

Editorial

"In My Experience.. Innovations in Reverse Shoulder Arthroplasty: The Roles of The Greater Tuberosity and Deltoid"

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The author discusses his views on innovations in reverse shoulder arthroplasty.

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Reverse shoulder replacement (rTSA) has really taken off and it's a very popular operation. For most indications, rTSA is doing very well. But there is a subgroup of patients that don't do as well and it is frequently the situation in which there is bone loss at the top of the humerus. When you don't have adequate proximal humeral bone stock, you can have fixation issues where the implant itself isn't stable, and at times can develop instability of the prosthesis. Initially, it took us a while to recognize how important the contour of the deltoid was in order to achieve stability of the rTSA prosthesis. It turns out that the greater tuberosity's absence or presence can be a defining line in terms of whether these implants have a chance at being stable and functioning well to start off with. As you make your way further down the humerus, the attachment of the deltoid being intact or not intact is really a critical thing as well. If you have a fully intact humerus with an intact deltoid, you've got a great chance of having a good functional outcome. If you have an intact deltoid but you're missing the

greater tuberosity and its entirety, you can still have a good outcome but your likelihood of instability goes up.

From an innovation standpoint, we were trying to figure out what we can do to innovate to correct this problem and the answer ended up being effectively harnessing biomechanics. We looked at what the deltoid does and what the greater tuberosity's relationship to it was in order to achieve stability. As the deltoid wraps around that greater tuberosity it generates a horizontal compressive effect, just like in the hip in that it compresses and stabilizes the reverse shoulder arthroplasty. In the absence of that greater tuberosity, the shoulder loses that compressive vector. We started to think about ways that we could recreate that deltoid compressor vector. Many people were doing it with just bone graft where you can use an allograft to replace the missing area bone. What we decided to work on was metal solutions.

We now have two different solutions that are metal-based. One is for marginal bone loss of the tuberosity that

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doesn't extend quite past the metadiaphyseal junction or really in the metaphyseal junction and we have created a humeral augmented tray where the tray has an extension on it that substitutes for the lost tuberosity bone. This piece actually extends off the tray and comes down to that metadiaphyseal flair and recreates the greater tuberosity in situations where you've had fracture malunions, greater tuberosity displacement, tumor surgeries, revision surgery and you've taken out the stem and a greater tuberosity is gone. You can address that with just the humeral augmented tray. If the bone loss gets more advanced beyond that, you could use a device that was originally designed for tumors to recreate the proximal humerus geometry with good fixation around the humeral shaft to re-establish both the length of the humerus, but also the prominence of the greater tuberosity to re-establish that deltoid wrapping. The results so far have been staggering. Not only have we been successful at improving stability, but if you have an intact deltoid attachment onto the humerus, some of the functional results can defy expectations. We have a few patients that have no soft tissue attachments above the deltoid attachment, and the rotator cuff is gone, the latissimus attachment is largely gone and they still have an overhead function and no horn blower sign. The arm hasn't fallen into internal rotation even though they have no posterior cuff. We think that by boosting the deltoid out laterally with this bulky proximal prosthesis, we take the posterior deltoid and we change the fiber orientation from being vertical to being a little bit more horizontal by stretching itself out laterally and that may allow this more lateral orientation of those fibers to achieve some external rotation and result in stability of the arm and space so it doesn't fall like a horn blower sign that you'd expect to see in a massive cuff tear patient that extends to the posterior rotator cuff.

It's very much like a lateralized hip and we borrowed that concept of using the muscular passage over a bony prominence and then the muscle then turns back down medial by passing over that bony prominence a slingshot effect, that compressive vector, is what we're leaning into with the design of these innovative products.

These are made by Exactech based in Gainesville, Florida. They are all titanium and the proximal bodies, there are four different sizes of the proximal bodies for the humeral reconstruction prosthesis and they're all based on sizing that we get on a CT scan study to look at what the range of proximal body sizes were. What we didn't think about at the time was that we were also putting glenospheres in these patients. Even though the largest size is sort of a reasonable size for a large human, we most commonly

don't use the largest size because we're used to lateralizing a bit and filling up dead space on the glenoid side, so you end up not having to use as much of a humeral-sided bulk to achieve stability and good motion.

The humeral augmented tray, or as we call it the 'HAT', sits on top of existing stems. This is an option that allows you to use the tray to sit on top of an existing stem that gets good fixation distally and this wraps around to provide that depth at tuberosity contour. As you lose more bone, the regular stems wouldn't have effective fixation, so a tumor reconstruction prosthesis was developed along with the surgeons at the University of Florida, the orthopedic oncology team and they helped design a system that actually is meant to be used with a horizontal osteotomy – the kind of resection that you would expect with a tumor. This type of resection leaves you with a tube of diaphyseal bone, and they came up with this concept of putting a ring on the outside that increases the rotational stability of the prosthesis. The build-up on top of that was based on the biomechanical work that we had done in trying to restore the deltoid wrapping in reverse shoulder arthroplasty.

It's being used more and more particularly for proximal humerus fractures. We have started to see some surgeons use it instead of repairing the greater tuberosity or bolstering it to the greater tuberosity in cases of poor bone quality, repairing the tuberosity underneath it. Some surgeons using it to protect tuberosity repairs. In general, I think that the native greater tuberosity is probably adequate to achieve adequate deltoid wrapping if it is repairable if you balance the reverse appropriately and get it lateralized enough. I mean, if you look at this historically, the old data on the Grammont prosthesis which is far medialized had a four-and-a-half to five percent dislocation rate. They saw 1 in 20 of those were dislocating and it was far medialized and when Frankle and others started to lateralize the construct, the stability started to improve across the board. The implant that I use is lateralized but not on the glenoid side, it's lateralized on the humeral side. As long as you have a greater tuberosity there, the instability rate for that prosthesis is between a half and one and a half percent, so this dramatically improves it. However, but if you start to lose that greater tuberosity contour, it can be really helpful to have an off the shelf solution to address it.

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