Impact of Distalization, Lateralization, and the Distalization-Lateralization Index (DLI) on Outcomes Following Reverse Total Shoulder Arthroplasty

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INTRODUCTION:

Distalization and lateralization are key biomechanical parameters in reverse total shoulder arthroplasty (RTSA) that influence deltoid tension, joint stability, and the risk of complications such as scapular notching and acromial fractures. The Distalization-Lateralization Index (DLI), which quantifies the interaction of these two variables, has emerged as a potential predictor of outcomes, but the independent and combined effects of distalization and lateralization on function and complications remain unclear.

METHODS:

A retrospective review of 332 patients who underwent primary RTSA between 2010 and 2023 at a single academic center was performed. Radiographic measurements of distalization (change in acromiohumeral interval) and lateralization (change in acromiohumeral offset) were performed. The DLI was calculated as $\sqrt{}$ (distalization)2 + (lateralization)2. Outcomes included PROMIS Pain and Upper Extremity (UE) scores, range of motion (ROM), and complication rates. Bivariate analyses and multivariable regression models were used to assess associations, controlling for demographics and comorbidities. Spline regression models were utilized to identify peak values associated with maximum outcome improvement.

RESULTS:

Patients demonstrated significant improvements in PROMIS scores and ROM postoperatively. Greater distalization was associated with decreased internal rotation ($\beta = -0.13$, $p = 0.02$) and higher rates of scapular notching ($\beta = 0.08$, $p = 0.009$), while greater lateralization was associated with worse PROMIS Pain and UE scores ($p < 0.04$) but fewer complications, including scapular notching ($\beta = -0.14$, $p = 0.01$). On multivariable analysis, greater lateralization and distalization independently predicted worse PROMIS UE scores ($\beta = -0.34$ and -0.16, respectively; $p \leq 0.04$). Lateralization decreased the odds of postoperative instability (OR 0.87, $p = 0.03$) and notching (OR 0.93, $p = 0.01$), whereas distalization increased the risk of type 3 scapular fractures (OR 1.11, $p = 0.03$). Higher DLI values were associated with greater PROMIS Pain Interference ($\beta = 0.19$, $p = 0.01$) and lower PROMIS UE scores ($\beta = -0.29$, $p < 0.001$), reflecting the additive negative impact of combined distalization and lateralization on functional outcomes. However, no significant interaction between distalization and lateralization was identified, suggesting that DLI reflects cumulative burden rather than synergistic effects. Based on spline regression modeling, beyond 23% distalization and 30% lateralization, a decrease in PROMIS UE scores was observed. DLI values of 15.5 and 30.9 represented the points beyond which PROMIS UE scores declined (Figure 1) and PROMIS pain interference scores increased (Figure 2).

DISCUSSION AND CONCLUSION:

Both distalization and lateralization independently impact functional outcomes and complication risk following RTSA. While lateralization appears protective against instability and scapular notching, it is associated with worse functional scores. Increased distalization heightens the risk of scapular fractures and impairs internal rotation. DLI values beyond 30.9 are associated with worse PROMIS pain interference scores. In conjunction with prior literature demonstrating increased incidence of acromial and scapular stress fractures with a DLI of 29, these results suggest that increases in distalization and lateralization beyond this point may result in suboptimal outcomes.

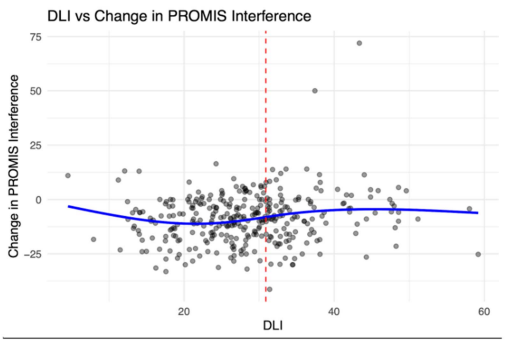

Figure 2. Spline regression model demonstrating peak value of maximum outcome improvement for PROMIS pain interference score as a function of DLI, which demonstrates that outcomes peak at a DLI value of 30.9.

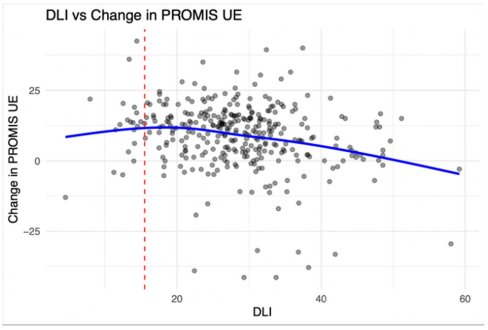

Figure 1. Spline regression model demonstrating peak value of maximum outcome improvement for PROMIS UE score as a function of DLI, which demonstrates that outcomes peak at a DLI value of 15.5.