

**The COVID swab and the skull base – how to stay safe**

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The mass testing program during COVID-19 has seen vast numbers of nasal and nasopharyngeal swabs performed. We present an extremely rare case of skull base injury and CSF leak with subsequent meningitis, occurring as a complication of a COVID-19 diagnostic swab. We highlight the importance of understanding sinonasal anatomy and refining the sampling technique to reduce the risk of skull base injury. We recommend retaining the swab parallel to the nasal floor and pointing the swab no higher than the external ear canal opening. This content should provide additional support to public health agencies involved in educating healthcare providers.

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## **Clinical Record**

A 67-year-old lady was referred to our Ear Nose and Throat department with confirmed cerebrospinal fluid (CSF) rhinorrhea. This followed recent treatment for proven bacterial meningitis, having presented to a regional hospital with headache, nausea and photophobia. The patient precisely recalled the onset of unilateral rhinorrhea, which occurred within hours of an “extremely painful” Coronavirus disease (COVID-19) swab test. She had no other historical or medical risk factors for a CSF fistula (e.g. previous surgery, trauma), nor harbored any stigmata of Idiopathic Intracranial Hypertension (IIH). Intra-operative evaluation confirmed a small, well demarcated defect (2-3mm) in the left anterior skull base in the posterior cribriform plate (see Figure 1 and 2). The defect was successfully repaired with a fat-plug and free mucosa overlay graft. The patient made a full recovery and remains leak free. Given the historical description, timeframe and clinical findings we believe the injury to be a complication of the COVID-19 swab.

## **Discussion**

In response to the global COVID-19 pandemic, there has been an overarching public health goal to slow transmission rates. Instrumental to achieving this goal is the mass test and trace programs to rapidly identify and isolate cases. While nasopharyngeal sampling is regarded as a safe procedure when performed correctly, our case highlights the occurrence of skull base injury during nasal swabbing. This represents a very severe but extremely rare complication of mass testing. At the time of writing and to our knowledge, our case appeared to be the only such complication identified in Australia. This equates to a national incidence of skull base injury from COVID-19 swab testing of 1 in 7,393,693<sup>1</sup>. Sullivan et al recently reported a CSF leak following a COVID-19 swab

in a patient with a known history of IIH, nasal encephalocele and sinus surgery<sup>2</sup>. Our case had no such pre-existing history to confound the aetiology of the leak.

Safe techniques in obtaining deep nasal and nasopharyngeal swabs have been published by numerous public health authorities globally during the COVID-19 Pandemic<sup>3,4</sup>. Although deep nasal swabs aiming to sample nasal mucosa at approximately 2-3cm depth have been reported to be inferior to nasopharyngeal swabs, they are less invasive<sup>3,4</sup>. It is of the authors opinion that descriptions of techniques for deep nasal and nasopharyngeal swabs may be easily confused by healthcare providers. It appears that a possible area for confusion relates to recommendations in patient positioning of a 70-degree angle of head extension<sup>3</sup>. Confusion may occur where guidance does not reference the angle of swab insertion. In this setting, there is significant risk of damage to the skull base if the swab is introduced in a horizontal orientation in relation to the tester with excessive depth and force. Previous anatomical study by Lang (1989) identified measurements and angles of the skull base to key nasal landmarks<sup>5</sup>. The average height from the nasal floor to the weakest area of the nasal roof (cribriform plate) is 45.73mm (range 38-52mm) anteriorly within the nasal cavity (Figure 3)<sup>5</sup>. The angle whereby the opening of the sphenoid sinus is encountered is approximately 30 degrees from the horizontal at a distance of 61.50mm (range 43-69mm) from the anterior nasal spine. Therefore, consideration must be taken by healthcare providers in relation to the length of swab (135mm at the authors institution) and angle of introduction to allow safe swab testing.

We recommend that a safe and effective approach for deep nasal and nasopharyngeal sampling does not depend upon any head extension. More crucially, it involves swab insertion into the nasal cavity at a plane between the opening of the nose and the external ear canal on the patient, which can be considered as the horizontal plane for the purpose of relationship to surface anatomy (Figure 4). This will allow the swab to be inserted parallel to the nasal floor which would avoid injury to the middle turbinates.

Swabs inserted in an upward orientation into the nasal cavity (greater than 30 degrees) not only have a risk of failing to achieve an adequate diagnostic sample from the desired nasal mucosa and nasopharynx, but also puts the patient at greater risks of injury to the thin and delicate areas of the skull base (attachment of middle turbinate and cribriform plate) which are superior and anterior to the sphenoid sinus ostium. Figure 5 illustrates a safe arc for swabbing and danger areas that should be avoided. We urge that this angle is not exceeded when performing diagnostic tests as it places the patient at greatest risk of serious adverse events.

### **Lessons for Practice**

- Skull base injury and CSF leak is a possible but very rare complication from COVID-19 swab testing.
- There have been limited reports of complications secondary to COVID-19 nasopharyngeal swabs. As mass testing continues, the accumulation of reports of complications will be essential to improve practice.
- A 70-degree head extension exposes the skull base to injury if the tester performs the incorrect technique.
- Swabs must be inserted at a horizontal plane between the nasal opening and external ear canal.

## References

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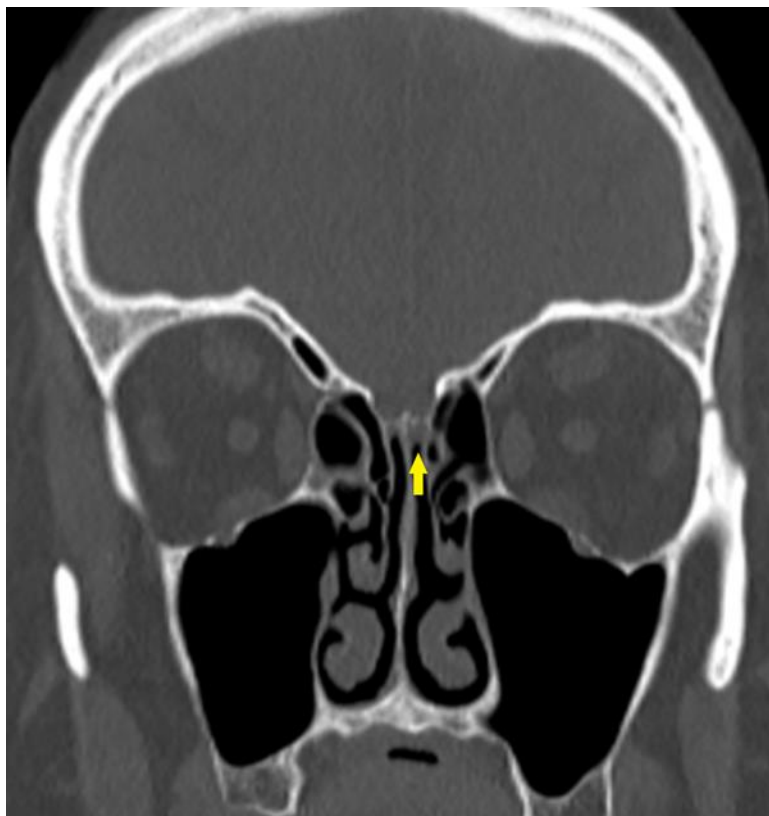


Figure 1 – CT sinuses coronal view showing defect in the left cribriform plate (yellow arrow).

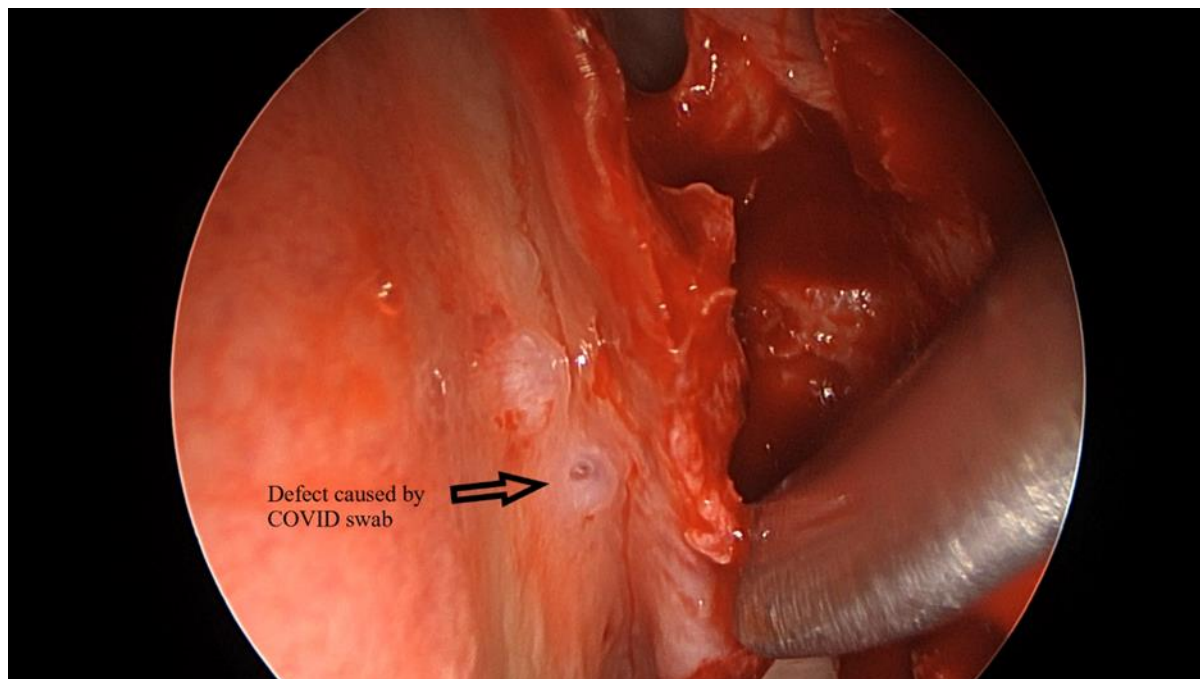


Figure 2 – Endoscopic view (45-degree endoscope) of defect created by the COVID-19 swab (left nasal cavity).

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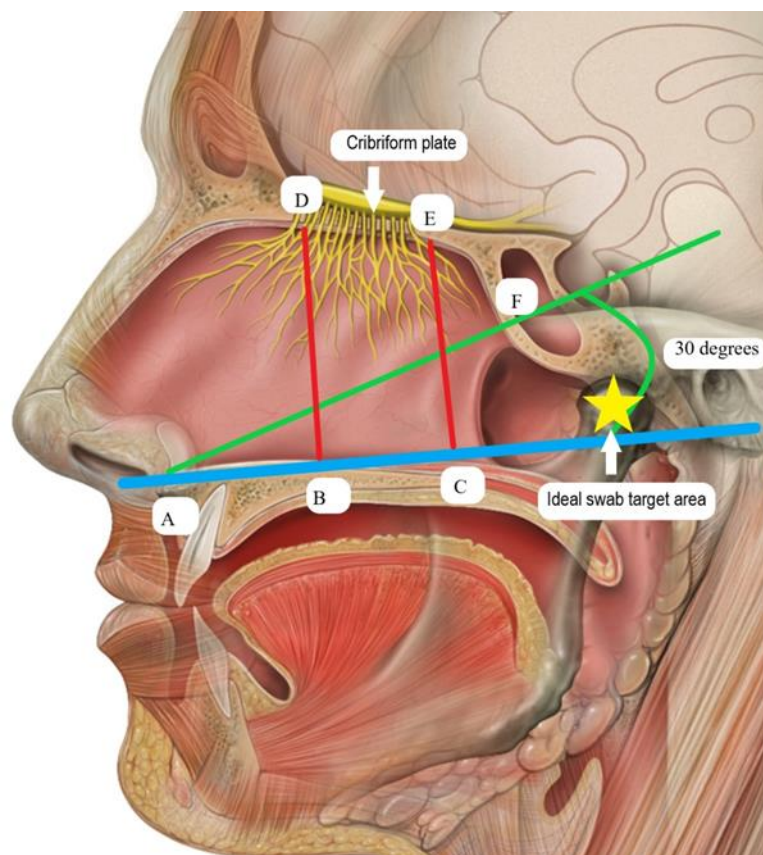
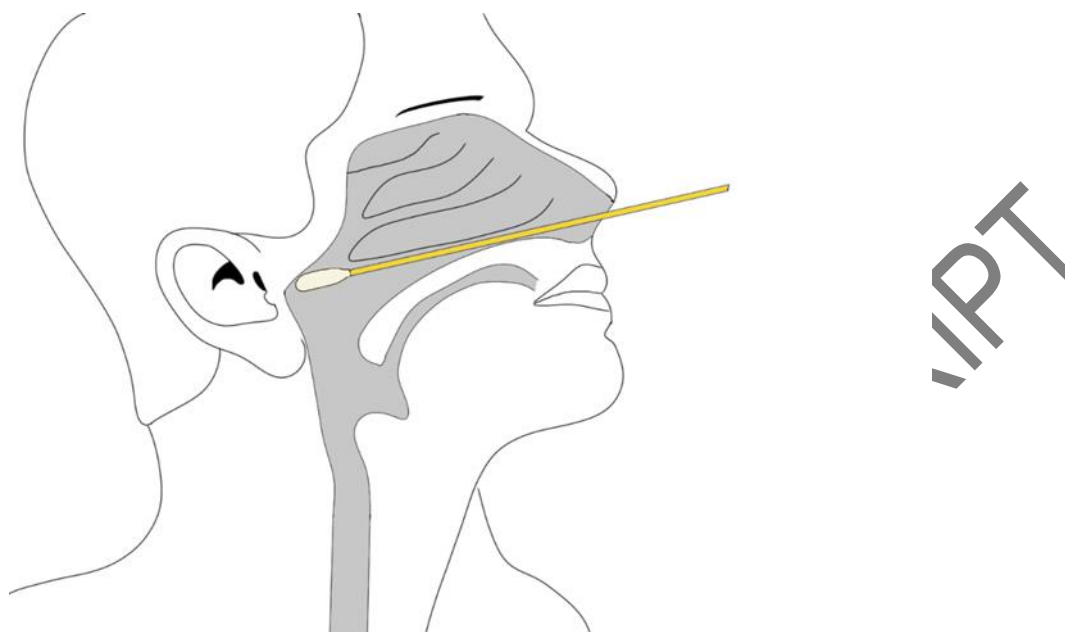
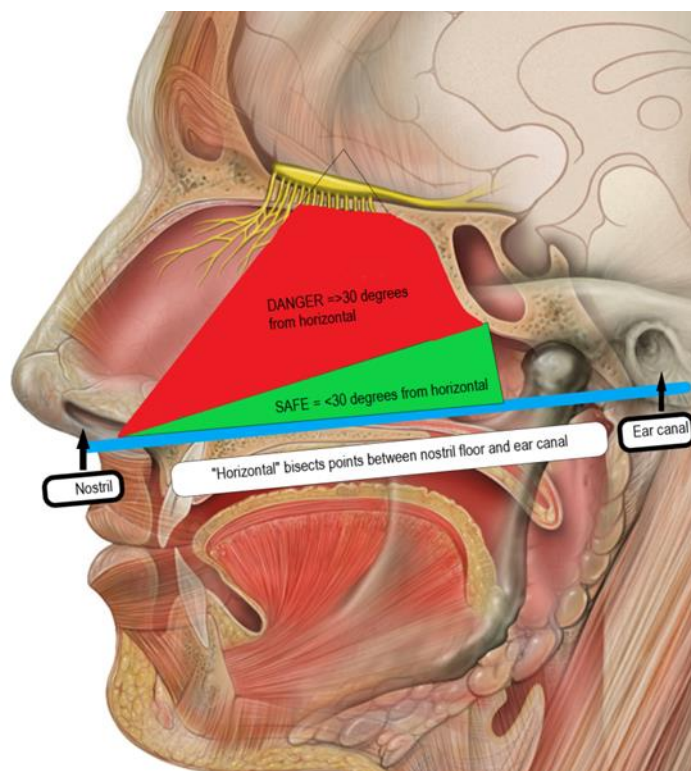


Figure 3 – Measurements from nasal floor to skull base and sphenoid<sup>5</sup>: A-F = 61.50mm (43-69mm), B-D = 45.73mm (38-52mm), C-E = 44.93mm (36-52mm). Ideal swab target for nasopharyngeal swab indicated by the yellow star. “Head anatomy with olfactory nerve” by PJ Lynch and CC Jaffee. [https://commons.wikimedia.org/wiki/File:Head\\_olfactory\\_nerve.jpg](https://commons.wikimedia.org/wiki/File:Head_olfactory_nerve.jpg) under a Creative Commons Attribution 2.5. Full terms at <https://creativecommons.org/licenses/by/2.5/>. Original image adapted by SG Mistry.



**Figure 4 – Illustration of safe nasopharyngeal swab technique following the horizontal plane between the nostril and the external ear canal along nasal floor.**



**Figure 5– Diagram to illustrate safe angles to swab (Horizontal considered line that bisects nasal floor and external auditory canal).** “Head anatomy with olfactory nerve” by PJ Lynch and CC Jaffee.

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