Abstract Introduction
Patellar tendon ruptures are injuries caused by the forced flexion of the knee against eccentric loading. These injuries occur most commonly in patients younger than 40 years of age. Avulsion of the tendon from the distal pole of the patella is the most common finding at the time of surgery, however the tendon can be disrupted throughout the midsubstance or at the insertion of the tendon on the tibial tubercle. Surgical repair is indicated to restore the extensor mechanism of the knee. Although many techniques have been described for patellar tendon repair, classically, distal pole patellar tendon ruptures are repaired using two non-absorbable running locking stitches tied through longitudinal patellar drill holes. Post-operatively, the patient is then immobilized in knee extension for at least 6 weeks.

Numerous reports exist discussing different methods of repair of patellar tendon ruptures. These reports tend to be small numbers of cases describing a new or modified surgical technique. Mersilene tape, Dacron graft, Dall-Miles cables, and harvested semitendinosis and/or hamstrings tendon have been used, however, a paucity of biomechanical data on patellar tendon repair strength exists in the literature. In a recent literature review, one study examined the biomechanical properties of the standard patellar tendon repair, augmentation with non-absorbable suture, and augmentation with a 2.0 Dall-Miles cable. While this study did show the benefit of augmentation, it does not test our preferred method of augmentation, hamstrings autograft.

The use of semitendinosis for augmentation of patellar tendon rupture was first described by Kelikian et al., in 1957. It is a suitable graft because it is strong, native tissue, does not require an additional surgery for removal, and allows for immediate mobilization post-operatively.

The purpose of this experiment is to evaluate the biomechanical properties of patellar tendon rupture repaired using augmentation with hamstrings autograft compared to standard suture repair when an active rehabilitation protocol is initiated.

Materials and Methods
This study was approved by the State University of New York at Buffalo institutional review board. Cadaveric knees were utilized. Skin and subcutaneous tissues were removed. Nylon webbing was sutured into the quadriceps, and connected in series via a steel cable to a servohydraulic actuator (MTS model 858). The femur and tibia had into the quadriceps, and connected in series via a steel cable to a servohydraulic actuator. A defect was created in the patellar tendon by transversely cutting the tendon 3mm distal to the inferior pole of the patella. The knees were then placed on the MTS machine via a custom jig. A 5-lb. weight was attached to the tibial rod 33 cm distal to the medial femoral epicondyle. One specimen was then taken through 1 cycle to obtain displacement parameters for cycling. Using the displacement criteria obtained from one cycle, the repair was then taken through 250 cycles at 0.25Hz. Displacement was measured continuously, and analyzed after 10, 100, and 250 cycles.

Results
Eight cadaveric knees were tested (Four in each study groups). A paired student’s t test was used to compare gap formation. After one cycle there was a significant difference between the augmented repair (3.62mm +/-0.94) and standard repair (8.91mm +/-2.42). (p<.05) There were also significant differences between the augmented repair and standard repair at 10 (4.57mm +/-0.76 vs. 10.45mm +/-2.03) and 100 (6.46mm +/-0.58 vs.12.09mm +/-1.68) cycles. (p<.05) Upon completion of 250 cycles, which is used to simulate a standard active rehabilitation protocol, there was a significant difference between the augmented (7.26mm +/-0.88) and standard repair as well (13.24mm +/-1.93).

Discussion
This study shows that augmentation of a patellar tendon repair with hamstrings autograft decreases gap formation at the repair site after cyclic loading up to 250 cycles. The hamstring autograft is tensioned in place with the knee at 90 degrees, after the primary repair has been secured at 30 degrees. This allows the hamstrings grafts to function as a fixed loop, and unload the patellar tendon while in greater degrees of flexion. Similarly, Dall-Miles cables or external wire fixation have been used successfully as this fixed loop, however both often require later surgical removal. A repair augmented with hamstrings, a native tissue, does not require later removal. Additionally, studies have shown that harvesting the medial hamstrings leaves little functional deficit.

Gap formation is frequently used as a measure of integrity of tendon repair. Larger tendons of the body may have a greater tolerance for gap formation at the repair site. A study on Achilles’ tendon repair showed that patients with significant gap formation at 12 weeks post-operative (11.5mm) recovered 89 percent of plantarflexion strength when compared to their unaffected limb. With regards to patellar tendon repair, due to a paucity of data, the significance of sizeable gap formation remains unclear.

This data illustrates that augmentation of patellar tendon repair decreases gap formation at the repair site after cyclic loading. Patients with poor tissue, or those that are prone to stiffness are those that may benefit the most from augmentation. From our data, it can be concluded that a repair augmented with the hamstrings is better able to sustain an early motion protocol. Clinically, we have found augmented repairs to perform quite well, and allow for early rehabilitation. We cannot advocate the use of early motion protocols in patellar tendon repairs performed in the standard fashion.

References
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