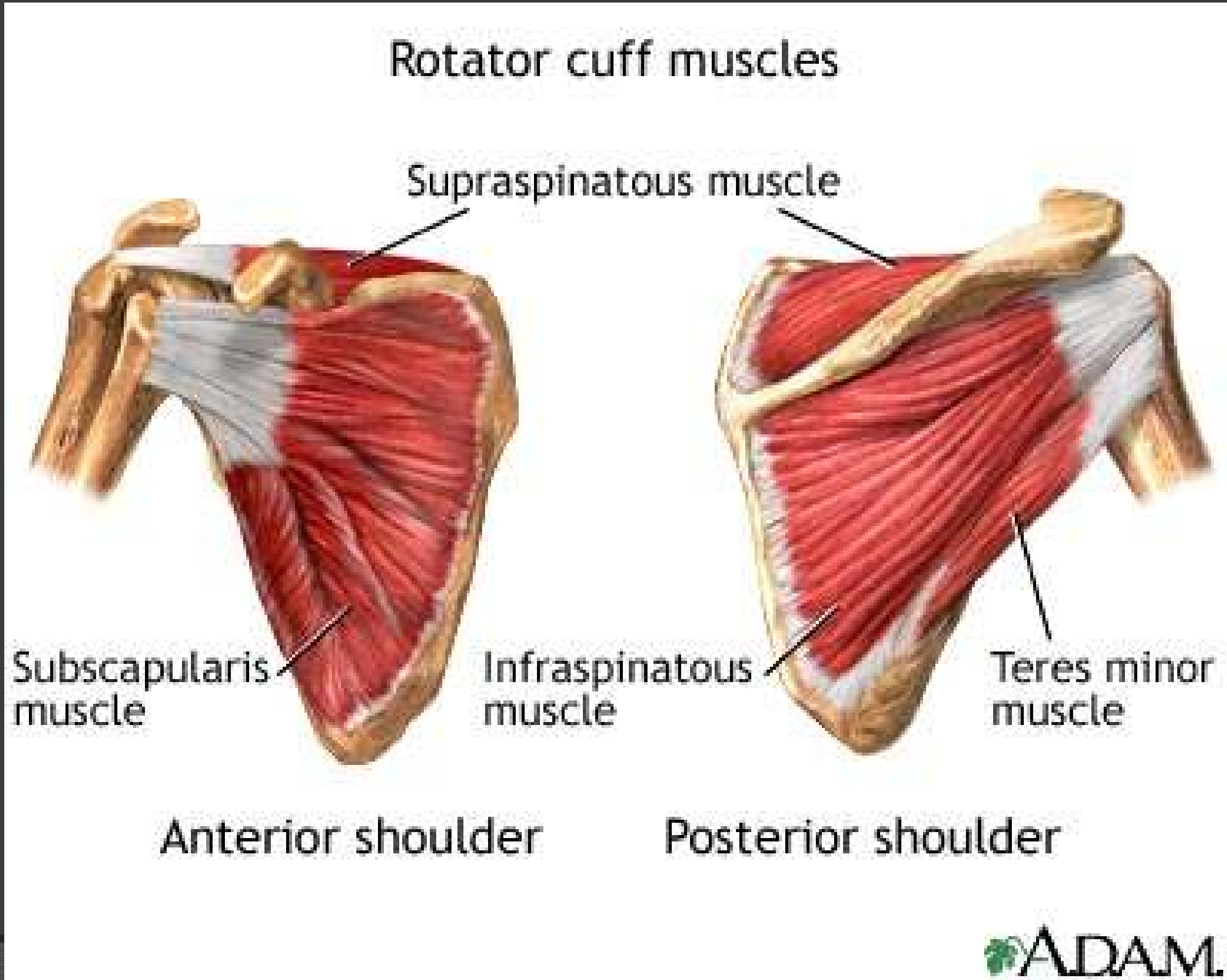
THE ROTATOR CUFF CURRENT CONCEPTS ARTHROSCOPIC REPAIR

Paul Manning
Nottingham University Hospitals

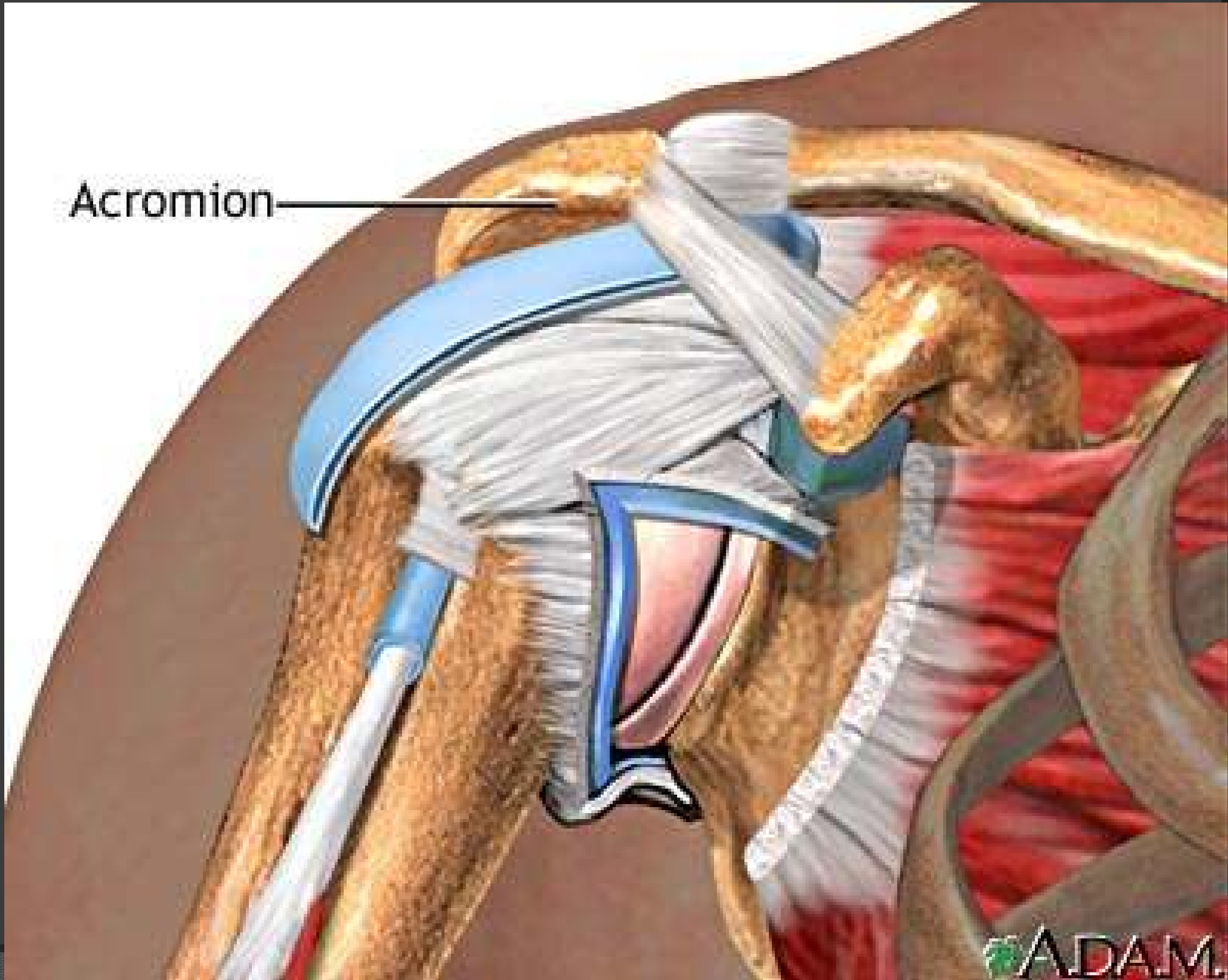
Summary

- Simple Anatomy
- Types of Tear
- Arthroscopic Repair
  - Anchors
  - Patient Physiology
  - Repair Configuration
  - Rehabilitation
- Conclusion

Anatomical


Rotator cuff muscles
Supraspinatous muscle
Subscapularis muscle
Infraspinatous muscle
Teres minor muscle
Anterior shoulder
Posterior shoulder
A.D.A.M.

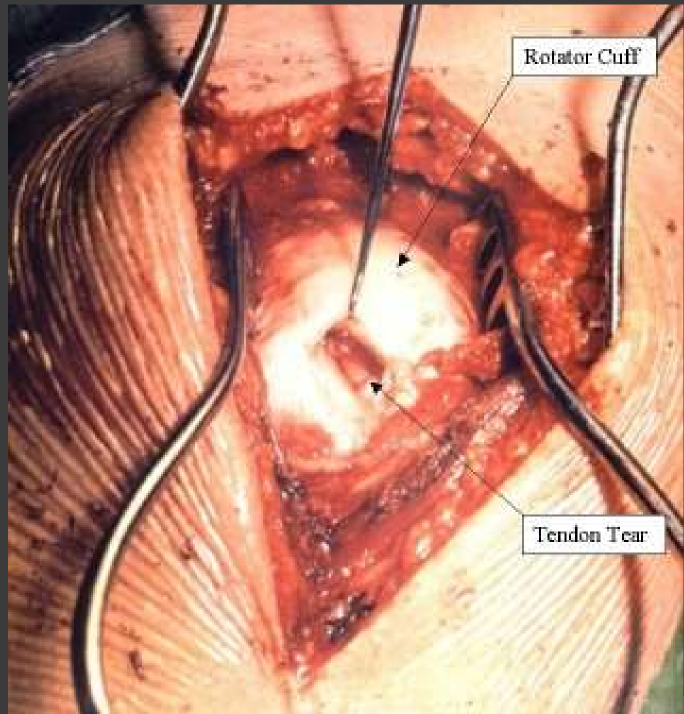
Anatomical



Types of Tear

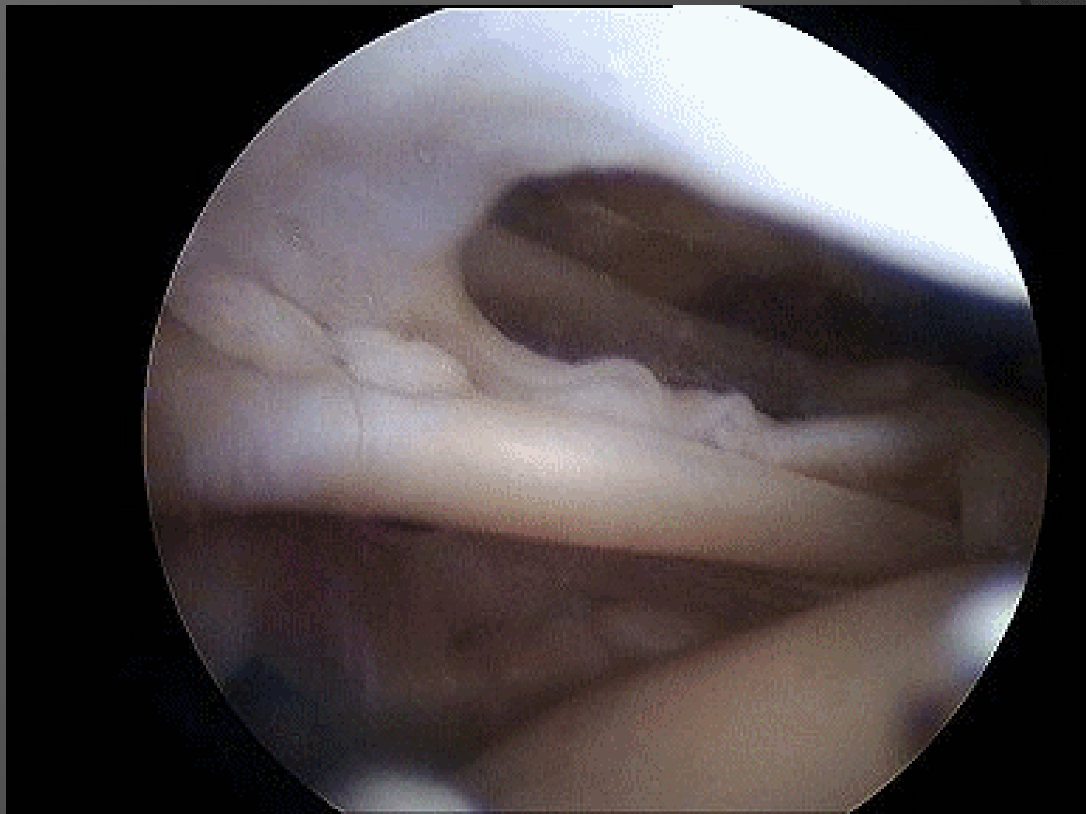
Small/Medium

< 3cm



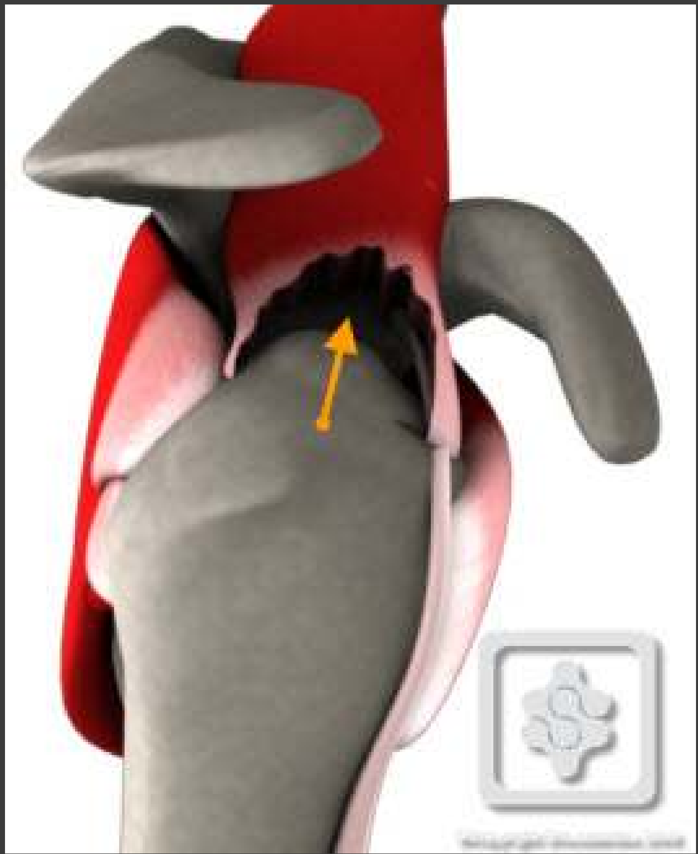
<60 Wear and Tear

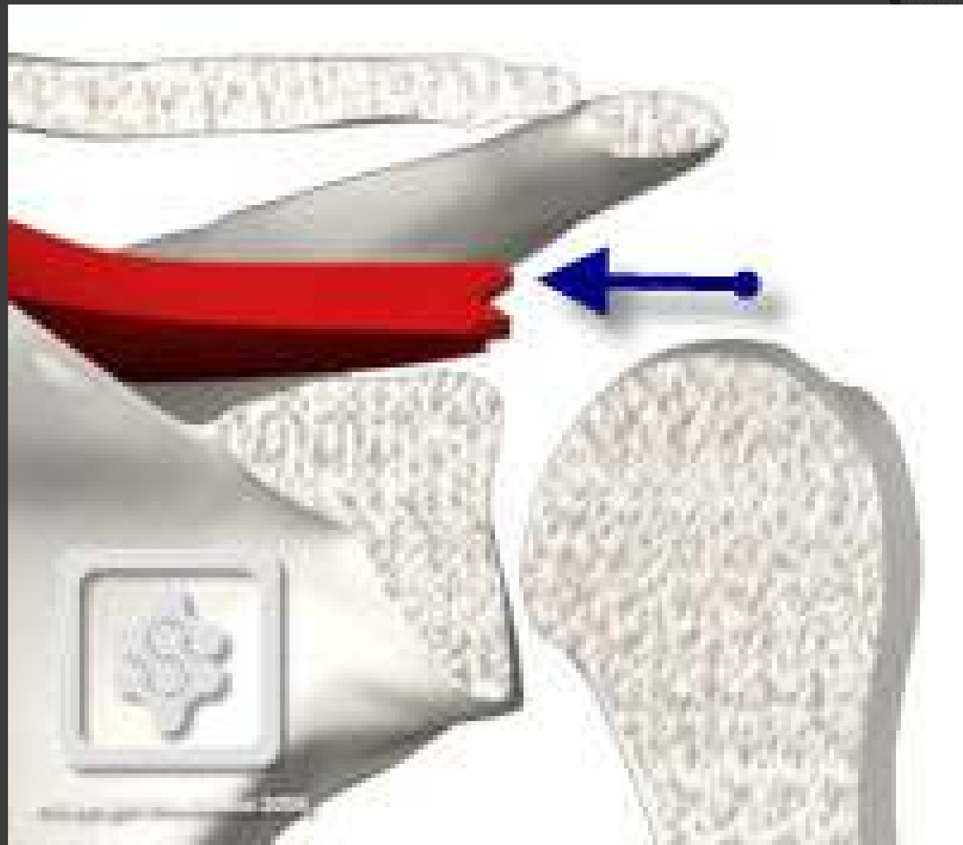
<60>45 Post Dislocation



Best Candidates for Repair

Massive Tear
>5cm

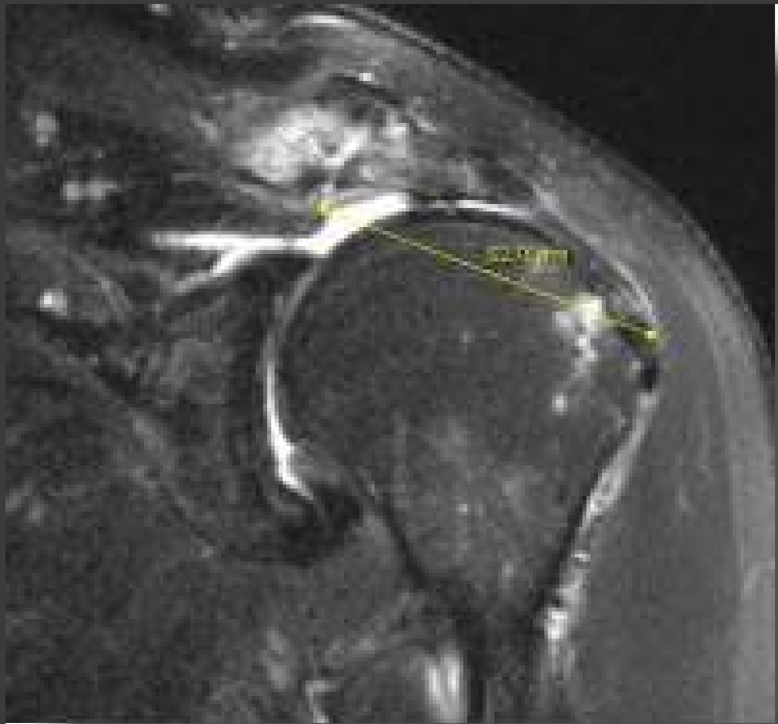


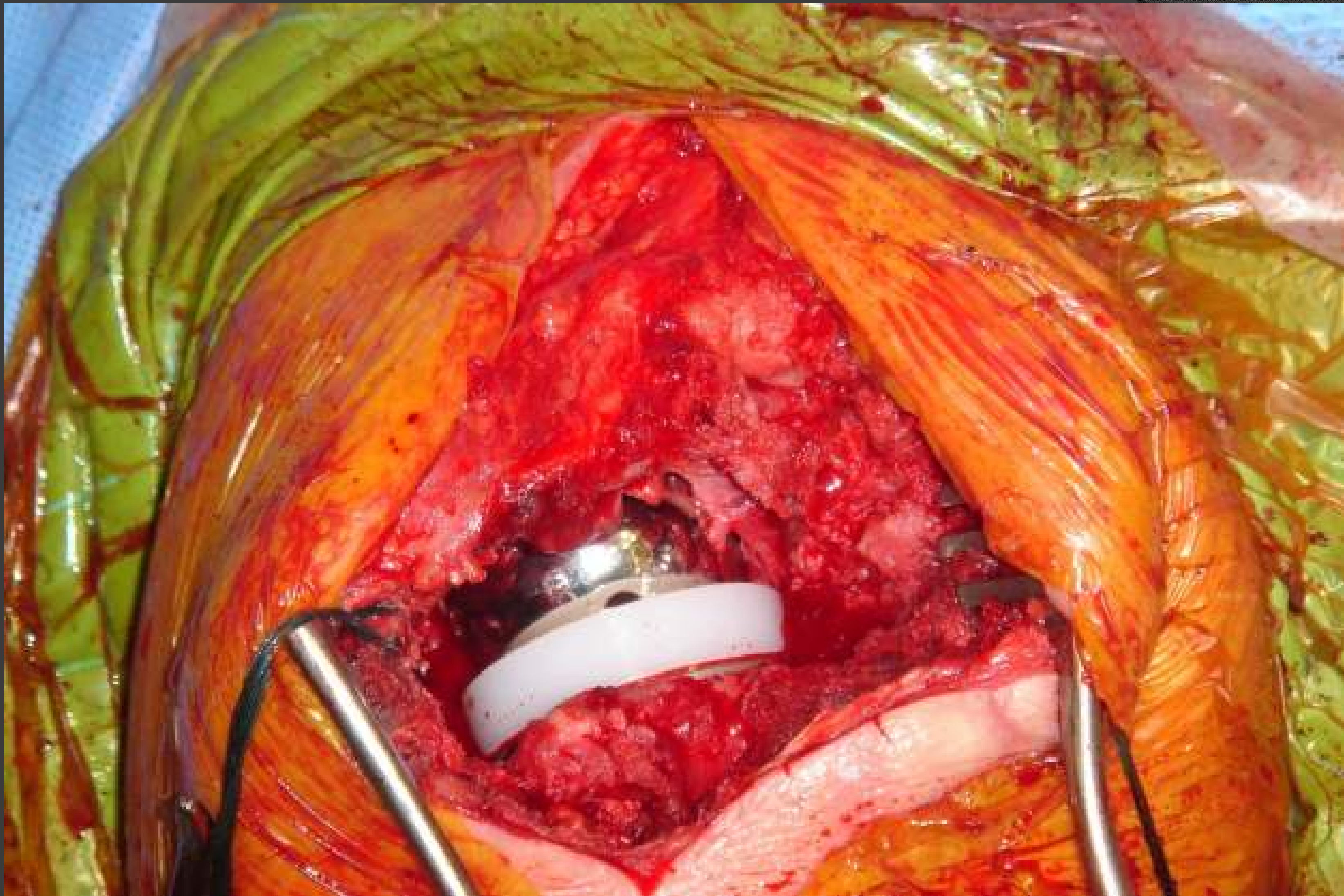


- >60

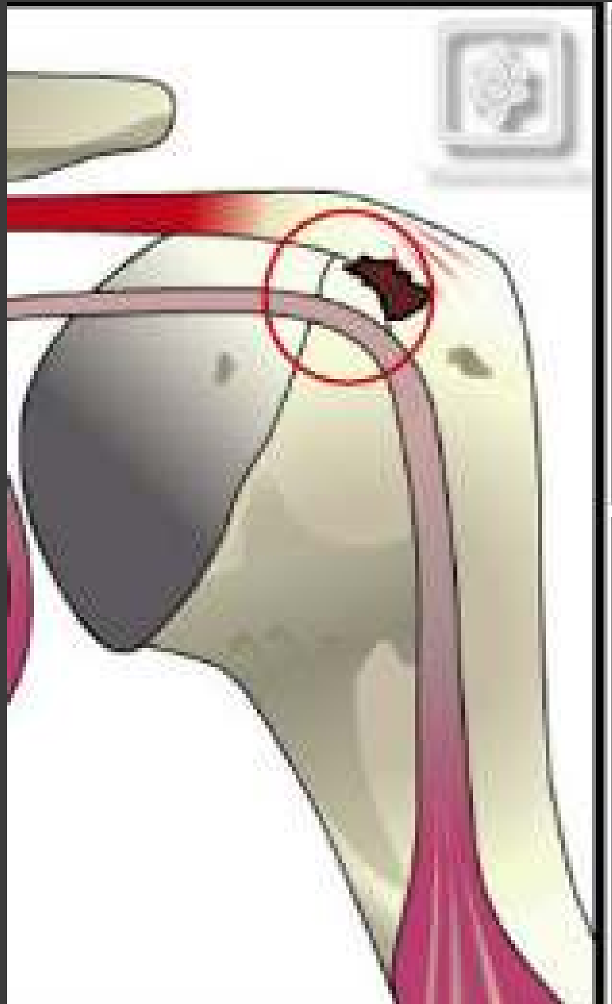
Treatment of Massive Tears

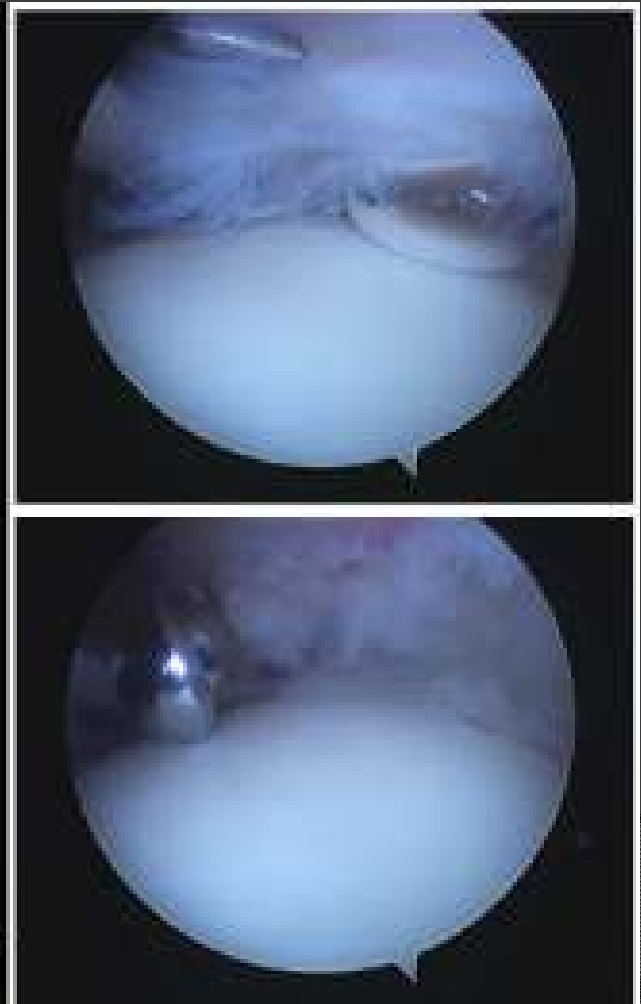
- Deltoid Rehabilitiation
- Repair with Orthobiologic Material
  - Platelet Rich Plasma
- Muscle Transfers
- Arthroscopic Subacromial Decompression and Cuff Debridement/Biceps Tenotomy
  - 80% Good/Excellent results for pain (not function) (Gartsman)
- Reverse Arthroplasty

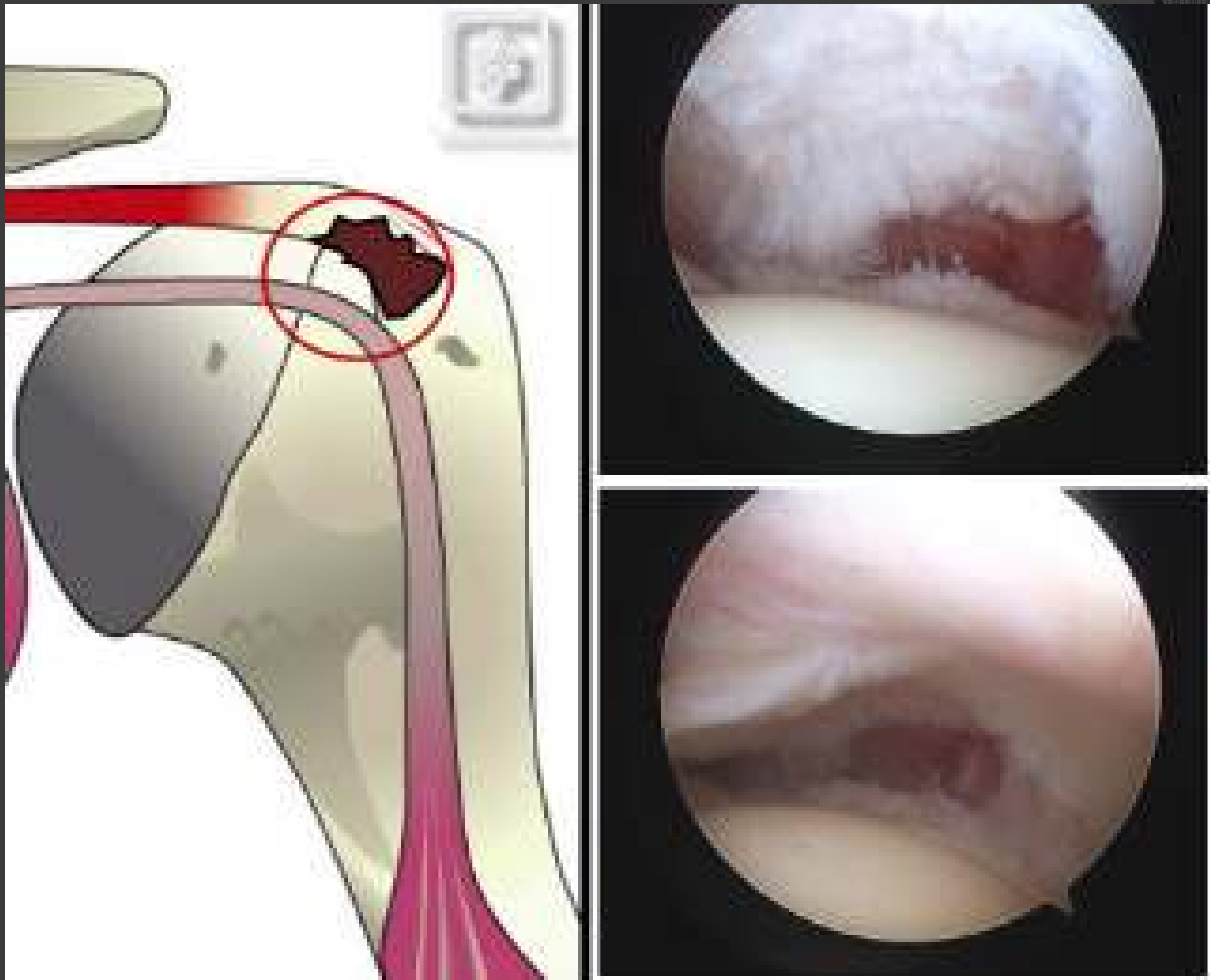




Partial Tears



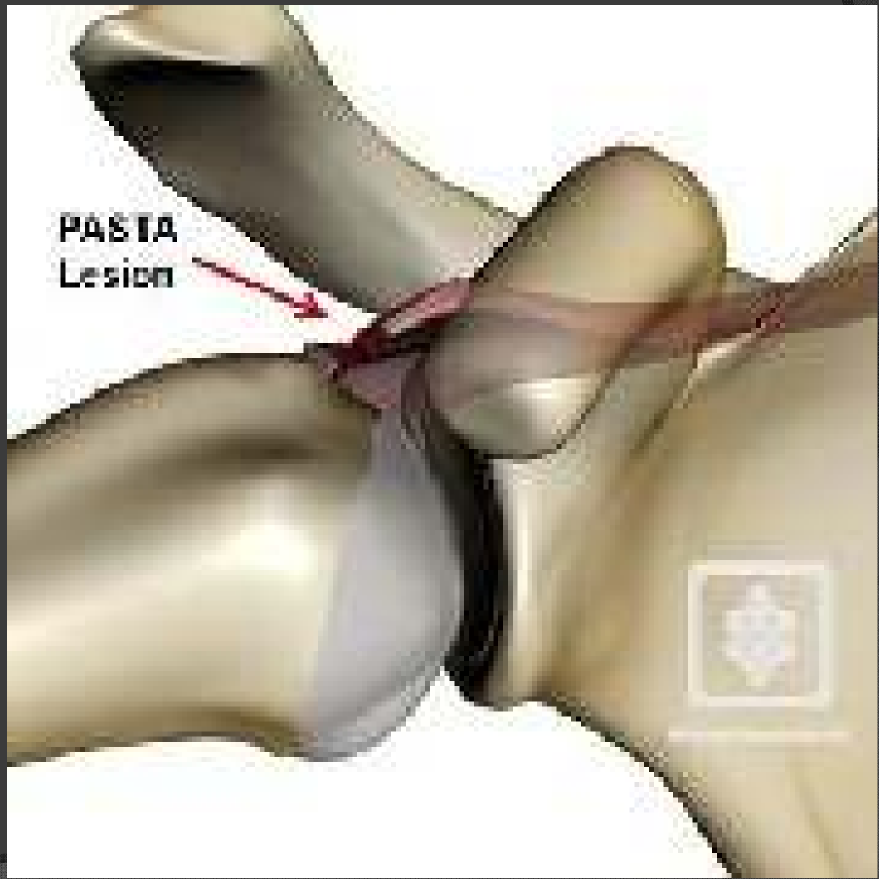




PASTA Lesions

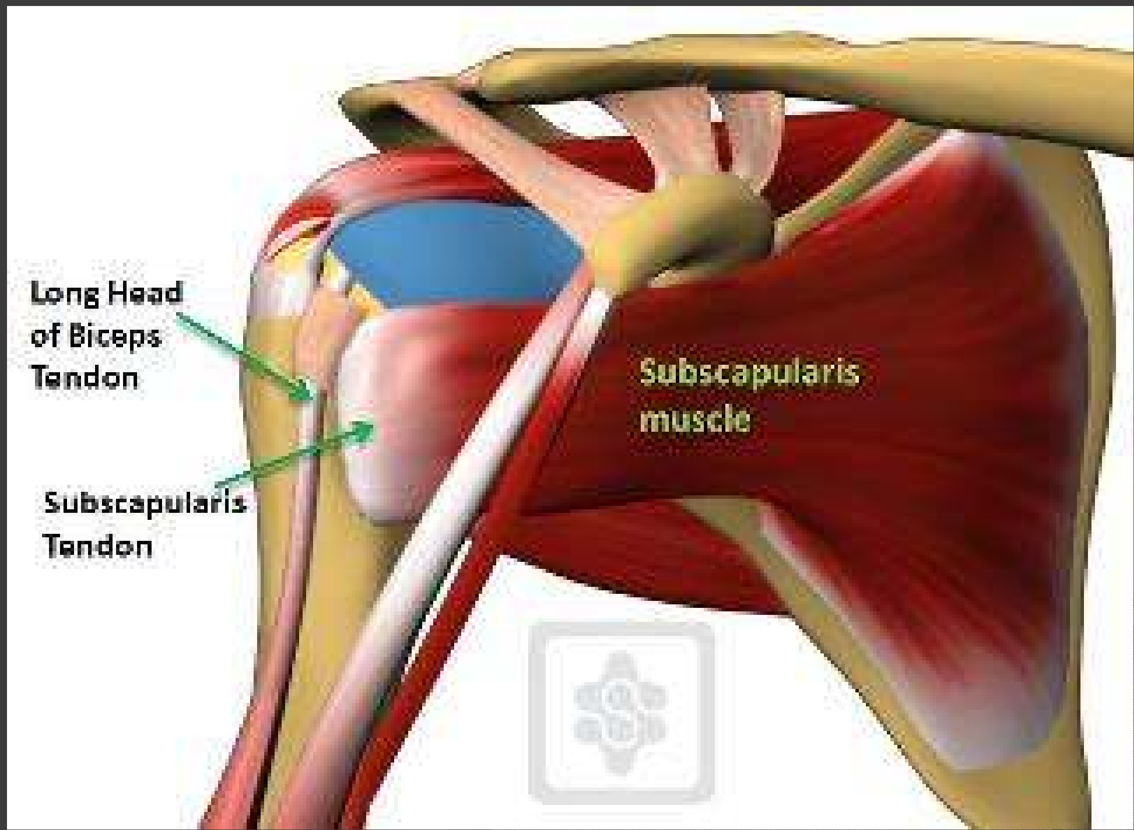
PASTA

- Young
- Painful
- Debride
- Beware Stiffness



Subscapularis

- Rare, liked by examiners



Arthroscopic Repair
Small & Medium Tears

- Current Concepts

Cuff integrity after arthroscopic versus open rotator cuff repair

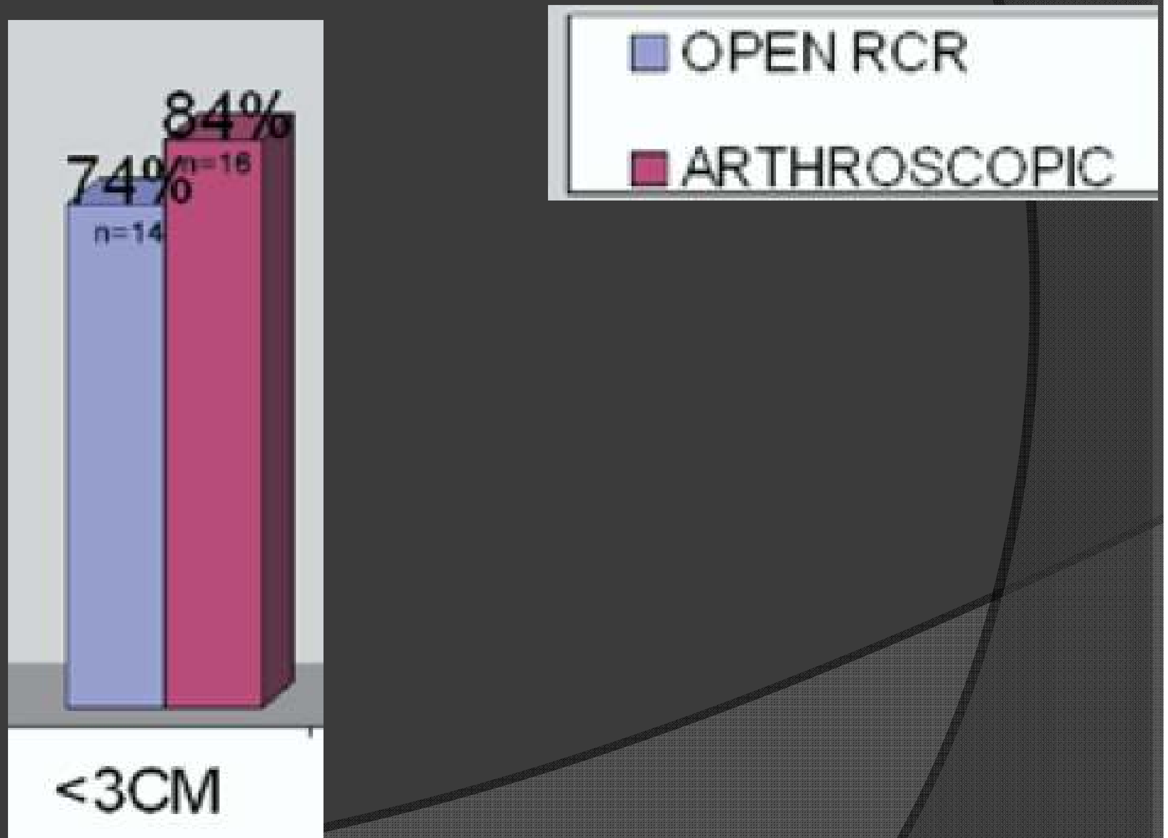
Julie Bishop 2006

JSES Volume 15, Issue 3, Pages 290-299 (May 2006)

- Prospective study
- MRI scans
- 1-year follow-up

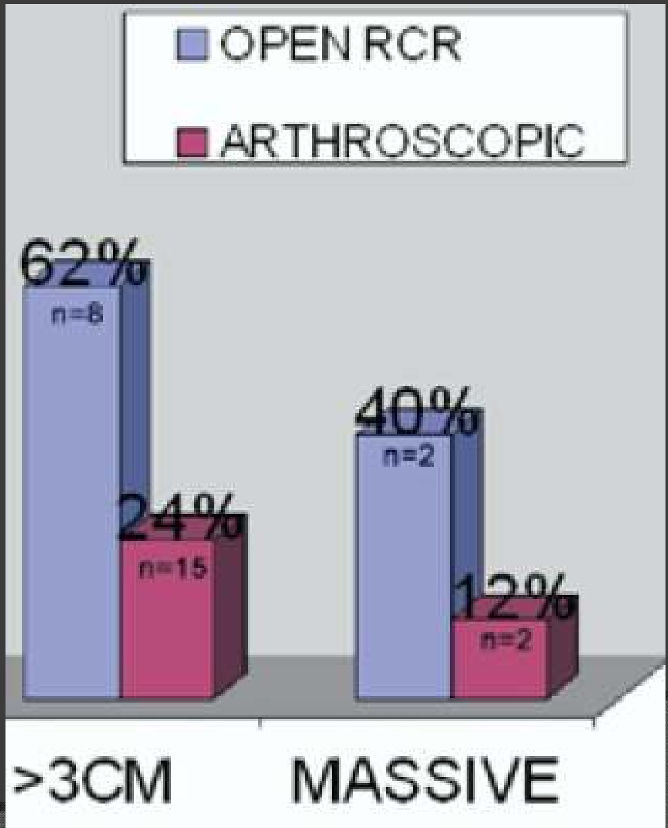
Cuff integrity
after arthroscopic versus open rotator cuff repair:
A prospective study
Julie Bishop 2006

- Cuff integrity is comparable for small tears

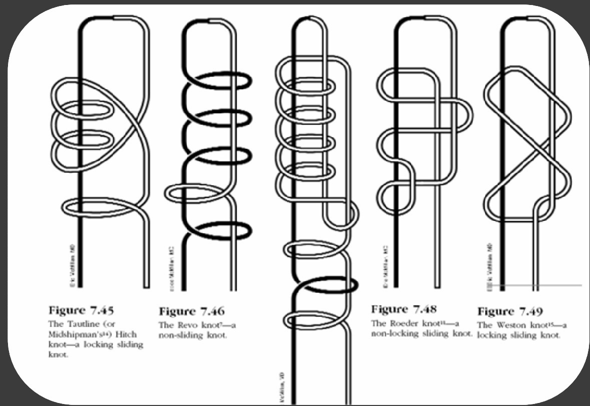


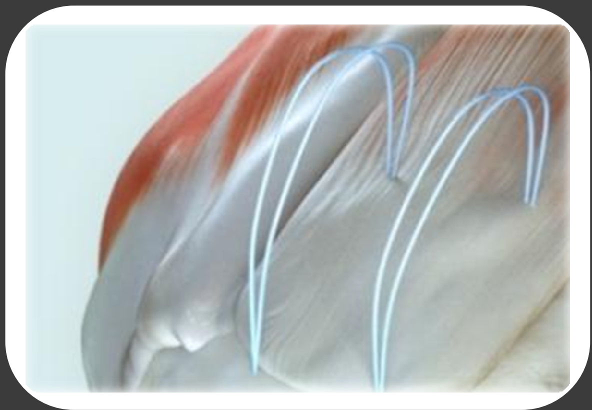
Cuff integrity
after arthroscopic versus open rotator cuff repair:
A prospective study
Julie Bishop 2006

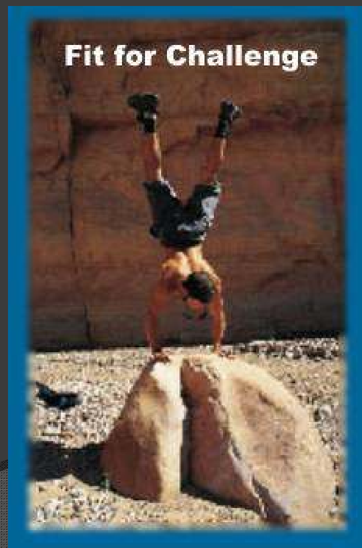
- Large/Massive tears have twice the retear rate after ARCR



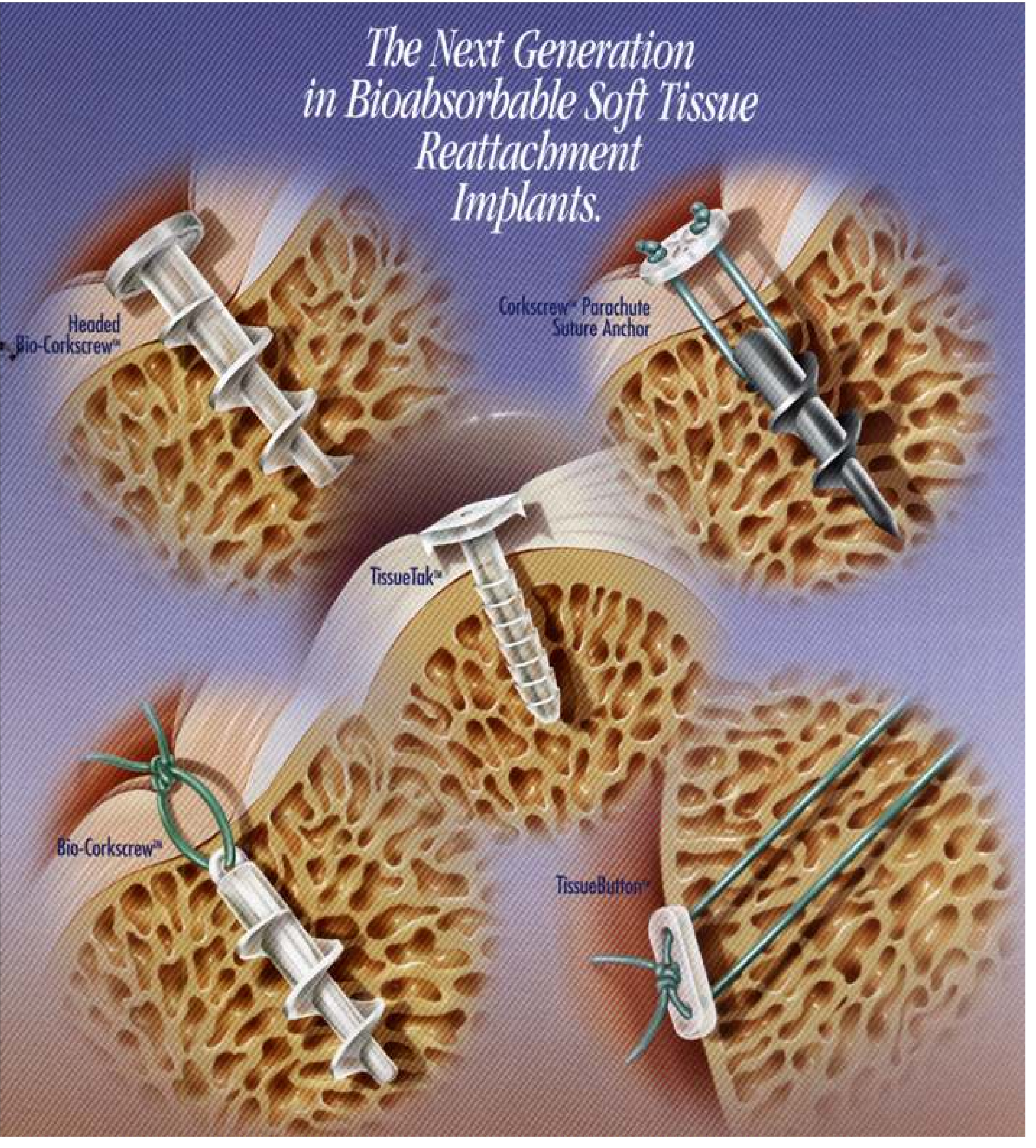
Arthroscopic Cuff Repair



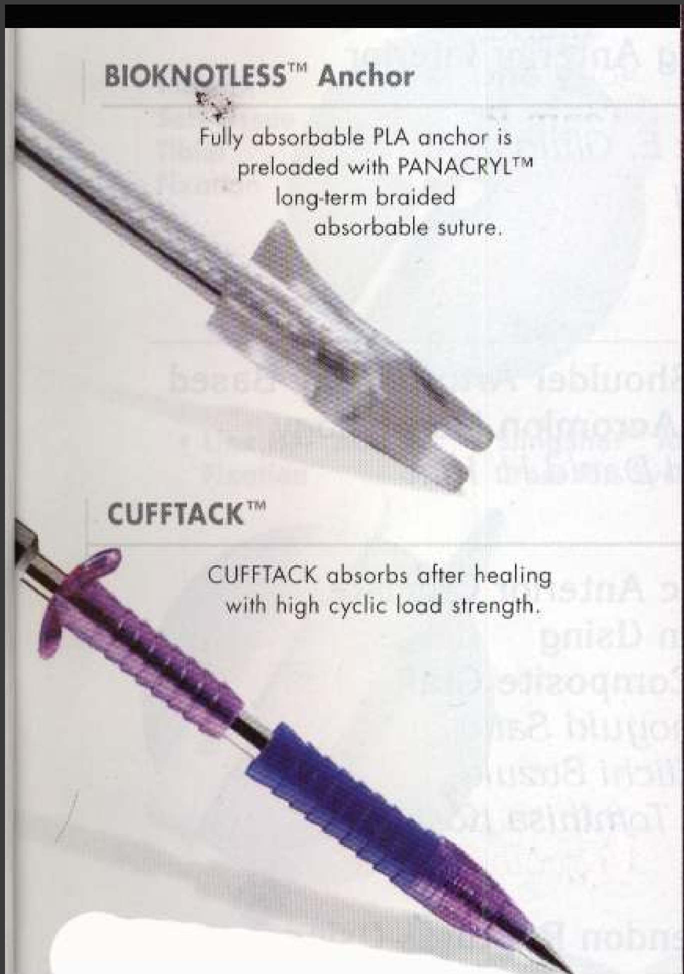




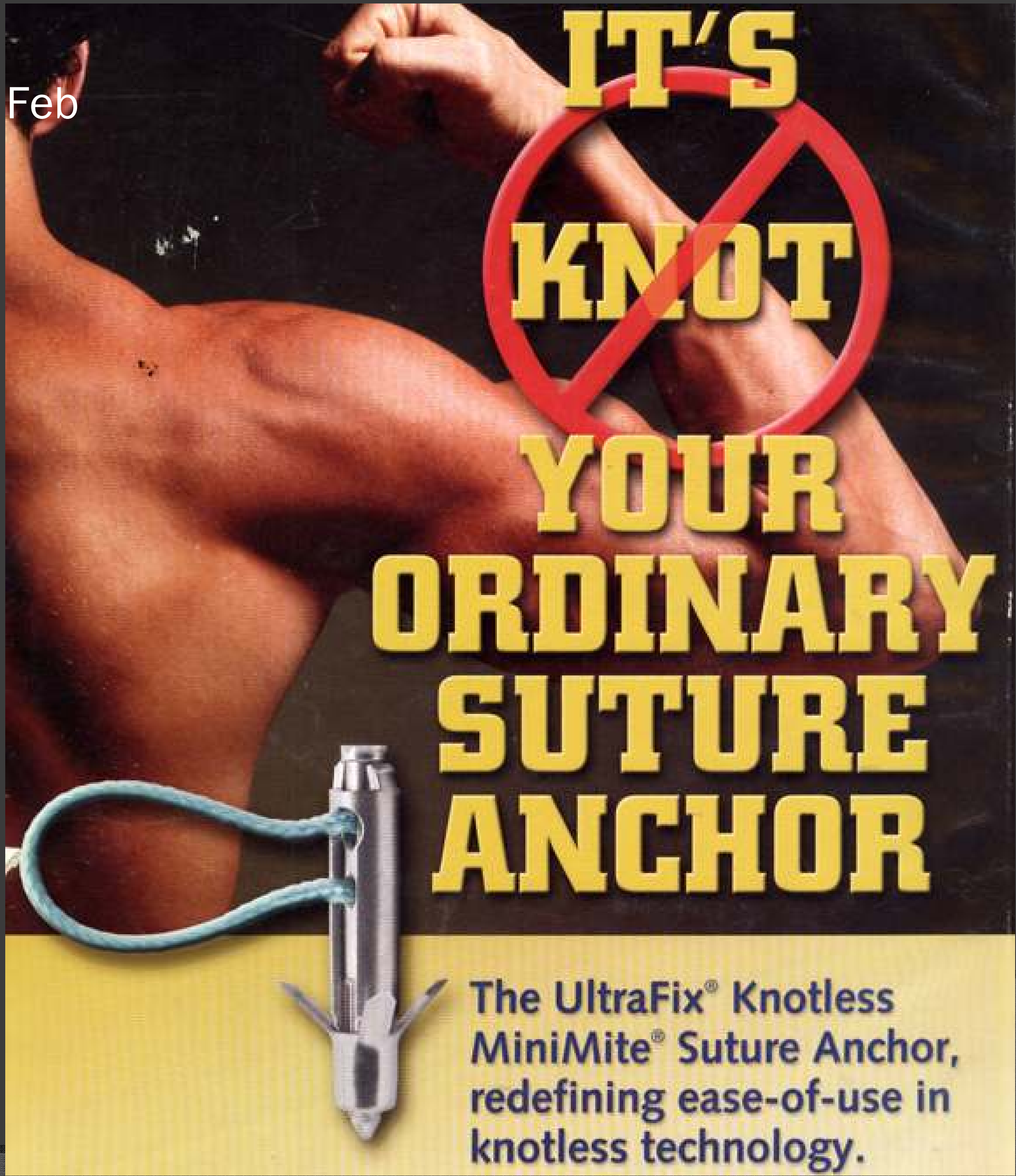
Arthroscopy
March 2000



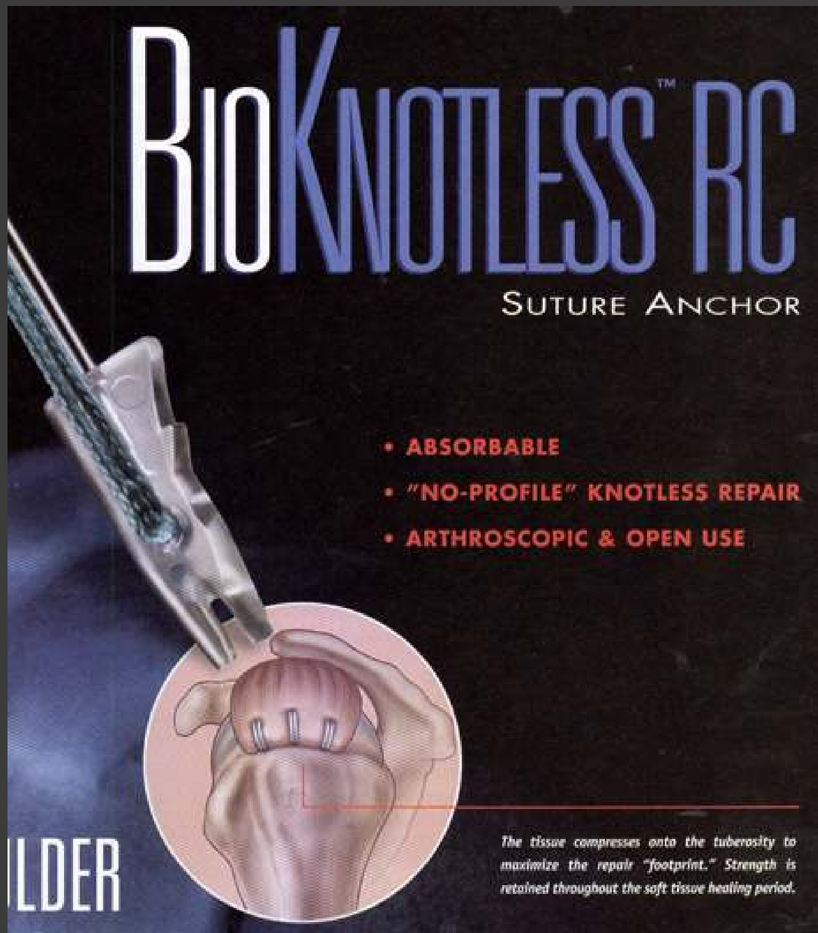
Arthroscopy June 2002



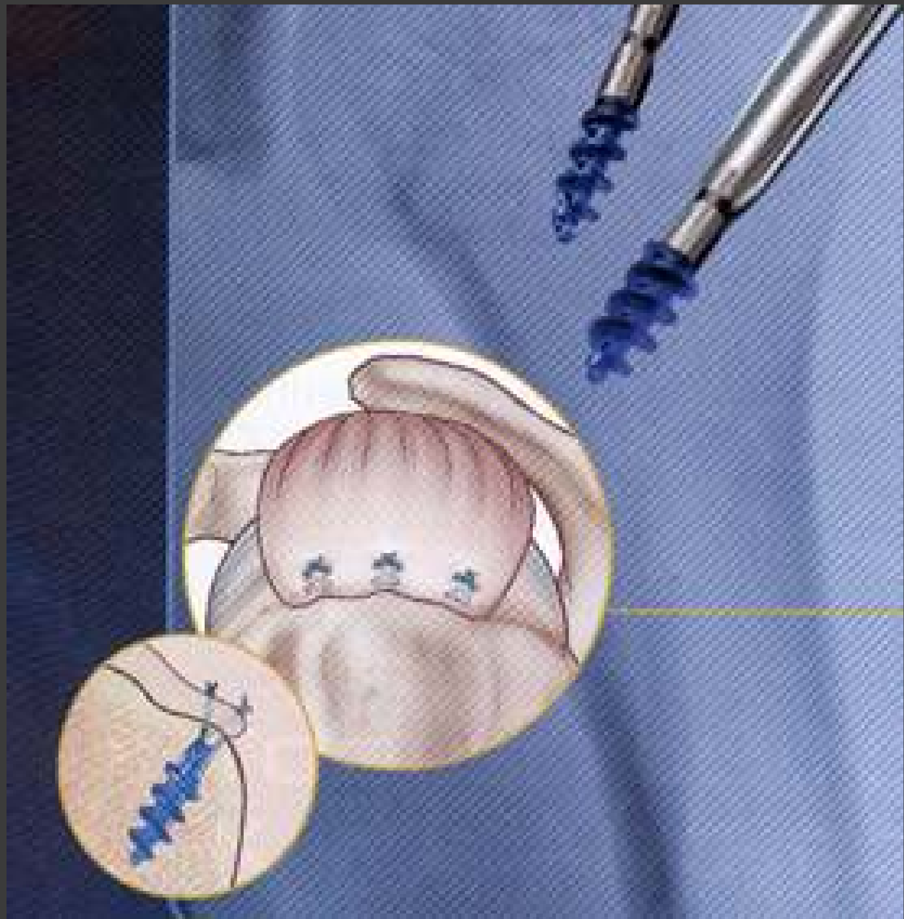
Arthroscopy Feb 2003



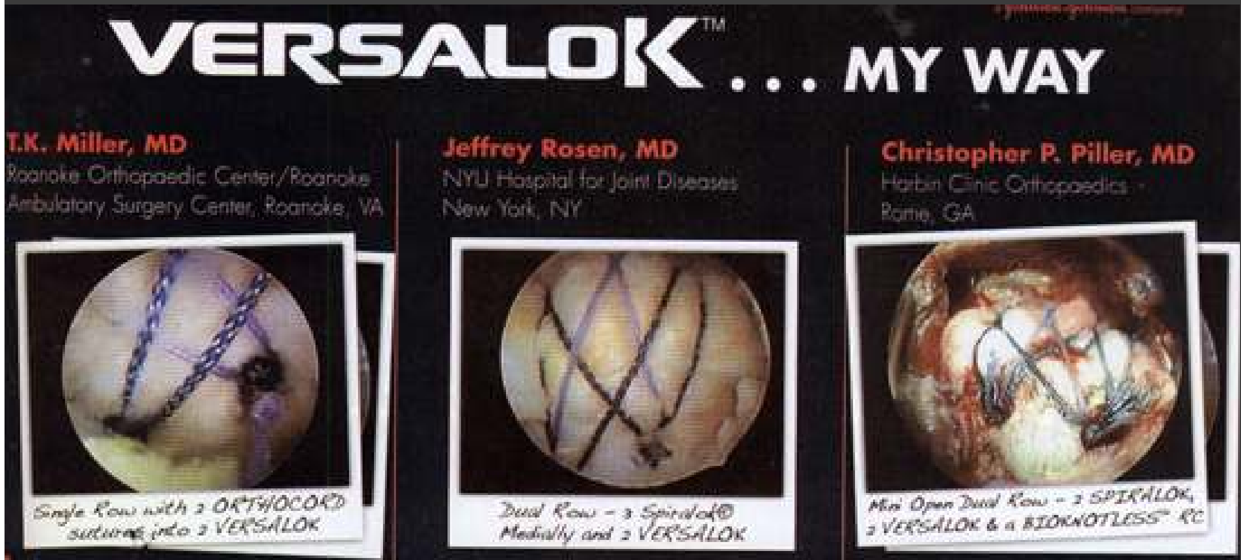
Arthroscopy Nov 2003



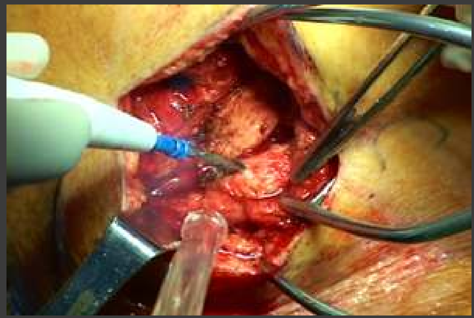
Arthroscopy June 2004



Arthroscopy 2007



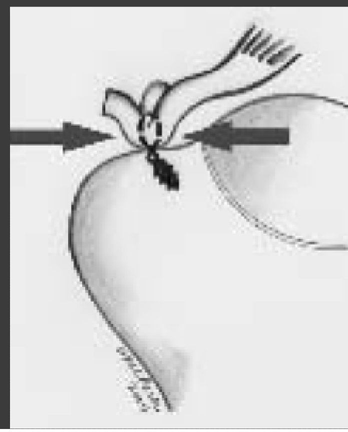
Arthroscopy 2008



Open

Mini-open

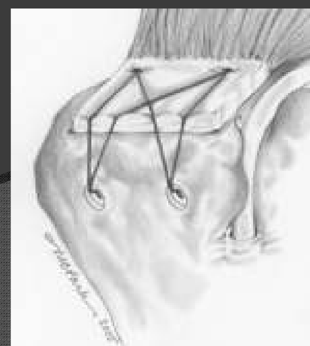
Arthroscopic



Single layer

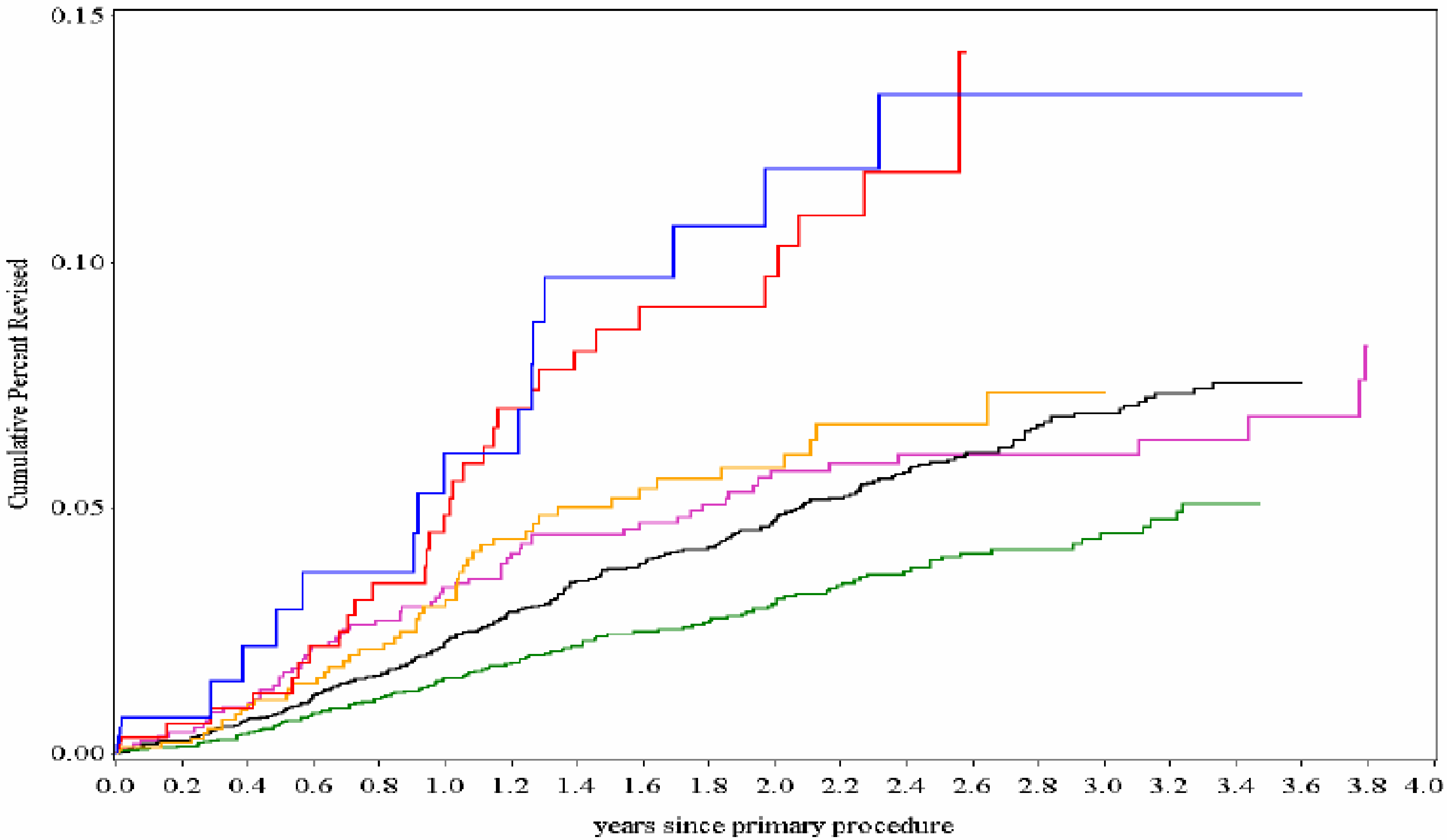
Double layer

Trans-osseous



Joint Replacement Registry

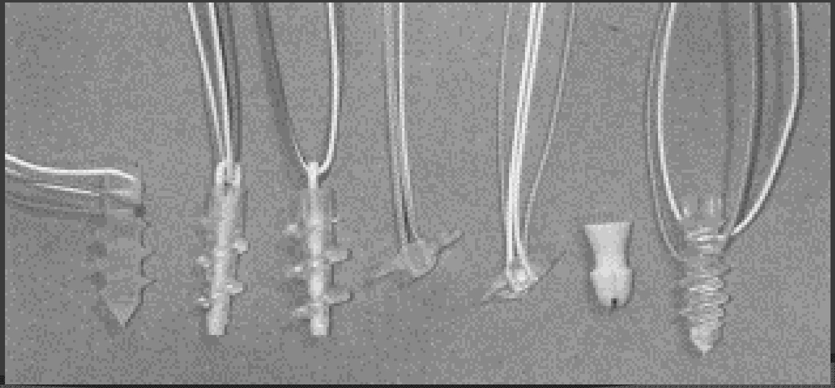
Figure K13: Cumulative percentage of Revision of Unicompartmental Knee Prostheses

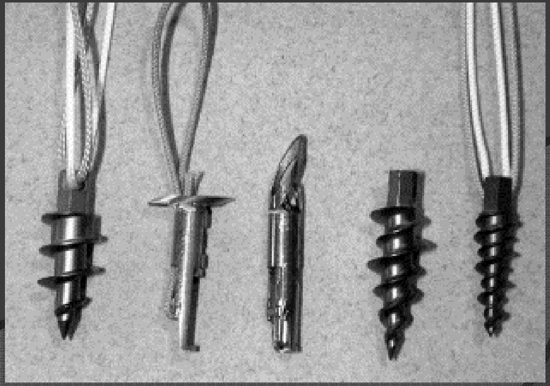


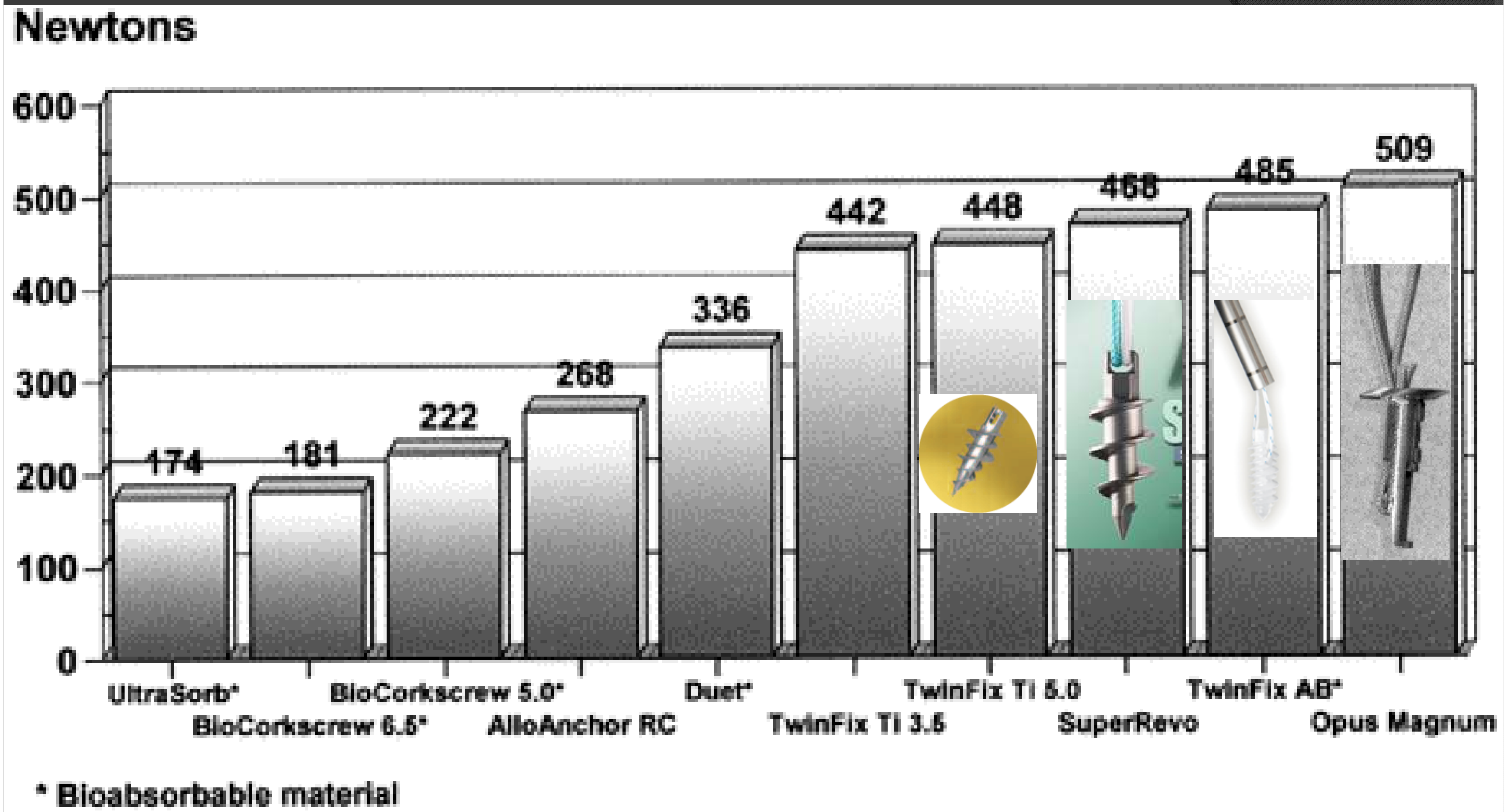
Sutures and suture anchors: update 2003

Barber 2003

- Anchors should not represent the weakest portion of a repair.





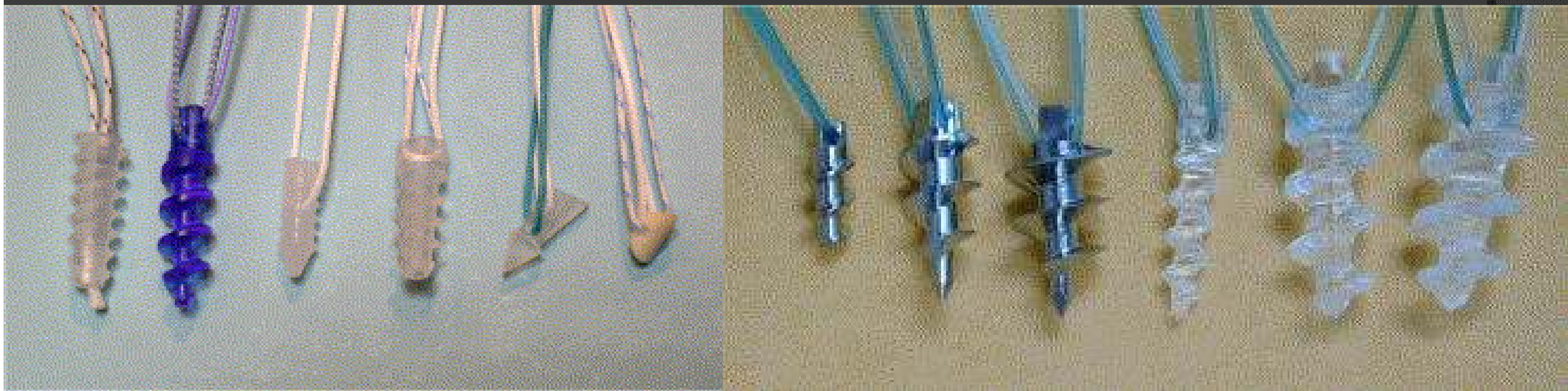

Newtons
600
500
400
300
200
100
0
174
181
222
268
336
442
448
468
485
509
UltraSorb*
BioCorkscrew 6.5*
BioCorkscrew 5.0*
AlloAnchor RC
Duet*
TwinFix Ti 3.5
TwinFix Ti 5.0
SuperRevo
TwinFix AB*
Opus Magnum
* Bioabsorbable material

Barber 2003

Sutures and Suture Anchors—Update 2006

Barber 2006

- Higher load to failure
- screw-type versus nonscrew designs



Fixation of knotless suture anchors
Brown 2008

- The three suture anchors tested

- Opus Magnum
- Mitek Bioknotless RC
- Smith & Nephew TwinFix 5.0 Titanium.

Suture Anchor Materials, Eyelets, and Designs: Update 2008
F. Alan Barber

- Suture anchors were tested in fresh porcine
- Cortical
- Cancellous Bone

Barber 2008

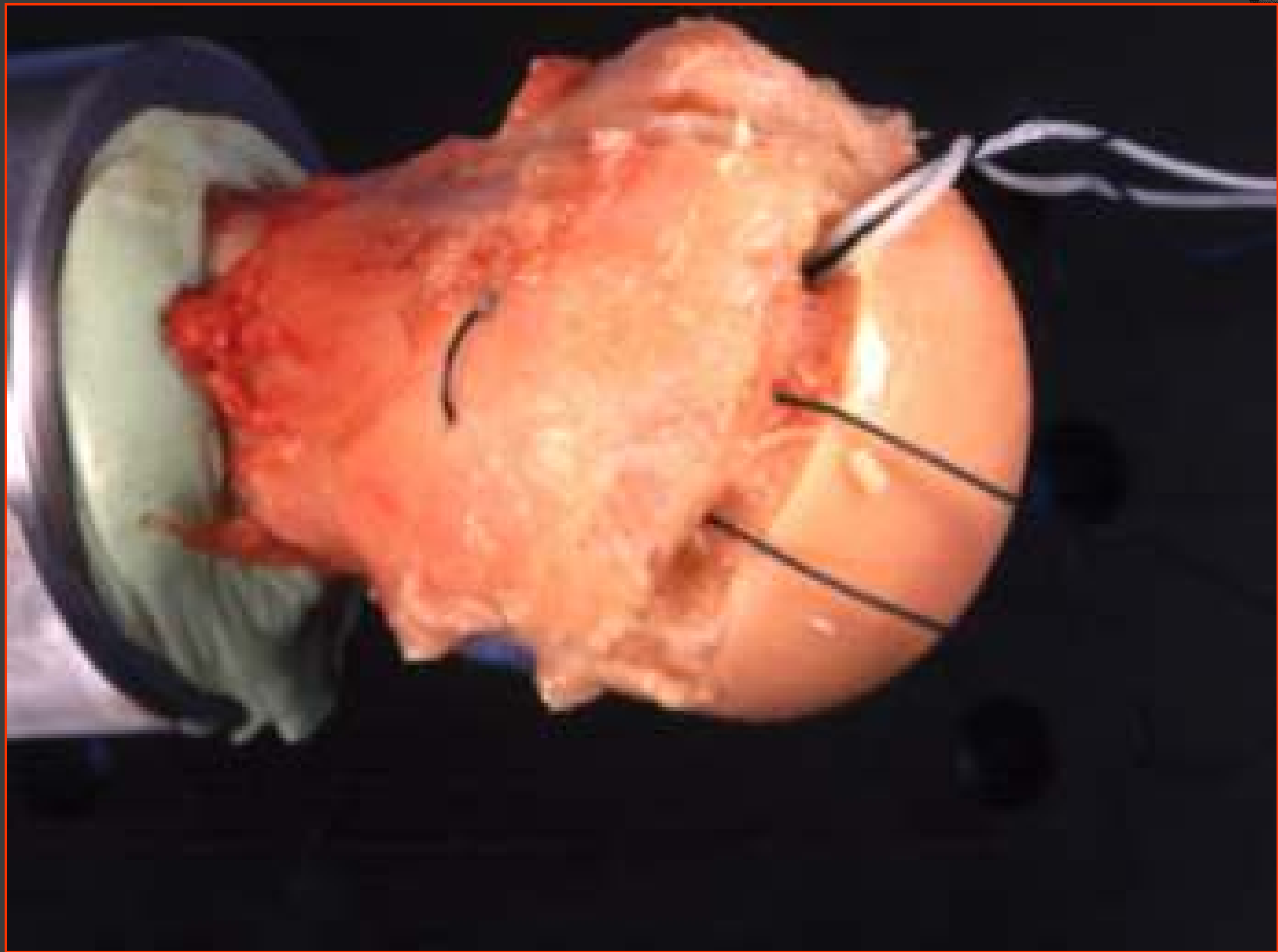
Table 1. Suture Anchor Properties

Anchor	Material	Suture	Load	Minor (mm)	Major (mm)	Length (mm)	Other Information
Kinsa	PEEK	No. 2 Ultrabraid	Single	2.9	3.4	15.14	3.0 tapered drill
Kinsa RC 5.5	PEEK	No. 2 Ultrabraid	Single	3.5	5.5	15.0	3.8-mm awl
BioRaptor 2.3PK	PEEK	No. 2 Ultrabraid	Single	2.3	3.0	11.56	2.6-mm drill
TwinFix PK FT 5.5	PEEK	No. 2 Ultrabraid	Double	3.5	5.5	14.99	3.8-mm awl; also available triple-loaded
TwinFix PK FT 6.5	PEEK	No. 2 Ultrabraid	Double	3.5	6.5	14.99	3.8-mm awl; also available triple-loaded
SwiveLock C	PLLA, PEEK	2-mm Fibertape	Single	3.7	5.5	15	5.5-mm punch; available with open (forked) and closed eyelets
PEEK SutureTak	PEEK	No. 2 FiberWire	Single	2.3	3	12	2.2-2.9 mm stepped drill
Corkscrew FT II	Titanium	No. 2 FiberWire	Triple	3.7	5.5	16	Also available in 4.5- and 6.5-mm and double-loaded
VersaLok	Titanium, PEEK	No. 2 Orthocord	4 strands	4.9 × 31	Expands to 6.3	4.9 × 27	—
BioKnotless	PLLA	No. 2 Orthocord	Single	2.9	3.9	9	"Internal" No. 2 Orthocord loop
BioKnotless BR	Biocryl Rapide	No. 2 Orthocord	Single	2.9	3.9	9	"Internal" No. 2 Orthocord loop
Healix Peek	PEEK	No. 2 Orthocord	Triple	3.9	5.5	18	Also available in 4.5- and 6.5-mm; also available double-loaded

Barber 2008

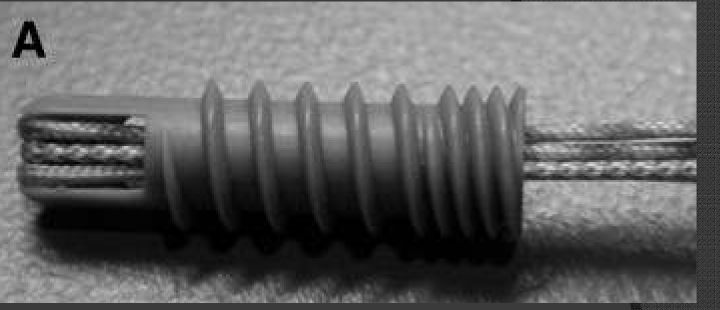
Cancellous Loads to Failure

Anchor	No. of Tests	Mean Force (N)	Range (N)
Kinsa	7	173.7	101-265.5
Kinsa RC 5.5	10	193.4	84-237
BioRaptor 2.3 PK	10	76.0	29-116
TwinFix PK FT 5.5	12	445.7	255-587
TwinFix PK FT 6.5	12	505.4	344-603
Healix Peek	10	390.1	348-482
VersaLok	9	379.2	151.2-730
BioKnotless	4	242.6	203.2-275.1
BioKnotless BR	7	268.5	165.3-359
Corkscrew FT II	12	330.3	187-409
SwiveLock C	12	563.8	134-879
PEEK SutureTak	11	144.8	33-193

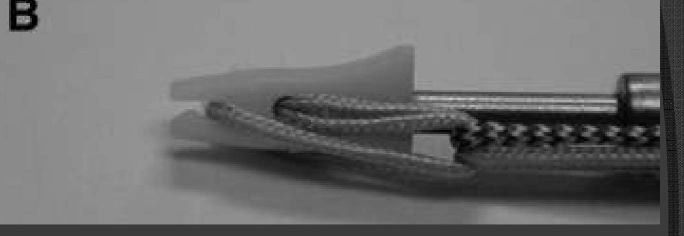


Worst case-Cancellous Bone

- screw
  - 350 N

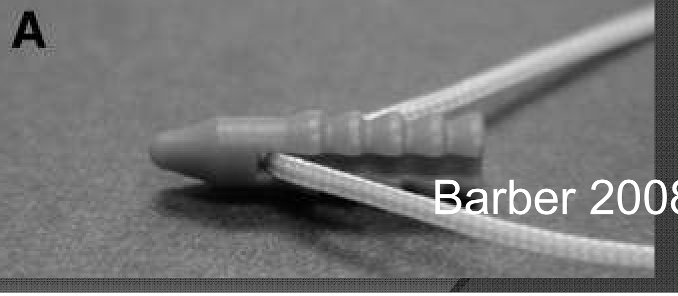


- The toggle anchors
  - 165 N



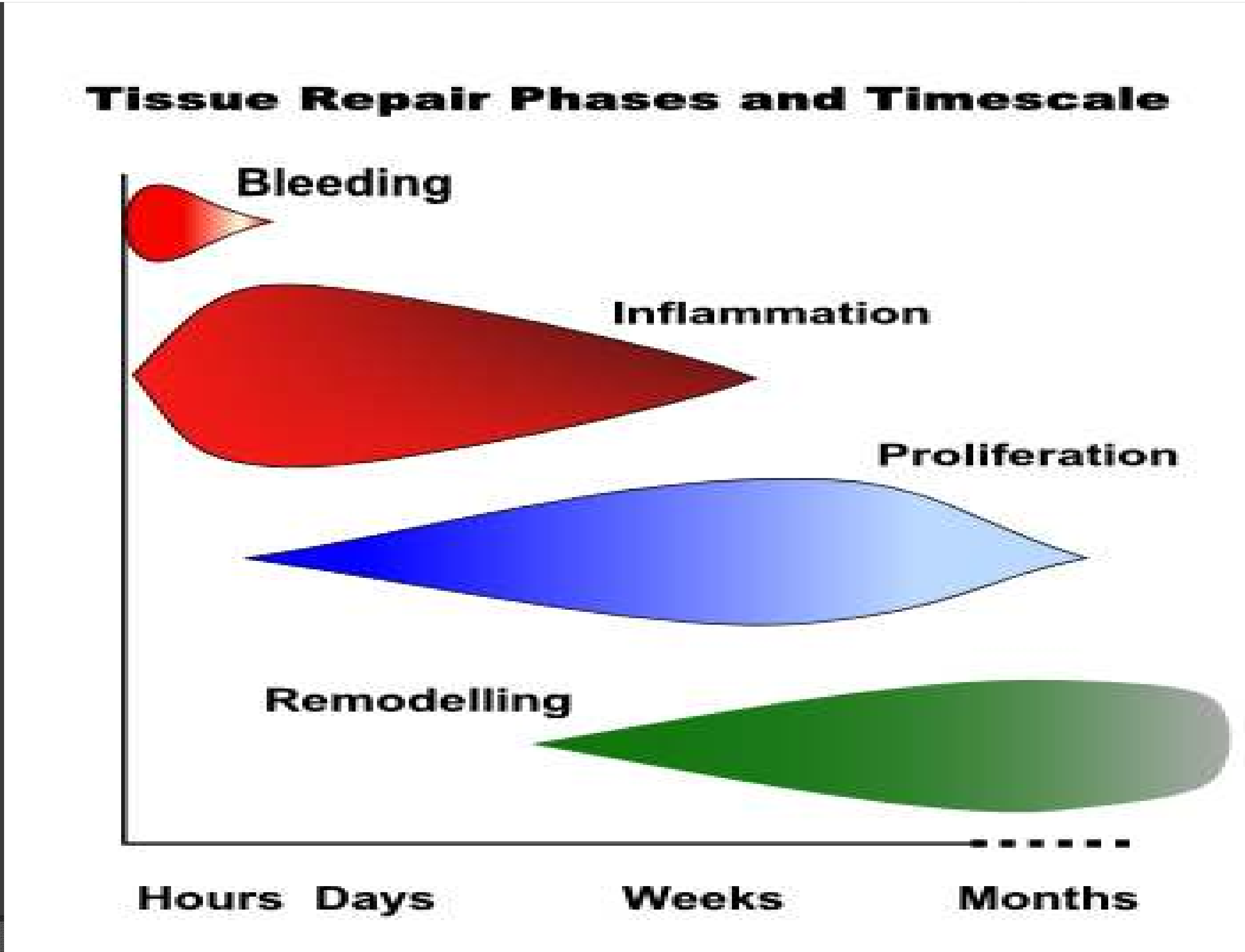
- expanding bolt designs
  - 150 N

- Push-in anchors
  - 29 N



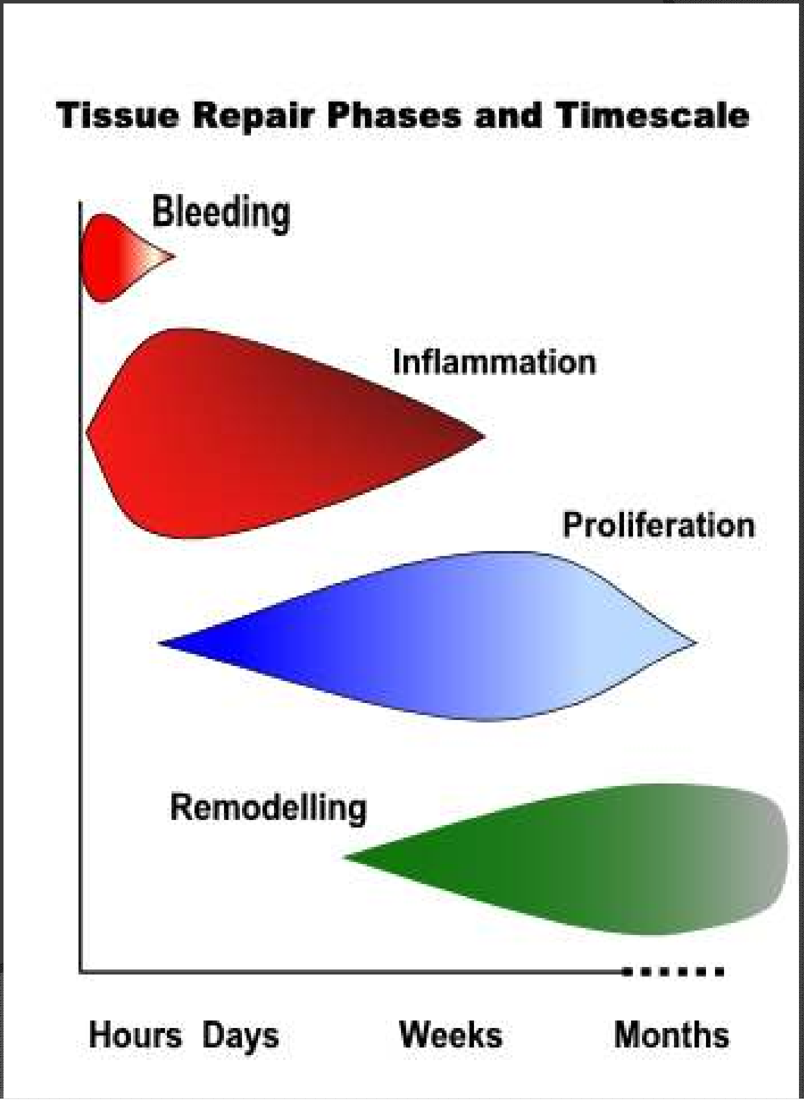
Barber 2008

Tissue Healing


Tissue Repair Phases and Timescale
Bleeding
Inflammation
Proliferation
Remodelling
Hours
Days
Weeks
Months

Tendon Healing
Three phases

1. Inflammatory phase
2. Proliferative phase
3. Maturation and remodelling phase



Inflammatory phase

- the first 7 days
- platelets from blood plasma enter the tear to initiate clot formation
- **fragile bond**
- Chemotactic mediators attract inflammatory white blood cells

Proliferative phase

- 2 to 3 weeks after tendon repair
- Fibroblasts, myofibroblasts, and endothelial cells, form **granulation tissue**.
- This tissue replaces the original fibrin clot with the scaffolding of a more permanent repair tissue
- Fibroblasts initially produce type III collagen, which is arranged haphazardly in the absence of cross-linking

The maturation and remodeling phase

- Begins week 3 after injury or repair
- synthetic activity slowly tapers and scar tissue organizes
- Immature type III collagen is replaced by mature type I collagen
- The collagen is continually remodeled until permanent repair tissue is formed

Histology of repair

- Miyahara
  - dog model
  - restored by 24 weeks.
- Gerber
  - goat model
  - no histologically normal infraspinatus tendon-bone interface in a even at 6 months after surgery
- healing rates vary in different animal models

Cortical vs McCloughlin

St Pierre

- Goat
- formation of the collagen fibre-bone interface occurred by 12 weeks
- NO DIFFERENCE whether attached to cortical surface of the greater tuberosity or trough in the tuberosity.

Conclusion

“The surgeon should be aware of performance properties when selecting an anchor or suture”

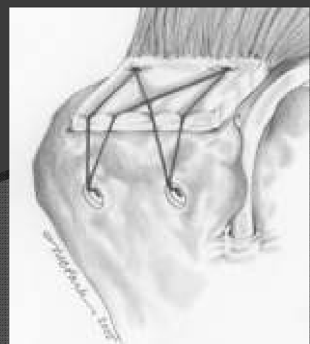
Barber 2003

Technique

Single layer

Double layer

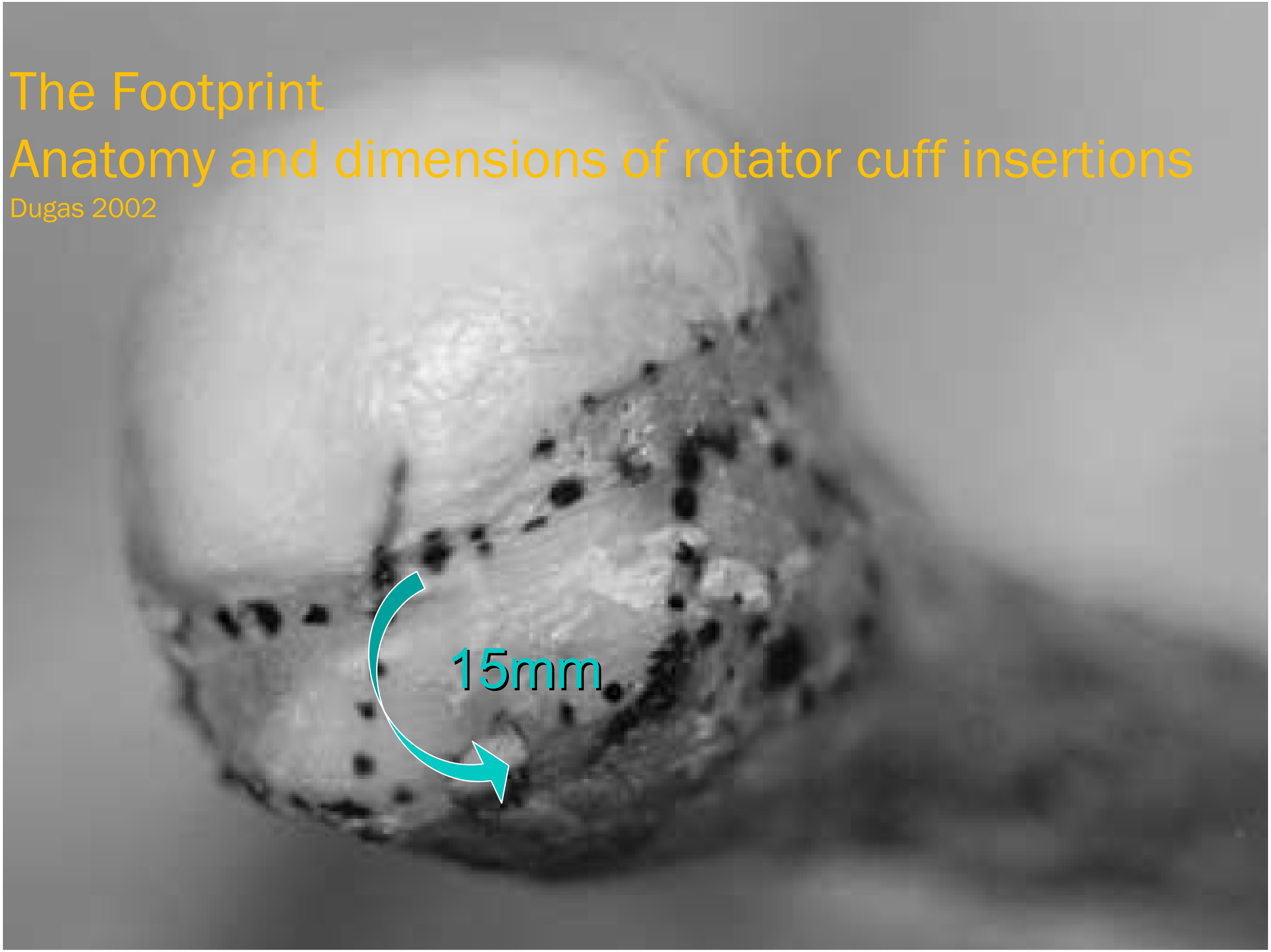
Trans-osseous



The Footprint

Anatomy and dimensions of rotator cuff insertions

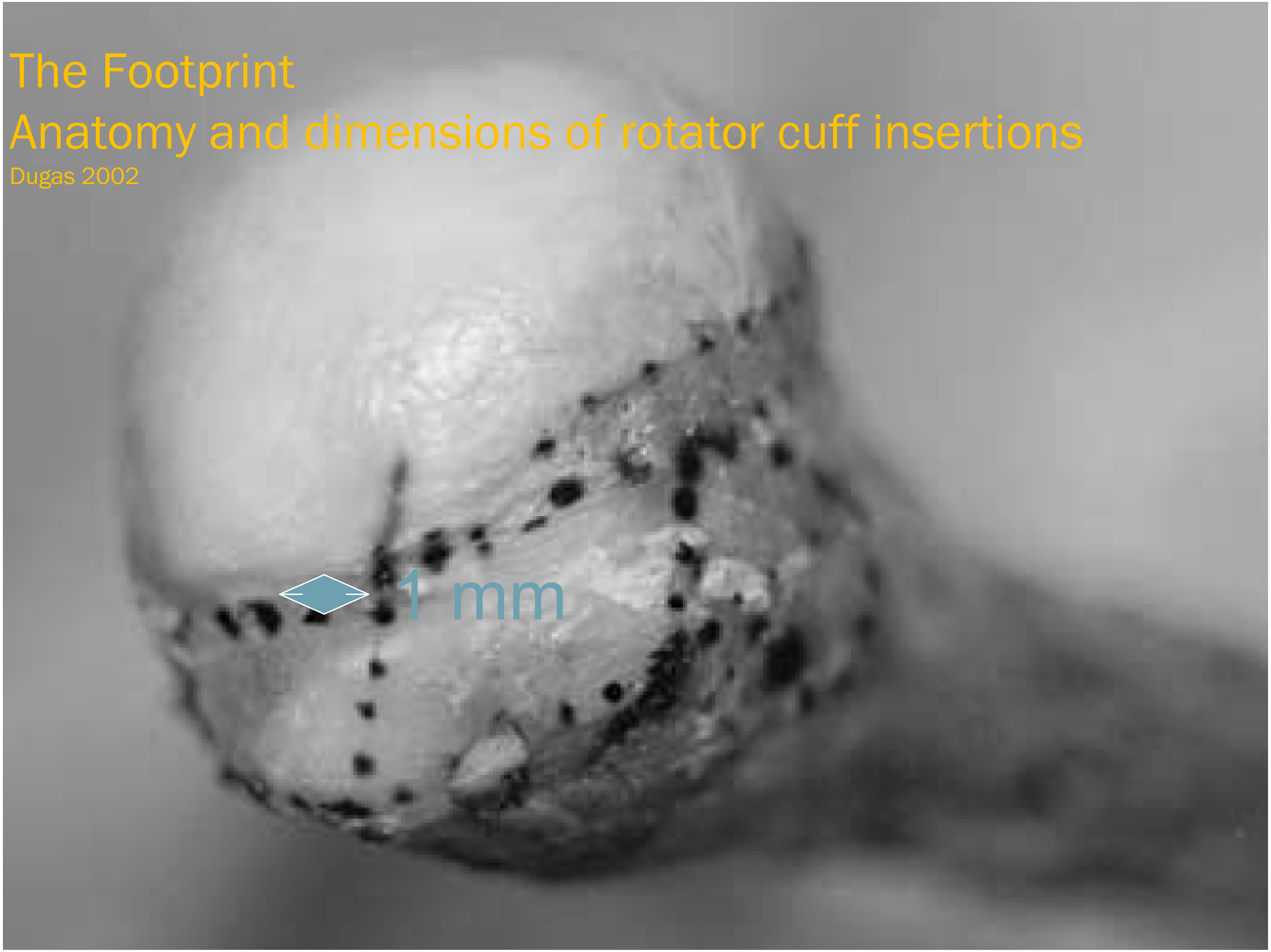
Dugas 2002

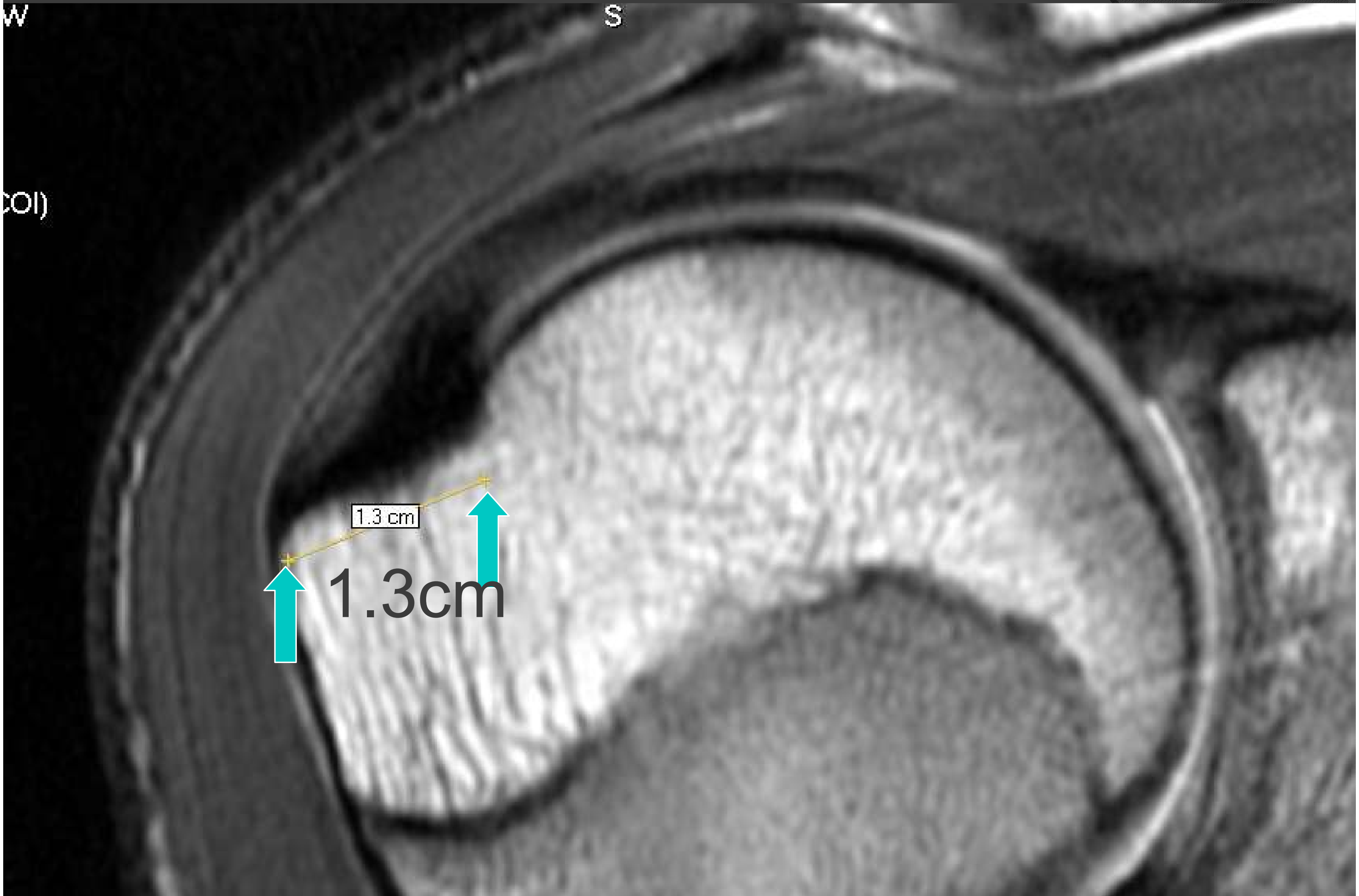


The Footprint

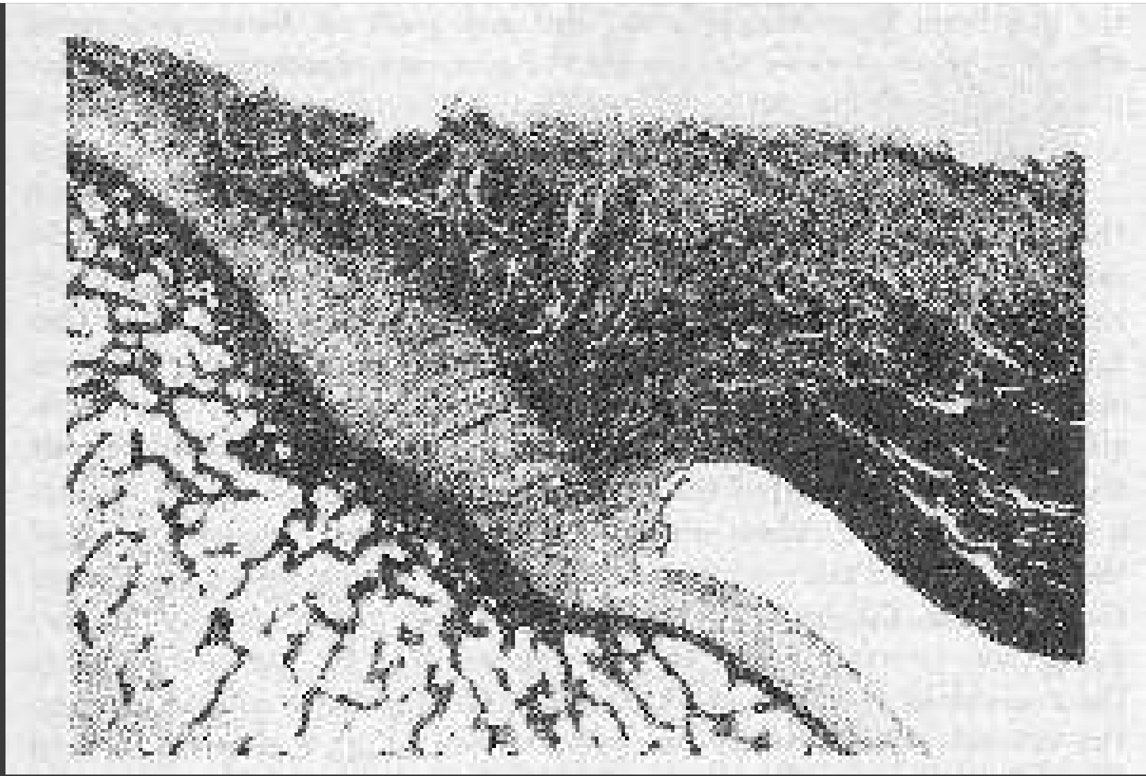
Anatomy and dimensions of rotator cuff insertions

Dugas 2002




W
S
COI)
1.3 cm
1.3cm

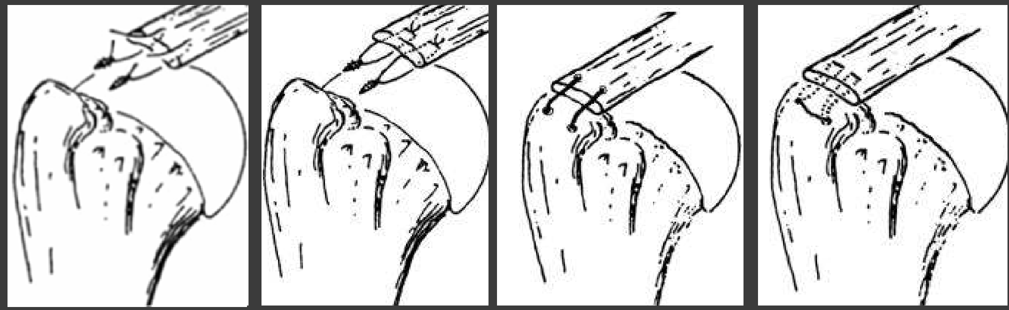
- EM of supraspinatus footprint
- Curtis 2006

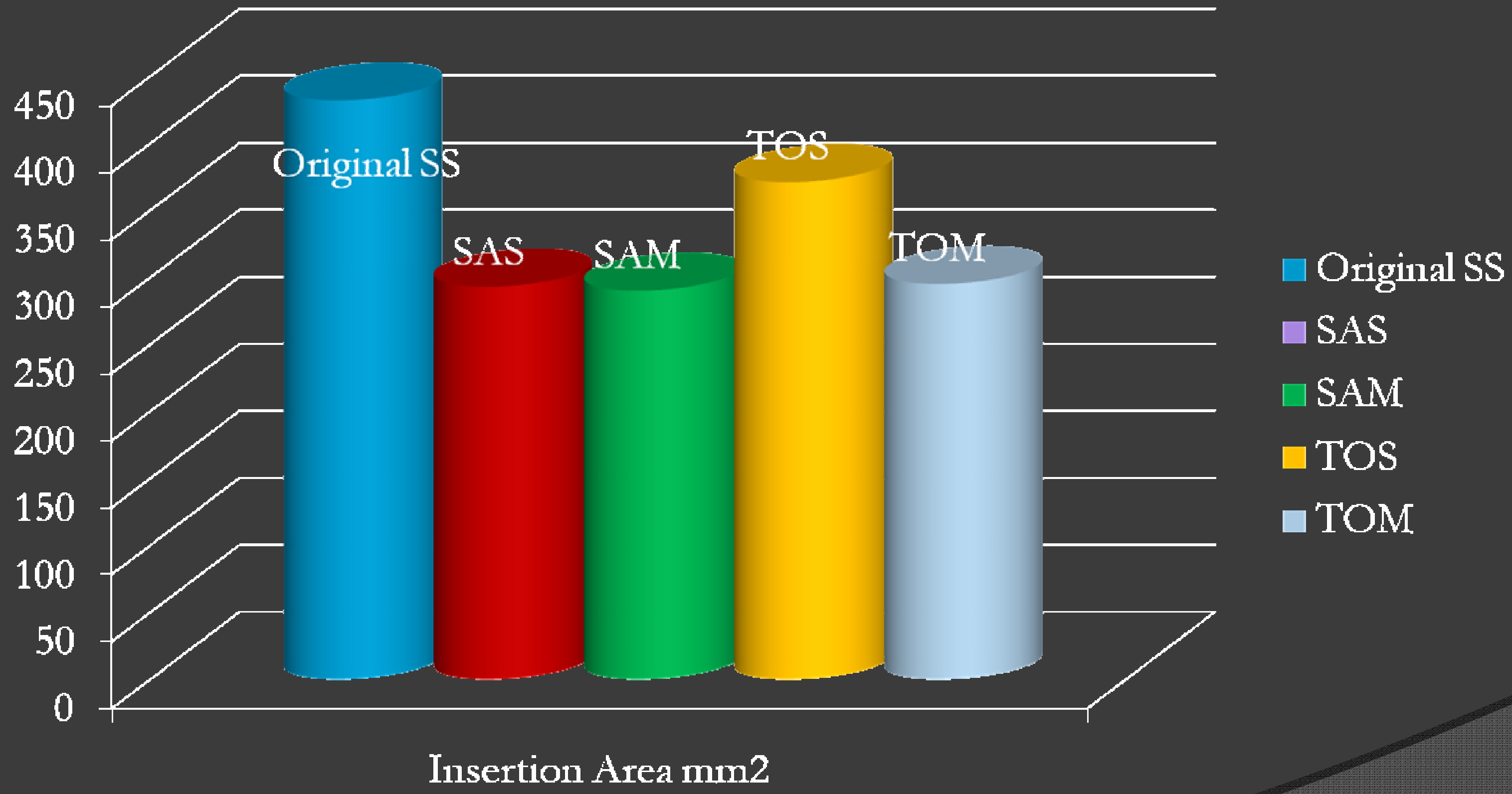


- “Notice how close to the rim of the articular cartilage the fibers are attached and that a few of them in this specimen have given way at the very edge”

The anatomy of the human shoulder

- **CHAPTER I**
- **Codman 1933**





Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 18, No 5 (May-June), 2002: pp 519–526

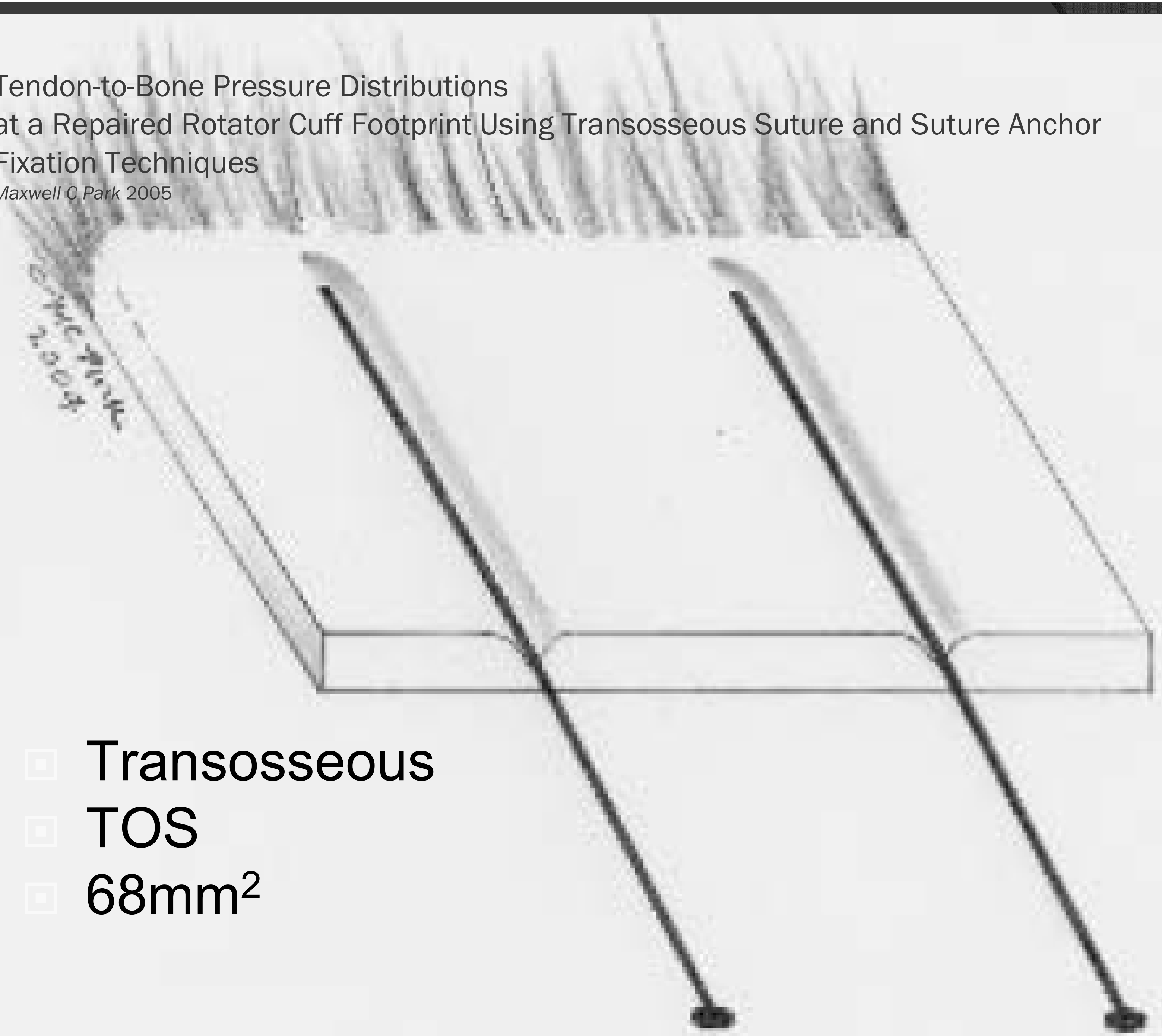
Tendon-to-Bone Pressure Distributions

Transosseous Suture and Suture Anchor Fixation Techniques

Park 2005

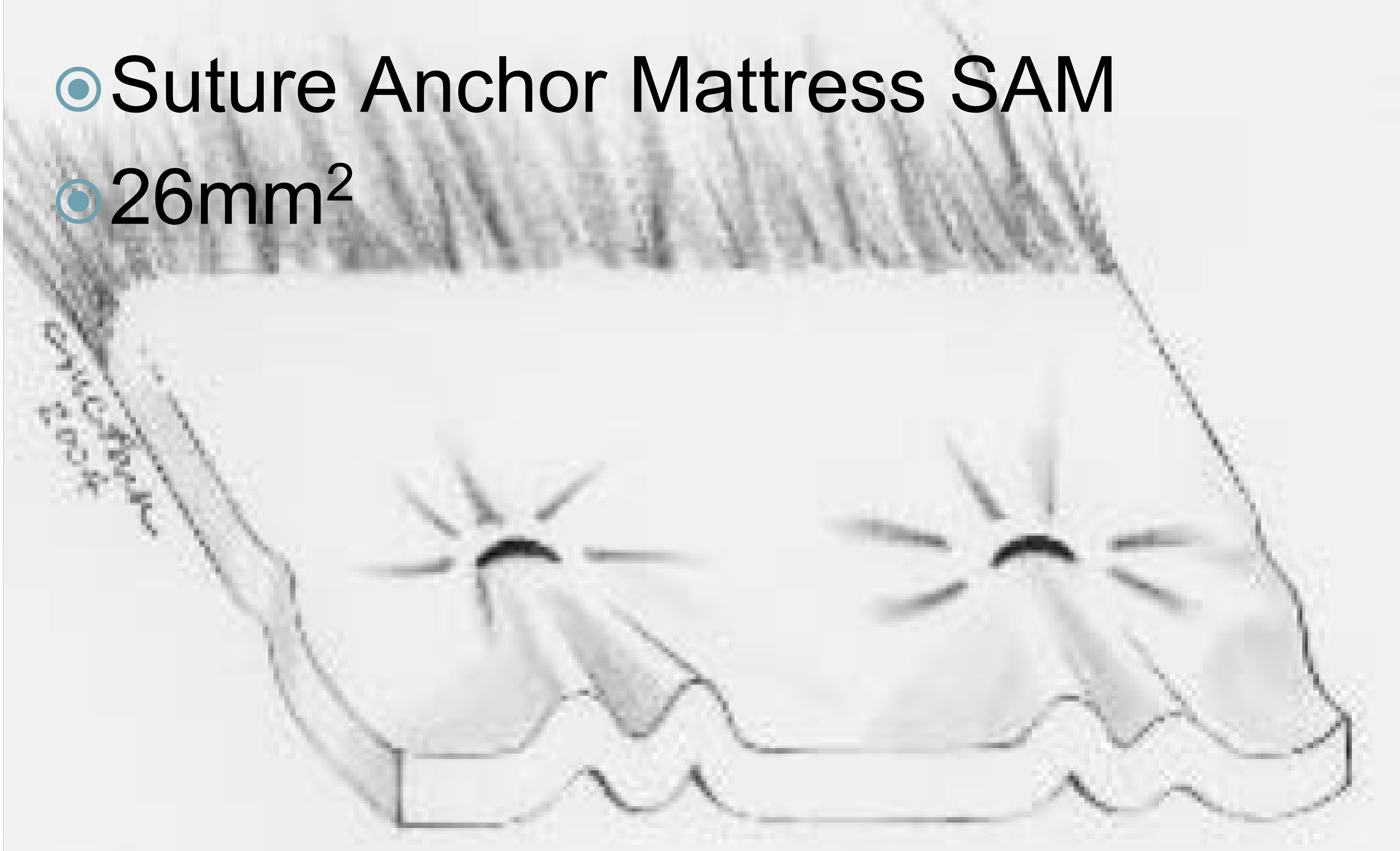
Tendon-to-Bone Pressure Distributions
at a Repaired Rotator Cuff Footprint Using Transosseous Suture and Suture Anchor Fixation Techniques

Maxwell C Park 2005

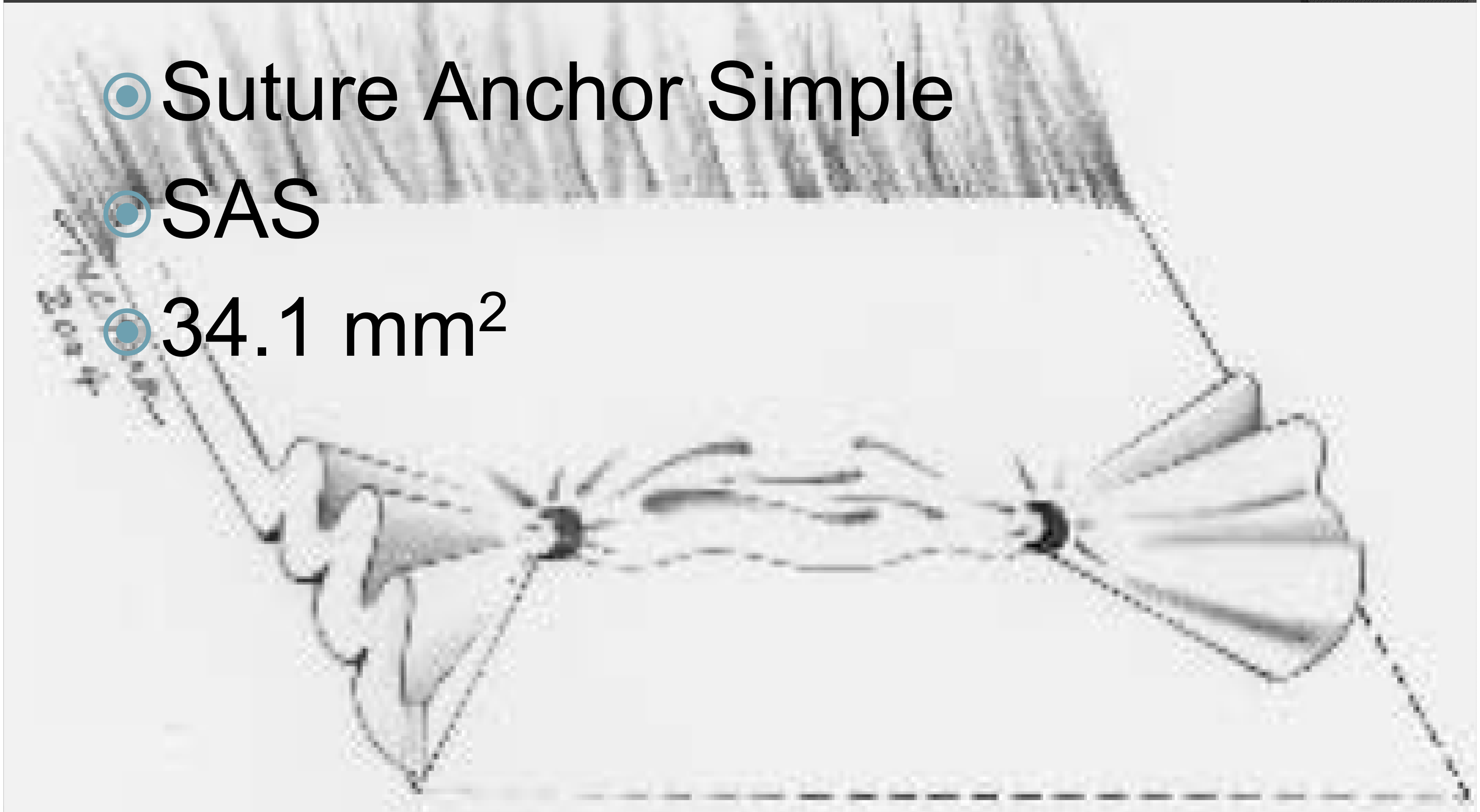


- Transosseous
- TOS
- $68mm^2$

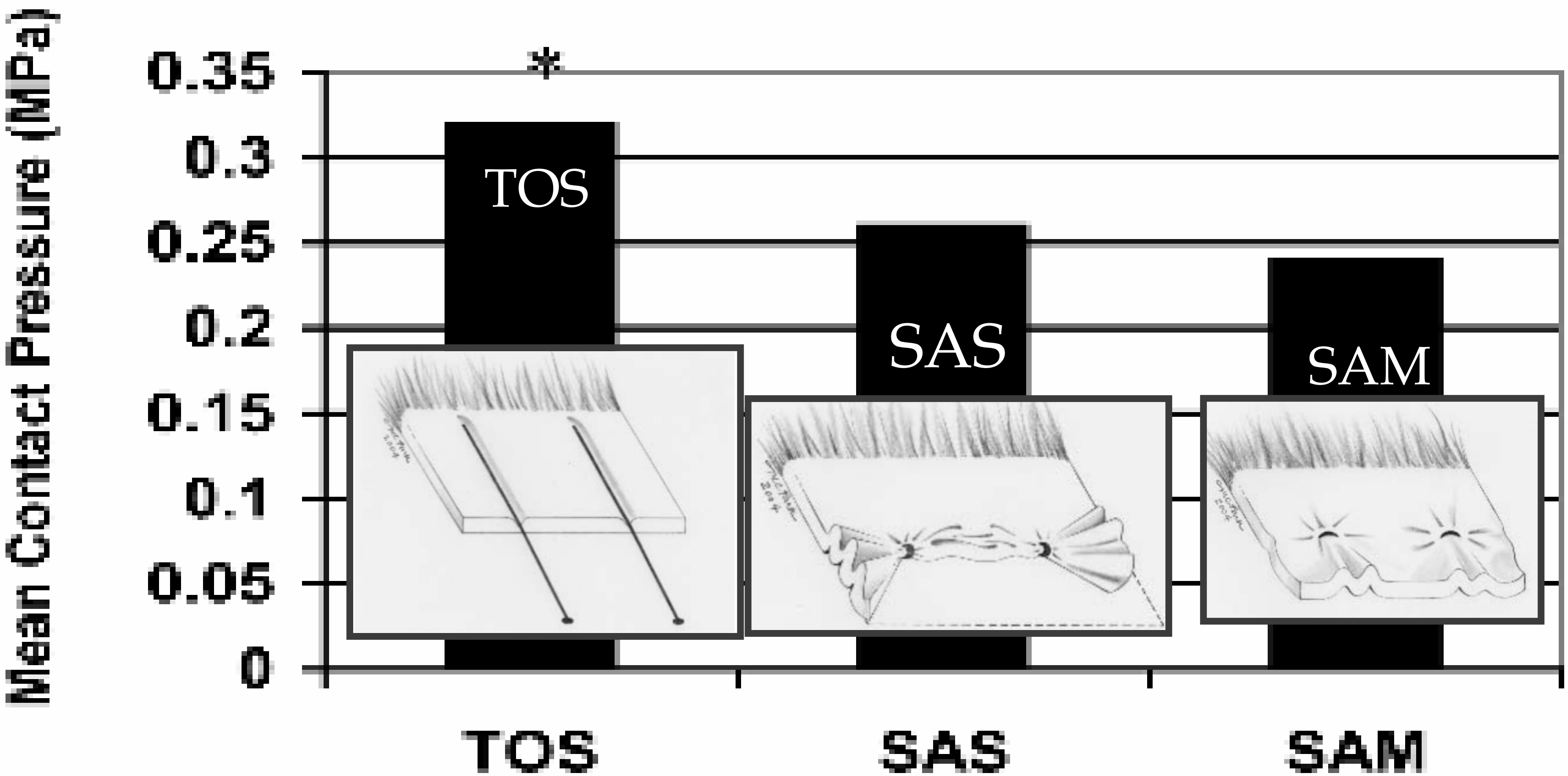
- Suture Anchor Mattress SAM
- 26mm^2



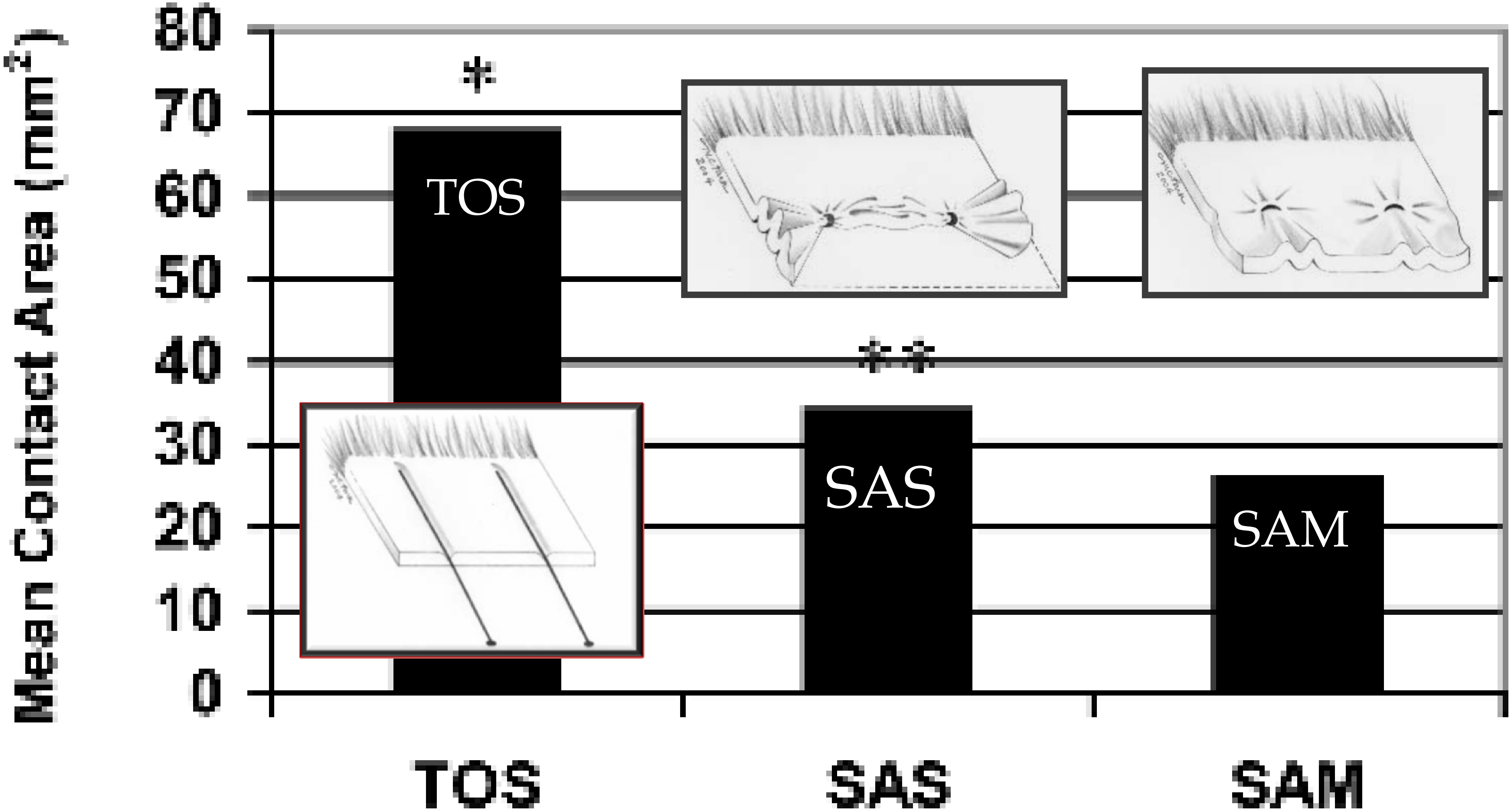
- Suture Anchor Simple
- SAS
- 34.1 mm^2

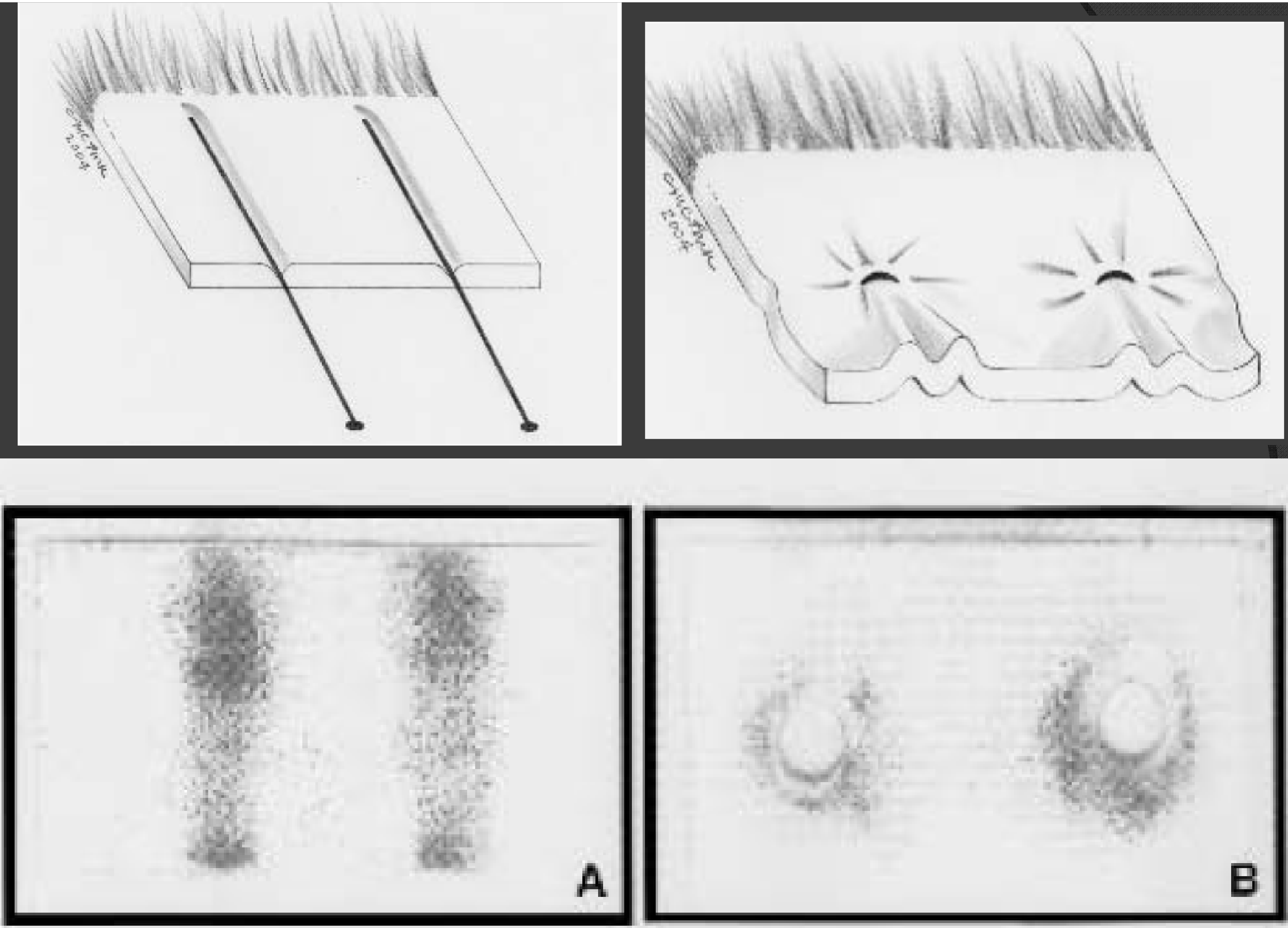


Interface pressure



Contact Area



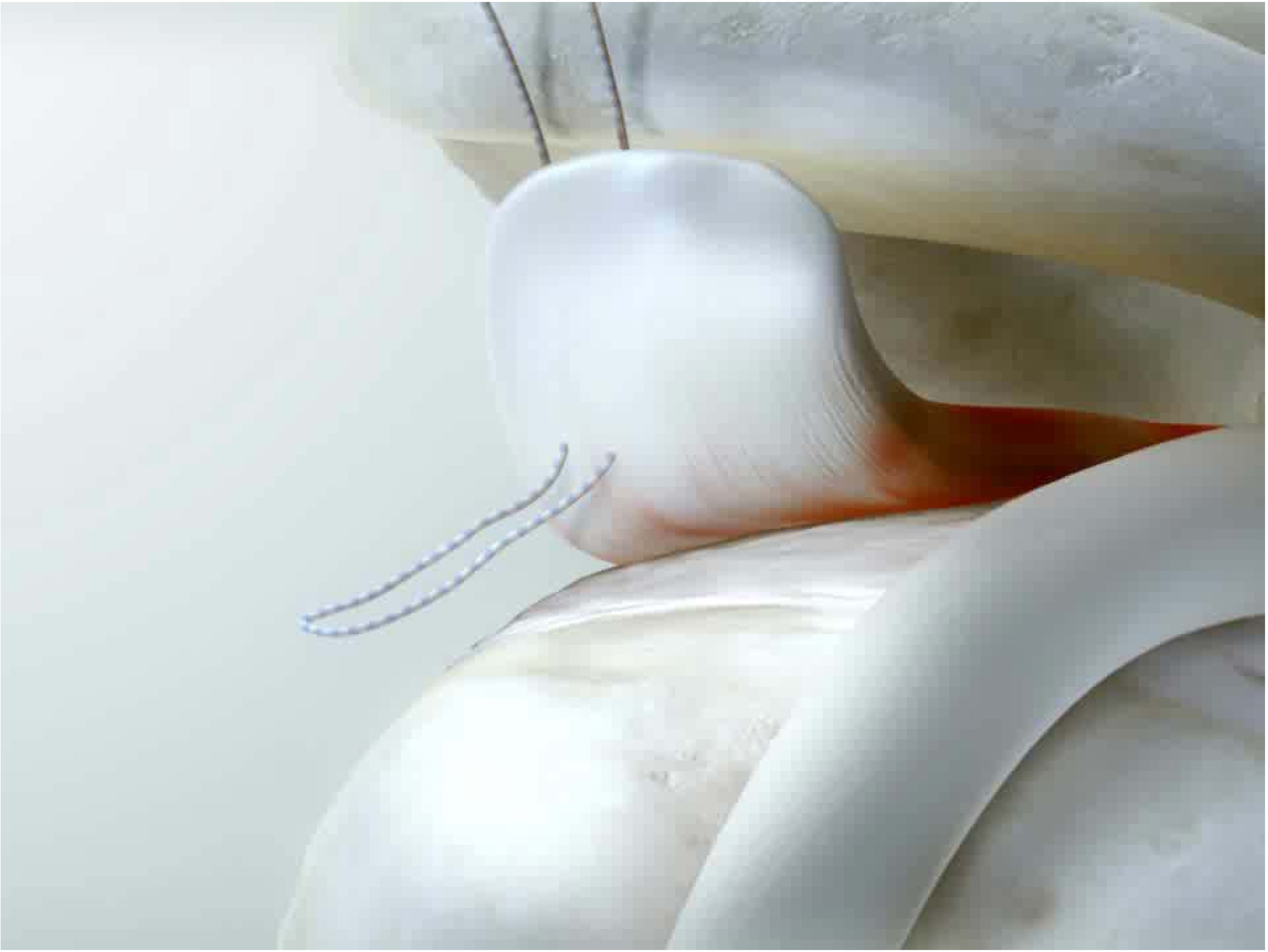


Transosseous technique

Suture anchor technique

Arthroscopic Transosseous Equivalent

- Many different techniques
  - Double Row fixation
  - Various Suture Patterns



Contact Area, Contact Pressure, and Pressure Patterns of the Tendon-Bone Interface

Tuoheti 2005

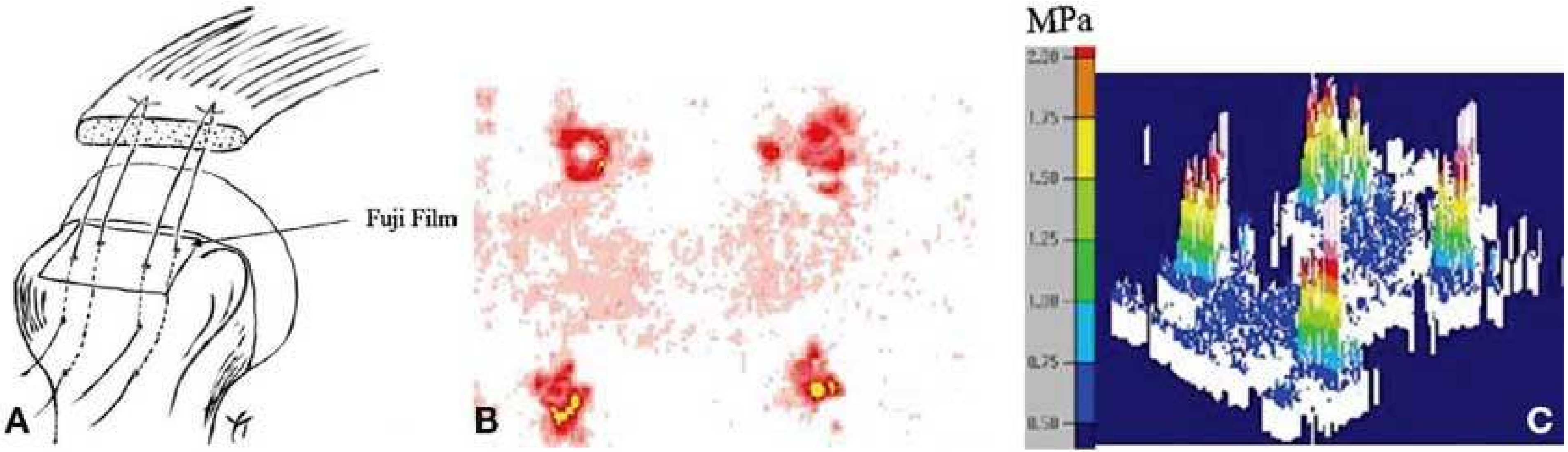
- differences among the
  - Transosseous
  - single-row suture anchor
  - double-row suture anchor techniques

Transosseous- TO

Not TOS

Tuoheti 2005

- ***pressure-sensitive film*** between the tendon and bone



Single-Row Suture Anchor- SRSA

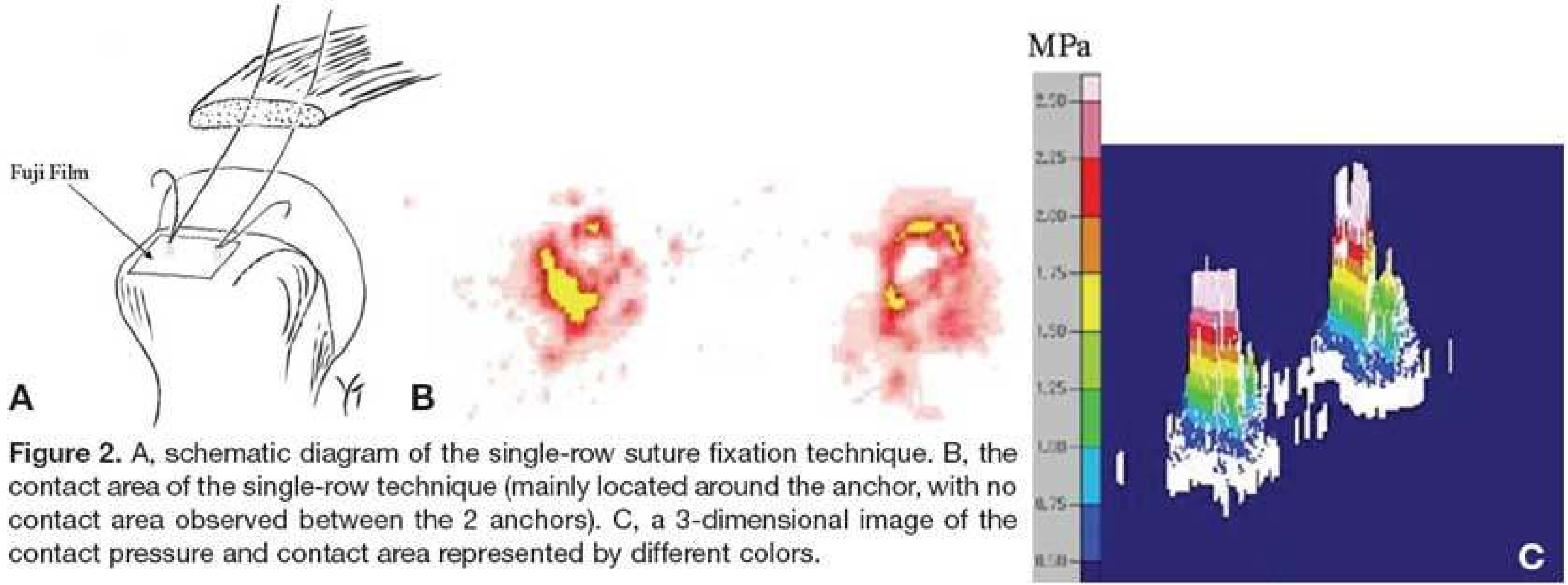


Figure 2. A, schematic diagram of the single-row suture fixation technique. B, the contact area of the single-row technique (mainly located around the anchor, with no contact area observed between the 2 anchors). C, a 3-dimensional image of the contact pressure and contact area represented by different colors.

Double-Row Suture Anchor - DRSA

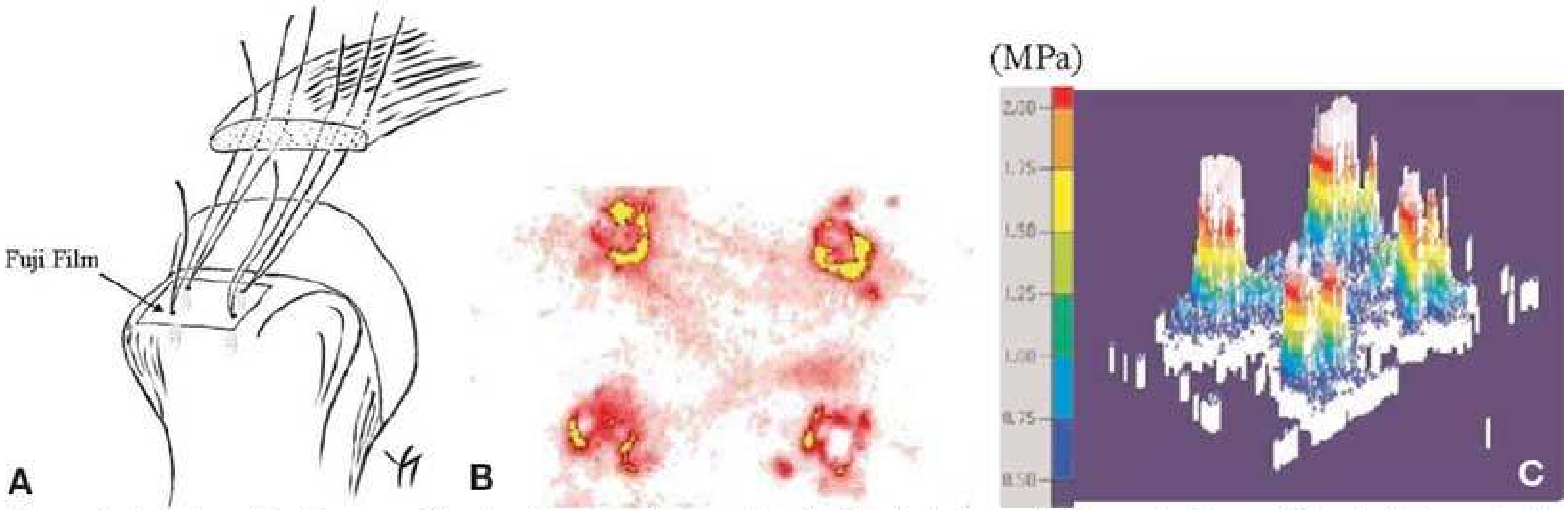
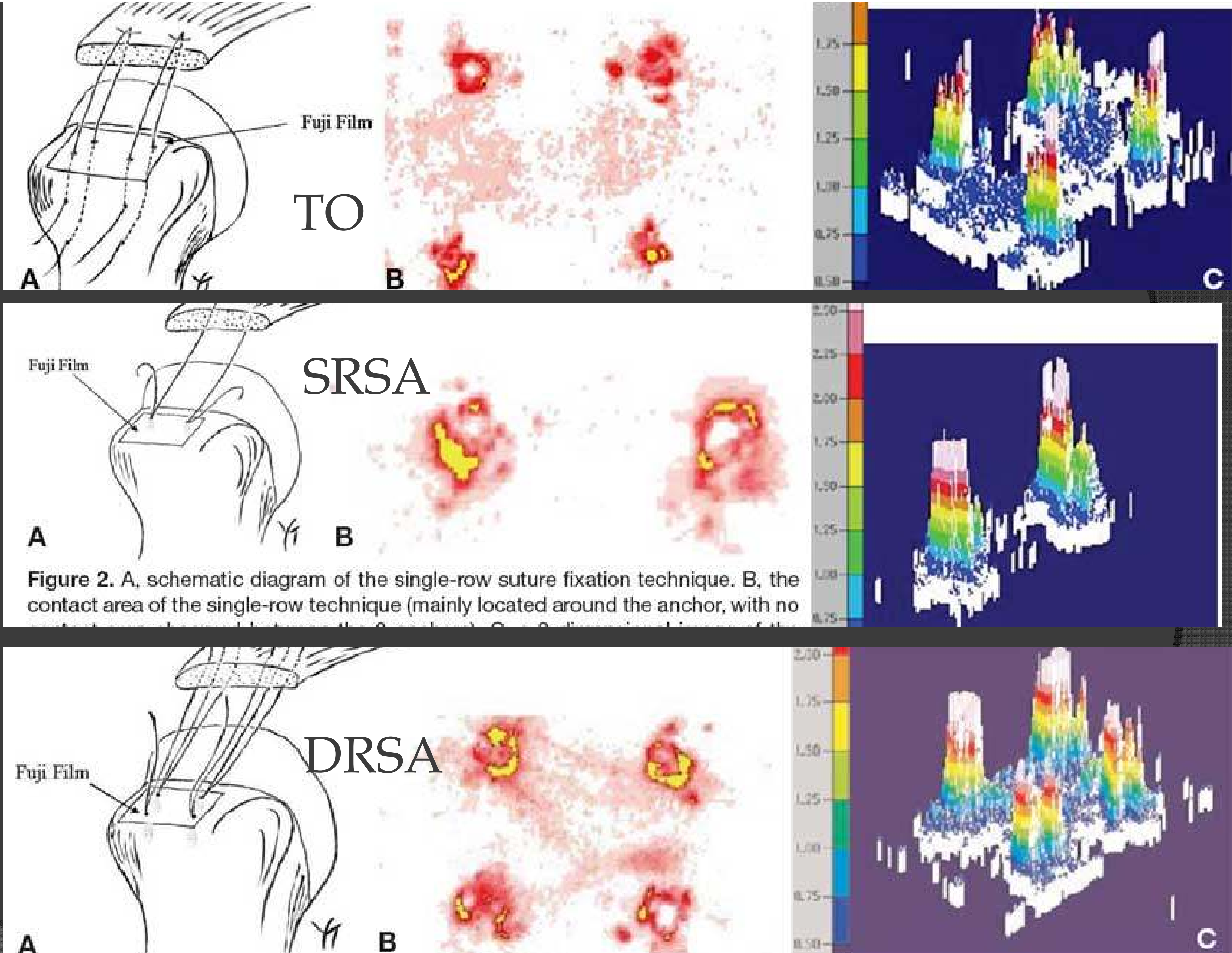
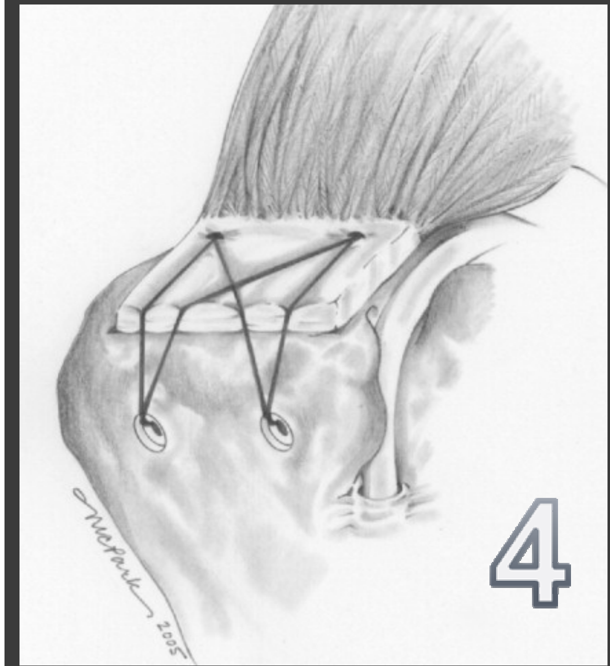
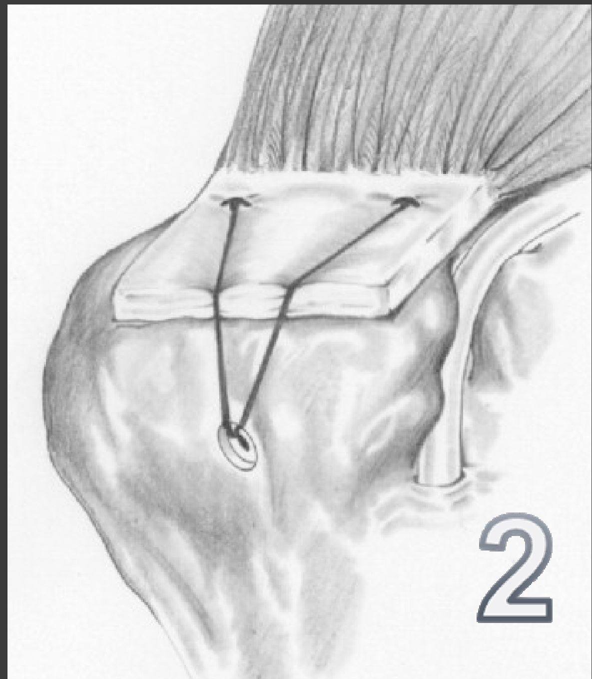


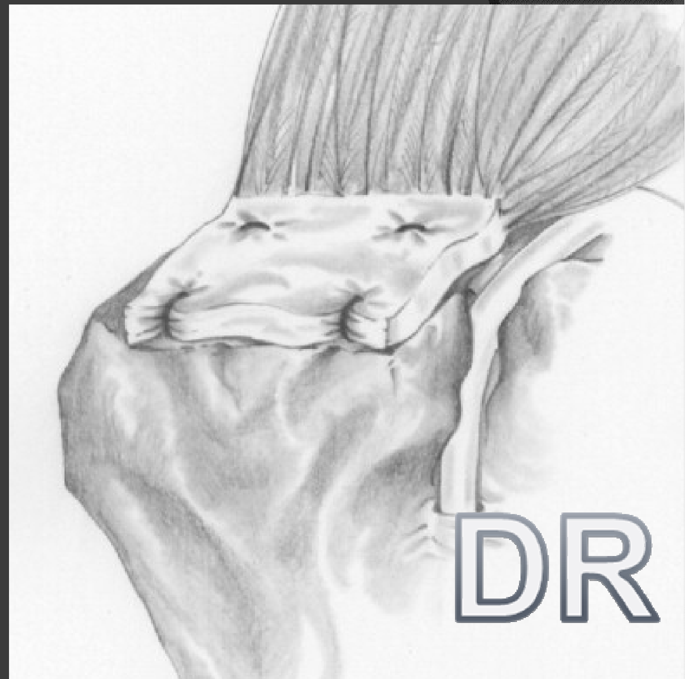
Figure 3. A, schematic diagram of the double-row suture anchor fixation technique. B, the contact area of the double-row technique (mainly located around the anchor as well as in the central area between the 4 anchors). C, a 3-dimensional image of the contact pressure and contact area represented by different colors.


TO
Fuji Film
A
B
C
SRSA
Fuji Film
A
B
Figure 2. A, schematic diagram of the single-row suture fixation technique. B, the contact area of the single-row technique (mainly located around the anchor, with no
DRSA
Fuji Film
A
B
C

Biomechanics of transosseous-equivalent repair compared to a double-row technique
Park 2007







TOE-
four suture-bridges.

TOE-
two suture-bridges

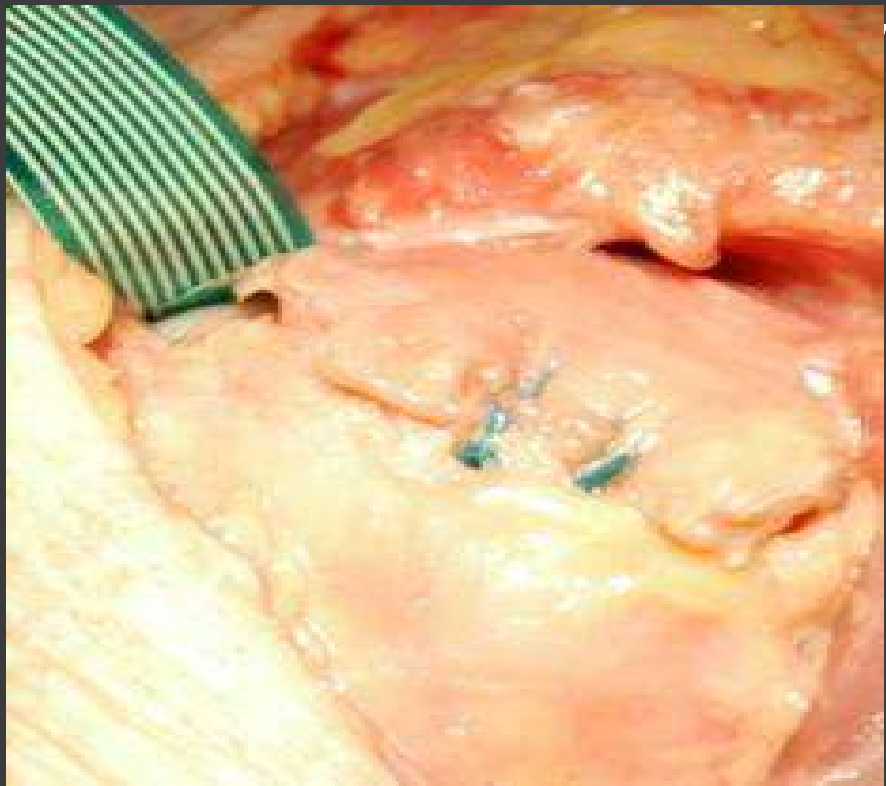
Double-row rotator cuff
repair technique

Need to Rehabilitate

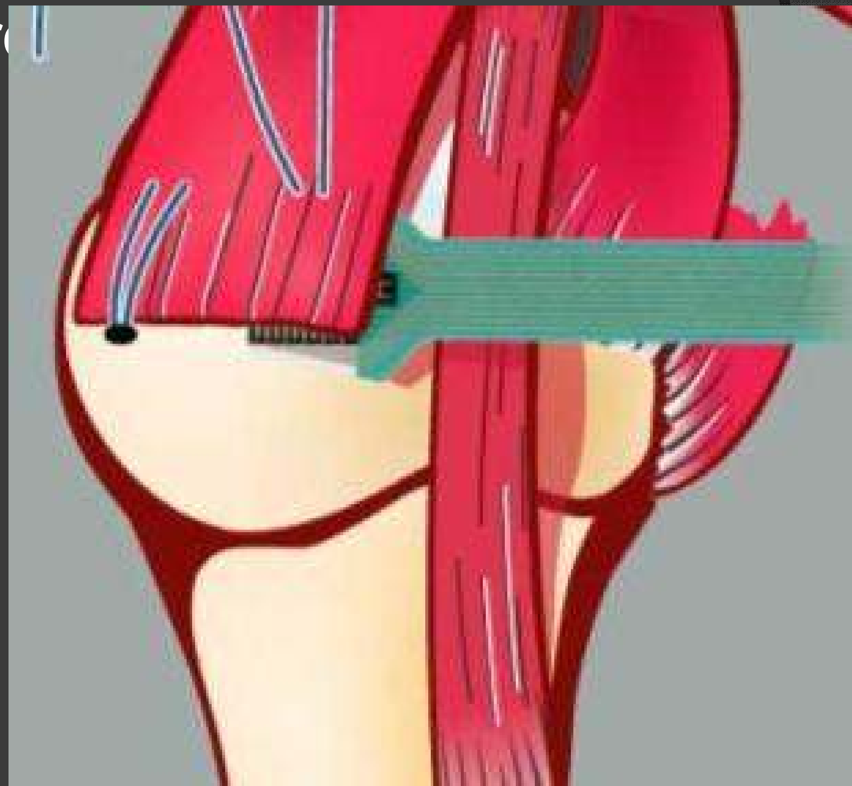
- Early Movement
  - Passive

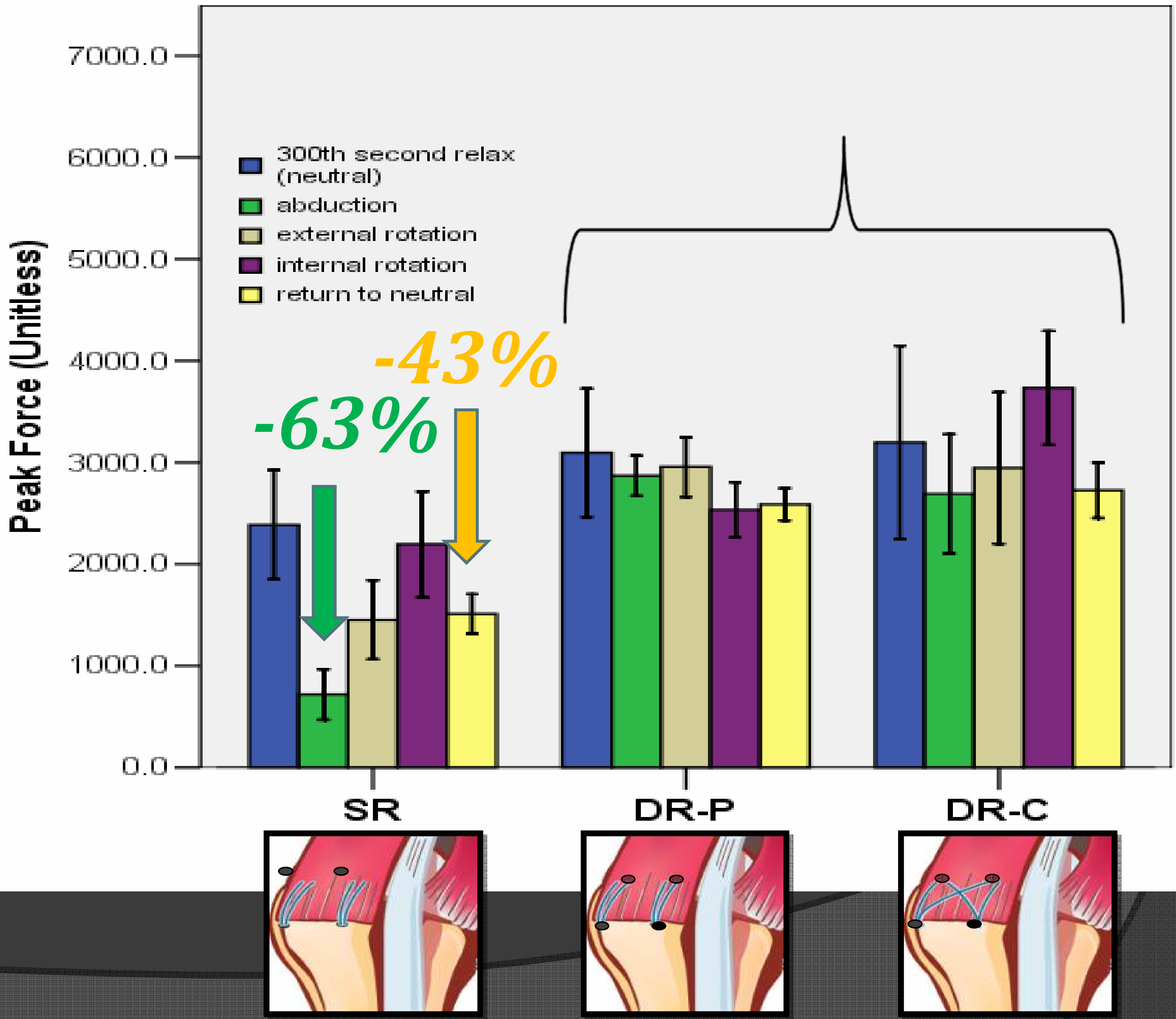
Methods (Haber et al)

- An I-Scan 6900 electronic pressure sensor-TekScan



ver





Peak Force (Unitless)
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
300th second relax (neutral)
abduction
external rotation
internal rotation
return to neutral
-63%
-43%
SR
DR-P
DR-C

m1

ABDUCTION RESULTS IN PERILOUSLY LOW LEVELS OF CONTACT WITH SINGLE -ROW REPAIRS

Slide 76

m1 mark, 21/08/2006

Conclusions

- Basic Principles of Anatomy, Tissue Healing & Biomechanics still apply to techniques for Rotator Cuff Repair
- Small/Medium Tears do very well with Arthroscopic Repair
  - Surgeons must understand
    - Properties of anchors
    - Biomechanics of cuff function
    - Appropriate rehabilitation protocols

Thankyou