Reverse Shoulder Arthroplasty

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Welcome to this OR Live presentation, brought to you by Zimmer.

Hi. I'm Evan Flatow and this is my partner, Brad Parsons. We're here in New York to bring you a video of a recent case of reverse shoulder arthroplasty for cuff deficient arthritis. You should be aware that I helped design the system that's shown in this video, so I receive royalties and therefore have a conflict of interest with the product shown.

And I am a consultant for Zimmer involved in the medical education of orthopedic residents and do receive compensation for that, as well.

Now, reverse shoulder arthroplasty is a new option in the last decade for cuff deficient shoulder arthritis in the United States. The indications are a patient with painful arthritis, absent rotator cuff, a less demanding occupation or lifestyle and usually over the age of 70, and ideally who has pseudo paralysis where you can lift their arm up but they can't do it actively. And the reverse arthroplasty is indicated for that type of patient. In a younger patient with an intact cuff, we would consider a traditional shoulder replacement.

There are two basic approaches you can use for reverse shoulder replacement. The standard delto-pectoral approach, or the superior approach, which we're going to show you here tonight. We will put in a little footage of delto-pectoral so we can contrast the two and show some of the different features. The delto-pectoral approach allows a very good exposure down the humerus and is very useful in cases where there's a lot of contracture that needs inferior release, if you have to dissect out the plexus or the nerves, there are large osteophytes that might get in the way, or especially if you've had previous replacement surgery or a plate for fixation of a fracture and you need to get exposure down the shaft to remove those.

The advantage of a superior approach is it's especially useful if you've had previous open rotator cuff surgery or a deltoid defect because you can use the same incision and repair any deltoid defects at the close of the case. It also is reported to have lower rate of instability, or dislocations, although it's also reported to have a higher rate of getting the components in not perfect position because you're operating from the top, as we'll show you.

Many surgeons prefer one or the other. Obviously, the delto-pec is the workhorse approach that might be used in an average practice. I prefer the superior approach for sort of common cuff arthroplasty in an elderly thin patient where the head is already rising up under the skin, and it's very natural to just bring it through the deltoid split, as you'll see in this video. But I think if you have to use one approach, the delto-pectoral is probably better.

I would agree with that. I find the delto-pec to be very -- it's very familiar to most people as Dr. Flatow said, it's extensile. And often with revision surgery, as is the bulk of my arthroplastic practice, it's more helpful to be able to gain exposure inferiorally around the plexus and remove any prior arthroplasties. So I primarily use the delto-pectoral approach.

The three features you should watch for in this video are the things that are different between a reverse and a standard total is, first of all, we don't like a sloppy fit with the reverse because it is a constrained prosthesis and we don't want it to dislocate. So, unlike a conventional shoulder replacement where you might want about 50 percent push-pull, we want a pretty good fit in a reverse. The other feature that's different is we like to have the humerus in less retroversion. So we're usually going for between zero and 20 degrees of retroversion, rather than 20 to 40 degrees, as in a conventional replacement.

So this is a 72-year-old patient with cuff deficient arthritis. She had had previous instability, a previous rotator cuff repair, two arthroscopic repairs which had failed, and she went onto the current condition. We'll show the videotape now, please.

So, as you see here, she has arthritis. The head is translating superiorly because she has cuff deficiency. And she has atrophy, as you see on the left, of her supraspinatus and infraspinatus, but a pretty good teres minor and subscapularis. If there's flail external rotation with a lag and a poor infraspinatus, we sometimes do a concomitant latissimus dorsi transfer, which we're not going to do here.

This is a right shoulder and you see we're making an incision in the skin creases. My long finger is on the coracoid, my index and thumb are around the acromium, which are marked out. And we're going to start to make the standard superior approach and then raise subcutaneous flaps.

You can also use a vertical incision along the anterior lateral edge of the acromium. This approach tends to be a little bit more cosmetic in the skin lines and also allows excellent exposure to the glenoid and inferior shoulder.

You can see why this approach is a little quicker in the standard virgin case because, after you cut skin and make your deltoid split, you're done with the approach instead of having to do the whole delto-pectoral approach with its many layers.

But here we are elevating the flaps. And we're starting to see the raffia between the anterior deltoid and the lateral deltoid. My finger there is on the anterior lateral corner of the acromium. And the incision, however you put it, should be over that. We're measuring now from the anterior lateral corner, and in small people you don't want to go more than about 3 centimeters. In larger people you can go about 4 centimeters to avoid injuring the circumflex branch of the axillary nerve. And here we're coming along, and then we're going to place a stay suture at the distal part of the split to prevent propagation of the split, which injure the circumflex nerve.

Superiorly, you want to make sure that your incision goes onto the anterior lateral edge of the acromium, rather than reflecting the deltoid off the edge. That will allow you to have a stronger stout cuff of tissue to repair superior and inferiorally along the fascial edges.

When we take the split up, as you see, we're going to come to the anterior lateral corner and then we're going to along the anterior superior edge of the acromium to the front of the AC joint. Some people take it down what flakes of bone. I tend to take it down as a thick sleeve of tissue with the coracoacromial ligament insertion of the deltoid origin to make it very stout so it holds sutures.

Here we're going up. We went to the anterior lateral corner, and now we're reflecting the deltoid origin off the front of the acromium. You notice a few millimeters back from the anterior edge, so that we don't cut into the hamburger of the muscle, but have that nice, thick periosteal flap. And, as we take it down, you'll see that the coracoacromial ligament is still underneath. And now we're going to come under the acromium so that leave the coracoacromial ligament to reinforce that deltoid flap and make it very thick and very solid. We don't want to cook the tissue, we just want to take it down.

And now you can see the subscapularis. We're going to take down the upper part. One of the nice thing of the superior approach is if the patient already has a tear going into the upper half of the subscap, you may not have to take an subscap down, just operate through the tear. Or, at most, you take down the upper half, or 2/3, whereas in the delto-pectoral approach you usually have to do a more complete takedown.

Here, a traction suture is being placed on the subscapularis and we can do some mobilization on the inside to free it up from the capsule and to expose it and make it easier to move. And you see here we're going to now open the deltoid split and just herniate the humeral head up through the deltoid split, and then place some Darrach or other retractors to expose it.

Now, we're going to a delto-pectoral approach. And this is a right shoulder. You see we've just legated, and we're dividing the circumflex vessels. And there's the bottom of the subscapularis. And you see, with the delto-pectoral approach, you can see the deltoid to the right. You have a much better exposure of the shaft and the bottom of the humerus. You see the whole bottom of the subscapularis on the right. I'm feeling down around the humeral neck. You can find the circumflex arteries and the axillary nerve. And so it's a much better approach down the shaft.

As opposed to conventional arthroplasty, we often use a subscap soft tissue takedown, rather than an osteotomy because of concerns of osteotomy fixation and the fact that the cut of the humerus is a little bit more valgus and anteverted, and we worry about crushing that soft bone of the tuberosity later on.

So you saw how we put on the cutting guide in the delto-pec, now we're going back to the superior approach, and we're now coming from the top. And you see the difference is you don't see the neck of the humerus as well, but on the other hand, you have a perfect exposure right down the shaft of the humerus. You're not pushing against the deltoid, and you can place these sequential reamers to find the axis of the canal.

And the start point is the same at the top of the humerus, 1 centimeter medial and 1 centimeter posterior to the bicipital groove, which you often want to identify.

And we like to have a precise cutting guide that gives you a very reproducible cut. And we designed a different cutting guide for the superior approach which, as you see, is more low profile and more like a patellar clamp. Some people like to use this even for the delto-pectoral, but this goes in over the top of it and has these flanges that holds onto the head, and this clips onto the reamer to give us the correct cut. And then we have these retroversion rods that we put in. And then you line them up with the forearm, and if they're between these, the forearm is between these two rods, you're between zero and 20 degrees of retroversion. Here it is. We're lining it up with the forearm. And I tend to do most of these at about 15 degrees of retroversion, which is the right version if I want to convert this later to hemi if I have any fixation problems. Or conversely, if we put at hemi in at 20, in this system, we can go back and forth between a hemi and a reverse.

These are pins to hold the cutting guide onto the proximal humerus. And then we can remove the outrigger and take the reamer out, and we have our cutting surface for the cut. We want to have a very precise cut, so the trabecular metal can get in-growth. This can be used without cement in certain fracture situations and to have the porous tantalum interact with tuberosities. Or it could be used with cement. And we're going to cement this case, because in the typical osteoporotic elderly patient with cuff arthropathy, we would do a cemented implantation.

As opposed to a true anatomic neck cut, seen with conventional primary arthroplasty and a cuff intact shoulder, this is a more valgus and, as Dr. Flatow said, anteverted cut. So it may look at little strange initially when you first start doing reverse shoulder arthroplasty, but you do want it a little bit more valgus and a little bit more anteverted, almost into the tuberosity.

So, after we remove the cutting guide, we're going to use the second reamer, which is the reamer from TM stem, which puts a more conical cut in the upper humerus. We stop when we get to the cut. And then, for the reverse stem, we have this third reamer which makes a very precise cut so that the trabecular metal cone at the top can really get a good approximation to bone. I never liked using systems that crushed the proximal humerus or put a big box of metal which no in-growth could occur top. And this puts a lower profile conical shape of porous tantalum. We're again putting on these retroversion rods on this reamer so we can again check that we're in the same retroversion as we did our initial cut. And later we can use the same position to implant.

So now, we're going to put our stem. You see how we've prepared the proximal humerus. And we're going to put our stem in, which fits in like this with this inserter. And then what we're going to do is, after we've prepared the humerus, we're just going to push it down and posterior to do our glenoid preparation. This is one of the nice features of the superior approach. Instead of having to push the humerus always out of the way with an anterior look at the glenoid, you're looking down over the top of the cut of the glenoid. And you actually have a very nice end-on view in most cases.

We're doing a little bit of a capsular release here at the bottom. You have to be careful. The superior approach doesn't give you as good control of the circumflex or the nerves if you get into any bleeding or trouble. But usually if you just do it subperiostealy, you'll be fine.

We're going to put in now a Fukuda retractor and then some angle retractors. And you see, as you look over the cut, you actually have a very nice view of the glenoid. And you want to be sure that we expose the inferior glenoid. Because, unlike a conventional arthroplasty, we're not going to put this in the center, we're going to put the circular baseplate at the bottom of the glenoid where the circular part meets the upper teardrop part so that we don't have any bone protruding below the baseplate that could interact. We're going to put this pin in, using this guide. And the nice thing about the pin is it can be changed if you don't like the angle. And so you can judge that you like it perfectly. And, once you've decided it's in the right position, you can over-drill it with the 6 millimeter drill that's going to hold the reamer and allow us to do a precise reamer. You don't want this to be aiming up. If anything, you want it to be horizontal, or tilted slightly down.

At this point, we're going to ream by hand, with a little bit of inferior tilt to try to gain a little bit of inferior tilt of our baseplate. You want to be careful that you don't aggressively ream inferiorly and get to the soft cancillus bone.

Now, we're looking at a delto-pectoral approach to illustrate the difference. You see how they Fukuda retractor on the left is so close to the reamer, sometimes it can be hard to get an end-on view. We always do hand reaming, even though in this particular video it looks like this was done on power. But we recommend hand reamer to protect it.

Let's stop the video for one second. This is the second reamer. First of all, again this is the delto-pectoral approach. And you see how the humerus, that's the lesser tuberosity there and the deltoid, and even the drapes get in the way of your approach because of the fact that you're coming in from the front. On the other hand, you have better access to the bottom of the glenoid into the nerve, but your actual approach for reaming and drilling is a little harder.

What the second reamer does is, after you've prepared the bone to accept the trabecular metal baseplate, the second reamer is like a hat, or a step reamer. And it makes sure that you remove any bone that might contact the glenosphere, which has to sit down with a firm Morris taper. And you don't want to prevent any precise articulation of that.

If you can't get the second reamer, let's go back to the video. If, for any reason you can't fit this larger reamer in, you can use a burr to remove any overhanging bone. As we're now back to the superior approach, and you see

there's a little bit of bone beyond the reamer. And since we couldn't quite fit the large -- the second reamer, in here, we're just using a burr to remove any bone that might impinge on the glenosphere.

You can see how the drill hole in the glenoid is more inferiorly in the center of the teardrop, as Dr. Flatow said, rather than in the true center of the glenoid, as we're used to doing in conventional arthroplasty.

So once we have reamed it and prepared it, we're now going to over-drill this up to the size of the TM post, because we want a perfect articulation with the TM. And we don't want the reaming to have sort of oblonged the hole or made it not perfectly reamed. So we do the second drilling. And now we put in the trabecular metal baseplate. And you pack this in. And actually the press fit and the friction of the TM is so much that it's probably got the strength of a couple of screws. Before you put the screws in, you can almost lift them off. Let's stop this for a second.

One point about implanting the TM baseplate is it's very important to have a straight-on shot when you're putting it in because it does have such a friction bite that if you try to work it around the corner, you can get an early seating, which you want to avoid. So it's very important to get a straight-on shot. What this illustration is showing is the result of a cadaver study that we did at Mount Sinai, looking at the optimal screw length orientation for the TM baseplate. And what we found was, if you orient your superior screw towards the coracoid base or between the coracoid base and the 12 o'clock position and the inferior screw along the plumb line, or long access line, the glenoid at 6 o'clock, that will give you an optimal length screw. Let's go ahead and restart the video.

And then what we see on the lateral view is you could see you have a superior angulation of the super screw up towards the coracoid base, and really a straight-on shot of the inferior screw. Although it's possible to get the sort of home run screw down the scapular pillar, it can also gain, or be exposed out the bone or go in and out the scapula, which you would like to avoid.

It can be horizontal or tilted slightly down, but not all the way down. Now, in this system, the screws can be put in through a 30 degree arc. So you can find the bone you like. If you don't like the first drill, you can re-drill it a different direction. And when you put the screw in, it lags the baseplate down against the bone. And you feel the bone, not the plate, when you tighten the screw down.

After we have the two screws in, now we're drilling the superior one, as you see, going a little anterior and superior up toward the coracoid base where there's good bone. We like to have at least 40 on the inferior screw and at least 30 on the superior screw. And the drill has gradations on it, so you can sort of approximate it, and than you can use a depth gauge to be sure.

Once these screws are in and you've tightened them down, we then put locking caps on with a torque wrench. And when you break the torque wrench, you have a cold well of these lacking caps that give you a fixed angle locking screw configuration that adds to the biomechanical stability. You'll see, we'll bring it down and then you can see the torque wrench jump.

That's a real advantage of this system is that you could find a good bone with good screw purchase, bicortically, and then convert it into a lock system to gain longevity of your implant.

You then want to be sure there's nothing that's going to hang up; the head. We're going to go put the glenosphere on now. It's got to be an end-on shot so it seats perfectly. You feel it slip down, and then we'll impact it and check that it's solid. We're then going to put in the trial humeral stem again. And we're going to try and, as I said, we don't want a sloppy fit. We're going to want a fit that doesn't have any shucking, although you can be a little looser in the superior approach because stability is less of an issue. But you don't want it to shuck more than a slight bit. And you want to be able to bring it into external rotation and extension, as well as forward flexion and not have it catch on the glenoid neck and not have it come out of joint or shuck.

Here we are putting on the retroversion rods, again with this introducer, so we can check that the same angle you did your cut is the angle you're putting your trial in, and is the same angle you're going to put your permanent component in. Here we're going to put our thinnest liner on. It should go in about -- it should sit about halfway up before you push it and should be a little hard to reduce. In this case, you see we put it in. There's a little bit of shucking. It opens up, it open books a little bit. So, we're going to go with a slightly thicker insert.

As Dr. Flatow said, it's very important to check the arm in all positions. You want to make sure the patient's arm can get to the contralateral axilla. But importantly, for stability you want to check that adducted, externally rotated position as if the patient was pushing off from her chair because that's the position we worry about instability.

So, here we are trying probably a plus 3 insert. And this will have much better feel and feel stable. You also want to be very sure you didn't leave on any osteophytes inferiorally on the glenoid that might catch on the humerus because one of the mechanisms of instability is opening like a book where it hits, not just shucking.

So, now that we like that, we're going to buy it. We're doing to take out the trial. We're going to prepare the shaft with a brush, and then with pulsating jet saline lavage. We're going to put in a cement restrictor and we're going to use a Thrombin-soaked sponge, a peroxide-soaked sponge, and the prepare it for cementation. The cement goes down, and ideally is more around the distal part than over the trabecular metal part. But in this cuff arthropathy case, it really needs only cement. We're not so worried about in-growth. In a case where there might be an old fracture in tuberosities, to repair you'd want to leave cement off the proximal TM so you could repair the tuberosities. As you see, we can again put on these retroversion rods and check that our position is the same as initially. If we're happy with it, we can buy that we can impact this down.

The TM does allow you that press fit capability in patients with stronger bone or, as Dr. Flatow said, in revision settings where you're trying to get tuberosities to heal in malunions or non-union situations.

So, once we like that, we'll let the cement cure. Once the cement is cured, we're going to do another trial reduction because sometimes it might be in a slightly different height, which might affect the stability. So we're going to check this again. If that's okay, we're going to then put this little drill in to make sure that the finger on the introducer for the polyethylene can fit in there. This has to go in the correct orientation because the angle of the polyethylene is more horizontal than the metal cut, so that the metal is the right angle for a hemi. It allows you to convert. It also it makes a little bit more vertical cut in the bones. You have better exposure of the glenoid, which is a nice feature. We also have a slightly more vertical angle than prior designs, which we think gives us less notching and better stability because you don't catch on the edge.

We're now bringing the subscap back, placing a double #2 fiber wire Krackow suture that we're going to bring through a drill hole -- drill holes under the lesser tuberosity and tie over an endo button for secure fixation, as well as #5 Ethibond Mason-Allen sutures around the lesser tuberosity and through the tendon.

We've learned that this anterior soft tissue repair is critical for the stability of the implant. And certainly, if you're doing a delto-pectoral approach, you really need to make sure you have a meticulous stout repair or the subscapularis. And in some revision settings where the subscapular is deficient, we may consider even a pectoralis transfer to augment the anterior stability and soft tissue envelope.

In the early days of reverse arthroplasty, it used to be said you don't need to fix the subscap, it isn't a problem, but that turns out not to be true as the data is accumulating. The subscap repair is important for stability.

This is the endo button, where we bring the sutures through to prevent them cutting through the bone because it would have to pull that whole plate down through the cortical bone of the lateral lesser tuberosity, or biceps groove. We usually lay this just at the inner table of the biceps groove next to the lesser tuberosity. We going to

lay that down and tie it down. As you see, we'll irrigate. And then really all you have to do is repair the deltoid. We use heavy non-absorbable sutures through the bone of the acromium with a Mason-Allen stitch to the anterior deltoid, repair this all the way down the split, remove the stay suture. And you see, it's a very secure repair. There's the skin incision with a subcuticular stitch.

This is the x-ray pre-op on the left. On the right, you see a good position of the stem and the baseplate at the inferior aspect of the glenoid with the screws in good position. Usually, the patient is in a sling for a few weeks. We don't want to rush their motion to maintain stability and let the deltoid heal. And then we begin a gradual functional use.

I think you have to remember with the rehab that, unlike a conventional shoulder arthroplasty, we don't want to have vigorous terminal stretches. Because this is a constrained implant, we don't want to have notching, we don't want to have the humerus hitting the edge of the glenoid and opening like a book. So we encourage active use and daily activities through a limited range, rather than pushing vigorously for a terminal range.

The other thing to keep in mind is there's a fairly large dead space between the acromium and the superior part of the implant. And so, often we'll drain these patients for a day to try to prevent hematoma formation, especially in the revision setting where we're worried about infection and other things.

There is a higher rate of infection with reverse replacement, probably because they're done more for revisions and you have this dead space that can fill up with a hematoma, which is essentially a culture medium. So, I use antibiotic-impregnated cement when I do the reverses. I make sure I drain them until the drain output has diminished. And I'm very careful about looking for any sign of infection even in a patient who just had a rotator cuff repair because they may have some lingering colonization. You want to be careful putting in a reverse in that setting.

I think we have the opportunity to get some of your questions through the Web link that you shown on the screen. Dr. Parsons, what are your indications for the superior approach? When do you tend to use that?

So, as you said, I will use the superior approach primarily when I'm doing a cuff deficient arthritic who's has either prior rotator cuff surgery and has a good anterior soft tissue envelope to try to preserve that, those soft tissues. Especially if they've had a deltoid dehiscence that I need to try to repair, as that's the important workhorse muscle for this implant. And so, that's my routine. As I said, I tend to do a lot of delto-pectoral approaches because of revision surgery and what have you, but I do like the superior approach for those isolated incidents.

I will sometimes even put the patients up in a abduction pillow if I've done a deltoid repair. Let's say they had an old deltoid dehiscence, or a defect in the anterior lateral corner of the acromium. I'll go right through that, do the reverse replacement, close that up, and then put them up in a pillow for few weeks to just take some of the strain off that repair and let the deltoid heal down. Usually, stiffness is not a big problem. You can do a little more aggressive motion with a superior approach simply because we're not as worried about instability. But in general, we're going for sort of strong, functional movement through a careful range.

I think one of the things we've learned, as we've done more and more reverse shoulder arthroplasty, is that we have to make sure we try to position that baseplate as low as possible. We had a higher incidence of notching possibly because of the superior positioning of the baseplate. And, as we've been able to put that lower the glenosphere hangs over the inferior edge of the glenoid face, that seems to have impacted the incidence of notching as well, and probably has an important part in the stability, the early stability of the implant until you get in-growth.

I think it's also important to think about that when you're doing the approach. For example, in a conventional shoulder replacement, you have to release the anterior capsule under the subscap, maybe the superior capsule

just behind the coracoid, and some of the inferior capsule. But you certainly don't get all the way to the posterior capsule in the average case. However, in a reverse, first of all because they have the stability of the implant, but secondly, because you have to expose the inferior glenoid, you are able to -- you need to actually find the inferior glenoid and subperiostealy expose it even unto removing part of the origin of the triceps long head.

Now, you also want to make a pocket for the humeral component to reach under the glenoid so that it's not going to catch and lever the humerus out. So, if there are bone osteophytes, you want to remove them. And if there is soft tissue there, you want to elevate it so that the humerus can actually reach under the glenosphere and sit in that pocket and not hit something.

So, we have a few questions that have come in from you. The first question is, do you use drains, and if so, how many.

So, I routinely drain. As we talked about, these patients can get at hematoma in the dead space between the acromium and the implant. So I will routinely drain the patient until the drain output is fairly minimal. At our institution we keep them on antibiotics for 24 hours. And hopefully the drain output is low enough that we can take them out at the time of antibiotic stoppage.

Another question is, why such good results with the TM reverse and scapular notching? I think he's referring to a paper we saw from Greg Nicholson at the last meeting. Is it because of the 53 degree neck angle? Well, you know, there was a lot of debate about what should be the best neck angle for reverse arthroplasty. And traditionally, it had been done a little more like 60 degrees in previous designs because that's what had been done. People worried about stability, that it might come out if it didn't have a good grasp under the glenosphere. We thought it should be a little more vertical because we thought this would avoid notching and actually reduce instability because it wouldn’t catch on the edge of the glenoid and lever out. And, in fact, that's been our experience. We've seen very little notching in the first several years of this, compared to up to 30 or 40 percent in the first several years in other studies. And we haven't had a problem with stability. So, we're happy so far with our clinical findings in this system.

In facture situations, how do you judge the height?

Well, judging the height when your landmarks are distorted, as in fractures, can be challenging. And so, you need to look at your, and feel your soft tissue cues. And so, there's you want to look at the tension of the strap muscles. That could be a judge of the tension on your system. The height, one of the nice studies done by Dr. J. P. Warner showed us that the height of the top of the head in a hemi arthroplasty, or in an anatomic situation, is 5.3 centimeters from the top of the pectoralis major. So the pec tendon can be a reference to height as well. In general with the reverse, because we're trying to get that tight fit, I go more by the soft tissue tension, rather than the conventional arthroplasty where we're tying to restore the height perfectly to get anatomic head tuberosity relationships.

If you're doing a reverse for a fracture, and this is a controversial topic, it was first really done in Europe. And what the study by Daniel Mole has shown is that, if you take a group of older patients with very poor tuberosities where statistically you're going to have a less good result with a hemi. If you look at most series on hemi's, if you happen to get a 55-year-old with a four-part fracture who's very motivated, you may get a wonderful result with a hemi. But if you do a hemi for a fracture, even with very good technique, in an 85-year-old slightly confused patient with very osteoporotic tuberosities, you may get a good result, but you also run the risk of getting a very stiff, or a flail shoulder that can't be lifted, although the re-operation rate is low. What's come out the studies by Daniel Mole and others in France is that a reverse is a more uniform result. In other words, your average elevation with a hemi might be 100 degrees, but no one patient is 100 degrees. You have a bunch of patients who get 160 degrees and a bunch of patients who get 80 degrees, whereas with a reverse you'll get 100 to 130 degrees of elevation in everybody or in most patients. So the reverse is more predictable. It's less dependent on

tuberosity healing for elevation. The problem is, we used to think well you didn't have to worry about the tuberosities. But that isn't true. If you don't get tuberosity healing, they get very poor external rotation. And even if they can lift the arm, they can't raise it because of the external rotation. But we can focus more on healing of the infraspinatus and teres minor and worry less about the supraspinatus because the reverse mechanism will give us elevation.

But, to get back to your question, when we do a reverse for fracture, we tend to tension by the strap muscle tension, by the deltoid tension, by how much push-pull we have, rather than by putting together the fracture pieces, which is how I tend to do it, with a hemi arthroplasty.

Well, the questions are flying in. One question is, what is the level of pain that that particular patient will be in when they come out of anesthesia. You should know that we do most of our joint replacements under regional block without using general anesthesia. Although if the patient's older or there's a revision, we sometimes will use an LMA with it. We do all of our arthroscopies just with block with the patient awake and just sedation. What's your experience been with your patients?

Well, most of the time when you're talking about an arthroplasty, their pain relief is fairly rapid and early on. And the benefit of having the regional anesthesia is you can often bridge that gap very nicely with a longstanding block. So, in the hospital they're able to start some gentle mobility of the body and the arm, and have better pain relief. So, with the arthroplasty, it tends to be fairly profound, their early pain relief.

One of the questions is, is motion more or less limited with the superior reverse versus the traditional. And I assume the question means the approach: superior approach versus delto-pectoral. And the answer to that is I don't think there's any difference in motion. If anything, you're a little more willing to let the patient push their motion because there is less of a risk of stability.

But then the next part of this question is, does the reverse allow patients to play tennis or sports where the arm swings backward. Our experience has been that, as long as you're actively positioning the arm in space, there really isn't anything you can't do, as long as you're not doing very heavy loads or impact. The problem with the reverse is because it catches at the extremes of motions sort of like internal impingement in a baseball player where the humerus comes to the edge of the sphere, you don’t really want violent, or forceful terminal stretches because it will start to cause notching or impinge on the fixation. So, what I tell my patients is, "You can swim, you can do any activity that involves putting your arm wherever you want in a sort of graceful, gentle way, but you don't want violent motions or high speed motions." Some of the cases we've heard of of people having trouble are with starting a lawn mower or getting yanked by a dog on a leash or things like that.

One question is, when would you use the 40 millimeter glenosphere and when would you recommend the 36? So the routine that I use is I start with a 36. And, for the vast majority of patients, that's going to be the appropriate size. And I judge the size of the glenosphere mainly by the interoperative assessment of stability. If I've got stability and I do not have posterior inferior impingement, as we spoke about, then I will stay with the 36 glenosphere. Sometimes in very large patients, or patients that have a substantial amount of glenoid deficiency, other issues, we may do a 40 millimeter glenosphere, but I almost routinely use the size 35.

I think that the 40 gives you a little more stability. But one of the nice things in the system is you can go back and forth between the 36 and the 40 without changing the metathesis. So if you've already implanted the system and have a change of heart, or if you're doing a revision for instability, you can go up from a 35 to a 40 and space it without having to pull out the stem. In some systems, they were made so you're committed with the stem, which I think is a mistake. The 40 is more stable. If it's a bigger person, you could fit a 40. You can go ahead and do it. But you don't want to be impinging against the coracoid anteriorly. And you want to be sure that it fits within the shoulder.

In addition, you also don’t have change the baseplate. You can keep the same baseplate and go to the 40.

So, another question is, do you prefer to perform this procedure in a lateral position or in the sitting beach chair position?

I routinely do arthroplasty in the beach chair position. I think it allows for an extensile approach down the arm, if necessary for revision surgery. And so, I will routinely do this in the beach chair.

Another question is, what are the symptoms of someone who is referred to you for this operation. Well, I've got to say if the symptoms are what the patient complains of, a lot of my patients come to me who don’t really -- who aren’t really good candidates for this operation. There's an awful lot of people who are very young, in their 50's, who have had failed rotator cuff surgery. They don't have pseudo paralysis. They can lift their arm, but they're just not strong. They know the MRI shows they have a recurrent tear, and they don't have a lot of pain. They're just unhappy. They've heard about this magic reverse prosthesis and they want it. And these are really very poor candidates for this. There's a very -- we don't know what's going to happen 15 or 20 years out. The data from Europe with the early design showed that at seven to eight years you might get some loss of function, at nine or ten years you might get some mechanical problems because it is semi-constrained. And so, we really don't like doing this, with the exception being a patient in their 50's who really has no other option and is totally disabled, can't lift their arm, is in terrible pain, there can be exceptions to any indications. But you wouldn't want to do it in this sort of common patient who simply wants to be stronger or play sports better. But in terms of the patients that we think are good candidates, as we said before: bad pain, an inability to lift the arm actively, and a willingness to adopt a more sedentary lifestyle.

Now the patient who had external rotation loss, who has flail external rotation, where you can push their arm out but it falls back, in those patients, as Christian Gerber has taught us and Pascal Boileau has written about, we will often combine a latissimus transfer with the procedure. Now that can be done through a superior approach, but you have to add an accessory incision for the latissimus. But in that case, we would almost always do a delto-pectoral because you would simply go down on the humerus, find the latissimus tendon, take it off, route it around the humerus and bring it around the outside almost like the old lapiscapose [sp], rather than having to do the kind of latissimus we'd do for a cuff operation. So, if I'm going to do a latissimus, which I do in someone who doesn't have a good teres minor and has flail external rotation in addition to cuff deficient arthritis and pain and pseudo paralysis, then we would do the latissimus. So the rule of thumb is the reverse helps you lift your arm, but the latissimus helps you rotate the arm externally.

One note is if, what do you do, the conical reamer may seem large at times for a small humerus. What do you do? Well, in the early days of reverse when we only had systems with huge metal caps at the top, we would routinely destroy the proximal humerus. I think with a more low profile design like this, you can protect that in most cases but there are occasional cases where you will, the reamer will sort of tear into the lesser tuberosity or take out some of the lateral wall. But you've got beautiful fixation down the shaft, and that really isn't a problem. You just do what you have to do to get it down there. You can try seating the prosthesis a little higher, but that's an example where, before you cement, you better be sure that you can reduce that. Because you don't want to be in a situation where you've got you're stem in and, with your thinnest insert, you can't get a good reduction without over-tensioning the system.

I would agree with that, yeah.

What is the average recovery time for this procedure?

Well, generally we'll kept patients a little bit slow in activity in a sling for three or four weeks. And then we'll allow them to use their arm. Often, they can to therapy on their own for gentle stretches or pulley maneuvers at home.

And, as they gain better deltoid strength and tone, many patients can get back to overhead activities in as short a period as two to three months and can have full recovery in six to nine months.

One of our emails was, I will not be able to see it tonight at 7:00. Is there some way I can view it at another time. I think there is a way people can look at this later, but I don't actually know what it is.

A little birdie just told me the archive will be up two hours after the show. So, you can either watch it late tonight right before some late night TV or watch it later than that, even.

Dr. Parsons, do you typically cement or press fit this system? And go through your indications for each of that.

I typically cement the reverse shoulder. As Dr. Flatow said, a lot of the times in a cuff deficient patient who's a little bit older and has a little bit of osteoporotic bone, I worry about bone fixation, even with the TM proximally. There is an incidence of humeral subsidence in reverse shoulder arthroplasty, and we've learned that from some of the French series. And so, you do have to worry a little bit about humeral loosening with this implant as compared to conventional arthroplasty. And someone who's younger with good bone or we're worried about some sort of tuberosity issue with fixation, then we may not have that proximal cement. But my routine is generally to cement the implant.

Another question is, how do you gauge tilt of the baseplate. And we talked about that a little before. I think it's important to do the best you can with this, because it's a very important step. This should never be rushed. And what we usually do is, we first expose the glenoid, as you saw in the video, and then once we decide where we like it and we're at the bottom of the circle of the glenoid. So the glenoid is like a teardrop and the bottom is circular. You want to put that baseplate lined up with the inferior edge of the glenoid. It can be a millimeter or so up because the glenosphere is a little larger than the baseplate. But you certainly don't want the glenosphere above the edge of the bone. Now, when you decide you like it, you can put in that pin, using that guide. I, at that point, do what I call a time out. Now, most of you have time outs in your hospital where you have to verify is this the right patient, is it the right versus the left shoulder, do they have any allergies, whatever your hospital does. I like to consider that moment a time out. And we can ask my assistant, we can ask any other surgeons who are in the room, "Do you like that position?" I may, in some cases, stop and take an image view or an x-ray of the scapula. And I can look at that pin in the scapula. So, I don't do that routinely, but I'll do whatever it takes to convince myself that I really like that position, that it's in the right position, north/south, and it's at the right tilt. You don't want surprises later. So, if you're not sure, get an x-ray, feel around the bottom of the scapula, put your finger in. Do whatever it takes. Once you -- if you don't like it, you can take the pin out and aim it a different direction. That's why it's a pin and not a drill. Once you like that, you take the canulated drill and over-drill that. And now you're committed. Because you don't want to make a big drill hole in many different places. Any other tips?

Well this is where your 3-dimensional imaging, preoperatively, and your preoperative planning can come into play as well. Often with cuff deficient arthritis you may get superior wear of the glenoid, so you have actually an inclination of the glenoid face. And if you don't identify that, preoperatively, you may get fooled into putting our baseplate with a superior tilt. So, this is also where you want to make sure that you have adequate imaging, preoperatively, identify those superior tilted glenoids, and make sure that you either can ream the inferior side and get it flat or with a little bit of inferior tilt. Or, in some rare cases, we even consider bone grafting the superior glenoid to convert that glenosphere baseplate to a vertical or slightly inferior tilted position.

So, another question we have is, how tight is tight, in terms of tension? What's your thinking on that?

Well, when we originally started doing this, we would consider it wasn't tight enough unless you had it what Dr. Tom Norris has called shoe horn tight. And what we've learned actually is you can actually sometimes make these too tight. And so, as Dr. Flatow demonstrated in the video, you want to use a couple of landmarks when

you're doing this. And those are your soft tissue tension, as we've said a few times, of the strap muscles and deltoid. We like to see if there's any vertical shuck of the implant where you can get separation of the glenosphere from the metaphases in sort of a neutral position. And then you want to make sure that the patient has a supple range of motion of abduction to about 70 or 80 degrees, can reach the contralateral axilla, can get the arm above the head with forward elevation and they're not too, too tight. And that's what generally what I will use.

Well this segues into our next question beautifully. One of the questions is, what is the impact on the nervous system from this surgery, if any. Well, I can tell you, you can stretch the nerves doing this operation. Remember, you're bringing the humerus down and pushing on the -- putting traction on the plexus. And we have seen patients who have developed some temporary traction symptoms in the axillary nerve, for example. You also have to be careful that the axillary nerve doesn't bow-string right up into you baseplate or into your articulation. So, I don't actually like to expose it and cut it away so that it can come up like a string. I like to leave a little muscle over it, a little fat, a little soft tissue. I just palpate it. I typically reach under the deltoid laterally and feel the circumflex. And then I put my finger down at the front of the subscapularis. And I can transmit a little tug -- we call it the tug test -- on the nerve and convince myself know where it is. And I just keep it out of harm's way. Sometimes when I'm reaming, I'll put my finger there, doing anything else, just so I sort of know where it is. But you really want to be careful that you don't traumatize that. And you don't want to over-tension it to the point where the nerve is under undue tension.

Sometimes, you can even use an interoperative nerve stimulator or a hand-held device or interoperative nerve monitoring if you're really concerned in revision settings where the plexus may be scarred because obviously, that axillary nerve is critically important to the function of the deltoid. So, in rare situations, I'll use that as well to document that the nerve is firing after I've done my final implant, make sure the deltoid's still working.

And, if there's any question, you know, you never want to not know what's going on with the nerves. There's a company that makes very nice stimulator, called the Checkpoint Stimulator, I think, that I tend to use because it has the right settings and the right voltages. And, if there's any question, I'll put the stimulator and see if I can still transmit a nice signal. Sometimes, if you over-tension it, you can lose that signal, that ability. And Dr. Parsons, you've actually used even nerve monitoring, the way the spine surgeons do, in revision cases. I know you did some of your training with Jerry Williams, who's really done a lot of research in watching nerves during surgery.

Well, in fact, I used it today. And I find, as Jerry Williams taught me, in the revision setting with the stiff shoulder where they have passive external rotation less than 10 or neutral to the side, those are the patients that you have to be very worried about having a plexus injury as you free up the mobility of the shoulder and put those nerves on stretch. And so, we use an interoperative assessment with SSEP, and EMGs that allow me to get continuous monitoring of the nerve, so I'm really confident at the end of the case that we haven't done any damage to the plexus during some of these more complex procedures.

And I think another important thing is just to know your own limitations. I mean I don't doubt my abilities as a shoulder surgeon, but I'm not a plexus surgeon. And at my institution we have Dr. Michael Houseman, who's a superb micro surgeon and a leading plexus surgeon. And if I'm doing a difficult revision, I'll often ask him to stop in. And if we get into trouble digging the nerves out of scar, I don't guess where they are, I don’t hope they're okay. If I can't find them, or convince myself, I'll ask Mike to scrub in, and he'll actually do a formal dissection or free up the nerve. And I actually think some of the people who have a lot of pain in failed arthroplasty, it's because there's traction on the nerves as they move their arm. And freeing up the nerve can actually relieve pain, in addition to making your arthroplasty situation a safer condition.

So, it's been wonderful having you all with us tonight. And I hope you've enjoyed seeing the video. It will be posted in about two hours. So you can look at it again if you have further things you want to see. There are, of course, other ways to learn about shoulder replacement. You can do a skills course at the learning center that

the academy runs. You can do courses through Zimmer at the Zimmer Institute. You can look at videotapes on viewmedi.com, which has some wonderful videotapes, including some of ours. You can also look on the academy website on OKO, where they have some wonderful videos, including one of me doing a total shoulder from soup to nuts, through the superior approach and some on reverse arthroplasty. You can never do too much anatomy or too mush surgical practice. And it's certainly been a pleasure being with you here tonight. Thank you very much.

Thank you.