Suspensory Button Fixation Provides Superior Stability to Screws Placed at Oblique Angles: a Biomechanical Analysis

Kyle D. Paul, MD[1], Samuel Schick, MD[1], Joseph W. Elphingstone, MD[1], Marshall Williams, MD[1], John N. Manfredi, BS[1], Achraf Jardaly, MD[2], Susan Floyd[1], Eugene W. Brabston, MD[1], Amit M. Momaya, MD[1], Brent A. Ponce, MD[2]

[1] University of Alabama at Birmingham, Department of Orthopedic Surgery, Birmingham, AL

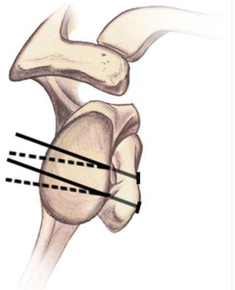
[2] The Hughston Clinic, Columbus, GA

Background

Glenoid bone loss is present in up to 22% of first-time shoulder dislocations, and up to 90% of these patients experience recurrent instability.[1,2] Significant glenoid bone loss (>15%) may warrant bony augmentation.[1,2]

Several fixation methods have been proposed to affix bony grafts. Screws are traditionally used to secure the graft and are preferred by 98% of surgeons.[3] However, screw-related complication rates range from 9 – 30%.[1,4-7] Novel, non-screw fixation methods (suture button constructs) have been described with satisfactory patient outcomes.[8,9]

Improper positioning of graft can occur, resulting in biomechanical instability, nerve damage, and early onset osteoarthritis.[10-12] To our knowledge, no biomechanical studies have compared screws to suspensory fixation in an angled construct.



Methods

Constructs of Interest and Assembly

Arthrex TightRope ® ABS 8 mm x 12 mm AR-1588TB with steel button tensioned to 80N and 3.75mm x 38mm partially threaded, cannulated screws tightened to 9Nm in single or double construct at 0º, 15º, and 30º on 15 lb/ft^3 on Sawbones® blocks

Biomechanical Testing

Based on Willemot et al., 7-phase, 100 cycle per phase, 1Hz, sinusoidal cyclic loading protocol following a stair-step pattern in load control, succeeded by load-at-failure.[13] End level for load-at-failure defined at 7.0mm below zero-point at beginning of each test.

Data and Statistical Analysis

Generalized Linear Models with LSD post-hoc testing to compare load-at-failure and cyclic displacement. Statistical significance set to $p<0.05$

Results

Cyclic Displacement

Single Fixation:

- At 0º and 15º, single screw and single suture button had comparable displacement (p=0.470 and p=0.428, respectively)
- At 30º, single screw had 40% less displacement than single suture button (p=0.001)

Double Fixation:

- At 0º, 15º, and 30º, double screw and double suture button fixation were comparable (p>0.05)

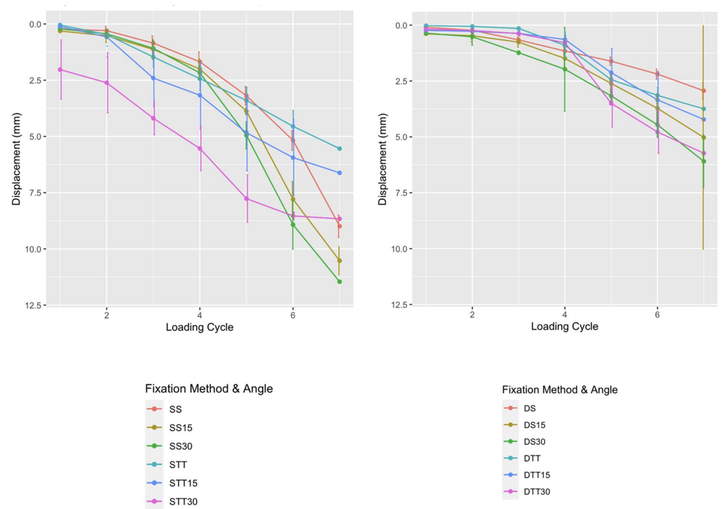


Figure 1: Screw and suture button construct single fixation (left) and double fixation (right)

Load-at-Failure

Single Fixation:

- At 0º, single suture button was 60% stronger than single screw (p<0.001)
- At 15º, single suture button was 52% stronger than single screw (p=0.004)
- Single suture button at 15º and single screw at 0º were comparable (p=0.31)

Double Fixation:

- At 0º, double suture button was 32% stronger than double screw (p<0.001)
- At 15º, double suture button was 35% stronger than double screw (p<0.001)
- Double suture button at 15º and 30º was comparable to double screw at 0º and 15º, respectively (p=0.28 and p=0.77)

Construct			Mean (N)	SD	Min	Max
Single	Screw	SS	196.8	5.8	187.6	201.8
		SS15	146.3	8.2	133.9	152.9
		SS30	114.8	7.7	108.1	126.8
	Suture Button	ST	313.7	50.7	236.9	359.6
		ST15	223.4	95.5	90.9	345.7
		ST30	80.2	11.5	68.6	99.5
Double	Screw	DS	422.0	25.0	387.3	452.3
		DS15	291.5	34.3	252.6	344.5
		DS30	250.2	40.6	186.1	285.2
	Suture Button	DT	557.2	18.6	535.7	576.6
		DT15	394.2	26.4	362.8	432.9
		DT30	299.0	42.0	260.5	360.1

Table 1: Load at Failure

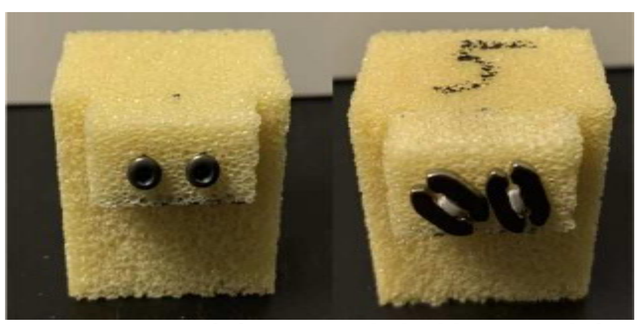


Figure 2: Graft fixation with double screw (left) and double suture-button (right)

Discussion/Conclusion

Suspensory button fixation provides significantly greater load-at-failure capacity over screw fixation **up to 15º**

Suspensory button fixation offers superior strength **even when placed at oblique angle** to screws at 0º

Placement at 0º is optimal regardless of fixation selection, but **suspensory button fixation** may clinically provide more strength while offering **greater margin of error** in graft positioning

References

1. Piasecki, D.P., N.N. Verma, A.A. Romeo, W.N. Levine, B.R. Bach, Jr., and M.T. Provencher, *Glenoid bone deficiency in recurrent anterior shoulder instability: diagnosis and management.* J Am Acad Orthop Surg, 2009. **17**(8): p. 482-93. doi: 10.5435/00124635-200908000-00002

2. Provencher, C.D.R., M.C. Md, S. Bhatia, N. Ghodadra, R. Grumet, B. Bach, et al., *Recurrent Shoulder Instability: Current Concepts for Evaluation and Management of Glenoid Bone Loss.* J Bone Joint Surg Am, 2010. **92**(Supplement_2): p. 133-151. doi: 10.2106/JBJS.J.00906

3. Shareareh, B., T.B. Edwards, A. Shah, and T. Shybut, *Variation in Technique and Post-operative Management of the Latarjet Procedure Amongst Orthopedic Surgeons.* J Shoulder Elbow Surg, 2020. doi: 10.1016/j.jse.2020.07.027

4. Athwal, G.S., R. Meislin, C. Getz, D. Weinstein, and P. Favorito, *Short-term Complications of the Arthroscopic Latarjet Procedure: A North American Experience.* Arthroscopy, 2016. **32**(10): p. 1965-1970. doi: 10.1016/j.arthro.2016.02.022

5. Cerciello, S., K. Corona, B.J. Morris, D.A. Santagada, and G. Maccauro, *Early Outcomes and Perioperative Complications of the Arthroscopic Latarjet Procedure: Systematic Review and Meta-analysis.* Am J Sports Med, 2019. **47**(9): p. 2232-2241. doi: 10.1177/0363546518783743

6. Griesser, M.J., J.D. Harris, B.W. McCoy, W.M. Hussain, M.H. Jones, J.Y. Bishop, et al., *Complications and re-operations after Bristow-Latarjet shoulder stabilization: a systematic review.* J Shoulder Elbow Surg, 2013. **22**(2): p. 286-92. doi: 10.1016/j.jse.2012.09.009

7. Rollick, N.C., Y. Ono, H.M. Kurji, A.A. Nelson, R.S. Boorman, G.M. Thornton, et al., *Long-term outcomes of the Bankart and Latarjet repairs: a systematic review.* Open Access J Sports Med, 2017. **8**: p. 97-105. doi: 10.2147/OAJSM.S106983

8. Boileau, P., P. Gendre, M. Baba, C.E. Thelu, T. Baring, J.F. Gonzalez, et al., *A guided surgical approach and novel fixation method for arthroscopic Latarjet.* J Shoulder Elbow Surg, 2016. **25**(1): p. 78-89. doi: 10.1016/j.jse.2015.06.001

9. Taverna, E., R. D'Ambrosi, C. Perfetti, and G. Garavaglia, *Arthroscopic bone graft procedure for anterior inferior glenohumeral instability.* Arthrosc Tech, 2014. **3**(6): p. e653-60. doi: 10.1016/j.eats.2014.08.002

10. Boileau P, Saliken D, Gendre P, Seeto BL, d'Ollonne T, Gonzalez JF, et al. *Arthroscopic Latarjet: Suture-Button Fixation Is a Safe and Reliable Alternative to Screw Fixation.* Arthroscopy 2019;35(4):1050-61. doi:10.1016/j.arthro.2018.11.012

11. Bukva B, D'Hooghe P, Poberaj B, Alkhelaifi K, Hutchinson M, Landreau P. A combined tension-band braided polyester and suture button technique is a valuable treatment alternative for transverse patellar fractures in athletes. *Musculoskelet Surg* 2019;103(3):283-7. doi:10.1007/s12306-019-00587-1

12. Kalouche I, Crepin J, Abdelmoumen S, Mitton D, Guillot G, Gagey O. Mechanical properties of glenoid cancellous bone. *Clin Biomech (Bristol, Avon)* 2010;25(4):292-8. doi:10.1016/j.clinbiomech.2009.12.009

13. Provencher, M.T., Z.S. Aman, C.M. LaPrade, A.S. Bernhardson, G. Moatshe, H.W. Storaci, et al., *Biomechanical Comparison of Screw Fixation Versus a Cortical Button and Self-tensioning Suture for the Latarjet Procedure.* Orthop J Sports Med, 2018. **6**(6): p. 2325967118777842. doi: 10.1177/2325967118777842