Tendon retraction after rotator cuff repair and its relationship with postoperative repair integrity and shoulder function

[1] Sambit Sahoo, MD, PhD, [1] Bong-Jae Jun, PhD, [1] Andrew Baker, MS, [1] Cathy Shemo, BS, [1] Tammy Owings, DEng, [1] Yuxuan Jin, MS, [1] Jason Ho, MD, [1] Vahid Entezari, MD, [1] Mark Schickendantz, MD, [1] Lutul Farrow, MD, [1] Alfred Serna, MD, [1] Joshua Polster, MD, [1] Carl Winalski, MD, [1] Peter Imrey, PhD, [1] Eric Ricchetti, MD, [2] Joseph Iannotti, MD, PhD, [1] Kathleen Derwin, PhD,
[1] Cleveland Clinic, Cleveland, Ohio, USA; [2] Cleveland Clinic Florida, Weston, Florida, USA
derwink@ccf.org

Disclosures: S. Sahoo: 1; Viscus. 4; Becton Dickinson, J&J, Medtronic. B. Jun: 1; Viscus. J. A. Baker: 1; Viscus. C. Shemo: None. T. Owings: None. Y. Jin: None. J. Ho: 2; DJO. 5; Zimmer Biomet. 6; Liberty Surgical. V. Entezari: 3B; DJO. 5; DJO. M. Schickendantz: None. L. Farrow: 5; OREF. 8; AJSM, VJSM. A. Serna: None. J. Polster: 4; Mediphany. C. Winalski: 3B; Siemens. 4; Pfizer. 8; Osteoarthritis and Cartilage, Skeletal Radiology. P. Imrey: 3B; GE Healthcare. 8; JASN. E. Ricchetti: 1; DJO. 3B; DJO, Depuy. 8; JSES. 9; Am Board of Ortho Surgery, ASES, AAOS. J. Iannotti: 1; Viscus, Depuy, Arthrex, Tornier, DJO, Wright Medical. 3B; Collamedix, DJO, Medical Device Business Services, Wright Medical. 4; Custom Orthopaedic Solutions. 7B; Wolters Kluwer Health. K. Derwin: 1; Viscus. 3B; Collamedix. 8; JBJS. 9; ORS.

INTRODUCTION: Currently, rotator cuff healing following repair may be defined as "intact", "attenuated", "partially re-torn", or "failed" based on signal abnormalities and the observation of a recurrent defect (i.e., a "gap") on postoperative MRI or ultrasound. However, current imaging modalities are inadequate to discern the extent to which the repaired tendon has "failed with continuity", i.e., undergone significant retraction in the absence of a recurrent defect. This study aims to investigate the extent to which tendon retraction – *with or without* a recurrent defect – is a common and clinically predictive structural outcome following rotator cuff repair (RCR). We measure and describe tendon retraction, shoulder patient reported outcome measures (PROMs) and functional measures (shoulder strength and range of motion (ROM)) after RCR, and assess the relationship of each to postoperative repair integrity (by clinical MRI) at 2 year follow-up.

METHODS: Patients undergoing primary, arthroscopic double row (or double-row equivalent) repair of the supraspinatus and/or infraspinatus tendons by one of seven shoulder surgeons between 2016 and 2018 were enrolled into a prospective cohort study [IRB 16-089, ClinicalTrials.gov# NCT02716441]. At the time of RCR, one to four radiopaque markers were tied to the superficial surface of the repaired tendon(s) just medial to the repair site. Each patient had shoulder imaging preoperatively (MRI only), day of surgery (CT only), and 3, 6, 12 and 24 months after surgery (both). Tendon retraction was quantified at each postoperative time by measuring the change in distance from the radiopaque markers to the humeral greater tuberosity on CT images [1-3] and taking the mean over each patient's markers, where apparent tendon retraction of >5mm exceeds the usual range of measurement variation[4].Two musculoskeletal radiologists, blinded to the tendon retraction and clinical data, assigned a Sugaya score of repair integrity to the MRI studies[5]. Preoperatively and at each postoperative time-point, patients also completed PROMs (Penn Shoulder Score, PSS) and were tested for isometric abduction strength (only postoperatively) and active ROM in the scapular plane.

RESULTS: 117 patients were enrolled in the study (**Table 1**), and 113 patients completed 2y follow-up. Tendon retraction increased in all patients after surgery, averaging 13.4±7.9 mm at 2y (range, 4.4-46.4 mm), with most retraction occurring by 6-mo (**Figure 1**). Patients with a Sugaya 4/5 full-thickness retear (17% at 2y) averaged appreciably more tendon retraction at all postoperative times than those with an intact repair or partial thickness retear (Sugaya 1/2/3) (**Figures 1, 2**). However, at 2y, 53% of patients with an intact repair or partial thickness retear (Sugaya 1/2/3) had mean tendon retraction >10mm. PSS (42±15.5 points at preop; 93±10.9 points at 2y), abduction strength (8±4.1 lbf at 6mo; 12±5.3 lbf at 2y) and active abduction ROM (94±43° at preop; 155±18° at 2y) improved postoperatively. There was considerable overlap in these outcomes between patients with and without a full-thickness retear at 2y (**Figure 2**).

DISCUSSION: Half of RCR patients with intact repair or partial thickness retear at 2y had significant tendon retraction >10mm, suggesting that these patients have undergone some degree of "failure with continuity"[2]. At 2y, patients with a full-thickness retear had overlapping distributions of PSS, shoulder abduction strength, and range of motion with patients with an intact repair or partial thickness retear, but greater tendon retraction, suggesting that tendon retraction may provide more sensitive information about repair integrity and postoperative shoulder function than Sugaya score alone. Multivariable analysis to investigate relationships between RCR healing (by tendon retraction and/or Sugaya score) and PROMs, abduction strength and/or ROM is ongoing.

SIGNIFICANCE/CLINICAL RELEVANCE: We anticipate that incorporating postoperative tendon retraction as well as the integrity of the repaired tissue from MRI into the assessment of structural outcomes following RCR will yield an improved understanding of rotator cuff tendon healing as well as a novel quantitative metric to evaluate treatments aimed to improve healing.

REFERENCES: [1] Derwin, KA et al. J Biomech 45, 2012. [2] McCarron, JA et al. Am J Sports Med 41, 2013. [3] Sahoo, S et al. PLoS One 14, 2019. [4] Jun, BJ et al. JSES Int 4, 2020. [5] Sugaya, H et al. Arthroscopy 21, 2005.

ACKNOWLEDGEMENTS: NIH NIAMS R01AR068342

Table 1. Baseline demographics and tear characteristics (n=117).

Age	58.4 ±8.4 y
Sex	F 44% , M 56%
BMI	30 ±6
Race	White 86%, Black 11%
AP tear size	2.2±0.8 cm
ML tear size	1.2±0.5 cm

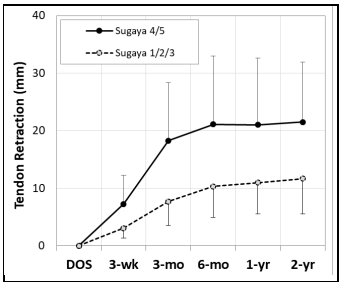

Figure 1. Mean tendon retraction in patients with Sugaya score 1/2/3 vs 4/5 during 2y after RCR

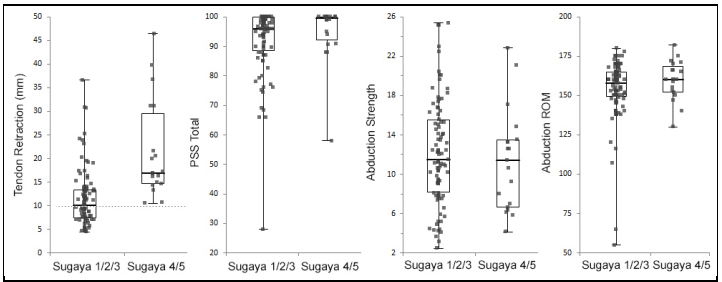

Figure 2. Individual patient tendon retraction, PSS total, shoulder abduction strength, and range of motion at 2y, grouped according to Sugaya score (1/2/3: 83%; 4/5:17%)