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CORR Insights

CORR Insights®: Implant Design Variations in Reverse Total Shoulder Arthroplasty Influence the Required Deltoid Force and Resultant Joint Load

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Where Are We Now?

Reverse shoulder arthroplasty has become an important and powerful tool in the treatment of a variety of severe shoulder pathologies, including rotator cuff arthropathy, complex proximal humeral fractures, and failed anatomic arthroplasties. With increased widespread use, numerous studies have been performed on how changes in its basic components affect the biomechanics and function of the implant. It is clear from several biomechanical studies [2–6] that placement of a reverse total shoulder arthroplasty lowers and medializes the center of rotation of the glenohumeral joint in comparision to the normal anatomic center of rotation. This effectively improves the deltoid moment arm reducing the overall loads to abduct the arm. It also reduces the rotator cuff moment arms, placing the posterior rotator cuff at a disadvantage and subsequently limiting some of the ability for external rotation.

With any new technology, however, there exists complications, and the reverse shoulder arthroplasty is not free from this issue. Complications of particular concern include scapular notching, limited ROM, acromial stress fractures, deltoid overtensioning, and dislocation. Several techniques that have been used to reduce common complications associated with reverse shoulder arthroplasty (instability, scapular notching and reduced external rotation motion and strength) include glenosphere lateralization, humeral lateralization, and humeral lengthening. It is currently unclear which of these options is the best strategy to limit these problems without incurring further negative consequences like increased deltoid force for abduction. Excessive deltoid loads can lead to deltoid related pain, acromial stress fractures, and potentially early functional decline due to deltoid senescence.

The current study by Giles and colleagues further defines the overall effects of changes in implant variables

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on deltoid force for abduction and joint loads after reverse total shoulder arthroplasty in a single system. They found that glenosphere lateralization and humeral lengthening are both options to improve implant stability, and have a detrimental effect on overall deltoid force to abduction and joint loads. These data agree with previously published work showing that the deltoid force to abduct is larger with glenosphere lateralization of 10 mm as well as with humeral lengthening [4, 6]. The current data support the idea that lateralization of the humerus reduces deltoid loads required for abduction, which to my knowledge, has never previously been reported, and is one of the major contributions of the current paper.

Where Do We Need To Go?

Theoretically, humeral lateralization will lead to improved external rotation by placing the posterior rotator cuff at a better biomechanical advantage, as well as improved stability. However, clinical and biomechanical data supporting this are absent.

The current data supports that humeral lateralization may be the best option, in comparison to glenosphere lateralization or humeral lengthening, to improve function and limit complications after reverse shoulder arthroplasty. Humeral lateralization actually reduces deltoid force required for abduction and joint loads, as opposed to glenosphere lateralization or humeral lengthening. Biomechanically, the data suggests that glenosphere lateralization and increasing polyethylene insert thickness will improve stability at the cost of increased deltoid force required for abduction [4, 6]. Clinically, it has been shown that glenophere lateralization can reduce notching and instability. A more lateral humeral position has been shown to be associated with more deltoid wrapping and better posterior deltoid moment arms and tensioning [2, 3, 5].

Additionally, the biomechanical effects of humeral lateralization, including the effects on ROM, scapular impingement, and stability remains unknown. Similarly, the clinical effects of a lateralized humeral component compared to a medialized humeral component on stability, ROM, deltoid related pain, acromial stress fractures and scapular notching is unknown.

How Do We Get There?

We need additional biomechanical studies to determine the relative benefit of humeral lateralization on shoulder stability, passive and active ROM, and scapular impingement. Clinical studies comparing a lateralized humeral component versus medialized humeral component are required to confirm the relative benefits regarding stability, notching, deltoid related pain and acromial stress fractures. Finally, long-term functional outcomes are required on the lateralized humeral component design. The purpose of long-term followup would be to determine if the same functional decline occurring approximately 10 years after a medialized humeral component with a traditional Grammont design is avoided with a lateralized humeral design [1].

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