Biomechanical Analysis of Anteroinferior Bankart Repair Anchor Types: Has Technology Surpassed Surgeon Technique?

MIDWEST ORTHOPAEDICS AT RUSH

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BACKGROUND

- Shoulder stabilization surgeries are performed at nearly 7 procedures per 100,000 person-years
- Failed repairs of Bankart lesions can cause recurrent dislocation, subsequent injury, and more complex surgeries that can include bony augmentation
- Current literature on the mechanics of knotless and knotted anchors is conflicting

PURPOSE

To perform a quantitative biomechanical comparison of three labral fixation devices: soft body tensionable knotless anchor (SB knotless), knotted soft body anchor (SB knotted), knotless interference polyetheretherketone (PEEK) hardbody anchor (HB knotless).

HYPOTHESIS

- The three anchor types will exhibit similar biomechanical properties including elongation, failure load, and stiffness but the SB knotless would display different failure mechanisms from the SB knotted and HB knotless anchors

METHODS

Specimen Properties

- 21 glenoid cadavers underwent CT scans to assess bone quality in the region intended for anchor fixation
- Each shoulder was randomized into one of the three groups
- The three groups were comparable in mean age, bone mineral density, and BMI

Specimen Preparation

- The humeral head was disarticulated from the glenoid, and artificial Bankart lesions were created with a scalpel on the AI quadrant of the labrum
- Specimen were then potted in acrylic cement, ensuring as much scapular spine was embedded in the acrylic as possible, with the glenoid fossa 1 cm above the PVC pipe
- 3 anchors of the same type were placed at the 3:30, 4:30, and 5:30 labral positions. Sutures were passed through 1 cm of tissue and knotted anchors were tied with 5 square knots

Mechanical Testing

- Anchors were tested simultaneously as one construct by pulling the capsular tissue connected to the AI quadrant, pulling perpendicular from the glenoid
- Preload testing (5N for 2 min) was followed by cyclic loading (5-25 N, 100 cycles) then by load-to-failure testing (15mm/min).
- Mechanical testing variables and failure mechanism were recorded (bone failure, capsule failure, or implant failure)

RESULTS

Anchor Group	SB Knotless	SB Knotted	HB Knotless	P-Value
Maximum Load to Failure (N)	309.7 ± 125.6	226.4 ± 34.8	256.5 ± 90.5	0.25
Stiffness (N/mm)	31.9 ± 8.5	23.0 ± 5.2	34.1 ± 16.5	0.13
Energy to Peak Load (N-mm)	3352.2 ± 1893.2	2260.9 ± 1065.8	2436.7 ± 1569.0	0.40
Cyclic Creep (mm)	2.8 ± 1.2	3.1 ± 1.8	2.2 ± 0.9	0.44
Cyclic Elongation (mm)	1.1 ± 0.5	1.2 ± 0.7	0.80 ± 0.4	0.40
Elongation Amplitude (mm)	0.85 ± 0.19	0.84 ± 0.17	0.85 ± 0.18	0.99
1st Cycle Excursion (mm)	1.7 ± 0.8	2.0 ± 1.3	1.4 ± 0.5	0.52
Extrusion at Max Load (mm)	19.1 ± 6.6	18.5 ± 8.0	13.8 ± 4.8	0.28

Figure 1. Results of mechanical testing. Data are reported as means ± standard deviation

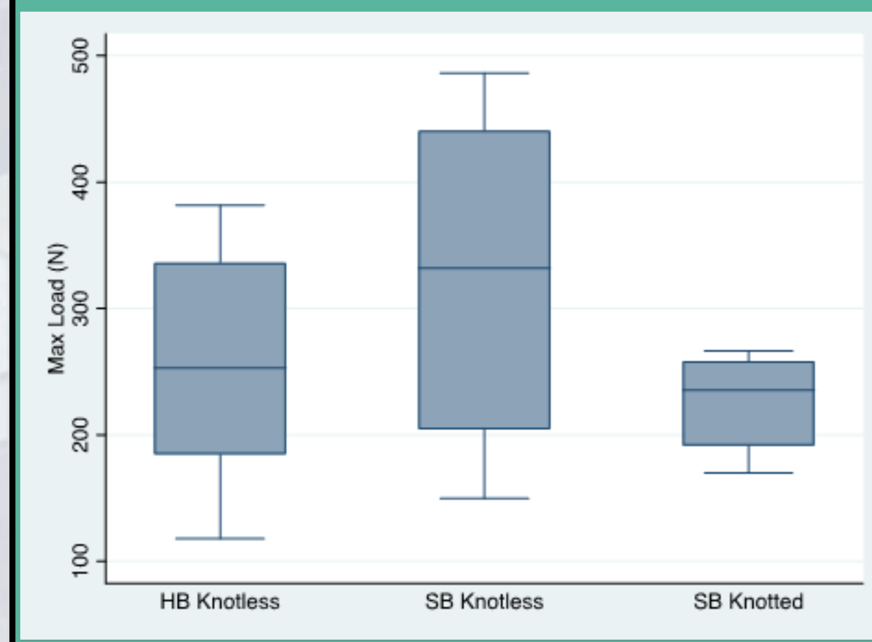

Figure 2. Boxplot demonstrating max load to failure by anchor type

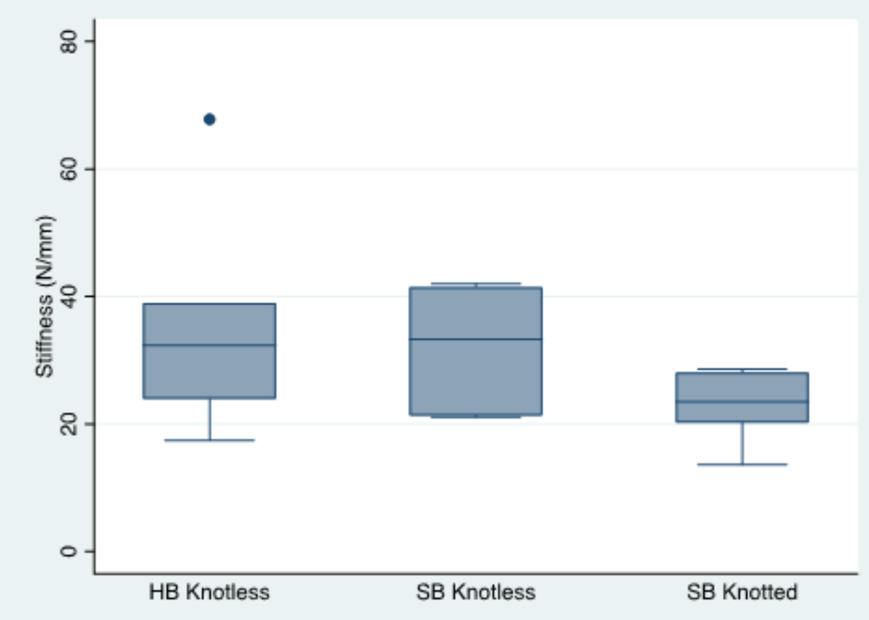

Figure 3. Boxplot demonstrating construct stiffness by anchor type

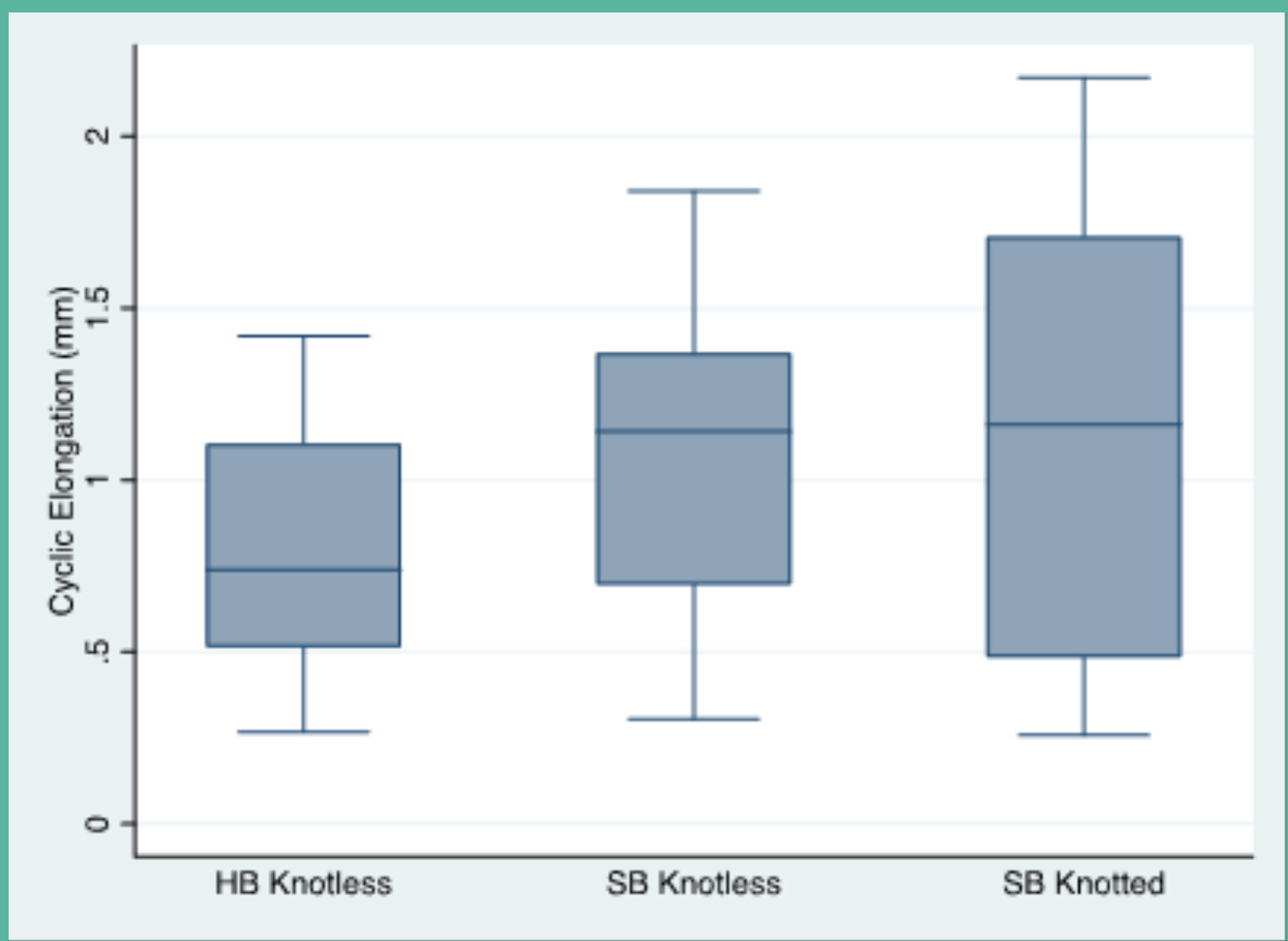

Figure 4. Boxplot demonstrating cyclic elongation by anchor type

RESULTS

Human Cadaveric Properties

Anchor Group	SB Knotless	SB Knotted	HB Knotless	P-Value
Age (years)	58.3 ± 7.3	62.6 ± 7.1	58.6 ± 5.9	0.43
Body Mass Index	26.0 ± 7.6	26.5 ± 5.8	30.4 ± 6.2	0.42
Bone Mineral Density (HU)	254.0 ± 59.9	238.4 ± 59.9	254.6 ± 51.1	0.84
Laterality (Right)	4 (57.1%)	6 (85.7%)	7 (100%)	0.26
Sex (Female)	0 (0%)	4 (57.1%)	2 (28.6%)	0.098

Figure 4. Human cadaveric shoulder specimen properties

- Cadaveric specimen were similar in age, BMI, bone mineral density, laterality, and sex

Impact of Demographic Factors

- As shown in Figure 1, no anchor types were found to be significantly different in max load to failure, stiffness, and cyclic elongation among our other variables

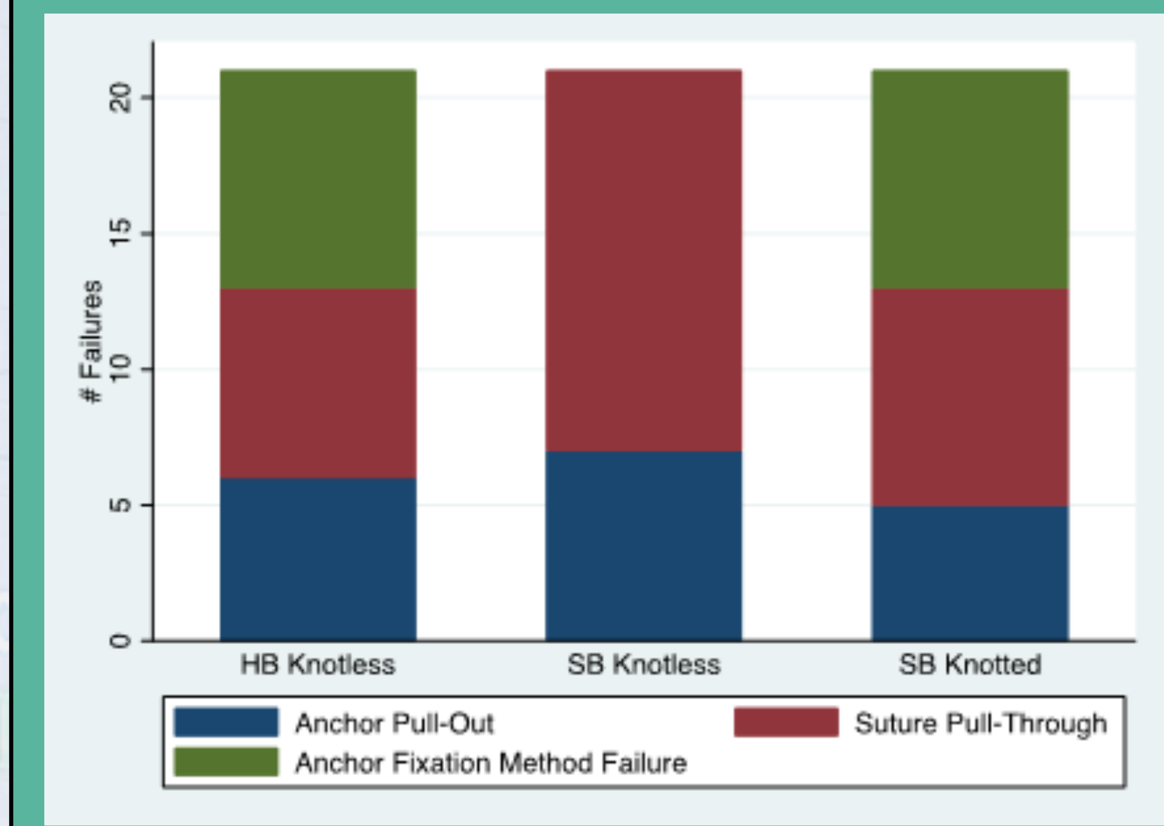

Figure 5. Demonstration of failure mechanisms by anchor type

Failure Mechanisms

- As seen in Figure 5, SB knotless anchors had 0 failure due to anchor fixation, supporting the authors hypothesis
- Data support the benefit of SB knotless anchors in avoiding know failure seen with knotted anchors

CONCLUSION

- The SB knotless device had significantly fewer anchor fixation method failures than the SB knotted anchors
- With no significant mechanical testing differences found between the three anchor, all suture anchors provide adequate repair strength for Bankart lesions
- HB knotless and SB knotless anchors had different failure mechanisms revealing an area of future study
- Advantages of the new SB knotless anchors include:

1. Smaller holes in the glenoid which may reduce fractures
2. Due to size, multiples places of fixation can be achieved
3. Facilitates percutaneous placement of anchors allowing inferior fixation, critical to instability repairs
4. Allow opportunity to retention anchors
5. Removes variability/difficulty with knot tying