Introduction:

A sophisticated interaction of intrinsic and extrinsic muscles as well as its tendons, crossing several joints, provide coordinated and precise finger movements. Further, there is a linkage of the interphalangeal joints by the intrinsic muscles and the oblique retinacular ligament. By this, fusion of one finger joint will affect the function of the adjacent joints in the same finger. As the ulnar fingers share a common deep flexor muscle (DFP) belly, connected partially to the index finger’s DFP, there is additionally a coupling between adjacent fingers during gripping (quadriga effect). Consecutively, fusion of one finger joint can compromise the function of the other three fingers. Former studies investigated healthy subjects, mimicking stiffness of one or more finger joints with splints, neglecting the effect of muscular adaption and shortening of a finger by joint resection. To overcome these limitations, our study investigates in vivo if an isolated fusion of a single DIP joint influences grip force and the load distribution of the whole hand when gripping cylindrical objects using manugraphy.

Methods:

Ten patients, who had one single DIP-joint fused due to posttraumatic joint destruction, but without other structural lesions of the hands, were included in this study. On average 55 (17 - 121) months postoperatively, patients returned for a manugraphy analysis (Fig. 1). Patients performed grip force tests, using three cylinders covered with a pressure sensor matrix and with 100, 150 and 200 mm circumference to measure the total grip force and the load distribution pattern of both hands. The grip force and the load applied by each of the four fingers were compared for the affected and the healthy hand. Due to the small number of patients, only descriptive statistics were provided.

Results:

Two patients had the index finger involved; both omitted the affected finger during gripping evidently (Fig. 2). Their total grip force was 57%, 62% and 60% of the healthy opposite side, for the small, middle and large cylinder respectively (Fig. 3).

Eight patients had a fusion of the middle finger DIP. All of them had an apparent load peak at the finger tip III (Fig. 4) while using the 150mm cylinder, six patients had such load peaks additionally on at least a second cylinder size. Their total grip force was 94%, 101% and 94% compared to the healthy side. If the dominant hand was affected, the hand was even stronger than the healthy, non-dominant hand.

Analyzing the load applied exclusively by each finger, there was a different pattern apparent for the DIP joint II and DIP joint III fusions: the operated index finger showed a considerable force loss, but also the other fingers were weaker than those of the healthy side (Fig. 6). Patients with a DIP joint fusion of the middle finger applied considerable less force with the middle and ring finger, but the index and small finger performed with the same or even higher finger force compared to the healthy side (Fig. 7).

Conclusion:

Although this study investigated a small study group, DIP joint fusion of the index finger seems to affect the total grip force more than DIP joint fusions of the middle finger. This confirms the results of some previous experimental studies and might be contributed to the “Quadriga-effect” of the finger flexors (Horton et al.: “The Effect Of Flexor Digitorum Profundus Quadriga On Grip Strength”, JHS, Europ. Volume 2007, 32E: 2: 130-134).

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