Introduction
Adhesion formation is a serious problem affecting the outcome of finger function after flexor tendon repair. Rehabilitation performed immediately after repair prevents adhesion formation by moving the repaired tendon within its sheath. In order to move the finger, sufficient force must be applied to the tendon to overcome the gliding resistance between tendon and sheath as well as the forces to move the joints, finger inertias, and any external load (external resistance). Combined, these forces make up the work of flexion (WOF) which has been experimentally used to evaluate finger function. However, this method fails to partition the work between gliding resistance and other sources, making it difficult to identify the source of any limitation observed. Factors such as joint stiffness and the mechanical moment arm of the tendon across the joint will influence the readings, so that the precise effect of adhesions on gliding characteristics cannot be assessed. Distinguishing the different components of the WOF would aid in understanding causes of reduced finger flexion following tendon injury and repair. In this study, we describe a method that is capable of simultaneously measuring both WOF and the resistance between tendon and flexor sheath.

Materials and Methods
The testing device consists of a testing frame, actuator, linear potentiometer, and two load transducers (Figure 1). The frame holds the digit to be tested by placing a K-wire through the metacarpal bone. The distal end (attachment) of the flexor digitorum profundus (FDP) tendon is exposed and one third of the distal phalanx is transected. A small load transducer (BG-1000G, Kulite Semiconductor Products, Inc, Leonia, NJ) is fixed to the remaining distal phalanx with a screw. The distal end of the FDP tendon is divided from its sheath. In order to move the finger, sufficient force must be applied to the tendon to overcome the gliding resistance between tendon and sheath as well as the forces to move the joints, finger inertias, and any external load (external resistance). Combined, these forces make up the work of flexion (WOF) which has been experimentally used to evaluate finger function. However, this method fails to partition the work between gliding resistance and other sources, making it difficult to identify the source of any limitation observed. Factors such as joint stiffness and the mechanical moment arm of the tendon across the joint will influence the readings, so that the precise effect of adhesions on gliding characteristics cannot be assessed. Distinguishing the different components of the WOF would aid in understanding causes of reduced finger flexion following tendon injury and repair. In this study, we describe a method that is capable of simultaneously measuring both WOF and the resistance between tendon and flexor sheath.

Results
During tendon flexion the gliding resistance between the tendon and sheath causes Fp to always be larger than Fd. The Fp curve represents the force necessary to flex the digit and thus the area under this curve represents the total work of flexion (WOF), including the work used to raise the 1.96 N weight and the digit weight. The area under the Fd curve represents the work expended by the resistance between tendon and sheath (Figures 2 and 3).

For Specimen 1, in the intact state roughly 10% of the WOF is expended by the resistance between tendon and sheath (Figure 2A). After repair with the modified Kessler suture, the total WOF increased 24% while the gliding resistance increased 274% (Figure 2B). The gliding resistance comprised 31% of the new WOF. This one set of figures clearly demonstrates the relationship between gliding resistance and WOF, and shows why WOF is a relatively insensitive measure if one is specifically concerned with tendon gliding after tendon repair.

After saline injection to simulate joint stiffness (Figure 2C), the total WOF increased 33% compared to non-injection. In contrast to Figure 2B, the effect was minimal for gliding resistance (7.7% increase). This shows that there can be a differential effect on WOF by factors such as edema or joint stiffness that can significantly increase the WOF, even when tendon gliding itself is relatively unimpaired. Analysis of Specimen 2, in which the high friction Becker suture was performed, showed a substantially larger increase in