Is Supraspinatus Atrophy on MRI Associated with Histologic Atrophy of Supraspinatus Muscle Fibers?

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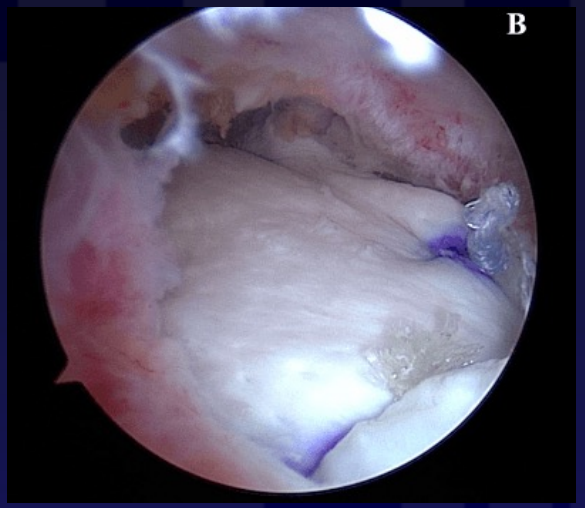
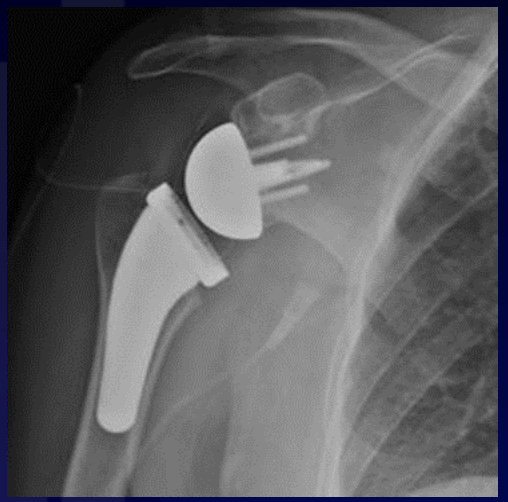
Disclosures

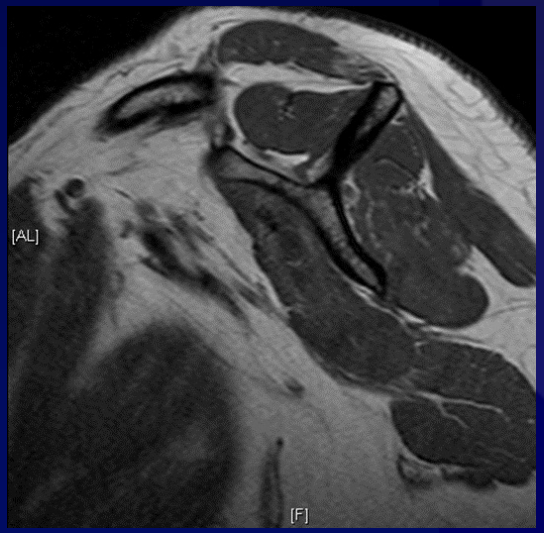
Jay Levin: Stryker, Zimmer, Johnson & Johnson Stock

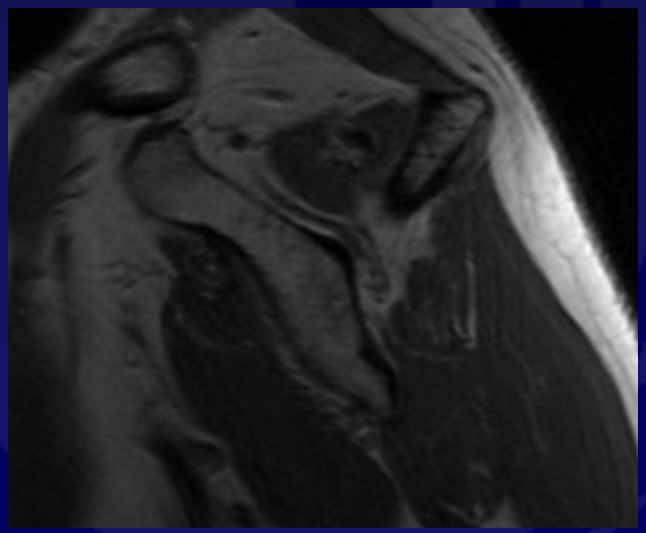
Christopher Klifto: Additive, Integra Consulting

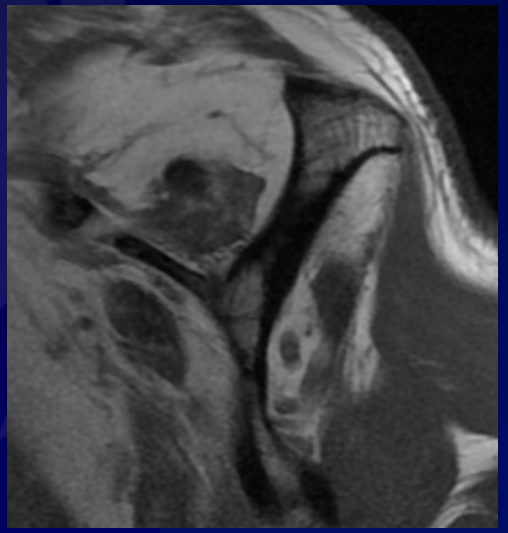
Oke Anakwenze: Exactech, Additive, DJO, Tornier, Lima Consulting











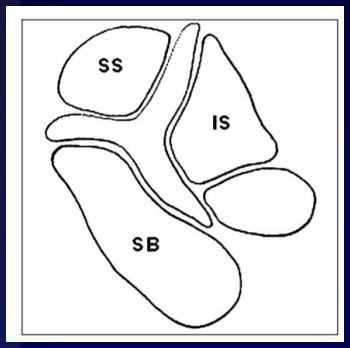
Muscle Atrophy and Treatment Decisions

> Clin Orthop Relat Res. 1997 Nov;(344):275-83.

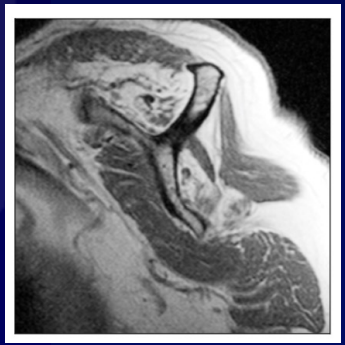
Prediction of rotator cuff repair results by magnetic resonance imaging

H Thomazeau [1], E Boukobza, N Morcet, J Chaperon, F Langlais

- 30 chronic RC tears
- MRI oblique sagittal view
- Supraspinatus atrophy correlated with tear size and increased risk of re-tear



Scapular Y view



Atrophy on Sagittal Oblique view Correlates with Repairability

Tendon retraction with rotator cuff tear causes a decrease in cross-sectional area of the supraspinatus muscle on magnetic resonance imaging

Shoji Fukuta, MD, PhD[a,*], Takahiko Tsutsui, MD[a], Rui Amari, MD[a], Keizo Wada, MD[b], Koichi Sairyo, MD, PhD[b]

Journal of Shoulder and Elbow Surgery
www.elsevier.com/locate/ymse

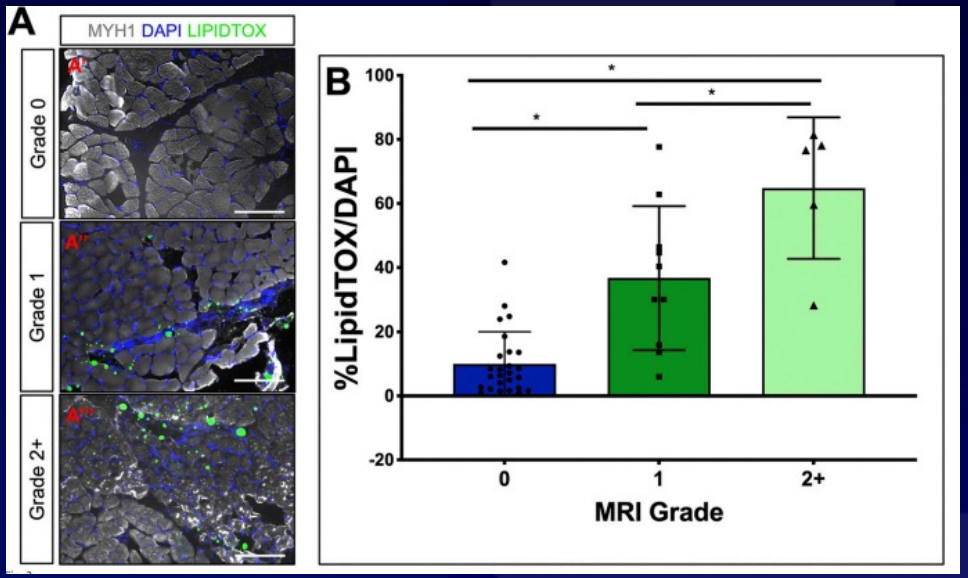
- 76 shoulders
- Cross-sectional area (CSA) measured
- Negative correlation between tendon retraction and CSA
- CSA on medial slices was preserved for small and medium tears, decreased for large and massive tears

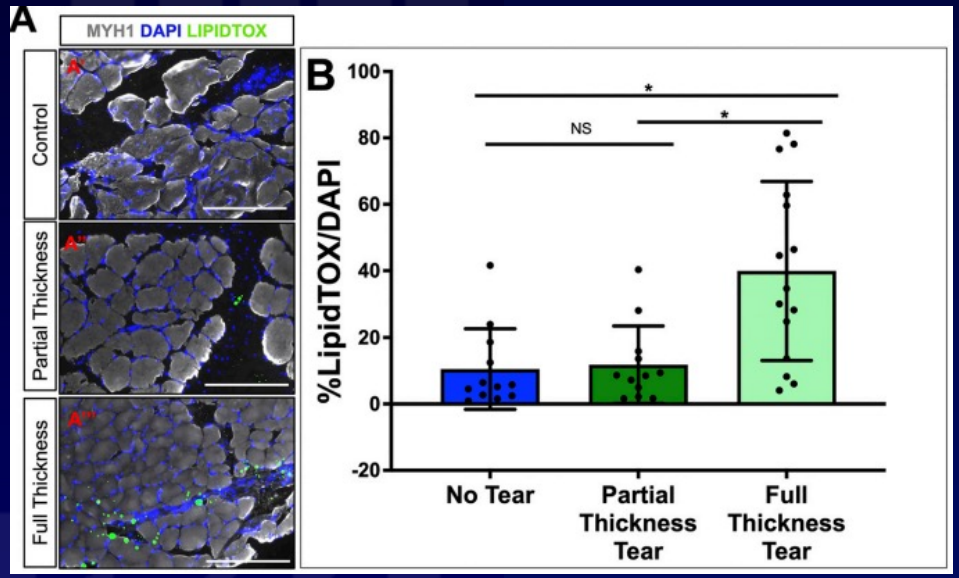
Scapular Y view may falsely overestimate atrophy in setting of retraction

Histologic Differences in Human Rotator Cuff Muscle Based on Tear Characteristics

Lindsey Ruderman, BA*, Abigail Leinroth, BA*, Helen Rueckert, BS, Troy Tabarestani, MD, Rafeal Baker, MD, Jay Levin, MD, MBA, Chad E. Cook, PT, PhD, FAPTA, Christopher S. Klifto, MD, Matthew J. Hilton, PhD, and Oke Anakwenze, MD, MBA

Investigation performed at Duke University, Durham, North Carolina





Fatty Accumulation corresponds to MRI Findings

Questions

Myofiber Size	Is atrophy on MRI associated with histologic myofiber size?
Tendon Retraction	How does apparent atrophy on MRI change with tendon retraction?
Myofiber Size vs. Tendon Retraction	What is the relative impact of both features on apparent atrophy on MRI?

Methods
Patient Sample

8 Controls

Surgery Non-Rotator cuff

14 partial-thickness tears

Surgery for Rotator cuff pathology

16 full-thickness tears

Surgery for Rotator cuff pathology

38 Patients

8 Controls and 30 Tendon Tears

Methods
Classification and Grading

Tendon Classification*

- No Tear
- Partial
- Small to Medium
- Large to Massive

- *DeOrio Classification

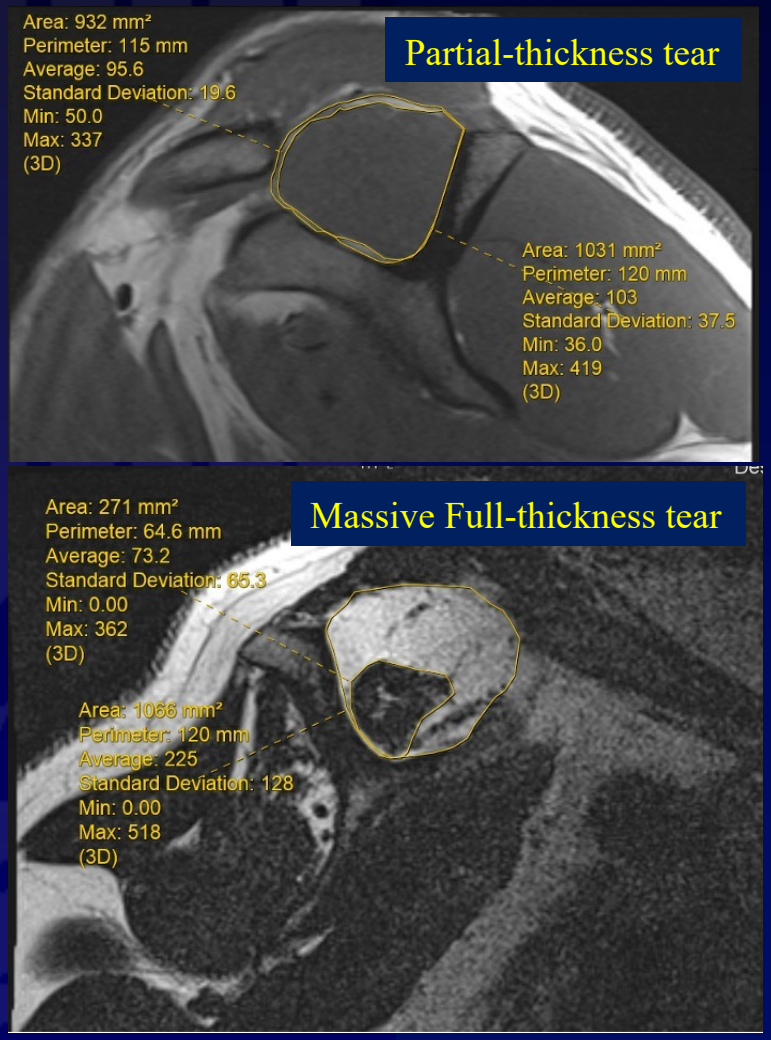
Muscle Atrophy**

- Cross-sectional area (mm^2)
- Occupation Ratio
- Tangent sign

- Performed by 2 surgeons
  - Kappa = 0.98
- ** Research assistants blinded

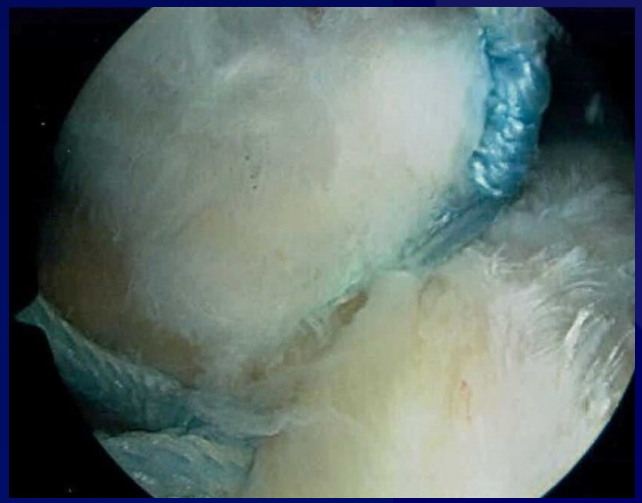
Occupation Ratio

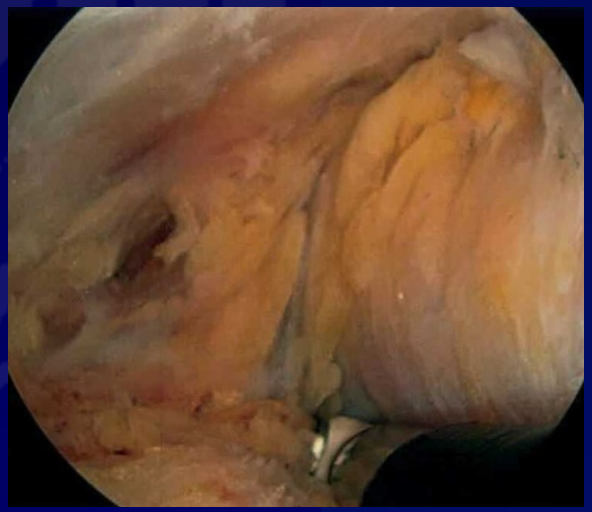
- CSA of supraspinatus on Y shaped view
- Divided by CSA of supraspinatus fossa
- <0.5 (occupies < half of fossa) considered atrophy



Biopsy

- Muscle Biopsy performed
  - 2.4mm arthroscopic biter
- Same Surgeon
- Supraspinatus sample collected
- Biopsy performed post-repair

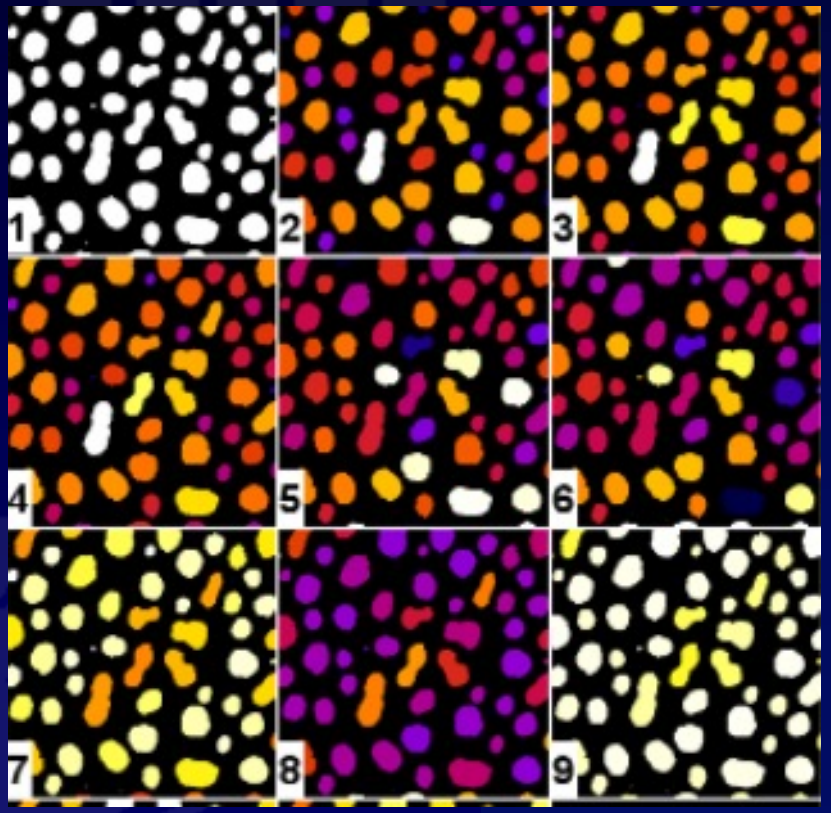




Histology
Myofiber Size

LAMININ

- Quantification of myofiber size
- Heat Map Analysis



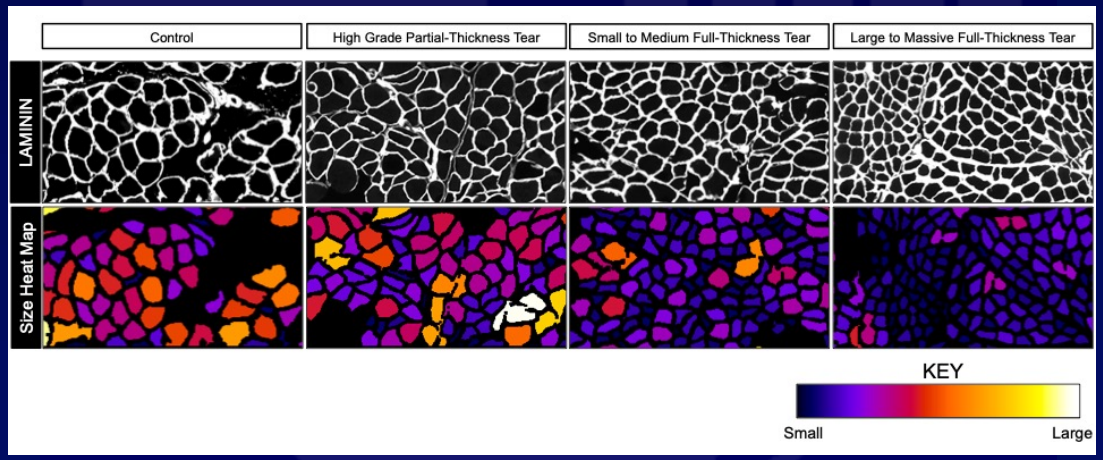
Demographics

Table 1 – Patient demographics					
	Control	Partial Thickness Tear	Small to Medium Full-Thickness Tear	Large to Massive Full-Thickness Tear	p values
Number of patients	8	14	8	8	
Age*	44.50 ± 17.05	55.29 ± 12.71	66.38 ± 9.55	63.75 ± 6.09	0.004*
BMI	28.43 ± 5.27	29.11 ± 4.85	29.07 ± 7.59	32.24 ± 4.64	0.513
Male Gender	6 (75.0%)	10 (71.4%)	4 (50.0%)	6 (75.0%)	0.652
White Ethnicity	6 (75.0%)	5 (35.7%)	4 (50.0%)	5 (62.5%)	0.315
VAS Pain	5.50 ± 2.07	6.86 ± 2.41	4.29 ± 0.95	5.43 ± 2.57	0.094
ASES	45.71 ± 16.87	39.57 ± 11.90	53.43 ± 9.95	47.43 ± 15.34	0.172
SANE	55.00 ± 20.49	54.93 ± 15.72	45.00 ± 14.83	41.43 ± 15.74	0.260
A,B,C represent p values for post-hoc Tukey honest significant difference test					

*Older age in larger tears

Muscle Atrophy and Histologic Analysis

Supraspinatus muscle atrophy on histologic and magnetic resonance imaging analysis					
	Control	**Partial Thickness Tear**	**Small to Medium Full-Thickness Tear**	**Large to Massive Full-Thickness Tear**	P values
Number of patients	8	14	8	8	
Histologic					
Mean Supraspinatus Myofiber Size (μm)	2,249.0 +/- 713.8$_a$	2,257.1 +/- 876.2$_b$	1,485.0 +/- 523.8	1,218.3 +/- 441$_{a,b}$	0.004 A=0.029 B=0.011



Decreasing myofiber size in larger tears

Muscle Atrophy on MRI

Supraspinatus muscle atrophy on histologic and magnetic resonance imaging analysis					
	Control	**Partial Thickness Tear**	**Small to Medium Full-Thickness Tear**	**Large to Massive Full-Thickness Tear**	P values
Number of patients	8	14	8	8	
Retraction (cm)	$0_{a,b}$	$0_{c,d}$	$1.55 \pm 0.78_{a,c,e}$	$3.70 \pm 1.52_{b,d,e}$	<0.001**
Magnetic Resonance Imaging (MRI)					
Mean Occupation Ratio	$0.7313 \pm 0.1192_{a,b}$	$0.6625 \pm 0.1205_{c}$	$0.5266 \pm 0.1477_{a}$	$0.3798 \pm 0.1138_{b,c}$	<0.001**
Occupation Ratio < 0.5	0 (0%)	1 (7.1%)	3 (37.5%)	7 (87.5%)	<0.001**
Tangent Sign Present	0 (0%)	0 (0%)	2 (25.0%)	6 (75.0%)	<0.001**

Decreasing occupation ratio and higher rate of tangent sign in larger tears

Tendon Retraction, Myofiber Size, and Occupation Ratio

- **Strong** correlation between **tendon retraction** and **occupation ratio**
- **Moderate** correlation between **myofiber size, age** and **occupation ratio**

Table 3 – Pearson correlation between tendon retraction, myofiber size, and occupation ratio				
	Tendon retraction (cm)	Myofiber size (μm)	Occupation Ratio	Age
Occupation Ratio	-0.725** (Strong) (p<0.001)	0.593** (Moderate) (p<0.001)	--	-0.512** (Moderate) (p<0.001)
**p<0.001				

Multivariable Analysis

- Tendon retraction ($p<0.001$), smaller histologic myofiber CSA ($p=0.047$), and age ($p=0.034$) → independently associated with supraspinatus atrophy on MRI.
- For each additional **1cm** of tendon retraction there is an associated decrease in occupation ratio by **6%**

Tendon Retraction (++) and Decreased CSA (+) associated with MRI atrophy

Limitations

- Possible biopsy variation can alter results
- Sample size could be larger
  - Confounders
- Retrospective study

Conclusion

- Quantified contribution of myofiber size and tendon retraction to observed atrophy on MRI
- Supports use of MRI to evaluate atrophy
  - Combination of true atrophy (smaller role) and tendon retraction (larger role)
  - Use results to normalize supraspinatus atrophy measurements for retracted tears
- Future work to assess chronicity and repairability of tears using normalized atrophy measurements