



# Risk Factors for Rotator Cuff Fatty Accumulation: A Histological Analysis

*Steven Bokshan MD, Troy Tabarestani BA, Lindsey Ruderman BA,  
Helen Rueckert BS, Jay Levin MD, MBA, Matthew J. Hilton, and  
Oke Anakwenze MD, MBA*

***Duke University, School of Medicine***



**Duke Orthopaedics**

# Disclosures



- The authors have no disclosures relevant to this work



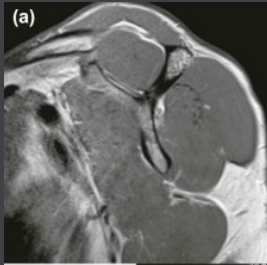
- Introduction – Fatty Rotator Cuff Atrophy
- Which patient or surgical risk factors modulate this?
- Why is this important?
- Future Implications for Patient Management

# Background/Objectives



- Fatty rotator cuff atrophy – popularized by Goutallier in early 90s with CT scan
- Scale from 0 to 4. Pathological change occurs over months to years

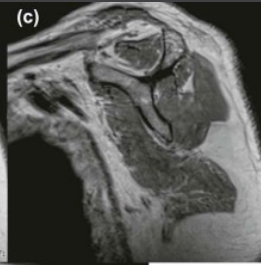
0 - Normal



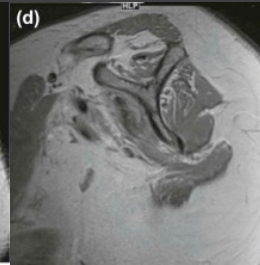
1 –  
Some Fat Streaks



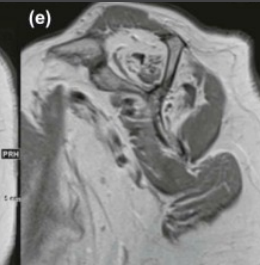
2 –  
Muscle > Fat



3 –  
Muscle = Fat



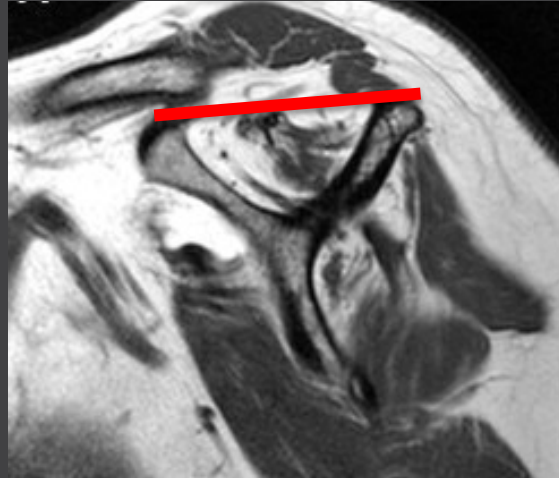
4 –  
Muscle < Fat



# Background/Objectives



- Goutallier noted that stage 2 was the turning point
- Positive Tangent Sign (below): 84% post-test probability of rotator cuff tear being non-repairable





- Largely unable to restore muscular health/structure after rotator cuff repair beyond grade 2

**Review Article**

## Fatty Infiltration and Rotator Cuff Atrophy

**Abstract**

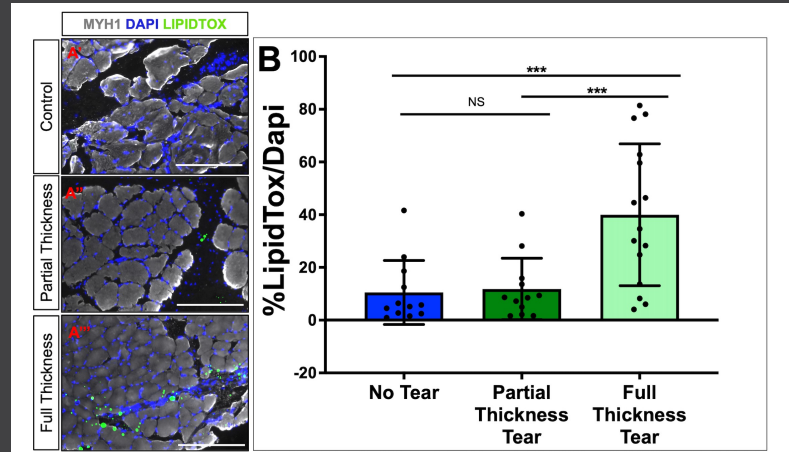
Moderate to severe fatty infiltration and rotator cuff atrophy are commonly associated with poor clinical outcomes and failed rotator cuff repair. Numerous animal and human studies have attempted to elucidate the etiology of fatty infiltration and rotator cuff atrophy. Mechanical detachment of the tendon in rotator cuff tears is primarily responsible. Suprascapular nerve injury may also play a

Bradley R. Kuzel, MD  
Steven Grindel, MD  
Rick Papandrea, MD  
Dean Ziegler, MD

# Materials and Methods



- Prospective cohort study of 51 patients undergoing rotator cuff repair
- Supraspinatus biopsies taken medial to musculotendinous junction after repair
- Biopsies were histologically stained with LipidTox (lipid marker) and normalized to normal of cellular nuclei (DAPI) >> LipidTox ratio (Cutoff of 30 used to define a "fatty" rotator cuff)



# Results



- A total of 51 with a mean age of 60.1 years (SD: 10.5 years)
- 19 high grade partial, 10 small, 7 medium, 10 large, and 5 massive tears
- Females patients made up 57.1% of the fatty cohort which was statistically greater compared to the non-fatty group ( $p = 0.042$ )
- Massive and large tear sizes were significantly more likely to occur in the fatty group ( $p = 0.005$ )



# Results



<b>Patient Variable</b>	<b>Odds Ratio (95% Confidence Interval)</b>	<b><i>p</i> - value</b>
<i>Age (per year)</i>	1.03	0.448
<i>Sex</i>		
<b>Female</b>	4.9	<b>0.036</b>
<i>Tear Type</i>		
<b>Full Tear (vs. partial)</b>	15.4	<b>0.008</b>

*Female sex (5x)* and *complete tear (15x)* independently associated with fat deposition

Chronicity, mechanism (traumatic/atraumatic), diabetes, HLD, statin usage not associated

# Results



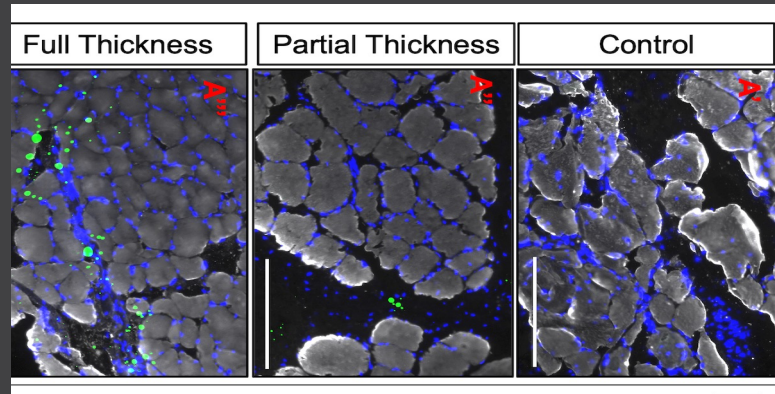
Patient Variable	Non-Fatty Rotator Cuff	Fatty Rotator Cuff	p - value
ASES (mean $\pm$ SD)	39.9 $\pm$ 11.2	47.7 $\pm$ 19.1	0.048
VAS (mean $\pm$ SD)	6.7 $\pm$ 1.8	4.9 $\pm$ 2.4	0.002
SANE (mean $\pm$ SD)	51.9 $\pm$ 19.2	52.5 $\pm$ 15.3	0.433

Fatty group had HIGHER ASES functional scores and lower VAS pain

# Conclusions



- Take great care with rotator cuff tears that progress from partial >> full (clock is ticking)
- This may be particularly true for female patients (5x odd risk of fatty rotator cuff)
- Clinical examination/course can be misleading as fatty atrophy may be “protective” of pain and functional scores



# References



- Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. *Clin. Orthop. Relat. Res.* [Internet]. 1994 Jul;(304):78–83. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/8020238>
- Kissenberth MJ, Rulewicz GJ, Hamilton SC, Bruch HE, Hawkins RJ. A positive tangent sign predicts the reparability of rotator cuff tears. *J. Shoulder Elb. Surg.* [Internet]. 2014;23(7):1023–1027. Available from 22. Rosa-Caldwell ME, Greene NP. Muscle metabolism and atrophy: let's talk about sex. *Biol. Sex Differ.* [Internet]. 2019 Dec 28;10(1):43. Available from: <https://bsd.biomedcentral.com/articles/10.1186/s13293-019-0257-3doi:10.1186/s13293-019-0257-3>
- Werthel J-D, Boux de Casson F, Walch G, Gaudin P, Moroder P, Sanchez-Sotelo J, et al. Three-dimensional muscle loss assessment: a novel computed tomography-based quantitative method to evaluate rotator cuff muscle fatty infiltration. *J. Shoulder Elb. Surg.* [Internet]. 2022 Jan;31(1):165–174. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1058274621006455doi:10.1016/j.jse.2021.07.029>
- Yamaguchi H, Suenaga N, Oizumi N, Hosokawa Y, Kanaya F. Will Preoperative Atrophy and Fatty Degeneration of the Shoulder Muscles Improve after Rotator Cuff Repair in Patients with Massive Rotator Cuff Tears? *Adv. Orthop.* [Internet]. 2012;2012:1–7. Available from: <http://www.hindawi.com/journals/aorth/2012/195876/doi:10.1155/2012/195876>
- Zoico E, Rossi A, Di Francesco V, Sepe A, Oliosio D, Pizzini F, et al. Adipose Tissue Infiltration in Skeletal Muscle of Healthy Elderly Men: Relationships With Body Composition, Insulin Resistance, and Inflammation at the Systemic and Tissue Level. *Journals Gerontol. Ser. A Biol. Sci. Med. Sci.* [Internet]. 2010 Mar 1;65A(3):295–299. Available from: <https://academic.oup.com/biomedgerontology/article-lookup/doi/10.1093/gerona/glp155doi:10.1093/gerona/glp155>