Opponensplasty: A Biomechanical Study Quantifying Work of Thumb Opposition

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BACKGROUND

- Thumb opposition is a complex function important for pinch and grasp.
- Loss of thumb opposition can be compensated with the use of tendon transfers.
- The purpose of this biomechanical study was to fully quantify the forces required for thumb opposition utilizing the four commonly used tendon transfers.

METHODS

- Five fresh-frozen cadaveric arms were used to quantify the forces required for thumb opposition from neutral to the middle finger utilizing a portable Instron apparatus (Fig 1).
- The four tendon transfers performed were the: Flexor Digitorum Sublimis (FDS)/Bunnell transfer; Abductor Digiti Minimi (ADM)/Huber transfer; Extensor Indicis Proprius (EIP); Palmaris longus (PL)/Camitz procedure (Fig 2 A-D).
- Each arm underwent the four tendon transfers and the average force curves of thumb opposition in relation to displacement were generated (Fig 3).
- The work of opposition, stiffness, and maximal force produced for each tendon transfer was averaged between the five arms (Table 1).

RESULTS

- EIP opponensplasty required the greatest amount of work to achieve the desired opposition in four of the five arms ($P<0.005$).
- In one of the five arms ADM/Huber transfer required the most work for opposition. This was an anomaly and experimental error is suspected ($p<0.006$).
- There were no differences in work of thumb opposition between the PL and FDS transfers in all of the arms.
- Further, in four of the five arms the EIP opponensplasty had the greatest stiffness of all the tendon transfers. ($p<0.0024$).

CONCLUSIONS

- EIP tendon transfer for opposition is the least efficient as this required the most amount of work and force per unit of motion at any point through thumb opposition.
- The work of flexion was linear throughout the range of motion for opposition.

Figure 1. Instron Apparatus

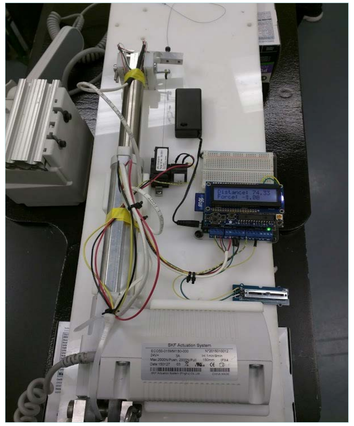

Figure 2. FDS (A), ADM (B), EIP (C), and PL (D) Tendon Transfers

Figure 3. Force and Displacement of Tendon Transfers in Arm 1

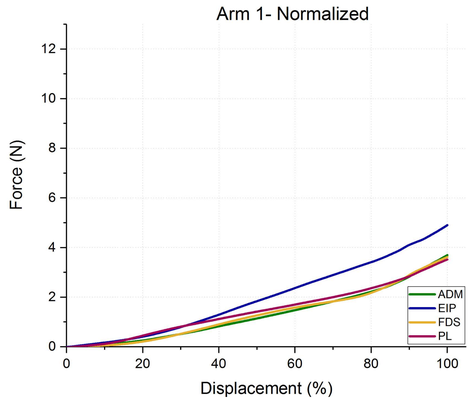

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Table 1. Opponensplasty Biomechanical Data Averages

Tendon Transfer	Work (J)	Stiffness (N/m)	Max (N)
FDS/Bunnell	0.0942	153.5102	6.9224
ADM/Huber	0.0868	158.9160	6.4394
EIP	0.1530	226.8680	8.7224
PL/Camitz	0.0932	147.1788	7.4488