Does the Dynamic Sling Effect of the Latarjet Procedure Improve Shoulder Stability? A Biomechanical Evaluation

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INTRODUCTION
The Latarjet procedure, a transfer of the coracoid and the conjoint tendon, is commonly used to treat anterior glenoid bone loss due to instability. The transferred conjoint tendon is thought to provide a stabilizing sling effect; however, the significance of this mechanism is unknown. The purpose of this in-vitro biomechanical study was to evaluate the effects of the Latarjet procedure, with and without conjoint tendon loading, on shoulder stability and range of motion (ROM).

METHODS
Cadaveric human shoulders (n=8, average age: 78) were tested in a custom shoulder simulator capable of applying loads to the conjoint tendon, rotator cuff, long head of biceps, and three deltoid heads. Passive muscle loaded ROM and shoulder stability with an anterior applied external load were evaluated with a repeated measures design with three conditions: intact, 30% anterior glenoid defect, and Latarjet with and without conjoint tendon loading. Unloaded and 10N loaded conjoint tendon states were randomized and testing was performed in adduction and 90° combined abduction. Combined shoulder abduction was achieved using a glenohumeral-scapulohumeral rhythm of 2:1. Outcome variables were joint dislocation, translation, stiffness, and internal/external rotational ROM. Joint stiffness was tested in neutral and 60° of external humeral rotation using an anteriorly direct load up to 70N. Humeral internal/external rotation ROM was determined using a predefined clinically relevant applied torque. Outcome measures were statistically tested using One-Way ANOVAs with significance set to p<0.05.

RESULTS
All 30% glenoid defects caused dislocation in abduction and external rotation. The loaded Latarjet prevented dislocation in all specimens, while the unloaded stabilized 6 of 8 specimens. The loaded Latarjet, as compared to the unloaded, significantly reduced anterior joint translation in abducted external rotation (8.9±9.6mm, p=0.035) and neutral (7.0±5.9mm, p=0.012).

In abduction external rotation, there were no significant differences in joint stiffness between loaded and unloaded transfers (p=0.176); however, the unloaded Latarjet did approach a statistically significant reduction as compared to intact (p=0.081) (Figure 1). In adduction, there were no significant differences in joint stiffness between the intact condition and the loaded Latarjet (p=0.228); however, in neutral rotation the unloaded Latarjet (p=0.015) and the 30% defect (p=0.011) had significantly less stiffness than the intact condition, and were nearly equal to each other.

No significant differences were found in rotational ROM in adduction; however, in abduction the loaded Latarjet significantly reduced rotational ROM as compared to unloaded (29.03±15.16, p=0.014).

DISCUSSION
The Latarjet procedure is a common treatment for patients exhibiting anterior shoulder instability with associated anterior glenoid bone loss. As a consequence of the Latarjet, the conjoint tendon group is shifted to a new position, which is thought to provide dynamic stabilization beyond the effect of the bone graft alone. This stabilization is described as a dynamic sling, which supports the humeral head.

The current study found that the Latarjet procedure without the sling effect was able to prevent most dislocations (75%); however, the addition of conjoint tendon dynamic loading was able to restore stability in all specimens (100%). Despite the unloaded Latarjet’s ability to prevent 75% of dislocations, it did allow significantly greater humeral head translation than the loaded condition indicating that the conjoint tendon does have a significant influence on humeral head kinematics. Analysis of the stiffness data across all four of the shoulder configurations indicated that the Latarjet procedure tested without conjoint tendon loading provided a minimal stiffening effect. This was especially true for neutral rotation where the stiffness was essentially equal to the un repaired 30% defect and stiffness was significantly less than at intact for both adduction and abduction. In contrast, the loaded Latarjet procedure appeared to have initiated the theorized sling effect and increased joint stiffness; however, the increase in stiffness was not statistically greater than that of the unloaded case. An important observation from this data is that external rotation appears to improve the stiffness especially during conjoint tendon loading. This finding can be explained by the increased wrapping of the tendon around the humeral head caused by external rotation (Figure 2).

Evaluation of ROM data showed that the sling effect caused significant restriction of internal/external rotation in abduction compared to the 30% defect and the unloaded cases; however, this difference was not significant compared to the intact loaded state indicating that the sling effect is unlikely to limit motion beyond the physiologic level.

The results of this study indicate that glenohumeral joint stability is improved when the transferred conjoint tendon is loaded, thus supporting the existence and importance of the sling effect. Stability parameters, however, are not fully restored to the intact level.

SIGNIFICANCE
The study explored the dynamic effect of the conjoint tendon group on the Latarjet transfer. These findings of enhanced stability are clinically significant as they will help to guide surgeons in their use of the Latarjet procedure and their expectations of the sling effect.

REFERENCES