# Suture anchor selection

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## I. Introduction

### History

- Du Toit & Roux (1956): Johannesburg stapling technique
- Dr. LL Johnson

### Clinical applications of suture anchors in shoulder surgery

Principally for the fixation of tendons of ligaments to bone
- Glenohumeral instability
- Rotator cuff repair
- SLAP lesion repair
- Biceps tenodesis
- Hand, elbow, knee, foot surgery

### Advantages

- less exposure(arthroscopic)
- standardized load to failure properties
- better holding strength
- ease of insertion
- multiple sutures

### Disadvantages

- increased costs(anchors and instruments)
- extra instrumentation
- learning curve to master
- consider "Deadman s" angle

**Desirable features (Ideal Implant)**

- easy to implant
- excellent pullout strength
- prevent suture abrasion
- does not "complicate" subsequent surgery
- will be bioabsorbable with no reaction from the patient as the material dissolves.

## II. Biomechanical considerations in suture anchor design

- anchor pullout strength
- suture tensile strength
- anchor-suture interface

## III. Implant size considerations

- must be large enough to have adequate load strength
- must be small enough to fit in the space without the tendency to come loose or damage the adjacent structures
- larger anchors are better suited for the cuff repair, smaller anchors are better for the Bankart and SLAP repairs

(3.5 mm to 4.1 mm diameter in the maximum size for labral repair)

- Ideally, the smallest implant of sufficient strength to obtain the most stable fixation for soft-tissue healing will allow not only multiple fixation points but also minimizing articular surface compromise and maximize restoration of the normal anatomy.

## IV. Implant design considerations

- anchor pullout strength
- suture-anchor interface (eyelet) design
- anchor material composition
- eyelet design and orientation

## V. Suture material considerations

- decreased incidence of suture breakage during knot tying, limiting anchor compromise

- strength and ease of sliding for knot tying
- knot durability related to suture slippage (unraveling)
- suture cutout through repaired tissue

## VI. Potential benefits of bioabsorbable suture anchors

- greater ease of postoperative imaging
- potential restoration of bone stoke, after resorption
- ease revision surgery

## VII. Knotless suture-based anchors

- Require familiarity with their use
- Provide secure suture fixation of soft tissue to bone
- Do not require knot tying
- Provide a no-profile or low-profile repair without requiring a nonsuture component of the anchor to remain intraarticular
- Suture-first technique vs. through-tissue technique

## VIII. Sutureless anchors in shoulder surgery

- Bankart stabilization & rotator cuff surgery
- Simplicity of their insertion
- Overall sucess is inferior to that of suture anchors
- Possibly significant complications (inflammatory reactions, intraarticular migration, failure reduction)

## IX. Potential sources of anchor failure

Goradia: - Bioabsorbable tacks/metal suture anchors/transosseous sutures
- cyclic loading, cadaver model
- No. of cycles to 100% failure: tack group >> transosseous group

Cummins: - Sheep rotator cuff model
- Bioabsorbable tacks/Mitek rotator cuff Quick Anchors
- Inferior initial load properties in bioabsorbable tacks

Wilkerson: Bioabsorbable tacks used in rotator cuff and labral repairs have been reported to break and back out from tacks s insertion point

Thal: - suture strength
- knotless suture anchor > standard suture anchors

Zumstein - Mitek G II standard metal anchor/Mitek knotless suture anchors
- cadaveric glenoids
- The standard anchor allowed significantly less suture displacement than the knotless anchor, although the ultimate tensile strength and mode of failure were similar.

# Failure point of suture anchors

- at the suture-tendon interface
- in the suture substance
- at the suture-anchor interface
- in the anchor itself
- at the anchor-bone interface

**Suture materials**

Baber: - Biomechanical evaluation of several suture and anchor types
- No.2 Ethibond failed at 92N of load
  No.5 193N of load
  No.2 Panacryl(Ethicon) 99N of load
  No.2, 5, 2-0 Fiberwire(Arthrex) 188N, 483N, 82N of load
- The suture anchors all failed at higher loads than their associated sutures.

**Interface between the suture anchors and structure strands**

Bardana: - sutures oriented at 45° to the anchor are significantly more prone to abrasion and breakage
- rotation of the suture with respect to the anchor did not significantly affect the abrasion rate of the suture.

Meyer: - increased suture abrasion at 45°
- decreased suture failure load by 73%
- anchor eyelet design may also influence suture abrasion

**Anchor mechanical strength: design/material**

- Biodegradable polymers, bioabsorbable suture anchors
- PLA(polylactic acid), PGA(polyglycolic acid)
- The time period of mass loss
    - molecular weight of polymer
    - crystallinity

- porosity
- advantage: little artifact generation on MRI
  Avoid problems with permanent implants such as during revision surgery
- disadvantage: more expensive
  Increased wear characteristics at eyelet

**Biomechanical strength of absorbable and nonabsorbable anchors**

Demirhan: 75% loss of initial pullout strength of PGA wedge-type suture anchors within the first 3 weeks compare with similar nonabsorbable anchors
Bardana: eyelet failure in bioabsorbable anchors
Dejong: no significant differences

**Suture anchor vs transosseous tunnel technique**

Reed: suture anchor(in the suture) >> TTT(in the bone)
Burkart: Mitek RC > TTT
Lewis: no differences in healing time, but, anchor > TTT

Must consider: The suture type
Implant design
Implant material

## X. Technical considerations

Anchor orientation/Implantation patterns/Implant locations

### Anchor orientation

Burkart:
- ideal orientation of suture anchors in RC => "Deadman"
- ideal angle between the anchor and pull of the RC should be ≤ 45°

Liporace: in vivo study, similar pullout strength : 30°∼90°

### Single or Double rows

Double row may reestablish the rotator cuff footprint
--> may allow for better healing
--> may restore the biomechanical properties of the healed cuff

Woltrip, Demirhan:
Duel site fixation (suture anchor + TTT) > single row or TTT alone

Location: important role in anchor pullout strength

Meyer: BMD below the articular surface and in the GT in FTRCT

<< intact specimens

Baber: GT cadaver (avg. 80yrs)

- posterior area of GT > anterior
- no difference between GT, LT, humeral neck
- no correlation between BMD and suture anchor pullout strength

Tingart et al:

- CT
- total , trabecular, cortical BMD in different regions of the GT & LT
- higher BMD in posterior portion of GT
- clear association between BMD and load to failure

## XI. Complications of anchor use

- failure of the tissue, suture, or anchor before healing

Kaar (Metallic anchors)

- extraosseous anchor placement
- anchor migration
- intraarticular anchor dislodgement with consequent articular damage
- local foreign body reaction

Bioabsorbable anchors

- Inflammatory reaction

## XII. Summary

1. Many design features including suture type, anchor size and geometry, and anchor material, play a role in the overall strength of the anchor. In addition, technical considerations such as implant orientation, pattern, and location may affect the ultimate success of the repair.
2. Multiple fixation points provide a biomechanically sounder construct in Bankart repair. The size of the glenoid and its rim make anchor size a critical consideration in implant selection and implementation.

## REFERENCES

1. Athanasiou KA, Agrawal CM, Barber FA, et al: Current Concepts: Orthopaedic applications for PLA-PGA biodegradable polymers. Arthroscopy 14:726-737, 1998
2. Barber FA, Feder SM, Burkhart SS, et al: The relationship of suture anchor failure and bone density to proximal humerus location: A cadaveric study. Arthroscopy 13:340-345, 1997

3. Barber FA, Herbert MA, Click JN: Suture anchor strength revisited. Arthroscopy 12:32-38, 1996
4. Barber FA, Herbert MA, Richards DP: Sutures and suture anchors: Update 2003. Arthroscopy 19:985-990, 2003
5. Bardana DD, Burks RT, West JR: The effect of suture anchor design and orientation on suture abrasion: An in vitro study. Arthroscopy 19:274- 281, 2003
6. Cummins CA, Strickland S, Appleyard RC, et al: Rotator cuff repair with bioabsorbable screws: An in vivo and ex vivo investigation. Arthroscopy 19:239-248, 2003
7. Burkhart SS: The deadman theory of suture anchors: Observations along a south Texas fence line. Arthroscopy 11:119-123, 1995
8. Burkhart SS, Diaz Pagan JL, Wirth MA, et al: Cyclic loading of anchor based rotator cuff repairs: Confirmation of the tension overload phenomenon and comparison of suture anchor fixation with transosseous fixation. Arthroscopy 13:720-724, 1997
9. Burkart A, Imhoff AB, Roscher E: Foreign-body reaction to the bioabsorbable Suretac device. Arthroscopy 16:91-95, 2000
10. Chow JC, Gu Y: Material reaction to suture anchor. Arthroscopy 20: 314-316, 2004
11. Dejong ES, DeBerardino TM, Brooks DE, et al: In vivo comparison of a metal versus biodegradable suture anchor. Arthroscopy 20:511-516, 2004
12. Demirhan M, Atalar AC, Kilicoglu O: Primary fixation strength of rotator cuff repair techniques: A comparative study. Arthroscopy 19:572-576, 2003
13. Demirhan M, Kilicoglu O, Akpinar S, et al: Time-dependent reduction in load to failure of wedge-type polyglyconate suture anchors. Arthroscopy 16:383-390, 2000
14. Galatz LM, Ball CM, Teefey SA, et al: The outcome and repair integrity of completely arthroscopically repaired large and massive rotator cuff tears. J Bone Joint Surg Am 86A:219-224, 2004
15. Goradia VK, Mullen DJ, Boucher HR, et al: Cyclic loading of rotator cuff repairs: A comparison of bioabsorbable tacks with metal suture anchors and transosseous sutures. Arthroscopy 17:360-364, 2001
16. Kaar TK, Schenck RC Jr, Wirth MA, et al: Complications of metallic suture anchors in shoulder surgery: A report of 8 cases. Arthroscopy 17:31-37, 2001
17. Lewis CW, Schlegel TF, Hawkins RJ, et al: Comparison of tunnel suture and suture anchor methods as a function of time in a sheep model. Biomed Sci Instrum 35:403-408, 1999
18. Liporace FA, Bono CM, Caruso SA, et al: The mechanical effects of suture anchor insertion angle for rotator cuff repair. Orthopedics 25: 399-402, 2002
19. Lo IK, Burkhart SS: Double-row arthroscopic rotator cuff repair: reestablishing the footprint of the rotator cuff. Arthroscopy 19:1035-1042, 2003
20. Magee T, Shapiro M, Hewell G, et al: Complications of rotator cuff surgery in which bioabsorbable anchors are used. Am J Roentgenol 181:1277-1231, 2003
21. Meyer DC, Felix E, Ruffieux K, et al: Influence of test temperature and test speed on the mechanical strength of absorbable suture anchors. Arthroscopy 20:185-190, 2004
22. Meyer DC, Fucentese SF, Koller B, et al: Association of osteopenia of the humeral head with full-thickness rotator cuff tears. J Shoulder Elbow Surg 13:333-337, 2004
23. Meyer DC, Nyffeler RW, Fucentese SF, et al: Failure of suture material at suture anchor eyelets. Arthroscopy 18:1013-1019, 2002
24. Reed SC, Glossop N, Ogilvie-Harris DJ: Full thickness rotator cuff tears. A biomechanical comparison of suture versus bone anchor techniques. Am J Sports Med 24:46-48, 1996
25. Tauro JC: Arthroscopic rotator cuff repair: Analysis of technique and results at 2- and 3-year follow-up.

Arthroscopy 14:45-51, 1998

26. Thal R: A knotless suture anchor: Design, function, and biomechanical testing. Am J Sports Med 29:646-649, 2001
27. Tingart MJ, Apreleva M, Zurakowski D, et al: Pullout strength of suture anchors used in rotator cuff repair. J Bone Joint Surg Am 85A:2190-2198, 2003
28. Waltrip RL, Zheng N, Dugas JR, et al: Rotator cuff repair. A biomechanical comparison of three techniques. Am J Sports Med 31:493-497, 2003
29. Warme WJ, Arciero RA, Savoie FH, et al: Nonabsorbable versus absorbable suture anchors for open Bankart repair: A prospective, randomized comparison. Am J Sports Med 27:742-746, 1999
30. Wilkerson JP, Zvijac JE, Uribe JW, et al: Failure of polymerized lactic acid tacks in shoulder surgery. J Shoulder Elbow Surg 12:117-121, 2003
31. Zumstein M, Jacob HA, Schneeberger AG: In vitro comparison of standard and Knotless metal suture anchors. Arthroscopy 20; 517-520, 2004