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Mental and behavioural disorders increase the risk of tendon rupture after flexor tendon repair in zone I and II

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Abstract

Introduction: The effect of mental and behavioural disorders (MBD) on the risk of tendon ruptures after flexor tendon repair is not well understood. This study aimed to analyse the association between MBD and tendon rupture after flexor tendon repair in zones I and II.

Methods: Data from the Swedish National Registry for Hand Surgery (HAKIR) on patients with a complete flexor tendon repair at our department between 2012 and 2019 were followed for a minimum of 2 years to assess the rate of rupture. Independent variables were collected from HAKIR and clinical records: prevalence MBD based on ICD-10 codes F0-F99, age, sex, injured tendon, number of injured fingers, day to surgery, core suture, digital nerve injury, smoking, injury mechanism, and rehabilitation method. Multiple logistic regression was used to assess the association between variables.

Results: A cohort of 593 patients with 49 ruptures (8.2%) was identified. Potential causes of rupture were non-adherence behaviour in 16 (33%), accidents in seven (14%), infections in six (12%), and no clear cause in 20 (41%) patients. Patients with MBD had an association to rupture (OR 3.6), 17.7% ruptures compared to 7.2% in patients with no diagnosed disorders. Patients >50 years of age had a higher risk compared to patients <25 years (OR 4.3), 15% compared to 3.9%' respectively. Men had a higher risk compared to women (OR 2.9), 10% compared to 4.3%' respectively.

Conclusion: We identified an association between the prevalence of mental and behavioural disorders and rupture after flexor tendon repair.

Keywords

Hand therapy, rehabilitation, risk factor, flexor tendon repair

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Introduction

Tendon rupture after flexor tendon repair in zones I and II is a well-known problem in hand surgery. A rupture rate of 4%–5% has been reported in several studies.[1–3] Previous studies have mainly focused on non-patient-related factors such as surgical techniques and postoperative rehabilitation methods. Despite several improvements in these areas, such as using multistrand core sutures and early active motion regimes, tendon ruptures are still common complications after repair. In recent years, mental and behavioural disorders (MBD) have received more attention in medical research. MBDs have been associated with several complications after surgery in general.[4] MBD increased the probability of wound complications after hip replacement[5] and the probability of a problematic initial recovery after carpal tunnel release.[6] For the patient, rehabilitation after flexor tendon repair includes a complex process of performing exercises and, avoiding loads while still managing everyday life. Previous research has shown a high prevalence of non-adherence to these recommendations in patients with rupture after flexor tendon repair.[7,8] MBDs have

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previously been listed as reasons for non-adherence after flexor tendon repair.[9] However, there is a lack of research regarding the potential influence of MBDs on rupture risk after flexor tendon repair and the potential influence on adherence. This study aimed to analyse the association between MBD and tendon rupture after flexor tendon repair in zones I and II and to describe reported causes of rupture such as overload, accidents or infections.

Methods

We assessed data from the Swedish National Registry for Hand Surgery (HAKIR),[10] diagnostic codes and free text data from clinical records. Patients with a complete flexor digitorum profundus (FDP) or flexor pollicis longus (FPL) tendon repair in zones I and II were identified in HAKIR. The registry excludes injuries with concomitant fractures or vascular compromise. We included all tendon repairs performed at our department between 3rd February 2012 and 30th June 2019. Patients were then followed for a minimum of 2 years to assess the rate of tendon ruptures. Ruptures were identified through a reoperation or clinically as a sudden loss of all motion in the distal interphalangeal joint (DIP) or the interphalangeal joint (IP) in thumb injuries. These evaluations were performed retrospectively by analysing reoperation data from HAKIR and range of motion data from clinical records for all patients in the identified cohort.

Variables collected from HAKIR were age, sex, injured tendon and extent of FDS involvement (isolated FDP, FDP and partial FDS, FDP and complete FDS, FPL), number of injured fingers (single or multiple), days between injury and repair, core suture (braided polyester, braided polyblend, or non-resorbable monofilament) and digital nerve injury (absent or present). The prevalence of MBDs was based on registration in the clinical records of ICD-10 codes F0-F99 (Chapter V, Mental and Behavioural Disorders). This group of codes includes all types of mental, behavioural and neurodevelopmental conditions. Other variables collected from clinical records were smoking (yes, no or unknown), injury mechanism (sharp or saw/crush), and rehabilitation method (early active motion, Kleinert, immobilisation or other). These variables were pre-agreed and chosen based on previous studies[3,11–13] and clinical experience. Data from clinical records were analysed by either two surgeons.

All tendon repairs were performed or supervised by an experienced hand surgeon in our department. A dorsal protective cast, secured with bandage and tape to the hand was used on all patients during the first 4 weeks after operation. The cast immobilized the metacarpophalangeal joint (MCPJ) in approximately 45–70° of flexion, the wrist in neutral and the IP in straight positions during this period. Injuries to the FPL were immobilized with a lesser angle of MCPJ flexion and with slight volar abduction in the thumb. In the case of early active motion or Kleinert rehabilitation, the immobilisation method allowed for exercise during these weeks. All patients received written and oral instructions not to use their injured hands in activities during the immobilisation period.

Data were analysed at the level of each patient and not at the digit level since most variables were patient-related. Normally distributed data are reported as mean and standard deviation (SD), non-normal distributed data as median and interquartile range (IQR). Logistic regression was used to assess the association between potential risk factors and rupture. This was done in two steps, first as crude associations, assessing each individual's association to rupture, and then as multiple logistic regression, assessing the adjusted association to rupture. Variables for the multiple logistic regression were based on a cut-off p-value of <0.2 from the crude associations. This procedure and cut-off were determined before analysis to include potential confounders and significant variables. The associations are expressed as odds ratios (OR) with a 95% confidence level (95% CI), we considered a p-value level of <0.05 as significant. The potential effect of interactions was tested between significant variables. The test of Hosmer Lemeshow was used to assess the goodness of fit in the model. A p-value >0.05 was interpreted as a good fit for the data in the model. Variables in a regression model should not be too highly correlated with each other, to test the assumption of independence between variables the variance inflation factor was observed. All statistical tests were done using IBM SPSS version 27. The Swedish Ethics Review Authority reviewed and approved the study (Dnr 2017/2023-31 and 2019-00880).

Results

A cohort of 593 patients with injuries to 717 fingers was identified (Table 1). The median age at surgery was 34 (IQR 24–46) years, and 185 patients (31%) were women. In patients with MBD, 29 (48%) had more than one F0-F99 diagnosis. Thirty patients had Attention-deficit/hyperactivity disorder (ADHD) (F900), 32 patients (52%) had depression and/or anxiety (F300-F499), 20 patients had a diagnosis related to psychoactive substance use (F100), and five patients had an autism diagnosis (F845). In total, 54 patients (92%) had ADHD, depression and/or anxiety or some combination of these diagnoses. A total of 49 (8.2%) patients had post-operative tendon ruptures, 33 ruptures were identified by secondary surgery and 16 ruptures were identified clinically as a sudden loss of all motion. There was a median of 14 days (IQR 11–34) between tendon repair and rupture. The potential aetiologies of the ruptures were reported as non-adherence behaviour to restrictions in 16 patients (33%), accidents in seven (14%), infections in six (12%), No clear cause of ruptures, without any reports of

Table 1. Patient and injury distribution and the frequency of ruptures after flexor tendon repair in zone I and II.

Variables	Number of patients (% with rupture)	Variables	Number of patients (% with ruptures)
Sex		Number of fingers	
Women	185 (4.3)	Single	522 (9.2)
Men	408 (10)	Multiple	71 (1.4)
Age		Injured tendon	
<25	153 (3.9)	FDP	270 (6.3)
25–50	329 (8.5)	FDP + partial FDS	121 (4.1)
>50	111 (15)	FDP + FDS	220 (5.5)
		FPL	106 (16)
Smoking		Injured digital nerves	
Yes	165 (9.1)	None	419 (7.9)
No	397 (8.3)	One or both	298 (6)
Unknown	31 (3.2)		
Mental and behavioural disorders		Rehabilitation	
No	531 (7.2)	Early active	441 (9.3)
Yes	62 (17.7)	Kleinert	86 (2.3)
		Others	66 (9.1)
Injury mechanism		Core suture material	
Sharp	555 (8.5)	Braided polyester	427 (6.8)
Saw/crush	38 (5.3)	Braided polyblend	113 (12.4)
		Non resorbable monofilament	53 (11.3)
Days to repair			
<48	337 (9.2)		
>48	164 (7.3)		
>7 days	92 (6.5)		

FDP: flexor digitorum profundus; FDS: flexor digitorum superficialis; FPL: flexor pollicis longus.

overload, were identified in 20 (41%) patients. For a total of 112 patients, there was information in the clinical records of problems with broken or very dirty casts. In this group, the rupture rate was 15%, compared to 4.5% in the group with no reports of cast problems.

In the crude model, patients with MBD had an association with rupture (OR 2.8 95% CI 1.3–5.8) (Table 2), with 17.7% ruptures compared to 7.2% in patients with no diagnosed disorder. In patients with MBD there were five ruptures following non-adherence behaviour (8%), compared to 11 ruptures (2%) in patients without MBD (Fisher's Exact Test $p = 0.02$). FPL repairs were associated with an increased risk of rupture compared to FDP injuries in the crude model (OR 2.5 95% CI 1.2–5.3) (Table 2). Injury to multiple fingers, core suture material and rehabilitation method had a p-value <0.2 in the crude model. Mechanism of injury, digital nerve injury, days between injury and repair, and smoking had a p-value >0.2 in the crude models (Table 2).

In the multiple logistic regression model, MBD had an association with rupture risk while adjusting for age, sex, type of tendon injury, rehabilitation method, core suture material and number of injured fingers (Negelkerke R square 16.5) (Table 3). Patients with MBD had an increased risk for rupture (OR 3.6) compared to patients with no diagnosed disorders. In the same model, age and sex also were associated with rupture (Table 3). Patients over 50 years of age ($n = 111$) had a higher risk of rupture compared to patients under 25 years ($n = 153$), 15% compared to 3.9%. Men ($n = 408$) had a higher risk of rupture compared to women ($n = 185$), 10% compared to 4.3%. There was no interaction effect between MBD and sex or age. However, there were only nine observations among patients with MBD over 50 years of age, and there were no ruptures in this small group of patients which affected our ability to properly assess the influence of any interaction between age and MBD. The Hosmer Lemeshow test indicated goodness of fit in the model. The variance inflation factor indicated an independence of observations. There were no missing values except in the variable smoking, where 31 patients were classified as unknown.

Discussion

We identified a significant association between MBD and tendon rupture after flexor tendon repairs in zones I and II after adjusting for potential confounders, age, sex, rehabilitation method, injured tendon, number of injured fingers, rehabilitation method and core suture material. This is the

Table 2. Variables and their crude association to rupture after flexor tendon repair in zone I and II.

Variables	OR (95%CI)	p-value	Variables	OR (95 CI%)	p-value
Sex			Number of fingers		
Women	Ref		Single	Ref	
Men	2.5 (1.1–5.4)	0.023	Multiple	0.1 (0.0–1.0)	0.054
Age			Injured tendon		
<25	Ref		FDP	Ref	
25–50	2.3 (0.9–5.6)	0.074	FDP + partial FDS	0.6 (0.2–1.8)	0.405
>50	3.8 (1.4–10.2)	0.007	FDP + FDS	0.8 (0.4–1.9)	0.685
			FPL	2.5 (1.2–5.3)	0.014
Smoking			Injured digital nerves		
Yes	1.103 (0.6–2.1)	0.764	None	1.3 (0.7–2.4)	0.403
No	Ref		One or both	Ref	
Unknown					
Mental and behavioural disorders			Rehabilitation		
No	Ref		Early active	Ref	
Yes	2.8 (1.3–5.8)	0.006	Kleinert	0.2 (0.1–1.0)	0.047
			Others	1.0 (0.4–2.4)	0.957
Injury mechanism			Core suture material		
Sharp	Ref		Braided polyester	Ref	
Saw/crush	0.6 (0.1–2.6)	0.492	Braided polyblend	1.9 (1.0–3.8)	0.054
			Non resorbable monofilament	1.8 (0.7–4.4)	0.237
Days to repair					
<48	Ref				
>48	0.8 (0.4–1.6)	0.481			
>7 days	0.7 (0.3–1.7)	0.420			

FDP: flexor digitorum profundus; FDS: flexor digitorum superficialis; FPL: flexor pollicis longus; OR: Odds ratio; CI: confidence interval.

first study to highlight the association between MBD and the risk of rupture after flexor tendon repair. Previous research has found higher rates of complications in patients with mental disorders after rotator cuff repair,[14] hip surgery and knee joint arthroplasty.[15] ADHD, depression and anxiety were the most common diagnoses in our cohort. Several factors are likely to affect the increased risk of rupture in this group of patients. Depression has been shown to affect the regulation of inflammatory cytokines[16] and these also play an important role in tendon healing[17] potentially increasing the risk of rupture. Similar to previous research[7,8,18] we identified a significant proportion of ruptures following some type of non-adherence to rehabilitation. The proportion of non-adherence rupture was greater in patients with MBD which may suggest that MBD affects adherence. Previous research has shown that depression and anxiety may affect rehabilitation adherence.[9,19] One potential cause may be that adherence to rehabilitation after flexor tendon repair imposes high mental and behavioural demands, and patients can report frustration and a struggle to meet these demands.[20,21] The prevalence of MBD in our cohort was 10.5%. Previous research has reported a higher prevalence of mental disorders, 32.8%.[22] The prevalence of MBD in the patients with flexor tendon injuries in the present study was evaluated only by using the ICD-10 coding which may have resulted in some underreporting.[23]

Previous research regarding the influence of sex on rupture risk is conflicting. Dy[24] reported no sex difference in reoperation rates while we[3] reported a higher risk among men in a previous paper. Harris[7] and Lalchandani[25] reported a somewhat higher, but not significant rupture rate in men. The healing properties of tendons decrease with age, which can be one explanation to our results of an increasing rupture risk with age. The negative effect of age has been shown in previous studies. The detection of ruptures may affect the frequency, as well as the potential risk factors. We identified ruptures both clinically and through reoperation. This may explain the higher rupture rate of 8.2%. To report ruptures only by secondary surgery may lead to underreporting in frequency and skewness in potential risk factors. One factor is that the willingness to undergo secondary surgery is affected by several factors, age being one of them. In our data, we found that patients >50 years with rupture had a reoperation in about 50% of cases compared to about 90% in patients between 25 and 50. Injury to the FPL tendon increased the risk for rupture in the crude model but not in the adjusted model. This was probably affected by the fact

Table 3. Adjusted associations between significant variables and rupture after flexor tendon repair in 593 patients.

Variables	OR[a] (95% CI)	*p*-value
Sex		
Women	Ref	
Man	2.9 (1.3–6.6)	0.01
Age		
<25	Ref	
25–50	2.5 (0.9–6.4)	0.06
>50	4.3 (1.5–12.3)	0.006
Mental and behavioural disorders		
No	Ref	
Yes	3.602 (1.6–8.1)	0.002
Injured tendon		
FDP	Ref	
FDP + partial FDS	0.7 (0.2–2.0)	0.495
FDP + FDS	0.96 (0.4–2.2)	0.937
FPL	1.8 (0.8–4.0)	0.144
Number of fingers		
Single	Ref	
Multiple	0.1 (0.01–1.1)	0.065
Rehabilitation		
Early active	Ref	
Kleinert	0.2 (0.1–1.0)	0.062
Others	0.6 (0.2–1.7)	0.375
Core suture material		
Braided polyester	Ref	
Braided polyblend	1.4 (0.7–2.9)	0.343
Non resorbable monofilament	1.6 (0.6–4.4)	0.335

FDP: flexor digitorum profundus; FDS: flexor digitorum superficialis; FPL: flexor pollicis longus; OR: Odds ratio; CI: confidence interval.
[a]Odds ratios adjusted for all variables in the model.

that FPL injuries had a higher proportion both of males and patients above 50 years of age. Type of rehabilitation method and core suture material had an association to rupture in the crude models but not after adjusting for other variables in the multiple model. There are a great discrepancies in the literature regarding ruptures and Kleinert mobilisation.[26] The number of different rehabilitation protocols in use also makes comparisons difficult.

A limitation in this study is the low number of observations in some categories which affected our ability to assess interaction effects. It also affected the certainty in our associations which is shown in the wide confidence intervals. Only 62 patients with 11 ruptures had MBD in our cohort which may affect the certainty of our associations due to a low number of observations, especially in the multiple model. Including data from clinical records can be a limitation, although we have reliable routines for documentation in our department and we used a protocol for assessing data for this study. Potential aetiologies of ruptures were categorised into four groups. The fact that these groups were limited to data from clinical records made us disregard other potential influential factors such as rupture being influenced by the condition of tendon ends and the level of injury. Another limitation is the lack of detailed data regarding the tendon repairs. However, the fact that we only included patients from our department minimizes the potential influence of this, because we mainly use four-strand core sutures with 4-0 circumference.

In conclusion, to our knowledge, this is the first study of the association between MBD and ruptures after flexor tendon repair. This study highlights the association of MBD, together with higher age and male sex on rupture risk. Awareness of this potential risk factor could help clinicians understand the mechanism of rupture better and suggest potential opportunities for future interventions to avoid this complication. More research is required to understand the underlying mechanisms and the influence of different MBD on rupture risk after flexor tendon repair. Research is also required to identify optimal strategies for postoperative rehabilitation to prevent complications in patients with different types of MBD.

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Author contributions

J.S. and M.A. researched literature and conceived the study. J.S. and M.A. were both involved in protocol development, gaining ethical approval, patient recruitment and data analysis. J.S. wrote the first draft of the manuscript. Both authors reviewed and edited the manuscript and approved the final version of the manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethics statement

Ethical approval

Ethical approval for this study was obtained from the Swedish Ethical Review. Dnr 2017/2023-31 and 2019-00880.

Informed consent

Individual patient consent was not sought for the present study because the research is based on data only from a national registry and medical journal.

Guarantor

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