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Epidural Blood Patch Basics: What They Are and Why They Fail

Thank you. It's good to be here. I'm Ian Carroll. I'm gonna give you a little primer on epidural patches, why they work, why they don't work. And since we have a lot of patients in the audience, somebody approached me outside about something that I had done several years ago that wound up helping them.

Can I see a show of hands? How many of you, uh, at some point did a 48-hour flat test? All right, keep your hands up if the 48-hour flat test helped ultimately guide you to treatment. All right, good. That's worthwhile. I like that. Thank you. All right. This year Andy [Callen] and I will be looking at data on the 48-hour flat test and actually get that into print.

So let's talk about epidural patches. This is a Google Drive folder I share with resources for patients. It has the various papers that I talk about in this talk, the 48-hour flat test, the contact information spreadsheet for doctors that are, have expressed interest in treating CSF leaks is compiled by Duke and Stanford um, and ultimately more to come here.

So, let me start by showing you a picture of the dura. What you can see here is, let's see if, is there a pointer that works here? So, this is the dura, all right? So you have your spinal cord in here, nerve roots coming off, and you have this little fibrous tissue surrounding the bag. That's the dura, that's what we're all talking about here, that can wind up with a little hole in it.

If you look at it in cross section, again, spinal cord. This is the space where the CSF would be and the dura surrounding it, all right, nice and deep inside the body. Again, the dura up there and the edges of it here and what it looks like when it's taken out of the body. You got the spinal cord in here with the nerve roots coming out.

And the dura, this kind of fibrous tissue structure, and it shouldn't be surprising to doctors who've never heard of a spontaneous CSF leak, that one would happen because every other connective tissue in the body gets torn. Aortas get torn, blood vessels get torn, menisci get torn, ligaments get torn. Why would this one part of the body not get torn?

Not have a problem? Every connective tissue structure in the body has a failure rate. So what is a blood patch? A blood patch is when we inject blood or fibrin glue outside the dura. This is how we do it. This is how we've kind of decided works best

in our hands. I don't like putting the needle in the back and then going looking for the blood.

That is a recipe for not getting enough blood or making compromises in the sterility of the blood that you're going to use. So, if you've had a blood patch with me, this process will look familiar to you. We do a full surgical chlorhexidine prep of the arm. After that... This is from the first year I was doing this, you can see that little green hub of the IV, that's an 18 gauge.

We will not use an 18 gauge now, we will only use a 16 gauge or an A line, because when you put an 18 gauge in, and you wait 20 minutes, and that plastic gets soft, three quarters of them will still draw, but 25 percent won't give you all the blood that you want. But if you put a 16 in the antecube, you will get all the blood you want, when you want it.

So we put in a 16 in the antecube, we don't put it in the wrist, we don't put it in the forearm, we don't put it somewhere else. You get a 16 in the antecube or you get an A line. And those draw all the time. You never wind up not getting your 40 of blood. And if you want to do... 3 or 4,000 epidural blood patches and have an infection rate of zero, then in fact, doing this kind of thing where you do a full surgical prep as opposed to just a little alcohol before you draw your blood, I think is worthwhile.

We then connect it to sterile tubing that is primed with sterile saline. That gets connected to a syringe here at the other end, and that syringe will ultimately go on my epidural tray so that I don't have to keep the patient's IV site sterile any longer. I just have to keep the syringe sterile. And it turns this from a two person procedure into a one person procedure where I've gotten my access to my blood.

I'm not drawing the blood yet, but I know that when I draw back on that syringe that's connected to a 16 gauge in the antecubital fossa, I'm going to get all the blood that I want. Then we put the needle in the back, you can see this is one of the fellows I'm training, this is a T4-5, and when we're coming in with that needle, so you've got the vertebral column in the front, the skin of the back is back here, and we're trying to get, so the spinal cord's number 5, the subarachnoid space full of spinal fluid is number 6.

The dura is number three, and the epidural space here is number four. We're trying to get in to number four, but not go two millimeters too far and get into the bag of fluid. And there is the rub. This is a little cartoon of what that looks like, again, spinal cord, this epidural space being distended with fluid injected through a needle, and the thin membrane of the dura.

So once we get our needle in the back, we go ahead and draw the saline out. And then after drawing the saline out, we draw the blood, connect the blood to the needle, and inject that under fluoro. That's what it looks like on a contralateral oblique. You can see contrast spreading in the epidural space.

Often, when we do that kind of injection, this image is from a 2006 review by Dr. Schievink in JAMA. When you inject through an intralaminar approach, as I just illustrated, often the blood will pool on the back surface of the dura here, and so you'll see that the blood is actually kind of pushing on the back surface of the dura.

That's just fine if your puncture is on the back surface of the dura. It's just fine if you have a post-dural puncture headache from a dural puncture where the puncture is on the dorsal dura, but Andy showed a bunch of pictures where there was some kind of calcific spike on the ventral dura.

And you can see, if you've got a spike here on the ventral dura that, or a little hole in the ventral dura from a little calcified osteophyte, that putting blood back here ain't gonna do a whole lot of good. And maybe with a lot of volume, maybe some of that'll spread around there, but I don't know. Certainly not reliable.

And so that's where doing these transforaminal approaches can really work. You fill up that foramen and it kind of pushes into the ventral epidural space, the space in front of the bag. This was one of our very first patients. In fact, this is the patient that I was just showing you who had this T4-5 calcific spike

penetrating through her ventral dura. Her MRI of the brain was read as normal. It was before the Bern score. It would be high Bern score now, but it was, there was no pachymenangeal enhancement, and it was read by a good board certified neuroradiologist as normal. She had no ventral epidural collections at all, but she had that spike and ultimately we wound up doing a transferaminal fibrin glue, which kind of covered that.

She got better for several weeks after that and then her symptoms recurred. And she went and had surgery with Dr. Shievink, and was totally fixed for six weeks, and then her symptoms recurred. Uh, but after that, with repeated patches here, transforaminally with fibrin glue, she had like four more patches, and now it's been like five years, and she hasn't had a recurrence.

I don't understand why the patches worked after the surgery, but not before. More mysteries of leakers. Now, let me talk to you about six reasons why I think a properly done epidural blood patch can fail and they are that somebody can have something called an intact plica mediana dorsalis. They might in fact have a ventral dural puncture that's not being covered. They may have a dural fistula formation, which is different than a CSF-venous fistula. They may have a dural bleb formation. They may have a CSF-venous fistula. Or they may have something that the neurosurgeons are starting to talk about but really hasn't been published that much, these neomembranes or pseudoduras forming over the leak.

All right, failure point one, a functionally intact plica mediana dorsalis. It turns out that many individuals have a fibrous septation in their epidural space right in the midline and the dorsal epidural space behind the bag.

This was a 35 year old woman who'd had a lumbar puncture. After the lumbar puncture, she had a spinal headache rated at 10 out of 10. She'd had at least one failed blood patch. The image from the the fluoroscopic lumbar puncture is here, you can see that entering, it's not a true AP image, and so it's hard to tell if that's really on the left or the right of midline.

What you can see when I patched her is when I dropped a needle at that level, just to the left side of midline, The contrast spread here is up and down, and if I gave more it'd keep going up and down, but there ain't no spread at all to the other side of midline at the segment where I'm patching. So, here I am, I'm patching the right level, and I'm getting no spread at all on the other side of midline, even though I'm getting plenty of spread up and down, and then when I went ahead and dropped in the second needle on the other side, because I really couldn't be sure which side of the midline her puncture was on, but I knew if it was on the right side, I was gonna totally miss it with this

almost exactly midline needle, but was giving me left sided spread. So then I injected through the the right sided needle. Now I've got spread on both sides of the midline. Again, before the right sided needles injected, after the right sided needles injected, nice plaga mediana dorsalis there. This can seem excessive.

This was somebody who had a chronic leak after a lumbar drain. You can see that we planned to put in two needles at two levels. And you can see after I've injected the left sided needles, I have spread across three levels and zero spread two millimeters across the midline. All right, I think this is hugely important.

If the puncture is on one side, you got to make sure you get spread on that side of the midline. That's what it looks like after dosing the needles on the other side. It takes me exactly three minutes to put in another needle on the other side of the midline. You just have to care hard enough to do it.

So, if you have a plica mediana dorsalis, then a properly done bedside epidural blood patch, where we don't know if we're on the same— so imagine you had a labor epidural, you had a puncture, and your anesthesiologist does a bedside epidural blood patch. There's a 50 percent chance they're going to wind up on the right side of midline, or I should say the same side of midline as your accidental dural puncture.

And whether they wind up on the correct side of midline or not, you're gonna feel better temporarily because all the blood they inject, even if it's on the wrong side of midline, is going to be compressing the dura and restoring intrathecal pressure temporarily, even though the leak is not covered. And then you will rapidly start to feel worse again over the next couple of days because you have, while you temporarily pressurized the bag, you did nothing to seal the leak.

So, if you haven't covered the defect, the patient will feel better initially and then recur. And, what would the natural consequence of that be? The natural consequence would be that looking at the effectiveness of blood patches for an acute, immediate post-dural puncture headache. If you looked in the first 48 hours, you might say, Oh, we help 80 percent of people with our blood patch.

But, in fact, you would expect that your long term success from sealing the leak would be much lower. And, in fact, those studies like Webb and Dr. Floods from 2014 that looked at long term rates of chronic headache after an accidental dural puncture find rates more like 50 percent effective, which would be more what you'd expect if sometimes you land on one side of the midline than you land on the wrong side of the midline.

It's worth noting that simply repeating the procedure gives you a 50 percent chance of landing on the other side of midline, which is just a couple of millimeters after going nine centimeters deep. So you can do that or you can use a bilateral paramedian approach under imaging guidance, as we've kind of shown here.

Failure point two is a ventral dural puncture. So the same patient, this was the lateral image they got from their lumbar puncture, that needle's pretty far forward. I was worried that they had done this. And remember I showed you that image from Dr. Shevink's article showing you how the dorsal con the dorsally injected blood may just be on the back surface.

And so, if you want to get stuff on the front surface, you really got to come in like that, transforaminally. And so we did that for her, and you can see here, there it is. So we've got contrast on the dorsal surface from my paramedian needles, but I've put a transforaminal needle here. We're getting nice spread of the contrast on the front surface of the bag as well.

That's kind of what I think Linda Gray talks about doing what she's doing under CT and I see people talk about in the communities, "360 patches," making sure that you get it. on both sides of the midline, front and back. And I think what is whether it's at Duke or Stanford or here with Dr.

Callen, the people who are into this, they're going to take the time to make sure you get the spread all the way around. This was an 18 year old woman who was transferred to Packard Hospital at Stanford a month after a recognized unintended dural puncture during a labor epidural. She had two epidural blood patches that had failed.

You can see her subdurals and midline shift and her spine MRI showed this. The neuroradiologists will not be surprised by the very clear ventral collection, which you can see there and on the lateral there. And this explains why her bedside epidural blood patches didn't do nothing to help her. And she was on her way into big trouble with those bilateral subdural hematomas and midline shift.

And by the time she got to Stanford, she had this for over a month. And my concern was that the... The edges of the hole, while likely ventral, were probably nicely epithelialized, which means that the cells of the bag had grown around the edges of the hole and in some way healed it. It was not little friable edges after a month that are trying to heal, at least I wasn't confident that it would be, and so I thought that it was reasonably likely this woman was going to need surgery to fix this.

If possible. And that convincing a surgeon to do that would be tough at Stanford because they're going to have to cut through, they're going to have to come in from behind, they're going to find the dorsal dura, have to cut it open, and then look through the dorsal dura to try to find some pinhole on the ventral dura.

So we did a digital subtraction myelogram, something that we hadn't done at the kids hospital at Stanford before. We got some advice from Dr. Maya and Dr. Schievink, given directly to our interventional radiology colleagues to help them do this in just the right way. And what you can see here is, here's the needle coming in.

It's in the spinal fluid, and it injects contrast within the spinal fluid, which is layering out here, and then right here, you see a teeny little bit of contrast passing through the ventral dura into the ventral epidural space, and then over time it gets bigger. Again, Dr. Maya and Schievink helping give us advice on how to do that.

So, she wound up having surgery to fix that and did well. So, here's another case where a properly done epidural blood patch may do nothing to cover or seal the defect. Again, the patient would feel better initially as you pressurize the bag without sealing the defect, leading to long term rates of success that are lower than the artificially inflated estimates of early success, which you get from just pressurizing the bag.

Simply repeating a blood patch in this case is unlikely to be helpful. So what do you want to do? You want to possibly use a transforaminal approach under imaging guidance. Do the imaging that will give the surgeon the confidence to open that dorsal dura and go looking for a ventral leak.

And the surgeon should carefully evaluate the ventral dura. Failure point number three is a dural fistula formation. This is not a CSF-venous fistula. This is what I was worried was happening in the ventral dura of the last patient. So, this was a doctor who came and saw us. She had a venous sinus thrombosis in her head.

One of the veins had clotted and she then had an infarct in her brain. Wound up having to have a right frontal craniotomy and had a lumbar drain placed for that. A lumbar drain being a big tube put into her dorsal dura, uh, in her lumbar spine. After she recovered, and she remarkably recovered from her neurologic deficits, but she was left with persistent headaches, which for a long time were attributed to her brain surgery.

And then afterwards were recognized to be postural. She had bilateral digital subtraction myelograms at Mayo Clinic, which showed no evidence of leak. And they had tried multi level thoracic epidural blood patches, which also provided no relief. I was worried about the lumbar drain, and so you see here me putting a needle in her lumbar spine.

Here's contrast along the dorsal epidural space with this being the margin of the dorsal dura. And what you see here that's unusual is, now I've put in a ton of contrast and it's lining up along the dorsal dura. And up here, you see this little ventral line, that's some of this contrast having penetrated through a hole from the lumbar drain up here, right?

When I went ahead and repeated it, injecting right over it, you got this on a digital subtraction image. This is less convincing because the skeptic could always look at this and say, oh, Dr. Carroll plunked her right? So we repeated it with another digital subtraction, injecting at the level lower, and again.

You see that little thing up there, even when my needle's not up there. So that gave the surgeons the confidence to go look there, and what did they find but a little hole from the lumbar drain. No bleb. No bleb on the MRI. Andy and I love blebs now. Looking for blebs all the time. Looking for blebs here.

Looking for blebs there. Looking for blebs everywhere. No bleb. Just a hole. Totally invisible on MRI. And it was a pretty big one. And this is what I mean by the edges are epithelialized. This hole is not some friable edge thing that's trying to heal. This thing has healed in the open configuration. This is one of the things that is a challenge for us.

We have to figure out how to find this. And I think the hint on how to find this is here. Intravasation. All right? This is the opposite of a myelogram. Contrast injected in the epidural space is finding its way through the hole into the intrathecal space, and we are just starting to scratch the surface of this intravasation.

This is going to, I think, be a useful tool for us to figure out when somebody has one of these little holes. Interestingly, that was a huge hole, and this showed up really early, but for those from other institutions who might be inclined to look for this, what we found is actually delayed imaging, four minutes after you've injected the contrast on the epidural space, eight minutes later, that may be when you see most of your intravasation.

So we're playing with that at Stanford. Hopefully have more to talk about with that. Alright, so again, a properly done epidural blood side patch may not cover that defect, or it may cover it, but just totally fail to seal it. I put fibrin glue over that. She was better for about 48-hours. It was so short that we were almost not convinced that she really had a leak there because I had in my head up until this case that if I put fibrin glue over a leak, they're going to definitely be better for a week or two.

She was better for like 24, 48-hours. And then, just goes to show how big her hole was. Simply repeating that patch is unlikely to help. So you gotta, you have to figure out some way of getting positive imaging of that. Failure point four is the bleb. Alright, the bleb. This was the first bleb that I ever found.

It was in a young student who had developed a nerve pain problem in her legs, the pain clinic had put a spinal cord stimulator in, she had a known accidental dural puncture when the stim was getting put in, they offered her a patch, she got a patch, she was fine for six weeks, six weeks afterwards she started having terrible headaches and nausea.

And these were not attributed to the previous puncture, which was six weeks earlier. These were attributed to her nerve pain problem. I'm vomiting because my pain's so bad. And it took us several myelograms to find that little bleb. That's the spinal cord stim lead next to it. That's the bleb, full of contrast.

And that's what it looks like at surgery, that little potato bug looking thing, which then gets sewed up. And she has now gone to med school and is interested in going into pain to help people with leaks. So, if you've got a bleb, again, you may cover but not seal the defect. Patient may feel better and then recur. You've got to try and find that bleb, and there is, it's interesting, we don't have any real data, what percentage of these blebs get long term relief from a patch, what percentage are going to require surgery to fix them, um, and then I, we've had other people talk about CSF-venous fistulas, at this point our understanding is it's a kind of leak, that a blood patch doesn't really fix.

Transforaminal fibrin patch at the site of the fistula, maybe yes, but blood patches may not really do much for this group. And then there's this idea that in some people with a leak, and this may have been, this may be part of what complicates trying to treat some of these blebs. There's, I've heard, I don't know if it's Dr. Lennarson's experience, but Schievink and Jürgen Beck have talked about dissecting down to where the bleb is and finding some new kind of membrane that is over the bleb, that is outside the dura, and they think that when we're trying to patch it, sometimes we're just on the wrong side of this membrane.

And they have to dissect that membrane off to actually repair the dura. So, lots of reasons why a blood patch might not work. And yet, sometimes, these things work. And so, that's the basics of epidural blood patches and why they might not work. Understanding these limitations can help shape your response and lead you to having what we call in medicine a differential diagnosis.

Not, Oh, the patch worked or it didn't work, but having a differential diagnosis for when the patch doesn't work. It doesn't mean that they're not leaking. It can mean all kinds of things. It's nuanced, just like everything else. And with that, I'll wrap it up. Thank you.