Dr. Ronit Malka:

Hey, everyone. Welcome back to another episode of ENT in a Nutshell. My name is Ronit Malka and today, we'll be discussing midface fractures, specifically Le Fort and zygomaticomaxillary fractures with facial plastic and reconstructive surgeon, Dr. Scott Bevans. Welcome back, Dr. Bevans.

Dr. Scott Bevans:

Hi, Ronit. Thanks for having me again.

Dr. Ronit Malka:

Since relevant midfacial anatomy is so critical to understanding patient presentation, we're going to deviate from the usual outline a bit and discuss this first. Could you briefly review the normal facial skeletal structures that are typically involved in Le Fort and ZMC fractures?

Dr. Scott Bevans:

Of course, they say a picture is worth a thousand words, so I guess that means we're going to be using a thousand words to talk about this. But if you have the chance, I'd recommend just pulling one up on a computer because the picture is really helpful. What we'll do is just talk through if you can imagine a picture of a skull, and the picture I have in my mind has all the little colored bones that are labeled.

Dr. Scott Bevans:

The maxilla, which is the most inferior bone, holds all the teeth. That's obvious. What we tend to forget is that it extends medially. It extends all the way up to the medial orbital wall. It articulates with the nasal bones and the frontal bone there, and then posteriorly inside the orbit, it articulates with the lacrimal bone with lacrimal sacs. Laterally, the maxilla articulates with that zygomatic bone. That articulation actually occurs relatively high and lateral, almost in the middle of that malar eminence.

Dr. Scott Bevans:

That leads us to the zygoma. The zygoma is the bone that's providing the anterior projection and the lateral width of the face. Superiorly, it articulates with the frontal bone. We call that suture the zygomaticofrontal suture or ZF suture. If we follow the zygomatic arch around laterally, it's going to meet with the temporal bone and that articulation, of course, we call the zygomaticotemporal suture. If we look at the deep surface of the zygoma along the skull base and in a posterior aspect of the orbit, it articulates with the sphenoid bone and we call that, of course, the zygomaticosphenoid suture or ZS suture.

Dr. Scott Bevans:

Aside from seeing that ZS suture interorbitally or during sinus [inaudible 00:02:11], we don't actually often externally see the sphenoid bone except in drawings and CT scans. But if you pull one up... Actually, I pulled one up last night and my daughters were looking at it and they were like, "Oh, looks like a butterfly, dad. It's got all these wings and holes." In fact, almost everything on the sphenoid is labeled a wing and I'll explain that. You got the lesser wing superiorly and the greater wing. The greater wing is what makes up the most of the skull base and it has all the holes that... Well, we know those holes, the foramen ovale and the foramen rotundum. Inferiorly, there are these two smaller wings. If you remember back to Greek, a pterodactyl, that P-T prefix, that's Greek for wing. Those two small wings are actually the pterygoid plates, the medial, lateral pterygoid plates.

Dr. Scott Bevans:

The sphenoid itself houses a whole bunch of important structures. In the region of those pterygoid plates, it articulates back with the maxilla to kind of create this closed circle. In between all of those articulations are, in most cases medially, air containing spaces which kind of creates what effectively becomes a crush zone in the central portion of the face when it comes down to facial trauma.

Dr. Scott Bevans:

Again, those sutures that are in play are the zygomaticofrontal suture, the zygomaticosphenoid suture, the zygomaticotemporal suture and the zygomaticomaxillary suture. Now, those sutures actually are not where all midface fractures occur, though, and I think we'll talk through that more in a little bit.

Dr. Ronit Malka:

Great. Oftentimes, then, a lot of these fractures are involving the orbit as well. Can you speak to a little bit of that?

Dr. Scott Bevans:

So we've kind of marched around the orbital, what I'd call, exoskeleton. But if we look at the internal portion of the orbit, the frontal bone creates the superior orbital rim and then extends along posteriorly to create the orbital roof. Medially, we talked about this, that frontal bar meets the maxilla. As we march posteriorly along the medial orbital wall, we've got that small lacrimal bone and then the thin ethmoid bone that is behind it leading back to the optic foramen. Along the floor of the orbit, most of that is actually the orbital surface of the maxilla and then in the very back, you've got this crest of palantine bone.

Dr. Scott Bevans:

Again, we don't see much of this palantine bone, but the palantine bone is useful because it tends to be really hard and it creates that nice ledge that we want to rest a plate on. And then in the very back of the orbit, the posterior aspect of the orbit, is actually that sphenoid bone which we talked about before. Now, we've talked through all seven of the bones that comprise the orbital cavity. I think when you think through them this way, it's much less intimidating to try and remember them.

Dr. Ronit Malka:

Got it. Thank you so much. We also hear a lot about facial buttresses and their involvement in directing fracture patterns and facial trauma. Could we go over what these different buttresses are and how they relate to normal anatomy?

Dr. Scott Bevans:

A lot of times when we talk about these, we'll separate them into vertical buttresses and horizontal bars. The vertical buttresses are essentially transmitting the force of mastication all the way up to the skull base, helping preserve that midfacial crush zone. The nasomaxillary buttress extends from the maxilla essentially where the canines are superiorly all the way up to that frontal bone. It'll [inaudible 00:05:24] line. It goes around the lateral aspect of the piriform aperture. This tends to be the strongest vertical buttress in the face.

Dr. Scott Bevans:

As we go laterally now, there's a parallel buttress that starts about the region of the premolars or molars and extends vertically from the maxilla up to the zygoma and so we call that the zygomaticomaxillary buttress. And then if you look at the posterior surface of the maxilla, and this is where the force transmitted from the third molars is, that's the pterygomaxillary buttress. So the nasomaxillary buttress, the zygomaticomaxillary buttress and then the pterygomaxillary buttress. Some people consider septum and its articulation with the vomer an unpaired cental buttress. Others talk about the ramus and condyle unit as being another vertical buttress.

Dr. Scott Bevans:

Now, we're going to transition to horizontal bars. Horizontal bars are what establish the midface width and projection. Superiorly, we've got that frontal bar created by the frontal bones, the supraorbital bar. The infraorbital bar is actually almost continuous with the zygomatic arch and so you may hear people refer to them as the infraorbital bar or the zygomatic bar because it tends to wrap all the way around that zygomatic arch from a functional standpoint. The maxillary alveolus is the hard palate and that's the third midface horizontal bar.

Dr. Ronit Malka:

I know you've touched on it a little bit already, but keeping in mind that framework that we've just discussed, how does normal facial skeletal structure impact functional outcomes?

Dr. Scott Bevans:

That's the critical thing, and particularly when we think about our surgical approach to reducing and fixating midface fractures, we really want to be focused as much or more on the functional components. Any time there's a fracture that involves the orbital walls, we have the potential to increase or decrease the orbital volume. That can create hyper or hypoglobus. Globe malposition is how we generally refer to that... which can have other functional effects, diplopia and so on.

Dr. Scott Bevans:

The other big factor at play here is occlusion. Any time there's a maxillary fracture, we have the potential to create malocclusion, and then we can also have a lateral midfacial fracture... And I'm talking really about zygomatic arch fractures or ZMOC fractures... that can then impinge on the muscles of mastication. We didn't spend much time talking about those, but remember that underneath the zygomatic arch, you've got the temporalis muscle that connects down to the coronoid. If you have significant indentation of that zygomatic arch, it doesn't seem like it would have a functional effect but in fact, it may actually impinge on the temporalis muscle or restrict the motion of the coronoid, causing trismus. Those are significant functional aspects of our surgical endeavors.

Dr. Ronit Malka:

Great. Now that we've reviewed normal facial structure, could you discuss the different types of disruptions we see with Le Fort and zygomatic fractures?

Dr. Scott Bevans:

Yeah, and maybe I'll start by talking about zygomaticomaxillary fractures because they're far more common. There are some regional variation, but most midface trauma now is from motor vehicle accidents followed by what some people describe as disorderly conduct, and then there's this category of other injuries, sports injuries, et cetera. Generally, when we see a threat coming, we'll turn out head

to protect ourselves and so you can guess that most of the midface trauma actually occurs to the lateral facial structures.

Dr. Scott Bevans:

We talk a lot about ZMC fractures or ZMOC fractures. These used to be described as tripod fractures. Now, we kind of understand that based on the fracture patterns... Not so much the suture, but the fracture patterns... they include four locations and so we call them tetrapod fractures now. That's the reason why they used to be called tripod fractures, is because when you pull the zygoma out of the body, the articulation with the maxilla, which creates both the inferior orbital rim and that zygomaticomaxillary buttress, they're actually part of the same suture. In isolation, the zygoma looks like a tripod but practically speaking, we don't get a fracture in that suture line. We get a fracture in the inferior orbital rim and the zygomaticomaxillary buttress and so there's actually four points of fracture there.

Dr. Scott Bevans:

If you have a copy of POSHA, for instance, it'll talk about the Zingg classification where type A is isolated to one segment of the zygoma, and then it subcategorizes those whether or not it's the arch, the lateral orbital wall or the inferior orbital rim. Type B are classic tetrapod fractures that involve all four of those processes, and then type C usually has a significant amount of comminution of that zygomatic bone.

Dr. Scott Bevans:

In contrast, Le Fort fractures... And by the way, I think of Le Fort fractures in terms of almost like an elevator of midface mobility. These are usually from an anterior blow. They require a significant force. The bottom of the elevator is going to be a Le Fort I. When you do a maxillectomy or when a patient has a maxillary advancement, these are the same cuts that we would make. They're low cuts. They're just above the maxillary alveolus, involves going through the nasomaxillary buttress, the zygomaticomaxillary buttress and then, of course, the pterygomaxillary buttress. That's usually caused by low, anterior to posterior force.

Dr. Scott Bevans:

A Le Fort II, if you can picture this, is often called a pyramid fracture. The maxilla and nasal complex are separated from the facial skeleton, but they're held intact. That means that the fracture starts laterally, crosses the zygomaticomaxillary buttress and then ascends up into the orbit. There's always an inferior orbital rim fracture and then it crosses through the medial orbital wall. Typically, this is from a force that's directed superiorly against the maxilla or posteriorly along the Frankfort horizontal line.

Dr. Scott Bevans:

A Le Fort II fracture... Now, we're at the top floor of our midface mobility elevator... is total craniofacial dissociation. That's essentially when you get separation of the facial skeleton from the skull. It includes an NOE pattern fracture, and I think we covered those in a separate episode in greater depth. These are high velocity impact and often involve some sort of other skull base or significant sphenoid fracture. This is a straight line. It's drawn through the orbit. You get a ZF suture fracture in addition to that NOE pattern and a pterygoid fracture. In case I didn't specifically mention it, in order to have a Le Fort fracture, you have to have a fracture that extends to the pterygoid plates in order for the midface to be totally mobile.

Dr. Ronit Malka:

Got it. With all that in mind, could you walk us through how a patient with a Le Fort or zygomatic fracture would present?

Dr. Scott Bevans:

Demographics, usually males, again, age 20 to 30 as with most trauma. It's uncommon to have this in kids because the maxillary sinus isn't well pneumatized and so that force is usually transmitted differently and their bones are more flexible. But, as we mentioned, more likely lateral than medial. When you have those lateral blows, those patients will come in with a loss of malar prominence. They may have trismus, as we discussed, from impingement in that temporalis muscle, the coronoid process. They may have a palpable step-off in the inferior orbital rim, and then you can have all the things associate with an orbital fracture, diplopia, enophthalmos, hypoglobus, globe malposition.

Dr. Scott Bevans:

Additionally, a lot of these can involve mucosal surfaces in the inside of the nose so they can present with epistaxis. That might be mitre mucosal trauma or that can be from a concomitant septal fracture or it could be actually from a laceration of the mucosa from a sharp bone at the piriform edge. A lot of these fractures also involve the inferior orbital foramen, which will cause cheek and tooth hypoesthesia.

Dr. Scott Bevans:

For Le Fort fractures, that classic patient presentation is midface retrusion with an anterior open bite. That's from the pull of the lateral medial pterygoid muscles. As that maxilla slides back, there's no buttress that exists in that sagittal plane that prevents the maxilla from telescoping back and so it rocks up anteriorly and you have early contact posteriorly. That's what really creates the open bite that's characteristic in the Le Fort I and Le Fort II fractures.

Dr. Scott Bevans:

In Le Fort III fractures, if you ever see a picture of a patient that has a Le Fort III fracture, you can actually see the entire midface lengthen while the midface projection still sort of falls back in. It'll have decreased nasal projection, decreased malar projection while the whole midface is longer. The most common type of Le Fort fracture is actually a Le Fort II fracture, followed by a Le Fort I and then Le Fort III fractures, although there is some regional variability in reports from various areas of the country.

Dr. Ronit Malka:

There's not much of a differential diagnosis for these patients, but these fractures are in some pretty high real estate regions of the face. What are some comorbid or complicating conditions you're looking for in these types of fractures?

Dr. Scott Bevans:

Well, and this kind of points again to the reason why we have to be systematic and do our complete top of the head to collarbone secondary survey. About a quarter of ZMOC fractures will have other associated injuries, and all of this is periorbital. We have to be really careful about our periorbital examination. Patients can come in with lid swelling but it's still really important to do a thorough ophthalmologic exam. We need to access binocular and monocular vision. We need to make sure their pupil is round, there's no blood in the anterior chamber, and like any orbital wall fracture, I'm getting

ophthalmology consults on all these folks just to make sure that they don't have some vitreal or retinal pathology that I can't see just on a naked eye examination that I could make worse by putting pressure on the globe.

Dr. Scott Bevans:

We want to be careful to look also for NOE fractures. Specifically, that means just look at the medial canthal angle. Even though these patients are swollen, it's really uncommon to lose the sharp angle of definition at the medial canthus just from swelling. If you see a blunted medial canthal angle, that's a big red flag. Even on radiology examinations, sometimes, depending on the type of medial canthal disruption, that may not be visible so we have to catch that. Again, just encouragement. Put on gloves, do your full top of the head to the collarbone examination.

Dr. Scott Bevans:

The other one that we've already spoken about is this is really, really commonly involving the infraorbital nerve and so we want to do a good job checking our sensation, both sensation of the cheek as well as the dental sensation. And then because the central nasal structures may be involved, we also want to make sure that there's not a septal fracture or septal hematoma which, if we decide to delay intervention on, could cause a serious threat to the septal cartilage.

Dr. Scott Bevans:

Finally, we've mentioned a bit you get the sense epistaxis is going to be a big part of this. Often in these patients, we have to do some intervention before we get very far into the examination, even leading up to nasal packing. But we need to screen a couple of the arteries that run through the maxilla and most of the time, if you get significant bleeding, it's just from mucosal injury. But every once in a while, you can actually have an injury to the sphenopalatine artery or even, in a super rare circumstance, to the carotid artery.

Dr. Scott Bevans:

I can tell you, actually, a story about a young female who came in after an orthognathic surgery, a Le Fort I osteotomy, with this recurring massive nasal hemorrhage. It turns out that you can get hemorrhage like that from a pseudoaneurysm. In her case, she didn't have a pseudoaneurysm. She had a lacerated sphenopalatine artery, but that's something that we sometimes have to endoscopically clip.

Dr. Scott Bevans:

And then finally, there's the dental portion of the maxillary alveolus so we need to screen for dental damage. That might mean that there's a subluxed tooth, periodontal damage with loosening of the tooth but it's still sort of in the socket, or even luxation where the supporting structures of the tooth have damage enough to allow it to loosen. We want to know that before we intubate the patient and then also to help kind of plan our surgical approach to treat that.

Dr. Scott Bevans:

I should mention one more thing, and I think we'll talk about imaging in just a moment, but we also want to be a little bit wary of unilateral Le Fort fractures. A unilateral Le Fort fracture means that there has to be some sort of [inaudible 00:17:08] split to allow one side of the midface to mobilize so much. In those patients, I'm looking specifically for a palatal fracture. A palatal fracture is easy to miss, but it'll make it difficult to get the occlusion stable if I don't address that during a surgical intervention.

Dr. Ronit Malka:

All right. What other imaging or lab studies would you be considering in a patient with these fracture patterns, and what specifically would you be looking for in these studies?

Dr. Scott Bevans:

A lot of times, by the time we see that patient, we've already gotten a CT face, but that's kind of what you need. That's the mainstay of imaging, a one millimeter cut CT which allows us to look at all three views. We need to check all three views because that axial plane is going to show you the facial width and allow you to scroll through the pterygoid plates, see how much space the coronoid has underneath the zygomatic arch. The coronal view is where we're going to be able to evaluate the nasal aperture and the orbital exoskeleton, the orbital volume. The sagittal planes, again, allow us to look at the midface projection and make sure that it's symmetric on both sides.

Dr. Scott Bevans:

This is another case where I'm a big fan of 3D reconstructions. They allow us to get a good snapshot which nicely characterizes the degree of rotation, for instance in ZMOC fractures, that we'll need to address intraoperatively, and we can communicate effectively with the patient.

Dr. Scott Bevans:

And then I mentioned before if a patient has significant epistaxis on presentation, then we may need to even think about doing a CT angio. And there's another indication. If you have a patient with a Le Fort III fracture, a total craniofacial dissociation, that requires such a significant mechanism in force transmission that we probably need to consider getting a CTA in those patients as well.

Dr. Ronit Malka:

What are your indications for taking these patients back to the operating room?

Dr. Scott Bevans:

In general, what we want to establish is return to normal form and function and so we think about the metrics that we use to evaluate that. Is their occlusion stable? Do they have malocclusion? This is often tricky because the sensation is almost always disturbed in these fracture patterns because of involvement of the infraorbital nerve or the pterygopalatine fossa. The sensitivity of the periodontal ligament is what tells the patient whether or not they're having malocclusion. It can perceive a human hair between the teeth.

Dr. Scott Bevans:

Now, if that sensation is totally shot because of an injury, it's definitely going to alter their sensation of occlusion. But, objectively also, we can see whether or not they have trismus, whether or not there's impingement on the temporalis muscle or the coronoid process. Obviously, malocclusion can be influenced by presence of a palatal fracture that needs to be stabilized.

Dr. Scott Bevans:

And then there's this form aspect. Is there a facial aesthetic change, malar flattening or facial widening or even shortening of the midface? The bottom line, we'll repeat this over and over again, is if there's involvement of any of the vertical buttresses, we really have a low threshold to intervene operatively.

Dr. Ronit Malka:

All right. Broadly speaking, what are some of the treatment options for these fractures?

Dr. Scott Bevans:

There is conservative management and there's open reduction internal fixation. When we say conservative management, it doesn't that we're not intervening. There's the observation category and for those patients, we're talking about patients that really have non-displaced or less than a millimeter of displacement and their fractures are totally stable. They don't need any intervention. For those patients, pain is going to limit their activity. But, remember that the maxilla and the vertical buttresses are transmitting the force of mastication up through their skull. If there's any mobility to the maxilla, every time a patient tries to eat something, they're going to risk displacing those fractures. The tendency will be for the maxilla to contract vertically and leaving them with an anterior open bite.

Dr. Scott Bevans:

Again, we have a low threshold to go in and plate those vertical buttresses. Or, conservative may mean not observation but that we're going to do something under local anesthesia. Here, we're talking about closed reduction. When it comes to midfacial fractures, we're really only using this for isolated zygomatic arch fractures and maybe palatal fractures. With those arch fractures, the technique that I'm referring to more commonly now is a suture reduction technique, which I hadn't used or one of my residents taught me about it but essentially, you use a big 2-0 or even 0 Prolene suture and under local anesthesia, you're passing a couple of those sutures deep to the fractured portion of the zygomatic arch. Then, you put lateral traction on those sutures and you can pop that bone into place and you can even use an ultrasound to verify that it's reduced. You can stabilize that with a Fox Eye Shield or with an Aquaplast splint.

Dr. Scott Bevans:

Similarly, for isolated palatal fractures, if the teeth are stable, we can use them to manipulate, to reduce and then to fixate the fractures. Either you're using an Erich arch bar or by using dental brackets. Just as a reminder, if the teeth are at all mobile, we should not try to put a wire around them because as we tighten that wire, the teeth will pop right out. In those cases, generally, I need to have our OMFS colleagues bond a bracket to the tooth and then place a dental wire to reestablish the maxillary arch.

Dr. Scott Bevans:

I have, in a pinch, twisted a 24 gauge wire and then tried to dermabond it to the teeth. You can have mixed success with that, really, if you don't have access to one of your oral surgery professionals. Or, I guess you can manufacture a poor man's palatal splint either using an Aquaplast splint or acrylic like using a Gunning splint. But again, those can sometimes be less ideal than the elaborate splints that the OMFS service can make and attach to the stable dentition. Those are examples of closed reduction without internal fixation. But again, for the majority of patients, we're going to do some element of reduction with internal fixation.

Dr. Ronit Malka:

When you're considering operating on a patient with a Le Fort or a zygomatic fracture, what time frame are you usually thinking about for getting them back to the OR?

Dr. Scott Bevans:

Operative intervention ideally occurs in the first 24 to 48 hours before their swelling is really significant or after it started to resolve in 10 to 14 days. It's really ideal if their swelling has resolved enough that we can visually align these bones, but not so long that a fibrous union has started to form. That usually happens in the 10 to 14-day window.

Dr. Scott Bevans:

Again, that's not super rigid. It's not a deal-breaker because we can use an osteotome and slide it into those fracture sites. But in the process, most of the time you'll make the fracture a little bit bigger. If there's really significant, what I call, facial smash, we'll sometimes go in and fix the exoskeleton first and get the exoskeleton in place and then come back in a week or two for any more refined orbital wall reconstruction. That way, we can get the exoskeleton in the right place while things are still mobile.

Dr. Ronit Malka:

Got it. That makes sense. The treatment options for these different types of fractures, as you mentioned, can vary considerably. If you are going to the operating room... Let's start with zygomatic arch fractures first... how would you approach those?

Dr. Scott Bevans:

And by the way, the AO Surgery Reference online, AOCMF Surgical Reference, it covers all these options really well. It was some really helpful pictures on it so I'd recommend using that if you're headed towards the operating room. But to answer your question, for zygomatic arch fractures, there's kind of two classically described approaches, the Keen, which is a transoral approach, or the Gillies, which is a transtemporal incision.

Dr. Scott Bevans:

I always had trouble remembering these when I was in residency so just remember that the Gillies incision is in the same place like the gills on a fish. It's out by the ear. In that Gillies incision, you go down to the temporalis muscle so that you're deep to the deep layer of the temporal fascia. Protects the frontal branch of the facial nerve where it crosses the zygoma. There's a couple different ways to do that but essentially, you make a two-centimeter beveled incision one inch above and one inch anterior to the helical root, [inaudible 00:25:03] your cut down to the muscle and that'll put you superior to the anterior branch of the superficial temporal artery and then just slide underneath that fascia down to the zygoma.

Dr. Scott Bevans:

As a side bar, I've got this old Le Ray surgical textbook that was published in the 1960s when they were still using wires to fixate all these facial fractures. They illustrate this Gillies approach and then there's this little asterisk down there and these cautions and it says, "Don't fulcrum off the skull and fracture it." That's just a reminder to us that you have to pull pretty hard on this. For that reason, sometimes you have to use a more direct approach. By that, what I'm really talking about is a percutaneous approach.

Dr. Ronit Malka:

What additional approaches would you be considering for a ZMOC fracture?

Dr. Scott Bevans:

In contrast to a zygomatic arch, normally for a ZMOC fracture, at minimum, we're going to need to expose a couple of the fracture sites to look at them directly for adequate reduction, and then we also have to have enough exposure to be able to control the zygoma to actually achieve this reduction. Commonly speaking, you're going to use a gingivobuccal sulcus incision and at least one or two periorbital approaches. The two periorbital approaches I most commonly use are a lateral bleph incision... That takes me down to the zygomaticofrontal suture... and an inferior fornix incision, which transconj approach which takes me down to the inferior orbital rim.

Dr. Scott Bevans:

That lateral bleph incision, it hides super well. It's a horizontal incision and then you can cut vertically straight down to the ZF suture. We used to advocate for making an incision in the brow, but I'll tell you that it's almost always visible and so we just don't advocate for that anymore.

Dr. Scott Bevans:

For that transconj incision, remember that the more medial you need to go along the inferior orbital rim, the more lateral release that you need. By that, I mean that if the fracture is medial to the infraorbital foramen, you should be thinking about or prepared to cut the canthus. Cutting the canthus is not rocket science. I assure you that you can sew it nicely back together again. But the flip side is that I've tried transconjunctival approaches to the inferior orbital rim and ended up putting enough traction on the lower lid in order to achieve perpendicular exposure for screw placement, that I've torn it. When you tear the lower lid, the weakest point is actually at the inferior canalicular system. The repair for that often involves a minoca stent or a Jones tube and an oculoplastics consult. The bottom line is you want to avoid that if you can.

Dr. Scott Bevans:

With that combination of incisions, with transoral and periorbital incisions, there are a few different ways that we can control the rotation of the zygoma while generating the kind of force that we need to reduce it. Sometimes, you can just use a Kocher clamp on the lateral orbital rim and grip that one point then use a Boies elevator, a Gillies elevator, hooked underneath the zygomatic arch, the transoral incision.

Dr. Scott Bevans:

But even with these two points, it can be difficult to both generate enough force and control the rotation. Another option that we talk about is a Carroll-Girard screw. That's a long screw that you place in the body of the zygoma. However, again, unless we've done an extended canthotomy cantholysis and really separated that lower eyelid, it can be difficult to actually get that screw in place unless you do a percutaneous approach. There's been a couple of times that I've actually broken off a Carroll-Girard screw trying to move that bone.

Dr. Scott Bevans:

There's this alternative approach that I first learned in Fellowship. I was taught by Kris Moe while I was at [inaudible 00:28:23], and it's to use this bone hook. The bone hook is actually an orthopedic bone hook that now I call the BABH, standing for the big arse bone hook. You make this little tiny skin incision just below the junction of the horizontal zygomatic arch and the vertical zygomaticomaxillary buttress. You make that incision parallel to the relaxed skin tension line, essentially in a smile line, and you go only through the skin about the width of the 15 blade, then you engage this BABH so that it's pointing

across the face. The handle's going across the face to the contralateral eye. As you rotate it up into a vertical position, you'll catch the body of the zygoma right at this crotch where that zygomatic bone is the strongest, which is what you need.

Dr. Scott Bevans:

While I've got the BABH in one hand, I've got my non-dominant hand actually kind of pushing the head down and bracing this fragment so as I pull it anteriorly, I don't over reduce it when it starts to mobilize. That technique actually gives me enough force to make the anterior pull that I need to disimpact the zygoma as well as gives me a vector for superior rotation and medial rotation, which I'm going to need to reduce those fractures. As I'm doing all this, of course, I'm looking through all these little access points to make sure that the fractures are reducing in all those locations.

Dr. Scott Bevans:

Then once everything is lined up, I'll slide down the medial surface of the lateral orbital wall and check the zygomaticosphenoid suture alignment. This is a super, super helpful visualization. This confirms that the rotation of the zygoma is going to be correct for me. Now, you can imagine that the amount of force that you're putting on the exoskeleton is significant. Sometimes as you're disimpacting the ZMOC, the orbital floor, and even lateral orbital wall, can totally unzip. You can take a patient that has what looks like a nonoperative floor fracture and you may make it operative because we increase the orbital volume by disimpacting the zygoma.

Dr. Scott Bevans:

And there's a debate about when you should intervene, whether you should wait and see if the patient is going to become symptomatic from that change in orbital volume, but I would just say at a minimum, if the patient before the surgery has any element of enophthalmos or hypoglobus, and we haven't reduced that ZMOC, we should be ready probably to do that orbital floor recon at the time of our surgery.

Dr. Ronit Malka:

Great. Once you have put in the gargantuan effort to achieve reduction, how many points of fixation do you actually need?

Dr. Scott Bevans:

This is debatable, too. We've confirmed that reduction on the ZS alignment and we got the zygomaticofrontal suture exposed right there. There are some people that say you can just put a single mini plate on that ZF suture. That single point of fixation, that's probably not the standard of care. We usually aim for getting at least two to three points of fixation.

Dr. Scott Bevans:

The easiest ones to access are the zygomaticofrontal suture and the zygomaticomaxillary buttress. As long as you got the exposure in those two locations, I'm putting mini plates on both of those spots. Now, I've also got the inferior orbital rim exposed. As long as I'm mindful of the tension that I'm placing on that lower eyelid, it's a really low morbidity process to put one additional mini plate on that inferior orbital rim.

Dr. Ronit Malka:

In a similar vein, when you're approaching a Le Fort fracture, how would your surgical approach be different?

Dr. Scott Bevans:

That's a great question because there's a couple of key differences. The first one is our airway plan. For almost all these fractures, we're going to need to assess not only the nasal passage, but more importantly, even, the occlusion. My experience has been that sometimes, there's enough room in the retromolar trigone to accommodate an oral endotracheal tube. I know this because usually with their mouth closed, I can slide my finger in the retromolar trigone around the maxilla with their mouth closed.

Dr. Scott Bevans:

If that's the case, I can use an oral tracheal intubation. If I have any concern about that, then we can move to a nasotracheal intubation. Again, most of the time here, even though we have some work to do on the nose, we can work around a nasotracheal tube. Alternatively, if the patient has a panfacial fracture, or I'm going to need to do a significant amount of mobilization, or they have a bad skull base injury, or I'm concerned for carotid dissection, then I'll just have them orally tracheally intubated and I'll convert that to a submental intubation or a temporary tracheostomy tube.

Dr. Scott Bevans:

The actual surgical approaches, in terms of incisions, are actually fairly similar, though. They're extended. You're often going to make a bilateral gingivobuccal sulcus incision or extend your transconjunctival incision both laterally and/or medially, depending on the exposure that you need. But at minimum, we're going to need intraoral exposure and periorbital exposure, likely through a transconj or maybe even a subciliary approach.

Dr. Scott Bevans:

Here, again, the critical step of the entire surgery is to mobilize the midface and reestablish occlusion and orbital volume, and make sure our reduction is correct. For the mobilization, in this case, there are these big disimpaction forceps called the Rowe disimpaction forceps. They look a little bit like this big medieval torture instrument. There's a curve. The handles on one curve to the left and the handles on the other curve to the right. There's this large notch that goes around the teeth and articulates with the maxilla and then a flat side of these forceps that goes in the nasal passage. You have to put both of those in and again, you can do this most of the time around an endotracheal tube that's in the nose, but we're going to grab the left and the right side of the maxilla and then with the head stabilized, we're going to need to disimpact the maxilla down and anteriorly.

Dr. Scott Bevans:

I'll just warn you, as you imagine, there's big blood vessels flowing right next to where we're going to be moving the maxilla. It's possible for us to make patients bleed in this process, but we have to be able to mobilize it down and anterior. Again, the other big difference is now that the maxilla is mobilized, in all these Le Fort fractures, we're going to need to reestablish the occlusion. Once we move it, we're going to lock them into occlusion. We can either use IMF screws or interdental fixation or Erich arch bars to lock the mandible down to the maxilla. When we reduce the rest of the fractures, we're going to use the maxilla and the mandible and move them as one unit until we get all those fractures perfectly aligned.

Dr. Scott Bevans:

The other big difference, and I would just say I know we're going to talk about NOE fractures in a different podcast, but we need to be wary of these, especially when we have a Le Fort II or a Le Fort III fracture because again, this is the time to address those, and we want to address them while we have this surgical exposure. I should mention, also, that sometimes, these midface fractures can be more comminutive than just ZMOC fractures. If there's more than four to five millimeters of gaposis on a horizontal bar or a vertical buttress, and I'm really confident that my reduction is good, then I'm going to need to use some bone grafts in here.

Dr. Scott Bevans:

For panfacial fractures or significant comminution associated with Le Fort fractures, I'll consent all these patients to use a parietal bone graft unless they have a contraindication. In general, the midface is well enough vascularized that I can fixate a monocortical bone graft and it'll revascularize pretty well.

Dr. Scott Bevans:

I'll also share a couple other tips, and most of these are from my past failures, but whenever I'm doing significant reduction of the midface exoskeleton or orbital reconstruction, I try to have some verification of accuracy. That might mean either I'm using intraoperative navigation or I'm using O-arm intraoperative CT scan because there's good data to show that about 30% of the time, we change hardware position based on an intraoperative CT or navigation. It also has shown to save patients from revision surgeries.

Dr. Scott Bevans:

Don't forget also, after your plates are on and you're satisfied with the hardware location, there's still the nose to deal with. Often, there's nasal bone or septal fractures or tooth fractures that we need to deal with. Sometimes, I'll just make a checklist up on the board because it's easier than you think to forget about some of these things. After I've done work around the orbit, I always want to check the pupil and do forced ductions. To facilitate a pupil check, I'll either have a corneal protector in or on the contralateral side, I'll just do a temporary tarsorrhaphy suture at the lateral limbus.

Dr. Scott Bevans:

Finally, when you're closing up, make sure you close periosteum over your hardware and then use a big PDS or long-lasting suture to resuspend the malar fat pad and anchor it back to something that's rigid, either orbital rim plate or periosteum. But that's really important, especially when we have a big, swinging lid exposure and we've released all the suspensory midface ligaments to achieve our open reduction internal fixation.

Dr. Ronit Malka:

Great. Now that we've reviewed the treatment arm of this, what kind of postoperative care such as antibiotics or food or activity restrictions would you typically provide for these patients?

Dr. Scott Bevans:

Most of the time, we're not necessarily leaving this patients in MMF, but I will tell them, "Hey, stick to a soft, no chew diet at least for a couple of weeks," and then I've got them doing intraoral wound care, essentially doing rinses and nasal irrigations.

Dr. Scott Bevans:

In wounds that aren't grossly contaminated, there's no really convincing data to use antibiotics beyond the immediate postoperative period. Normally practically speaking, I'm using them while the patient is in-patient and hooked up to an IV. But after about 48 or max 72 hours, or they discharge from the hospital, whichever is less, I'll shut those off.

Dr. Scott Bevans:

One caveat, again, is that for some dental injuries, actually the recommendations are to use longer antibiotic coverage. Those are cases where I will send patients out on oral antibiotics. By definition, all ZMOC and Le Fort fractures are going to involve the sinus passage and so I always counsel patients about sinus precautions... No nose blowing, sneeze with the mouth open... to prevent subcutaneous emphysema.

Dr. Ronit Malka:

Moving on to your outcomes or expectations for these patients, what are your expectations for surgical correction of Le Fort and zygomatic fractures? What defines for you a good outcome?

Dr. Scott Bevans:

I think we usually know in the operating room whether or not we've gotten a perfect reduction. That usually means that we've resolved trismus, that the occlusion is good and that the facial width and height are reestablished. Now, for the patient to perceive that, depending on their severity of fracture, they may be swollen for weeks. We may be seeing them back for weeks at a time and sort of reassuring them, "Hey, you know what? The exoskeleton fixation is good here. When the swelling resolves, you're going to do well." Ultimately, I guess the judgment about whether or not we've been successful or had a good outcome is going to be based on whether or not the patient is pleased with their return to form and function.

Dr. Ronit Malka:

Makes sense. What are the main complications that you're keeping in mind or trying to avoid when treating these fractures?

Dr. Scott Bevans:

I've shared with you a few of my pearls from prior surgical mistakes, but we have to remember... We got to counsel these patients that any time there's a fracture, particularly around the teeth or nasal mucosa, there is the risk of infection. That infection can then exacerbate bone loss or hardware loosening, patients can have nonunion or plate exposure, all of those things.

Dr. Scott Bevans:

Sometimes, it's difficult to separate was that our surgical approach that's, for instance, causing their diplopia or their epiphora, or was it actually the injury itself, the fracture? But statistically, when we look at these, the most common surgical complications are usually actually secondary to inadequate reduction. That might mean that the patient has persistent trismus from zygomatic arch impaction, or incomplete reduction of the zygomatic rotation. It may mean they have continued facial asymmetry, we didn't reestablish the facial width or height. It could mean that the orbital volume reconstruction was inaccurate and they have enophthalmos or hypoglobus leading to diplopia. Again here, sometimes just periorbital trauma. You can have intraconal fat loss which changes the orbital volume as well.

Dr. Scott Bevans:

When we speak about, particularly, fractures involving the medial orbital wall and potentially NOE, there's the risk of prolonged telecanthus. Or if we don't adequately reduce the malocclusion, they can have persistent malocclusion anterior open bite. Similarly, if we don't address the nasal passages completely, poor nasal breathing can be another problem.

Dr. Scott Bevans:

Failures in reduction is probably the most common one. Secondary to that, there's failures in the approach or fixation. Nerve damage, poor healing causing visible scarring or eyelid retraction, damage to the eyelid or lacrimal system, as we mentioned. It's actually easier to put a screw in the lacrimal system and that can be symptomatic sometimes. Midface ptosis, again, we try to avoid that by adequately resuspending the midface but it can descend over time.

Dr. Ronit Malka:

As a follow-up question, how do you typically treat these complications if they do occur?

Dr. Scott Bevans:

Well, of course we have to address the underlying cause. If it's underlying infection or malnutrition that's causing poor healing, we have to address that. Specifically when it comes to hardware, sometimes plate removal may be necessary. That can either be because it's exposed intraorally or it's exposed through the conjunctiva, causing eyelid retraction. But generally speaking, these plates are so small that if we have good periosteal coverage and a watertight closure, the risk of long-term exposure is pretty low. For nonunion, there are times when you have to reosteotomize people and use bone grafting or even free flap reconstruction in severe comminution, but those are the minority of patients. For sensory nerve injuries, we generally expect some level of spontaneous recovery, but it may take weeks to months to achieve that.

Dr. Ronit Malka:

How frequently do you typically follow up with these patients postoperatively?

Dr. Scott Bevans:

If I do occlusion or orbital reconstruction work, I'm usually seeing them every couple of weeks for at least a month or two, often longer.

Dr. Ronit Malka:

To briefly summarize, today we covered Le Fort and zygomaticomaxillary midface fractures, which can involve all the large bones of the skull and the seven bones of the orbit, as well as multiple facial buttresses. We reviewed Le Fort classifications into Le Fort I through III, and the Zingg classification which breaks zygomatic fractures down into types A through C.

Dr. Ronit Malka:

Patients with Le Fort fractures classically present with midface retrusion and malocclusion with an anterior open bite, and may have midface mobility or asymmetric fracture patterns, but also have pseudoaneurysm, dental damage and palatal split fractures. Patients with zygomatic fractures often present with loss of malar prominence or trismus, but can also have periorbital ecchymosis or edema,

cheek numbness, diplopia, hypoglobus, enophthalmos or epistaxis that can require nasal packing. Notably, these patients often have multiple concomitant facial fractures like nasal, orbital or NOE fractures because of the high energy involved in these injury patterns.

Dr. Ronit Malka:

CT facial is the mainstay of diagnosis with these patients, though you should consider CT angiography if the patient has a Le Fort III fracture, based on the mechanism, or if the patient is experiencing delayed intermittent epistaxis, concerning for pseudoaneurysm. These fractures usually require open fixation, but can include more conservative management including closed reduction and splinting or arch bar fixation.

Dr. Ronit Malka:

Indications to operate include facial aesthetic change or functional impairment, usually with malocclusion, trismus, vision changes, palatal fracture and sometimes with significant involvement of a facial buttress. Operative fixation ideally should be performed within 24 to 48 hours, but can be safely performed before 10 to 14 days to prevent scarring, fibrotic changes and bone resorption from beginning. Generally, treating these operatively includes initial reduction of fractures with further stabilization using mini plates, intramaxillary fixation or bone grafts for significant bone loss.

Dr. Ronit Malka:

Surgical approaches for ZMC fractures include the named Gillies approach through the temporal scalp and intraoral Keen approach, as well as options for gingivobuccal sulcus, coronal upper or lower bleph and less commonly, lateral brow incisions for additional exposure, always being mindful of not damaging surrounding structures while generating enough force to achieve adequate reduction.

Dr. Ronit Malka:

Le Fort fractures are usually surgically approached similarly, involve reducing the fracture, placing the patient in maxillomandibular fixation and then stabilizing buttresses, usually focused on the nasomaxillary and inferior orbital rim buttresses and the ZM or ZF articulations.

Dr. Ronit Malka:

Postoperatively, patients should be put on a soft, no chew diet for a few weeks, sinus precautions and wound care with nasal irrigation and oral rinses, and can also be started on postop antibiotics if they have dental injury.

Dr. Ronit Malka:

The main complications from ZMC and Le Fort fracture operative repair are secondary to incomplete reduction and include continued or new trismus, facial asymmetry, palpable or visible plates, malunion or nonunion and impaired nasal breathing. Other complications can include forehead and cheek hypoesthesia from injury to the supraorbital and infraorbital nerves, dental injury, midface ptosis or eyelid or lacrimal injury.

Dr. Ronit Malka:

Thinner or absorbable plates are sometimes used to avoid plate extrusion or visibility but otherwise, treating the underlying condition resulting in the complication, such as infection or inappropriate

activity, and possible surgical revision are the mainstays of treatment for complications. Dr. Bevans, did you have anything you'd like to add?

Dr. Scott Bevans:

No, that was a really nice summary.

Dr. Ronit Malka:

Great. Thanks so much for being with us.

Dr. Scott Bevans:

My pleasure.

Dr. Ronit Malka:

Thank you for listening to our podcast today. As usual, we'll end with a couple of review questions. Like always, I'll ask the question, pause for a few moments to allow you to think of the answer or pause the podcast and then I'll give the answer.

Dr. Ronit Malka:

Starting off, describe the Le Fort classifications. A Le Fort I fracture consists of a horizontal fracture through the maxilla and nasal septum and the lateral nasal walls, lateral maxillary sinus, and extends into the pterygomaxillary junction. A Le Fort II fracture is a pyramidal fracture involving the nasofrontal sutures, medial and inferior orbital walls and zygomaticomaxillary suture, as well as the lateral maxillary sinus and pterygomaxillary junction like in a Le Fort I. A Le Fort III fractures results in craniofacial disjunction involving the frontal process of the maxilla, lacrimal bones, ethmoid sinus, orbital floor and inferior orbital fissure, ZF suture and zygomatic arch in addition to the nasofrontal suture and pterygoid plates from a Le Fort II.

Dr. Ronit Malka:

What is the characteristic deformity associated with midface fractures? The characteristic deformity associated with midface fractures are an anterior open bite and midface retrusion. This is from unopposed posterior and inferior traction on the mobile maxillary fragment by the medial and lateral pterygoid muscles.

Dr. Ronit Malka:

And finally, what approaches would be most appropriate for an isolated, simple or noncomminuted zygomatic arch fracture? A Gillies approach through a temporal incision or a Keen approach through a transoral incision would be most appropriate for an isolated, simple zygomatic arch fracture. Thanks again for listening, and we'll see you next time.