Shoulder Load And Shift Test Repeatability During a Novel Quantitative Ultrasonographic Assessment

Satoshi Takeuchi[1,2], Calvin K. Chan[1], Soichi Hattori[1], Christopher Gibbs[1,2], Satoshi Yamakawa[1]
Yuji Yano[1], Volker Musahl[1,2,3], Albert Lin[1,2], Kentaro Onishi[1,2,4], Richard E. Debski[1,2,3]
[1] Orthopaedic Robotics Laboratory, [2] Department of Orthopaedic Surgery, [3] Department of Bioengineering,
[4] Department of Physical Medicine and Rehabilitation
University of Pittsburgh

Introduction

Anterior instability of the glenohumeral joint is a common pathologic condition. To determine the degree of instability, anterior translation of the glenohumeral joint is generally assessed using the load and shift test. Anterior translation is graded on a scale of 0 to 3 that is based on the anterior-posterior width of the glenoid; however, the test is subjective and has been previously reported as insufficiently repeatable at 43-50%.[1] Since ultrasound has been established as an objective and quantitative method,[2] the repeatability of the load and shift test may be improved using ultrasound.

Objective

To evaluate repeatability of the load and shift test using a quantitative ultrasonographic assessment.

Materials & Methods

- 6 fresh-frozen, cadaveric shoulders (mean age 50.8 years, range 28-58 years)
- Scapula was fixed rigidly to simulate sitting position

Load and shift test

- Compression load to set the humeral head at the center of the glenoid: baseline state
- Anterior translation load (manual max): anterior load state
- 0° and 60° of external rotation (ER 0 and 60) at 0°, 30° and 60° of abduction (ABD 0, 30 and 60)

Ultrasonographic assessment of anterior translation of the glenohumeral joint

- 6-15 MHz linear matrix array ultrasound transducer (LOGIQ S8, GE Healthcare, USA) (Fig. 1A)
- Landmarks: 1) anterior edges of the humeral head and 2) glenoid, and 3) conjoint tendon
- Anterior translation: Difference between anterior edges of the humeral head and glenoid between baseline (D_C) (Fig. 1B) and anterior load states (D_T) (Fig. 1C)

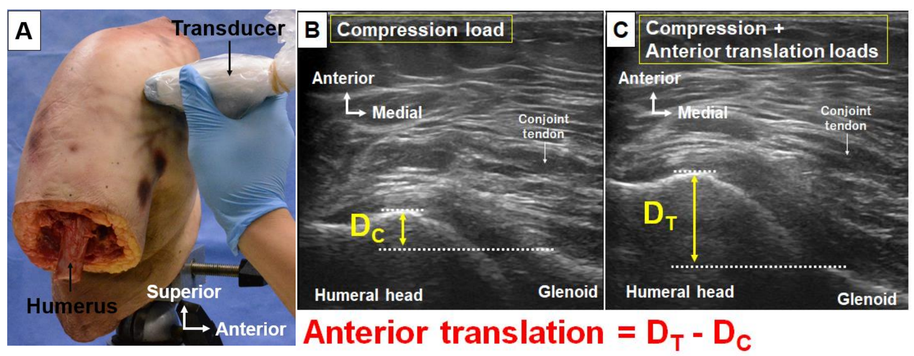
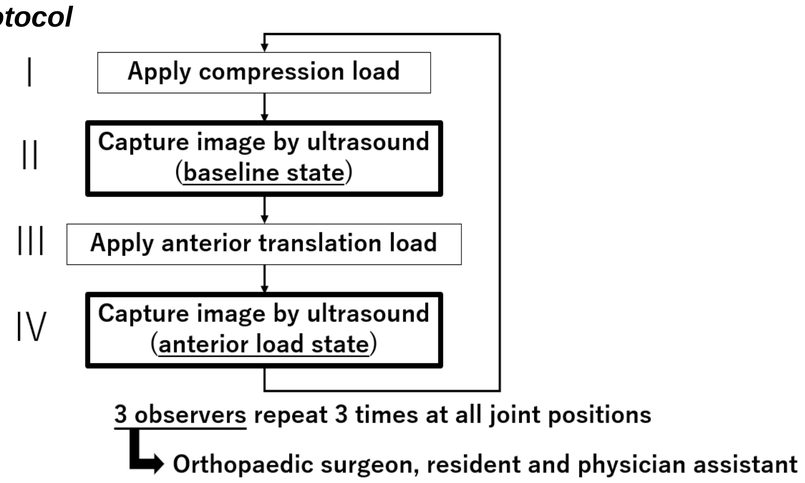


Fig 1: (A) Transducer position
(B) Ultrasound images of the baseline and (C) anterior load states.

Experimental protocol



Statistics

- Intra-class correlation coefficient (ICC)
- One-way ANOVA (significance set at $P < 0.05$)

Results

Repeatability of the load and shift test

At all joint positions,

- Intra-observer repeatability: good to excellent (ICC, 0.712-0.950).
- Inter-observer repeatability: moderate to good (ICC, 0.610-0.834).

Anterior translation of the glenohumeral joint (Table 1)

- Anterior translation of Observer 2: significantly greater than those of other observers.

Table 1: Anterior translation during the load and shift test (mean ± SD, mm)

Joint position	*Observer 1*	*Observer 2*	*Observer 3*	*P value*
Across all positions	**7.2 ± 3.4†**	**9.2 ± 3.1†, §**	**7.6 ± 3.3§**	**0.001***
ABD 0 ER 0	4.2 ± 1.9	5.2 ± 1.9	4.1 ± 1.3	0.235
ABD 0 ER 60	6.1 ± 3.3	7.4 ± 2.4	6.3 ± 3.1	0.502
ABD 30 ER 0	7.2 ± 2.9	9.4 ± 1.8§	6.7 ± 2.1§	0.018*
ABD 30 ER 60	8.8 ± 3.4	11.5 ± 1.9	9.2 ± 2.6	0.050
ABD 60 ER 0	9.5 ± 3.9	10.7 ± 2.0	10.0 ± 3.8	0.661
ABD 60 ER 60	7.8 ± 2.5†	10.8 ± 2.8†	9.4 ± 2.7	0.030*

*; P<0.05, †; Significant difference between observer 1 and 2 (P<0.05)
§; Significant difference between observer 2 and 3 (P<0.05)

Discussion

- Repeatability of the load and shift test
  - Standard grading: poor (0.43-0.50)[1]
  - Ultrasonographic assessment (This study): moderate to excellent (0.610-0.950)
    - Repeatability improved using ultrasound regardless of joint position and observer's clinical experience compared to standard grading system
- Significant difference among observers in anterior translation (P<0.05)
  - Inter-observer repeatability slightly lower than intra-observer repeatability due to the difference of the individual manual max force

Significance

- Repeatability of the load and shift test was improved using a quantitative ultrasonographic assessment.

Acknowledgements
Support from the University of Pittsburgh Swanson School of Engineering, Department of Bioengineering, Orthopaedic Surgery

References
[1] Levy et al. AJSM. 1999.
[2] Rathi et al. Man Ther. 2016