

Massive Irreparable Rotator Cuff Tears: Is Superior Capsular Reconstruction Here To Stay???

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Disclosures

- I have no relevant disclosures related to this topic
- Available on AAOS website

Case: History

- 62 y/o RHD Male with chronic R shoulder pain
- Starting a lawn mower 8 months prior to presentation and “felt a pop” in R shoulder
- Unable to lift arm immediately following injury
- Cannot perform yard work, exercise, water ski (**typically very active**)

Case: Physical Exam

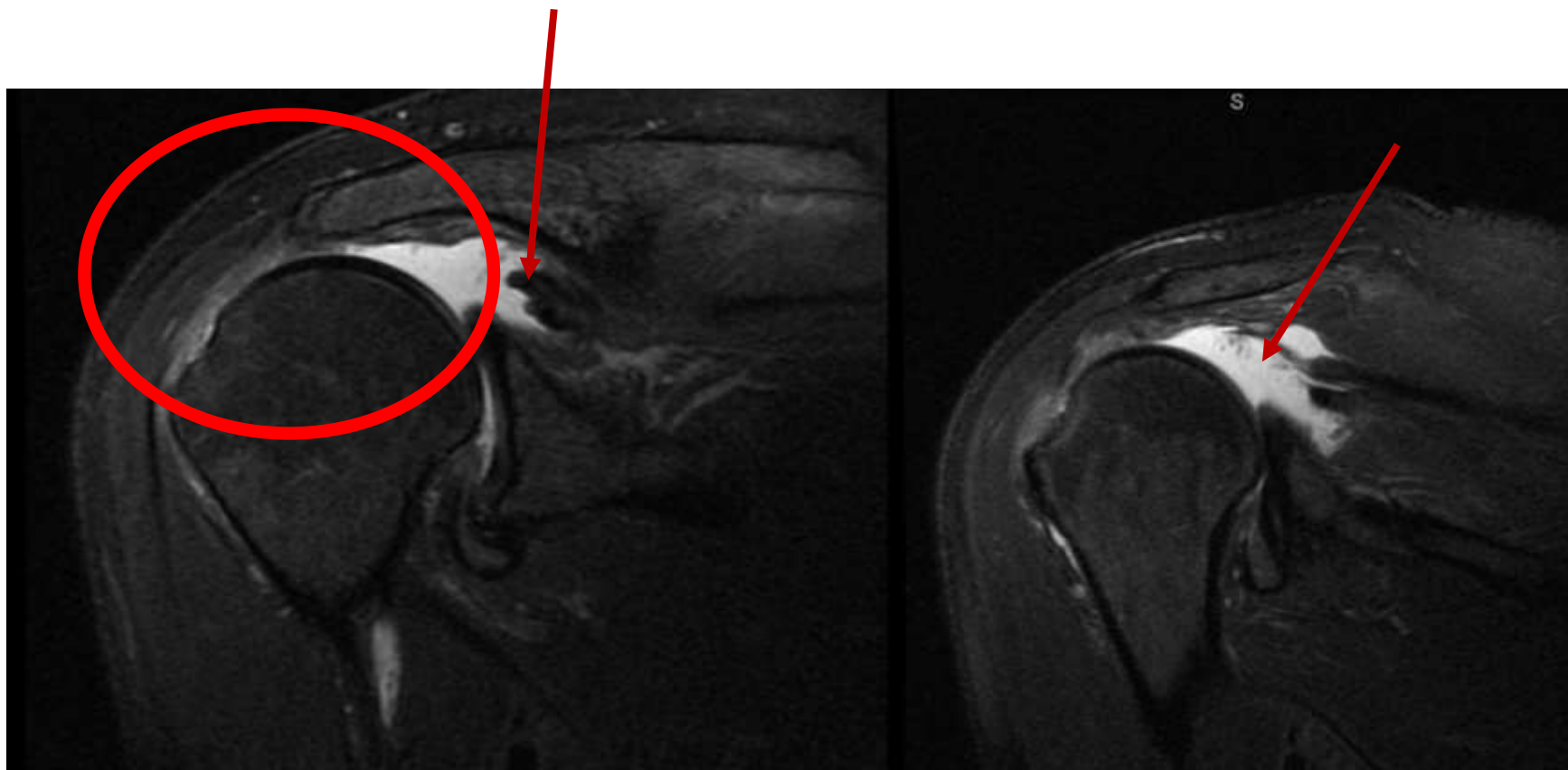
Right Arm:

- Active forward elevation – 170° (with significant effort)
- Active external rotation – 70° (with significant effort)
- Active internal rotation – T10
- **Rotator cuff strength:**
 - Supraspinatous: 3/5
 - Infraspinatous: 3/5
 - Subscapularis: 4+/5

Case: X-ray (AP + Grashey)



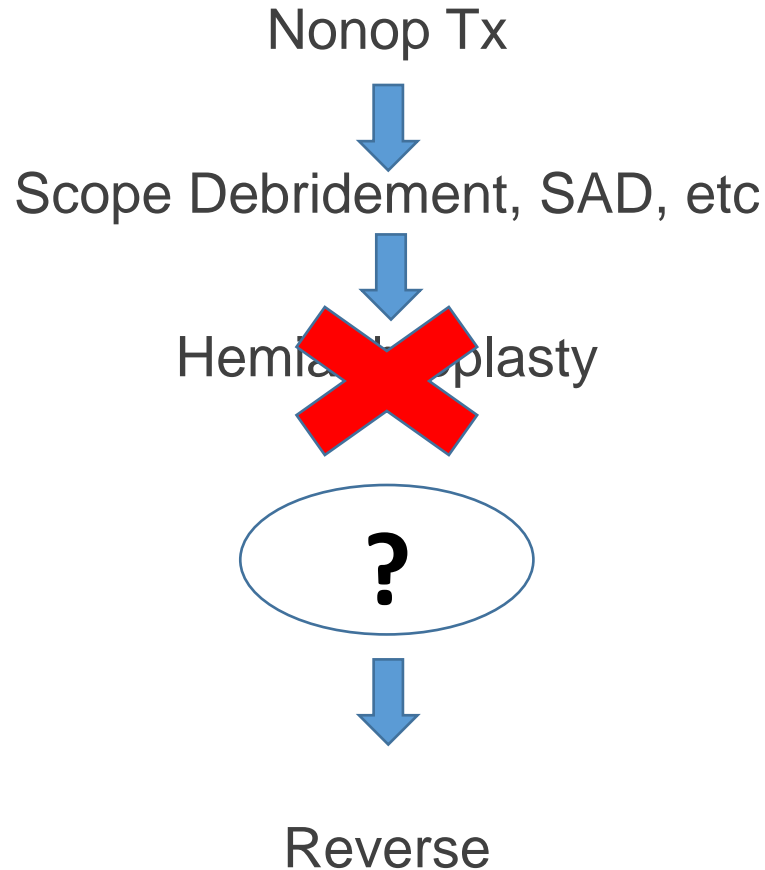
Case: MRI



Case: MRI



Irreparable Cuff Tear Options

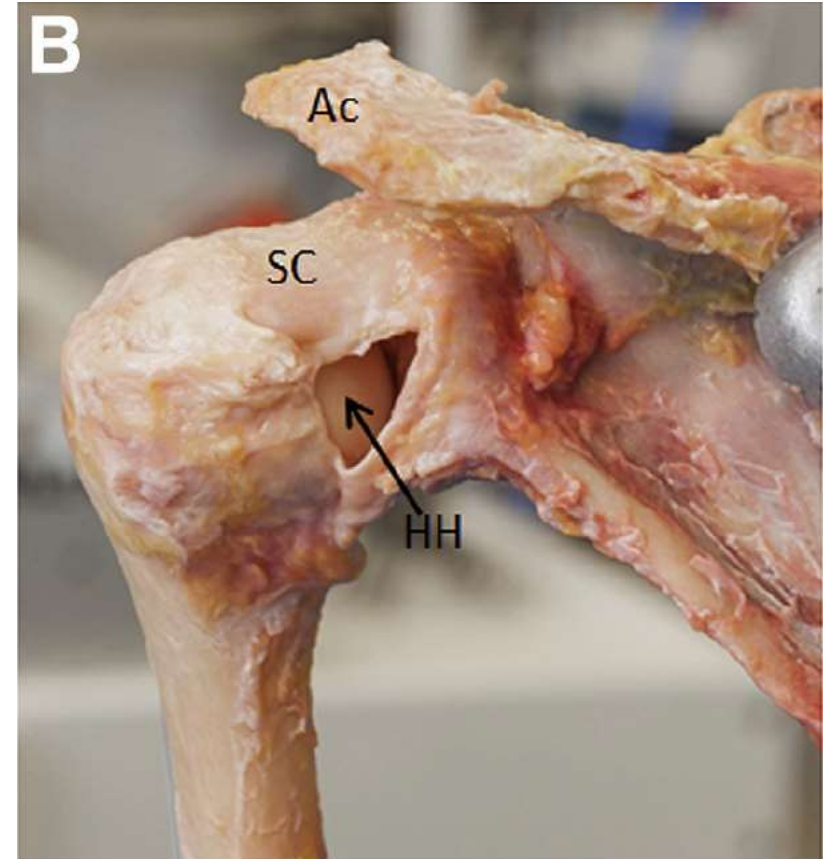


The Superior Capsule

Superior Capsule

What is it?

- Extends from the superior glenoid → greater tuberosity
- Lies on the undersurface of infra/supra
 - **Torn simultaneously in massive RCT**
- Can occupy $>, =$ surface area of the GT covered by the supra tendon



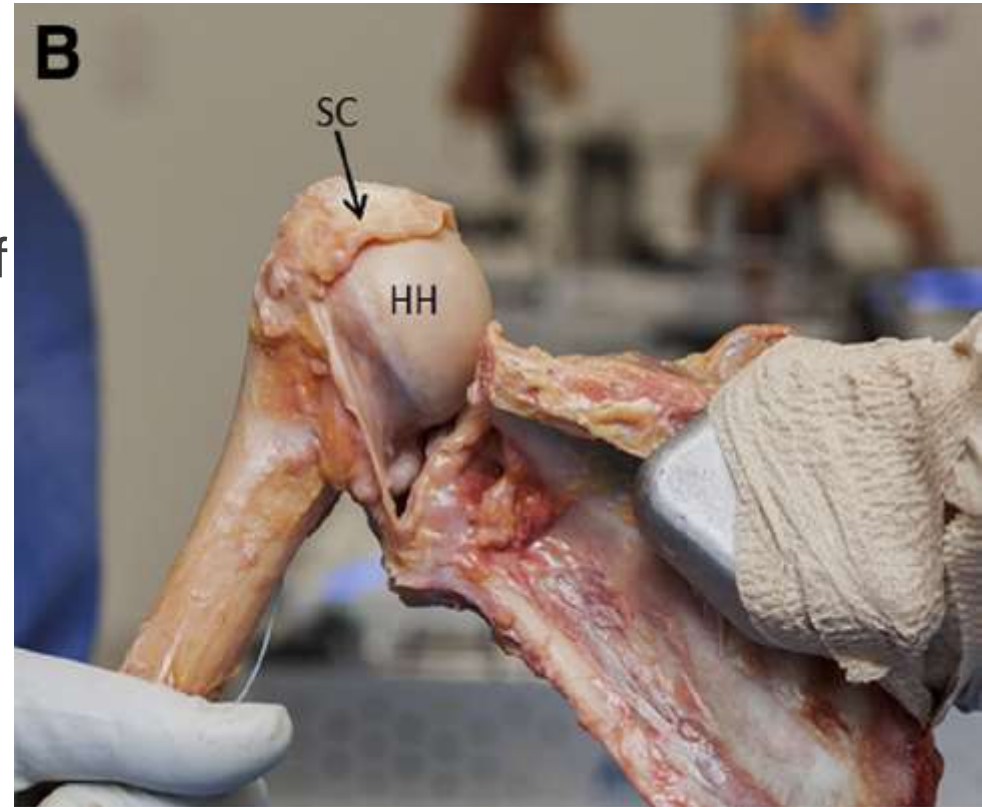
Tokish et al. 2020

Adams et al. 2016

Superior Capsule: Biomechanics

What does it do?

- Acts as a stabilizer
- Transmits forces of the rotator cuff
- **Creates a fulcrum**



Adams et al. 2016

Superior Capsule: Biomechanics

> [J Shoulder Elbow Surg.](#) 2014 May;23(5):642-8. doi: 10.1016/j.jse.2013.09.025.

Epub 2013 Dec 31.

Role of the superior shoulder capsule in passive stability of the glenohumeral joint

[Yoko Ishihara](#)¹, [Teruhisa Mihata](#)², [Mallika Tamboli](#)³, [Lauren Nguyen](#)³, [Kyoung Jin Park](#)³,
[Michelle H McGarry](#)³, [Shinro Takai](#)⁴, [Thay Q Lee](#)³

Affiliations + expand

PMID: 24388150 DOI: [10.1016/j.jse.2013.09.025](#)

- Cadaveric sectioning of the superior capsule
- Significant increase in:
 1. GH translation in all directions
 2. Increased acromiohumeral contact pressures at 30 degrees abduction

Biomechanical Outcomes

Biomechanics: SCR

Superior Capsule Reconstruction to Restore Superior Stability in Irreparable Rotator Cuff Tears

A Biomechanical Cadaveric Study

Teruhisa Mihata,^{*†‡§} MD, PhD, Michelle H. McGarry,^{†‡} MS, Joseph M. Pirolo,^{†‡} MD,
Mitsuo Kinoshita,[§] MD, PhD, and Thay Q. Lee,^{†‡} PhD
*Investigation performed at the Orthopaedic Biomechanics Laboratory,
VA Healthcare System, Long Beach, California*

Biomechanics: Superior Stability

Superior Capsule Reconstruction to Restore Superior Stability in Irreparable Rotator Cuff Tears

A Biomechanical Cadaveric Study

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Investigation performed at the Orthopaedic Biomechanics Laboratory, VA Healthcare System, Long Beach, California

TABLE 2
 Subacromial Contact Pressure^a

	Intact		Supraspinatus Tear		Tendon Patch		Superior Capsule Reconstruction		Double-Layer Patch	
	Pressure, MPa	Pressure, %	Pressure, MPa	Pressure, %	Pressure, MPa	Pressure, %	Pressure, MPa	Pressure, %	Pressure, MPa	Pressure, %
0° abduction										
0° external rotation	0.05 ± 0.01	100	0.07 ± 0.04	140	0.04 ± 0.01	80	0.01 ± 0.01 ^c	20	0.03 ± 0.01 ^c	60
30° external rotation	0.06 ± 0.01	100	0.11 ± 0.03 ^b	183	0.06 ± 0.01 ^c	100	0.01 ± 0.01 ^c	17	0.05 ± 0.01 ^c	83
45° abduction										
30° external rotation	0.07 ± 0.01	100	0.14 ± 0.03 ^b	200	0.08 ± 0.01 ^c	114	0.07 ± 0.01 ^c	100	0.07 ± 0.01 ^c	100
60° external rotation	0.06 ± 0.01	100	0.13 ± 0.03 ^b	217	0.08 ± 0.01 ^c	133	0.07 ± 0.01 ^c	117	0.07 ± 0.01 ^c	117
90° abduction										
30° external rotation	0.08 ± 0.01	100	0.10 ± 0.02 ^b	125	0.10 ± 0.01	125	0.09 ± 0.01 ^c	113	0.08 ± 0.01 ^c	100
60° external rotation	0.11 ± 0.02	100	0.13 ± 0.01	118	0.11 ± 0.02	100	0.10 ± 0.02 ^c	91	0.09 ± 0.02 ^c	82

^aValues are given as mean ± standard deviation. Subacromial contact pressure percentage was calculated by dividing each datum by intact data at the same position.

^bA significant difference compared to the intact states ($P < .05$).

^cA significant difference compared to the simulated supraspinatus tear ($P < .05$).

Biomechanics: Side-to-Side Suture?

Biomechanical Role of Capsular Continuity in Superior Capsule Reconstruction for Irreparable Tears of the Supraspinatus Tendon

Teruhisa Mihata,^{*†‡} MD, PhD, Michelle H. McGarry,[†] MS, Timothy Kahn,[†] BA, Iliya Goldberg,[†] MS, Masashi Neo,[‡] MD, PhD, and Thay Q. Lee,[†] PhD
Investigation performed at the Orthopaedic Biomechanics Laboratory, VA Long Beach Healthcare System and University of California, Irvine, Long Beach, California, USA

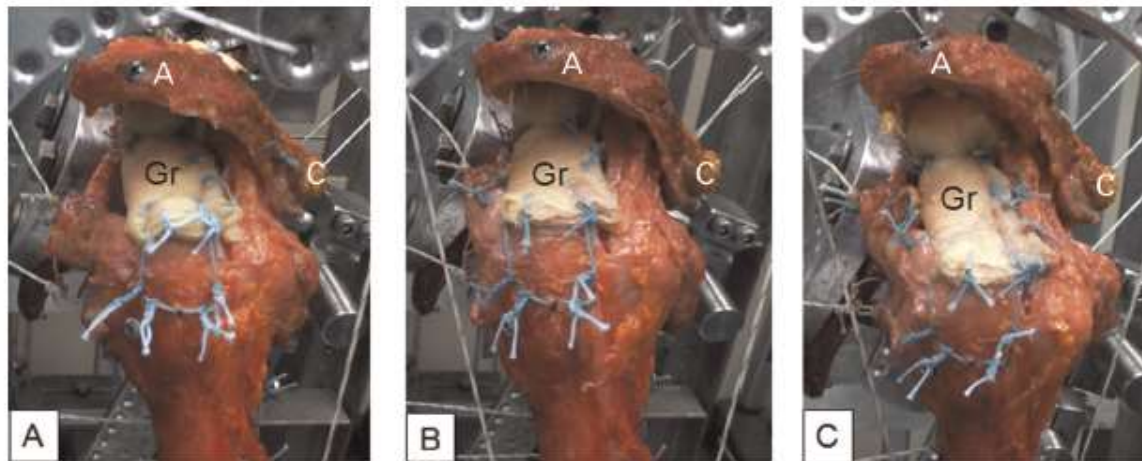


Figure 2. Testing conditions: (A) Superior capsule reconstruction (SCR) without side-to-side suturing. (B) SCR with posterior side-to-side suturing. (C) SCR with anterior and posterior side-to-side suturing. A, acromion; C, coracoid; Gr, graft.

Biomechanics: Hypothesized Mechanisms

1. “Spacer effect” by the patch itself → dampened head + acromion forces
2. “Trampoline effect” → graft physically holds the head inferiorly
3. “Force coupling” → graft heals to RC → Force generated via posterior cuff → across patch → improves vertical force couple → **optimizing the otherwise dysfunctional rotator cuff force**

Toskish et al. 2020

Clinical Outcomes

Clinical Outcomes

Five-Year Follow-up of Arthroscopic Superior Capsule Reconstruction for Irreparable Rotator Cuff Tears

Teruhisa Mihata, MD, PhD, Thay Q. Lee, PhD, Akihiko Hasegawa, MD, PhD, Kunimoto Fukunishi, MD, Takeshi Kawakami, MD, PhD, Yukitaka Fujisawa, MD, PhD, Mutsumi Ohue, MD, and Masashi Neo, MD, PhD

Investigation performed at the Department of Orthopedic Surgery, Osaka Medical College, Takatsuki, Japan

- 30 Patients treated with SCR
- Followed clinically and radiographically for 5 years
- Healed vs unhealed with graft tear (n=3; 10%) were compared to preop

Clinical Outcomes

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TABLE III Preoperative and Postoperative Shoulder Scores and VAS Scores

Scores	Preoperative*	1 Year Postoperatively*	5 Years Postoperatively*	P Value		
				Preoperative vs. 1 Year	Preoperative vs. 5 Years	1 Year vs. 5 Years
ASES						
Healed	27.7 ± 20.3 (19.7 to 35.7)	84.0 ± 16.3 (77.6 to 90.5)	93.2 ± 10.2 (89.2 to 97.3)			
Graft tear	40.0 ± 16.1 (0 to 79.9)	73.9 ± 10.2 (48.6 to 99.2)	84.0 ± 6.9 (66.8 to 101.2)			
Total	29.0 ± 20.0 (21.5 to 36.4)	83.0 ± 16.0 (77.0 to 89.0)	92.3 ± 10.3 (88.5 to 96.1)	<0.001	<0.001	0.03
JOA						
Healed	50.5 ± 14.4 (44.8 to 56.2)	87.2 ± 11.7 (82.6 to 91.8)	92.3 ± 10.6 (88.1 to 96.5)			
Graft tear	60.3 ± 5.5 (46.6 to 74.1)	73.8 ± 11.3 (45.7 to 102.0)	83.0 ± 5.6 (69.0 to 97.0)			
Total	51.5 ± 14.0 (46.3 to 56.7)	85.9 ± 12.2 (81.3 to 90.4)	91.4 ± 10.5 (87.4 to 95.3)	<0.001	<0.001	0.09
VAS						
Healed	7.0 ± 2.1 (6.2 to 7.9)	1.2 ± 1.8 (0.5 to 1.9)	0.7 ± 1.7 (0.1 to 1.4)			
Graft tear	5.7 ± 3.2 (-2.3 to 13.7)	1.7 ± 1.5 (-2.1 to 5.5)	2.0 ± 2.0 (-3.0 to 7.0)			
Total	6.9 ± 2.2 (6.1 to 7.7)	1.3 ± 1.8 (0.6 to 1.9)	0.9 ± 1.7 (0.2 to 1.5)	<0.001	<0.001	0.48

*The values are given as the mean score in points and the standard deviation, with the 95% CI in parentheses.

Clinical Outcomes

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Investigation performed at the Department of Orthopedic Surgery, Osaka Medical College, Takatsuki, Japan

TABLE IV Preoperative and Postoperative Shoulder Range of Motion

Range of Motion	Preoperative	1 Year Postoperatively	5 Years Postoperatively	P Value		
				Preoperative vs. 1 Year	Preoperative vs. 5 Years	1 Year vs. 5 Years
Active elevation* (deg)						
Healed	83 ± 52 (63 to 104)	141 ± 37 (127 to 156)	154 ± 32 (142 to 167)			
Graft tear	103 ± 81 (-99 to 306)	110 ± 40 (11 to 209)	127 ± 21 (75 to 178)			
Total	85 ± 54 (65 to 105)	138 ± 38 (124 to 152)	151 ± 32 (139 to 163)	-0.001	<0.001	0.22
Active external rotation* (deg)						
Healed	26 ± 20 (18 to 34)	37 ± 20 (29 to 45)	41 ± 19 (34 to 49)			
Graft tear	33 ± 6 (19 to 48)	37 ± 29 (-35 to 108)	37 ± 29 (-35 to 108)			
Total	27 ± 20 (19 to 34)	37 ± 20 (29 to 44)	41 ± 20 (34 to 48)	0.05	0.006	0.4
Active internal rotation† (deg)						
Healed	L4 (S to T12)	L2 (S to T12)	L1 (S to T10)			
Graft tear	L3 (L4 to L3)	L4 (S to L3)	L3 (S to L1)			
Total	L4 (S to T12)	L3 (S to T12)	L2 (S to T10)	0.05	<0.001	0.07

*The values are given as the mean angle and the standard deviation, with the 95% CI in parentheses. †The values are given as the level of the vertebral body.

Clinical Outcomes

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Teruhisa Mihata, MD, PhD, Thay Q. Lee, PhD, Akihiko Hasegawa, MD, PhD, Kunimoto Fukunishi, MD, Takeshi Kawakami, MD, PhD, Yukitaka Fujisawa, MD, PhD, Mutsumi Ohue, MD, and Masashi Neo, MD, PhD

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Range of Motion	Preoperative	1 Year Postoperatively	5 Years Postoperatively	P Value		
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Total	85 ± 54 (65 to 105)	138 ± 38 (124 to 152)	151 ± 32 (139 to 163)	<0.001	<0.001	0.22
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Active internal rotation† (deg)						
Healed	L4 (S to T12)	L2 (S to T12)	L1 (S to T10)			
Graft tear	L3 (L4 to L3)	L4 (S to L3)	L3 (S to L1)			
Total	L4 (S to T12)	L3 (S to T12)	L2 (S to T10)	0.05	<0.001	0.07

*The values are given as the mean angle and the standard deviation, with the 95% CI in parentheses. †The values are given as the mean, with the range in parentheses.

Clinical Outcomes

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Investigation performed at the Department of Orthopedic Surgery, Osaka Medical College, Takatsuki, Japan

TABLE II Preoperative and Postoperative Acromiohumeral Distance and Hamada Grade

	Preoperative*	1 Year Postoperatively*	5 Years Postoperatively*	P Value		
				Preoperative vs. 1 Year	Preoperative vs. 5 Years	1 Year vs. 5 Years
Acromiohumeral distance (mm)						
Healed	3.4 ± 2.3 (2.5 to 4.3)	9.5 ± 2.3 (8.5 to 10.4)	8.7 ± 2.8 (7.6 to 9.8)			
Graft tear	3.1 ± 1.5 (-0.6 to 6.8)	6.0 ± 3.2 (-2.0 to 13.9)	3.2 ± 2.2 (-2.3 to 8.6)			
Total	3.4 ± 2.2 (2.6 to 4.2)	9.1 ± 2.6 (8.1 to 10.1)	8.1 ± 3.2 (6.9 to 9.3)	<0.001	<0.001	0.16
Hamada grade						
Healed	2.3 ± 0.8 (1.9 to 2.6)	1.3 ± 0.7 (1.0 to 1.5)	1.3 ± 0.7 (1.1 to 1.6)			
Graft tear	3.0 ± 1.0 (0.5 to 5.5)	2.3 ± 1.5 (-1.5 to 6.1)	3.7 ± 0.6 (2.2 to 5.1)			
Total	2.3 ± 0.8 (2.0 to 2.6)	1.4 ± 0.8 (1.1 to 1.7)	1.6 ± 1.0 (1.2 to 1.9)	<0.001	<0.001	0.71

*The values are given as the mean and the standard deviation, with the 95% CI in parentheses.

Clinical Outcomes

Five-Year Follow-up of Arthroscopic Superior Capsule Reconstruction for Irreparable Rotator Cuff Tears

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Investigation performed at the Department of Orthopedic Surgery, Osaka Medical College, Takatsuki, Japan

Additional Results:

- 10/12 patients involved in strenuous work returned to full duty
- Graft thickness did not significantly change over 5 years

Clinical Outcomes

Arthroscopic Superior Capsular Reconstruction With Acellular Dermal Allograft for the Treatment of Massive Irreparable Rotator Cuff Tears: Short-Term Clinical Outcomes and the Radiographic Parameter of Superior Capsular Distance

William T. Pennington, M.D., Brian A. Bartz, P.A.-C., Joann M. Pauli, P.A.-C., Carol E. Walker, B.A., and William Schmidt, B.S.

- 88 Patients treated with SCR
- Followed clinically and radiographically for 1 year
- Additionally, dynamometric strength testing was performed

Clinical Outcomes

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Functional/Clinical Results

- aFE: 120° → 160° (P = .044)
- aAB: 103° → 159° (P = .007)
- VAS: 4 → 1.5 (P = .005)
- ASES: 52 → 82 (P = .005)

Clinical Outcomes

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Radiographic Results

- AHD: 7.1mm → 9.7mm (P = .049)

Clinical Outcomes

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Strength

Table 3. Dynamometric Strength Measurements (lb)

	FF		ABD		EXT	
	Surgical	Nonsurgical	Surgical	Nonsurgical	Surgical	Nonsurgical
Preoperation	4.8 (0-11.5) <i>P</i> = .00051	14.1	4.1 (0-11.9) <i>P</i> = .000013	13.9	7.7 (0-19.2) <i>P</i> = .018	16.5
6 months	6.2 (0.5-18.0) <i>P</i> = .016	13.0	5.8 (0.5-17.0) <i>P</i> = .0022	11.1	9.3 (3.2-20) <i>P</i> = .011	15.2
1 year	9.8 (3.0-18.1) <i>P</i> = .44	11.5	9.2 (0.5-16.1) <i>P</i> = .39	10.1	12.3 (2.0-20.3) <i>P</i> = .060	14.7

NOTE. Results of dynamometric strength measurements (in pounds) taken on the surgical extremity and nonsurgical extremity are depicted. Measurements are statistically different until 1 year postoperation, when there is no significant difference between the surgical and nonsurgical extremity.

ABD, abduction; EXT, external rotation; FF, forward flexion.

Clinical Outcomes

Arthroscopic Superior Capsular Reconstruction With Acellular Dermal Allograft for the Treatment of Massive Irreparable Rotator Cuff Tears: Short-Term Clinical Outcomes and the Radiographic Parameter of Superior Capsular Distance

William T. Pennington, M.D., Brian A. Bartz, P.A.-C., Joann M. Pauli, P.A.-C., Carol E. Walker, B.A., and William Schmidt, B.S.

Failures:

- 3 patients with evidence of failure on MRI (all at the greater tuberosity)
- 1 patient dissatisfied with outcome (converted to RTSA despite evidence of graft incorporation)
- Overall rate: 4.5% of failure

Clinical Outcomes

Superior Capsular Reconstruction for the Operatively Irreparable Rotator Cuff Tear: Clinical Outcomes Are Maintained 2 Years After Surgery



Stephen S. Burkhart, M.D., Joel J. Prankun, D.O., and Robert U. Hartzler, M.D., M.S.

- 41 Patients treated with SCR
- Followed clinically and radiographically for 2 years

Clinical Outcomes

Superior Capsular Reconstruction for the Operatively Irreparable Rotator Cuff Tear: Clinical Outcomes Are Maintained 2 Years After Surgery



Stephen S. Burkhart, M.D., Joel J. Prankun, D.O., and Robert U. Hartzler, M.D., M.S.

Outcome Measures	Preoperative	1-Year Postoperative	<i>P</i> *	2-Year Postoperative	<i>P</i> [†]	<i>P</i> [‡]
ASES score (0-100)	52 [46-57]	90 [87-92]	<.0001	89 [86-92]	.9	<.0001
VAS pain (0-10)	4.6 [3.8-5.4]	0.5 [0.2-0.7]	<.0001	0.7 [0.4-1]	.2	<.0001
SSV (0-100)	39 [33-44]	88 [85-92]	<.0001	83 [79-87]	.03	<.0001
Active FE, °	140 [120-159]	172 [168-176]	.002	167 [159-176]	.5	.006
Active ER, °	37 [29-44]	48 [42-53]	.002	59 [51-67]	.02	<.0001

Results reported as mean [95% confidence intervals] or median [interquartile range].

- SSV ↓ 5% between 1 year and final f/u (P. .03)
- aER improved 11° from 1 year and final f/u (P. .02).

Clinical Outcomes

Superior Capsular Reconstruction for the Operatively Irreparable Rotator Cuff Tear: Clinical Outcomes Are Maintained 2 Years After Surgery



Stephen S. Burkhart, M.D., Joel J. Prankun, D.O., and Robert U. Hartzler, M.D., M.S.

Complications:

- 3 (11%) graft tears found on MRI
- 2 (5%) revisions
- 6 (14%) Failures to achieve clinically important improvement in ASES Score

Clinical Outcomes

Superior Capsule Reconstruction for Irreparable Massive Rotator Cuff Tears: Does It Make Sense?



A Systematic Review of Early Clinical Evidence

Burak Altintas,^{*†} MD, Michael Scheidt,[‡] BS, Victor Kremser,^{*} BS, Robert Boykin,[§] MD, Sanjeev Bhatia,^{||} MD, Kaveh R. Sajadi,[¶] MD, Scott Mair,^{*} MD, and Peter J. Millett,^{###} MD, MSc
Investigation performed at the University of Kentucky, Lexington, Kentucky, USA

“The current evidence suggests that SCR is an alternative for symptomatic patients with irreparable MRCT; however, the included studies were fair to poor in quality, and there were some notable complications. Long-term follow-up will determine the longevity and ultimate role of this new method in the treatment of irreparable MRCT.”

> [J Shoulder Elbow Surg.](#) 2019 Jun;28(6S):S100-S109. doi: 10.1016/j.jse.2019.04.011.

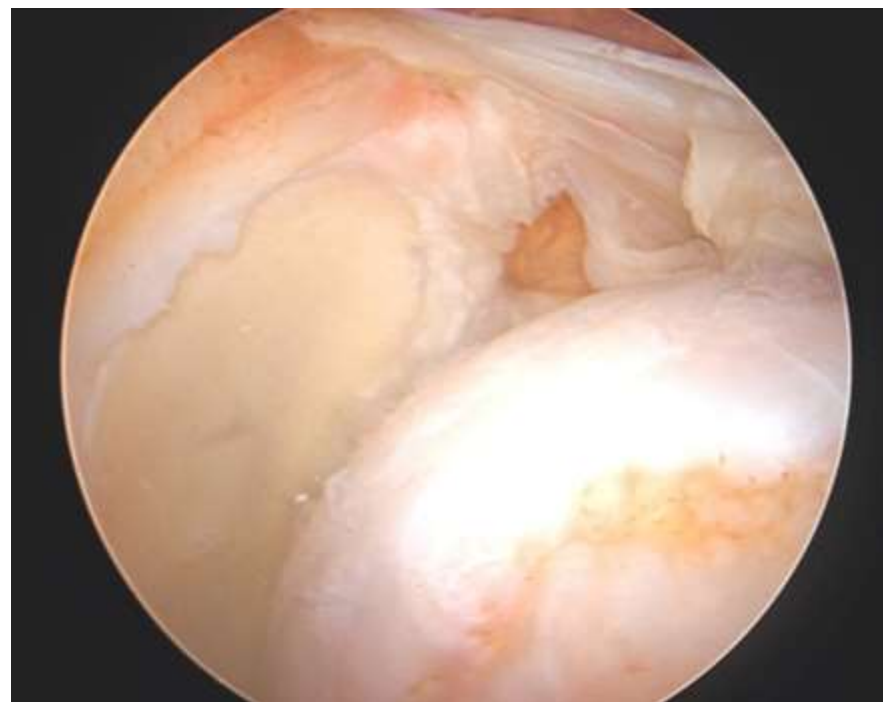
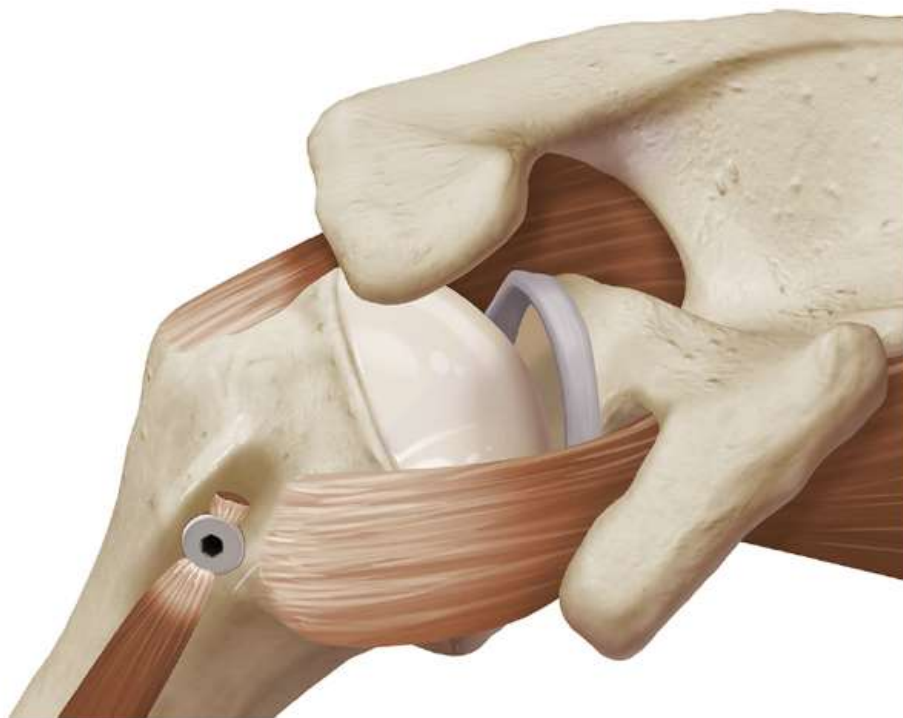
Superior capsule reconstruction using dermal allograft: early outcomes and survival

Jarret M Woodmass ¹, Eric R Wagner ², Kyle A Borque ³, Michelle J Chang ³, Kathryn M Welp ³,
Jon J P Warner ⁴

- High rate of persistent pain and poor function leading to clinical failure in 65% of patients.
- Risk factors: Female, revision, high fatty infiltration, low surgeon volume

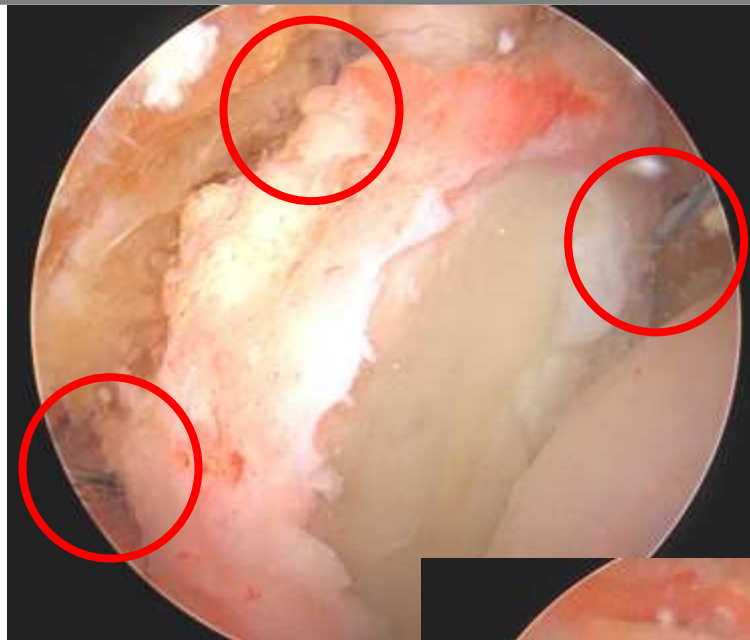
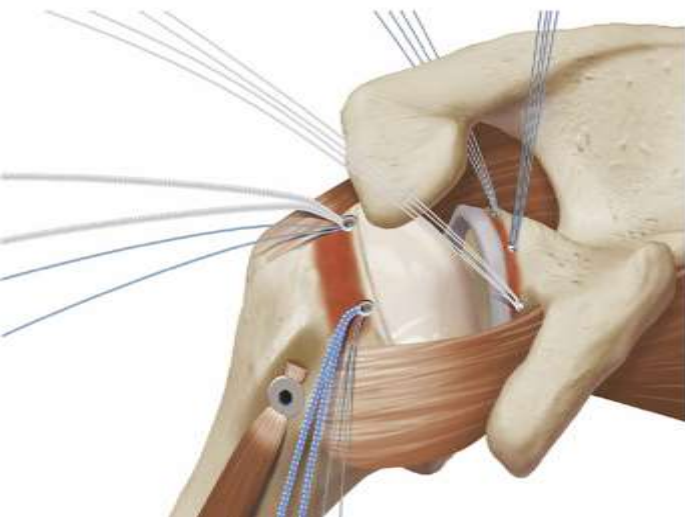
Reconstruction

Reconstruction: Massive Tear



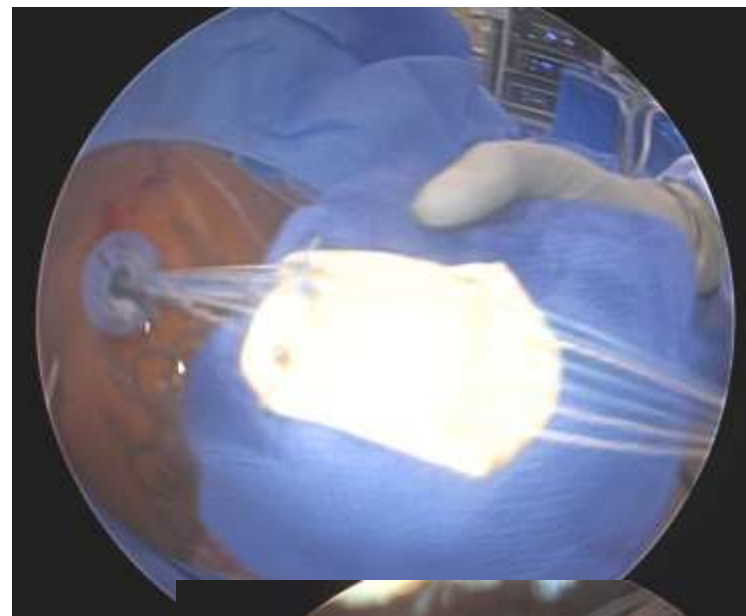
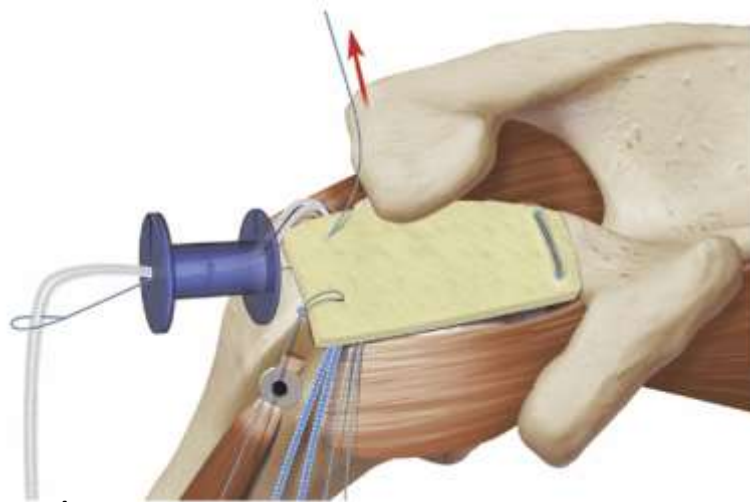
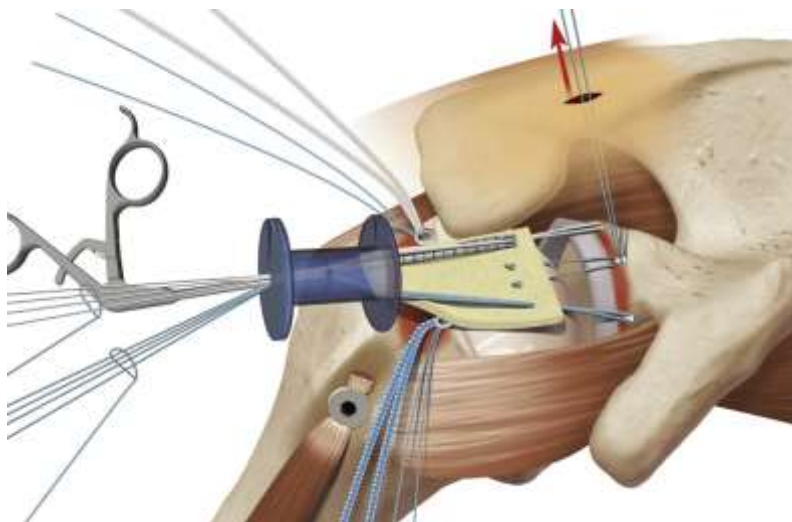
Burkhart et al. 2016

Reconstruction: Anchor Placement

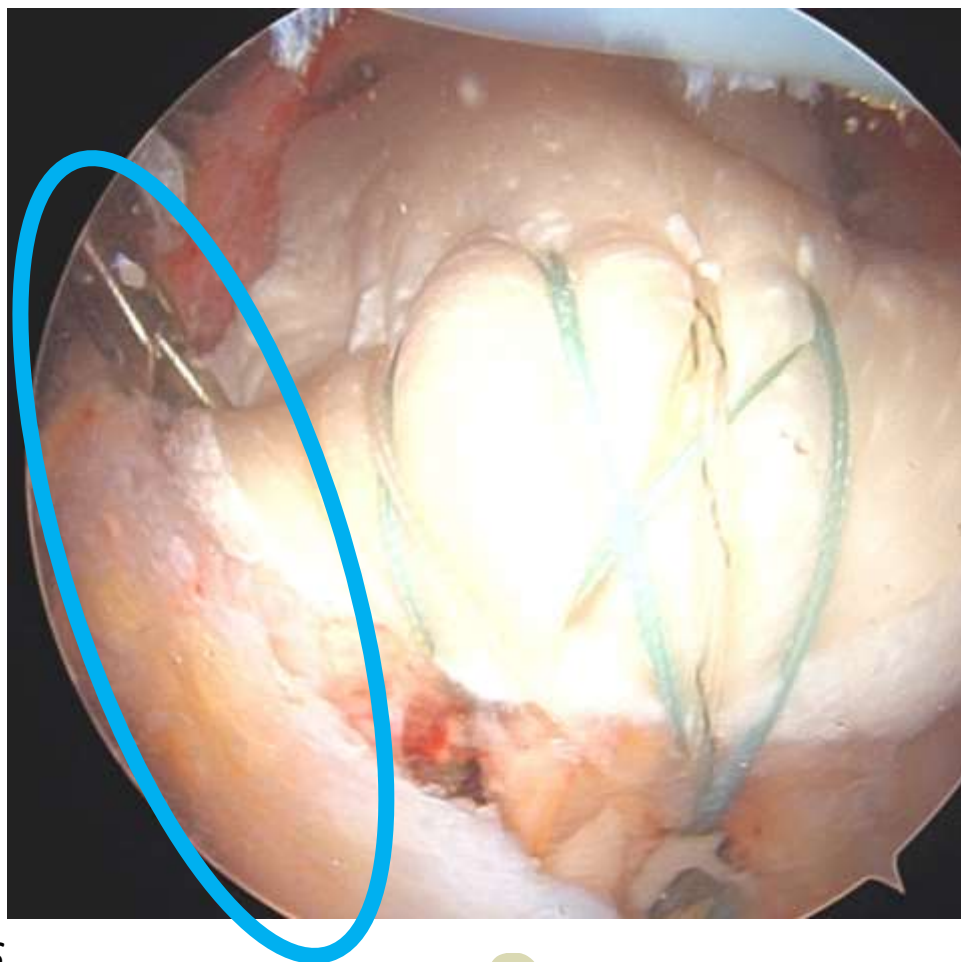


Burkhart et al. 2016

Reconstruction: Parachuting the Graft

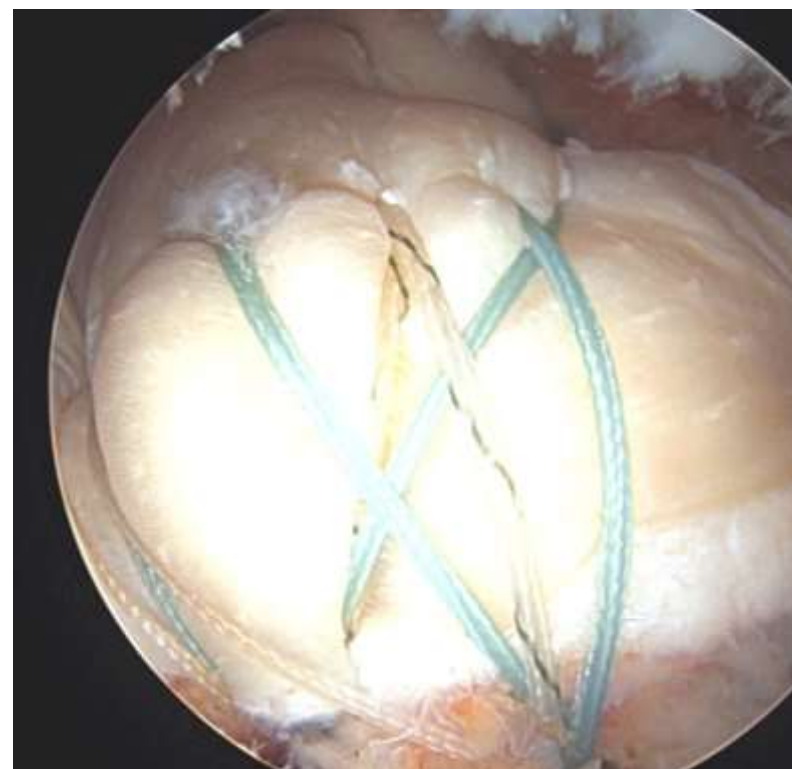
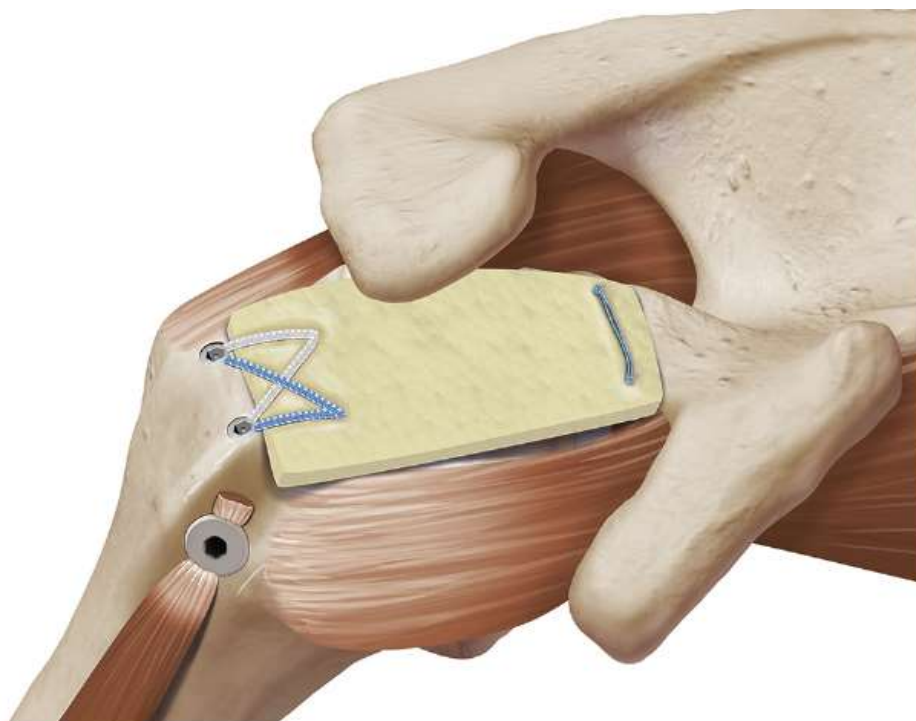


Reconstruction: Side to Side Repair



Burkhart et al. 2016

Reconstruction: Final Construct



Burkhart et al. 2016

Case: Physical Exam ~1 year (FE)



Case: Physical Exam ~1 year (ER)



Case: Physical Exam ~1 year (IR)



Case: Physical Exam ~1 year (Strength)



SCR....Here to stay???

- NO gold standard
- Early clinical outcomes of SCR are promising
 - Doesn't burn bridges
 - Intact subscap
 - Caution with pseudoparalysis
- Longer term follow-up
 - Diverse group of investigators is needed to further validate this technique and determine its longevity

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