Surgical Repair for Proximal Rectus Femoris Avulsion: Biomechanical Study

Justin F.M. Hollenbeck[1], Alexander R. Garcia[1], Haruki Nishimura[1], Kohei Yamaura[1], Vera Stetzelberger[1], Justin R. Brown[1], Scott Tashman[1], Mitchell S. Mologne[1], Wyatt H. Buchalter[1], Soshi Uchida[1], Marc J. Philippon[2]
[1]Steadman Philippon Research Institute, Vail, CO, [2]The Steadman Clinic, Vail, CO
Jhollenbeck@sprivail.org

Disclosures: Justin F.M. Hollenbeck (N), Alexander R. Garcia (N), Haruki Nishimura (N), Kohei Yamaura (N), Vera Stetzelberger (N), Justin R. Brown (N), Scott Tashman (N), Mitchell S. Mologne (N), Wyatt H. Buchalter (N), Soshi Uchida (N), Marc J. Philippon (1-Smith+Nephew, Arthrosurface, Bledsoe, ConMed Linvatec, DJO, SLACK, and Elsevier; 4-Arthrosurface, MJP Innovations, Vail Valley Surgery Center, Vail MSO Holdings, MIS, EffRx, Olatec, iBalance (Arthrex), Manna Tree Partners, Stryker, Trimble, 3M, Bristol Myers Squibb, Pfizer, AbbVie, and Johnson & Johnson; 8-The International Society for Hip Arthroscopy; 9-Steadman Philippon Research Institute and Vail Health; 5-**S**mith+Nephew, ConMed Linvatec, Ossur, Arthrex, Siemens Medical Solutions, and Steadman Philippon Research Institute (SPRI). SPRI is a a 501(c)(3) non-profit institution supported financially by private donations and corporate support, including Arthrex, DJO, MLB, Ossur, Siemens, Smith & Nephew and XTRE; 2,3B-Smith+Nephew, MIS, Olatec, and NICE Recovery Systems)

INTRODUCTION: Proximal rectus femoris (PRF) avulsion occurs in the athletes, and some cases require surgical treatment after failed conservative treatment. Suture anchor repair and tenodesis repair are both mainstay treatments, however, there is no consensus as to which repair is superior. Therefore, the purpose of this study is to compare the failure load and elongation at failure between the suture anchor repair with suture bridge technique (SBR) and the tenodesis repair (TR) for PRF avulsion, and the stiffness among these two repairs versus the native state. We hypothesize that the suture anchor repair with suture bridge technique will be stronger than tenodesis repair and exhibit equivalent stiffness to the native tendon.

METHODS: Seven pairs of human cadaveric hemi-pelvises with no evidence of prior injury or abnormality were dissected to the PRF and sartorius origins. Biomechanically, each specimen underwent preconditioning followed by a distraction test to determine stiffness of the native specimen. Each specimen of a pair received one of the repairs (SBR or TR), while the other specimen in the pair received the other repair. After repair, each specimen underwent preconditioning followed by a pull to failure. The failure load, elongation at failure, stiffness, mode of failure, and stiffness as a percentage of native were determined for each repair.

RESULTS: The SBR group exhibited stronger failure load (223±51 N; $p = 0.0116$) and significantly higher stiffness as a percent from native (70.4±19.0%; $p = 0.0085$) than the TR group (153±32 N; 33.8±15.5%). While stiffness of the repair state in SBR group (41.5±9.4 N/mm) was not significantly different than the native state (66.2±36.0 N/mm), stiffness of the repair state in the TR group (20.3±7.5 N/mm) was significantly lower than the native state and the SBR group (Native: 65.4±22.1 N/mm, $p < 0.001$; SBR: 66.2±36.0 N/mm, $p = 0.02$). The SBR group primarily failed at the repair site (71%), and the TR group primarily failed at the suture-sartorius interface (43%) and at the muscle (29%).

DISCUSSION: The suture bridge technique demonstrated significantly higher failure load and stiffness compared to tenodesis. Additionally, the suture bridge technique exhibited stiffness equivalent to the native state, while tenodesis had significantly lower stiffness. The SBR is superior to the TR in terms of failure load, stiffness, and percent stiffness from the native state. Based on the findings in this biomechanical investigation, SBR may be a better surgical option than TR to optimize failure load and stiffness.

CLINICAL RELEVANCE: SBR should be the preferred surgical treatment over TR for PRF repair. Using this technique, postoperative exercise and weight bearing may be possible as soon as pain is controlled, therefore avoiding range of motion restriction and partial weight bearing.

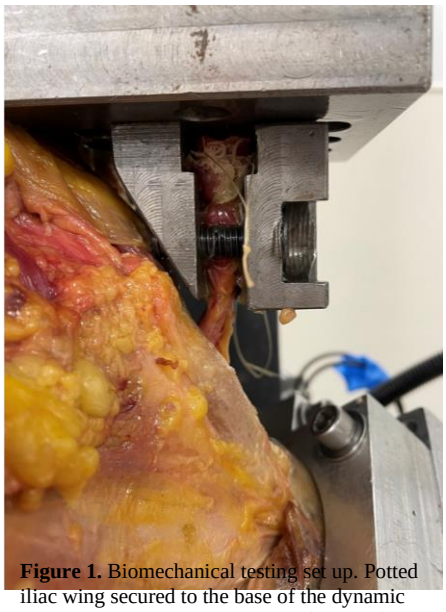

Figure 1. Biomechanical testing set up. Potted iliac wing secured to the base of the dynamic tensile testing system, and rectus femoris fixed within a clamp that is secured to the end effector of the dynamic tensile testing system

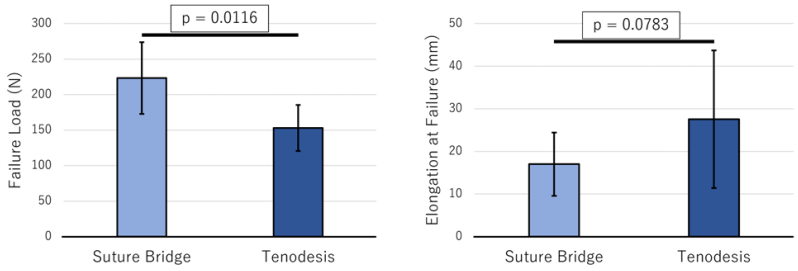

Figure 2. Failure load (left) and elongation at failure (right) for the suture bridge repair group and the tenodesis repair group

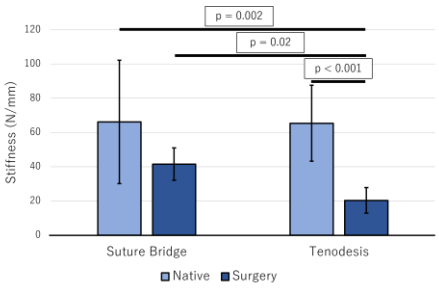

Figure 3. Stiffness values of native and repair state for the suture bridge repair group (left) and the tenodesis repair group (right)