SCOTT HANSEN: I do general plastic surgery. And I do a lot of hand surgery as well. And I just looked at my schedule for next week. I think I'm doing three or four spine closures next week. So it's been a lot of volume for us.

My only disclosure. So what's the background? I think we all understand the background here. These complex patients, especially the ones that are coming to UCSF, have a very high incidence of complications. And I think towards the end of my talk, I'll talk a little bit about maybe some preventative things that we're doing to not get to this position. But this is what we're up against.

The etiology, as we all know, trauma, infection, I think the more common one that I'm seeing is post-operative wound dehiscence, radiation, patients who had tumor resections, pressure ulcers, and burns, all of which make the reconstruction very difficult. But our goals of reconstruction and plastic surgery in general are really to protect the underlying vital structures and provide stable soft tissue closure. The muscles-- all of these are-- some of which that we're using superficial, intermediate, and deep-- we generally use the superficial or intermediate muscles for reconstruction. And if I'm in the deep muscles, then something's gone wrong.

Superficial muscles-- the trapezius is one of our workhorses for reconstruction. Innervated by the spinal accessory nerve, it elevates the scapula and externally rotates the arm, along with the other superficial muscle, the latissimus muscle, another big workhorse for us in plastic surgery. It inserts in the proximal humerus, innervated by the thoracodorsal nerve. And its action is to extend, adduct, and medially rotate the arm. And this is important, too, because now as we get more involved with the spine surgeons, a lot of these patients are actually seeing me preoperatively now, which is nice, because I can talk to them about the different things I may use and some of the post-operative things they may experience if I use one of their bigger muscles for reconstruction.

The rhomboid major and minor, really just kind of for completeness sake, are not muscles that I routinely use for spine reconstruction. Now, the workhorse in the mid portion of the spine obviously are the paraspinous muscles. They're situated posterolaterally to the spinal column, between the spinous processes and the costal angle of the ribs.

They have a common tendinous origin. They arise from the lower thoracic lumbar vertebrae, sacrum, and thoracodorsal fascia and kind of fan out laterally. And again, the deep muscles of which, again, if I'm down here, then something has gone very wrong.

The superficial fascia of the back is continuous with the Scarpa's fascia. The thoracolumbar fascia is kind of an investing fascia. And you can see how this fascia invests the muscles of the back, the paraspinous muscles along the anterior, middle, and posterior layer and how they flare out. And that's important to us, too, because as we're mobilizing these muscles and releasing this fascia, this is part of the way that we closed these spine wounds as I'll show you here in a few minutes.

So our standard patient population-- usually open wound plus or minus exposed hardware. The hardware comes in various shapes and sizes. Patients can present with dural tears, CSF leaks. Imaging, which is obviously done by the spine surgeons evaluating the hardware-- it's usually always immediately deep to or in our wounds that we're dealing with, which provides a more challenging situation.

Now, the patient factors, and I'm sure across the country they're no different than UCSF, but our patients really have a lot of issues with nutrition, obesity, radiation history, underlying osteomyelitis or bony infections, and then multiple previous procedures. So the timing-- usually it's kind of a mixed bag. If we get these early, we can debride the non-viable tissues and with negative cultures and again with the spine team, who's obviously making these calls regarding the preservation of hardware, if we can get to these early, versus doing these in subacute or chronic stage, greater than six weeks out, which they come to us frequently as well. At that point, we have bacterial colonization of hardware usually necessitating hardware removal and a bigger dissection and a bigger dead space and more need for a muscle flap reconstruction.

So the treatment principles-- it's debridement, debridement, debridement. I think every time that we have trouble or we do a closure and we have a failure or a complication or the wound breaks down again, it's almost always because of inadequate debridement. Culture-directed antibiotics prior to definitive coverage is really important. Spinal fusion-- obviously, if that decision's made by the spinal surgeon, it can render the paraspinous muscles more expendable for my elevation and kind of mobilization to get them to cover the wound.

Then the wound assessment-- in plastic surgery, we really try to look at the wound, the wound type, what tissues are missing, how deep is the wound, the zone of injury, systemic host factors, and donor tissue availability. And as I alluded to earlier, there's numerous risk factors here. And oftentimes patients come with three, four, or five of these in our patient population. And we know that patients with one or more of these risk factors, now the complication rates are exceeding 40%.

So the reconstructive options-- I really try to think of every case from the simple-- especially as I get more gray hair, I try to keep it down on the lower end of the ladder, the more simple ways. But then we can move up the reconstructive ladder, as we call it, to more complicated tissue transfers or even sometimes free tissue transfer. Negative pressure has also been an additive to our practice. I'm sure you guys are using it a lot as well, which has kind of helped us in our reconstructive tool box.

So secondary closure, local wound care-- these are simple wounds. There's no exposed hardware. You can do wet-to-dry dressings or negative pressure, the dressing changes and allow the wound to heal by secondary intention. The second easiest thing would just be primary closure. Again, a simple wound-- just the wound margins are debrided, enclosed primarily.

Skin grafting I just put in here for completeness sake. But again, in the back, we generally never really use skin grafting. It has a high failure rate. And it obviously doesn't provide good durable tissue over any hardware of any sort.

Tissue expansion is something, again, that we use sparingly. But again, if we have a massive loss of skin, sometimes we can use tissue expansion to gain more skin to advance that over the midline portion of the back. Just an example of a simple case a patient again, with multiple comorbidities who had both an anterior and posterior spinal approach. You can see she was also on steroids. The wounds broke down. We debrided, got to good healthy tissue, and then closed it simply.

Now, when we're talking about those bigger wounds, bigger dead spaces, then muscle flaps are really the gold standard. And you can see-- and I'll go through each of these. You can see the different areas of the cervical, thoracic, and lumbar and sacral spines where these flaps come in handy if you need soft tissue coverage in those areas.

The upper portion, as you see on the upper left-- you can see that the trapezius and latissimus flaps are ideal for those areas. The mid-portion of the back, the paraspinous muscles really are the gold standard. The second-line treatment there could be the latissimus muscle. And then as we get down in the lower portion of the spine, that's actually probably the hardest area for us to reconstruct. And we can use turnover latissimus flaps or gluteal flaps to get coverage in that area. And I'll show you examples of those.

So the paraspinous muscles-- again, the segmental muscle-- they get blood supply from the dorsal segmental aortic branches. They're perfect for midline defects, high thoracic to low lumbar. The cervical regions, they taper out. And they're not that robust to close any wound in that area. They have medial and lateral perforators. And that's important as I show you how we elevate this flap.

And then when we're doing our dissection, especially when we're using paraspinous muscles, we try to keep the trapezius, latissimus, and serratus-- really attach that overlying skin, because that's the muscle that are supplying perforators to the overlying skin that keeps overlying skin alive, because at the end of the day, we want to minimize our dissection through that area to maintain perfusion to the overlying skin. And we can do paraspinous muscle flaps. And again, this is better in cartoon, because you can't really see-- appreciate this in real cases.

But you can either advance it-- you can see how we can mobilize the muscle. And we can release the fascia laterally to advance the muscle to the midline. Now, doing it this way, we maintain the lateral perforating vessels to the muscle. And again, as you can see from the-- is there a pointer up here? I don't know.

SPEAKER 1: [INAUDIBLE]

SCOTT HANSEN: Oh yes, I'm sorry. You can see here, when we're elevating the skin, if we see perforators, we try to maintain those perforators to keep the overlying skin well-perfused, because some of the complications we get into is if we do too much of a dissection, we lose that skin. Then we can extend those flaps nicely to provide good, stable midline coverage. And here's just a clinical example of elevating the paraspinous muscle, getting good advancement and muscle over the hardware.

So we can use paraspinous as a turnover muscle. I don't do this as much. But again, the same dissection anteriorly, you have to take the perforating blood vessels to the skin, which is why I don't use this as often. You can go down and then release the muscle, unfurl the muscle, and roll the muscle towards the midline for stable closure.

Here is an example of a patient who had hardware infection. He came in at a chronic phase, multiple draining sinus tracts. The wound is debrided nicely. We mobilized the paraspinous muscles on both sides and bring those together. I used an 0 PDS interrupted figure of eight to bring the muscle together in the midline and then debride all the sinus tracts and then do a multiple layered closure, usually maybe three to four additional layers over that for closure over drains.

As I mentioned, the latissimus muscle is a muscle that we use kind of sparingly only if the paraspinous muscles are not working for us. You can use the latissimus muscle as a muscle only or use it with a skin island as well. It's a type 5 flap.

In plastic surgery, we've labeled all the flaps. Actually, the work was done at UCSF looking at the blood supply to the flap. So you can use latissimus muscle based on its primary blood supply, which is the thoracodorsal artery, or you can elevate the muscle based on its secondary segmental perforating branches from the intercostal and lumbar perforators. And I'll show you how we do that.

So again, you can use the latissimus muscle for lower cervical, thoracic, lumbar defects. These are the larger defects, 10 to 12 centimeters in length. It is a second-line option, as I mentioned. Again, it is also optimal for non-fused spinal wounds, radiation to erector spinae muscles. You can advance it thoracodorsal or use it as a turnover flap for lower defects.

Now, when we use a turnover flap, we separate the primary blood supply, which is a thoracodorsal. And then we can rotate the flap down based on those intercostal perforators, being careful to save those perforators. And you can see that over here. We say those-- those vessels are about 5 centimeters out from the spine. So we look for those, maintain those, because that's going to provide all the blood supply to our flap.

An example of which, again, these lower spinal defects-- here, we elevate the latissimus dorsi musculocutaneous flap, so with a skin island, we can elevate that flap and then rotate it down to the lower portion of the spine. Another good example, we designed these skin islands perpendicular so we can close them. This skin island is designed right over the latissimus muscle. We maintain that blood supply between the skin island and latissimus flap, elevate that, and can rotate into the defect nicely.

The trapezius is a great muscle for the upper portion of the spine, the cervical spine. We use this one quite often actually. We can use-- again, use this as a muscle flap or a flap with a skin island as well. It's a type II flap and has a dominant transverse cervical artery as its blood supply, which is 99% of the time how we rotate this muscle and keep the muscle alive.

Again, we use it for those high cervical wounds where the paraspinous muscles have limited mobility and size. We can rotate it to that area or advance it into that area. And so we elevate the muscle off the paraspinous and rhomboid muscles. And then when we designed the skin island, as you can see in this cartoon, we want to make sure we keep that skin island designed over the muscle. You can extend it a little bit over the muscle by about a centimeter or so, but you risk losing part of that skin due to lack of blood supply if you create it too much over the edge of the muscle.

Here's an example of how we'd use the trapezius muscle as an advancement flap. We can mobilize the trapezius muscle on either side of this wound and bring it over and get nice, stable coverage over the hardware. As a skin paddle, again, here's a patient who has a tumor on the spine. It's been resected. And now we can design our trapezius musculocutaneous flap, again rotate that flap up to the defect, covering the defect nicely.

You can use trapezius without skin. Here's an example of a high cervical wound. After the spine team is now complete, we have this big defect with a patch. We design our incisions.

We bring the trapezius muscle. We divide it from the spine of the scapula, acromion, and from the clavicle. We can rotate the muscle. There's the muscle mobilized just based on its blood supply now. We can rotate that muscle up nicely into that defect and provide nice, stable coverage and close the wound directly.

Another example of a cervical wound. Again, we designed our trapezius flap, skin island only. Elevate the skin island. In this case, we didn't make the bigger incision. We did this kind of minimally invasively by elevating the skin off the muscle, elevating the muscle, and rotating it into the defect.

Now, for the lower portion of the spine, it becomes very difficult. We can use a perforator flap based on the gluteus muscle. This is a fancy flap where we can actually Doppler out the superior gluteal artery and then design a skin flap around the superior gluteal artery, elevate that skin based on that blood supply, and then rotate that into the defect, because again, there's not a lot of local tissues that you can use to get into that defect.

As I mentioned earlier, tissue expansion-- we can use these, again, sparingly. I use these in my practice sometimes with, like, congenital melanocytic nevi. We can expand skin locally over the course of several years to expand skin to remove that skin that has a higher chance of melanoma.

Incisional negative pressure has been a big part of our practice. Is anybody in the room using incisional negative pressure regularly on their spine wounds? A couple people. Yeah.

So we use it a lot in both spine surgery and vascular wounds. And there's been a lot of great data out there actually of late, level one data showing the usefulness of negative pressure. Back 10 years ago, we were using regular wound VACs and were actually cutting the wound VACs into incisional size and using standard wound VACs.

Now, we have companies-- I'm not married to either one of them. But there's a couple companies out there who we get incisional negative-pressure devices from. We can place these on those higher risk wounds. And you can see, sometimes we can use it in a bigger fashion, the whole zone of injury, dead space where we can kind of compress that wound, or just use it right over the incision itself.

Here's one of our cases from recently, how we used incisional negative pressure. We closed the wound in the standard fashion. After we do our interrupted nylon sutures in the skin, we apply our negative pressure dressing to the back. And then we keep it on there for approximately five to seven days postoperatively.

Looking in your literature, the spine literature, there has been a few studies out there, this one showing a 50% decrease in the reduction of dehiscence using incisional negative pressure and a significant reduction in surgical site infections by 10 versus 14%. So that was significant. So dropping the infections and reducing the dehiscence rates. And that's the same literature in the vascular literature showing a 50% decrease in dehiscence rates.

And then lastly, free flap coverage, which we try not to do. But if we cannot find any local tissues at all or the defect is too big, then we basically have to find a muscle. Here, I've given examples of a rectus muscle or a lateral thigh flap where we can just transplant into the area. The back is a very difficult area in that there's not a lot of receptor vessels. And so we have to oftentimes use vein grafts or loop grafts to get into that area to kind of supply our free flap.

Here's a case I did a few years ago. I don't know if this is [INAUDIBLE] case or not. But this is a very complicated patient who had multiple spine surgeries. And we were left with a huge defect and really had no options to salvage. The hardware had to stay in there.

And so I came up with a thought like, well, what if I take latissimus muscle. And I know that I can't turn it down there and it wouldn't reach. So I took the latissimus-- I elevated the latissimus muscle off its primary pedicle. I then did a loop-- a vein-- a loop graft there. And then I detached the latissimus muscle, then reattached it to my loop graft and basically slid the latissimus muscle down the back with a skin island to provide stable coverage of the hardware in the wound.

So as I mentioned at the start of the talk, how do we avoid the disasters that I've been showing you? Well, we've really looked at our patients carefully and patients who have previous hardware infections, previous scarring, radiation, CSF leaks. We've really made a point to see these patients a lot earlier and even me see them preoperatively to get involved in their care to help close them up. And we have a much lower complication rate with that algorithm.

Our postop management's no different than probably what you have. I mentioned that we keep our incisional VACs on for five to seven days plus antibiotics, depending on the spine team. We do keep our superficial drains in until they're less than 30 CCs for three consecutive days. I think the spine team tends to pull theirs sooner. But then I see these patients in follow-up. And I manage the drains and the wounds postoperatively.

So this just kind of summarizes what I've talked about in the upper, middle, and lower spine. These are all-- if you think about it in these ways, we can come up with a reconstructive option for each of these areas. Thank you.

[APPLAUSE]