The Effects of Combined Bony Defects on Anterior Glenohumeral Stability: A Cadaveric Study

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Shoulder Injury

- Approximately 1.7% of the general population will experience a glenohumeral dislocation

- Approximately 95% of patients with anterior shoulder instability have a humeral head defect, a glenoid defect, or both

- Radiographic studies on shoulders with chronic anterior instability have shown
  - 90% incidence of humeral head defects
  - 87% incidence of glenoid defects
  - 54% incidence of combined defects
Clinical Significance of Bony Defects

- Burkhart and De Beer reported a 10.8% recurrence rate following arthroscopic Bankart repair
  - 67% recurrence with significant bone defects
  - 4% recurrence in patients without significant bone defects

- Boileau et al. performed arthroscopic stabilization for recurrent anterior instability
  - 15.3% recurrence rate
  - Strong association with defects >25% glenoid surface $(p=0.01)$

- Voos et al. performed arthroscopic Bankart for anterior instability
  - 18% recurrence rate
  - 3.9 risk ratio with large humeral head defect $(>250\text{mm}^3)$
Biomechanical Significance of Bony Defects

• Itoi et al. showed a decrease in glenohumeral stability with anteroinferior glenoid defects >25% of glenoid width.

• Yamamoto et al. showed a decrease in glenohumeral stability with glenoid defects >26% of glenoid width.

• Kaar et al. showed a decrease in glenohumeral stability with humeral head defects greater than 5/8 of the humeral head radius.
Study Aim

Investigate the effects of combined humeral head and glenoid defects on anterior glenohumeral stability across a range of arm positions.
Hypothesis

Combined bony defects will lead to increased instability compared to an isolated defect.

The “critical” size of humeral head and glenoid defects that need to be addressed to restore stability will be smaller when combined rather than isolated.
Methods

- 18 Fresh-Frozen shoulder specimens
  - All soft tissues dissected
Sizes of Lesions

- **Humeral head defect sizes:**
  - Intact condition (no defect)
  - 6% humeral head diameter
  - 19% humeral head diameter
  - 31% humeral head diameter
  - 44% humeral head diameter

- **Glenoid defect sizes:**
  - Intact condition (no defect)
  - 10% glenoid width
  - 20% glenoid width
  - 30% glenoid width
Testing Protocol

Custom shoulder dislocation simulator was used:

• Seating (home) position for humerus defined

• Translate glenoid at constant velocity under compressive force to cause a controlled anterior dislocation

• Compressive load: 50N
Outcome Measures

• **Percent of Intact Stability Ratio**
  - Stability ratio for a given trial divided by the stability ratio in the intact state at that arm position for that specimen

• **Percent of Intact Translation**
  - Distance to dislocation for a given trial divided by the distance to dislocation in the intact state at that arm position for that specimen
Combined Defects in the Position of Apprehension

Decrease in Percent ISR as Humeral Head defect size increases
Decrease in Percent ISR as Glenoid defect size increases at each Humeral Head defect size

Figure 1: Percent of Intact Stability Ratio (stability ratio for a given trial divided by the stability ratio in the intact state for that specimen). * P < .05   ** P < .0001
Combined Defects in the Position of Apprehension

Decrease in Percent ISR with
- Humeral Head defects of 44%
- Glenoid defects of 30%
- Combined defect with 19% HH and 20% Glenoid

Percent ISR for combined 19% HH and 10% Glenoid nearly equal to isolated 20% Glenoid defect

Figure 1: Percent of Intact Stability Ratio (stability ratio for a given trial divided by the stability ratio in the intact state for that specimen). * P < .05  ** P < .0001
Combined Defects in the Position of Apprehension

Decrease in Percent IT as Humeral Head defect size increases
Decrease in Percent IT as Glenoid defect size increases at each Humeral Head defect size

Figure 2: Percent of Intact Translation (distance to dislocation for a given trial divided by the distance to dislocation in the intact state for that specimen). * P < .05 ** P < .0001

Combined Defects in the Position of Apprehension

Decrease in Percent IT as Humeral Head defect size increases
Decrease in Percent IT as Glenoid defect size increases at each Humeral Head defect size

Figure 2: Percent of Intact Translation (distance to dislocation for a given trial divided by the distance to dislocation in the intact state for that specimen). * P < .05 ** P < .0001
Combined Defects in the Position of Apprehension

Decrease in Percent IT with
- Humeral Head defects ≥ 31%
- Glenoid defects ≥ 20%
- Combined defect with 19% HH and 10% Glenoid

Percent IT for combined 19% HH and 10% Glenoid lower than isolated 20% Glenoid defect
Additional Findings

• There was a notable difference in baseline stability ratio between specimens
  • Not explained by differences in glenoid or humeral head sizes

• Large variance in glenoid concavity depth in the Intact State
  • Range 0.3mm to 2.5mm

• Linear Regression provided the following relationship for the Intact State
  Stability Ratio = 10.7 + 8.9 x Glenoid Concavity Depth (R2 = 0.74)

• Previously reported by Lippitt et al.:
  Stability Ratio = 9.7 + 10.3 x Glenoid Concavity Depth
Additional Findings

• With a 10% loss of glenoid width
  • Loss of glenoid concavity depth ranged from 3% to 42%

• With a 20% loss of glenoid width
  • Loss of glenoid concavity depth ranged from 17% to 76%.
Conclusion

- Stability decreased due to smaller combined defects
- % Intact translation for 10% GD + 19% HH was lower than isolated GD.
Conclusions

• Combined humeral head and glenoid defects produce greater instability than either defect found alone

• In shoulders with combined humeral head and glenoid defects, bony reconstruction may be indicated for humeral head defects as small as 19% of the humeral head diameter and glenoid defects as small as 10% of the glenoid width, especially if the glenoid defect produces a significant loss of glenoid concavity depth


References


References


Thank You