INTRODUCTION: Immediate mobilization of repaired tendons has beneficial effects on the functional outcome of the repair, in both experimental animals and clinical studies. Therefore, many techniques for improving the strength of the tendon repair have been reported. The Teno Fix™ system (TFS) has been devised to improve initial flexor tendon repair strength and reproducibility without having to resort to complex suturing techniques that are difficult to use clinically. We wished to compare the biomechanical characteristics of TFS repair with standard modified Kessler type suture repairs.

MATERIAL AND METHODS: We compared TFS with modified Kessler suture (MKS) and double modified Kessler core suture (DMKS) in 27 cadaver profundus tendons. The FDP tendons were surgically exposed between the A2 and A3 pulleys in index, middle and ring finger. There were three groups of tendon repairs. 1: TFS with peripheral suture. The TFS consists of a tendon fixation device which has a corkscrew-shaped steel coil around metal core placed in each tendon end, and a stainless steel cable with a crimped metal beads on either side provides co-option of the lacerated tendon ends. 2: MKS with 4-0 Nylon. 3: DMKS with 3-0 Ticron. For the peripheral suture, 6-0 polypropylene was used. We randomized each repair group so they were performed on 3 index, 3 middle and 3 ring fingers.

Preparation: The plate, which held the specimen, was mounted on the main load cell of the MTS (Bionix 858 Material Test System, MTS, Eden Prairie, MN). The wire cables from the extensor digitorum tendons of the index, middle and ring fingers were attached to a single 450g counterweight via the backside pulleys to achieve and maintain full finger extension of all three digits in the resting condition. The wire cables from the FDP tendons were individually attached to the linear variable differential transformer (LVDT) via the front side pulley and were advanced at a rate of 50 cm/min, simulating active finger flexion motion following Aoki's method.

The work of flexion and maximum force: Each finger was displaced from full extension to palmar touch, while displacement and tensile tendon force were recorded. To standardize work of flexion measurements among specimens, we defined the start and end points of displacement to establish a constant testing interval. The testing interval began when the force reached 1N and ended when the excursion reached 50 mm. Using the testing interval, the standardized work of flexion was calculated as the area under the force-displacement curve before (Control) and after repair (Repair). The maximum force was defined as the force at the end point of the determined displacement interval.

The work of pinch: The 25 Lb load cell was positioned in the path of the pinch motion of each finger-tip such that they just made contact (i.e. no force was generated). Then the tendon was pulled in tension by the LVDT, thereby flexing the finger until a force of 3.5N was generated at the fingertip. At this point, the three joints on each finger (MP, PIP, and DIP) were measured to validate if predetermined characteristic angles of 15°, 70° and 30° (± 5°), were attained in these joints. If not, the position of the load cell was adjusted. We defined the start point as 0 N tip force and the endpoint as the point when 3.5 N was measured at the load cell. To determine the increase in the work of flexion (%), maximum force (%), and work of pinch (%), we compared the control and repair values using the following formula: Increased values (%)=(Repair - Control) ×100 / Control

The strength and stiffness of tendon repair: The strength of tendon repairs was tested by load to failure after the above protocols were performed on the repaired tendons following the method established by Lotz et al. Each repaired tendon was harvested and fixed with a special tendon clamp and mounted onto the MTS. The specimens were loaded in tension at a constant displacement rate of 0.33 mm/second until failure. The applied load was measured using the main load cell of the MTS. The specimen deformation was defined as the grip travel, which was determined using the LVDT. The failure load was measured as the peak load (N) of the load-displacement curve and the stiffness of the repair was determined as the slope of the most linear portion of the load-deflection curve (N/mm).

RESULTS: There was a statistically significant difference between the DMKS and the TFS (p=0.001). There was also a statistically significant difference between that of the MKS and the TFS (p=0.005). However there was no statistically significant difference between the TFS and the DMKS (p=0.024). There was also a statistically significant difference between the stiffness of the MKS and the DMKS (p=0.024). There was also a statistically significant difference between the MKS and the TFS (p=0.001). However there was no statistically significant difference between that of TFS and the DMKS (p=0.120).

DISCUSSION: The work of flexion was initially proposed by Lane et al. as a mechanical measurement of tendon gliding; it represents the summation of force necessary to move the tendon along its displacement, and is related to friction. Aoki et al. showed the usefulness of work of flexion measurements to evaluate tendon gliding. They found that work of flexion increased in direct proportion to the amount of suture material within the repair site. We found a statistically significant difference between the 4-strand DMKS and the 2-strand MKS, with the work of flexion being increased in the 4-strand repair, following the patterns previously established. In our study, there was no statistically significant difference between TFS and either of the two modified Kessler type suture repairs we employed. These results indicate that the effect of a corkscrew-shaped steel coil of the TFS on friction increase was similar to that of the conventional suture repairs. The correlation between the number of strands and tendon repair strength has been previously established. In this study, the TFS and 4 strand DMKS with 3-0 Ticron offers favorable load to failure and stiffness compared to conventional 2 strand suture techniques. This study established that TFS and 4 strand DMKS are attractive alternatives for flexor tendon repairs. Based on our data, we feel that TFS repair and 4 strand DMKS can withstand early active mobilization to prevent rehabilitation adhesions after operation, and potentially improve the repair strength and excursion during the post operative period.