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ORIGINAL PAPER
PŮVODNÍ PRÁCE

Is Extensor Indicis Proprius Tendon Transfer an Innocent Surgical Procedure for the Restoration of Extensor Pollicis Longus Function?

Je přenos šlachy *extensor indicis proprius* nevinným chirurgickým zákrokem pro obnovení funkce *extensor pollicis longus*?

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ABSTRACT

PURPOSE OF THE STUDY

The aim of this study to evaluate the subjective and objective results of Extensor indicis proprius (EIP) to extensor pollicis longus (EPL) transfer with an emphasis on donor site morbidity.

MATERIAL AND METHODS

17 patients (59% men, 41% women) who underwent EIP-EPL transfer were retrospectively analyzed. The mean age was 43 (9–64) years, and the mean follow-up was 72 (19–124) months. The extensor strengths were measured according to the Medical Research Council (MRC) scoring system. Nail tip-table surface distance (NTD) was measured to evaluate extension loss, and pulp-palm distance (PPD) to evaluate thumb flexion-adduction limitation. Grip and key pinch strengths were measured and corrected regarding the dominance and compared with those of the non-operated side. Quick Disability of Arm, Shoulder, and Hand (QDASH) and satisfaction scores of the patients were evaluated.

RESULTS

Donor site morbidity was detected in 6 patients (35%). The extension strength of the index finger was found to be significantly lower than the non-operative side ($p<0.05$). Thumb mean NTD and PPD values were 6.8 (0–50) and 2.9 (0–20) mm, respectively. The index finger mean NTD was 0.6 (0–10) mm. The grip strength was 86% (43%–100%) and the pinch strength was 82% (31–100%) of the expected strengths. Compared to the preoperative period, there was a significant decrease in the QDASH score ($p <0.05$). Postoperative QDASH scores of patients with donor site morbidity were significantly higher than those without ($p <0.05$).

CONCLUSIONS

Although patients are generally satisfied with the EIP-EPL transfer results, the permanent morbidity rate in the index finger is high. Therefore, alternatives other than EIP should be considered for transfer to EPL in individuals whose occupation requires complete and strong index finger extension.

Key words: extensor pollicis longus, neglected tendon laceration, extensor indicis proprius, tendon transfer, donor site morbidity.

INTRODUCTION

The extensor pollicis longus tendon passes through the dorsal third extensor compartment at the level of the wrist and extends the interphalangeal and metacarpophalangeal joints of the thumb (14, 16, 18). It also contributes to thumb adduction from the carpometacarpal joint, as it rotates towards the thumb at the level of Lister's tubercle with an angle of 45 degrees (14, 18). Neglected loss of its function is encountered after tendon ruptures or unrepaired acute lacerations. Old distal radius fractures, osteoarthritis, rheumatoid arthritis, and inappropriate local steroid injection may lead to tendon rupture (16. 18).

Tendon lacerations or acute ruptures could be repaired primarily or by tendon grafting (2, 16). But in ruptures associated with degenerative processes and in neglected cases tendon transfer is preferred (10, 16, 21). Although many tendons have been used for the transfer (2, 4 7); the most commonly used and almost the gold standard is the use of the extensor indicis proprius (EIP) tendon (10, 11). Because EIP's fiber length, physiological cross-sectional area and tensile direction are similar to EPL (7, 8, 12, 18). In this study, we aimed to evaluate the long-term subjective and objective results of the EIP tendon transfer in neglected EPL lacerations and ruptures with emphasis on the problems associated with the donor site morbidity.

MATERIAL AND METHODS

Study group

The collection of patients' data for the study was done after obtaining institutional clinical research ethics committee approval (Decision number: 2019/354). Patients who underwent EIP-EPL tendon transfer due to EPL tendon injury between June 2009 and March 2018 were reviewed retrospectively. Patients with a follow-up period of less than 18 months, who did not attend regular follow-ups, who did not want to participate in the study, and who underwent revision surgery were excluded from the study. As a result, 17 patients (10 men, 7 women) were included in the study. All patients were informed about the purpose of the study according to the principles of the Declaration of Helsinki and gave their verbal consent to participate in the study.

Surgical technique

The surgeries were performed under regional or general anesthesia with the classical method (22). A transverse incision was made just proximal to the level of the second metacarpophalangeal (MCP) joint. The EIP tendon was exposed on the ulnar side of the extensor digitorum communis tendon of the index finger (EDC-2). It was cut proximal to the extensor hood. After dissection from the surrounding soft tissues, the EIP tendon was pulled to a second transverse incision at the wrist level. A third longitudinal incision was made at the level of the thumb MCP joint. The EIP tendon was brought subcutaneously from the wrist level to this third incision. With the wrist in 30 degrees of extension and the thumb in full extension, it was sutured to the EPL tendon by the Pulvertaft method at appropriate tension (22). The distal stump of the EIP tendon was sutured to the EDC-2 tendon (12, 18, 21).

Evaluated parameters

Index finger and thumb extension strengths of the patients were measured by three researchers according to the Medical Research Council (MRC) scoring system and their averages were recorded.

The extension lag level in the fingers was evaluated by measuring the nail tip-table surface distance (NTD). In this measurement, the patient was asked to try to touch the nail tip of the index and thumb to the table while the elbow was in 90° flexion, the wrist and hand were in full supination, and in contact with the table surface. The distance between the nail tip and the table surface in the fingers that could not make full contact with the table surface was measured in millimeters.

The pulp-palm distance (PPD) was measured in millimeters to evaluate flexion-adduction of the thumb and flexion of the index finger (8).

Grip and pinch strengths were measured in pounds (lbs) in both hands. Grip force was measured with Jamar dynamometer (Jamar® Baseline Evaluation Ins, hydraulic hand dynamometer). Pinch force was measured with pinchmeter (Waldemar Link GmbH & Co, NY, USA) in the key holding position. Expected grip and pinch forces were calculated. In this calculation, the difference in grip strength between dominant and non-dominant hands was taken into account, as suggested by Peterson et al. (19). According to this method, the expected strength of the right hand is calculated by adding 10% to the strength of the left hand in those who are right-handed and operated on their right hand. For those who are right-handed and operated on the left hand, the expected strength of the left hand is calculated by reducing the strength of the right hand by 10%. In patients with left-handed predominance, the expected strengths of both hands are considered to be equal (19). In this study, after calculating the expected strength of the operated side using the method described above, the measured force was proportioned to the expected force to calculate the percentage of achieving the expected strength as a result of the treatment.

Satisfaction and QDASH scores of the patients were evaluated. For the satisfaction score, the patients were asked to score from 0 (not at all satisfied) to 10 (very satisfied). The patients were asked to fill out a QDASH questionnaire consisting of 11 questions indicating their pre- and post-operative status.

Statistical analysis

The data was analyzed using SPSS software (ver. 25.0; IBM Corp., Armonk, NY, USA). To assess the normality of the data distribution, skewness and kurtosis values were utilized as statistical measures. These measures provided valuable insights into the symmetry of the data distribution, enabling us to determine whether the data adhered to a normal distribution. Categorical variables were compared using the Pearson chi-squared test, while an independent sample T-test was employed to compare parametric variables. We utilized the Pearson correlation test to evaluate the relationship between variables. Quantitative variables were presented as the mean ± standard deviation, and qualitative variables were expressed as numbers (n), frequencies, or ratios. Statistical significance was considered for p-values less than 0.05.

RESULTS

The mean age of the patients was 43 (min: 9, max: 64) years. The mean time between injury and surgery was 10 (min: 1, max: 97) months. The mean follow-up period was 72 (min: 19, max: 124) months. Eleven of the patients had closed EPL rupture. The remaining 6 had neglected traumatic lacerations. All patients were right dominant. Eleven patients were operated on the left hand and 6 on the right hand. In the postoperative period, infection, wound complication, and recurrence were not observed in any of the patients.

The index finger extension strength was found to be significantly decreased on the operated side compared to the normal side ($p<0.05$). Regarding the MRC system, this strength was 5/5 in 11 (64.7%), 4/5 in 5 (29.4%) and 3/5 in one (5.9%) patient. Two patients

stated that they were uncomfortable due to this loss of extension strength. Thumb IP joint extension strength was found to be 5/5 in 14 (82.3%), 4/5 in 2 (11.8%) and 0/5 in one (5.9%) patient.

Although one patient had 10 mm extension lag of index finger, independent active extension of the index finger was preserved in all patients. The mean NTD in the index fingers was 0.6 mm (min: 0, max: 10). There was no postoperative index finger flexion insufficiency in any of the patients. The PPD of this finger was zero in all patients.

The mean NTD of the thumb was 6.8 mm (min: 0, max: 50) and the mean PPD value was 2.9 mm (min: 0, max: 20). Active thumb IP joint extension was adequate in 14 patients (82.3%). The NTD in patients with thumb IP extension strength less that 5/5 were increased. It was 30 mm in two patients with 4/5 strength and 50 mm in one patient with 0/5 strength.

The mean grip strength of the operated hands reached 86% (43–100%) of the predicted strength, and the pinch strength reached 82% (31–100%) of the expected strength.

Preoperative and postoperative QDASH scores were 22.84±14.92 and 9.43±12.36, respectively. There was a significant decrease in this score compared to the preoperative ($p<0.05$). The mean satisfaction score from the surgery was 8.9 out of 10.

Six patients had donor site morbidity (loss of strength in 5 patients, both loss of strength and extension lag in 1 patient). Satisfaction scores were found to be lower in these patients with donor site morbidity (7.0±4.69) than those without (9.91±0.302), but there was no statistically significant difference (p: 0.052, r: -0.478). Postoperative QDASH scores of patients with donor site morbidity (19.92 ± 14.65) were found to be significantly higher than those without (3.72 ± 5.95) (p: 0.005, r: 645). The presence of donor site morbidity was significantly higher in female patients than in males (p: 0.006).

DISCUSSION

Primary repair is usually not possible in neglected EPL lacerations or ruptures. Tendon grafting is not preferred in these patients because of the avascularity of the graft and the need for two repair lines (2, 18, 21). For these reasons, reconstruction with tendon transfer is preferred. The most preferred procedure is EIP tendon transfer (10, 11, 20, 21). Although the common opinion is that after EIP-EPL transfer index finger weakness does not develop and independent extension is not restricted, there is no definite consensus on this issue. There are also reports on development of weakness and extension lag in the index finger after this transfer (2, 18, 21). In this study, we aimed to investigate the results of this transfer and the morbidity of the donor site in patients who have undergone sufficient time from their surgery.

In studies dealing with donor site morbidity, it has been emphasized that 30–50% of patients may develop a loss of extension strength in the index finger, and this loss may affect daily functions in up to 20% of patients (12, 14, 15, 17). On the other hand, Pillukat et al. reported that independent extension of the index finger was preserved in all patients in their case series (20). In accordance with the literature, in the patients included in this study, independent active extension of the index finger was preserved. However, 35% of the patients had loss of extension strength in the index finger. The postoperative QDASH scores of these patients who had donor site morbidity were also found to be significantly higher. Because of these results, we concluded that donor site problems may be significant after EIP transfer. Therefore, the patients should be informed about the possible morbidities. Alternatives other than EIP should be offered to patients who do not want to develop weakness in their index fingers or who need to have full and strong extension of this finger occupationally, such as musicians.

Successful restorations of the functions of the EPL tendon have been reported after the transfer of alternative tendons such as extensor pollicis brevis, abductor pollicis longus (APL), accessory APL, brachioradialis, extensor digiti minimi, extensor carpi radialis brevis (ECRB) and longus (ECRL) (2, 3, 4, 5, 7). Chitnis et al. reported satisfactory results after APL-EPL transfer and that thumb abduction was not affected (3). Similar satisfactory results have been reported after accessory APL-EPL transfer (2). Cui et al. reported good and excellent results in all patients after ECRB-EPL tendon

Table 1. Intraoperative wrist and thumb positions for the adjustment of transfer tension in studies on extensor indicis proprius to extensor pollicis longus transfer and their postoperative results regarding extension and flexion deficit levels of the thumb

Author/s	Position of the wrist	Position of the thumb	Mean thumb extension lag	Mean thumb flexion deficit
Magnussen et al. (14)	50 degree extension	full extension	14 mm	6 mm
Lemmen et al. (12)	50 degree extension	full extension	24 mm	7 degrees
Jung et al. (8)	neutral position	full extension	10 mm	15 mm
Jung et al. (8)	30 degree flexion	full extension	20 mm	10 mm
Kamoi et al. (10)	neutral position	2.0 cm elevated from the surgical table	12 mm	4 degrees
Present study	30 degree extension	full extension	6.8 mm	2.9 mm

transfer and that wrist motion and strength loss did not develop (4). Justan et al. reported that after ECRL-EPL tendon transfer, thumb interphalangeal joint extension lag developed, which had a slight effect on the patient's hand functions, and that the extension difference between the operated and the contralateral wrist was the same as in the preoperative period (9). To achieve full and strong extension for the index finger other tendon transfers such as APL, accessory APL, extensor pollicis brevis, extensor digiti minimi, ECRL and ECRB may be considered as a suitable alternative surgical method to the EIP-EPL tendon transfer (2, 3, 4, 5, 7, 9).

The most important factor in obtaining satisfactory thumb functions in EIP-EPL tendon transfer is to provide appropriate muscle-tendon tension during surgery (10 11, 13, 16). If tendon tension be low it leads to extension lag of the thumb. If tension be high, thumb flexion would be restricted (13). Many positions have been suggested for the wrist and thumb to adjust the appropriate tension (8, 11, 21). Low et al. In their cadaver study found that the optimal tension was obtained when the thumb was in full extension and the wrist in the neutral position (13). In different studies the extension deficit of the thumb has been reported to change between 10 to 24 mm, and the flexion deficit between 6 to 15 mm after EIP-EPL transfer (Table 1). In general, it has been stated that these results do not cause functional loss in patients (8, 10, 12, 14, 17). In our study, the elevation deficit was 6.8 mm and the flexion deficit was 2.9 mm. We too found that the patients were satisfactory with the results of the surgery in relation with the restoration of thumb functions.

In addition to the intra-operative position of the thumb and wrist, the amount of tension of the EIP muscle and the safe repair technique are also effective on the results of EIP-EPL tendon transfer. Recently, tendon transfer with the wide-awake local anesthesia no tourniquet (WALANT) method has become popular. Proponents state that this technique provides the control of tendon tension with active movements during the surgery (1, 6). In a study comparing traditional and WALANT techniques, better results regarding the range of motion of the thumb joints were reported in WALANT group (6). We did not use the WALANT technique in the patients included in this study. Our experience with WALANT in our subsequent patients suggested that this technique is very useful in adjusting the tension of the transferred muscle-tendon unit.

In this study, the pulp-palm distance, a method previously defined in the literature, was measured to evaluate index finger flexion and thumb flexion and adduction (8). To evaluate the extension adequacy of these two fingers, we measured the nail tip-table surface distance. This measurement technique facilitated the assessment of fingers' extension. We think that this method is appropriate for the evaluation of the thumb retroverting function of the EPL, which consists of extension and adduction components.

The strength of this study is the length of the follow-up period, while the weakness is the small number of patients. This small number can significantly influence the statistical analysis. Increasing the number of participants would enhance the study's power, enabling the detection of smaller effects and providing more reliable conclusions.

CONCLUSIONS

The transfer of the EIP tendon for restoration of EPL functions is not a completely innocent operation. Although patients are especially satisfied with the restored function of the thumb, the possibility of permanent morbidity in index finger as the donor site is not low. For patients who requiere full and strong extension of the index finger is indispensable, alternative tendon transfers such as APL, accessory APL, extensor pollicis brevis, extensor digiti minimi, ECRL and ECRB should be considered as viable surgical methods to the EIP-EPL tendon transfer.

Ethical approval

Ethics committee approval was received for this study from the Clinical Research. Ethics Committee of Mersin University, Turkey (Decision number: 2019/354).

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