

Knotless Double-Row Rotator Cuff Repair

Scientific Update



As the understanding of anatomy and techniques has improved, rotator cuff repair has advanced from single-row to double-row repair. A double-row repair is the current gold standard for restoration of anatomy, biomechanical strength, and postoperative healing. Initial double-row repairs consisted of two independent rows of anchors. The advancement of knotless technology provided the ability to create suture-bridging constructs in which sutures from the medial anchors were secured laterally with knotless anchors to create linked constructs.

Initially, these constructs were created by first tying knots medially, and then bringing the remaining limbs out to additional anchors. However, completely knotless double-row constructs such as the SpeedBridge™ repair can be created and have biomechanical and clinical advantages over knot-tying constructs.¹⁻⁸ Biomechanically, knotless repairs appear to be more reliable and increase the self-reinforcing phenomenon of a double-row rotator cuff repair in which the tendon is compressed across the footprint under load.¹⁻³ Clinically, a knotless technique reduces operative time and leads to equivalent or improved healing rates compared to knotted repairs. The same studies also support a lower retear rate for a double-row versus single-row repair.⁴⁻⁸

Hanypsiak BT,
DeLong JM,
Simmons L,
Lowe W,
Burkhart S

Biomechanical Studies

[Knot strength varies widely among expert arthroscopists.](#) *Am J Sports Med.* 2014;42(8):1978-1984. doi:10.1177/0363546514535554

- 73 expert surgeons were asked to tie 5 knots using their preferred knot
- Mean load to failure was 231 N; however, the range was 29 N to 360 N, and the standard deviation of the individual surgeon ranged from 6 N to 133 N
- Variability persisted regardless of whether the surgeon performed more or less than 200 arthroscopic cuff repairs per year
- Only 37% of surgeons had an average load to failure within 20% of the mean, and only 18% of the individual knots had a load to failure within 20% of the mean

Takeaway: There is considerable variability BOTH between surgeons and within knots tied by surgeons using their go-to knot.

Denard PJ,
Adams CR,
Fischer NC,
Piepenbrink M,
Wijdicks CA

[Knotless fixation is stronger and less variable than knotted constructs in securing a suture loop.](#) *Orthop J Sports Med.* 2018;6(5):2325967118774000. doi:10.1177/2325967118774000

- 34 surgeons completed suture loops either by tying knots or creating a knotless construct with a 5.5 SwiveLock® anchor and #2 FiberWire® or FiberTape® suture
- Load to failure was the highest with the knotless FiberTape technique (276 N compared to 161 N/151 N; $P < .001$)
- Load to 3 mm of displacement (indicating loss of loop security) was higher with the FiberTape technique (199 N) compared to the knotless FiberWire technique (90 N; $P < .001$) and knotted FiberWire technique (59 N; $P < .001$). The difference between the knotless FiberWire and knotted FiberWire technique was also significant ($P = .024$).
- Variability based on an F -test for variance was highest in the knotted group

Takeaway: Based on the assessment of multiple surgeons, a knotless technique leads to improved construct strength, loop security, and reliability compared to a knotted technique. Parameters are improved with FiberTape suture compared to #2 suture.



Park MC,
McGarry MH,
Gunzenhauser RC,
Benefiel MK,
Park CJ,
Lee TQ

[Does transosseous-equivalent rotator cuff repair biomechanically provide a “self-reinforcement” effect compared with single-row repair?](#) *J Shoulder Elbow Surg.* 2014;23(12):1813-1821. doi:10.1016/j.jse.2014.03.008

- Biomechanical study of 10 matched pairs of cadavers comparing a single-row repair to a linked double-row repair with #2 suture (SutureBridge™ repair). Contact properties were measured as the supraspinatus was loaded (0, 20, 40, 60, and 80 N).
- Contact area, contact pressure, and peak contact pressure were all higher with the linked double-row repair
- Contact pressure increased with a progressive supraspinatus load and increased with a higher slope in the double-row repair compared to the single-row repair, indicating self-reinforcement

Takeaway: Linked double-row repairs demonstrate self-reinforcing properties whereby the repair is pressurized when subjected to medial load. This may improve clinical healing.

Smith GCS,
Bouwmeester TM,
Lam PH

[Knotless double-row SutureBridge rotator cuff repairs have improved self-reinforcement compared with double-row SutureBridge repairs with tied medial knots: a biomechanical study using an ovine model.](#) *J Shoulder Elbow Surg.* 2017;26(12):2206-2212. doi:10.1016/j.jse.2017.06.045

- Biomechanical study of 9 matched pairs of ovine shoulders comparing a SutureBridge double-row repair with medial knots to a completely knotless technique (no medial knots). Footprint contact pressure was measured with progressive load (0 N-60 N)
- Load to failure was equivalent between the groups
- Footprint contact pressure increased under load in both groups; however, the progression (slope) in contact pressure was greater in the knotless group

Takeaway: Self-reinforcement of a linked double-row repair may be higher with a completely knotless technique.

Park MC,
Peterson AB,
McGarry MH,
Park CJ,
Lee TQ

[Knotless transosseous-equivalent rotator cuff repair improves biomechanical self-reinforcement without diminishing footprint contact compared with medial knotted repair.](#) *Arthroscopy.* 2017;33(8):1473-1481. doi:10.1016/j.arthro.2017.03.021

- Biomechanical study of 8 matched pairs comparing SpeedBridge™ repair with SpeedBridge repair with addition of medial knots (2 mattress sutures). Footprint contact pressure was measured with progressive load.
- Self-reinforcement, measured as the slope of contact pressure under load, was greater with the knotless construct
- Medial knots show an adverse biomechanical effect by inhibiting self-reinforcement

Takeaway: Further support for the concept that self-reinforcement of a linked double-row repair may be higher with a completely knotless technique.



Hoffman TR,
Lamplot JD,
McClish SJ,
Payne C,
Denard PJ

[Three medial all suture anchors improves contact force compared to two hard body anchors in a biomechanical two-tendon rotator cuff tear model.](#) *Arthrosc Sports Med Rehabil.* Accepted manuscript. Published online August 4, 2022. doi:10.1016/j.asmr.2022.05.012

- This was a two-part biomechanical study
- Part 1: Double-row repairs were compared in 12 matched-paired cadavers in a 2-tendon rotator cuff tear model
 - FiberTak® SpeedBridge™ repair: three 2.6 mm all-suture anchors medially
 - Classic SpeedBridge repair: two 4.75 mm SwiveLock® anchors medially
 - Both groups had two 4.75 mm SwiveLock anchors laterally
- No difference was observed in load-to-failure or cyclic displacement between groups
- Part 2: SynDaver® model was used to assess footprint contact area under 10-N incremental loads up to 40 N
- Contact force higher in the FiberTak SpeedBridge group as follows:
 - 25% increase at 20 N ($P = .01$)
 - 26% increase at 30 N ($P = .02$)
 - 30% increase at 40 N ($P = .04$)

Takeaway: The increased points of fixation and suture crossings in the 3 medial anchor FiberTak SpeedBridge construct improves contact force compared to a classic SpeedBridge construct

Takeaway: Furthermore, the difference in contact force progressively increases with larger medial loads, suggesting improved footprint compression with the FiberTak SpeedBridge construct. The FiberTak SpeedBridge construct may therefore be particularly beneficial in larger rotator cuff tears.

Clinical Studies

[Arthroscopic rotator cuff repair using modified Mason-Allen medial row stitch: knotless versus knot-tying suture bridge technique.](#) *Am J Sports Med.* 2012;40(11):2440-2447. doi:10.1177/0363546512459170

- Prospective evaluation of 110 arthroscopic rotator cuff double-row repairs of medium-sized tears, of which 51 were repaired with a completely knotless technique and 59 had medial knots
- Mean follow-up was 21 to 22 months
- Based on postoperative MRI, healing was 94% in the knotless group compared to 81% in the group with medial knots ($P < .001$)
- There were no medial failures in the knotless group, whereas 8 of 11 failures in the knotted group were medial (type II) failures

Takeaway: A completely knotless technique may improve healing and decrease medial failures compared to a double-row technique with medial knots.

Rhee YG,
Cho NS,
Parke CS



Johannsen AM,
Arner JW,
Elrick BP,
Nolte PC,
Rakowski DR,
Horan MP,
Millett PJ

[Minimum 10-year outcomes of primary arthroscopic transosseous-equivalent double-row rotator cuff repair.](#) *Am J Sports Med.* 2021;49(8):2035-2041. doi:10.1177/03635465211015419

- Retrospective evaluation of double-row rotator cuff repairs for full-thickness rotator cuff tears of 1 to 3 tendons (involving at least the supraspinatus) at one center
- Patient-reported outcomes and need for revision were assessed for 91 repairs at a minimum of 10 years postoperatively
 - 47 knotted repairs (SutureBridge™ repair)
 - 44 knotless repairs (SpeedBridge™ repair)
- Only 5 patients (5.5%) required revision surgery
- Mean postoperative ASES score was 93 points
- Mean postoperative SANE score was 88 points

Takeaway: Following a double-row repair of a full-thickness supraspinatus tear with a knotted or a knotless technique, there is a very low chance (~5%) of revision 10 years following repair.

Pogorzelski J,
Fritz EM,
Horan MP,
Katthagen JC,
Hussain ZB,
Godin JA,
Millett PJ

[Minimum five-year outcomes and clinical survivorship for arthroscopic transosseous-equivalent double-row rotator cuff repair.](#) *J Am Acad Orthop Surg.* 2019;27(24):e1093-e1101. doi:10.5435/JAAOS-D-18-00519

- Retrospective cohort study with a single surgeon
- Comparative analysis with patients who underwent arthroscopic rotator cuff repair (RCR) with a knotless tape bridge (TB) repair to those who had a knotted suture bridge (SB) repair technique at a minimum of 5 years of follow-up
- 192 shoulders were analyzed for a minimum of 5-year follow-up with a mean follow-up of 6.6 years
- For TB repairs, scores improved significantly ($P < .001$) and for SB repairs, all scores improved but only the ASES score and SF-12 PCS ($P < .05$) demonstrated statistical significance
- Postoperative clinical survivorship was 96.6% and 93.6% for knotted SB repairs and 96.7% and 93.9% for knotless TB repairs at 2 and 5 years

Takeaway: Patients treated with double-row transosseous-equivalent rotator cuff repair using either a knotted SB or knotless TB repair showed excellent clinical results in primary and revision cases and in small or large tears with low revision surgery rates.

Takeaway: Patients who had transosseous-equivalent repairs also showed significant improvements in patient-reported outcomes at 5 years postoperatively.

Eibuluk AM,
Coxe FR,
Fabricant PD,
Ramos NL,
Alaia MJ,
Jones KJ

[Does medial-row fixation technique affect the retear rate and functional outcomes after double-row transosseous-equivalent rotator cuff repair?](#) *Orthop J Sports Med.* 2019;7(5):2325967119842881. doi:10.1177/2325967119842881

- Systematic review of 32 studies comparing double-row repairs with and without knots
- 5 studies reported on completely knotless transosseous-equivalent techniques, 25 reported on techniques with medial knots, and 2 reported on both
- Both techniques resulted in similar improvements in functional outcomes
- There was a downward trend in retear rates using a completely knotless technique

Takeaway: While prospective studies are warranted, a completely knotless technique results in an equivalent functional outcome and perhaps decreased retearing compared to a knotted technique.



Millett PJ,
Espinoza C,
Horan MP,
Ho CP,
Warth RJ,
Dornan GJ,
Katthagen JC

[Predictors of outcomes after arthroscopic transosseous equivalent rotator cuff repair in 155 cases: a propensity score weighted analysis of knotted and knotless self-reinforcing repair techniques at a minimum of 2 years.](#) [published correction appears in *Arch Orthop Trauma Surg.* 2017;137(12):1761]. *Arch Orthop Trauma Surg.* 2017;137(10):1399-1408. doi:10.1007/s00402-017-2750-7

- Retrospective review of 35 SutureBridge™ repairs (medial knots) to 102 knotless SpeedBridge™ repairs performed by a single surgeon
- No difference in functional outcome
- 52 patients had an MRI at a mean of 4.4 years postoperative
- Retear rate was 33% (4 of 12) in the knotted group, compared to 7.5% (3 of 40) in the SpeedBridge group

Takeaway: The SpeedBridge repair with 2 mm FiberTape® construct appears to reduce retear rates compared to a traditional SutureBridge with #2 suture and medial knots.

Dukan R,
Ledinot P,
Donadio J,
Boyer P

[Arthroscopic rotator cuff repair with a knotless suture bridge technique: functional and radiological outcomes after a minimum follow-up of 5 years.](#) *Arthroscopy.* 2019;35(7):2003-2011. doi:10.1016/j.arthro.2019.02.028

- Prospective evaluation of knotless SpeedBridge™ repairs for supraspinatus tears at one center
- 68 patients were evaluated clinically at a minimum of 5 years postoperative
- MRI was performed to assess healing at 2 years postoperative
- ASES score improved 48 points to 87 points
- 88% of tendons were healed postoperatively

Takeaway: A knotless SpeedBridge technique leads to excellent functional outcomes at a minimum of 5 years postoperative and has a healing rate of nearly 90% when used for single-tendon tears.

Burns KA,
Robbins L,
LeMarr AR,
Childress AL,
Morton DJ,
Wilson ML

[Rotator cuff repair with knotless technique is quicker and more cost-effective than knotted technique.](#) *Arthrosc Sports Med Rehabil.* 2019;1(2):e123-e130. doi:10.1016/j.asmr.2019.09.005

- Retrospective cohort study with 37 eligible patients undergoing arthroscopic rotator cuff repair performed by a single surgeon at an institution from 2 different 6-month periods of time
- 15 patients underwent a knotted suture bridge rotator cuff repair using Smith & Nephew Healicoil™ DL anchors
- 22 patients underwent a knotless suture bridge rotator cuff repair technique using Arthrex SpeedBridge™ repair with SwiveLock® anchors
- Operating room time also was reduced by approximately 40% (79.5 minutes for knotless; 121 minutes for knotted). Procedure time was 43.5 minutes for the knotless groups and 80 minutes for the knotted group.
- Operating room costs were significantly lower in the knotless group (MKL = \$3788.40, MKT = \$4262.90, $P < .01$)

Takeaway: Even though the knotless technique used more anchors and had a higher implant cost, it required less surgical procedure time and cost less overall than the knotted technique. Both had equivalent clinical results at short- and long-term follow-up.



References

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