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Boston
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Muscle Edema of Retraction & Pseudo Fatty Infiltration After Traumatic Rotator Cuff Tears: An Experimental Model in Sheep

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DISCLOSURES

- T. Martinho, S. Wang, A. Lädermann, J. Chiu, M. Nabergoj, S.W.L. Ho, B. von Rechenberg, H. Bothorel and F. Kolo have nothing to disclose.
- Alexandre Lädermann has received consulting fees from Arthrex, Medacta, and Stryker and is the founder of FORE, BeeMed, and Med4Cast.



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BACKGROUND

- Traumatic rotator cuff tears may be associated with muscle edema¹⁻⁴.
- Muscle edema can mimic fat on magnetic resonance imaging (MRI) → Appearance of “Pseudo-fatty infiltration”.
- Paucity of literature on the topic: Development? Characteristics? Interpretation? Consequences?
- Better understanding could facilitate treatment strategies.



PURPOSE

- Describe MRI characteristics of edema of retraction, *a type of muscle edema associated with acute rotator cuff tendon retraction*, in an animal model.

HYPOTHESIS

- Edema of retraction does exist and may be confused with fatty infiltration as seen on MRI.



METHODS

- Descriptive laboratory study on 12 alpine sheep.
- One veterinarian performed all procedures.
- Use of an established sheep model⁵⁻⁷:
 - Right Shoulder: Treatment group → Greater tuberosity osteotomy to acutely release of the infraspinatus (ISP) tendon.
 - Left Shoulder: Control group → Baseline muscle intensity.
- Weightbearing as tolerated immediately after surgery.



METHODS

- MRI exams timeline: Right after surgery, 2 & 4 weeks later
- Identical MRI protocol for all cases:
 - 3-T system with dedicated receive-only extremity coil,
 - Slice thickness of 3.5 mm,
 - T1-weighted, T2-weighted, and Dixon pure-fat sequences⁸,
 - Both scapular spines positioned in the imaging plane
→ transverse sections perpendicular to the glenoid cavity.



METHODS

- One musculoskeletal radiologist reviewed all images.
- Definitions:
 - Muscle edema: ISP T2 hyperintense signal.
 - Fatty Infiltration: Determination of the ISP fat percentage on 2-point Dixon sequences according Nozaki⁹.
 - Pseudo–Fatty Infiltration: ISP Hyperintense signal on T1-weighted but not on 2-point Dixon sequences.

RESULTS

- Edema of retraction: Hyperintensity on T1- and T2 weighted but not 2-point Dixon sequences
→ Pseudo-fatty infiltration resulting from edema formation.



Figure 1. Magnetic resonance imaging (MRI) at 28 days after surgical release of the infraspinatus tendon. (A) T2-weighted fat-saturated MRI in the sagittal view showing edema of the infraspinatus muscle (arrow). (B) Infraspinatus muscle with a blurry aspect and slight hyperintense signal (circle) in the sagittal view of T1-weighted turbo spin echo MRI. (C) In the axial view of 2-point Dixon pure-fat MRI, no fat is visible (circle), suggesting pseudo-fatty infiltration.

RESULTS

- Retraction edema:
 - Peri- or intra-muscular localization,
 - Characteristic “ground glass” appearance on T1-weighted sequences.

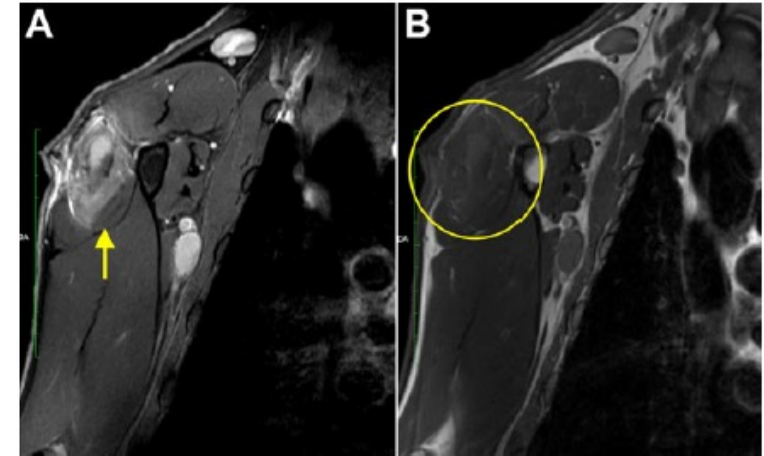


Figure 2. Magnetic resonance imaging (MRI) at 28 days after surgical tendon release. (A) Sagittal view of T2-weighted fat-saturated turbo spin echo MRI showing edema of retraction in the infraspinatus muscle (arrow). (B) Axial view of T1-weighted MRI showing a “ground glass” appearance of the infraspinatus muscle with a blurred aspect and slight hyperintense signal (circle).

RESULTS

- ISP Muscle edema:
 - Observed in all sheep,
 - Appeared hours after release,
 - Increased over time,
 - Led to a decrease in the fat percentage at 1-month follow-up
→ Edema dilution effect

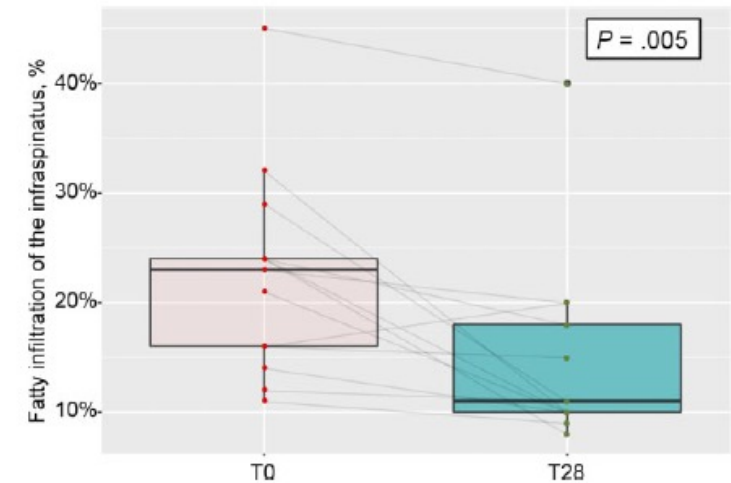


Figure 3. Box plot shows that the fat content (%) within the infraspinatus muscle of the sheep decreased significantly from immediately after surgery (T0) to 4 weeks after surgery (T28). The plots illustrate median values (bold lines), interquartile ranges (boxes), and 95% CIs (whiskers). The dots represent the sheep.



STUDY LIMITATIONS

- No inter- & intra-observer agreement.
- No further exams to exclude other causes of edema.
- Animal model may not be extrapolated to humans despite previous validation.
 - Sheep bear weight on their limbs, not humans.
- Short-term follow-up.



CONCLUSIONS

- Muscle edema was associated with acute and traumatic retracted rotator cuff tears.
- Edema of retraction has 2 important clinical implications:
 1. It can result in a pseudo–fatty infiltration imaging pattern.
 - Hyperintensity on T1- and T2 weighted but not 2-point Dixon pure-fat sequences.
 2. It influences the fat percentage within the muscle
 - Significant decrease in the fat percentage from 0 to 4 weeks after surgery due to the dilution effect of edema.



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