

## Dual Row Rotator Cuff Repair: Current & Evolving Techniques

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### Rotator Cuff Repair: Reasons for Failure

- Inadequate healing
  - Poor tendon quality (degenerated, retracted)
  - Muscle atrophy
  - Inadequate tendon bone contact (footprint restoration)
- Inadequate repair
  - Poor anchor fixation strength
    - Weak anchor
    - Osteoporotic bone
  - Inadequate initial fixation (knot tension, loop security)
  - Late suture or knot failure

### The Problem with Single Row Repair

- High rate of failure (recurrent tear)
- Limited contact area (footprint)

### Do Recurrent Tears Matter? Strength Correlates with Cuff Integrity!

- Lafosse JBJS July 2007
- Cole: J Shoulder Elbow Surg. July 2007
- Boileau: JBJS June 2005 (FE strength 7.3 vs 4.7 Kg)
- Sugaya JBJS Am. 2007 May
- Lichtenberg: Knee Surg Sp Tr Arth. 2006 Nov
- Bishop: J Shldr Elbw Surg. 2006 May-Jun

### Advantages of Dual Row

- Restore anatomic foot print
- Minimize pop motion at repair site

- Limit synovial fluid migration into repair site
- Extend healing surface
- Improve biomechanical strength with multiple points of fixation
- Improve contact pressure
- Stronger repair?
- Lower re-tear rate?
- Faster rehab?
- Better results????

### Footprint: Summary

- Normal            Approximately 12~15mm
  - Nottage Arthroscopy 2004
- Single Row
  - 5~6 mm
- Technique
  - Two separate rows
  - Suture bridge  
(Suture spanning)  
(transosseous equivalent)

### Review literature ● on Dual Row:

- Biomechanical studies
  - Tensile strength
  - Gap formation
  - Motion at repair site
  - Contact surface
  - Contact pressure
- Clinical results
- Cuff integrity on f/u imaging
- Single row vs
  - 2 separate rows
  - suture bridge
- The significance of complex suture patterns

## Biomechanical Studies: Simple Single Row vs. Dual Row & Transosseous Meier: Dual Row Stronger to Cyclic Loading

### 2 row > single row > TOS

- (TOS) failure            75.3 cycles
- (SRSA) failure        798.3 cycles
- (DRSA)                had no failures

### Kim: (AJSM 2006)

#### Less Gap Formation

#### Higher Ultimate Tensile Load

- Less gap formation with cyclic loading with 2 row repair ( $p < .05$ )
- Double row 46% higher UTL ( $p < .05$ ) & reduced strain  
*Kim DH, Elattrache NS, Tibone JE, et al. Biomechanical comparison of a single-row versus double-row suture anchor technique for rotator cuff repair. Am J Sports Med. 2006;34: 407-414*

### Tuoheti, Itoi et al AJSM 2005: Double Row Better Contact Area

- Double Row greatest contact area
- 42% greater than TOS
- 60% greater than single row
- Single row restores 46%
- Dual row restores 100% footprint

### Meier SW: Less Motion at Repair Site (submitted)

#### Biomechanical Studies: Double Row vs Complex Single Row

#### Ma: Higher Ultimate Tensile Load (Human Cadaver)

- Double Row mean UTL  $287 \pm 24$  N
- 3 single-row repairs tested
  - simple suture            191 N;
  - MMA                      212 N
  - massive cuff            250 N ( $P < .05$ ).

Nelson: Modified Mason Allen May Be Biomechanically Equivalent.  
But Double Row Has Greater Foot Print (Sheep)

- Same cyclic load to failure

- 74% greater surface area
  - mean surface area of  $258.23 \pm 69.7$  mm<sup>2</sup> versus  $148.08 \pm 75.5$  mm<sup>2</sup> for single-row fixation, a 74% increase (P= .025).

Baums: Two Row With Medial Mattress and Lateral Mason Allen Stronger Than Single Row Mason Allen (Time Zero Sheep study)

- Two Row repair with double row Mason Allen superior to isometric cyclic loading as well as Ultimate tensile loading

*Biomechanical characteristics of single-row repair in comparison to double-row repair with consideration of the suture configuration and suture material.*

*Knee Surg Sports Traumatol Arthrosc.*

*2008 Aug 29. [Epub ahead of print]*

*Baums MH, Buchhorn GH, Spahn G, Poppendieck B, Schultz W, Klingner HM.*

## Biomechanical Studies: Which Dual Row is Better?

Suture Bridge vs Double Row

Park: Improved Contact Pressure and Contact Area with Suture Bridge

- Contact area
  - 4 suture bridge (criss-cross)      124 mm
  - 2 row (separate)                      63.3 (p < .05)
- Contact Pressure
  - 4 suture bridge                          .27 Mpa
  - 2 row                                        .19 M (p = .002)

Park: Improved Ultimate Load with Suture Bridge

- Suture Bridge Transosseous equivalent      443.0 +/- 87.8 N
- Double-row technique (2 separate rows)    299.2 +/- 52.5 N (P = .043)
- Gap formation the same...
- 30 cycles (10~180 N) then pullout
- Used interference screw laterally

## Cuff Integrity:

Correlation With Clinical /Biomechanical Results

Ozbaydar: Double vs. Single Row

## Special lecture

Rabbit Healing Study: Tested at Time Zero, 4 and 8 weeks

- Larger number of healed tendon bone interfaces in 2 row at 8 weeks
- Greater mean load to failure in 2 row
- Improved load to failure correlated to increase surface area of healed tendon

Better Healing Rate: Charousset

- Anatomic (CT ?arth)
  - Dual Row
    - 19/31
  - vs Single Row
    - 14/35
- Retear
  - Dual
    - 7/31
  - Single
    - 14/35
- Clinical results equal

Huijsman: Ultra Sound Follow up

- 242 shoulders
- 22 mo f/u
- Good strength and ROM..
- 91% G/E results
- Intact Repair by US 83% overall
- Small 88%
- Medium 93%
- Large 78%
- Massive 47%

Anderson Ultrasound Study: Excellent Clinical Results Low Re-tear Rate

- 52 shoulders
- 2 separate rows of suture anchors
- Fu min 2 years
- Exc clinical results
- 17% re-tear on f/u U/S

Sugaya et al: Arthroscopy 2005

Single Row vs Dual Row

- Retear Rate (MRI-35 mo)
  - Single row 26%
  - Dual Row 10%
- No difference in clinical scores
- Retrospective non-randomized

Sugaya: Prospective MRI Study (2007)

Improved Cuff Integrity

- 86 pts
- 31 months
- 2 row
- 83% intact on fu MRI
  - 5% small- medium
  - 40% large- massive

LaFosse: CT Arthrogram

Excellent Clinical Results – Low Re-tear Rate

- 105 shoulder
- 22 mo f/u
- CT arthrogram
- Constant score 43 pre op – 80 post op
- 12/105 failed (11%)
  - Small 0%
  - Large/massive 17%
- Intact repairs correlate with better strength and AROM

Frank: Suture Bridge TOS Equivalent

88% Intact on MRI at F/U

- Frank J. B et al: Repair Site Integrity After Arthroscopic Transosseous-Equivalent Suture-Bridge Rotator Cuff Repair  
Am. J. Sports Med., Aug 2008; 36: 1496 – 1503

Large Tears (>3CM)

Better Clinical Results with Dual Row

Park et al AJSM July 2008

- 78 pts (half single row/ half dual row)

## Special lecture

- Dual Row
  - < 3 cm no difference
  - > 3 cm
    - Improved S&E scores Constant scores and Shoulder Strength Index

On the Other Hand...

Dual Row vs Single Row

No Difference

Grasso et al Arthroscopy 1/2009

- No stratification by size of tear
- No imaging to evaluate re-tear
- No suture bridge
- No “rip stop”
- Short term f/u (2 yrs)
- Prospective, randomized
- 40 pts each group
- Two row simple technique

Dual Row: Summary of Literature

- Dual row restores better footprint (100%)
- Simple dual row stronger than simple single row
- ultimate tensile load, cyclic loading
- Complex dual row stronger than complex lateral row (Mason Allen)
- Dual row has less gap formation
- Cyclic loading
- Better cuff integrity on imaging f/u -2yrs  
(CT arthrogram, MRI, U/S)
- Better healing in rabbit f/u study
- Increased contact pressure and contact area
- Dual Row using Suture bridge better than two separate rows.
  - Ultimate Load, contact pressure, contact area
- Clinical Benefits
  - Strength and function ARE better with intact repair ( esp for LARGE tears)
  - and dual row results in an intact repair more often than single row
- ...There may be no benefit for smaller tears!

When I do Dual Row

- 80% of cases
- Reducible tendon
- Adequate tissue

Dual Row: Technical Options & Evolving Techniques

- Original Technique: Two Separate Rows
  - Tie sutures both rows
  - Increased OR time
  - Increase technical difficulty
  - Increase knots in SA space
- Newer Techniques
  - Knotless locking anchors for lateral row
  - Faster
  - No knots
  - ability to tension

Dual Row: Technical Options & Evolving Techniques

- Newer Techniques– Cont.
  - Suture Bridge: Compress footprint
    - with knots
  - Suture Bridge
    - with knotless locking anchors
- Evolving Techniques
  - Suture bridge with medial Rip-Stop (A-MA) stitch
  - Knotless medial & lateral row

Dual Row: Original Technique

Two Separate Rows with Knots Medial and Lateral

Dual Row: Two Separate Rows Knotless Lateral Row

- Medial row standard mattress

Dual Row Technique: Suture Bridge

Need Medial Knots: Busfield et al AJSM March 08 Epub

- Cadaver Study

## Special lecture

- Suture span with / without medial knots
- Decreased gap formation, increased yield load and ultimate load with medial knot

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## Versalok: Self Locking Anchor

## Versalok: Strong pullout

- Load to failure
  - Cortical bone
    - 375 N
  - Cancellous bone
    - 379 N
- Biocorckscrew
  - 259 N
- Bioknotless
  - 124 N
- BioPushlock
  - 144 N

## Versalok: Allows Secure Knotless Suture Spanning

- Eliminate Multiple knots
  - Knotless anchors
- Decrease Surgical Time
  - Eliminate knot tying
- Optimal Tension
  - Tensionable anchor
  - No loop security issues
- No risk of knot slippage

- Costs
  - Multiple load anchor
  - Faster technique

Knotless Locking Anchors: Existing Options...

- Lock and Tension (all subcortical)
- Versalok
- Opus:
  - Original (Metal)
  - Magnum (PEAK)
- Locks ( extra cortical)
  - KFX
- Interference fit
  - Pushlock

Pullout Strength

The Versalok: Tensioning Gun

Versalok Basic Technique

Versalok Basic Technique

Versalok Benefits: Simplicity

- Simple technique:
  - No drilling
    - Single step insertion
  - Single or double loading
  - Easy/accurate tensioning

Versalok Benefits: Security

- Secure fixation even in poor quality bone !
  - Circumferential compression
  - Cortical and subcortical fixation
  - Excellent pull-out strength

Versalok Benefits: Versatility!

- Can use any suture
- Can use any suture passing method
- Single or double load anchor

## Special lecture

- Suture first, or anchor first
  - Avoid inadvertent suture unloading

## Versalok Benefits: Tensioning

- Allows tensioning of repair after anchor inserted! (before deployment)
- Secure suture tension every time
- Tensioning wheel for accuracy

## Versalok: Versatile Technique Options

- Single row lateral fixation:
  - Simple suture
  - Inverted mattress
  - Arthroscopic Mason Allen (single step)
- Double row fixation (improved footprint)
  - Separate Medial & lateral suture rows
  - Suture Bridge

## The Versalok: Advantages Summary

- Arthroscopic
- Knotless
- Simple!
  - Single step
  - No pre-drilling
- Secure fixation
- Accurate tensioning of repair
- Single or double loading of anchor
- Allows knotless medial and lateral rows

## Basic Suture Bridge

## Technique #1

- Medial mattress- lateral locking anchor

## Basic Suture Spanning Technique #2

- Multiple Simple sutures
  - No medial knots
- Lateral locking anchor

## Double Criss-Cross

## Suture Spanning

- With Medial Row Fixation

Dual Row:Criss–Cross

Dual Row: Criss–Cross

Dual Row: Criss Cross–cont.

Dual Row: Criss Cross–cont.

Dual Row: Criss Cross–cont

Dual Row: Criss–Cross–cont.

Dual Row: Criss Cross

Dual Row Suture Spanning: With Rip Stop (Mason–Allen)

Dual Row Suture Bridge

With Medial “Rip Stop”

Next Generation Suture Bridge: Knotless Lateral & Medial Rows

With Rip Stop

Next Generation Suture Bridge: Knotless Medial & Lateral Rows

With Rip Stop

Med and Lat Knotless: Rip Stop

Conclusion

- Dual Row Repair
  - Stronger to cyclic loading and UTL
  - Less gap formation in some studies
  - Better cuff integrity in imaging studies
  - Better contact pressure and contact area
  - Better restoration of footprint
  - Better strength correlating to cuff integrity
  - Improved clinical results for large/massive tears
- Suture Bridge
  - Further improves contact pressure/area & strength (UTL)
  - Best if used with medial knots
- Knotless locking anchor (Versalok)
  - Faster, easier, no knots to impinge
  - Stronger pull-out , consistent suture tension
- Techniques still evolving
  - “Even” tension med– lat rows
  - Dual Row Med & Lat knotless....w Rip Stop

What Would You Rather Have?

One point of fixation..... Ot Two ?

THANK YOU!