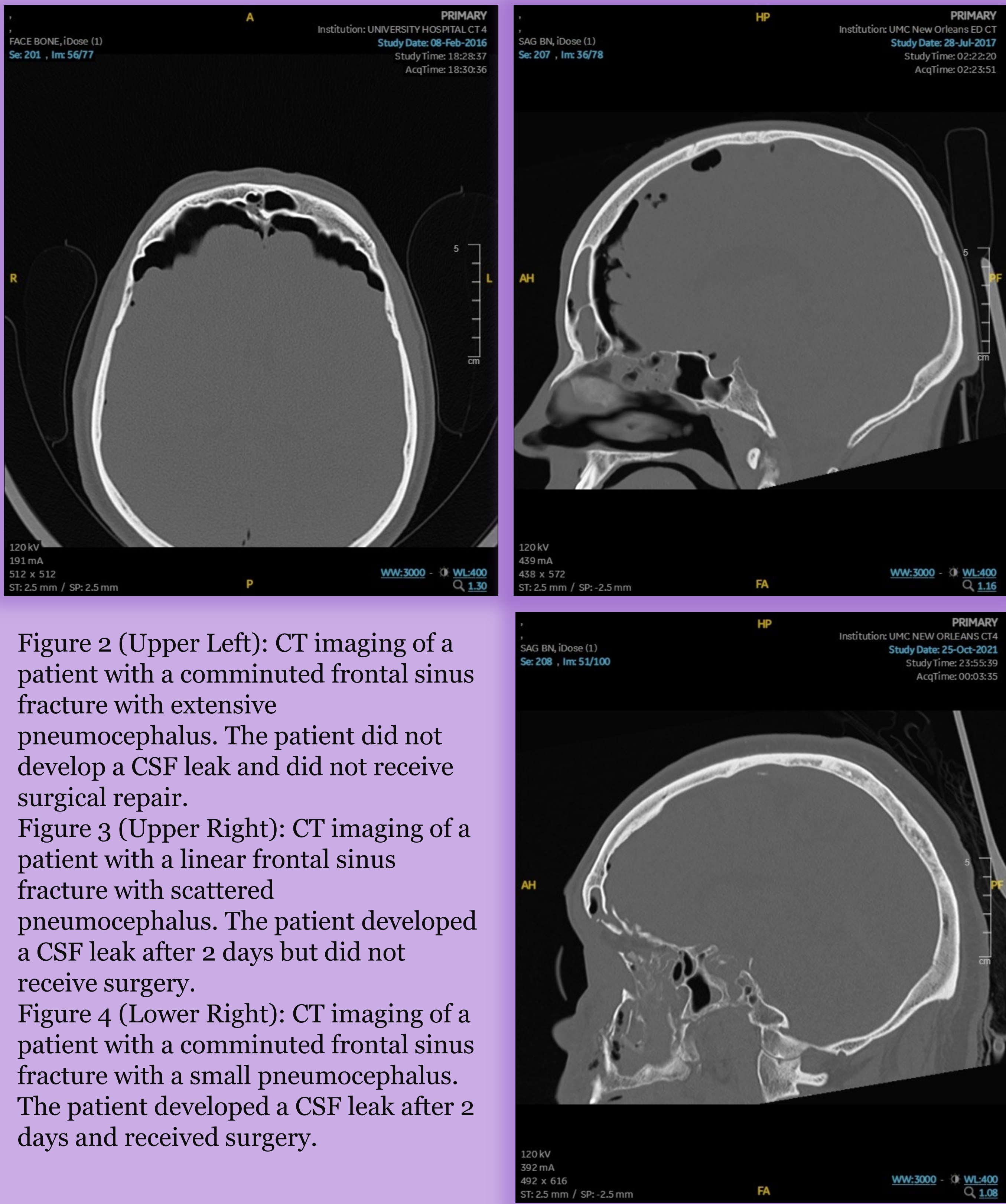


Figure 2 (Upper Left): CT imaging of a patient with a comminuted frontal sinus fracture with extensive pneumocephalus. The patient did not develop a CSF leak and did not receive surgical repair.
Figure 3 (Upper Right): CT imaging of a patient with a linear frontal sinus fracture with scattered pneumocephalus. The patient developed a CSF leak after 2 days but did not receive surgery.
Figure 4 (Lower Right): CT imaging of a patient with a comminuted frontal sinus fracture with a small pneumocephalus. The patient developed a CSF leak after 2 days and received surgery.

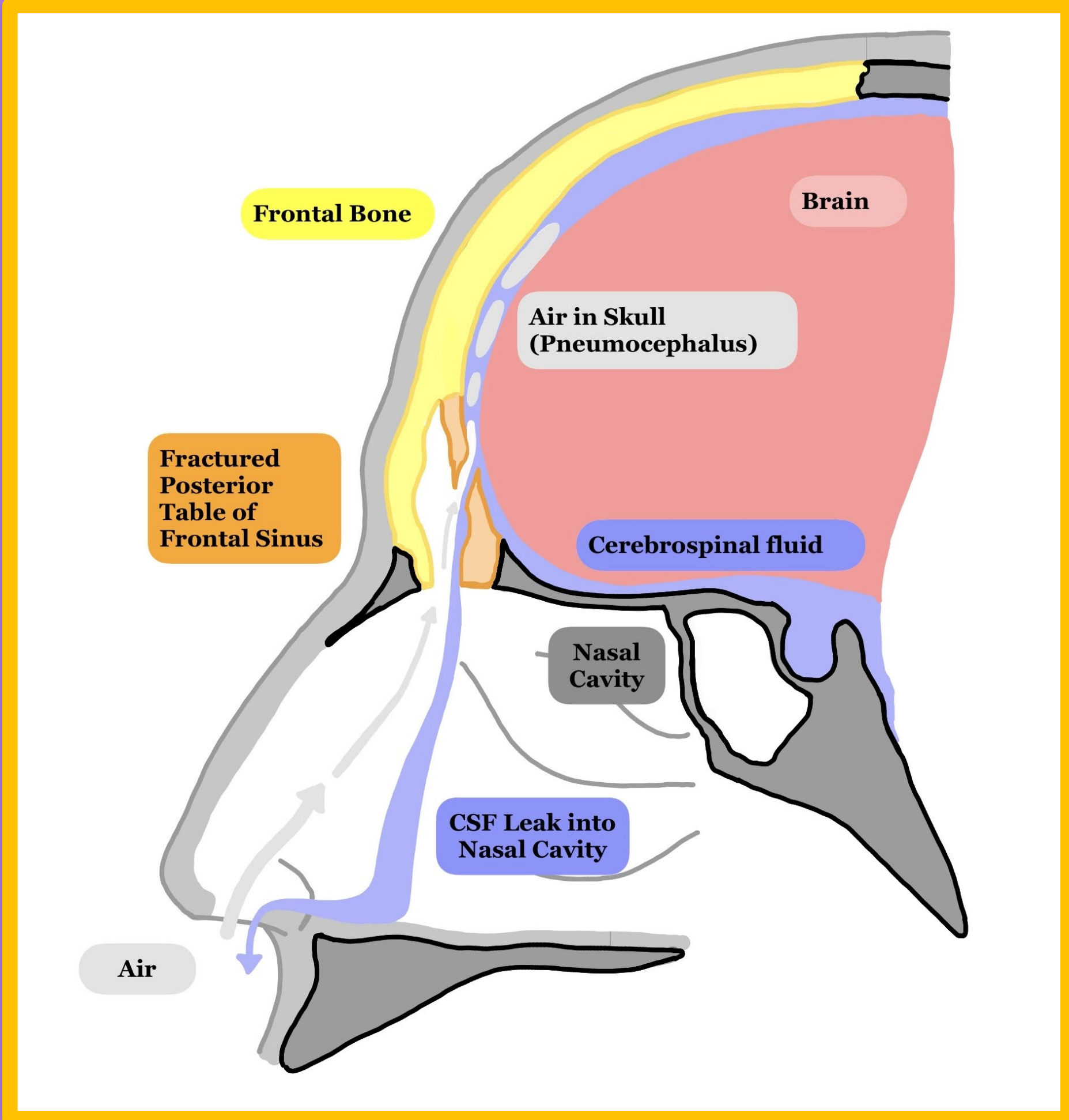


Figure 1: Illustration of a frontal sinus fracture developing both pneumocephalus and a CSF leak. The fracture allows for CSF to leak out of the normally sealed cranium, flowing through the openings of the frontal sinus into the nasal cavity and out the nares of the nose. The sinuses are typically filled with air, which can flow into the cranium through the same fracture that the CSF leak escaping through, causing air bubbles around the brain and skull bones that can be seen in imaging.

Future Directions

After data analysis is completed, we hope to either support or reject a correlation between the presence of pneumocephalus and the development of a CSF leak. This could have implications in better predicting patients requiring surgical repair of a frontal sinus fracture, preventing CSF leaks from developing in patients who don't receive surgery and preventing unnecessary surgery in those who might heal with non-surgical management. We also hope to do similar analysis with other pneumatized bone fractures, establishing data to better predict patients at risk of CSF leak development.