ETHAN WIESLER: Hello. My name is Ethan Wiesler. I'm a orthopedic surgeon at Wake Forest Baptist Health in North Carolina. And I'll be talking today about distal radioulnar joint, both the anatomy, disorders, and, in some fashion, the treatments.

Some of the basic anatomy seen here in cross-section is indicated by the numbers on the bottom 1, 2, and 3. Primarily, we'll be focusing on the distal radioulnar joint, indicated by the circles. The sigmoid notch as indicated, as a very shallow notch with an intended, if you will, different radius of curvature between the radius on the right and the ulna on the left. This is, in part, confers some stability to the joint, but also allows a very significant range of motion in prosupination arc.

In a coronal image or in a coronal section as you see here, there is a articular surface anatomy that can be very variable. In this particular specimen, there is an inclination. But another patient and other variations can be different with regards to the angle of the coronal sequence of the distal radioulnar joint.

Much of the stability is the bone, as I said in the previous slide. But there are significant soft tissue stabilizers that not only impart stability to the joint, but allow the joint to have range of motion. And we'll talk about some of these soft tissue structures in a minute.

In part, the supporting structures that allow the joint to be stable and not just slip in and out are structures of the distal radioulnar joint ligaments, both dorsal on the top of the slide and then on the palmar aspect, indicated by the PRU or the palmar radioulnar ligaments. Very significant soft tissue structure that not only imparts stability, but is also a cushion, is the triangular fibrocartilage complex. This is indicated in the yellow part of the slide, both in the coronal image on the top left and on the sequence image on the right side, which is an India ink stain.

One of the more important aspects of this structure that needs to be discussed in some fashion is the fact that the central portion as indicated by the red arrows is very devoid of blood vessels. The dark black vascular structures on the outside of the image on the right are blood vessels. And therefore, this part of the TFCC has a very significant healing potential.

Conversely, the central portion of this TFCC structure, being devoid of blood vessels, has a very impaired healing potential. And so when it is injured, we approach this part of the anatomy differently with regards to repairing that versus debriding it or removing it. And I'll talk about that a little later in the presentation.

The bottom picture indicates the fact that there are ligaments in the distal radioulnar joint that are loose in pronation and tight in supination. And on the very right part of the image, you see the volar structures with the gray arrow that's very tight in pronation. And therefore, the dorsal ligament is loose in pronation.

So when we do testing, as I'll talk about in a minute, the dorsal ligament is loose. So when we want to look at stability of the distal radioulnar joint, we want to look in neutral as you see in the middle of the bottom picture. But we also want to look at pronation and supination.

And pronation has a loose dorsal ligament and, therefore, would be less stable in pronation. And conversely, in supination, the dorsal ligament is tight and the palmar ligament is loose. This is important when we're examining the distal radioulnar joint in different areas of position.

We obviously want to compare the injured extremity to the other side. And just in pure physical exam, we want to look at the ulnar side of the wrist, the small finger side of the wrist to see what gross anatomic differences are seen. But then when we compare it to the other side, we can see a very significant difference.

For example, the patient that's indicated here on the left side of the screen, you can see a very different prominent tendon, which indicates disruption of one of the supporting structures that is called the extensor carpi ulnaris--- ECU-- and the subsheath that may be the result of chronic inflammation in a setting such as rheumatoid arthritis. Or in a dramatic setting where it's very prominent, it can be very painful. The nature of the injury, both on history and on physical exam, determines what options are available for repair or reconstruction.

X-rays are of very significant value in figuring out what our next steps are. Standard x-rays such as just an AP lateral of the wrists-- standard x-rays are generally sufficient. Different types of imaging tests may be necessary. But this is the starting point. Most importantly, these x-rays need to be a true AP in a true lateral. Because if there is only as little as 10 degrees of variation in the lateral x-ray, can alter the observer's interpretation of the stability of the distal ulna in regards to it's position in the radius.

A clenched fist view, as seen here, can alter the ulnar variance. The ulnar variance is the length of the end of the ulna vis-a-vis the end of the radius. We generally get neutral x-rays.

However, clenched fist views can shed additional light in the condition of ulnar variance and especially in a dramatic setting where ulnar variance may have been altered by the injury. It may have been altered by a congenital injury or issue. Or it may be just how the patient's anatomy is and this ulnar variance may be altered by a clenched fist x-ray.

Other studies may be helpful. And these are such as seen here. This is an arthrogram, where dye is injected into the wrist. And if there's a central TFC tear, a filling defect where dye is extravasating into the distal radioulnar joint, represents a central TFC tear.

Advanced imaging tests such as an MRI are very useful in examining the pathology of the distal radioulnar joint. They look at soft tissue structures that are not appreciated on an x-ray. A simple MRI can be valuable. But the addition of an MR arthrogram, which will be seen in the next slide, also has more value with regards to accuracy of the imaging test with regards to the soft tissue of the TFC and the other supporting structures such as mentioned earlier with the dorsal palmar radioulnar ligaments, as well as indicated here, where the red arrow on an MR arthrogram looks at the deep TFCC fibers.

Focus on the red arrow and you'll see not only an intact TFCC, but a tear of the deep fibers where they insert on a structure of the ulna called a fovea. This fovea structure is one of the other supporting and stabilizing soft tissue components of the distal radioulnar joint, which can be under appreciated on an wrist arthroscopy, which has been seen as the gold standard in terms of wrist pathology. I think at this point in time, the addition of an MR arthrogram adds significant value because it may look at not only the soft tissue structures that I mentioned of the TFC, but also the palmar radioulnar ligaments, as I mentioned in the very beginning part of the presentation, as well as adjacent structures of the TFC, lunotriquetral ligaments, and other ulnar carpal ligaments.

Another imaging test is called a CT scan. This has a role when there are more suspicious bony defects involving the distal radioulnar joint. And you see on the right imaging, the right side is the injured side. You see in different positions where the normal side on the left is both in pronation and supination.

And then in the images on the right, you can see the distal ulna it is subluxing palmarwards on the bottom right image. This can be taken care of both surgically. But it's important to know the direction of the instability and what kind of bony defects may be seen on these axial CT scans to help identify the nature of the pathology.

This is an example of an x-ray that on the right side where the arrow is indicating, there is a palmar subluxation of the distal ulna. The AP x-ray on the left side of the image shows an overlapping distal ulna of the radius. That should give the observer some index of suspicion of a distal radioulnar joint disorder.

And the image on the right, which is a good lateral x-ray as indicated by the fact that the pisiform is overlying the end of the scafoid and the metacarpals are well-lined up. So while you should initially be suspicious that perhaps the x-ray rotation is off, these parameters show that there's a good lateral x-ray and that the distal ulna palmarly subluxed. This is an arthroscopic examination of the TFC. And you see sutures in the repair.

However, the TFC is a structure that, as I mentioned before, when the deep fibers are torn, an arthroscopic image where was previously the gold standard to image of this structure and managed this structure, perhaps would under appreciate and even miss a deep fiber tear. So the addition of an MR arthrogram adds sensitivity to pick up approximately 90% of soft tissue disorders of the wrist. Arthroscopically can miss this structure and can be repaired, certainly, arthroscopically, and arthroscopically-assisted, but may require adjunctive open surgery.

The open approach has been well described. We'll talk about some of the surgical approaches. Generally, when arthroscopic examination is either adjunctive or not completely dealing with the pathology, open approaches have significant value.

This surgical approach is generally between a fourth and fifth dorsal compartment as indicated by these arrows. This is between extensor digitorum communis extensor digiti minimi tendons. These images are an open reconstruction of the TFC where on the right side of the surgical case, there's the ulna. The hand would be oriented towards the left. And in this image where the TFC arrow is shown, the TFC is torn from it's insertion onto the ulnar head and with different types of techniques, whether they be bone tunnels or anchors, can be reattached as seen in the bottom right.

Many reconstructive options have been offered and described as seen here. This picture on the left shows distal ulnar stabilization in the situation of instability. And as you can see in the middle portion, where the Brunelli procedure has been described and the Breen Jupiter procedure has been described. These are in a setting where there's been a distal ulnar resection and there's been distal ulnar instability.

The images on the right side of this slide show different types of soft tissue reconstructive procedures that, again, have been well described, more in the situation of distal radioulnar joint instability. And I'll talk about some of these other approaches and what my preferred approach is later. Again, this is for reconstruction in the setting of distal radioulnar joint instability.

Another condition well-described with, I think, very good radiographic parameters is a condition of ulnar impaction syndrome. So whereas the previous several slides were in the setting of instability, this condition is impaction where there's a relatively long ulna. And in the top right image, you see a red circle that shows a ulnar positive variance. It can be traumatic. It can be a non-traumatic or acquired. Or it could even be a normal variant.

But what's important to identify is the fact that in the body of the lunate in the center of the red circle you see a cystic formation or a cystic injury, whereby the TFC likely has a central tear as seen in a class 2D type tear. And the lunate in the center portion of the red circle has been traumatized, if you will, by the impaction of the distal ulna against the lunate. Generally when this is recognized, it's treated by an ulnar shorting osteotomy. It certainly introduces the risk of delayed union.

And the other surgeries have been described to treat ulnar prominence or ulnar impaction positive variance condition with a wafer resection. But generally at this point in time, the wafer resection that was described 20 years ago, has been largely abandoned in preference of a shortening osteotomy by any number of constructs. This particular x-ray shows a standard small plate shortening the ulna to a neutral or negative variance so as to minimize the impaction condition.

This x-ray and CT scan shows another distal radioulnar joint condition of arthritis. This can also be traumatic. It can be inflammatory or degenerative in nature. And you see in the x-ray on the left where there is a sclerotic and cystic formation of the distal radius and the sigmoid notch and wearing out patterns on the CT scan in the top right, consistent with a degenerative or even an inflammatory condition that is also a painful part of the distal radioulnar joint.

In the techniques for treating this condition of distal radioulnar joint arthritis, there are a number of options. And as I mentioned before, this Feldon wafer resection procedure, as depicted in the top right, is an option. The Bowers hemiresection procedure in the mid portion of the picture has been also described. And this osteotomy, as I mentioned before, also has an option.

But don't forget that in the condition of arthritis, you can't ignore the fact that there is an arthritic condition in the distal radioulnar joint and needs to be addressed in some fashion. So a simple osteotomy where it may shorten a variance condition, does not fully treat the condition of arthritis. So something else has to be done when there's an arthritic joint. The pitfalls of doing some of these other arthritic reconstructive procedures are that there will be a change in ulnar carpal translocation, decrease in grip strength, and there can be involved distal radioulnar joint impingement.

This procedure is called a Sauve-Kapandji. It is intended to perform an arthrodesis of the distal radioulnar joint with a screw construct and then removing a segment of the ulnar shaft, intentionally leaving a non-osseous portion. It's intended to reduce ulnar translation. It would solve an instability issue, as well as an arthritis issue, as well as maintain stability of the ulnar carpal joint. However, this has uses and also has disadvantages in certain conditions, depending on patient's activity level and their demands on their wrists.

This is an example of the pitfalls in dealing with just stylo-carpal impingement, where if a simple wafer-type resection is performed, you still have a prominent ulnar head. And you can still have issues of the ulna impinging on the radius and may be less reliable in the setting of instability. This also requires a stable soft tissue envelope. All of these need to be taken into consideration when talking about distal radioulnar joint reconstructive procedures.

As I mentioned earlier, if an ulna shortening is performed by virtue of taking out the distal ulna or doing a soft tissue interposition procedure only, you run the risk of this. And as seen in the left x-ray where there are the yellow arrow is in the middle, this is a condition that can be a very significant complication when one of these aforementioned procedures has been performed. This is when the ulna now converging on the distal radius by virtue of not only an instability in the dorsal ulna plane, but possibly an instability going radialwards.

What happens is in the grip position as seen on this x-ray, the distal ulna actually converges in towards the radius. And now you have not only a position of instability, but radial instability and a painful impingement not towards the carpis but on the radius. The treatment in this condition oftentimes requires a prosthesis of some sort, such as seen here. There are a number of different options. But suffice it to say that this issue of ulnar convergence needs to be addressed in some fashion with either prosthesis metal, pyrocarbon, soft tissue, a number of them have been well-described.

Another significant issue with regards to the distal radioulnar joint is instability that's following a fracture. Fractures, obviously, of the distal radius are exceedingly common. They can be distal radius fractures only.

They can also be associated with soft tissue structures that may be under appreciative at the time of the initial injury. These are seen with the red circles where they are involving the ECU, other ligaments of the lunotriquetral, or the TFC, as I mentioned before. Provider should have a high index of suspicion of soft tissue injuries when treating distal radius fractures.

This is a an x-ray of a very common distal radius fracture pattern. There is an intra-articular component to it. There is a dorsal tilt component to it.

Treatment, initially post-operatively, with this construct external fixation and pinning, can be very satisfactory to maintain stability of the osseous structures and the distal radioulnar joint. But it can under appreciate the soft tissue structures that I mentioned before. This imparts stability to the distal radioulnar joint. Oftentimes can render the distal radioulnar joint stiff post-traumatically. But maintenance is critical in terms of the overall alignment of the radial length vis-a-vis the ulna.

And that's what's managed in this kind of construct. The ulnar column of distal radius needs to be very carefully attended to when just distal radius fractures are treated. It is beyond the scope of this presentation to talk about all the distal radius fracture constructs.

But what is most important is that whatever construct is performed, whether it be external fixation, plate fixation, or volar plates, dorsal plates, it is critical to confirm that their distant radioulnar joint is congruent and the ular column of the distal radius is out to length. If this is not addressed, you can imagine a structure like this or a construct like this that has not satisfactory restored the stability of the distal radius at the sigmoid notch as you see with the arrow on the right. Then the ulna is prone subluxation, in this case, palmarwards.

In the long-term setting after distal radius fractures have been either not treated, not anatomically aligned, or not been able to be treated for any number of reasons, ignoring the distal radioulnar joint will contribute to wrist instability and wrist pain and possibly limited prosupination. And in this setting, the wrist needs to be addressed with some kind of construct that allows restoration of the distal radioulnar joint stability. In this slide, you'll see a external fixator pins and the restoration of ulnar length. But there is an ulnar styloid fracture with some distal radioulnar joint diastasis. This is another condition that needs to be observed and addressed with either reconstruction of the ulnar styloid and the surrounding soft tissue, as I mentioned earlier with the TFC and the deep fibers. But ignoring a widened distal radioulnar joint can be as bad as a convergent or a short distal radioulnar joint.

This is a traumatic condition that represents that the provider should have a high index of suspicion of another type of injury. This is a DRUJ diastasis, where you can see the distal ulna widened from its normal position in the sigmoid notch. And the associated ulna styloid fracture oftentimes represents tearing of the surrounding soft tissue structures such as the TFC and the extensor carpi ulnaris.

This injury pattern is commonly seen associated with a radial shaft fracture, such as in a Galeazzi fracture, where, by definition, the injury has to occur at the distal radioulnar joins in the TFC. And simple restoration of the radial anatomy may be sufficient to confer stability to the distal radioulnar joint. But again, by virtue of its pattern itself, should cause the provider to have some suspicion of a more proximal injury or more distal injury or some other kind of soft tissue structure.

And that would be something like this, where a distal injury at the level of the DRUJ can represent a proximal problem. And this is a very significant problem where there's a radial head fracture, distal radioulnar joint disruption, as well as an interosseous membrane injury. And this has been termed the Essex-Lopresti. And this is a very severe injury that needs to be recognized initially. And all components of these three issues need to be addressed surgically.

This may represent a combination where there's a restoration of the proximal injury, such as with a radial head if it's not reconstructable and distally, with the restoration of the DRUJ in conjunction with obviously other injuries, such as seen here with scaphoid capitate, lunar triquetrum, as well as DRUJ structures.

One final injury that needs to be addressed regarding the distal radioulnar joint is when the distal radioulnar joint structures are thickened and fibrotic, contracted, and stiff. Commonly follows a distal radius fracture. And the arthrosis and arthritis that may be present can be a contraindication to simply release. But stiffness, encapsular tightness of the distal radioulnar joint structures in the palmar and dorsal ligaments, as I mentioned in the very beginning part of the presentation, can be thickened by trauma. But one needs to have an understanding of the supporting structures and the bony anatomy in terms of treatment plan.

This is an example of these volar and dorsal ligament structures of the distal radioulnar joint. So if a patient has limitations in either the prosupination arc, thorough understanding of what structures should be lax or loose in the prosupination arc will help address the needed anatomy and pathology.

This is a fairly, on one hand, may look like a busy algorithm. But if you look at it carefully, there's really a couple of important points of treatment that should be addressed. So starting at the top of the treatment arm, understanding, obviously, we're talking about distal radioulnar joint, and first understanding of it's either unstable or there's arthrosis. Now, there can be both. But by and large, if there's arthrosis, it takes you on the left side where one would have to address the issues of ulnar variance.

And on the right arm, after arthrosis, when there's no difference of ulnar variance, then the different types of treatment plants. So the two very important aspects to emphasize are where there is instability or arthrosis and then the issues of ulnar variance. So understanding the anatomy of ulnar variance, instability, and arthrosis in the surrounding and important soft tissue structures will help guide treatment plans.

We'll talk about a couple of cases that may illustrate some of these important principles. This is an example-- the x-ray is on the left-- of a young person that has, you can see, bone spurs at the distal radioulnar joints. And on the CT scan on the right is post-traumatic in nature. And you can see the difference and the issues regarding the distal radioulnar joint, especially in a sigmoid notch.

So what are the options? The options are either a Darrach procedure, which is a distal ulnar resection, the S-K or the Sauve-Kapandji procedure, a wafer procedure, ulnar shortening osteotomy-- USO. All these are options.

It's important to take into consideration what are the patient's activities? What are his x-rays? What does his CT scan? Does he have arthrosis?

So in this particular case, we chose a distal radioulnar joint arthrodesis, ulnar shaft resection, which is a Sauve-Kapandji procedure, simply because it was a young man, needed strength and grip, and we felt reluctant to resect the distal ulna. We didn't want to put him through, yet, a potentially other operation and do the hemiresection. And here's a picture of his range of motion afterwards. And one it can expect to achieve this range of motion in clinical outcome in a young patient with a painful radioulnar joint.

This is a very, unfortunately, common condition, where this was a relatively young woman who had had bilateral distal radius fractures treated in a cast. And she had limited prosupination arc, especially limited supination. So you can see from the x-rays that the two images indicating her right and the images on the right side of her left wrist, both represent the same problem.

Basically what had happened here is her wrist fractures were treated non-operatively. And her distal ulnas are now prominent. Her distal radius has been shortened by the trauma in dorseflexion. And so this distal radioulnar joint pathology is secondary to the alteration of her radius because of the trauma.

So what are our options here? So again, remember the important concept is what is the primary pathology. The primary pathology for this patient is the fact that the radius has been shortened. There is not an arthrosis condition here. There is not unstable problem. But the ulnar variance is the issue.

And an elderly patient, certainly can consider resecting the distal ulna in a Darrach procedure. But in this patient, we elected to reconstruct, basically, rebuild her distal radius with dorsal osteotomy, bone grafting, dorsal plating. Both procedures, not done at the same time and put in bone grafting. And this reconstructed her distal radioulnar joint by addressing the primary pathology of the alteration of her sigmoid notch because of the radius fracture.

This is an example of another version of the distal radioulnar joint pathology with regards to wrist pain from having a patient already has had a Darrach procedure or obviously, a distal ulnar resection. This is a problem because now it's up to the provider to deal with the fact that there is no distal ulna to rebuild. The radiocarpal joint is likely OK.

Now, is this a problem of ulnar nerve instability or is this a problem of ulnar convergence? And the ulnar convergence is the problem where the ulna is now meeting up against the radius because of its instability. Is it dorsal? Is it palmar? And now what's remaining?

So what are the options here? What we did decide to do is do a tendon transfer because we determined that it was not a convergence option. If you recall in the previous slide, there was no notching of the distal radius at the level of the ulna. But her ulna was unstable. It was unstable both dorsal and palmarly because a previous provider did not address the soft tissue.

And we did tendon transfers involving both the flexi carpi ulnaris and extensive carpi ulnaris to stabilize the ulna in its instability. So while truly it's not a DRUJ problem, she started with a DRUJ problem from a previous trauma. The provider did a reasonable procedure by doing a Darrach or an ulnar osteotomy, ulna resection.

However, did not address the soft issue stabilizing structures and her ulna was unstable. So while in true form, this was not an DRUJ problem, her initial problem was. And her secondary problem was and required tendon transfers.

Here's an example of a 45-year-old white female with wrist pain from a remote injury, limited prosupination. And here's an example of a CT scan on the left, for some reconstructions on the top right, bottom left, that show also the issue of ulnar prominence or the ulna positive variance as well as DRUJ arthrosis. So what are the options? The options again are the Darrach procedure, where you remove the distal ulna. But don't forget she's 45.

You could do a Sauve-Kapandji type procedure where you fuse the DRUJ, resect some of the ulna, or some kind of arthroplasty. Again, with a young person, she's 45, wants to remain active, we elected to do a procedure that's the Sauve-Kapandji. And here you can see a very solid fusion maintenance of the ulna and the ulna carpal joint. It's important to take out about 2 centimeters. And this preserves all the range of motion.

So a lot of issues to deal with here. It's important to understand the anatomy. A lot of things going on, understanding the arthrosis, understanding the patient's needs, understanding the anatomy, all play a role. And we are making some strides in developing some different prostheses. And that's somewhat beyond the scope of what I wanted to present because I think some of this is maybe industry-driven. But know, again, that there are different prostheses that do have a role in reconstructing the ulnar joint, but understanding the stability versus arthrosis in patient needs and the demands are paramount. Thank you.