NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

# Professor Eric Can't Hear


*by*
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## Part I – Eric Goes Biking

Each Sunday, Eric and Frank met for their traditional 70-mile-cycling ride around southern California. Frank always called Eric before leaving the house so the two could meet nearby to begin their tour. One Sunday, Frank waited patiently for Eric to pick up the phone. He called once; no answer. He called again; there was still no answer. What was wrong with Eric?

Eric awakened minutes later to the sound of Frank banging on his door.

"ERIC, ARE YOU AWAKE?" yelled Frank.

Eric was startled and looked at his phone, which he used as an alarm. *That's funny*, thought Eric. *I set my alarm, but I didn't hear it.*

Eric frantically dressed, throwing on his clothes and helmet. In the meantime, Eric's daughter, Lily, groggily let Frank in the house as she too was awoken by Frank's yelling. She and Frank chatted while her dad prepared his water bottles. Annoyed by the early morning wakeup, Lily jokingly said, "Hey Frank, make sure you ride to Dad's left so he can hear you with his 'good ear'!"

Frank recalled a few times lately when Eric seemed to miss hearing things. Frank made a mental note of Lily's observation and decided to bring it up with Eric after their ride. But for now, Frank laughed with Lily. "Yep, you're right. Your dad and I are getting older!"

Meanwhile, as Frank laughed, Eric didn't react to Lily's comment, as if he hadn't heard her. But when Frank yelled, "Ready to go?" Eric jumped.

"Ready!" replied Eric.

They hopped on their bikes and off they went.

After beginning their bike ride, Frank thought about what Lily said and took her advice, staying on Eric's left side for the entire ride. While Eric seemed to hear everything Frank said, Frank was worried. He noticed that on some of the right-hand turns, Eric started to lose his balance. Frank found this strange and alarming, since Eric was a former cycling champion. When they ended their ride at the coffee shop, Eric was wobbly as they approached the counter.

"Hey buddy," said Frank. "I'll get your coffee today. You sit down and wait here."

### *Questions*

1. Should Frank be concerned about Eric? Why or why not?

2. What could be wrong? Suggest at least two possibilities.


*Credit:* Photo of Eric racing in 2005 Masters National Time Trial, courtesy of Simply Fit, Inc.

## Part II – Eric Visits His Primary Care Physician

"What seems to be bothering you today?" asked the doctor.

Eric sighed. "I'm having a hard time hearing my students in noisy classrooms and can't localize sounds very well. I'm 61 years old, so these symptoms may be a related to aging, but I'm worried about my loss of balance, intermittent dizziness, and ringing in my ears."

"Trouble with hearing and balance can have many different causes," the doctor explained. "Let's run a few tests to see what's going on."

Eric's doctor began with a simple "whisper test." Beginning with Eric's left ("good") ear, she whispered, "B, B, 8" and asked Eric to repeat it.

Eric replied, "No problem, Dr. Frost. B, B, 8."

"Okay, Eric, let's try your right ear," said Dr. Frost. "X, L, 5."

Eric paused and asked her to repeat the phrase. After the second attempt he admitted he had been unable to hear what she had said. Dr. Frost agreed Eric had some loss of hearing in his right ear but did not observe anything alarming when she placed the otoscope into his auditory canal.

During a follow-up appointment, an audiologist would confirm Eric had sensorineural hearing loss.

Dr. Frost next tested Eric's vestibular system because of his balance issues. Eric's doctor asked him to walk in different directions. She noticed Eric was unstable and stumbled when directed to turn right. Vertigo typically occurs when there is asymmetry between the right and left vestibular pathways.

Dr. Frost completed her exam with additional tests. She was uncomfortable diagnosing his condition until she could order an imaging test called magnetic resonance imaging (MRI). MRI is a useful test for observing soft tissues in the head. The results could be compared to a normal person his age and could be used for observing disruptions in the hearing and vestibular pathways.

### *Questions*

1. What is sensorineural hearing loss and how does it compare to conductive hearing loss?

2. Examine Figure 1 (see next page). Compare Eric's MRI with a normal MRI and circle any major differences that may be related to Eric's condition.

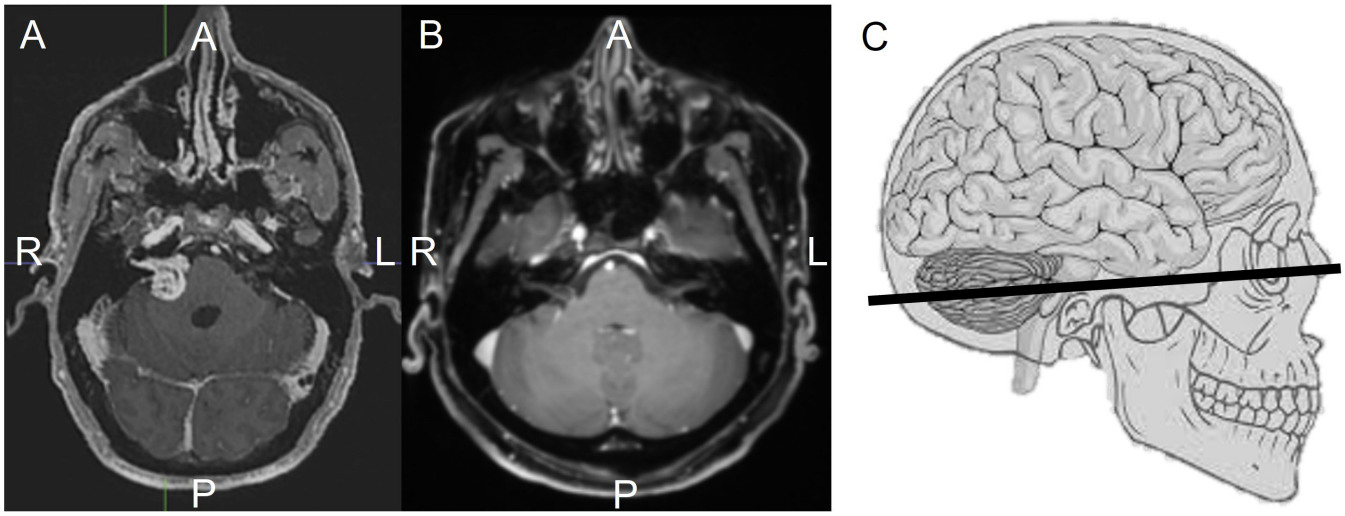


*Figure 1*. Transverse (axial) MRI images. (A) Eric's MRI and (B) a normal MRI observed at (C) the level of the cerebellopontine angle (the junction between the pons and cerebellum). To orient yourself, note that images of the brain are conventionally viewed from below (inferior view), as if looking up into the head. The patient's anterior (nose-side) is at the top of the image. KEY: R = right, L = left, A = anterior, P = posterior.

*Image credits:* (A) courtesy of Eric Sternlicht (coauthor); (B) courtesy of Craig Hacking/Radiopaedia.org, from the case "Normal MRI internal auditory canal," used in accordance with Radiopaedia guidelines; (C) public domain.

3. Based on Eric's symptoms and the MRI results, which areas best describe the general source of the problem?
   (a) Middle ear and inner ear
   (b) Inner ear and the internal acoustic meatus
   (c) Nerve and brainstem
   (d) Thalamus and auditory cortex

4. Based on Eric's conversations with Frank, Eric's interactions with the doctor, and your analysis of the images, what may be wrong with Eric?

## Part III – Eric Explores Surgery and the Impact on His Life

Professor Eric was next referred to a neurosurgeon. Eric was nervous as he asked Dr. Bui, "What's my best treatment option?"

"In your case, I would recommend surgery. To access the tumor, I will cut a flap in your temporal bone and insert the resection tools into the region where the tumor is (Figure 2). However, to do this, I must remove your inner ear sensory structures," replied the doctor.

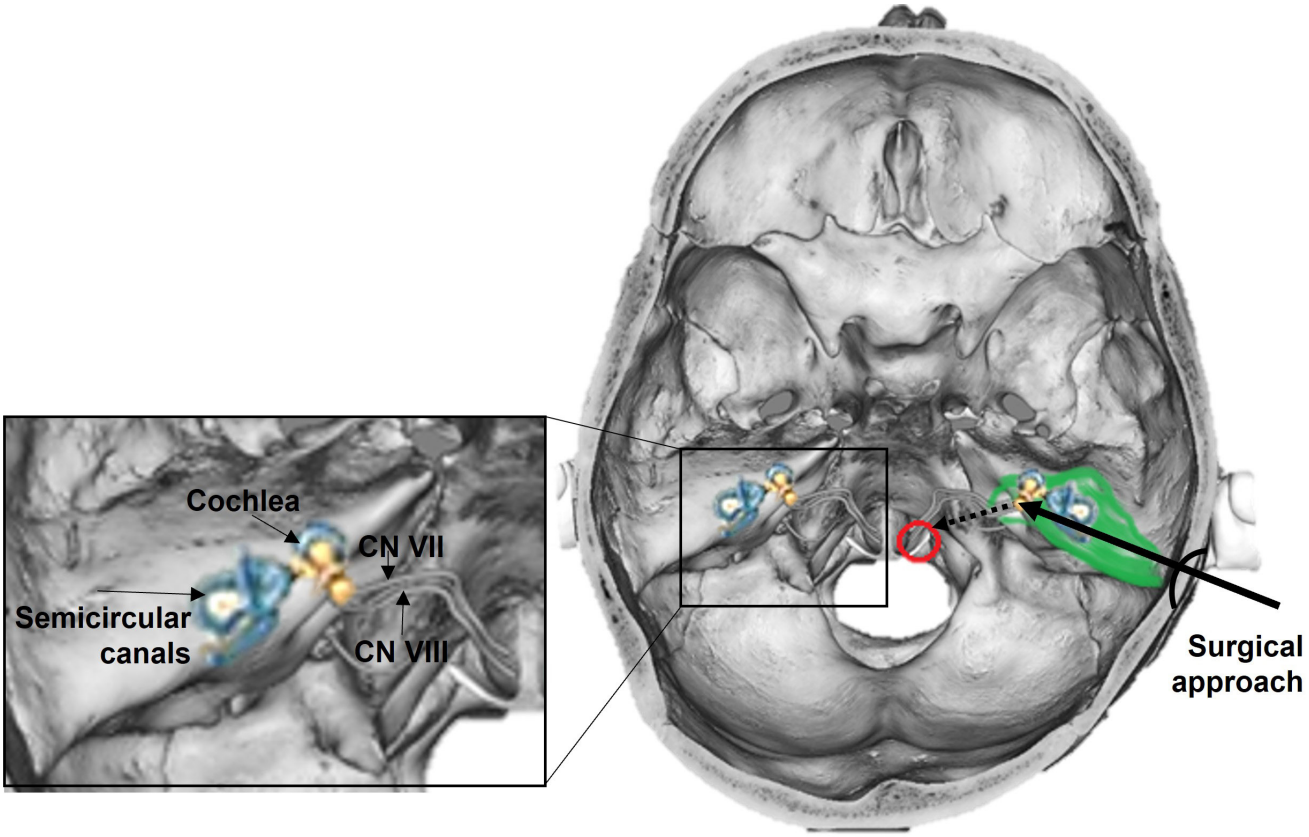


*Figure 2*. The recommended surgical method for Eric's tumor, known as a translabyrinthine craniotomy. To orient yourself, note the view of the skull is from above (superior view), as if looking down into the head. The surgery begins by incising the scalp behind the ear, then removing part of the temporal bone mastoid process and the deeper petrous bone inner ear sensory structure (shown in green and in the left inset), so that the surgeon can access the deeper tumor (red circle) inside the posterior fossa of the skull. The arrow shows the surgical approach into the middle ear, and the dashed arrow indicates the pathway into the posterior fossa. The procedure is called "translabyrinthine" because the surgeon must cross and remove the labyrinth, or vestibular structures that include the semi-circular canals, to access the tumor. *Credit:* Image created with Anatomage software (Ver 6), https://www.anatomage.com.

"That sounds like a major surgery!" Eric paused and then asked, "Will I go deaf?"

Dr. Bui replied, "To resect this tumor, we must remove the inner ear structures. This will lead to deafness in that ear, and you will no longer have stereo hearing. But you can participate in therapy to help."

"What are the complications?" asked Eric.

"Common complications from brain surgery include stroke, seizures, swelling of the brain, infection, nerve damage, cerebrospinal fluid leakage, and loss of some mental function. This specific surgery could cause facial weakness, balance issues, limb weakness, issues with swallowing, speaking, and other tongue movements, persistent headaches, coma, and—rarely—death."

Eric sat silently, so Dr. Bui continued. "This surgical approach has become the standard treatment for schwannomas of this type. We have had a lot of experience with this surgery and have learned a lot about these types of tumors. Although the tumor is not at risk of becoming cancerous (metastatic) and spreading to other parts of the body, if left untreated, its growth may result in problems worse than any complication."

Next, Dr. Bui outlined the four stages of the typical surgical process and recovery:

Stage 1 – Surgical Planning
Stage 2 – Surgery
Stage 3 – Possible Surgery Complications
Stage 4 – Rehabilitation.

Eric was given until his next appointment to consider surgery and its implications, and to make an important choice.

To help understand the surgical plan, you will work in teams to explore and present one of the four stages of Professor Eric's surgery, from his decision about when to have the surgery to his recovery and return to teaching. Using the team's answers to the questions you will be given, your team will orally summarize the assigned stage of the surgery for the rest of the class. Each team should consider the surgical approach outlined in Figure 2 as part of your discussion. The following is a summary of what the four teams will be working on. Those who are assigned:

*Stage 1 – "Can It Wait?" (Surgical Planning)* will explore the pros and cons of when to schedule the surgery.

*Stage 2 – "Review the Surgery Again?" (Surgery)* will summarize tumor removal and possibility of tumor remnants.

*Stage 3 – "What Happened?" (Possible Surgery Complications)* will investigate what can happen after surgery.

*Stage 4 – "When Can I Teach Again?" (Rehabilitation)* will summarize the challenges Professor Eric faced in order to return to teaching amid constraints imposed by the COVID pandemic.

## Stage 1 – "Can It Wait?" (Surgical Planning)

As a professor of health sciences, Eric knew how dangerous his tumor could become, but his diagnosis had come at a bad time. Eric's daughter, Lily, was about to graduate from college and he did not want to miss her graduation. He wondered how long he could delay the surgery.

At his next appointment, Eric asked Dr. Bui, "Can I delay the surgery until six months from now?"

### *Questions*

1. Eric's tumor originated at the junction between the central nervous system (CNS) and peripheral nervous system (PNS) myelinating glia. Name the two types of myelinating glia and how they differ. Because this is a tumor of a cranial nerve, which type of glia forms the tumor?

2. Identify and name the cranial nerves (V–IX) in Figure 3 below, indicating what other structures are near the tumor.

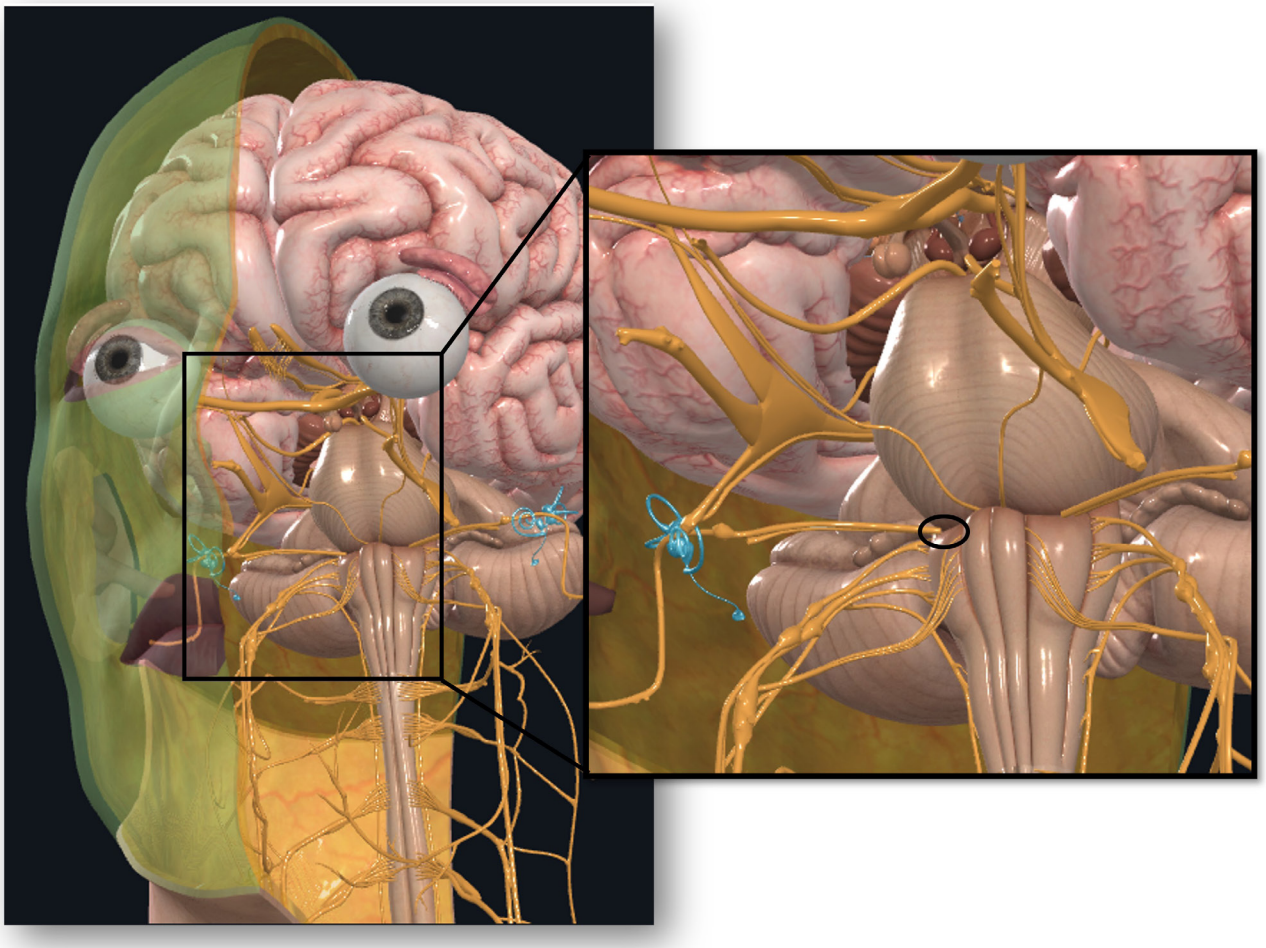

*Figure 3*. Cranial nerves (V–IX) near the location of Eric's tumor (see the black oval in the right panel of the figure).
*Credit:* Image created with Complete Anatomy™ software, https://3d4medical.com/.

3. If Eric decides to delay treatment, what might happen? Do you predict the tumor will change in shape or size over time?

4. If Eric did not have surgery at all, do you expect the tumor could impact Eric's lifespan? Are there particular areas of the brain involved in life-sustaining functions around the tumor?

5. How should Dr. Bui respond? Should Eric delay surgery? Why or why not? Be able to defend your answer.

## Stage 2 – "Review the Surgery Again?" (Surgery)

During surgical planning, Dr. Bui convinced Eric to have the surgery as soon as possible. The surgery was scheduled for a month later. While Eric was concerned about complications, he was confident the experienced neurosurgeon would be successful.

On the day of the surgery, Eric asked Dr. Bui, "Can you review the surgery with me once more?"

Dr. Bui replied, "I will use the translabyrinthine approach to access the tumor. The electrophysiologist will test the function of nearby structures as I carefully remove parts of the tumor. My goal is to preserve the neurological function of nearby structures while resecting most, if not all, of your tumor."

### *Questions*

1. Using Figure 4 below, label the anatomical structures the doctor will remove in the inner ear. What other nerves or anatomical structures that travel through the internal acoustic meatus could be affected during this surgery?

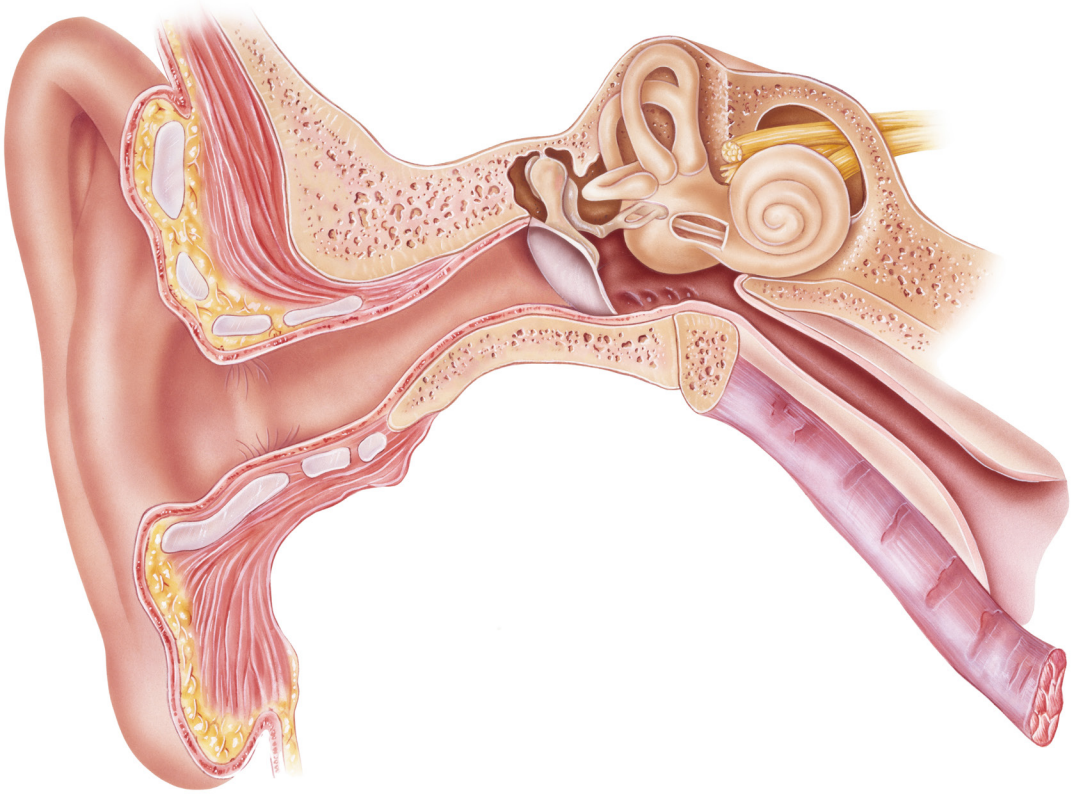

*Figure 4.* Internal acoustic meatus and the structures of the inner ear. *Image credit:* ©Medicalartinc | Dreamstime.com, ID 82089689, licensed.

2. What issues might arise if the additional areas you identified in Question 1 are damaged during surgery?

3. Compare the pre-operative and post-operative scan images in Figure 5 below. Do you think all of Eric's tumor was removed? Why or why not?

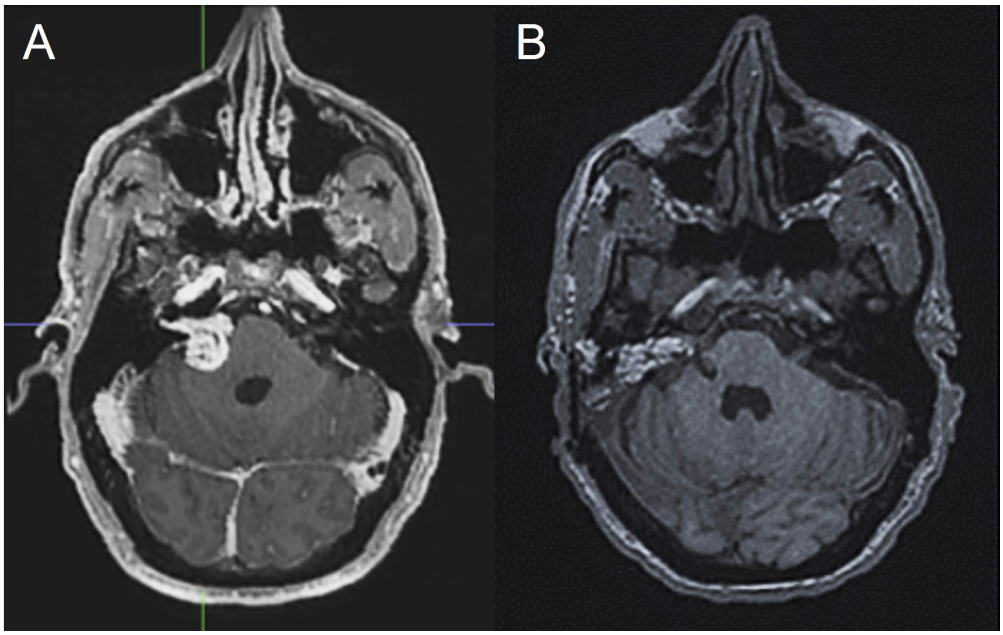


*Figure 5.* (A) Pre-operative and (B) post-operative MRI scans from Professor Eric (courtesy of Eric Sternlicht).

4. In the post-operative scan (Panel B of Figure 5), notice the white, hyperdense tissue where Eric's inner ear was removed. Adipose from Eric's stomach was implanted to fill the gap. Why do you think this technique, known as fat grafting, was used?

5. Is Eric making the right decision to have surgery? Why or why not? Be able to defend your answer.

## Stage 3 – "What Happened?" (Possible Surgical Complications)

After discussing possible complications during the surgical planning appointments, Eric scheduled the surgery for a month after his initial visit to the neurosurgeon. The day after Eric's surgery, he awoke to a visit from his friend, Frank.

"How are you feeling?" Frank asked as he entered Eric's hospital room.

"Not so well. I have a massive headache!" replied Eric.

"When did it start?" Frank inquired.

Eric replied, "This morning, but it seems to be getting worse. I feel like my head will explode."

Frank ran to get the nurse. As the nurse approached Eric's bed, she noticed Eric's face appeared swollen and clear fluid was leaking out of his nose.

### *Questions*

1. When performing surgery on the brain, what tissues need to be cut and then sutured to close the wound?

2. Why was Eric's head swollen and was it related to the clear fluid leaking from his nose?

3. Label the structures in Figure 6 that pertain to the normal production and flow of fluid within and around the nervous system.

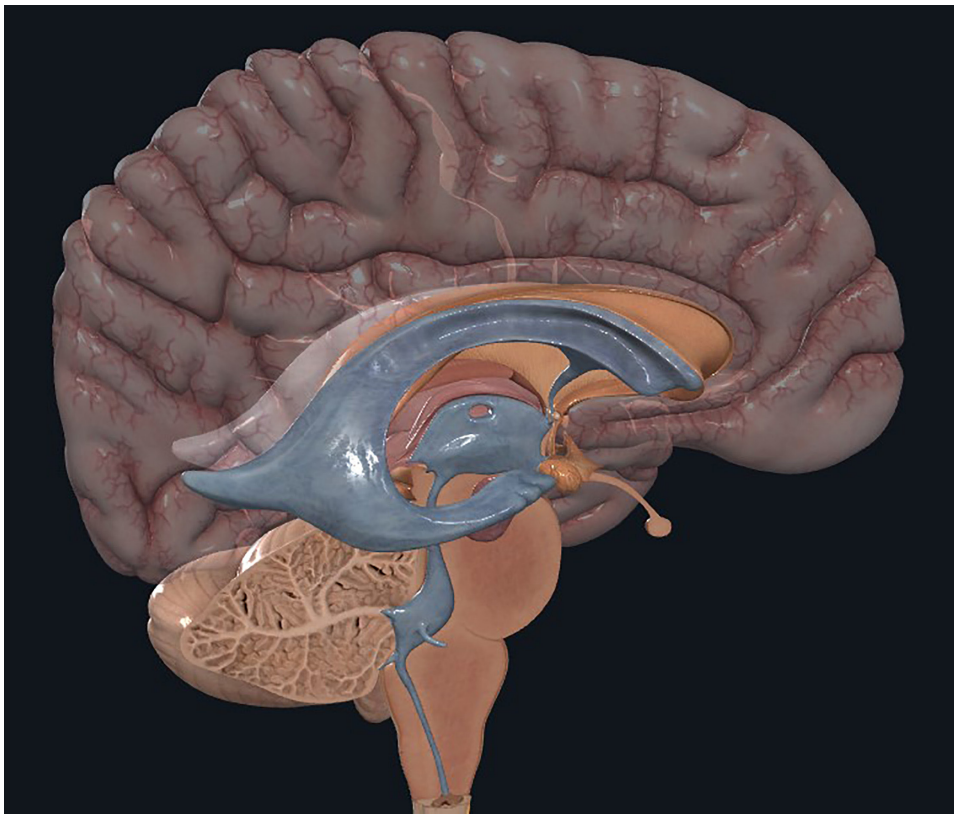

*Figure 6.* Structures related to the flow of fluid within and around the nervous system.
*Credit:* Image created with Complete Anatomy™ software, https://3d4medical.com/.

4. Why would fluid be leaking? Does it relate to Eric's headaches? Suggest a surgical intervention for this symptom. Draw an example of where this intervention should occur in Figure 6.

5. Even though there was a surgical complication, did Eric make the right decision to have surgery? Why or why not? Be able to defend your answer.

## Stage 4 – "When Can I Teach Again?" (Rehabilitation)

During surgical planning, Dr. Bui noted, "Eric, your initial recovery should be two to four weeks, after which you should return to normal activities. You will need additional rehabilitation to relearn some hearing and balance skills."

"That's great!" replied Eric. "I'll be able to return to teaching next semester."

After discussing possible complications, Eric scheduled the surgery for a month after his initial visit to the neurosurgeon.

Eric had the surgery and left the hospital after his post-operative recovery. In the following weeks, he required rehabilitation to regain his balance for walking since his inner ear was removed. He also had some common complications related to cerebrospinal fluid flow and infections that required additional surgery. Despite these setbacks, the benefits from his therapy made him feel well enough to return to teaching one class a few months after his October 2019 surgery.

But in March 2020, the COVID-19 lockdown resulted in many changes. His in-person therapy was canceled, and then subsequently moved to virtual sessions. His teaching also transitioned to remote online instruction, which caused increased screen-time for Eric. He quickly developed a stutter and had trouble finding his words. The screen-time was mentally exhausting, and he feared that his healing was not going well.

### *Questions*

1. Examine Figure 5 below. In both the pre-operative and post-operative MRI:
   a) indicate anterior, posterior, left, right;
   b) circle the tumor or tumor remnant; and
   c) label the brainstem, cerebellum, and cranial nerve VIII.

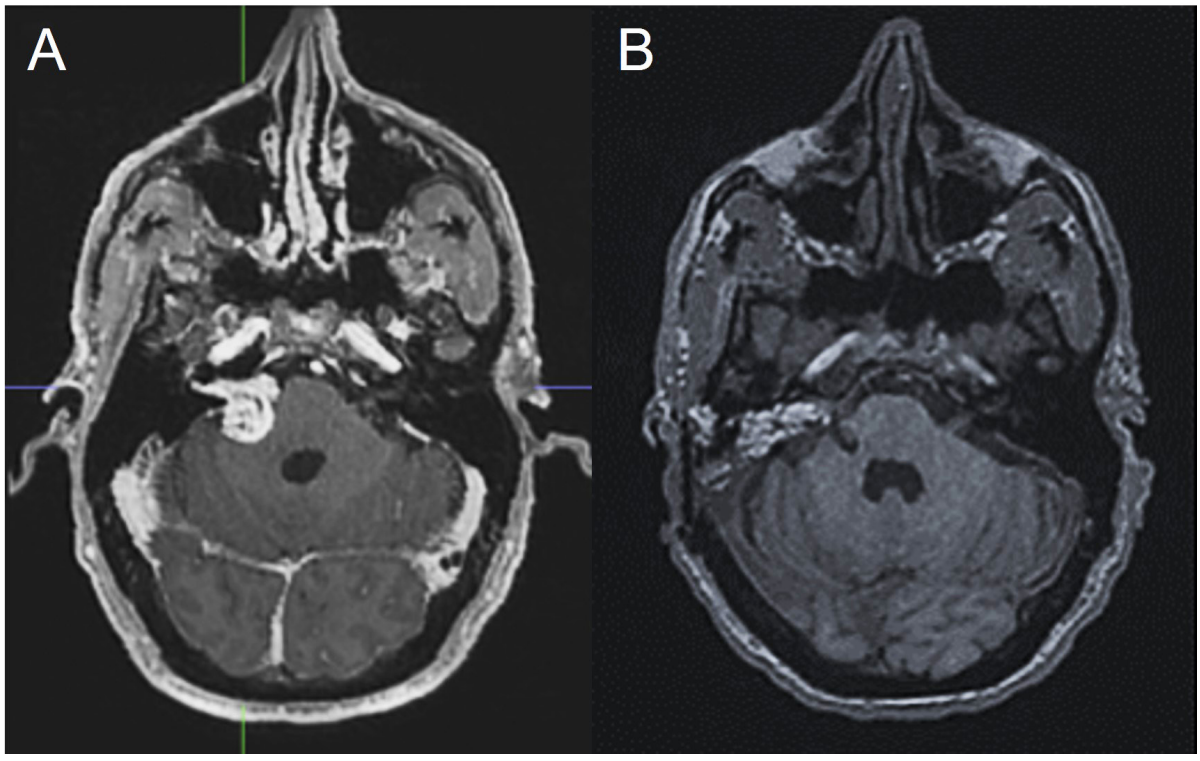


*Figure 5.* (A) Pre-operative and (B) post-operative MRI scans from Professor Eric (courtesy of Eric Sternlicht).

2. Hypothesize why Professor Eric may be experiencing exhaustion and a stutter.

3. What types of rehabilitation or therapy might a person experience after this surgery?

4. Predict how COVID-19 impacted the quality and quantity of Eric's recovery. When do you predict Professor Eric could return to teaching his normal load of four classes?

5. Even though there were complications with rehabilitation, did Eric make the right decision to have surgery? Why or why not? Be able to defend your answer.