Introduction: It has been thought that initial fixation strength is an essential consideration in optimizing rotator cuff repair. In response to this issue, we have developed a novel triple row suture technique that closely approximates the transosseous suture configuration by adding far lateral anchor screws to the double row technique in an arthroscopic fashion. Also, we introduced a new biomechanical testing setup, including contributions from the normal anatomy of the adjacent soft tissues, in combination with a cyclic and load-to-failure protocol to test the intact, injured and repaired rotator cuff tendon. These new contributing factors were selected to evaluate possible tear pathology and also provide a more realistic anatomic state before repair. Therefore, the overall objective of this study is to evaluate the biomechanical properties of intact, injured, and arthroscopically repaired rotator cuff utilizing a protocol that provides a more anatomic setting for evaluating newly designed rotator cuff repair techniques. We hypothesized that our novel triple row suture anchor rotator cuff repairs will provide an increased restoration of the native footprint and comparable, or better, initial biomechanical properties. We expect that this technique of the repair has high initial stability, large surface area of the repair and proper contact pressure, which undoubtedly affects the potential for healing between the cuff tendon and the underlying bone.

Materials and Methods: Seven fresh-frozen cadaveric shoulders (mean age 49±7 years, range 36-59) were used with a single axis testing machine in this study. The rotator cuff complexes were kept moist with saline solution and tested at room temperature with a crosshead speed of 0.5 mm/sec and an initial preload of 5 N. A custom sinusoidal tendon clamp was used to grasp 30 mm of the supraspinatus-infraspinatus tendon starting at the anterior edge of supraspinatus adjacent to the long head of the biceps tendon and continuing into the anterior portion of the infraspinatus, leaving the attachments of the subscapularis and infraspinatus continuous with the attachment of the supraspinatus. Cyclic creep and permanent elongation were evaluated in Intact, Deficient, and Reconstructed. The deficient cut was made 3cm from the proximal end encompassing 30% of the tendon. The reconstruction was a triple row rotator cuff repair. Over the three conditions cyclic loading was applied at 0.5 mm/s from 20 N to 100 N for 100 cycles to calculate creep, also a 5 N preload was applied (n=5) before and after cyclic loading to determine elongation, with 40 minutes relaxation time in between each load trial. Finally, a load to failure was performed on the reconstructed tendon at 1.25 mm/s. The proximal row of two anchors was placed at the anatomic neck of the humerus. The anchors were placed 2cm from each other. Each of two ends of the continuous suture from each anchor were then passed through the rotator cuff in a mattress fashion with a tissue bite of 8 mm, and two millimeters apart from the conjointing suture. Three anchors were then placed at the lateral aspect of the anatomic footprint as a middle row, almost covering the entire width of tendon laceration. One limb of the continuous suture strand was passed four millimeters from the lateral edge of the torn tendon in a simple fashion. Lateral simple sutures were then tied with an arthroscopic Nicky’s knot. As a third row, two additional holes were drilled 1 cm distal to the lateral edge of the footprint where distanced 1cm apart in the anterior-posterior direction. One suture end from a proximal anchor was then joined with one suture end from a distal anchor and secured using a Reef knot. Once the knot is secure, it is slid into the distal anchor and the remaining suture is drawn taught. The two remaining suture ends are then tied together using a Revo knot with the proximal suture strand acting as the post.

Results: Triple row repair provided a high ultimate strength (1185N±435) and high linear stiffness (168±59N/mm) with small amounts of cyclic creep (p<0.05) and permanent elongation.

Discussion: Cyclic and load-to-failure testing of the intact, injured, triple row repaired rotator cuff were performed to determine their cyclic behavior and structural properties. Small amounts of cyclic creep and permanent elongation were found for all states, even for the injured state. The cyclic loading of the injured tendon produced a characteristic U-shaped tear which has been described in the literature. The failure loads for triple row technique are comparable to those in other fixation studies. The ultimate strength of the triple row technique was reached high to 1200N. This is quite noticeable because former our study with same study design showed ultimate strength of double row just exceed 800N, which estimate two third of strength that our new technique could generate. These results might be explained because of the uniquely strong bone quality for insertion site for 3rd row, result in masking the weak mechanical strength that might encounter with middle row that usually is positioned on great tubercle, representing osteoporotic bed. In summary, the characteristic U-shaped tear confirms clinically observed scenarios which may be caused by overuse after a RC injury has been sustained. The small amount of cyclic creep, permanent deformation and high ultimate strength in the triple row repairs suggest that initial rehabilitation could be prescribed after surgery without compromising the initial stability of the repair.