

So this afternoon's session is kind of switching gears to a different area of access for endoscopy to - adding this to the retromastoid approach. Obviously the retromastoid approach is a longstanding approach, it's well known and has been used for many, many different types of pathologies and so adding in endoscope is not going to create a new approach but it does have some value for it. So again the main concept is that we are introducing the endoscope into the surgical field which just gives us a different perspective, it gives us the potential to see things deep in the view that we wouldn't see. The same analogy really holds true to the posterior fossa not just to the endonasal portion of the skull base.

Obviously one of the perhaps simpler and certainly Pittsburgh based procedures is microvascular decompression for tic douloureux or trigeminal neuralgia. Here is the anatomy, this is looking on the left side and you have typically a large superior petrosal vein complex and then there is the trigeminal nerve with varying degrees of compression. The endoscopic view, two things that you'll notice is first off there is a much wider field of view, we can work past the vein to see things at the - both the dorsal root entry zone but also to look for distal compression. There are theories that compression can only occur at the proximal segment and it's definitely the most common segment but there are very rare cases where distal compression can also result in trigeminal neuralgia.

Here is an example of a man who has had because of his age he hasn't been treated for quite some time, about 10 years, with typical trigeminal neuralgia. Obviously Dr. Jannetta at least in the U.S. and in Pittsburgh is predominantly responsible in sort of the lineage from which I think all of us here who are guest faculty have learned posterior fossa surgery, and endoscopy has been applied through

the years developed from there. Potential advantages for endoscopic MVD are improved visualization, you can do a smaller exposure. I generally still use a similar small size exposure with a microscope so I'm not sure it adds a lot but certainly less cerebellar retraction and neural manipulation but the visualization and the potential to not have to retract as much to get that visualization I think are the two big potential advantages. Again I don't use a different craniectomy for my retromastoids, you need less exposure to see but you also need room for the endoscope so it's kind of a wash from that perspective.

The initial steps we'll go through in the lab, the landmarks really are for the transverse and the sigmoid sinus. The sigmoid sinus is the digastric groove and we'll go through transverse sinus in the lab and your craniectomy really extends from the transverse sigmoid junction. And then the first step I usually do open the cerebello-medullary cistern in order to allow relaxation of CSF.

Positioning, and this is - there are a lot of logistics to bringing in an endoscope arm. I think the best pneumatic arms currently on the market are the ones that at least stores, markets or sells and these are - this is one that clamps onto the bedrail. The one issue with this you can see the arm as it extends out from a lateral position is right next to the endoscope arm and so you have to make sure that's properly padded and protected or even held up in place or placed in a sling in order to allow the endoscope arm to move in. You'll also see in the lab and then in our case on Friday there is a uni-arm which rolls in just like a microscope which is a little less logistically difficult but it does take up more floor space, so it sort of depends on what you are - what the advantages are for you. And then we do a full lateral positioning with an axillary role and taping the patient in place and then

just a small shave behind the ear. So I'll go through a small series, this is only up to 2013, we sort of continued about this rate with endoscopic cases. This is very early in the learning curve for these and I'll just kind of go through some results.

Again I showed you this case, and this is a guy who had gamma knife, etc. but here is starting off by letting off CSF low down from the cerebello-medullary cistern. This is again a right side, so the petrous apex is out here and I'm just trying to get the scope in a decent position just to let off some CSF down here. Opened up that arachnoid cistern and so this is being done with dynamic endoscopy not a scope holder. Sometimes you can do that but you need the same assistant every single time. I've gone, since I work with residents often I've gone more to an endoscope holder because I don't have to train the holder every time, I just find different positioning.

Now I was trained to always take the superior petrosal vein and essentially it almost always in the setting of a microvascular decompression doesn't lead to any problem whatsoever. But John, I know John's technique is to almost never unless he absolutely can't avoid it to take the superior petrosal vein and I think I've gained more respect for veins over time and I kind of have switched to that. And part of that is from the endoscope because the endoscope allows me to see around that vein a little better whereas with a microscope I find it a little more difficult to access.

That's the way we were trained, and I have not seen a problem with it.

(Inaudible)

One in 200, whatever it is. But so here you can see a really big double loop of SCA on the back side of this. You can see the - you know this you could probably obviously you are going to see this wall with a microscope as well but you wouldn't have quite this visualization. I can see for sure that I'm padding this on the backside of the nerve and then the rest of the technique is really very much the same. 'But the Whipple view and the visualization that you get there is really quite ideal. You can see - you know that is one of the things you can get with - is double vision both from 6 and from 4. And you can see in this view, I can see 6 in the depth so I'm not going to put in too much felt there and I could see 4 if it were in my view so I wouldn't cause any damage to that. It's not sagging below the tentorium as it can sometimes.

So he did quite well. This is a case of an atypical trigeminal neuralgia, so V1 distribution, burning type of pain and in my experience that tends to be more venous compression. It also has a lower chance for improvement I think partly because some of it is misdiagnosis, but here this is a left side, so there is left petrous, there is the left tentorium. We see a little bit of mild compression from an SCA loop but when we look on the backside - so one of the issues here look at this huge hump at the porous - the trigeminal porous, you can't even barely see the nerve here but looking, working with the endoscope I don't have to worry about drilling this down, I can just sacrifice this vein that's compressing the nerve from the deep side. You can also decompress these veins but usually some of the smaller veins if you examine them carefully you can - you can sacrifice one of those veins as long as you don't get any perforators on the brain stem when you are coagulating it. This is an up-

angled bipolar which is very useful to have an up-toed bipolar and I'm just decompressing the back side of it to make sure that vein is no longer in contact.

So I had 16 of these up just over - about a year, year and a half and the SCA was offending in most as you would expect. And most patients had excellent outcome. One patient with atypical had no improvement. I did have this patient who had had multiple glycerol rhizotomies and I wish I had the video of this but you literally the entire posterior fossa was black from the tantalum from the glycerol rhizotomies and you couldn't tell what was a vein, what was arachnoid, what was an artery, everything was literally black and I ended up cutting into the SCA. I don't think this was something I would have done better with a microscope, I think this was just a very you know bizarre case and he had an SCA infarct from that and a very complicated course from it.

(Inaudible)

So that was actually my - probably my second case I had done and it's the only time that I converted to microscope. And part of it was I just freaked out and I wanted things to be as I was used to. And I think that's absolutely fine to do that. I think at this point I wouldn't do anything differently, I wouldn't switch but I've gotten the hang of where I need the endoscope relative to my instruments which I think John will talk about this morning, he's show on in the prosection where you put your instruments relative to the endoscope is equally or more important in the retromastoid space as it is in an endonasal surgery. And so that's very key is understanding where do you move the scope when it needs to get a certain spot and I just was unsure of myself so I switched to microscope and

then ended up you know having to partially coagulate it. So it doesn't tend to be as much of an issue with sliming the scope, I think it has to do with the trajectories of cleating but the biggest issues with it is more what you said, if you don't have an experienced assistant who can flush the scope for you, you can really struggle.

Hemifacial spasm, I think the lower we go and the more complex things go the more important it is or I think the advantage of the endoscope show up even more. So trying to see that dorsal root exit zone, this is 9 and 10 on the left side, seeing the dorsal root exit zone of 7 which is really where the vascular compression is improved with the endoscope. So here we see that big trunk of vertebral and you can see the dorsal root compression here even in this cadaver.

So here is a case of typical hemifacial spasm, again this is a left side, so here are the lower cranial nerves, you see 9, 10 and 11. We are just working just past 8 here and just releasing some of the arachnoid on the flocculus, you can see a little branch of loop of PICA coming over the - actually it probably is a ICA loop. And just releasing get some very thickened arachnoid here over 9-10 and you just have to take time to recognize that and release it. I think again I can see very clearly here what's arachnoid, what's neurofiber and you can see here actually see 7 peeking out behind 8 which is not something sometimes you can see with a microscope. I can very clearly see this small loop that's compressing the dorsal root exit zone. I'm not having to retract the cerebellum, I don't have any retractor in place and I'm just working around the flocculus and I can then decompress, look for my lateral spread to disappear. And so I think it gives me a very direct view. Again the endoscope is pressed up against the petrous bone angled down back towards the brain stem and my instruments

come in then on the cerebellum and they sort of all triangulate together in order to work with my instruments below the endoscope

So again another 10 cases with hemifacial spasm and essentially everyone got not complete relief but near complete relief and everyone got some degree of relief. I did have two mild facial palsies and hearing loss in 3 patients, only one with complete hearing loss. One patient did require a feeding tube due to temporary dysphagia. If you get a very large vertebral artery with a small PICA loop you have to lift the vertebral up and pat it on the backside of 9-10. And Don, Mel, I don't know if you guys have the same experience but those are the ones where I really worry about dysphagia because you putting a lot of material and you are doing a lot of manipulation around 9-10.

And so geniculate neuralgia is not very common, it's very difficult to diagnose but I do think this is on case where I can pretty - I clearly see a difference in that I can find the nervus intermedius better with an endoscope because it tends to hide between 7 and 8, and so if I have an endoscope right next to there I can look around 8 and see it long before I dissect it.

So here is a case of geniculate neuralgia, it's a right side, you can see 11 coming up here and 9-10. Again that same thick arachnoid, that same hesitancy of dissection. And here again the endoscope is plastered against the petrous ridge and I'm dissecting below it. You could already see the 7-8 complex and look you can just see nervus intermedius in the depth there. Now this child did have - it was actually a 15 year old with geniculate neuralgia, did have some degree of throat pain but primarily deep ear pain, and John and I were just having a long discussion. If it's pure geniculate do

you really need to decompress 9-10 at all? Well he had a pretty significant, I mean there is a vessel loop here between 9 and 10, so you see a whole complex here, so I did decompress this. So I was able to decompress and this is pretty careful dissection that you have to do here and I found it was quite doable with the endoscope and I didn't find that it was a limitation. So after I decompressed 9-10 here I am - I can already directly see nervus intermedius, I can lift it up and then I can cut it. So the visualization of nervus intermedius is often very challenging but working with the endoscope I found it to be - that part to be actually much simpler. I've never had any difficulty spotting it right off. And he did quite well, similar kind of section nervus intermedius and all the geniculates, it's PICA essentially in all of them and everyone got at least some degree of relief either we are still requiring some meds or no meds at all. To be expected, not surprisingly there is some voice hoarseness or 9-10, or 10 dysfunction in these cases. So I do think endoscopic MVD is safe and effective and for me it's really been a foray, a way for me to get more comfortable working in the posterior fossa. I've advanced that in only a few cases to RMC for tumor and I think - I know John has much greater experience both with MVD as well as with tumors and so I'm looking forward to hear this thoughts on it.

Here are a couple of cases. This is a purely endoscopic case, I think Schwann here, I think he may show this case later so I may skip through this. But this is actually very wild tumor. This ended up being a tumor growing purely within the superior petrosal vein. So it's you know absolutely bizarre, you can see the setup here. So a patient in 3-pin fixation, lateral flexion, shave the retromastoid area. Just an MVD incision for this. Lateral retraction of the dura, releasing CSF. Again this is the left side so these are lower cranial nerves. Releasing CSF from the cerebellomedullary cistern. Here is



the tentorium, and there is the lateral petrous on the left side, you can see a little SCA loop here and then you see tumor just - actually I'm sorry this is cerebellum overlying it, but you see tumor in the depth here completely filling the superior petrosal vein complex, really very wild case.

So here is where I'm just dissecting around the edges of the tumor and then finally releasing it from within the walls of the superior petrosal vein. That's what that capsule of it essentially are walls of the superior petrosal vein. Because it was encapsulated here you can see the distal, there you see the distal trigeminal nerve after that. Completely decompressing the trigeminal nerve as well because she presented with some neuralgia. This is the way I was taught, Mel, you decompress these patients with face pain and tumors or do you just remove the tumor?

(Inaudible)

Yeah. What about you John, do you just take the tumor?

Yeah, I think probably get away with tumor, I just never, I always feel compelled to do the MVD as well.

I have a great case of (inaudible)

I think it's worth looking at it, and if you see - I like your idea of if you see compression maybe deal with it, but - so epidermoid tumors I think are probably the case where I've found the greatest value for endoscopic assistance. And if you look at it your trajectory for retromastoid approach - your

epidermoids like to intercalate with every cistern they possibly can. There is no true long access for these tumors so working around corners into these tumors really can make a big difference.

Here is a very simple case, this is a woman who presented with some vertigo and a straightforward case completely done with a microscope and no reason really that I have to use an endoscope for this but just to show you the view that I would get, this is the view with the microscope. You know working again, this is on the left side. And this is the view with the endoscope at the end of that. So just the width of view and the fact how well I can see the dorsal root exit zone just gives you some idea of the improved visualization you can get. And a 45 degree endoscope of course gives you even more ability to work around corners.

So where I've found this most useful is in the prepontine cistern, again your direct trajectory is very difficult to look across midline. Cases where it extends up into Meckel's cave it can be very difficult to see with a microscope even when you split the tent and then working out toward middle fossa it can be very useful. Here is an example of a recurrent tumor extending up towards middle fossa and here is an endo-assisted epidermoid and you can see again it goes all the way up to the prepontine cistern and I find it very difficult sometimes to see that or to see on the deep side of the cranial nerves. You know these tumors tend to be growing ventral to the cranial nerves and so doing a dorsal approach like a retromastoid doesn't give you full access to the entire tumor.

So here I resected as much as I could with a microscope. Let's see - and here is my microscopic view, again this is a right side, here is the tent up top, here is the 7-8 complex. Peeling tumor off the

brain stem, but you see I can't see this brain stem plane all that well, and I certainly can't see behind 7 and 8. Once I put in the endoscope I can really see this brain stem plane much more nicely, I'm working next to 7-8, below 5 which has been pressed up against the tent and now I can really see the brain stem to dissect this directly. It's not a blind dissection. And with an epidermoid if there is no plane there you can do some real damage to perforators if you are not careful, so I sort of force myself, I do everything that comes easily with a microscope and then I always set up an endoscope on these and I mean look at this tumor that's hidden behind this artery, there is no way you'd be able to see or access that if you didn't have the endoscope in there for that kind of visualization.

So I've found for these cases this made a big difference. This is purely a retrospective review but these are similar size tumors and the first 7 cases were done with purely microscopic, there was only one case with a complete resection, and then 7 endoscopic cases, 4 cases had complete resection. This is statistically significant. There were no new cranial neuropathies so a little less damage and a little better resection and the endoscope can make that difference of 10 to 20% in these tumors like epidermoid which for some of these patients may mean if not complete lack of recurrence, another decade of lack of recurrence. So I think for epidermoids it makes a real difference.

Acoustic neuromas I have not gotten comfortable doing these entirely endoscopically. I know Dan Piper used to do them this way but this is a woman with a little bit of extension into the IAC, it goes out pretty far actually and but she has intact hearing. So to try to preserve her hearing we don't want to drill as much of the porous which then leaves you with the problem of how do you see the distal aspect of the porous to know you've gotten this last cap of tumor? Well this is an angled endoscope.

Again if you drill too far in the porous I've drilled into the cochlea and now I've destroyed all of this work so far, so working with an angled endoscope and curved instruments I can work out into the part of the porous that I haven't drilled into to peel out the last bit of tumor. So I don't have to sacrifice tumor resection and I don't have to sacrifice hearing to get this last little bit of tumor. Here we working right on top of the 7th nerve here which is why this part is a bit tedious. But you can see the kind of view I can get and the kind of control we can have.

In this case I have an angled endoscope sitting on the cerebellum and I'm working out towards the petrous bone. And there is finally that last bit of tumor coming out. So that's the advantage that that can give us.

Have you don't any (inaudible)

With that yeah. So I've done probably 3 and in that situation I've been able to preserve hearing. Because one of my biggest issues is keeping the - you know the otologists want to see the lateral aspect of the tumor and they'll say you know I can't get this without drilling into the cochlea so we can't preserve hearing. So I finally convinced them to stop short, let me take a look at the end and you know I promise you we'll get that bit of tumor out. So that's been - it's not a major paradigm shift but those few patients who have hearing preservation and I think it improves that.

Here is a FM meningioma. You know we sort of did a full lateral approach for this but the issue with this is with a retromastoid approach you can't really see and I'll show you in a minute, you can't

really see the lower cranial nerves that well or beyond them. So here is the 11th nerve draped over this. Sort of working between the 9-10 complex and the 11th nerve we have the vertebral artery out here exposed. So I can resect this tumor with a microscope, no problem, okay. I can work around 11, I can peel it off of the dura. I mean I've done everything I can do from a skull based approach to get as wide a resection as I can; but I can't see around the vert and I can't see around the 11th nerve, I just can't see that area. But when I introduce the endoscope I can see that dura to know whether or not I've left any residual there. So here is again that view with a microscope, as soon as I bring in the endoscope here is 11, and again I'm working deep to vert. I can see tumor residual stuck onto the dura, I can see hypervascular dura. Obviously I'm not resecting the dura completely, but I am getting some residual off of it and I'm able to coagulate it to at least get a Simpson Grade II resection of this tumor. And that's simply not a view that I could have or safely access with a microscope.

One final other view, so that's looking out towards the lateral dura. This is a case of an ependymoma in the cerebellomedullary cistern and this will be a case where I'll look back towards the brain stem to try to see residual. So she presented with progressive headache and significant vestibulopathy and so again did a right far lateral approach and what I'll show you is here you see the tumor, very adherent. I'm doing all of this with a microscope, I think as John mentioned it tends to be a little more efficient. So I would get as much resection as I can with a microscope, some venous bleeding from the tumor. And here I think I've pretty much gotten everything. There is some that's going in the foramen of Luschka here so I peel the tumor out of foramen of Luschka, I've done a far lateral, I've drilled the jugular - I've done everything I can to get the most lateral to medial view and I think I've peeled everything out of the jugular, rather out of foramen of Luschka there. But once I put the

endoscope in I look out towards the lower cranial nerves first and then looking back now towards the brain stem back towards the foramen of Luschka here we see the entry of foramen of Luschka and sure enough I've left some tumor here. This chunk of tumor I just couldn't see with the microscope, so now I'm working upside down more or less, this is under a little PICA loop, and peeling this last bit of tumor out from foramen of Luschka. It's just not something I could see much less try to resect without the endoscope.

So I think it has a very different learning curve in the posterior fossa and I use it generally for endoscopic assistance. I do purely endoscopic microvascular decompressions, I don't think there is a reason to switch out between the two. And I think it gives you visualization around corners. Some brain stem structures out towards Meckel's cave, out into the porous acusticus and back towards the brain stem to make a safer dissection in those areas. Thank you very much.