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The benefit of early rehabilitation following tendon repair of the hand: A population-based claims database analysis

Pei-Chi Hsiao MD [a,b], Shu-Yu Yang OT [a], Chung-Han Ho PhD [c,d], Willy Chou MD [a,b], Shiang-Ru Lu MD [e,*]

[a] Department of Physical Medicine and Rehabilitation, Chi-Mei Medical Center, No. 901, Zhonghua Road, Yongkang District, Tainan 71004, Taiwan, ROC
[b] Department of Recreation and Health Care Management, Chia Nan University of Pharmacy and Science, No. 60, Sec. 1, Erren Road, Rende District, Tainan 71710, Taiwan, ROC
[c] Department of Medical Research, Chi-Mei Medical Center, No. 901, Zhonghua Road, Yongkang District, Tainan 71004, Taiwan, ROC
[d] Department of Hospital and Health Care Administration, Chia Nan University of Pharmacy and Science, No. 60, Sec. 1, Erren Road, Rende District, Tainan 71710, Taiwan, ROC
[e] Department of Neurology, Kaohsiung Medical University Hospital, No. 100, Tzyou 1st Road, Sanmin District, Kaohsiung 80754, Taiwan, ROC

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ABSTRACT

Study design: A retrospective cohort.
Introduction: The benefits of early rehabilitation after hand tendon repair have not been analyzed using population-based datasets.
Purpose of the study: to analyze whether early rehabilitation reduces the resurgery risk and the use of rehabilitation resources.
Methods: Patients (n = 1219) who underwent hand tendon repairs followed by rehabilitation were identified from a nationwide claims database and divided into 3 groups: early (<1 wk after tendon repair), intermediate (1–6 wk), or late (>6 wk) rehabilitation. The resurgery rate and the use of rehabilitation resources after tendon repair were calculated. Cox proportional hazards models were used to evaluate the relevant predictors of resurgery.
Results: The early rehabilitation group exhibited the lowest resurgery rate and used the fewest rehabilitation resources. Compared with late rehabilitation, early or intermediate rehabilitation conferred protective effects against resurgery in patients without a concomitant upper-limb fracture.
Conclusion: Our findings suggest the benefit of early rehabilitation after hand tendon repair.
Level of evidence: 4

Introduction

Tendon injuries are the second most common hand injury type.[1] Most tendon injuries require surgical repair and rehabilitation to restore hand function, and represent considerable burdens to patients as well as to health care systems.[2–4] Advances in surgical technology and materials have improved the outcome of tendon repairs in the hand, but complications remain common. The rates of tendon rupture and tendon adhesion following flexor tendon repairs have been reported as 4%–10% and 4%–9%, respectively.[5–7] These circumstances require secondary repairs, such as tenolysis or tendon reconstruction using a graft or prosthesis.[8] The potential prognostic factors of tendon injuries in the hand include the mechanism and severity of the injury, the status of the injured finger and surrounding tissue, surgeon skill, patient age and motivation for treatment, and the postsurgical management.[8]

Although the mechanisms and sites of tendon injuries are the key prognostic factors, postsurgical rehabilitation improves the functions and outcomes following tendon repairs in the hand, and is an essential step in managing repaired tendons.[9,10] Several protocols have been developed, including immobilization, early passive motion, and early active motion.[11,12] These protocols usually allow gradual finger movement with orthosis protection, followed by a stepwise increase in resistance to facilitate tendon gliding. Their differences depend on how the injured tendons are approached in the earliest stages of healing.[13] For flexor tendons, motions begun 4–5 days after repair are classified as “early”; for extensor tendons, those begun after 0–4 days are classified as “immediate”, and after 5–10 days as “early.”[14] Immobilization protects the repair site at the cost of undesirable edema, scarring, and adhesion.[11] Early passive or active motion promotes tendon gliding and avoids adhesion, but carries the risk of early repair-site rupture.[15] Despite these concerns, several clinical studies have demonstrated the greatest benefits of early mobilization when they were initiated within 1 week after surgery,[13,16] and early

* Corresponding author. Tel.: +886 7 3121101x6838.
E-mail address: srlu@kmu.edu.tw (S.-R. Lu).

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rehabilitation has recently become the standard protocol for most repaired tendons. However, the benefits of early rehabilitation regarding health care resource usage have not been analyzed using population-based data sets.

Purpose of the study

We conducted an analysis based on a Taiwanese nationwide claims database to investigate the benefits of early rehabilitation in patients who received repairs for injured hand tendons. We determined whether early rehabilitation reduces the need for a secondary surgical intervention as well as the use of rehabilitation resources.

Methods

Data source

In 1995, Taiwan launched the government-run single-payer National Health Insurance (NHI) program that provides universal coverage and equal access to all health care services to Taiwanese citizens. As of 2000, 21,400,826 participants, or 96.06% of the Taiwan population, were enrolled.[17,18] The National Health Insurance Administration collects claims records covering all inpatient and outpatient services. The entire dataset is de-identified, encrypted, and transformed into the computerized National Health Insurance Research Database (NHIRD), which is maintained by National Health Research Institutes (NHRI).[19] The NHIRD includes patient's sex, date of birth, detailed medical expenditures, treatment and prescription records, medical institutions providing services, and diagnostic and procedure codes (up to 5 each) based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM).

We used a subset of the NHIRD, the Longitudinal Health Insurance Database 2000 (LHID2000), which is published by the NHRI for research purposes. The LHID2000 contains all medical claims data since 1997 for 1 million people who were randomly selected from the 2000 Registry for Beneficiaries of the NHIRD. The LHID2000 provides an acceptable statistical representation of the entire population of Taiwan; no significant differences existed in age and sex between the study cohort and the general population.[19]

Study sample and definitions

We searched the LHID2000 using the order codes of medical expenditure applications in the NHI claims data to identify patients with extensor or flexor tendon injuries of the hand from January 1, 2000 to December 31, 2009. Only those who had received hand tendon repairs followed by postoperative rehabilitation within 1 year were included. The postoperative rehabilitation was also defined using the records of medical expenditure applications.

During the study period, among the 6830 enrolled patients who underwent tendon repairs in the hand, only 1219 had hand rehabilitation within 1 year following the repairs. Because personal identification information in the LHID2000 is encrypted to secure the patient confidentiality and thereby preclude ethical violations and, therefore, this study was exempted from review by the Institutional Review Board of Chi-Mei Medical Center.

Variables of interest

The primary outcome measure was the resurgery rate within 2 years after hand tendon repair. The following order codes of medical expenditure applications were used to indicate resurgical procedures: capsulectomy of the digital joint; release of hand scar contracture; tendon graft; tendon transposition, transfer, or lengthening; tenolysis; volar plate arthroplasty; tendon prosthesis implant; and tenodesis. The secondary outcome measures included time to resurgery as well as the number of rehabilitation sessions, total expenditure for rehabilitation, and total rehabilitation time (i.e., the interval between the first and the last rehabilitation session) within 2 years after hand tendon repair.

To clarify the timing distribution of rehabilitation after tendon repair, we subdivided the patients into 3 groups: early rehabilitation (<1 wk), intermediate rehabilitation (1–6 wk), and late rehabilitation (>6 wk) after tendon repair. The period selection (<1 wk, 1–6 wk, and >6 wk) was based on the physiology of tendon healing, which could be divided into 3 overlapping phases: inflammation (0–5 d), fibroplasia (3 d–6 wk) and remodeling (6 wk–6 mo).[20] Possible confounding variables considered in this study included patient and hospital characteristics. The patient characteristics included sex, age (<20, 20–35, 36–50 and >50 y), income, urbanization level of residence locality, the number of injured tendons (single or multiple), and the Charlson Comorbidity Index (CCI).[21] Concomitant injuries were also considered in this study, including injury to peripheral nerve(s) of the shoulder girdle and upper limb (ICD-9-CM: 955), injury to blood vessels of the upper extremity (ICD-9-CM: 903), and fracture of the upper limb (ICD-9-CM: 810–819). The hospital characteristics included the hospital level (medical center, regional hospital, and local hospital), and the surgical setting (inpatient and outpatient). The urbanization level was based on standards published by the NHRI.[22] These standards include the population density, proportion of the population with a college education level or above, proportion of the population aged ≥65 years, proportion of agricultural workers in the population, and number of physicians per 100,000 people. The most urbanized level is Level 1 and the least urbanized level is Level 7.

Statistical analyses

Statistical analyses were conducted using the Statistical Analysis System (SAS) software (Version 9.3, SAS Institute Inc., Cary, NC, USA). Continuous variables were expressed as means with standard deviations or medians with interquartile ranges (IQR). To compare the various rehabilitation schedules, we employed analysis of variance (ANOVA) on patient age, and the Kruskal–Wallis test for time to resurgery, number of rehabilitation sessions, total expenditure for rehabilitation, and total rehabilitation time. We further examined the differences between the rehabilitation groups by using Dunn's post hoc analysis after the Kruskal–Wallis test. We analyzed the categorical variables such as the age group, sex, urbanization level of the residence, level of hospital, income, resurgery, surgical setting, type of injury (single tendon or multiple tendons), CCI, injury to peripheral nerves of the upper limb, injury to blood vessels of the upper extremity, and fracture of the upper limb by using the Pearson's chi-square test. To assess the risk of resurgery during follow-up, the Kaplan–Meier method was employed and compared using a log-rank test. The univariate and multivariate Cox proportional hazards regression models were used to analyze the relative prognostic significance of the variables in predicting resurgery. The results of multivariate analysis were adjusted for confounding factors and presented as hazard ratios (HRs) and 95% confidence intervals (CIs). Statistical significance was set at $p < 0.05$ for all analyses. The Kaplan–Meier curves were plotted using STATA (Version 12; Stata Corp., College Station, TX, USA).

Results

The 1219 study participants (919 men and 300 women) comprised 472 (38.72%) patients who began rehabilitation within