Jason Barnes:

Hey there! Welcome to another episode of ENT in a Nutshell. My name is Jason Barnes, and today, we are again joined by Dr. Michael Gluth, neurotologist, and we'll be discussing cholesteatoma. Dr. Gluth, thanks so much for being here.

Dr. Michael Gluth:

Thanks for having me, excited about today's podcast.

Jason Barnes:

As an introduction, we'll be discussing cholesteatoma like I said, but as a plug, it's probably worth it to listen to the previous episode that we recorded together on chronic otitis media as that's a good foundation and introduction to what we're going to be talking about here.

Dr. Michael Gluth:

Yeah. I would definitely agree with that and encourage anyone who is listening to this to go back and listen to the Chronic Ear podcast first because that frames a lot of what we're talking about here today.

Jason Barnes:

To start, could you tell us how folks present with cholesteatoma?

Dr. Michael Gluth:

Sure. Similar to presentation of any patient with chronic ear disease, this is going to be someone classically that comes into the office with persisting otorrhea and hearing loss. Cholesteatoma is usually seen in patients who have some form of pre-existing chronic ear disease, and whether it's chronic purulent otorrhea or something just as simple as recurrent acute otitis media or a chronic eustachian tube dysfunction. Not always do the patient's recount this, but usually that's the case.

Then, with respect to the hearing loss, we're thinking about a unilateral conductive hearing loss, maybe mixed but usually conductive. Then, any of the other non-specific ear complaints, tinnitus, fullness in the ear, pressure, these are all common. Patients may have vertigo but that would be much less common, and if present, would be concerning for some type of inner ear complications, such as a perilymph fistula. I think it's noteworthy to mention that pain is not usually a prominent part of cholesteatoma presentation.

These are going to be mostly adults, but it's not rare in kids, so we definitely see cholesteatoma in children. Like I said, a lot of these patients have had underlying chronic ear disease. When we think about risk factors for chronic ear disease, which in fact are similar to those for acute otitis media, these patients may have pre-existing rhinologic disease, adenoiditis, eustachian tube dysfunction, past severe acute otitis media or otitis media with effusion, maybe they've had tympanostomy tubes in the pit in the past. It's controversial whether or not tobacco is an issue, but smoker would perhaps raise concern.

Social factors that we see with chronic ear disease like poor hygiene, living conditions, poor nutrition may or may not have an impact. Perhaps patients that have craniofacial abnormalities that impact eustachian tube dysfunction might be at higher risk for cholesteatoma. Then, one thing, I think, which is a bit interesting is the indigenous peoples of places like Australia, Alaska, southwestern United States, and Greenland are at high risk for chronic ear disease, but often, these folks have developed early perforation. It's thought that that it may actually be protective against developing a cholesteatoma in some cases. That's not definitive but that's just an interesting tidbit.

Jason Barnes:

What's some of the epidemiology around those presenting with cholesteatoma?

Dr. Michael Gluth:

For the common form of cholesteatoma or acquired type cholesteatoma, usually these are younger adults, so presenting within the second or third decade of life. There's a slight male predominance, but these are not hard and fast rule. Certainly, females and younger and older individuals can present to clinic with a cholesteatoma. Congenital cholesteatoma, which is a rare variance, uncommon variant, is far more common in males, usually diagnosed around the age of about 4 to 5. Altogether, cholesteatoma roughly affects about one in 10,000 individuals.

Jason Barnes:

When you first see a patient with cholesteatoma in your clinic, they have conductive hearing loss, maybe some otorrhea. Can you tell us how you perform physical exam? What types of things you're looking for? How you approach the speculum exam in clinic?

Dr. Michael Gluth:

Sure. Like I mentioned with the podcast on chronic ear disease, you're going to pay attention to the nose, the nasopharynx and any rhinologic condition that may contribute to eustachian tube dysfunction. But specific to the otoscopic exam, you start out, of course, looking at the condition of the eardrum. Usually, the eardrum has some type of retraction either involving the par flaccida or pars tensa, cholesteatoma from pars flaccida would be more common. Then, what you see is basically a retained tuft of squamous epithelium or keratin debris within the middle ear space.

Sometimes, if this is derived from pars flaccida, you may only see a small little tuft of skin just overlying the origin site, and sometimes there is a little bit of crusting or granulation in this area. Surprisingly, those findings can be subtle and what you're seeing in front of you can really just be the tip of the iceberg. Pars tensa cholesteatoma usually is associated with the typical things you would expect with chronic ear disease, so more general pars tensa retraction, perhaps underlying middle ear effusion.

If the pars tensa is normal and the patient has a pars flaccida origin cholesteatoma, you may see a retrotympanic white mass. That said, some of these patients have concurrent perforations, especially pars tensa cholesteatomas or any patient who's had a past tympanostomy tube. For example, you may see a posterior retraction pocket cholesteatoma of the pars tensa concurrent with an anterior residual perforation from a tympanostomy tube. Often, you'll see puss. We mentioned, aural polyp as being something that should raise one's suspicion for cholesteatoma, so that's something to be aware of.

Granulation tissue involving the middle ear, mucosa or associated myringitis of the drum head. You can see evidence of an eroded ossicular chain, so eroded incudostapedial joint. Atypical infection might be manifested by fungal elements or fungal spores in the ear canal or on the eardrum. You may see stigmata of past ear surgery, so postauricular incision, evidence of prior grafting or an extruded tube. Specifically, if there's a draining ear and there's a significant perforation present, then you need to be thinking about the condition of the margins of the perforation. Can you see evidence of squamous epithelial in growth around the under surface of the drum head? These usually are especially thickened and you should be thinking about this in someone who has had a past failed tympanoplasty.

Then, for the unique situation of congenital cholesteatoma, that would be a quiet ear with an intact eardrum, but a retro tympanic whitish mass usually in the anterior, superior aspect but posterior. A posterior mass is possible especially in East Asian populations.

Jason Barnes:

What else is on your differential diagnosis when you're seeing these patients in clinic?

Dr. Michael Gluth:

Right. Of course, you're going to think about the spectrum of chronic ear disease. Chronic otitis media without cholesteatoma, of course, is going to be the most common thing that you would see. But you need to think about other things, so any type of ear canal pathology. You'll also have referrals from primary care for cholesteatoma when in fact the patient has an osteoma or an exostosis. If there's a lot of infection, there may be something with in the spectrum of otitis externa. Then, there's also the situation of external auditory canal cholesteatoma, which pathologically is quite the same as middle ear cholesteatoma but different in clinical presentation, outlook and behavior.

I think you're also thinking about neoplastic disease, so malignant neoplasms, squamous el carcinoma, adenoid cystic carcinoma, especially or secondary involvement of the temporal bone by a parotid tumor. Any case of chronic ear disease where you see some granulation and case that's not responding to medical therapy, there should be a low threshold for biopsy. There's also benign neoplasms, so middle ear squamous papilloma, paraganglioma, or an adenoma. You should consider something uncommon like a Langerhans cell hystiocytosis, temporal sclerosis involving the middle ear or eardrum is a whitish plaque, which sometimes can also be confused for a cholesteatoma. Then, lastly, I think this is special, especially a radiologic condition, patients who've had chronic ear disease often will have erosion of the tegmen and these patients can develop a meningocele or encephalocele into the mastoid or attic and that also can be confusing for possible cholesteatoma.

Jason Barnes:

I next wanted to move on the pathophysiology, and I find this particularly interesting. Can you first just start with describing what is a cholesteatoma?

Dr. Michael Gluth:

Cholesteatoma is, in essence, a pseudo-neoplasm consisting of keratinizing squamous epithelium, which has been displaced into the middle ear space. These often have a sac or cyst-like structure that has become trapped within the middle ear. It's usually advancing medially, expanding, growing into the various invaginations of the middle ear and mastoid space. Keratin is particularly adept at generating secondary foreign body response. That's where you get aural polyp, and that's where you'll get a lot of associated inflammation with the giant cell reaction.

There is always this question of when does a retraction pocket become a cholesteatoma, so you'll see patients with retraction pockets that you follow over time. The simple idea there is that, if you have a pocket that's not outwardly self-cleaning and it's medially advancing and expansile then it becomes a cholesteatoma. I also think that it's important to understand that this is just not ordinary skin. Sometimes we'll simplify this into saying cholesteatoma is skin trapped in the middle ear space and. While that is correct, I'm thinking it's important to understand that the epithelium of the eardrum and the ear canal is unique in that there is gene expression that drives centrifugal migration. In other words, the epithelium that turns into an acquired cholesteatoma is uniquely migratory.

Also, we see that there is hyper expression of growth factors as compared to normal skin. Things like EGFR, epithelial growth factor receptor, or TGF-alpha. Really, this is metabolically very active skin that's inherently programmed to migrate. When we look at a cholesteatoma sac, there's two main parts to it. There's what we call a matrix. If you look at a slide of a cholesteatoma, the matrix looks just like skin from anywhere else, and then with all of the normal classic layers. Then, overlying the outside of

the sac, there is what we call a perimatrix. Perimatrix is just the slayer of loose connective tissue where there are blood vessels, and often that's the area where you'll see inflammatory cells.

The key thing is that, usually, at the interface between the perimatrix and underlying tympanomastoid bone, you see this destructive process going on of resorptive osteitis where you have osteoclastic mediated bone destruction. If you read some descriptions of this, sometimes it's described as being an enzymatically-driven process. That's really probably not the case, so that's probably misunderstood. The key thing is that this is an osteoclastic mediated resorptive process. Then, of course, in addition to that, the retained keratin debris of a cholesteatoma is a nidus for infection. In fact, the bone destructive process is known to be worse if the overall inflammatory process is ramped up, so to speak, by co-infection with bacteria, especially pseudomonas, so this has really been shown to be the case in the laboratory.

Jason Barnes:

We've already started to touch on this in presentation. You talked about two different types of cholesteatoma, one being acquired and the other being congenital. Could you first tell us about acquired cholesteatoma, and what some of the subsets are of acquired cholesteatoma?

Dr. Michael Gluth:

Sure. Acquired cholesteatoma is going to comprise the overwhelming majority of these cases. The classification of cholesteatoma is not uniform. Often, in the older literature, acquired cholesteatoma was broken down as being primary or secondary, but some of the newer classification systems are going more towards calling these retraction pocket or non-retraction pocket cholesteatomas. Retraction pocket cholesteatoma would be much more common, and of course, it is a cholesteatoma that forms out of an underlying retraction of part of the tympanic membrane. The most common site of formation would be the posterior aspect of the pars flaccida, followed by the posterior aspect of the pars tensa, followed by the anterior part of the pars flaccida.

The retraction pocket cholesteatomas are then further subtyped as being either a primary or retraction pocket pars tensa cholesteatoma, or pars flaccida cholesteatoma. Then there is a group of combination cholesteatomas, which involved both parts. In some of the older literature, you may have seen these referred to as, for example, a primary epitympanic or primary mesotympanic cholesteatoma, but that it is being replaced by the pars flaccida or pars tensa nomenclature.

In understanding retraction pocket cholesteatoma, there are a number of theories related to how folks develop these. I think one thing that's important to understand is that these theories are not mutually exclusive. In other words, it's not as if one of them is right and all of the others are wrong. There can be multiple things going on that can lead to a cholesteatoma. Overwhelmingly, the main theory has to do with retraction pocket development due to underlying dysventilation of the middle ear space. As we talk about in the chronic ear podcast, dysventilation can be universal involving the entire temporal mastoid space, or it can be selective or compartmentalized to a selectively involved just the attic, for example. We know that retraction pocket is a viable theory for development of cholesteatoma because we can see it unfold clinically in front of our eyes. We know that that happens.

There's another theory which is called the invasion theory. What happens here is that, basically, inflammation of the eardrum can result in a break in the basement membrane, and as the basement membrane breaks open, there can be in-growth of squamous epithelium through that break. This too is one that you can see histopathologic evidence of, so we know that it's possible for this to happen. How much of a role does this play in most of the cholesteatomas we see in the clinic? I don't know, but it is a viable thing.

Then there's two other theories, which I think really are theories in that they're somewhat speculative and there's not a lot of evidence to support. There's a more recently put forth traction pulsion theory. The idea is that you start to have a retraction and then the mucosa along the middle ear folds within the middle ear space will draw the epithelium inward, almost like a conveyor belt or something. Then the other one is known as the metaplasia theory. That would be a situation where the middle ear mucosa undergoes chronic inflammation and then you have this metaplasia where it turns into squamous epithelium. That's not very well supported, but you'll hear people talk about that a bit too.

Jason Barnes:

When you talk more about the primary cholesteatoma, there are some patterns of spread that you can consider. Can you tell us more about that?

Dr. Michael Gluth:

Yeah. Clinically, it's very useful to understand that there are classic pathways by which these spread to the various subsites of the temporal bone. With respect to the most common type, which would be the pars flaccida cholesteatoma, these develop as a retraction pocket that is within the lateral epitympanic space. The lateral epitympanic space is also known as Prussak space. Basically, the pars flaccida in the posterior aspect just overlying the malleus neck will retract inward and start to develop a cholesteatoma. These can expand from the attic either towards the mastoid or towards the mesotympanum. The spread from a pars flaccida cholesteatoma into the mastoid classically occurs with expansion lateral to the incus, and you can appreciate this on CT scans, and then from there, it will extend into the antrum and then begin to fill the entire attic.

With respect to expansion into the mesotympanum, there is a potential space called the posterior pouch of von troeltsch which is immediately under the posterior superior pars tensa, so expansion of a pars flaccida cholesteatoma will result in expansion of that pouch and then secondary involvement of the mesotympanum. I think one thing that's important to understand about pars flaccida cholesteatoma is that they often don't enter or involve the sinus timpani, or if they do, they do so secondarily as part of a pretty well-defined large sac that's otherwise filling the mesotympanum. Getting them out or rolling them out of that posterior mesotympanum is not always as difficult as, for example, the pars tensa cholesteatomas.

Then, I'll briefly mention that there is an alternate version that develops in the area of the anterior pars flaccida, so these cholesteatomas expand into the attic anterior to the neck and head of the malleus. They fill the anterior epitympanic space and extend into the super tubal recess, and really, the key pearl to know about these is that they have a higher than normal rate of associated facial nerve issues, and that's probably because the geniculate ganglion is present right in the area where they're expanding.

As far as pars tensa cholesteatoma goes, this develops from retraction of the posterior pars tensa. These patients often have significant underlying eustachian tube dysfunction and actually may have more extensive or global drum collapse. What happens is basically that the retraction pockets in the posterior pars tensa impacts the incus and then starts to extend into the posterior mesotympanum. Then, once that makes a transition from being a retraction pocket into a cholesteatoma, then you have one of these pars tensa cholesteatomas.

These often will involve the oval window niche very early, so stapes superstructure and row erosion or footplate involvement is very common. Then you'll have these cholesteatomas grow into the attic taking a course that actually extends medial to the incus. While they erode the incus long process,

that expansion medial to the incus often also erodes the underlying bone of the tympanic segment of the fallopian canal. I think one thing to keep in mind is that, in general, from a surgical standpoint, these pars tensa cholesteatomas have a much more complicated pattern of spread, which is more difficult to deal with as opposed to pars flaccida cholesteatoma.

Jason Barnes:

Great! We've discussed the primary acquired cholesteatoma, which you've taught us is also known as the retraction pocket cholesteatoma. Could you now tell us about the secondary acquired or the non-retraction pocket cholesteatoma?

Dr. Michael Gluth:

Sure. There's basically two subtypes of these. They're subtyped as being either due to a perforation, so this would be the situation again where you have squamous epithelial in growth around the margins of a perforation. This is something that you have to have a reasonably high index of suspicion to recognize because it's not always clinically evident in the office. Again, an important pearl there would be someone who's failed tympanoplasty maybe at higher risk of having one of these. The other type, subtype would be just the iatrogenic cholesteatoma. This would be a patient who's had implantation of squamous epithelium into the middle ear during some prior surgery. For example, a past tympanostomy tube or tympanoplasty or something.

Jason Barnes:

Could you tell us a little bit about congenital cholesteatoma?

Dr. Michael Gluth:

Sure. This comprises no more than maybe 2% to 5% of all cholesteatomas. It's almost it's probably going to vary dependent on how much of a pediatric practice a surgeon has. The diagnosis of congenital cholesteatoma is based on a few things. First of all, obviously, you definitively encounter cholesteatoma in the middle ear space. The patient should have no history of a perforation or significant eardrum retraction. There should be no history of prior ear surgery including placement of a tympanostomy tube as well. That said, it is okay to have had past middle ear effusion or acute otitis media.

Classically, again, this is a retro tympanic whitish mass, which presents in a patient who's maybe four or five years old, intimately associated with the tensor tendon and cochleariform process. The origin of these is not definitively known, but it's associated with an embryonic rest of epithelial tissue that's been implanted into the ear. There's been speculation as to whether or not reflux of embryonic fluid with epithelial cells into the middle ear space causes this, but no one really knows. Again, these often are not diagnosed until they have grown fairly large because patients might not have otorrhea or other stigmata of chronic ear disease. Generally speaking, most of otologist consider cholesteatoma, especially the large ones to be fairly challenging to deal with surgically.

Jason Barnes:

One of the questions that I like to ask, especially now that we've wrapped up the pathophysiology section, is what's the natural history of cholesteatoma? More specifically, what are some complications that occur in patients who have cholesteatoma or untreated cholesteatoma?

Dr. Michael Gluth:

Yeah. I think some of this has to do with how one chooses to define a complication. If you have a very loose definition of what a complication is, then you would expect that the overwhelming majority of cases would cause a problem. For example, if you consider erosion of the ossicular chain, especially the incus being the most common, a complication, then that's going to be extremely common.

In a general sense, most of the complications that we see from cholesteatoma, again, are a function of their ability to erode bone. Erosion of the ossicular chain, the fallopian canal, the otic capsule of the skull base, obviously, can lead to problems. Labyrinth fistula occurs in maybe 5% to 10% of all surgical cases. We think about those as being associated with a patient that presents with vertigo. Possibly they can have Tullio phenomenon, so that would be a vertigo or sensitivity to loud sound exposure. Then the classic physical exam finding associated with that is Hennebert sign, where there is vertigo and/or nystagmus induced with pneumatic otoscopy.

Facial weakness associated from cholesteatoma is pretty rare. Hard to know whether it's more common in cholesteatomatous, cases of chronic otitis media, the non-cholesteatomatous cases. These patients may have some degree of sensorineural hearing loss with or without associated serous or suppurative labyrinthitis. Lateral sinus or sigmoid thrombosis, this is the patient that has usually an associated mastoiditis that causes a septic thrombus of the sigmoid sinus. These patients have often high spiking fevers with a picket fence pattern.

Of course, coalescent mastoiditis, where you essentially have an abscess and destruction of the bony septations within the mastoid space and abscess formation underneath the mastoid periosteum. Then of course, the whole array of associated intracranial complications be it meningitis, CSF leak, development of an encephalocele, something like an epidural abscess, subdural empyema, brain abscess involving either the temporal lobe or cerebellum, or the rare instance of otic hydrocephalus.

Jason Barnes:

I, next, wanted to move on to workup, and as we've alluded to, we have an episode on chronic ear disease where you nicely talked through different things to consider in the patient with chronic ear disease including their ventilation status, tympanic membrane status. In terms of workup for cholesteatoma, could you speak to the role of imaging in these patients?

Dr. Michael Gluth:

Yeah. Imaging is, I guess, a little bit controversial. In my view, it's a good idea really for any case with cholesteatoma. It might not be necessary to make the diagnosis, that's usually based on clinical exam, but it can be highly suggested on a radiologic imaging and the imaging helps in a lot of other ways. This usually involves a fine cut CT of the temporal bone, and this gives us an idea of, first of all, what's the extent of cholesteatoma? Is it appear to be just limited to the middle ear? Does it extend into the mastoid, for example? What's the pneumatization status of the temporal bone? Is it highly sclerotic? Of course, that could affect your approach. Is there a problem with something like a labyrinthine fistula? Certainly, it would be useful to know about that ahead of your surgical case because that might impact approach but also the way you would counsel the patient.

What's the integrity of the skull base? What's the position of the sigmoid with the tegmen? That also may have bearing on which approach to choose. What's the course of the facial nerve? All of these things, I think, are very useful to know. Having said that, there are plenty of very experienced, very sensible surgeons that don't routinely get imaging. That's okay.

There are specific findings that we see on CT, which are more highly suggestive than not of there being cholesteatoma. The classic thing would be erosion or blunting of the scutum. The lateral wall of the attic, that portion of the ear canal which is immediately adjacent to the drum head at its superior

and slightly posterior aspect, so you can see that eroded. Again, that's highly suggestive of a pars flaccida cholesteatoma. It's certainly possible to have, for example, something like a pars tensa cholesteatoma without scutum erosion. Sometimes that confuses the radiologist and keep that in mind.

If you see soft tissue with adjacent expansile change or scalloping within the attic, then that would be suspicious. Obviously, if the soft tissue erodes into the labyrinth, you would worry about that. Most often, that would be the horizontal semicircular canal. Obviously, cholesteatoma is a soft tissue density but differentiating cholesteatoma matrix from something like mucoid effusion or aural polyp or thickened mucosa or some other neoplasm can be difficult. But again, really, that cardinal feature that is first look for would be blunting of the scutum associated with a pars flaccida cholesteatoma into the attic.

Jason Barnes:

Can you tell us about the role of MRI? When do you use it? What does it show in cases of cholesteatoma?

Dr. Michael Gluth:

Most patients are not going to get an MRI at the upfront diagnosis of cholesteatoma. That would be very, very uncommon. That said, it might be useful if you're concerned about the presence of disease that you're not able to view in the office. For example, surveillance. If someone's had past surgery and you're wondering about underlying recurrent cholesteatoma. If CT findings are unclear, sometimes MRI can add additional information with respect to the nature of whatever soft tissue was being visualized. Then, in particular, if there's concern for a CSF leak or the presence of encephalocele with associated skull-based erosion, then MRI can be useful for that.

This usually involves contrasted imaging, both T1 and T2 sequences. Really, the unique thing with MRI and cholesteatoma would be acquisition of non-echo-planar diffusion weighted images, which gives some ability to differentiate between cholesteatoma and other soft tissues.

Jason Barnes:

Can you tell us what that actually looks like on the scan?

Dr. Michael Gluth:

The cholesteatoma is extremely hyper-intense, so very, very bright white on these diffusion-weighted sequences. You do have to have some bulk of cholesteatoma to be detected. Most of the reviews say that somewhere of a minimum of say 2 to 3 mm of cholesteatoma diameter, if you're looking at a cyst or a pearl to be detected. There are some false negatives, especially when remnant epithelium is more of a sheet-like presence as opposed to a cyst or a sac, so keep that in mind as well.

Jason Barnes:

We've talked about conductive hearing loss being a symptom of cholesteatoma. Can you speak briefly to what an audiogram will look like and what you're looking for on the audiogram?

Dr. Michael Gluth:

Yeah. Obviously, before you operate on any of these patients, you're going to want to get an audiogram. First of all, the document, the hearing status, especially the inner ear status, but also to help guide what you're going to do surgically. You're going to see various degrees of ear bone gap, so either a conductive

or a mixed hearing loss. Tympanometry can be variable ranging from normal. If, for example, you had a small pars flaccida cholesteatoma that's limited to the attic, you may have a normal type A tympanogram. As is the case with the spectrum of chronic ear disease, you can have a type B or type C tympanogram as well.

Then, of course, there will also be speech audiometry. If a patient has very poor word recognition, someone who's not a candidate for functional tympano-ossicular reconstruction, that too can impact your approach. Whether you're gonna do, for example, a canal wall down approach or a subtotal petrosectomy with your canal closure.

Jason Barnes:

I, next, wanted to move on to treatment, but before we do, is there anything else you wanted to add about the diagnosis and workup for these patients?

Dr. Michael Gluth:

Yeah. Just a few general, simple diagnostic pearl. The overwhelming majority of time diagnosing cholesteatoma is based on physical examination. You look in the ear and you'll see that cholesteatoma is present. Again, we've already mentioned that if you see a polyp then you should have increased suspicion. I will also say that these ears often will look a lot different once you treat the patient for infection and granulation. I've had patients where I was highly suspicious of cholesteatoma, but after you calm things down with an ear drop, you can see what's going on a lot better and you may have been mistaken.

The other thing is that you really have to get down to carefully remove any crusting in or around the eardrum, especially if there is a crust over the pars flaccida area. Very often, I've seen cholesteatomas in this area overlooked because it was just a small crust that wasn't removed, and then the cholesteatoma wasn't seen. Along those same lines, you have to actually very deliberately look in the area of the pars flaccida, so I think that's important. Then, the last thing is, if you can't see the full extent of retraction pocket in the office, then really you should be thinking about investigating closer with imaging. I have operated on quite a few cases of very large cholesteatoma, where the office findings were very unimpressive, where you saw what looked to be just a deep, quiet pars flaccida retraction and then lo and behold, there's a very large cholesteatoma.

Jason Barnes:

Moving on to treatment. The first thing I wanted to ask is, are there any preventive measures that we can take to prevent patients from developing a cholesteatoma?

Dr. Michael Gluth:

It's hard to say this definitively, but probably recognizing these early as they're evolving is of some benefit. The idea being that if you see progressive retraction of the eardrum, then doing something like placing a tympanostomy tube or perhaps performing a cartilage tympanoplasty to prevent further retraction. Treating patients medically or maybe even doing something like a balloon eustachian tuboplasty might help. With respect to the non-retraction pocket cholesteatomas, you would think that perhaps this could be prevented by the surgeon that's performing the initial surgery by being careful that there's no epithelium within the middle ear space.

Then, as far as non-surgical measures, when we see these patients, again, our initial goal is to reduce inflammation and infection and that may aid in the diagnosis, but the bottom line is mostly these patients are going to eventually require surgery. These non-surgical things or preventative measures are

really trying to optimize condition of the ear to help facilitate ease of surgery. Rarely, you'll see a patient where you have a cholesteatoma or deep retraction pocket that can be serially cleaned in the office. You may do this in a patient who is, maybe really old or someone who cannot or will not undergo definitive surgery, but the role for that tends to be pretty limited.

Jason Barnes:

Next, moving on to surgical intervention. I feel like this is a pretty broad topic and there are a lot of ways to approach surgery in a patient with cholesteatoma. Could you break down how you approach these patients and what the surgical approach options are?

Dr. Michael Gluth:

Right. Similar to our goals for surgery dealing with any form of chronic ear disease, first, we're trying to render the ear safe, so we want to prevent complications. We want to dry the ear and limit infection. Then, finally, the purpose of the ear is to hear, so we want to facilitate hearing either through functional reconstruction or allowance of using some type of a hearing aid, or perhaps even placement of an implantable hearing device.

When we think about the ways that we can surgically approach cholesteatoma, in the overwhelming majority, what we're trying to do is definitively remove it. Of course, that is the ideal and that's usually what we're going for. However, there may be some cases where attempts at definitive removal have failed or there's some complicated aspect to the cholesteatoma, which makes this difficult or some complicated aspect to the patient. In those cases than what we opt for is a mode of exteriorization, where the cholesteatoma is exteriorized into some type of open space or cavity that's continuous with the ear canal.

There's a lot of ways that cholesteatoma can be managed. It's best not to be dogmatic about this. People often make these decisions based on their experience and comfort with various surgical techniques. But I think there are some general guidelines that I hope most people would think about. Of course, you want to think about the extent of the disease and try to tailor the aggressiveness of the approach to the extent of the cholesteatoma. You want to look at the anatomy of the temporal bone. Is it sclerotic or is it not? What's the status of the hearing and what's the prognosis for hearing reconstruction? What has happened in the past? What has worked previously or has failed previously? Of course, we don't want to just continue to do the same thing over and over. In general, over time, there's a tendency where we should be more aggressive perhaps.

Then, of course, we talk to the patient. What are their goals? What are they trying to achieve? Do they want just one operation? Or are they open to the idea of some type of second look? Thinking about this broadly, for cholesteatoma surgery, there's this idea of doing too much. In other words, if we do a procedure that is unnecessarily aggressive, then what we're doing is introducing more downside or more potential risk of complication or unfavorable things with respect to lifestyle, say for example the need to clean a mastoid cavity. On the other end, if you do too little, then you're probably imparting greater risk of there being residual disease and not getting all of the cholesteatoma out.

Really, the goal and why I think experience is important, and why I think the imaging is helpful, is to choose just the right amount of surgery, where you've optimized your ability to clear the disease, but while concurrently eliminating the complications or downside of whatever approach that we apply.

Jason Barnes:

With that being said, what are the general approaches that are used in this situation?

Dr. Michael Gluth:

Yeah. I think of this as basically five categories of approaches. This is not official or definitive, but I think as I go through this, it'll makes sense as to why we think about it this way. The first and most simple way to do this would be some type of a transcanal approach. Approaching a cholesteatoma, either with a microscope or an endoscope by way of the ear canal. This can be done either through the external meatus using a speculum or an endaural approach or by way of a postauricular incision. These trans canal approaches may include a canal plasty. Often they involve some type of an atticotomy.

Transcanal approaches are low in invasiveness and usually they're applied for cholesteatomas that only involve the middle ear space. It can be any of the subspaces, the attic, mesotympanum, hypotympanum, whatever, but generally these are cholesteatomas that don't extend into the mastoid. The benefit here is that there's minimal disruption to the natural anatomy and the low-level of invasiveness.

The con is that when you're working through a narrow ear canal, in some cases, it might be difficult to apply instruments into a narrow space. Of course, endoscopic ear surgery seems to be helping this problem. Then, you're not exteriorizing the disease, so as is the case with many of the other approaches, there needs to be ongoing surveillance or some type of a second look.

The second category of approach to cholesteatoma would be what I call a combined approach. Combined approaches basically involve the same transcanal approach, with or without atticotomy as we've just talked about, alongside an intact canal wall mastoidectomy. Cholesteatoma involves incus, so the incus is typically removed in these cases. As the attic is approached through the mastoid, often the incus buttresses is removed, and there may be an extended facial recess drill out to augment the view into the middle ear space. General indications for combined approach or canal wall up tympanomastoidectomy would be a cholesteatoma that extends into the mastoid or a cholesteatoma that has significant concurrent mastoiditis that needs addressing.

Perhaps it's applied in a case where there's no mastoid disease, but the surgeon decides that there's a benefit to having an additional trajectory for the instruments to approach the middle ear space through the facial recess. The benefits, these approaches preserve natural anatomy. They're generally associated with favorable hearing outcomes, and it addresses whatever is going on in the mastoid. The downside is that these approaches, like the transcanal approaches, require a second look or surveillance. These may be difficult and, in some cases, even impossible to undertake in a sclerotic temporal bone where the sigmoid sinus can be up against the back edge of the ear canal, where the tegmen can be very low lying. In general, the rates of leaving residual disease can range anywhere from 20% to 40%, so not a small rate of a residual disease.

The next grouping would be the open approaches. This would be your canal wall down tympanomastoidectomy. There's different iterations of that. Historically, there is a version called the Bondi's approach, which really is applied to the very narrow application of the lateral epitympanic cholesteatoma or pars tensa cholesteatoma that extends into the mastoid, but really doesn't have a component which is medial to the ossicles. These are cases where the ossicular chain is intact. Basically, the canal wall down is taken down as the lateral epitympanic space is exteriorized and the ossicles are preserved. These are your cases where you create a cavity, but on the flip side, you have excellent hearing.

That said, far and away the most common version of canal wall down surgery is the modified radical mastoidectomy. This would be a procedure where the mastoid is exteriorized alongside the attic, while preserving the rest of the middle ear space. The eardrum is grafted. There may be some form of ossiculoplasty. The middle ear space in these cases is much smaller than the natural middle ear space.

But this is a case where you can still have a functional reconstruction of the eardrum and the ossicular chain while providing wide access to cholesteatoma.

Then lastly would be the true radical mastoidectomy, and that would be where the entire eardrum and ossicular chain are removed without any attempt at reconstruction, so there is no middle ear space and basically the eustachian tube is plugged off in these cases. That would be very uncommon in the modern era.

Indications for open approach to cholesteatoma would be really any cholesteatoma that involves the mastoid where the surgeon feels more comfortable with the wall down type approach. Recurrent cholesteatoma that failed less aggressive approaches may be unresectable cholesteatoma. For example, a cholesteatoma that circumferentially involves the facial nerve and the mastoid segment where the surgeon doesn't think that it's really possible to get all the cholesteatoma out. Maybe a patient that has a complex labyrinthine fistula, where the thought is that removal of the matrix over the fistula might cause sensorineural hearing loss.

Any type of anatomy that's not suitable for a more conservative wall up combined approach. Then lastly would be some patient that can't potentially undergo the needed surveillance or second look that would really be required for other procedure, someone that just as demanding the best chance at only having one operation or is medically-unsuitable to have multiple operations or maybe unreliable from a follow-up standpoint.

The pros to open surgery is that this really is the gold standard for cholesteatoma control. There should be a 10% or less recidivism rate in most published theories. That's what we see. The thing about canal wall down surgery is that while it's certainly possible with non-open techniques to see the subsites where cholesteatoma might be involved, it's far easier to get your instruments into the surgical field with canal wall down wide lateral exposure to actually instrument the disease and dissect. While visualization might not be always superior, it's much easier, again, to do the actual dissection in these very difficult small spaces.

The downside of course is obvious. You're going to create an open mastoid cavity that's going to be associated with a lifetime need for cavity care. It does require skill to shape these cavities, so lowering the facial ridge, generating a large meatoplasty, saucerizing the cavity, perhaps amputating the mastoid tip, these are all things that are done to create a favorable cavity. I will say that even cases that are done by expert surgeons who have done lots of canal wall down procedures will have some percentage of patients who will go on to have an unstable draining cavity. The overall rate is somewhere from 10% to 50%, five zero, 50, and so the variation probably depends on the technique and experience.

These are generally associated with worse hearing outcomes that's not uniformly the case in the literature, but a general thing that we see, a trend. Then there's also the issue of caloric vertigo. Cold wind or water exposure to the ear can make the patient have vertigo. The next class is the so-called hybrid approach, tympanomastoidectomy. These all are similar in concept, so basically what has been done is that there is a canal wall down type exposure to remove the cholesteatoma. But then some type of reconstructive technique is applied to ultimately render the anatomy more like a canal wall up scenario. There's lots of versions of this something like removal of part of the bony canal wall and then replacing it after the cholesteatoma is removed.

Various forms of canal wall defect reconstruction with soft tissue or cartilage. There are mastoid cavity obliteration techniques with a exteriorized mastoid cavity is obliterated or and/or the attic is obliterated by applying some type of fillers such as bone pate or a liner like a soft tissue flap. The indications for these are the same as what we would see for a combined approach or open approach. Only the surgeon needs to be comfortable with them. What they really promise is the best of both

worlds. The benefits of canal wall down surgery in terms of disease control, but the benefit of canal up surgery in terms of avoiding a cavity having good hearing.

The downside is that these are challenging techniques. They're not always intuitive. There's a lot of nuance, so they're not easy to teach and they're not easy to learn. It takes more time to do these things. Then there's always some risk of burying disease. If you're going to, for example, obliterate the mastoid then you need to watch these patients and maybe even perhaps follow them up with a diffusion-weighted image MRI later.

Then, the final category, which I won't talk about too much, is subtotal petrosectomy with blind sac closure. This is essentially a radical mastoidectomy procedure where the ear canal is closed. Basically, elimination of all mucosal disease and pneumatized air cells, usually the labyrinth is kept in place unless there is a dead ear. The indication for something like this would be someone who is a very poor candidate for functional reconstruction, and maybe someone who's had numerous past failures of other attempts at surgery. This is applied for patients with chronic ear disease and cholesteatoma who are candidates for hearing implants.

The upside is that these patients can swim. It's highly effective because it gives broad aggressive treatment of cholesteatoma and tympanomastoid disease. It actually renders the environment sterile for future placement of an implant. The downside is that if all epithelium is not removed, or if the ear canal is not everted and overzoned properly, then you can cause an iatrogenic cholesteatoma. Then there's no physical exam, so it demands radiologic surveillance.

Jason Barnes:

we've talked through the different surgical approaches, could we now touch on some considerations that you have during your surgical approach in terms of actually removing the cholesteatoma?

Dr. Michael Gluth:

Yeah. Often, we talk about some of the spaces that are difficult to deal with surgically. These would be the spaces that are at high risk for cholesteatoma recurrent. Far and away, the most common that we talk about is the sinus tympani. The sinus tympani is located in the posterior mesotympanum also known as the retro tympanum. Knowing the anatomic borders of the sinus tympani are important. Superiorly, there is the ponticulus and fairly, there is the subiculum. Laterally, there is the mastoid segment of the facial nerve. Immediately, there's the posterior semicircular canal.

The sinus tympani varies in depth and pneumatization from temporal bone to temporal bone. Sometimes there's hardly any sinus tympani, and sometimes it's very deep where it extends past the facial nerve into the mastoid. Looking at that radiologically is useful. Other key difficult areas where recurrence can be a problem are around the stapes and throughout the oval window niche. I can tell you that's surgically a very difficult area to deal with in some cases. Recurrence can occur within the attic. There is the super tubal recess, and then there are the hypotympanic air cells.

It's important to know, however, that recurrence of cholesteatoma within the mastoid itself while possible in very extensive mastoid disease, it's actually not that common. It is possible to widely drill out the mastoid and clear disease from the mastoid, then so that's not really one of the areas that we worry about too much. A few other, I think, things to consider with pars tensa cholesteatoma, I think it's important to understand that this forms from a posterior pars tensa retraction pocket. When you're raising a tympanal middle flap, the sac begins immediately at the annulus.

Cholesteatoma dissection in those cases really begins with your tympanal middle flap, and getting above and below the sac before you elevate that flap I think is important, because the idea is

that you want to roll that sac out of the mesotympanum as a self-contained specimen, as opposed to tearing into that epithelium in the retro tympanum and then leaving multiple scraps of epithelium. That's a general principle of cholesteatoma surgery. In general, you want to try as far as possible to avoid piecemeal removal. Removing little bits of cholesteatoma is really not what you're going for. If you can expose most of the lateral aspect of the sac and then try to remove it as a single, self-contained specimen or at least removing it in a controlled way as large segments, that's really what you want to do. Because of the dilemma that I just outlined, pars tensa cholesteatoma tends to be surgically more difficult than pars flaccida cholesteatoma, so keep that in mind.

The other issue that often comes up is the idea of staging. Certainly, if you're doing a second look operation, then staging is already predetermined. We do think about staging with respect to functional reconstruction. If your middle ear is severely disease, often silastic sheeting is placed in the middle ear space, and then ossiculoplasty is undertaken at the second look, sometimes even through the mastoid of the facial recess. But otherwise, in most cases, it's fine to primarily place a prosthesis after the cholesteatoma is removed. Sometimes you can use this to support a cartilage graft that reconstructs the pars tensa, and the outcomes for these are usually still quite good. Of course, you can always revise these at a second look if needed, but in the big picture, maybe two tries are better than one.

When do we perform second look surgery? usually it occurs somewhere between 6 to 12 months, maybe in a pediatric patient closer to six months, and in adult patient closer to 12 months. If second look surgery is not being done, and instead second look is being done with an MRI, then we usually extend that out to somewhere like 9 to 18 months, so that we can detect that critical 3-mm threshold of cholesteatoma pearl. Then, lastly, I think would be this idea of how to manage a labyrinthine fistula. Some of these surgeons may choose to exteriorize into canal wall down open mastoid cavity. But it is safe in most instance is to remove the matrix off of the fistula.

The general idea is to complete your cholesteatoma resection, but intentionally leave the matrix over the fistula to be taken out last. Prior to doing that, you can flush the field with antibiotic drops and then fill it with saline and try to remove that matrix underwater if possible. Then immediately avoid suction and repair with bone wax, bone pate fascia, something. I will say, if you're already planning a surgical second look, it's also okay to potentially intentionally leave matrix over a labyrinthine fistula with a plan to remove it at the next operation once the middle ear and mastoid infection is cleared. I will tell you that sometimes when you do that, when you come back for whatever reason, there is no matrix or no cholesteatoma there as you might've expected.

Jason Barnes:

I, next, wanted to move on to outcomes, prognosis and follow-up. When you see these patients and you're telling them about surgery, how do you counsel them on what they should expect in terms of recurrence rates and hearing outcomes? How do you follow-up with them after surgery?

Dr. Michael Gluth:

Often, the word recidivism is used in the context of cholesteatoma. Recidivism is a word that means return or reverting back to a prior condition. There's two forms of cholesteatoma recidivism. The first would be recurrent disease. That would be a situation, say for example, a child where you've definitively removed cholesteatoma. You may even have had a clear second look operation, and then a few years later, the patient develops a new retraction pocket cholesteatoma. In other words, they continue to retract and once again develop a cholesteatoma. Things that we can do to help prevent that would be

aggressive cartilage grafting. Again, treating eustachian tube dysfunction, and then very careful observation to detect this process before it turns into full-blown cholesteatoma.

The other category of recidivism would be residual disease. That would be matrix of cholesteatoma that is left undetected during an operation. This is going to be dependent probably on the experience of the surgeon, the way in which the cholesteatoma is dissected, again, avoiding more piecemeal dissection. Perhaps applying more aggressive techniques when needed like open or wall down surgery might help. Then hopefully, we like to think that technology would help limit residual disease. The advent of endoscopic ear surgery, maybe using something like a laser to help dissect or oblate cholesteatoma may be helpful too.

With respect to hearing, favorable functional hearing reconstruction after cholesteatoma removal as defined as air backbone gap closure less than 20 dB, is going to be achieved by an experienced surgeon somewhere in the realm of 50% to 2/3 of cases. This is going to be highly dependent on case selection. A experienced cholesteatoma surgeon that gets referred the worst cases is going to have a harder time of it, even though they might be better at the surgery just because there will be so many more factors that are out of their control. If, on the other hand, you're just operating on early-stage small pars flaccida cholesteatoma, then you'd probably do better than that.

Then in terms of follow-up routine, this is a chronic condition, so patients need to be followed long-term. At least a yearly exam examination over the course of somewhere from 5 to 10 years is probably worthwhile. Kids, you might want to watch a little closer. There's still a lot we don't understand about cholesteatoma growth and recurrence, but kids seem to grow faster than adults, and so maybe seeing them more often than once a year is a good idea.

Jason Barnes:

Dr. Gluth, this has been a very helpful and comprehensive discussion on cholesteatoma. Thanks so much. Before I move on to the summary, is there anything else you'd like to add?

Dr. Michael Gluth:

No, I think I've said more than enough.

Jason Barnes:

Thanks. We'll now move on to our summary. Cholesteatoma is a collection of keratin debris, most often in the middle ear that can be destructive in nature, and most often presents with conductive hearing loss and otorrhea. The classically described types of cholesteatoma are congenital and acquired. Acquired is broken down into retraction pocket and non-retraction pocket, which was formerly known as primary and secondary. Workup includes physical exam, audiogram, and possible imaging including CT and rarely MRI. Treatment is complete surgical excision with many options, including the transcanal approach, combined approach with intact canal wall, open or canal wall down mastoidectomy, and subtotal petrosectomy with blind sac closure.

There's also hybrid reconstructive technique that allows the benefits of canal wall down with then creating canal wall up anatomy. Recurrence rates with canal wall up surgery are around 30%, which means regular follow-up of these patients is required based on physical exam or radiologically depending on the scenario. Dr. Gluth, thank you so much again. Anything else you'd like to add?

Dr. Michael Gluth:

No, I think that's it. It's been my pleasure.

Jason Barnes:

Okay. We'll now move on to the question asking portion of our time together. As a reminder, I'll ask a question, pause for a few seconds to give you time to think, and then give you the answer. For our first question, describe the two main types of cholesteatoma and the subsets of cholesteatoma.

We divide cholesteatoma into congenital and acquired subtypes. The acquired subtypes are much more common and are further divided into retraction type and non-retraction type. Retraction type is formerly known as primary acquired and can be further broken down into pars tensa, pars flaccida or combined subtypes. The non-retraction type is formerly known as secondary acquired, which can be associated with the perforation or iatrogenic.

For our next question, define Hennebert sign and Tullio's phenomenon, and when this is seen clinically. Both of these would raise suspicion for a defect of the otic capsule, though this isn't specific for cholesteatoma. Hennebert sign is the induction of vertigo and/or nystagmus with pneumatic otoscopy. Tullio's phenomenon is the induction of vertigo with loud noises.

For our next question, what is the name of the space that is lateral to the epitympanum that is a common site of cholesteatoma? The most common site of cholesteatoma formation is in the posterior lateral epitympanic space also known as Prussak space. for our last question, describe the CT and MRI imaging characteristics of cholesteatoma.

On CT scan, you'll see blunting of the scutum with soft tissue pacification in the attic, especially lateral to the incus. You may see expansile changes adjacent to the soft tissue in the attic or scalloping of the bone. There may be extension into the antrum and mastoid and at the junction of the soft tissue, there will be breakdown of air cell septations usually with an expansile appearing rounded type mass. On MRI, this will show diffusion restriction, which means with non-eco planar diffusion weighted images, cholesteatoma will be bright. Thanks so much for listening, and we'll see you next time.