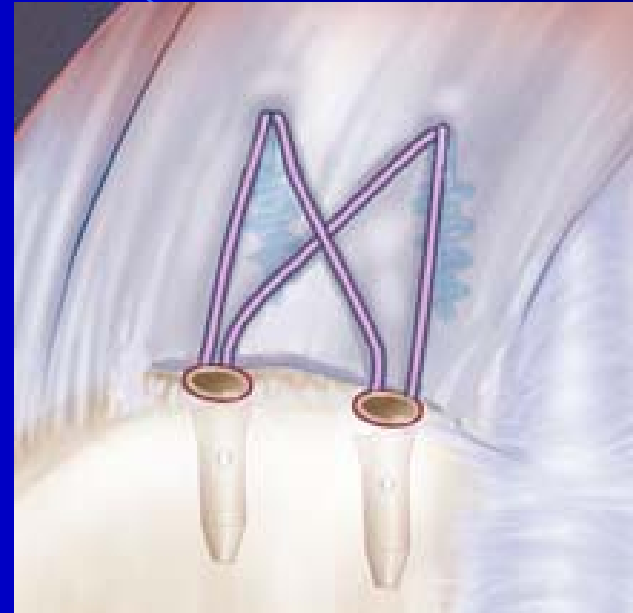
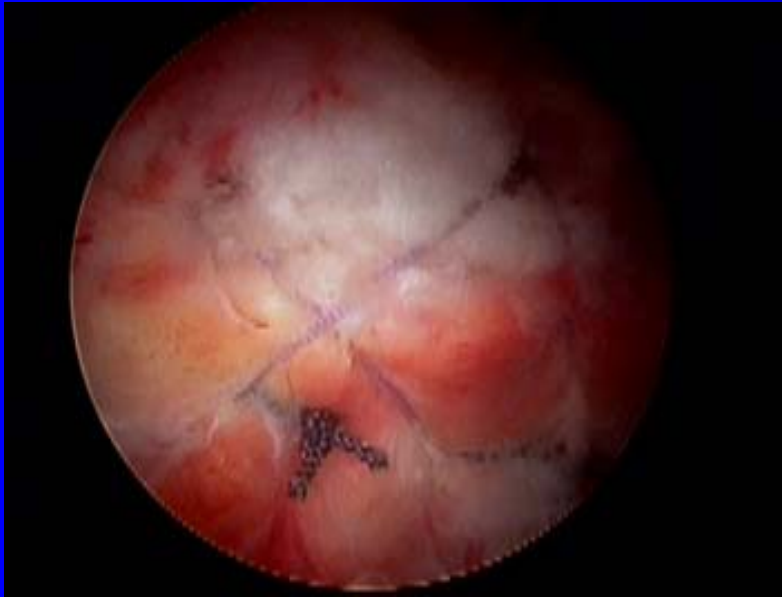


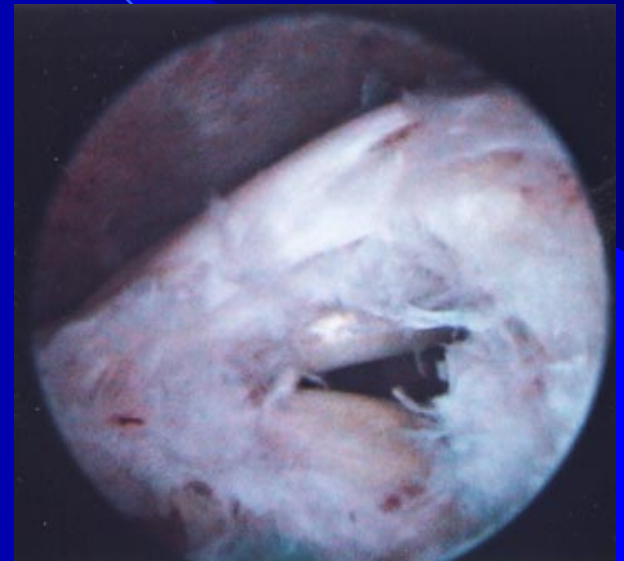
Dual Row Rotator Cuff Repair



Jeffrey Halbrecht, MD

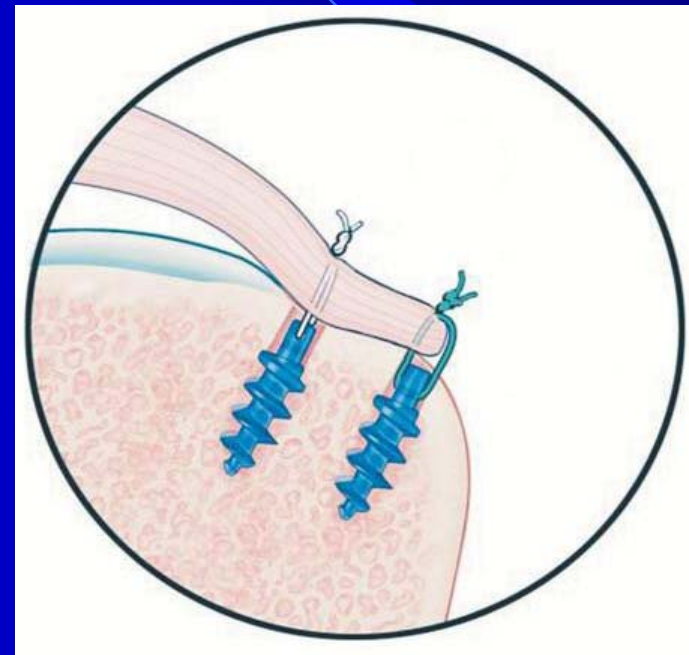
Why Dual Row?

- Poor structural integrity on f/u studies of single row repair
- Restore anatomy (footprint)
- Stronger Repair ?
- Faster rehab ?
- Better results ?



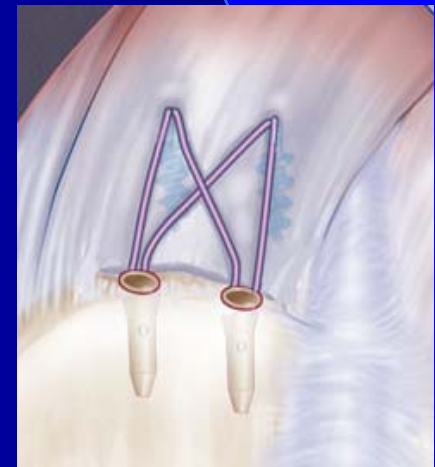
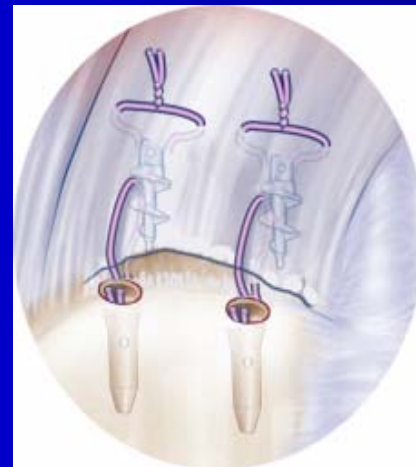
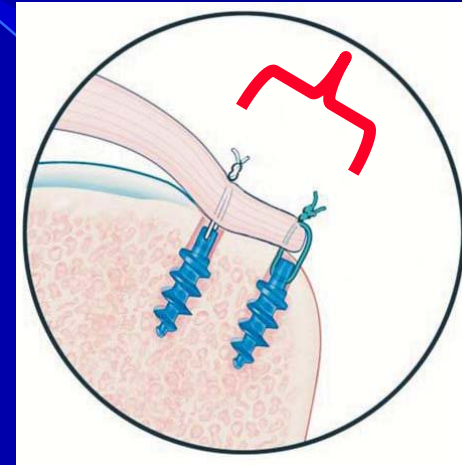
Advantages of Dual Row

- Restore foot print
- Minimize pop motion at repair site
- Limit synovial fluid migration into repair site
- Extended healing surface
- Improved biomechanical strength with multiple points of fixation



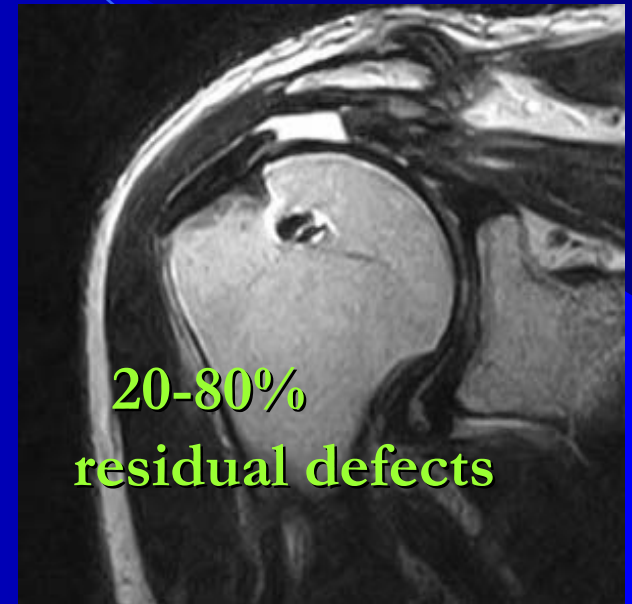
Dual Row Options

- Technique
 - Two separate rows
 - Suture spanning (suture bridge)



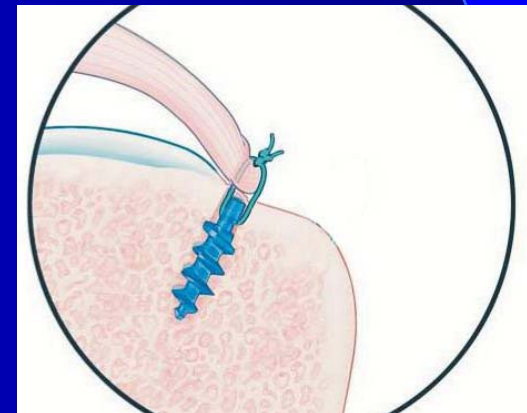
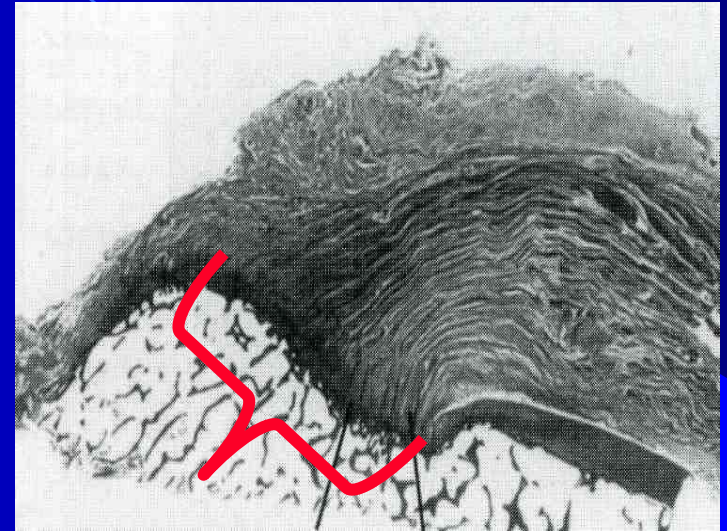
High Rate of “Recurrent Tears” after RTC Repair

- Harryman D: JBJS 1991
- Liu S: Arthroscopy 1994
- Gerber C: JBJS 2000 →
- Boileau P: ICSS 2004
- Galatz L: JBJS 2004
- Bishop J: AAOS/AOSSM Specialty Day 2004



Footprint: Summary

- Normal Approximately 12-15mm
 - Nottage *Arthroscopy 2004*
- Single Row
 - 5-6 mm



Review literature on Dual Row:

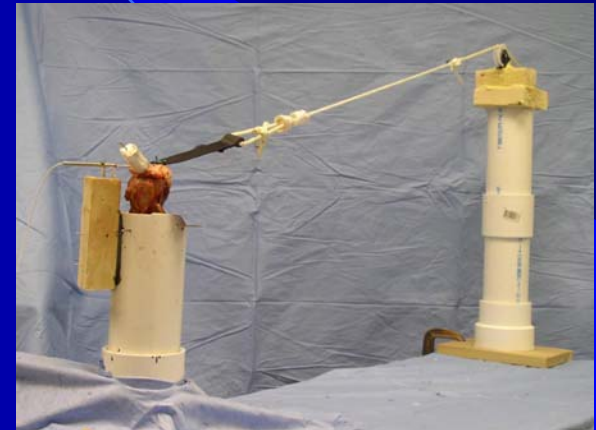
- Biomechanical
 - Tensile strength
 - Gap formation
 - Motion at repair site
 - Contact surface
 - Contact pressure
- Clinical results
- Cuff integrity on f/u imaging

Meier: Dual Row Stronger to Cyclic Loading

2 row > TOS > single row

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

5000 cycles : failure = 10mm or greater

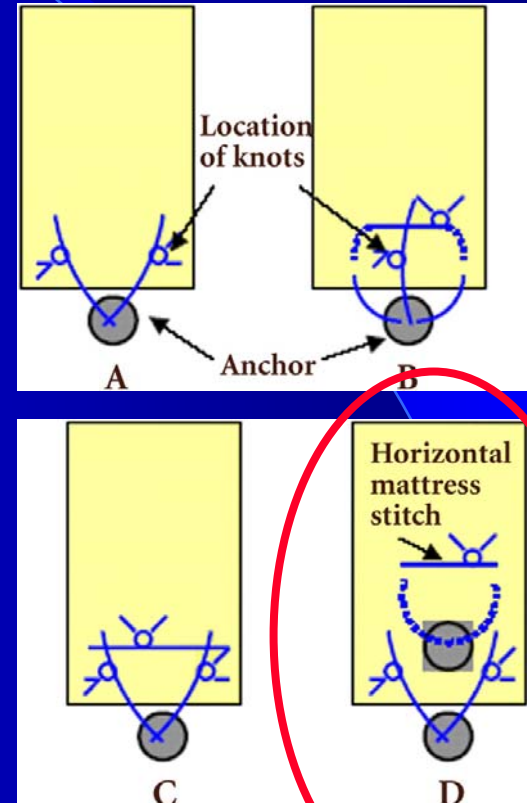


Meier SW, Meier JD.

The effect of double-row fixation on initial repair strength in rotator cuff repair: a biomechanical study.
Arthroscopy. 2006 Nov;22(11):1168-73

Ma : Higher Ultimate Tensile Load

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



Ma CB, Comerford L, Wilson J, Puttitz CM. **Biomechanical evaluation of arthroscopic rotator cuff repairs: Double-row compared with single-row fixation.** *J Bone Joint Surg Am.* 2006;**88**:403–410.

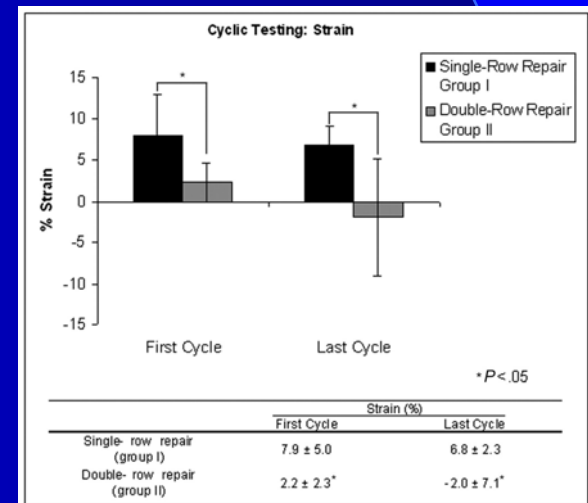
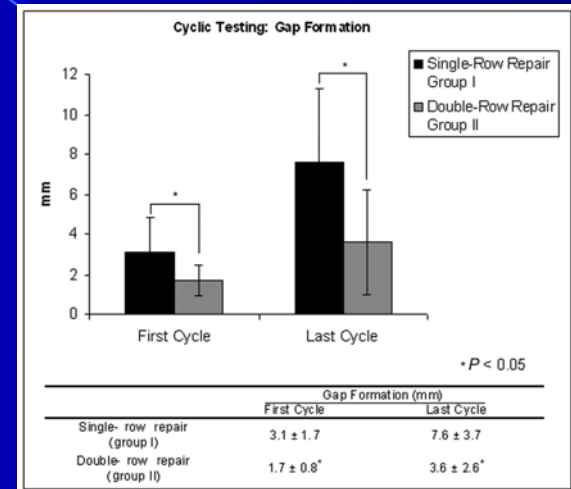
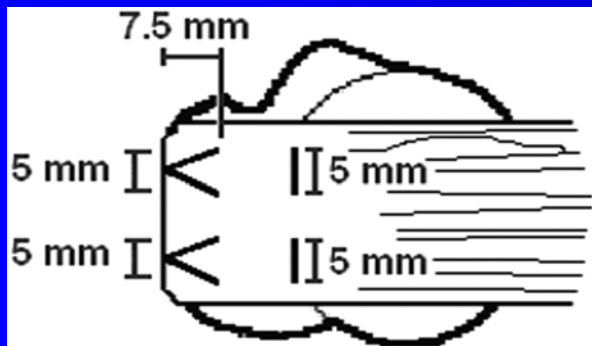
In vivo studies of UTL in a goat rotator cuff model showed no significant biomechanical differences between single-row and double-row repairs at 4 and 8 weeks

- Fealy S, Rodeo SA, MacGillivray JD, Nixon AJ, Adler RS, Warren RF. **Biomechanical evaluation of the relation between number of suture anchors and strength of the bone-tendon interface in a goat rotator cuff model.** *Arthroscopy.* 2006;22:595–602

Kim: Less Gap Formation Higher Ultimate Tensile Load

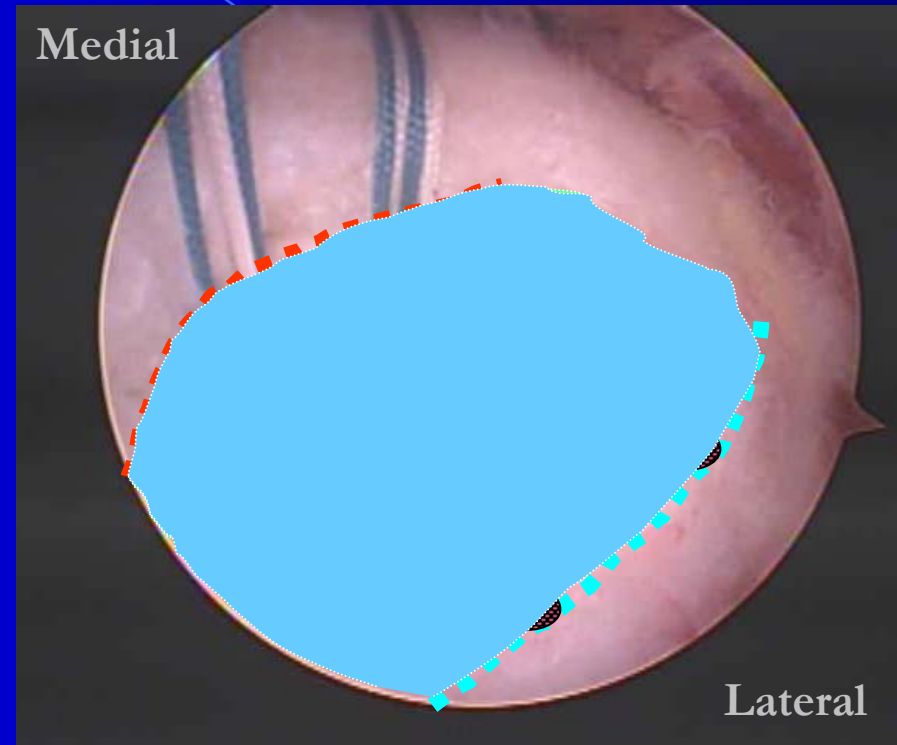
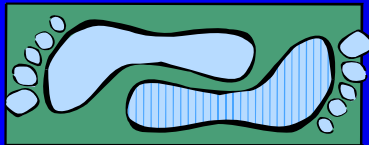
- Less gap formation with cyclic loading with 2 row repair ($p < .05$)
- Double row 46% higher UTL ($p < .05$)

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



Meier S: Restores Footprint

- Dual row restores 100% footprint
- TOS restores 71 %
- Single row restores 46%



S Meier : Rotator cuff repair: the effect of double-row fixation on three-dimensional repair site.

J Shoulder Elbow Surg. 2006 Nov-Dec;15(6):691-6

Park: Improved Ultimate Load with Suture Bridge

- Transosseous equivalent (suture bridge)
 - 443.0 +/- 87.8 N
- double-row technique
 - 299.2 +/- 52.5 N (P = .043).
 - Gap formation the same...
 - 30 cycles (10-180 N) then pullout
 - Used interference screw laterally

J Shoulder Elbow Surg. 2007 Feb 21; [Epub ahead of print]
Part II: Biomechanical assessment for a footprint-restoring transosseous-equivalent rotator cuff repair technique compared with a double-row repair technique.

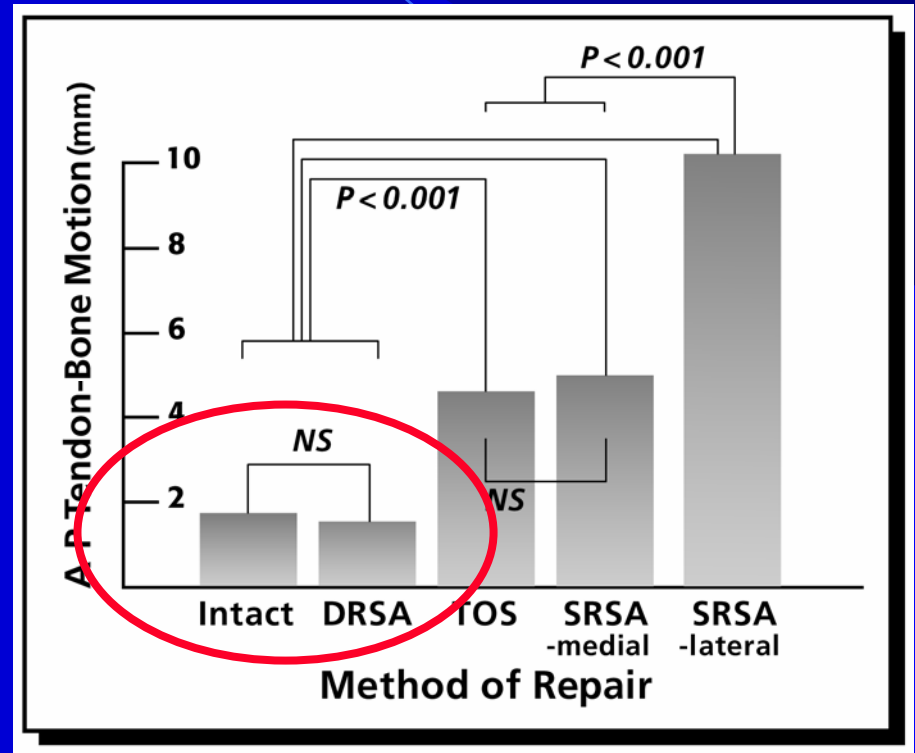
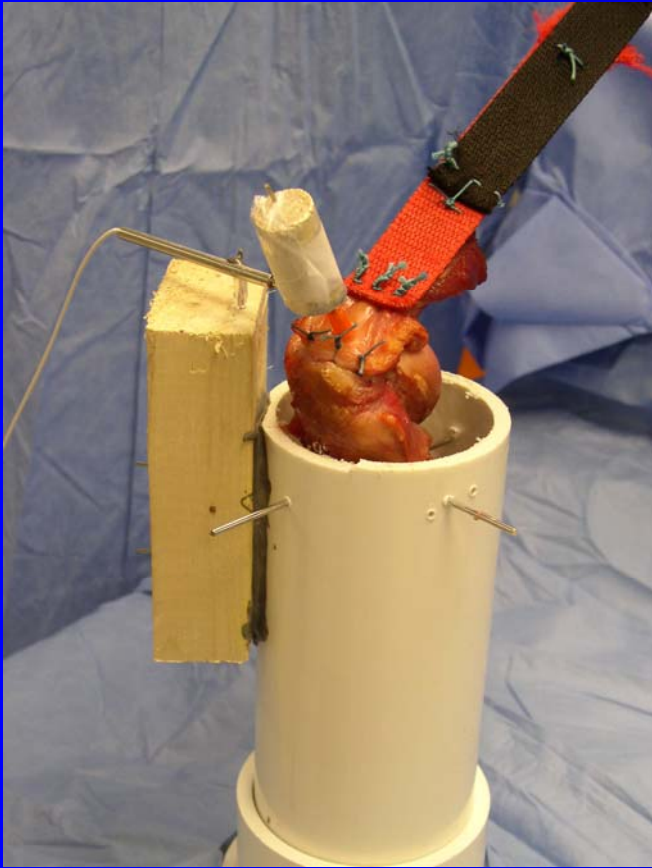
Park MC, Tibone JE, Elatrache NS, Ahmad CS, Jun BJ, Lee TQ.

Park: Improved Contact Pressure and Contact Area with Suture Bridge

- Increased contact area and contact pressure with 4 suture bridge technique
- 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)

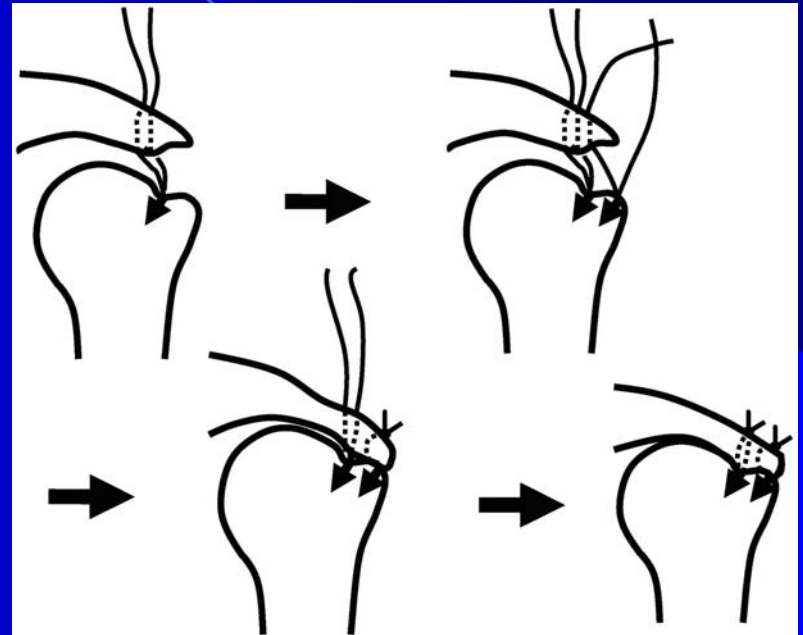
Park MC, Elattrache NS, Tibone JE, Ahmad CS, Jun BJ, Lee TQ. Part I:
Footprint contact characteristics for a transosseous-equivalent rotator cuff repair
technique compared with a double-row technique.

Meier SW: Less Motion at Repair Site (submitted)



Sugaya: Improved Cuff Integrity

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



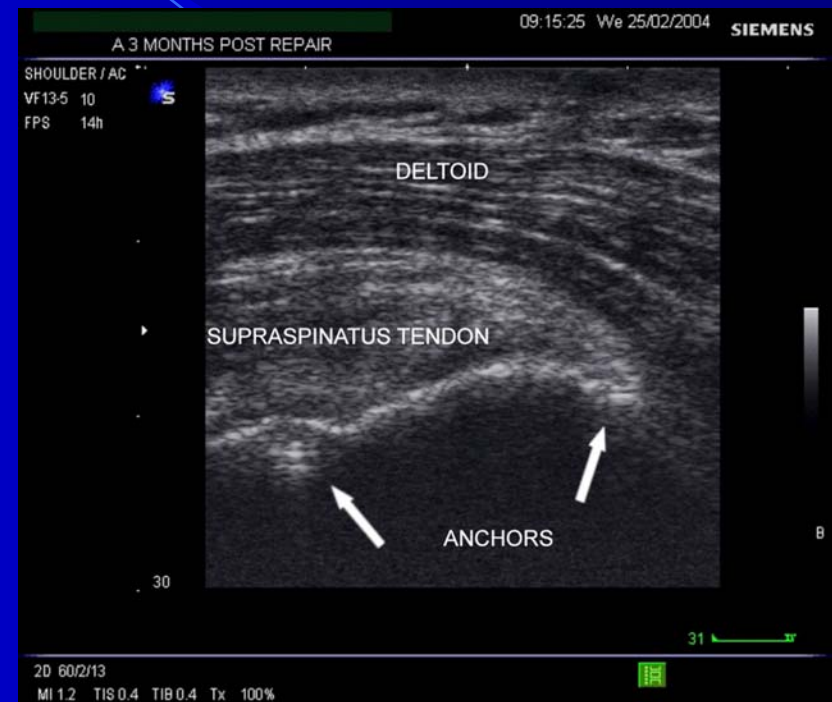
Sugaya H, Maeda K, Matsuki K, Moriishi J.

Repair integrity and functional outcome after arthroscopic double-row rotator cuff repair. A prospective outcome study.

J Bone Joint Surg Am. 2007 May;89(5):953-60

Huijsman: Ultra Sound Follow up

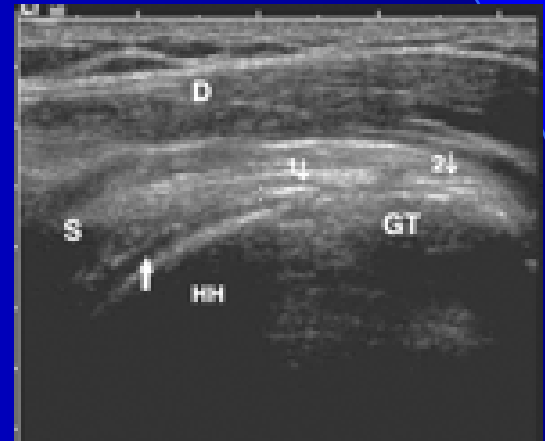
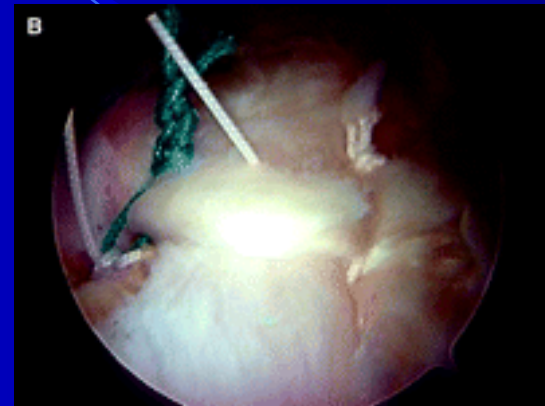
- Good strength and ROM..
- Good integrity by US 83% overall



Huijsmans PE, Pritchard MP, Berghs BM, van Rooyen KS, Wallace AL, de Beer JF.
Arthroscopic rotator cuff repair with double-row fixation.
J Bone Joint Surg Am. 2007 Jun;89(6):1248-57

Anderson: 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



Anderson K, Boothby M, Aschenbrener D, van Holsbeeck M **Outcome and structural integrity after arthroscopic rotator cuff repair using 2 rows of fixation: Minimum 2-year follow-up.** Am J Sports Med. 2006;34:1899–1905.

Rate of intact RC repairs at final follow-up:

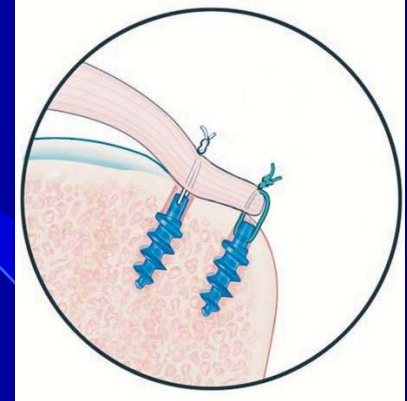
	Dual-row		Single-row			
<u>Pre-op</u> <u>tear size:</u>	Huijmans et al. (US)	Sugaya et al. (MRI)	Liu et al. (Arthrogm)	Bishop et al. (MRI)	Harryman et al. (US)	Galatz et al. (US)
Small	~91%	95%	80%	80%	80%	
Medium						
Large	~63%	60%	30%	18%	~48%	6%
Massive						
	<i>Submitted for pub.</i>	<i>AANA 2004</i>	<i>Arthroscopy 1994</i>	<i>AAOS 2004</i>	<i>JBJS 1991</i>	<i>JBJS 2004</i>

Summary of Literature

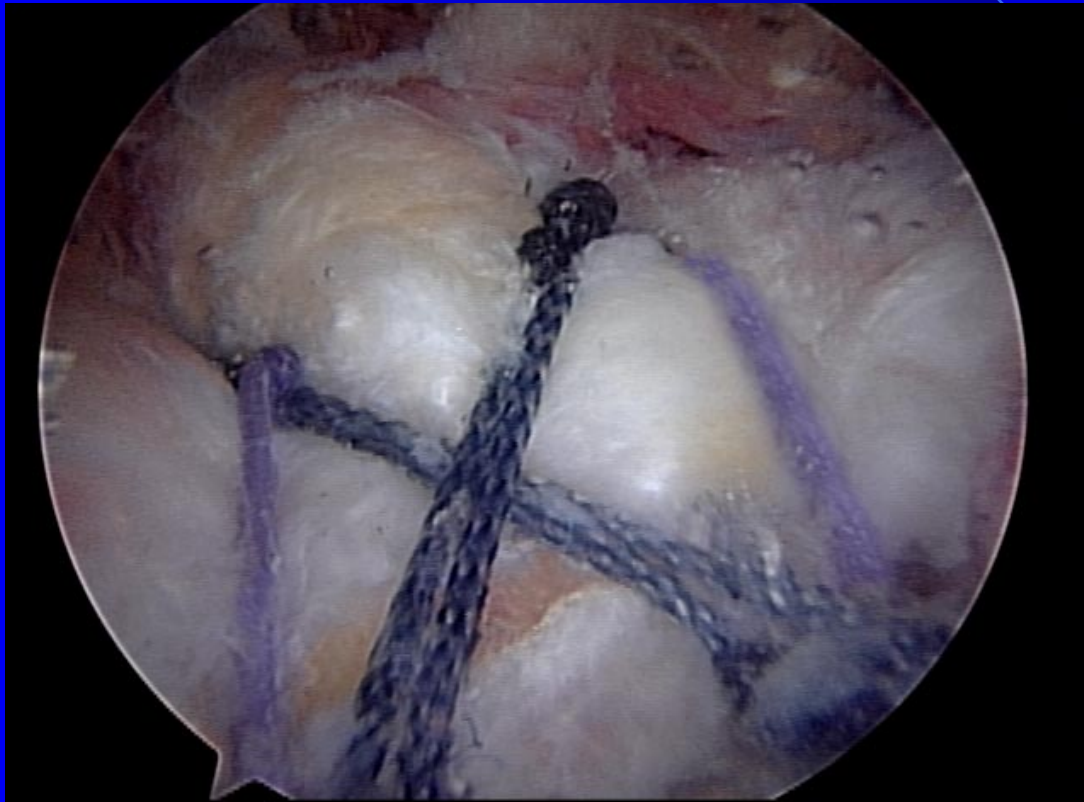
- Dual row restores better footprint (100%)
- Dual Row Stronger
 - ultimate tensile load, cyclic loading
- Less gap formation
 - Cyclic loading
- Suture bridge better than two separate rows.
 - Ultimate Load, contact pressure, contact area
- Increased contact pressure and contact area
- Better structural integrity on post op imaging

Criticisms of Dual-Row Repair:

- Potential for over-tensioning.
- Increased surgical time.
- Increased technical difficulty
- Increase cost.
- Multiple prominent suture knots.



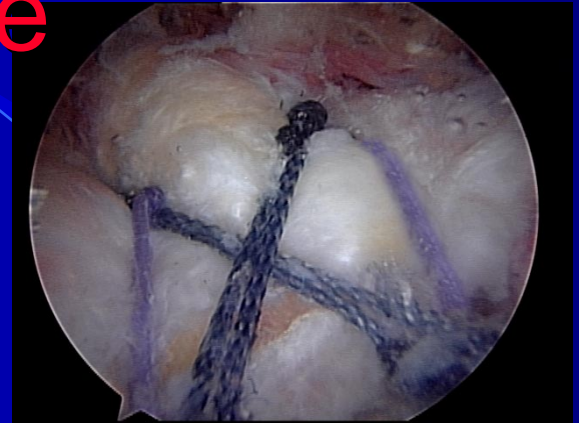
The Answer: Suture Spanning DR Technique with Versalok



Suture-Spanning DR Repair: Surgical Time

Meier et al. – *Submitted for publication 2007*

-30 patients
(15 SSDR/ 15 Standard DR)

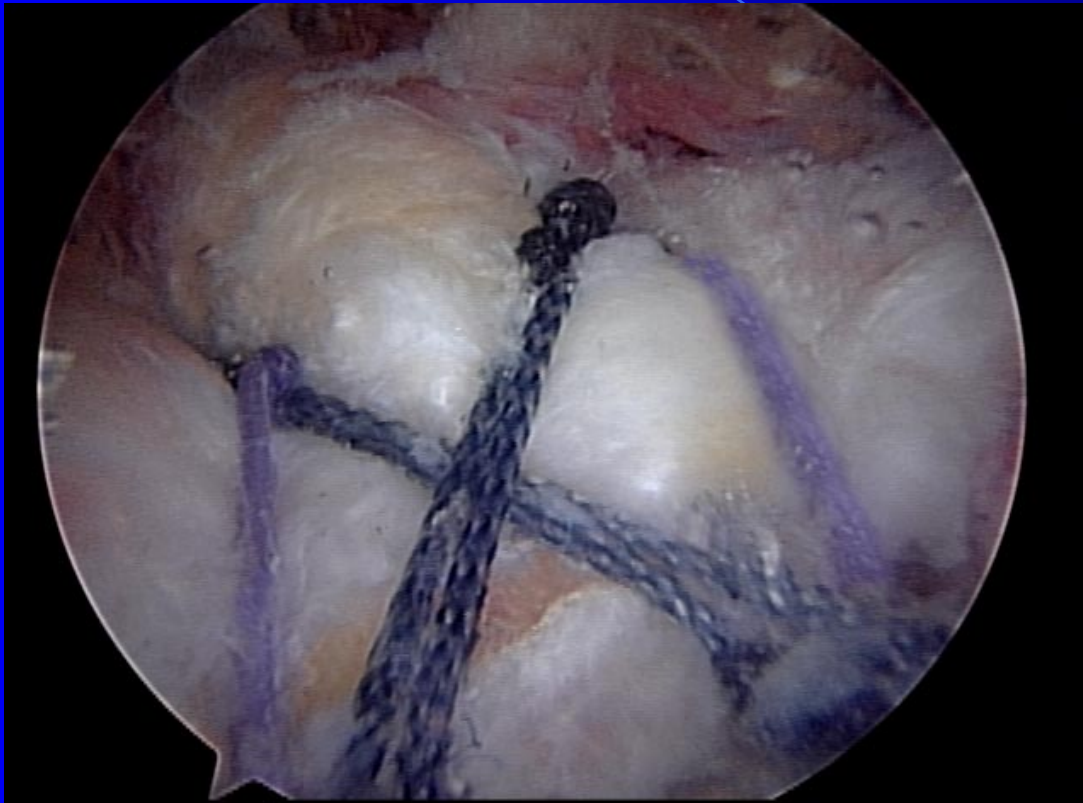


SSDR ~20 minutes faster ($p < 0.05$)

Dual Row Suture Spanning

- Multiple knots
 - Knotless anchors
- Surgical Time
 - 20 minutes faster ($p < .05$) (Meier et al: submitted)
- Tension
 - Tensionable anchor
- Costs
 - Multiple load anchor
 - Faster technique

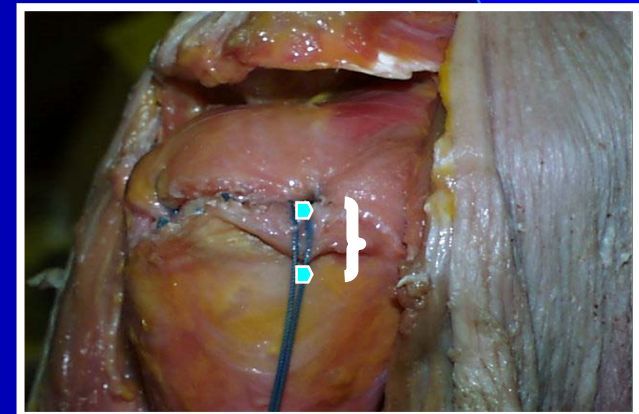
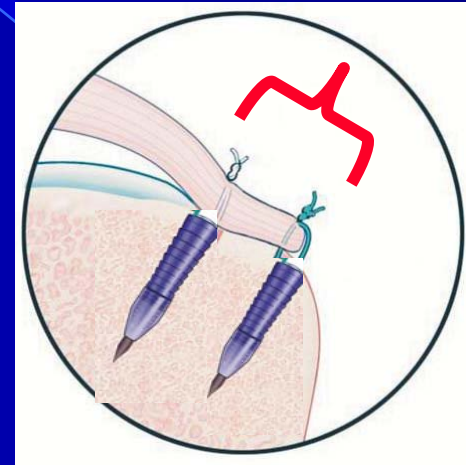
Low profile



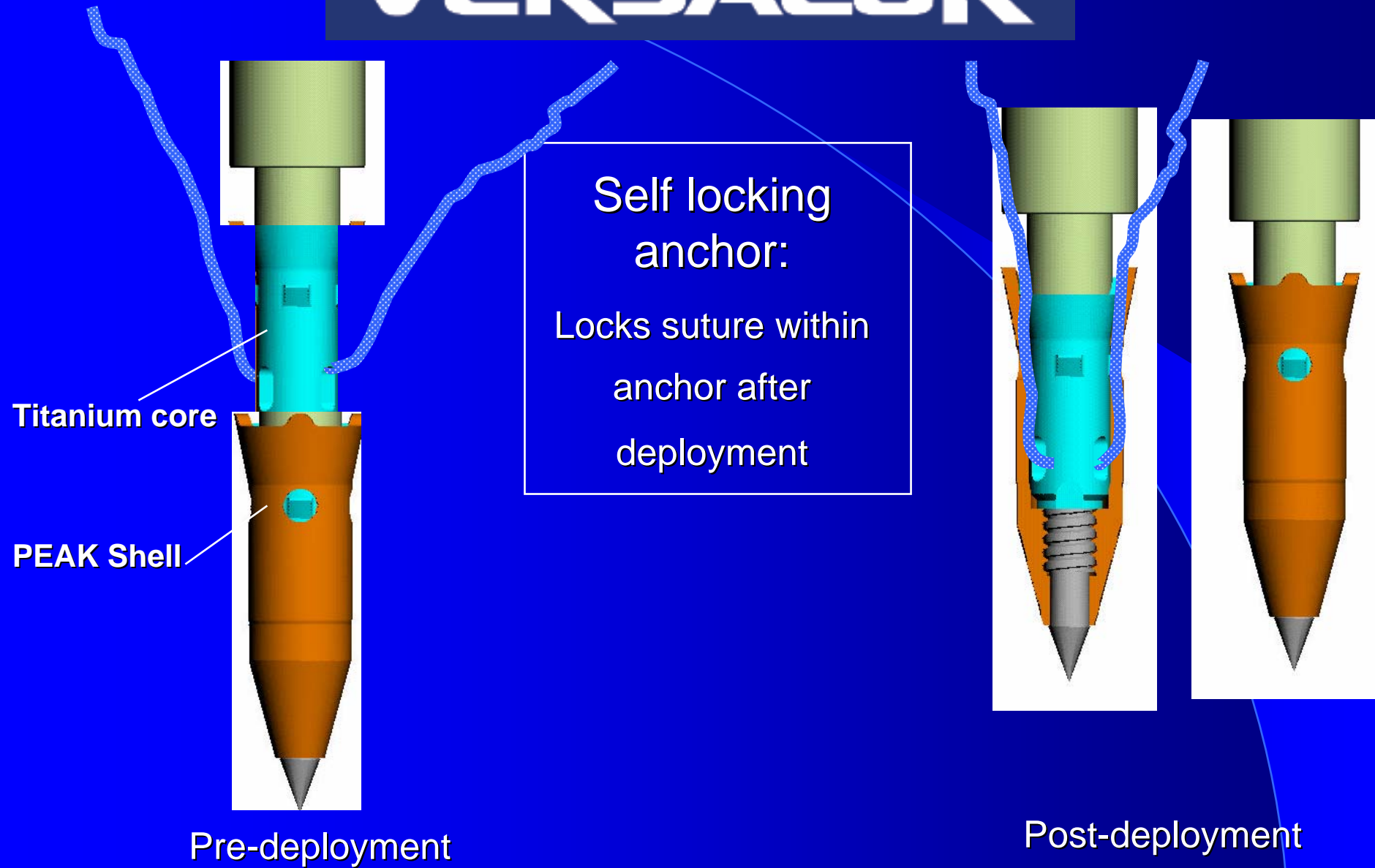
Prominent knots eliminated...

The Versalok: Dual Row Suture Spanning Advantages

- Arthroscopic
- Knotless
- Secure fixation
- Simple technique
- Nothing protruding into SA space
- Allow tensioning of repair
- Versatile technique
- Fast (save \$- OR time)
- Accurate tensioning
- Versatile

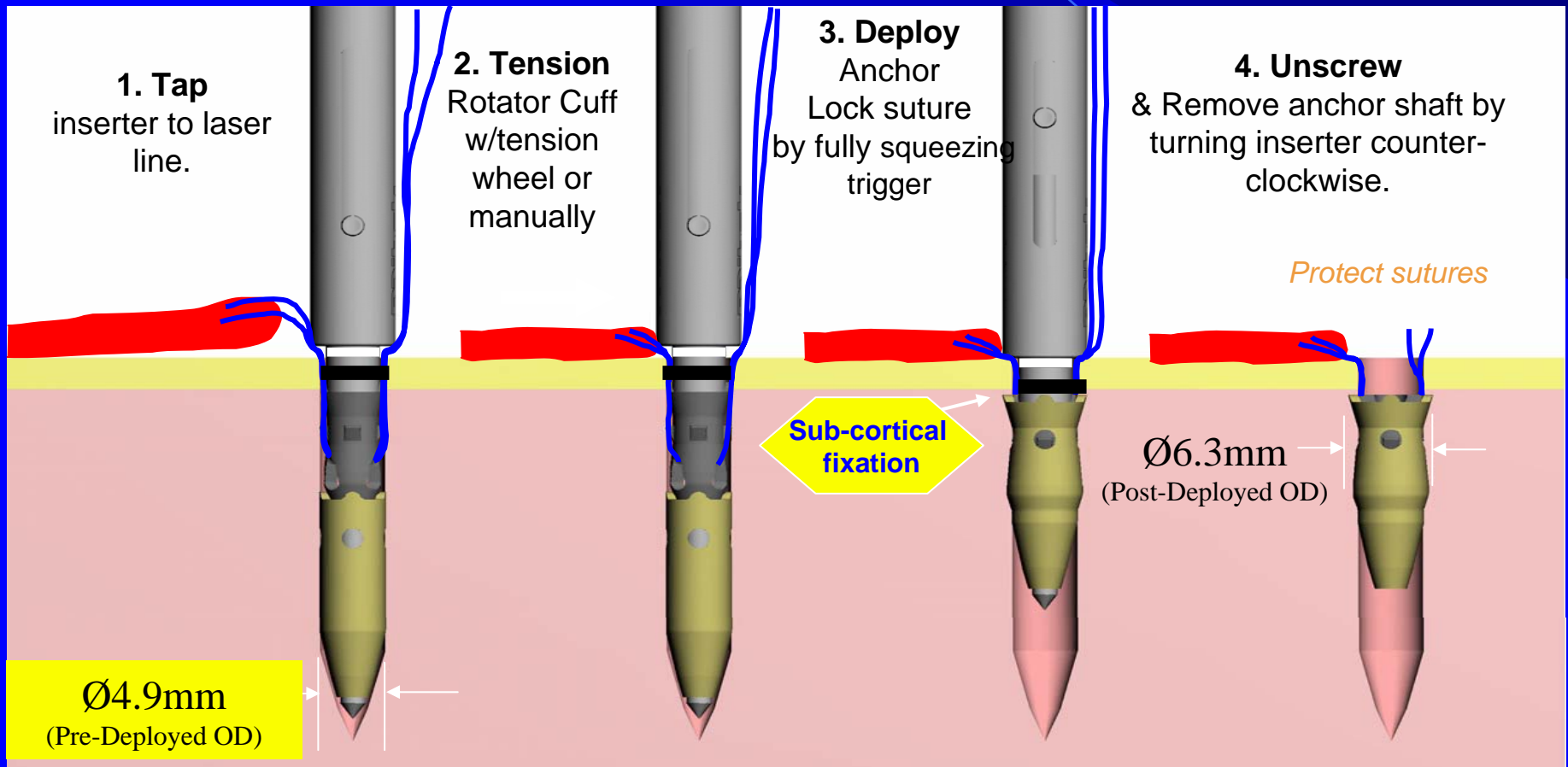


VERSALOK™



Versalok: Deployment

Expanding anchor locks sutures and fixes anchor to bone...



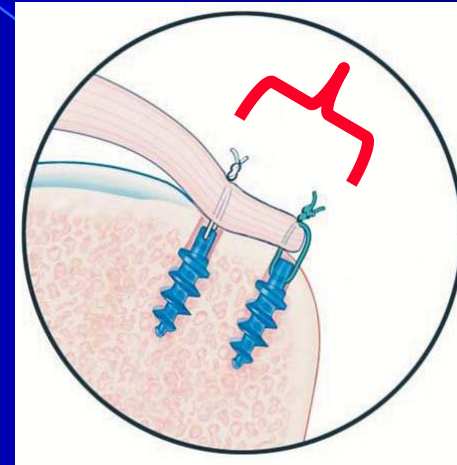
The Versalok: Tensioning Gun

Tensioning wheel

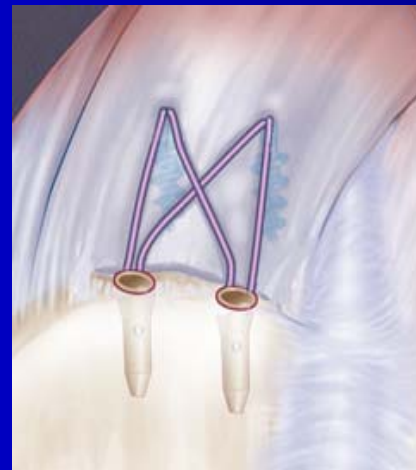


Dual Row

- Benefit:
 - Maximizes compression onto tuberosity
 - increasing fixation footprint
 - Decreased movement of cuff-bone interface during healing
 - Minimize synovial fluid infiltration

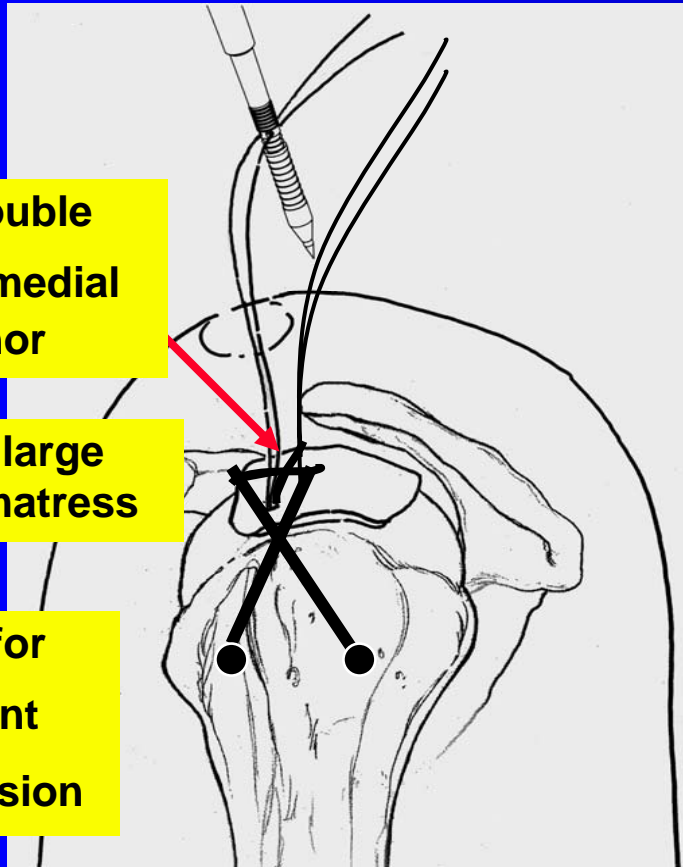


- Technique
 - Medial row:
 - Versalok: knotless mattress
 - Spiralok: standard mattress
 - Lateral row:
 - Suture spanning
 - Separate row



Dual Row:

Crossover : Suture Spanning Technique

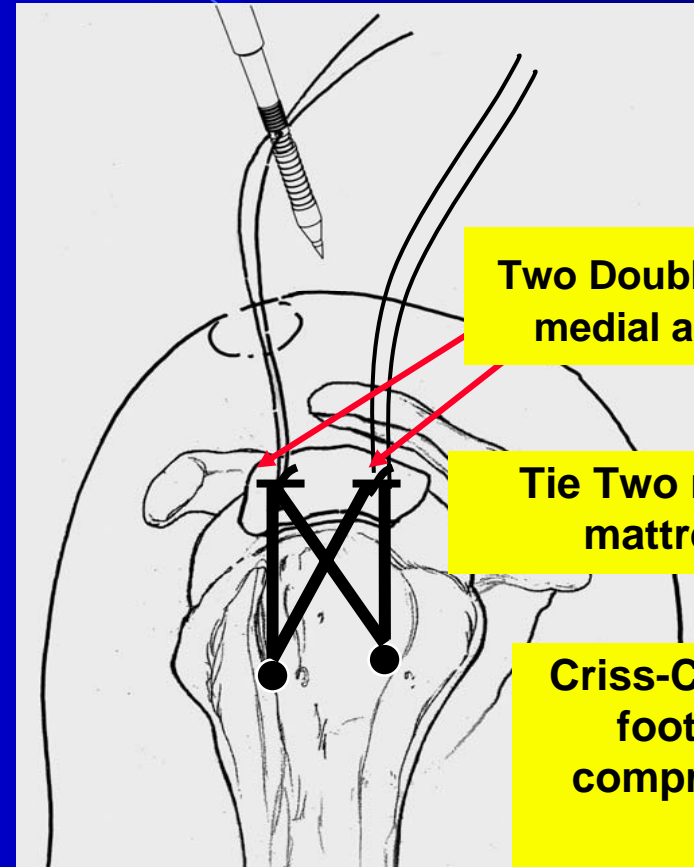


One double loaded medial anchor

Single large medial mattress

Cross for footprint compression

Single cross



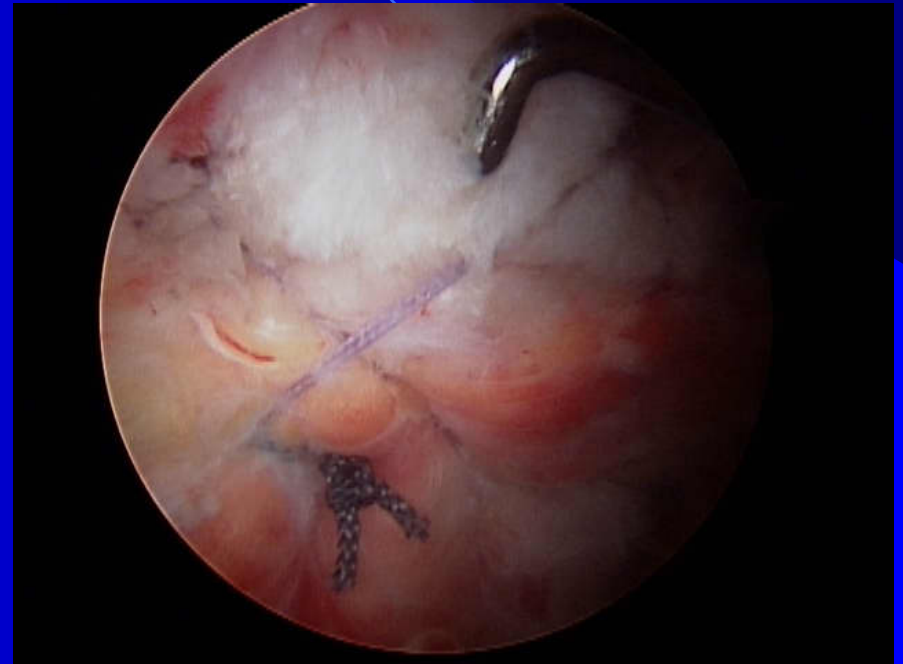
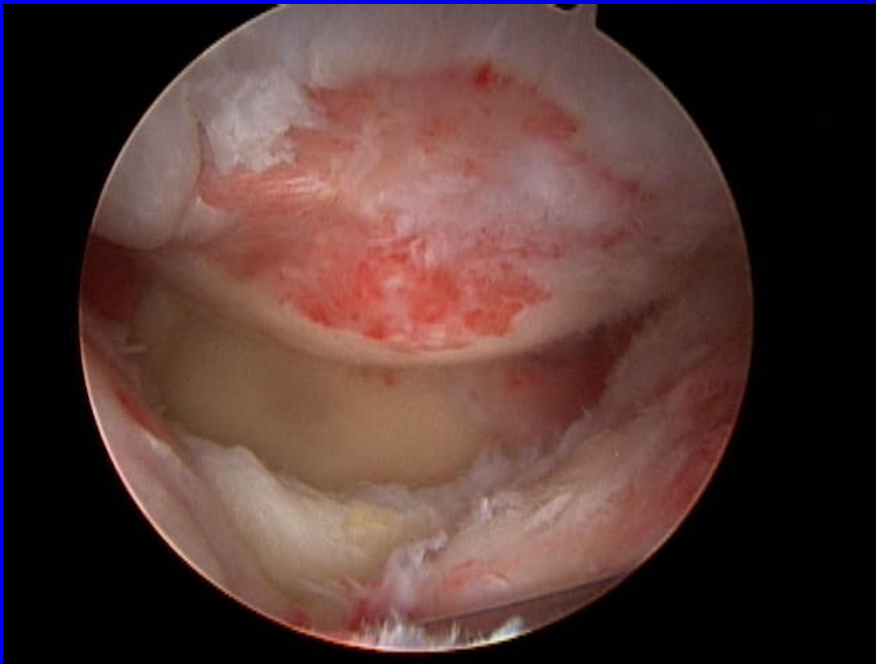
Two Double loaded medial anchors

Tie Two medial mattress

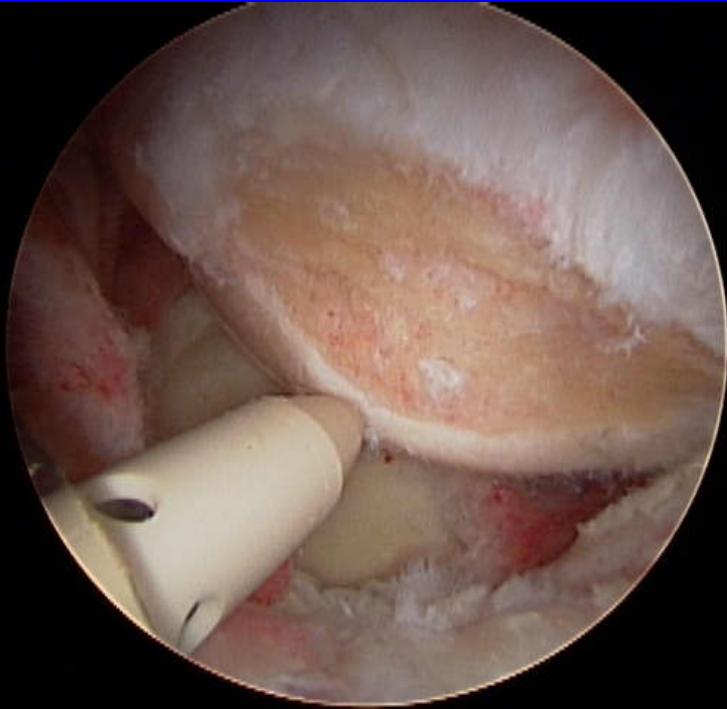
Criss-Cross for footprint compression

Criss-cross

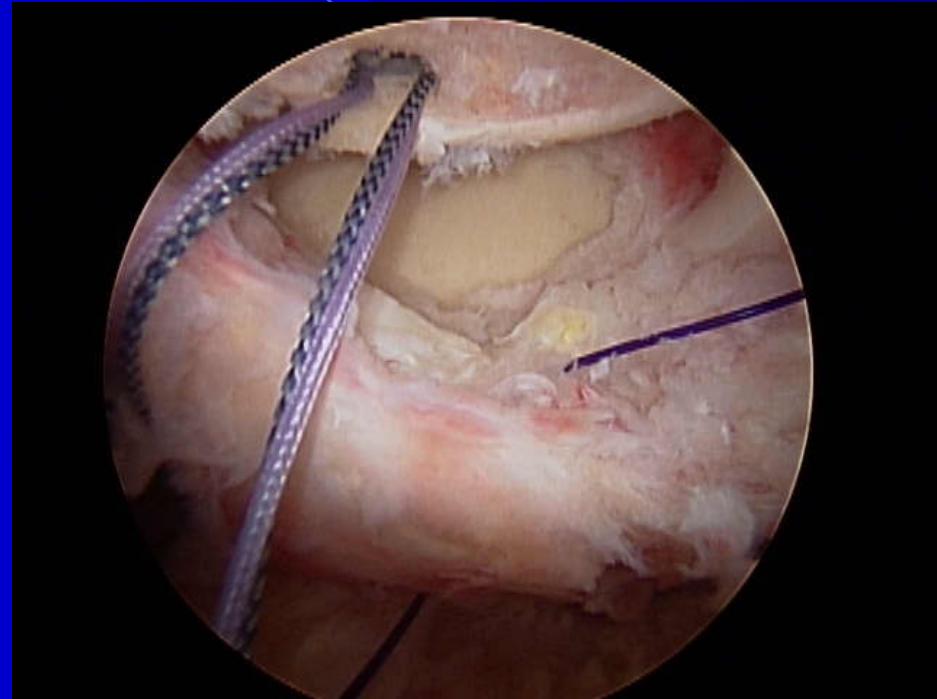
Dual Row: Criss- Cross



Dual Row : Criss- Cross

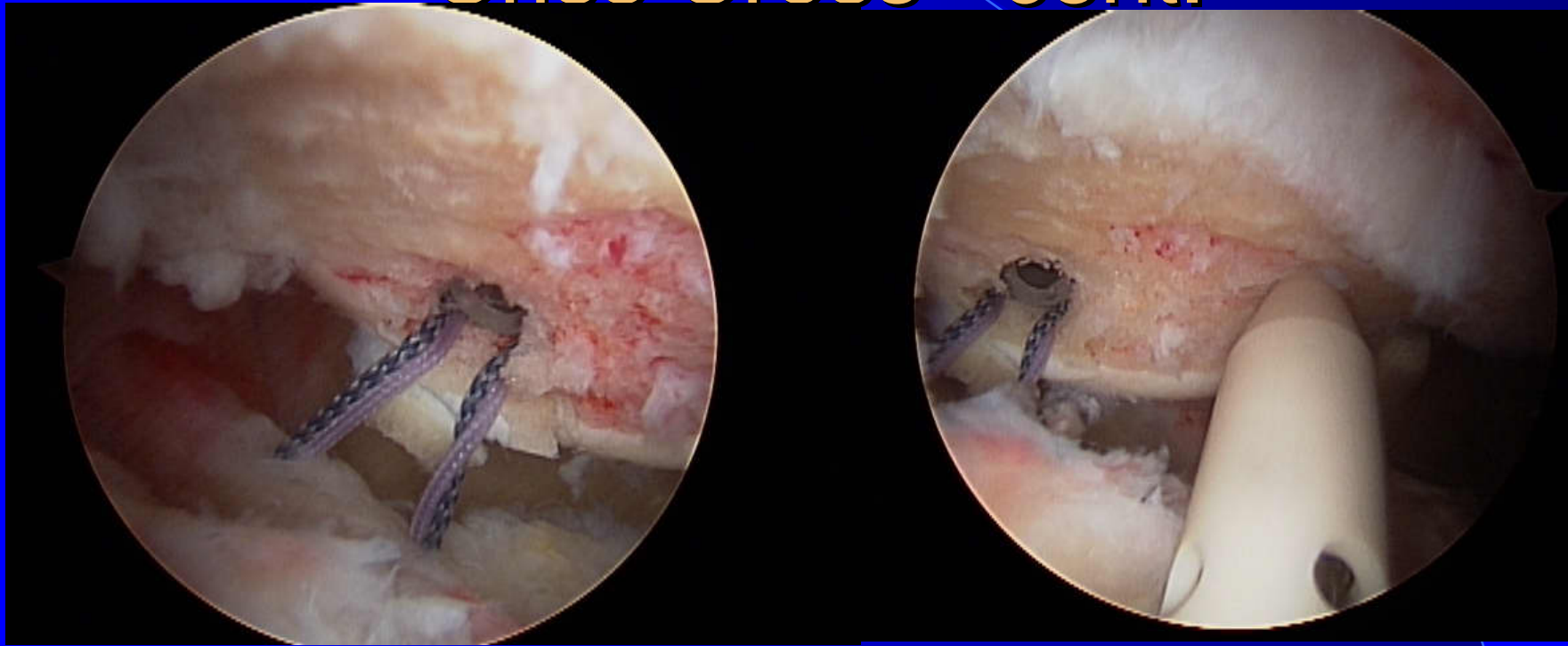


Medial Row anchors- double loaded



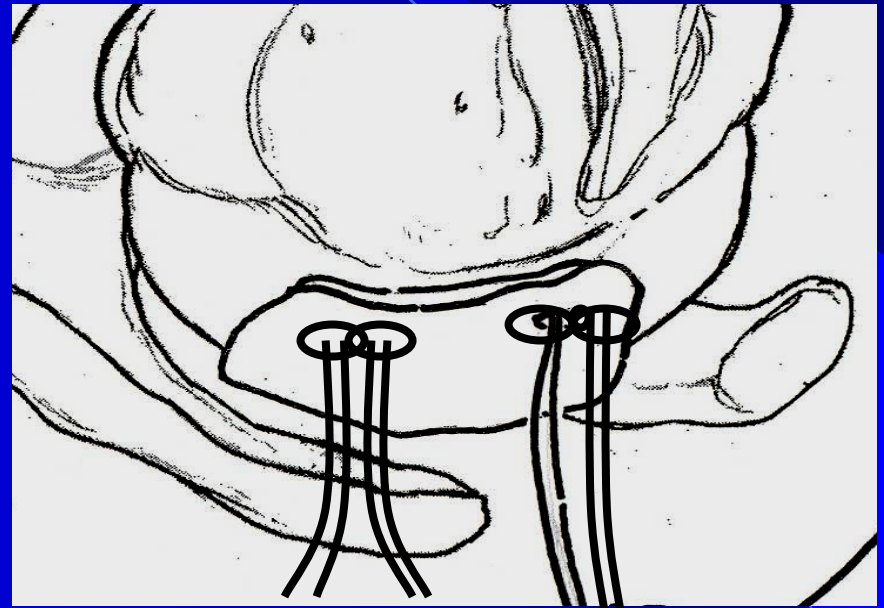
Shuttle sutures through tissue

Dual Row: Criss Cross –cont.

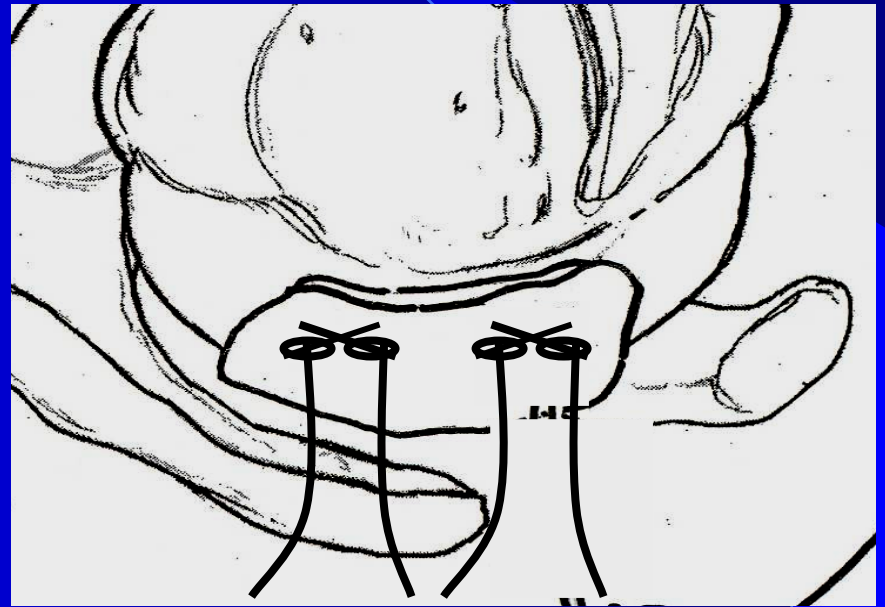
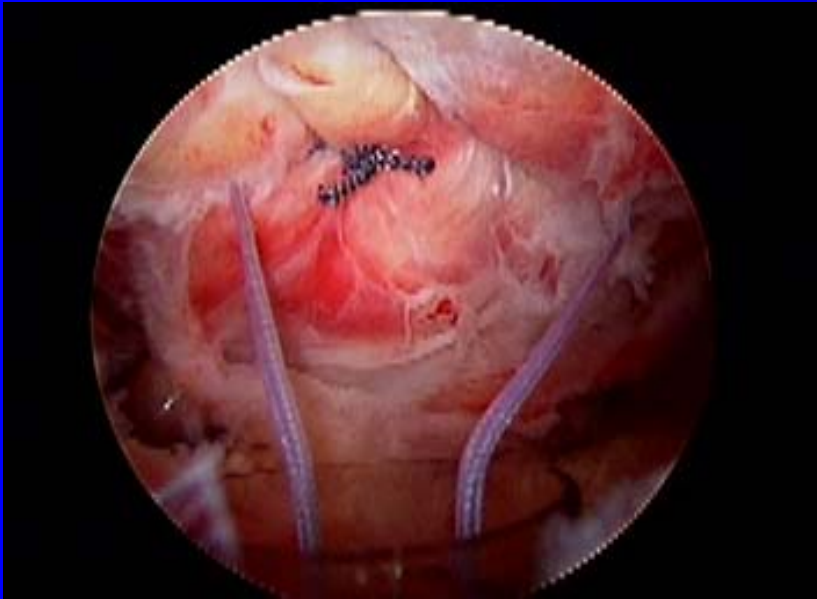


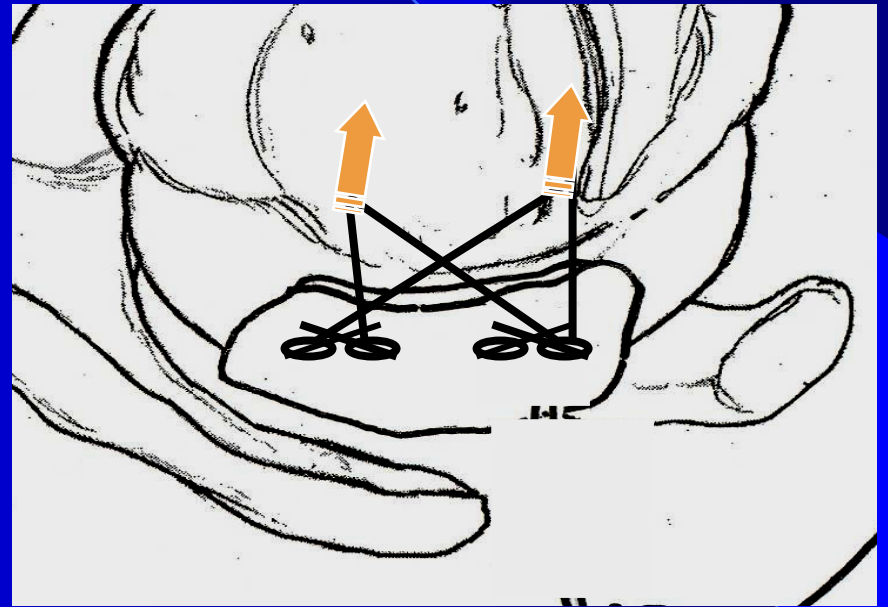
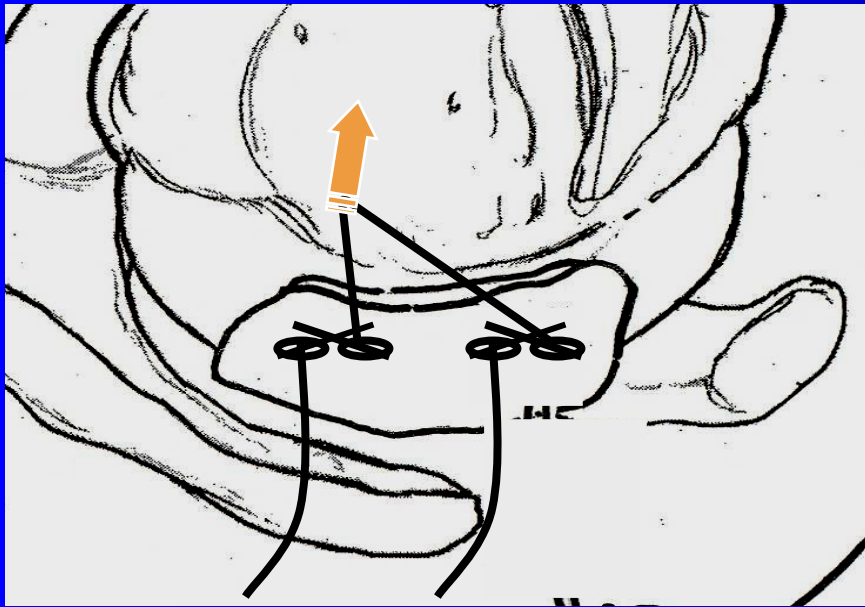
Repeat Two Anchors

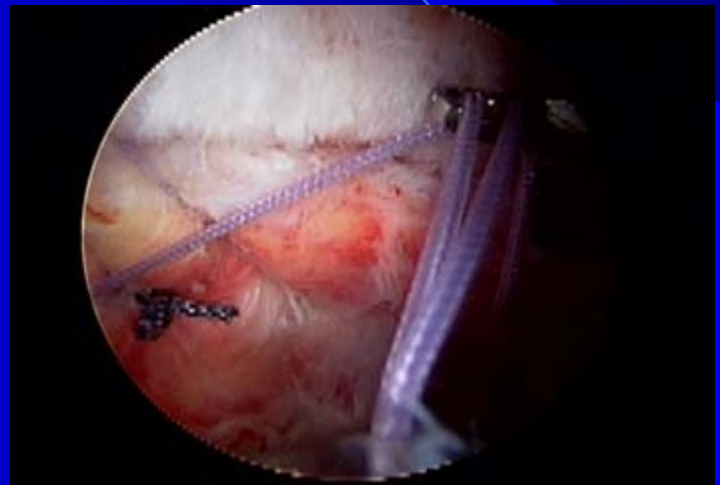
Dual Row: Criss Cross- cont.



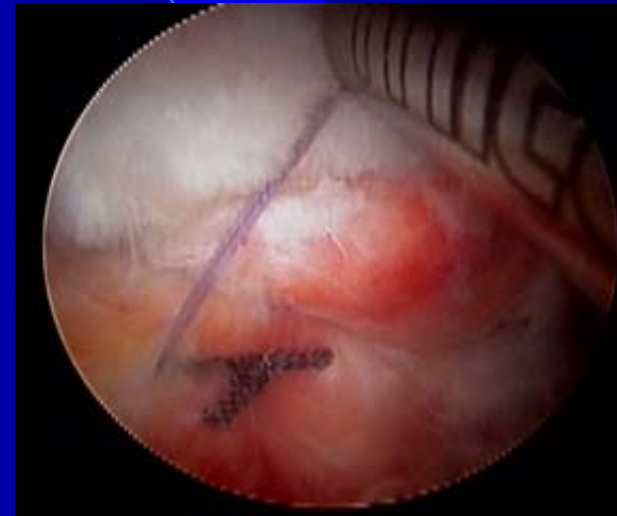
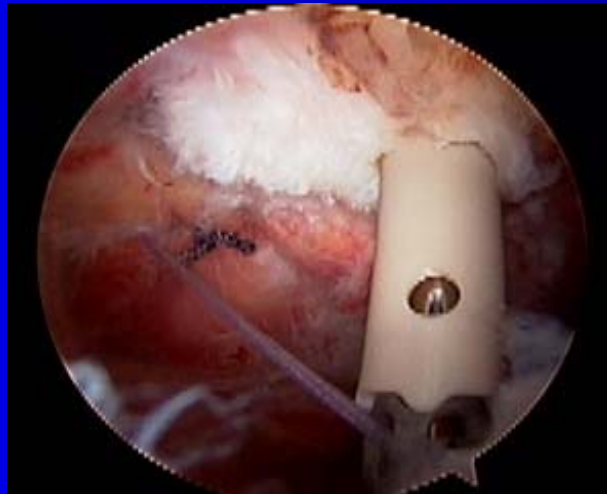
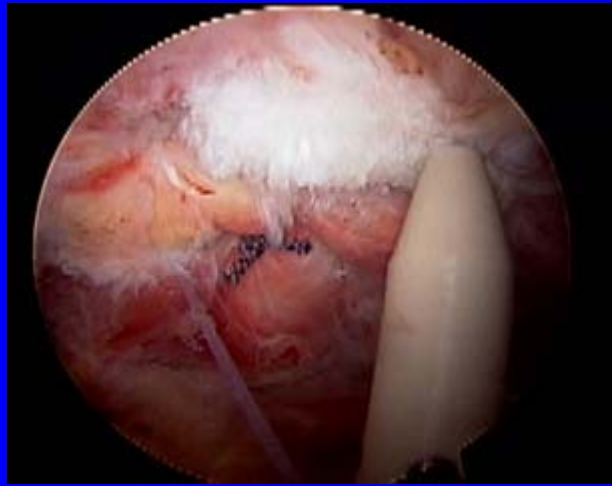
Dual Row: Criss Cross -cont



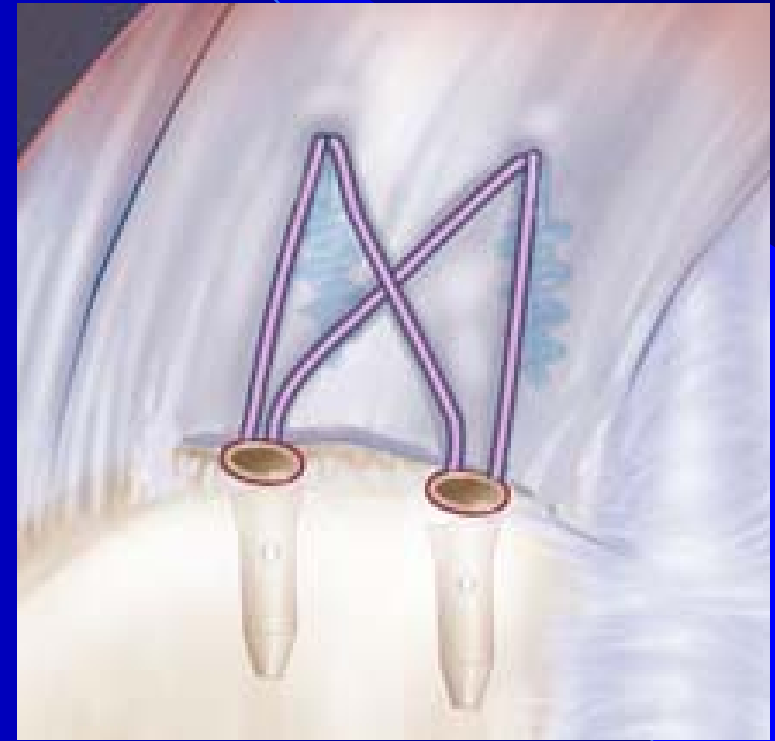
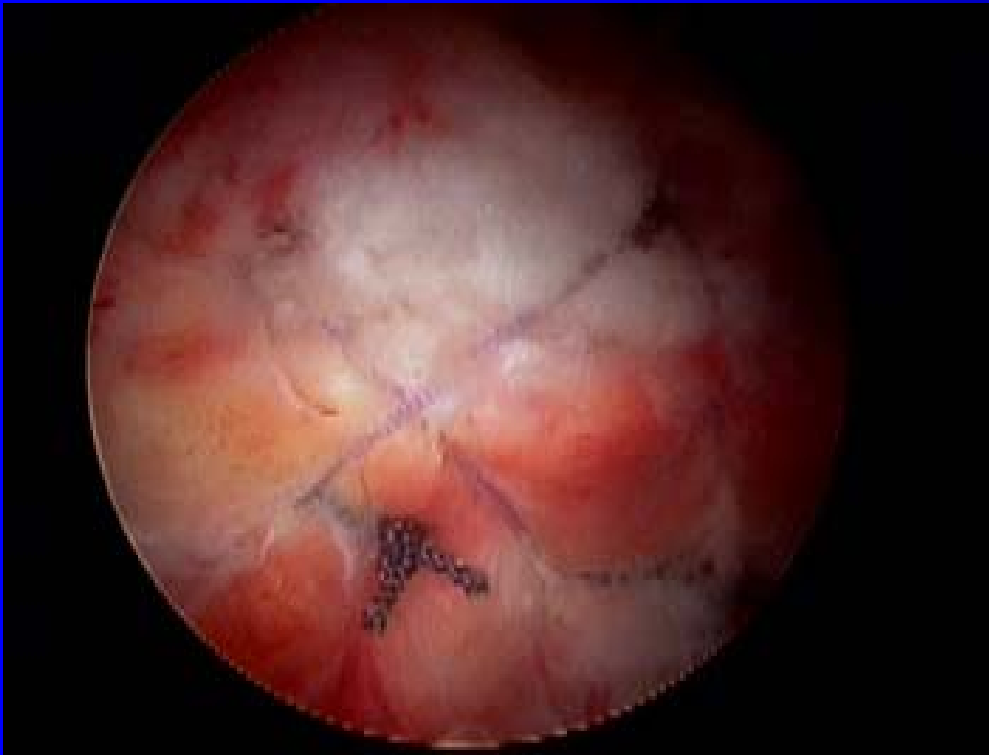




Dual Row: Criss Cross cont.



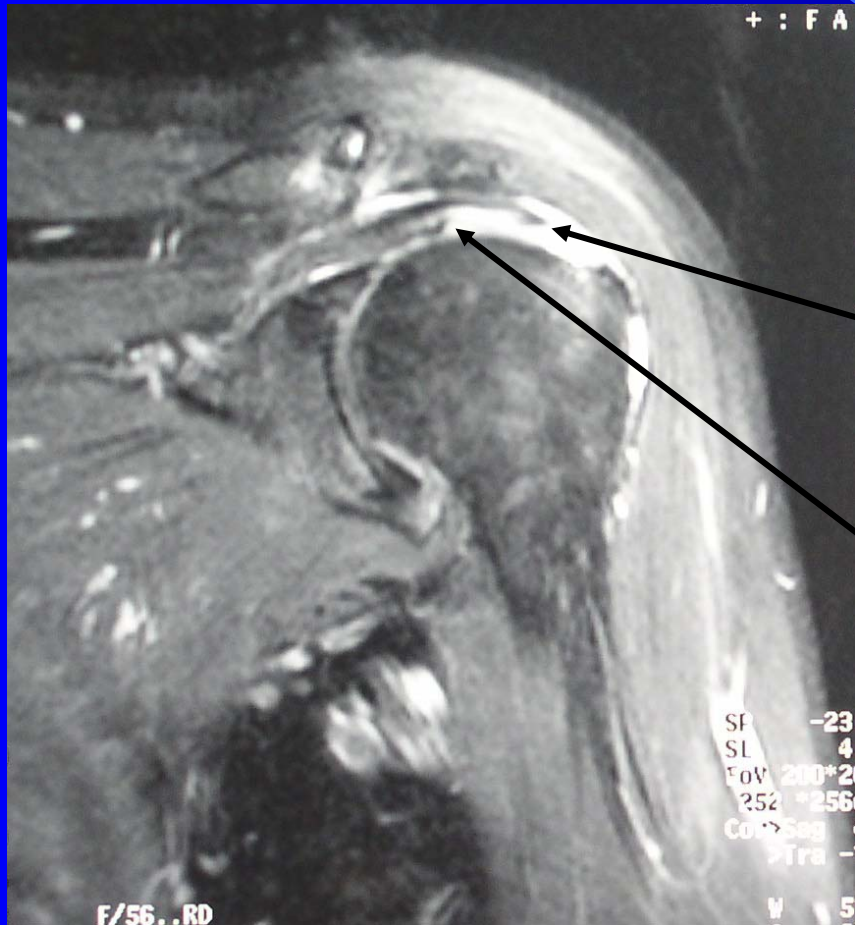
Dual Row: Criss –Cross- cont.



Dual Row: Criss Cross



Delamination



Superior (bursal)
layer

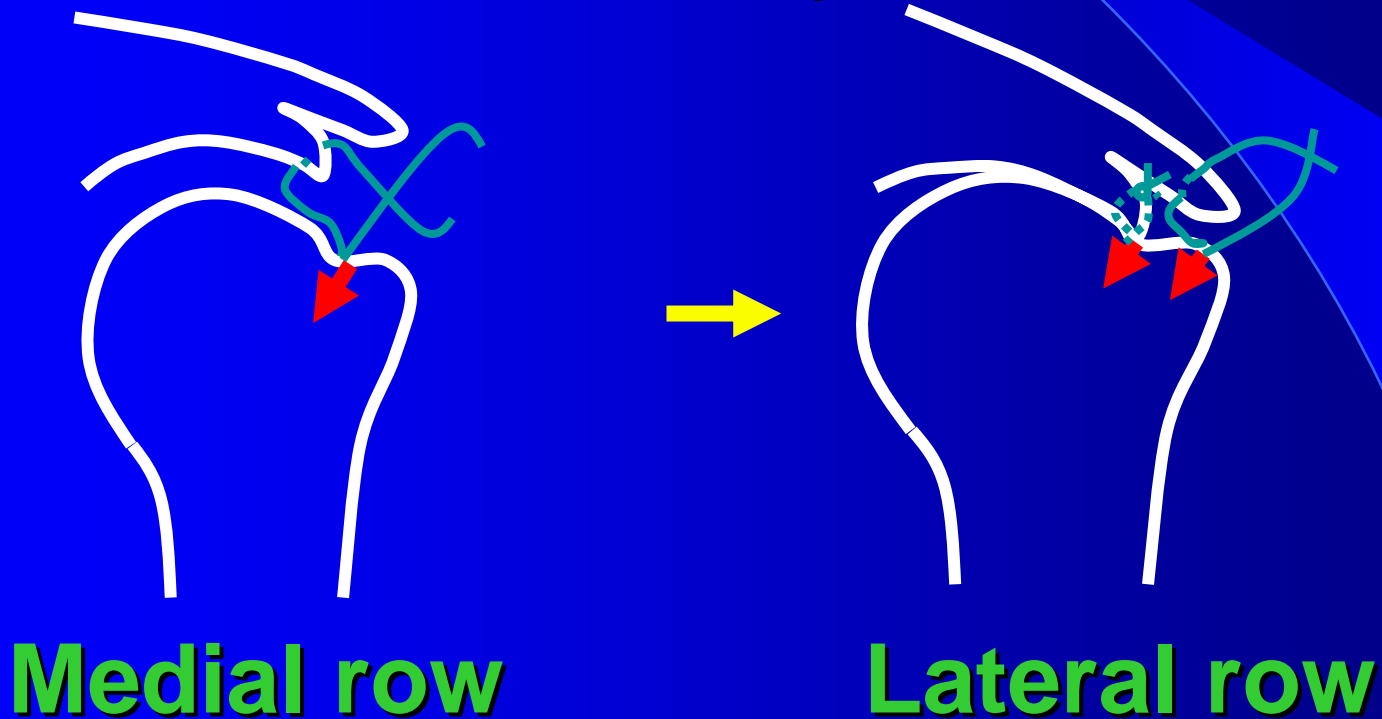
Inferior (articular)
layer

Delamination



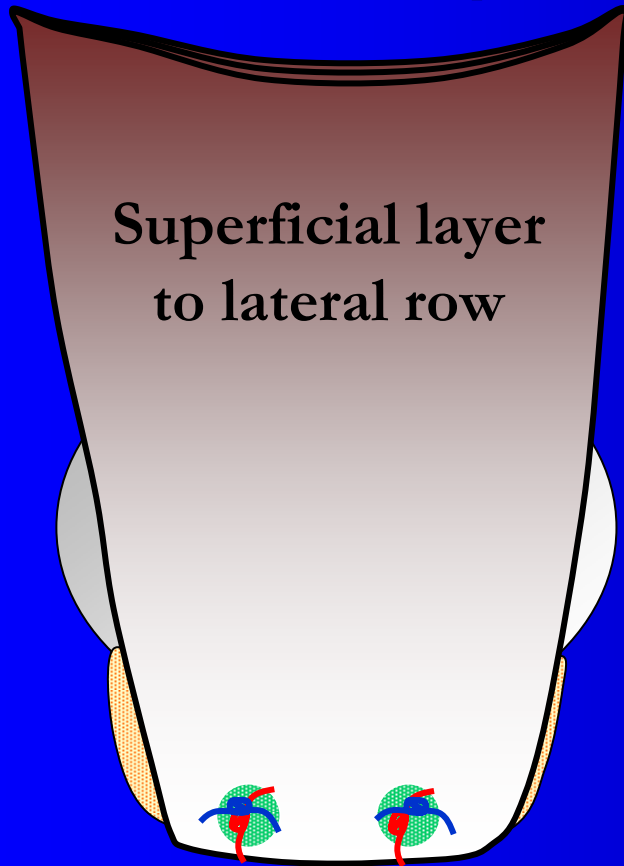
Consider anatomic footprint reconstruction
for ... *delamination*

Dual-row, “dual-layer” fixation



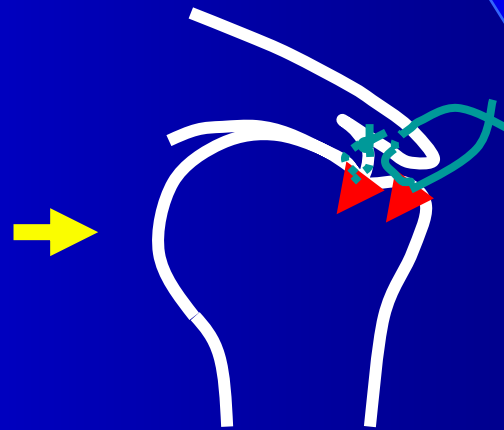
Slide courtesy of **Hiroyuki Sugaya, MD**

Repair Scenarios



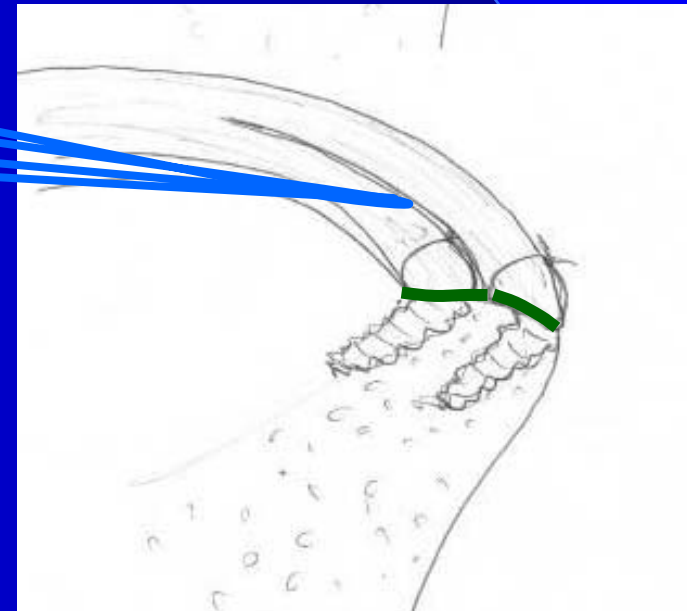
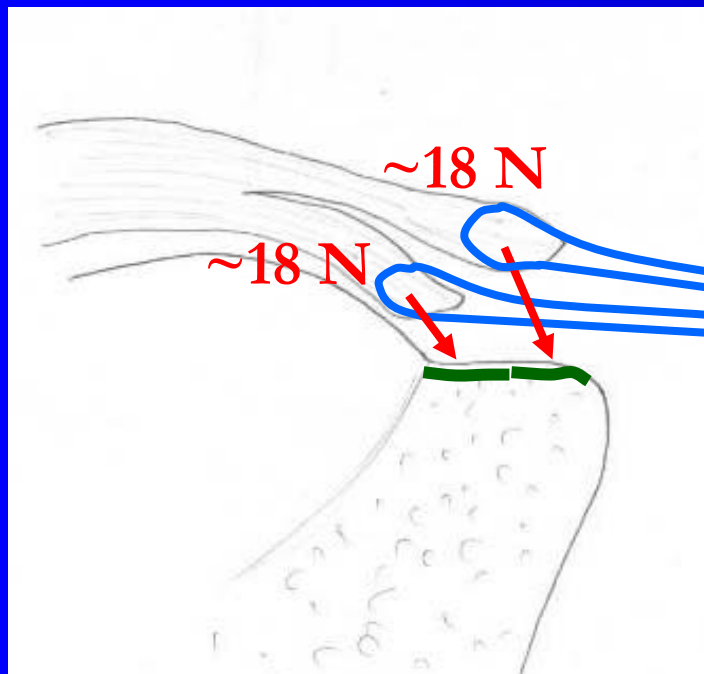
Delaminated tear

Dual-row,
dual-layer fixation

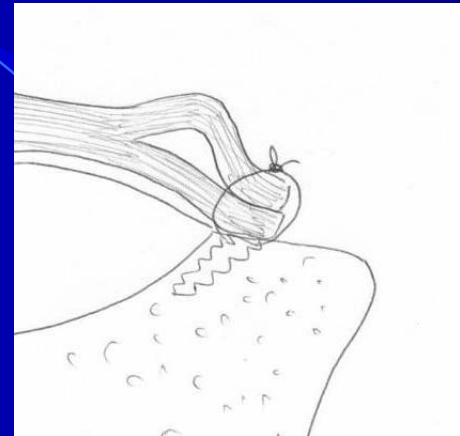
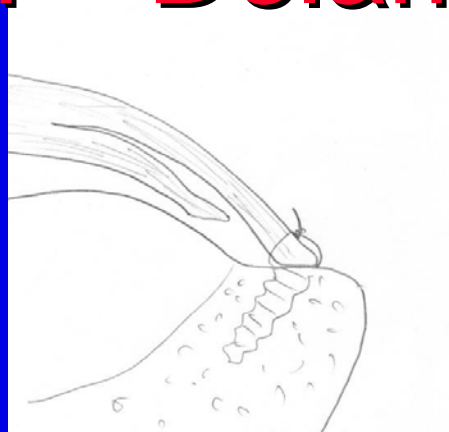
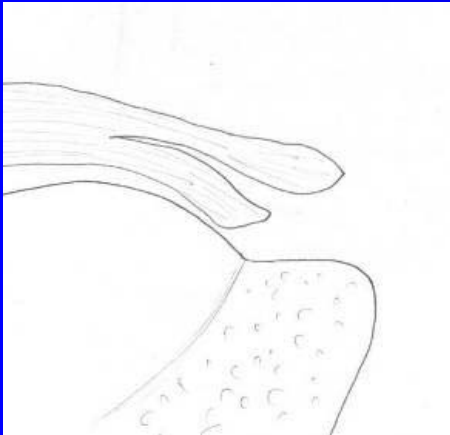


“Anatomic Repair of Delaminated Rotator Cuff Tears- Dual-Row/Dual-Layer Fixation”

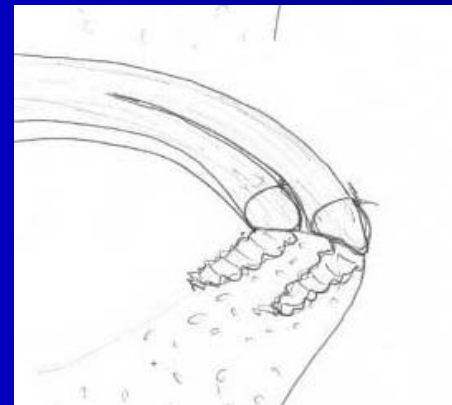
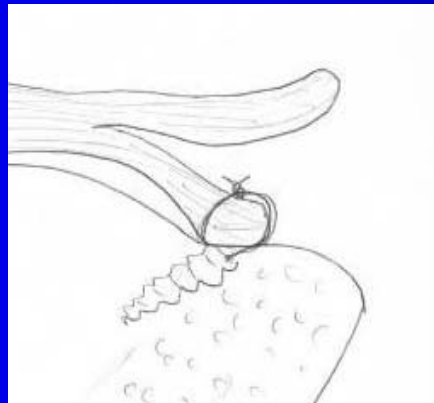
Meier et. al. – Submitted for publication 2007



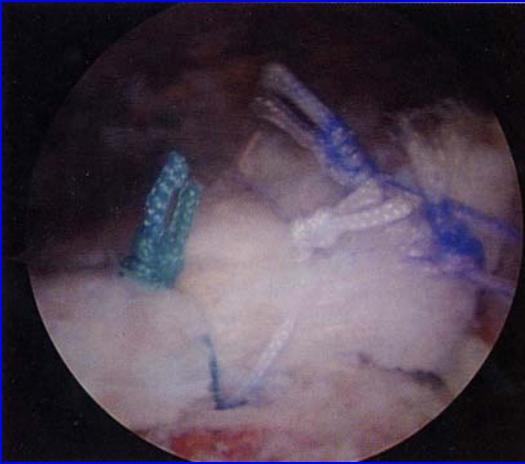
RTCT - Delamination



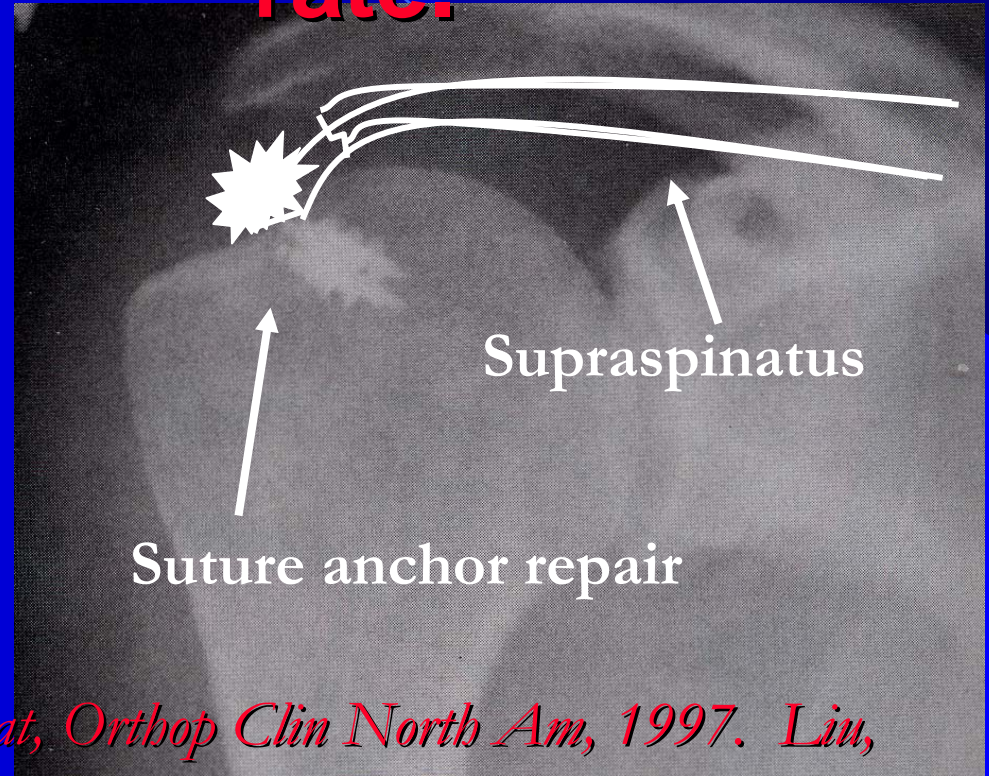
*Dual-Row/
Dual-Layer*



Rotator cuff surgery
→ high complication rate.

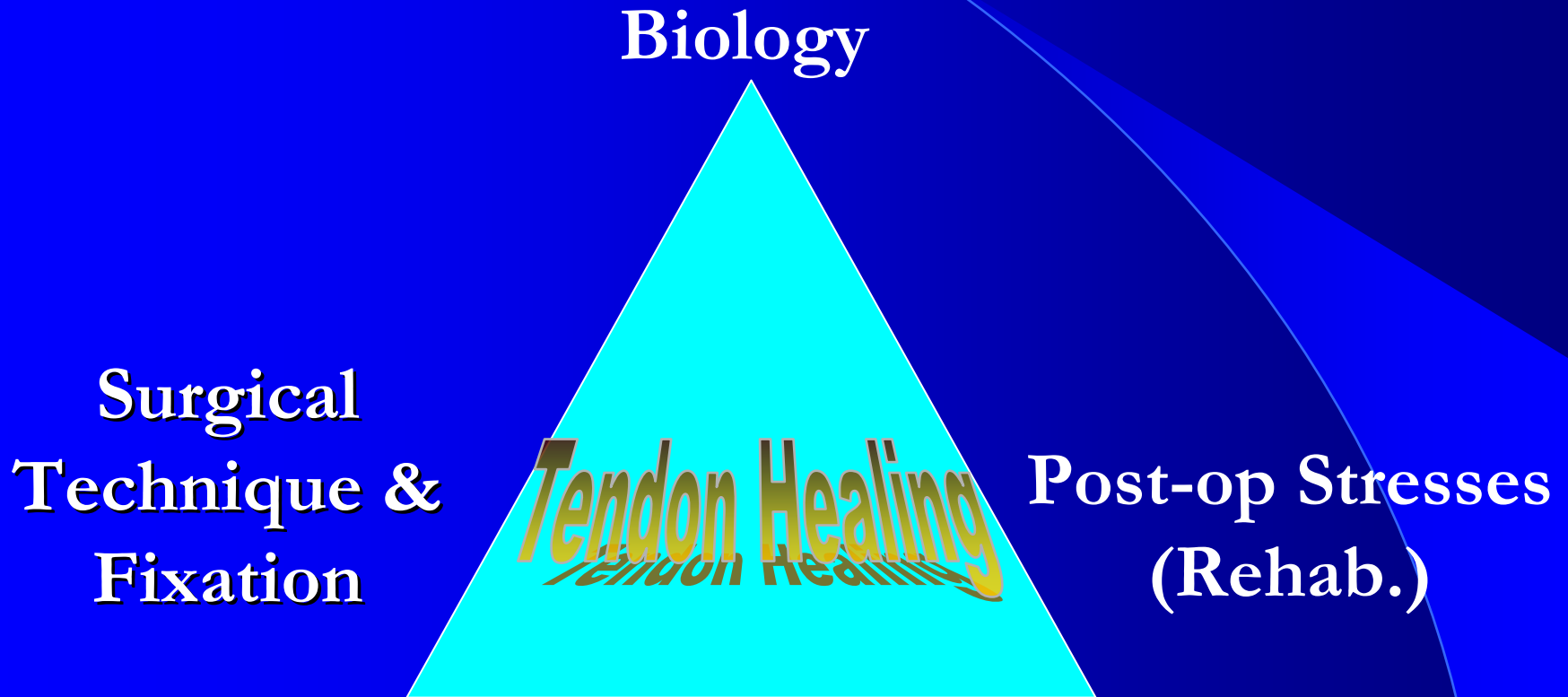


**failure
of
repair**



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Rotator Cuff Repair - Improving Results



What determines tendon healing?

Factors we can control...

Surgical Technique

– Anatomic restoration

- Recognize tear pattern and accurately re-approximate tear.
- Restore musculotendinous length-tension orientation.
- Address delamination.

● Restore footprint anatomically.
An anatomic repair is a **LOW TENSION REPAIR**