Arthroscopic Management of Full Thickness Rotator Cuff Tears

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RCT Classification

- **Size** (Cofield)
  - Small < 1 cm
  - Medium 1-3 cm
  - Large 3-5 cm
  - Massive > 5cm

- **Duration**
  - Acute
  - Chronic
  - Chronic with acute extension

- **Tendon involvement** (European classification)
  - Small – less than complete single tendon involvement
  - Massive – complete 2 tendon tear and greater
RCT Classification

- **Thickness**
  - Full
  - Partial

- **Shape**
  - Transverse
  - Linear
  - L shaped
  - Triangular
  - Crescent
  - U shape

*FIGURE 7-59* Diagram of the pattern variation of rotator cuff tears. A, Transverse-shaped tear, B, crescent-shaped tear, C, L-shaped tear, D, linear-shaped tear in line with the tendon fibers, and E, triangular-shaped tear.
Nonoperative

- 46 patients with full-thickness cuff tears treated conservatively
- F/U 2.5 yr ave
- Mean age 65 ± 11 yrs
- Significant improvement in comfort score, but physical function, and general health decreased significantly
- Lower social function significantly linked to no improvement
- Overall responsiveness of shoulder function to nonoperative care was poor

Goldberg et al, CORR 2001
Surgical Indications

- **Group 1** = intact RC with tendonitis or partial thickness RCT (SA impingement)
  - Non-surgical management has low risk with good results (70%)
- **Group 2** = small to medium sized RCT; pt age < 60; acute tears; tears with recent loss of function
  - Consider early surgical repair due to risk of tear extension, irreversible changes to RC and GH joint, and recurrent Sx
- **Group 3** = large chronic RCT; and pt age > 70
  - Initial trial of Non-surgical management has low risk due to presence of irreversible changes in RC and GH joint
  - RCR likely to fail if Acromiohumeral distance < 7mm, and/or grade 3-4 fatty degeneration (F=M or F>M)

*Lashgari and Yamaguchi  OKU Shoulder and Elbow 2*
Surgical Indications

- Active symptomatic patient
- Sedentary symptomatic patient after rehab
- Acute-on-chronic tear in active patient
  (re-establish “force-couple;” Burkhart, CORR 1992)
Anatomic Goal of Rotator Cuff Repair

To achieve high initial fixation strength, minimize gap formation and maintain mechanical stability until biology leads to healing.

Healing = pain relief, restoration of strength and ROM
Single row with suture anchor

Single row transosseous suture

Hybrid with medial suture anchor, lateral transosseous suture
Single row suture anchor

Double row suture anchor

Transosseous suture bridge

Anchor suture bridge
RCR: Bone to Tendon Healing

- Healing begins by formation of fibrovascular tissue interface between tendon and bone (Rodeo JBJS 1993, St. Pierre JBJS 1995)
- **Bone** grows into the interface tissue (Aoki JSES 2001)
- Collagen fiber continuity is gradually created between tendon and bone (Oguma JOR 2001)
Technical Goal

- Recreating the anatomic footprint provides large surface area for this healing

- Apreleva, Warner Arthroscopy 2001
- Meier et al. JSES 2006
- Brady et al. *Arthroscopy* 2006
Rotator Cuff Repair: *Facts of Life*

- **Cuff Slow to heal**
  - Repaired tendon must sit still for long period of time over as large an area of the healing zone as possible

- **Healed Cuffs have Better Function**

- **High Persistent Tear Rates Reported with Arthroscopic Repairs**
  - 29%, 43%, 41%, >90%
    - Boileau et al, *JBJS* 2005
    - Gazielly et al, *CORR* 1994
    - Galatz et al, *JBJS* 2004

- **Healing Failure vs. Repair Failure: BOTH**
Why Do We Fail?
Causes of Failed Repair

- Technical Failure: *Mainly Historical*
  - Inadequate technique
  - Inadequate implants
- Anatomic Failure
- Mechanical Failure
- Failure of Biology
Anatomic Failure

- 2 dimensional footprint (healing zone)
- 3\textsuperscript{rd} dimension: contact, compression
- Tissue tension:
  - Anatomic/physiologic resting length vs. tension overload
Footprint Anatomy

Supraspinatus footprint
~ 12 x 24 mm

Minagawa et al, *Arthroscopy* 1998
Dugas et al, *JSES* 2002
Ruotolo et al, *Arthroscopy* 2004
Restoring the Footprint

Transosseous repair restores larger repair site area (85%) than single row anchors (67%)

Improved healing potential

Optimize biology?
Restoring the Footprint: Evidence

- Meier et al. *JSES* 2006
  - Double row suture anchor recreated 100% original supraspinatus footprint
  - Transosseous simple suture and single row suture anchor significantly less (46%, 71% respectively)
- Brady et al. *Arthroscopy* 2006
  - With single, lateral row repair 52.7% of footprint uncovered
  - After medial and lateral row secured, NO Residual footprint uncovered
Mechanical Failure

- Strength
- Endurance
- Must Consider rotation
Mechanical Failure

- Supraspinatus contractile forces alone exceed 300N (Burkhart, Juul-Kristensen)
- Infraspinatus forces can exceed 600N (Hughes, Juul-Kristensen)
- When tear exceeds 1.2 cm, get into infraspinatus overlap
- Single row repair UFL 275N: barely sufficient for small tear limited to supraspinatus
Double-Row RCR

A Biomechanical Analysis of a Suture Anchor Rotator Cuff Footprint Repair Technique

David H. Kim, MD, Neal S. ElAttrache, MD, James E. Tibone, MD, Bong-Jae Jun, MS, Sergai N. DeLaMora, MD, Ronald S. Kvitne, MD, Thay Q. Lee, PhD

Double-row vs. Single-row

- Improves:
  - Strength (by 48%)
  - Stiffness (by 46%)
- Decreases:
  - Gap formation (by 42%)
  - Strain over footprint (by 66%) AJSM 2006
Double-Row RCR

- Double-row fixation had higher ultimate tensile load than three types of single-row fixation repairs (Ma, JBJS 2006)

- In cadaver study, improved initial repair strength with double-row versus transosseous or single-row repairs (Meier, Arthroscopy 2006)

- Gap resistant under rotation and abduction (Park, Siskosky, Idjadi, Costic)
Double-row sharing load

ER with less load-sharing

Interconnected construct with less “tension mismatch” & better load-sharing
Clinical Outcomes

- **Single Row:**
  - 29-94% persistent tear rates

- **Double Row:**
  - Intact 89% by Ultrasound *(DeBeer)*
  - 89% by CT/MRI *(Lafosse)*
Double-Row: Clinical Results

Anderson et al. AJSM 2006

- 52 Shoulders treated with arthroscopic double-row suture anchor repair
- Minimum 2 year follow up
- Statistically significant improvement in ROM, strength and functional scores vs. Preop
- 9/52 (17%) with retear or persistent defect on Ultrasound
What about healing?

- Double-Row Footprint repair is superior in the lab and in early clinical studies, but also want a construct that enhances healing to a greater degree.
- Goal: develop construct that provides increased contact/compression on the footprint.
- Suture bridge construct over footprint was developed.
Failure of Biology

- Musculotendinous quality/viability
- Bone Quality
- Healing potential:
  - Stem cells, growth factors
  - Fibrinolytic agents
Direct tendon-to-bone healing in high pressure environment (sheep ACL model) without fibrous interzone

Weiler et al. Arthroscopy 2002

G = Graft
Arrows = osseous bridging of the partially developed fibrous interzone between 4 and 8 weeks
S = Screw site
Footprint Compression

Can this be reproduced arthroscopically?

Traditional Transosseous

Suture Anchor Transosseous-Equivalent
Transosseous Equivalent: “Suture Bridge”
An arthroscopic “transosseous-equivalent” rotator cuff repair employing suture-bridges can provide significantly more pressurized contact area and overall pressure over a repaired rotator cuff footprint when compared to a double-row technique.

Can the favorable contact characteristics be maintained?
An arthroscopic “transosseous-equivalent” rotator cuff repair employing suture-bridges can provide significantly more strength and equal gap formation over a repaired rotator cuff footprint when compared to a double-row technique.
Advantages of the “Transosseous-Equivalent” technique

- Improved footprint contact (area & pressure)
- Improved strength and provides favorable tension angle (Rossouw et al, JBJS Br 1997; lateral cortex stronger than footprint)
- Minimal gap formation
  Tissue can only settle under cycling
- Low-profile (Burkhart, Arthroscopy 10(1), 1994; less “edge instability”)
- Does not rely on lateral-most tissue
Advantages of the “Transosseous-Equivalent” technique

• **Interconnectivity** (Burkhart, Arthroscopy 13(2), 1997; may reduce “tension-mismatch”)

• Facilitates Revision Repairs

• Medial row provides barrier between the synovial environment and the healing zone

• Containment of Healing Factors

• Allows for biologic manipulation in the future
Biologic Containment?

- Theoretically single row with “Crimson Duvet”

- In actuality, you get more of a bidet…
Early Clinical Results: Repair Site Integrity after Transosseous Equivalent RTC Repair

Elattrache, Frank 2007

- 25 patients, MRI evaluation
- Min 1 yr post-op
- SutureBridge Construct
- 22/25 intact
- 88%
Summary: Technique Comparison

- **Double row vs. Single Row**
  - Better Anatomy Restoration: *Double Row* (Mazzocca, Meier, Waltrip)
  - Mechanical Superiority: *Double Row* (Kim, Ma, Meier)

- **Transosseous Equivalent vs. Double Row**
  - Anatomic and Mechanical Superiority: *TOE* (Park, Siskosky, Idjadi, Costic)
  - Biologic Superiority: Containment and protection of the healing zone
Observations

- Most tears benefit from and are amenable to footprint-compression construct (SutureBridge) as part or all of repair.
- Include margin convergence for large U-Shaped and L-Shaped tears as necessary.
- Most do not require extensive releases or “interval slides”.
  - Personal preference is for balanced partial repair.
Observations

- Tears involving rotator interval usually mobilize adequately by releasing coracohumeral ligament
- **Order of repair (if torn):**
  - Subscapularis
  - Anterior Cable Attachment, Posterior Cable Attachment
  - Margin Convergence, If necessary
  - Central Suture Bridge
- **Grafts to bridge gaps are of questionable benefit over balanced partial repair**
Portal Placement
Surgical Instruments
Conclusions

- Footprint restoration
  - Biomechanically superior construct
  - Interconnectivity/load-sharing
  - Contact surface area, pressurization and healing potential
Why Do We Fail?

Traditional Single Row Repairs

- Do not restore anatomy
- Provide suboptimal biomechanics
- Cannot optimize or enhance healing zone biology

FOOTPRINT RESTORATION ADDRESSES ALL OF THESE CONCERNS
Thank You!