

Dr. Jason Barnes:

Hey there. Welcome to another episode of ENT in a Nutshell. My name's Jason Barnes, and today we're joined by Dr. Neil Patel and we'll be discussing temporal bone trauma. Dr. Patel, thanks so much for being here.

Dr. Neil Patel:

Thanks for having me.

Dr. Jason Barnes:

When we talk about presentation of the temporal bone trauma, of course, it's easy to predict what the presentation is, but can you describe a little bit what we commonly see with folks presenting with temporal bone trauma?

Dr. Neil Patel:

Absolutely. It turns out it's quite hard to fracture the temporal bone and so usually the trauma that a temporal bone fracture will accompany is pretty severe. So we're talking motor vehicle accidents at higher speed, falls from a pretty significant height, bike accidents with direct head trauma, seizures, assaults, things like that. And a lot of times it has to do with trauma to the side of the head or the occiput.

Dr. Jason Barnes:

Mm-hmm (affirmative). And I think a good question from a resident standpoint is, when you're called for a temporal bone trauma, it's usually maybe the patients in the trauma bay or they've just gotten up to the floor from the trauma bay, and there's probably a scan that demonstrates a temporal bone trauma, or there certainly is, because that's what they're consulting you for. What's your workup for these patients when you know they have a temporal bone trauma?

Dr. Neil Patel:

It's often difficult because by the time you've been called, the patient might be intubated, sedated in the ICU, but we always wonder, what are good questions to ask of the emergency department when you receive the consult? And probably the best one to ask is, "Before you put that breathing tube in, what was their facial nerve function?" And of course, they're not going to be able to give you a House Brackmann Scale estimate, but if you can get them to say that, "Oh, they seemed to be grimacing symmetrically," or "They were responding to pain and squeezing both eyes shut", or something like that, then you would have a good assessment of facial nerve before you potentially lose the ability to get a good neurologic exam. So, that's probably the only question that I ask them right up front.

Dr. Neil Patel:

Usually there's so much blood from the ear canal and blood from other places that people aren't going to reliably be able to tell you whether there's CSF otorrhea or rhinorrhea. And then when you actually visit with the patient, usually you're lifting sedation or something like that, but let's take, for example, perhaps a less severe injury where the patient just has a temporal bone fracture, but is otherwise neurologically intact, you can start by getting an assessment subjectively of whether the patient's experienced any acute changes in hearing, symptoms of vertigo, loud tinnitus, things like that. But most of it really comes down to the examination, and I can go into that next.

Dr. Jason Barnes:

Yeah, sure. So can you tell us what we're looking for on exam here?

Dr. Neil Patel:

So grossly, you want to do a good trauma exam and assess the whole facial skeleton, but skipping a lot of that, and just focusing on the ear, you'll look at the skin around the ear, and I've only seen a handful of true Battle's sign previously, but that's from bruising, from extravasated blood behind the ear, either the mastoid emissary vein, or a regional artery or vein. Sometimes people will have a raccoon sign, where they have periorbital ecchymosis associated with skull base fractures. And then after you assess the skin, obviously you're not going to feel any fracture lines, but looking through the ear canal, you might see a laceration in the ear canal. I really just look with a handheld otoscope. Don't try to aggressively clean anything out or irrigate anything out, because there's always the chance that the middle ear is open or the inner ear is open, and you don't want to introduce any bacteria if there's a CSF leak.

Dr. Neil Patel:

Go ahead.

Dr. Jason Barnes:

So oftentimes we'll be consulted after a CT scan has demonstrated this temporal bone fracture. If a normal CT scan has been obtained, would you also obtain a temporal bone CT specifically?

Dr. Neil Patel:

That's a great question. Nowadays, most trauma protocols include a sub millimeter slice thickness CT scan of the head, and usually that gives good enough views of the temporal bone. If you see a perfectly normal appearing temporal bone with no mastoid opacification, no middle ear opacification, of course, no fracture line, and perhaps secondarily, no pneumolabyrinth or air within the labyrinth or pneumocephalus in the region of the temporal bone, then you can probably be safe just with that scan and not have to obtain a direct temporal bone CT.

Dr. Neil Patel:

However, if any of those signs are present on the standard head imaging, or if the patient exhibits a worrisome examination finding, then I would obtain a dedicated temporal bone CT, and usually these are somewhere around 0.4 or 0.6 millimeter slice thickness scans.

Dr. Jason Barnes:

And when you're looking at this scan, can you tell us what the different classifications are or how we describe temporal bone fractures on a CT scan?

Dr. Neil Patel:

So this has changed seemingly over time and the nomenclature has changed. And really the main crux of it is, does it involve the otic capsule or not? And does it involve the facial nerve or not? Everything else is secondary. So the old way to describe these were longitudinal, transverse, or mixed. A longitudinal fracture parallels the petrous ridge, and a transverse fracture goes across the foramen magnum usually, and is perpendicular to that petrous ridge.

Dr. Neil Patel:

The transverse fractures are much less common, but have a higher chance of otic capsule or facial nerve involvement. And the longitudinal fractures have a lower chance of facial nerve involvement and involvement of other critical structures, however, longitudinal fractures are so much more common that we do see facial nerve injury and otic capsule involvement with a longitudinal fracture.

Dr. Neil Patel:

So usually when I define it, it's, "Is it otic capsule sparing or otic capsule involving? And does it involve the facial nerve or not?"

Dr. Jason Barnes:

Sure. So after you have done your physical exam and you have confirmed on your CT scan that you have a temporal bone fracture, what is the role of hearing testing both, maybe subjectively in the patient's room, but also obtaining an audiogram or audiometry?

Dr. Neil Patel:

Tuning forks are really your friend here. In the outpatient setting, you almost always have an audiogram to go on and tuning forks are more confirmatory, but when you're visiting with this patient in the ICU or in the emergency department, the tuning fork can really tell you a lot of what you need to know. And even in somebody whose mental status is waxing or waning, you can often get a reliable exam.

Dr. Neil Patel:

So remember your Weber and Rinne tests, if the Weber lateralizes to the opposite ear, you'd be worried about a sensorineural hearing loss. If it lateralizes to the ipsilateral ear, then usually you're safe, and it's conductive hearing loss related to hemotympanum or ossicular chain disruption, or something like that.

Dr. Neil Patel:

It's tough to get an audiogram on these patients in the hospital, but if you see a fracture that's concerning for otic capsule involvement, I do try to push to get one, once the patient is in a state where they can participate in the audiogram.

Dr. Jason Barnes:

Mm-hmm (affirmative). And what is the role for facial nerve testing here? Again, you've described that it's a complex issue because the patient may not be awake and able to participate. You may not be able to examine the facial nerve function. So how does facial nerve testing fit in here?

Dr. Neil Patel:

This is complicated. If a fracture clearly involves a part of the facial nerve, and generally you're not going to see a big disruption in the continuity of the facial nerve, but you'll see a fracture line that goes through one of the segments, and the most commonly affected segment is the perigeniculate facial nerve. So through the geniculate ganglion proximal tympanic segment or the labyrinthine segment. So if you see a fracture line like that, but the patient is intubated and sedated, you try your best to get an unsedated neurologic exam. This is really your best chance to determining whether they clinically have a facial nerve injury.

Dr. Neil Patel:

If a patient does have clinical evidence of acute complete facial nerve paralysis, then three days or so after the injury, to allow for Wallerian degeneration, you obtain electro diagnostic testing. At most institutions this comes in the flavor of what's called ENoG or electroneuronography, or evoked EMG. These are essentially two names for the same thing, and you want to have a good conversation with your neurologist and the testing personnel to make sure you're on the same page, because their terminology is sometimes not the same as ours.

Dr. Neil Patel:

The ENoG basically uses the contralateral side as a control and looks at the percent degeneration or the percent difference in the compound action potential generated by the evoked EMG response. And if that's greater than 90% degenerated compared to the contralateral side, then we get into the role for potential surgical decompression, which we would talk about later.

Dr. Jason Barnes:

Sure. And just to go back real quick, you said, "That you need to wait 72 hours for Wallerian degeneration." Can you describe why that is, especially in relation to how ENoG is actually tested?

Dr. Neil Patel:

Absolutely. So if a fracture goes through the labyrinthine segment or the geniculate ganglion, if you at that very moment, test the integrity of the facial nerve, at the stylomastoid foramen, which is the closest parts to the proximal facial nerve that you can get to, all the testing will be normal, because the facial nerve hasn't suffered the injury in that segment yet. Wallerian degeneration takes some time to move distally along the facial nerve. So from the fracture through the tympanic segment, through the mastoid segment, and then to the stylomastoid foramen, we estimate takes about two or three days. And so ENoG or evoked EMG involves a super maximal stimulus delivered at the stylomastoid foramen to evaluate the integrity of the facial nerve. It's anatomically intact, but you have to wait for that functional degeneration to occur.

Dr. Jason Barnes:

Got you. So we've talked about presentation and workup, and I'm trying my best to follow the typical format that we use, but it's a little bit tough because this isn't a patient who's presenting to your clinic.

Dr. Neil Patel:

That's right.

Dr. Jason Barnes:

So when we start to talk about, "pathophysiology," we talked about the different types of fractures. Can you also speak to all of the different complications, so to speak, that can be involved with temporal bone fracture?

Dr. Neil Patel:

Sure. Really we group these into hearing loss, facial nerve injury, CSF leak, and really everything beyond that, lacerations in the ear canal, having bloody otorrhea, things like that are secondary. The hearing loss, like I said before, you can sort out with a tuning fork and of course an audiogram. Conductive

hearing loss is definitely the most common, most common reason is just a hemotympanum or blood in the middle ear.

Dr. Neil Patel:

But if the laceration goes through the ear canal, often you'll have a tympanic membrane perforation, and the most common ossicular chain problem from particularly longitudinal temporal bone fracture, is dislocation of the malleus and incus or the joint between those. And that's, on a scan what we look for is, the typical ice cream cone shape of the body of the incus, and short process being the cone, and the ice cream, being the head of the malleus. When the ice cream falls off the cone or a separated, then we are concerned about discontinuity of that joint. And that's not something you have to intervene upon acutely. Usually these patients have a lot of other things going on, but an ossiculoplasty can be pursued later on. We usually give it some time to see whether the patient does have any conductive hearing loss at about the two or three month mark.

Dr. Neil Patel:

Sensorineural hearing loss typically only comes from an otic capsule involving fracture, but there's one other phenomenon that can cause a sensorineural hearing loss, and that's called a labyrinthine concussion. And often the fracture won't go through the inner ear, but they will have some vertigo or sensorineural hearing loss. So on imaging, you might see pneumolabyrinth or air within the cochlea or vestibule semicircular canals, from the fracture going directly through there.

Dr. Neil Patel:

Facial nerve injury, we talked about a little bit. Less common with longitudinal, more common with transverse. But the important thing again is, just whether the fracture goes through there or not. Longitudinal are just so much more common, that all the facial nerve injuries I've seen have been with longitudinal fractures.

Dr. Neil Patel:

And then CSF leaks are relatively common. Most people say somewhere between 10 and 30% can have CSF leaks. And oftentimes these will stop by themselves, up to two thirds in some series. But usually we look to see how high flow the leak is, whether there's any signs of it slowing down while the patient's in the hospital, and repairing it, if indicated.

Dr. Jason Barnes:

And to move in that same vein, that order that you just spoke through, can we now talk about treatment? I guess, to start, how do you treat conductive hearing loss? It seems like it's a lower priority on the list there.

Dr. Neil Patel:

I agree. And usually you have to wait for the hemotympanum to resolve, just like an otitis media with effusion or a postoperative patient who had ear surgery, you have to wait a good two or three months for that to completely resolve and unmask any underlying ossicular problems. If the fracture is really obvious, I still don't think that early intervention is necessary, because people can have a fairly obvious separation of the malleus and incus, but not actually manifest that much conductive hearing loss in the long run. So you might've done the surgery for nothing.

Dr. Neil Patel:

Tympanic membrane perforations usually spontaneously heal at about the same rate as a PE tube related perforation, and if the conductive hearing loss is persistent at that three month mark, then we do offer middle ear exploration to patients, and of course these are aidable also, if the patient doesn't want to undergo surgery.

Dr. Jason Barnes:

Sure. And is there anything you can do about the sensorineural hearing loss, if it's an otic capsule involving injury?

Dr. Neil Patel:

Usually we treat it much like a sudden sensorineural hearing loss, with some steroids, but if there's air in the labyrinth and if it's a profound hearing loss, it's really unlikely for that to recover. There have been cases of some recovery. So, if there are no contraindications, I think that steroids are reasonable, but otherwise we're thinking along the lines of cochlear implantation, and without going too far down that rabbit hole, you do have a finite period of time to get a cochlear implant in an ear that's had a fracture through it, a pneumolabyrinth, for fear of labyrinthitis ossificans.

Dr. Jason Barnes:

Sure. Now, facial nerve paralysis kind of poses an issue as well. Can you talk about the approach to treatment when you consider facial nerve decompression in these patients?

Dr. Neil Patel:

In general, we use that electro diagnostic testing, and if somebody has a House Brackmann grade six, complete facial nerve paralysis, and a fracture going through there, we usually obtain the testing, like I said, about three days after the injury, and your time window for intervention, which comes in the form of decompression of the facial nerve, your time window is about two weeks. Some people say you can do it up to six weeks, but we really try to do it in that early phase. And to be honest, of the patients who have such severe injuries, it's often difficult to get a clearance from their medical teams and neurologists and all the others involved, to do an intracranial operation to decompress someone's facial nerve. But in the less severe intracranial injuries with temporal bone fractures that involve the facial nerve, two weeks is that timeframe.

Dr. Neil Patel:

If it's an incomplete paralysis, the likelihood of improvement is very good. There is no role for electro-diagnostic testing in an incomplete paralysis. So anything better than a House Brackmann six. A delayed onset paralysis, where they were normal when they had the injury and a week or so into their hospitalization they develop some facial nerve weakness, that also is likely to recover spontaneously, and we do recommend corticosteroids for those patients.

Dr. Neil Patel:

And the decompression question comes up as far as approach, if they have hearing which most of them do, then you decompress it through a middle fossa plus or minus transmastoid approach to get the labyrinthine segment, geniculate ganglion, and tympanic segment generally. And if they have lost their

hearing completely with a otic capsule involving fracture, then it's quite straightforward to decompress all those segments through a trans labyrinthine approach. But this is less common.

Dr. Jason Barnes:

And going back to the immediate onset where you obtain ENoG, what cutoff are you using to determine, if you're not able to examine an awake patient, what cutoff do you use for ENoG to know that the facial nerve is totally out?

Dr. Neil Patel:

If you get testing at that three day mark, and it's greater than 90% degeneration compared to the contralateral normal side, then we consider that person a surgical candidate. If you get the testing and it's 70% degeneration at three days, you can repeat it later on, and usually at that point in time, you make an assessment of whether that patient's going to be a candidate for it, from an overall medical standpoint with their other traumas, and repeat the testing if necessary, but you really only have to walk down that road if you think that the patient's going to be a candidate.

Dr. Jason Barnes:

Mm-hmm (affirmative). And you already talked a little bit about CSF leaks, what's your approach to this? And do they require antibiotics?

Dr. Neil Patel:

That's a great question. There was one study that showed that antibiotics don't change any outcomes as far as risk of meningitis. And we really have a mixed view of this. We have patients who undergo uncomplicated acoustic neuroma surgery, develop a delayed CSF leak and present with meningitis, and we have other patients who have spontaneous temporal bone CSF leaks, and have been leaking for five or seven years and never develop meningitis. And we don't completely understand why there's a difference there, but in my opinion, with a traumatic CSF leak, with contamination from the injury, ear canal lacerations, et cetera, I do think that antibiotics are warranted. It's a low risk intervention, low cost intervention, and if it saves you one case of meningitis, I think that it's worthwhile.

Dr. Jason Barnes:

Sure.

Dr. Neil Patel:

We do observe these for a period of time. Usually it's the period of time while the patient's getting medically stabilized, and if they are medically stabilized, extubated awake, et cetera, et cetera, we then make another assessment, usually it's at about a week after the injury as to whether they're still leaking, is it a high flow leak or a low flow leak? And then intervene accordingly.

Dr. Jason Barnes:

Sure. And can you finally just speak to outcomes and prognosis? I know we walked through this somewhat systematically, but more with the facial nerve paralysis side of things, how do you typically counsel patients on this?

Dr. Neil Patel:

If somebody goes to a House Brackmann six immediately and you do a decompression, I think they have a reasonable chance of getting back to a three or so. It's uncommon that we see somebody get back to completely normal facial nerve function, and if they do it actually makes me wonder whether they had a true, complete, immediate facial nerve injury with immediate House Brackmann grade six paralysis. More often, that was one who was potentially normal when the injury happened, some swelling occurred, they went to a six and then came back to a one.

Dr. Neil Patel:

But generally we counsel patients that they'll be able to close their eye, have some smile, but probably have some synkinesis. There really isn't a lot of great controlled data, meaning patients who undergo decompression and patients who undergo medical management only, for immediate onset, complete facial paralysis following a temporal bone fracture, because these cases are just so rare. So it's really hard to counsel, but I think that it's a low risk intervention if somebody does have complete paralysis and they're medically stable to undergo a craniotomy.

Dr. Jason Barnes:

Well, Dr. Patel, I think we covered a lot here. Before I summarize what we talked about, is there anything else you think is worth mentioning that we haven't spoken about?

Dr. Neil Patel:

I think that's everything in a nutshell.

Dr. Jason Barnes:

Well, here's our summary for today. Temporal bone trauma is caused by significant trauma, such as motor vehicle accidents, bike accidents, and assaults. Initial evaluation should include facial nerve function and gross hearing test using a tuning fork. There are a couple of descriptions for temporal bone fractures. What's more commonly used these days is otic capsule sparing versus otic capsule involving, and also facial nerve sparing and facial nerve involving.

Dr. Jason Barnes:

But there's also the transverse versus longitudinal. The longitudinal fracture often involves a foramen lacerum and is more likely to be otic capsule sparing. And the transverse is often the foramen magnum, is otic capsule involving, or at least more likely to be.

Dr. Jason Barnes:

There are many complications that exist with temporal bone trauma, including conductive hearing loss, sensorineural, hearing loss, facial nerve paralysis, CSF leak, and perilymphatic fistula. CHL or conductive hearing loss often resolves on its own, as does CSF leak.

Dr. Jason Barnes:

Facial nerve exploration should be considered for immediate onset paralysis and ENoG is a helpful tool in understanding the severity of facial nerve dysfunction.

Dr. Jason Barnes:

Dr. Patel, anything else?



Dr. Neil Patel:

I think that's everything in a nutshell.

Dr. Jason Barnes:

Well, thanks so much for being here. We really appreciate it.

Dr. Neil Patel:

Thank you.

Dr. Jason Barnes:

And now I'll go into a few questions before we end our time here. Again, remember that I will ask a question, wait a few seconds for you to think about it, or press pause, and then give you the answer.

Dr. Jason Barnes:

So the first question is, describe what anatomical regions are involved in transverse versus longitudinal temporal bone fractures.

Dr. Jason Barnes:

A transverse fracture, typically involves the foramen magnum, and 50% of these can involve the otic capsule. And the longitudinal fracture usually involves the ear canal and foramen lacerum with a lower risk of involving the otic capsule.

Dr. Jason Barnes:

Describe the appropriate management for CSF leaks in these patients.

Dr. Jason Barnes:

CSF leaks should be probably tested to confirm it's a CSF leak with a beta-2 transferrin, but up to 80% of these will spontaneously resolve, and antibiotics can be considered if the leak persists for an extended period of time, or if the wound is grossly soiled.

Dr. Jason Barnes:

Under what scenario should facial nerve decompression be considered in this setting and what are the possible approaches?

Dr. Jason Barnes:

Facial nerve decompression should be considered for immediate onset paralysis with imaging convincing for facial nerve injury. And the two main approaches include translab if hearing is poor, and middle cranial fossa if the hearing is intact.

Dr. Jason Barnes:

Thanks so much for listening and we'll see you next time.