ORIGINAL RESEARCH PAPER
Volume - 11 | Issue - 07 | July - 2022 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ROLE OF EARLY PHYSIOTHERAPY IN FLEXOR TENDON INJURY

Surgery

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ABSTRACT

INTRODUCTION Flexor tendon injuries are underestimated considering their anatomical function in the hand. Primary suturing of the flexor tendon combined with immediate postoperative physiotherapy in terms of "Early Passive Movement" became the standard form of therapy following acute flexor tendon injuries of the hand. **MATERIALS AND METHODS** In a study between 2019 and 2021, a total of 75 flexor tendon injuries were analysed retrospectively. All patients were treated using a two-strand repair technique according to Modified Kessler. They received physiotherapy from the first postoperative day according to the occupational rehabilitation protocol. For statistical purposes, the factors: age, gender, range of motion (ROM), follow up interval, affected flexor tendon and zone were analysed. The time between injury and surgery was also determined, classified into groups and included in the study. **RESULTS** The mean follow-up interval was 6 months. Complications occurred in 5 % like secondary rupture (2 %), tendon adhaesions requiring tenolysis (3 %) and infection (1 %). The time interval between injury and operation, gender, affected zone, flexor tendon and affected finger nerve had no influence on outcome. **CONCLUSIONS** Using modified kessler's core suture technique as the primary treatment, combined with immediate postoperative physiotherapy in terms of "Early Passive Movement" according to the occupational flexor tendon rehabilitation program, an excellent clinical outcome and low complication rate was achieved.

KEYWORDS

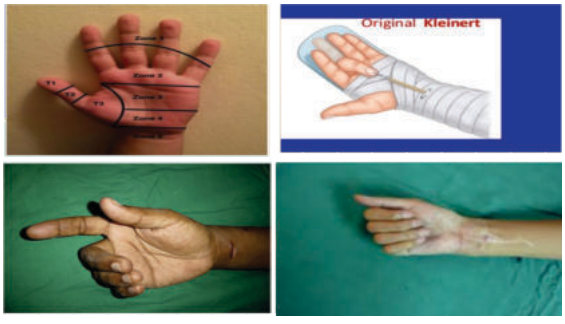
Flexor Tendon Injury, Early Passive Movement, Rehabilitation, Modified Kessler's Core Suture Technique, Early Physiotherapy

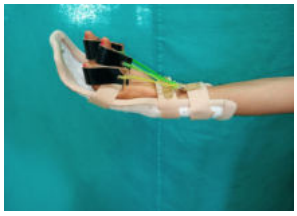
INTRODUCTION

The consequences of flexor tendon injuries are often underestimated in relation to the function of hand movements in daily routines.[1] If a flexor tendon is inadequately treated initially, not only is the patient unable to work, the probability of returning to the work force is decreased and increase chances of work disability. Since the 1960s there has been a turnaround in the treatment of acute flexor tendon injuries of the hand. Injuries that occurred in the so-called "no man's land" were not treated primarily, they were reconstructed secondarily. Prior to the Kleinert publications, the standard rehabilitation plan for acute flexor tendon injuries was a static postoperative Approach. Young and Harmon were the first to describe a dynamic postoperative treatment plan. Initially the method was not well known but after some modification and the Kleinert publication, it received international acceptance. In the literature discussions about the postoperative treatment of flexor tendons are still controversial. [2]The different postoperative treatment options vary from early, delayed passive mobilization to active mobilization. The isolated movement of the proximal phalanges does not lead to gliding of the flexor tendons: Both the proximal and distal interphalangeal joints must be moved to allow gliding of the flexor tendons. Per 10 degree joint movement the tendon glides from 0.3 to 1.3 mm. [3-5] Biomechanical studies have shown that 3-weeks post-surgery the suture has the same tensile strength, as at the time of surgery, and only 12-weeks post-surgery does the tensile strength of the repaired tendon increase significantly. Even today it is still unknown when the repaired flexor tendon actually regains its original tensile strength. Tendon repair techniques have been described since 1917 and to date many different techniques using core sutures have been published. As a result, the number of strands and core suture technique remain debatable. Nevertheless, the Kirchmayr technique modified by Kessler and Zechner remains one of the most popular approaches. Biomechanical studies have shown that an increased number of strands in core sutures results in a stronger repair. [6-7] But clinically a recent meta-analysis by Dy et al. was not able to show a significant difference between the number of core sutures and clinical rupture rate. Further, an increased number of strands lead to an increased gliding resistance through the flexor sheaths. A six-strand repair leads to twice the workload in flexion compared to a two-strand repair. This may cause stiffness and reduction in active motion in a clinical setting. A further controversial issue in the literature is immobilization after nerve repair. Brushart stated: "Nerve repairs are usually immobilized for 3 weeks; by this time they have gained sufficient strength to tolerate gentle traction". He based his statement on a biomechanical study by Miller from 1921. Therefore a 3-week immobilisation after nerve repair became standard therapy.[8] But since then much research has been carried out. Several biomechanical and clinical studies have been published, that were not able to find a significant difference in outcome between immediate mobilisation and immobilisation after nerve repair. Rather, an immobilization leads to a restriction in range of motion and longer sick leave. [9-11] The main aim of this study was to investigate the outcome after repair of acute flexor tendon injuries followed by immediate physiotherapy from the first postoperative day.

MATERIALS AND METHODS

All flexor tendon injuries from 2019 to 2021 in zones I and II were analysed, retrospectively. Patients with additional trauma to the hand (except additional finger nerve or artery injury), prior hand function impairment, age Below 18 years and pregnancy were excluded. Of the remaining 75 patients a retrospective database analysis was carried out. Surgical procedure in an operating room, under aseptic conditions, regional plexus anesthesia and blood tourniquet, all flexor tendons were sutured using a two-strand repair technique. A modified Kessler core suture, with a braided non-absorbable suture 3.0 was carried out. [12-13] In all cases both the superficial and profundus tendon were sutured. If the tendon was severed in zone I and the tendon stump was less than 1 cm, the flexor tendon was reinserted using a bone anchor. The pulleys A2 and A4 were left closed, but if necessary they were sutured and reconstructed using an extension plastic. If a finger nerve was also severed, it was coadapted with two sutures 10/0. Postoperative treatment every patient received a Kleinert splint. Thus the flexor function is deactivated and the finger is guided against the viscoelasticity of the synovial sheaths of the tendon and against the tension of the extensors in flexion. [14] Thus, from the first postoperative day, a specially trained physiotherapist leads the patient through passive flexion and active extension exercises at the wrist. The stitches were removed in the third postoperative week. [15]






RESULTS

A total of 75 flexor tendon injuries were analysed from 2019 to 2021, retrospectively. The mean follow-up was 6 months. In 20 cases the thumb was involved (26 %) and in 50 (66 %) cases fingers were involved and 25(33%) cases forearm cut injury was present. 15 injuries (20 %) happened due to suicidal activities and 45 (60 %) were work related and 15 (20%) due to assault. The predominant age was 35 years. In 75 patient's age ranged between 18 and 65 years. Men (65 %) were more frequently affected than women (35 %). 47 (63 %) patients had an injury in zone II and 27 (37 %) in zone I. However, surgical repair carried out within 25 h to 14 days showed significantly better results in assisted range of motion than operations within 6 h of injury. In addition patient's ranging in age between 18 and 65 years achieved a mean significantly better result in younger patients. Range of motion was also significantly better in patients under 65 years of age than patients over 65 years. Gender (men/women), time between injury and operation, affected zone, affected flexor tendon and involvement of a finger nerve (yes/no) showed no significant influence in the outcome. Complications occurred in 5 % like secondary rupture (2 %), tendon adhaesions requiring tenolysis (3 %) and infection (1 %).

DISCUSSION

Flexor tendon injuries are rare, but underestimated in the clinical routine. An inadequately treated flexor tendon leads to poor hand function and an increased inability to work. Until the 1960s, injuries of the flexor tendons were not primarily sutured. Since then, much research has been done and with improved microsurgical techniques and suture materials, primary flexor tendon repair in the so called "no man's land" has become standard treatment. There is also consensus that both tendons—the superficial as well as the profundus flexor digitorum tendon should always be repaired. Since Kleinert et al. published the first paper for rehabilitation after flexor tendon injuries many studies have been published. These presented new treatment protocols, yet in the literature the ideal method with the best outcome still remains debatable. In Summary three methods are described: firstly an active extension-passive flexion method, secondly a passive motion method and thirdly there is a controlled active motion method, which allows the patient to actively flex the finger. [16] A recent systematic review by Chesney et al. concluded that all three methods led to low rates of tendon rupture and good results in range of motion in zone 2 injuries. They identified that early active motion is superior to a static method, but were not able to find a significant difference in outcome between early active and passive protocols. Another systematic review and meta-analysis by Dy et al. using a dataset of 39 studies with flexor tendon repairs, they calculated a tendon rupture rate of 4 % and reported a frequency of adhesions of 4 % . In our study we had to perform a tenolysis in 1.7 % of the cases. Additionally, Chesney et al. analysed differences in range of motion between the various rehabilitation protocols. He reported 92 % "excellent" and "good" results in the Buck-Gramcko Score, for the Kleinert protocol, 86 % for the Duran protocol and 95 % for the combined Kleinert and Duran. In the Strickland Score he showed an average score of 68 % for the Kleinert protocol, 59 % for the Duran protocol, 93 % for the combined Kleinert and Duran protocol and 94 % for the active protocol. Our study achieved 94 % "excellent" and "good" results in the Buck-Gramcko Score, an average of 90 % in the Strickland Score, similar results as in the combined Kleinert/Duran and active protocol, but better results as the Kleinert and Duran protocol. [17-19]In a recent systematic review of flexor tendon repair rehabilitation protocols, Starr et al. concluded that passive protocols have a significant lower risk for tendon rupture, but a higher risk for decreased range of motion postoperatively. The risk for postoperative tendon rupture in the passive protocol was 4 % and in the active 5 %.Frueh et al. Compared, in a retrospective data analysis, early passive mobilization with a controlled active motion protocol after flexor tendon repair in zones 1 and 2. He reviewed the a controlled active motion group for 4 weeks after surgery, and reported significantly better results with respect to total active motion, but this difference disappeared after 12 weeks. He also reported quite a higher average rupture rate of 7 % compared to our study. As our follow-up interval total 6 months, functional results were not comparable due to the clearly shorter follow-up of only 12 weeks. Many reasons could explain the lower rupture rate in our study. Firstly, each patient received specialised physiotherapy and occupational therapy during the first 12 weeks and longer if necessary, if range of motion was restricted. Secondly, our study used the modified Kleinert splint. Thus the flexor function was deactivated and the finger was guided against the viscoelasticity of the synovial sheaths of the tendon. Thereby the patient was able to perform active extension exercises, but the finger was passively flexed by the rubber. Additionally the finger was fixed in a guarded flexed position. Thirdly, all patients were not allowed to do any hard work, especially tight grip activities, for at least 6 months after tendon repair. However, even today it is unknown at which point the repaired flexor tendon actually regains its original tear resistance. Woo et al. showed in a biomechanical study that 3 weeks after surgery the suture has the same repair strength, as at the time of the operation and does not increase significantly until the 12th postoperative week. [20] Today there is still a debate on the method and numbers of strands for core sutures for flexor tendon repair. In the last decades a two-strand technic became standard treatment. But much research has been done since then on both biomechanical as well as clinical levels that aimed to improve suture strength and promote active postoperative rehabilitation : Tanaka et al. defined in his study the so-called "safe zone". The "safe zone" describes the area between the smallest force, which is necessary to overcome the friction resistance, and the maximum force at which the strand will withstand tearing. In our study, all flexor tendon repairs were carried out using the modified Kessler suture. He shifted the knot from the longitudinal axis, between the tendon stumps, to the transverse axis and sank the knot into the tendon. He reported in a biomechanical and clinical study a tear resistance of up to 5000 g and through the shift of the knot achieved an increased tear resistance of 20 %. He also clinically reviewed 150 flexor tendon repairs using this technique and recorded only one rupture. Biomechanical and cadaver studies have proven that an increase in the number of strands lead to stronger repairs, but a concomitant higher gliding resistance. Other surgeons also increased their number of core sutures and reported similar results in case series of a reduced rupture rate. Another recent biomechanical study compared 2-, 4-, 6-, 8- and 10-strand techniques and showed for the modified Kessler suture, which is similar to the Zechner suture. In this study a running locking peritendinous suture was also sewn. In a biomechanical study Moriya et al. compared the modified Kessler (two-strand) suture to the Massachusetts General Hospital repair (MHG; four-strand), including the additional peritendinous suture. The MHG showed a significant higher load to perform a 2-mm gap and load to failure, but at the same time the MHG repair had a significant two times higher gliding resistance. Comparing current clinical studies, none were able to demonstrate a significant difference between the two strand and multistrand techniques.

In a systematic review Hardwicke et al. comparing two-strand with multistrand techniques and found a trend towards lower rupture rates in the multistrand techniques, but reached no significance. There was no significant difference in outcome in the Buck- Gramcko and Strickland Score categorizing the time between injury and operation in the groups\6 h, 6–24 h, 25 h–14 days, 15 days–3 weeks, [3 weeks. However, flexor tendons injuries, sutured 25 h to 14 days after injury, showed significant better results in range of motion than flexor tendons injuries treated within 6 h of injury. This shows that acute injuries of the flexor tendon need not necessarily be operated on immediately. Rather the operation should be performed under suitable aseptic conditions by trained specialists. Even today flexor tendon injuries represent a challenge to the attending surgeon. [21] These injuries are underestimated in clinical practice and can lead to impaired hand function. The ideal protocol with the best outcome is still under debate and each protocol has its advantages and disadvantages. To date it is not proven if an increase in core sutures leads to a better clinical outcome outside of the laboratory. Equally so, no review or meta-analysis has been able to show significantly better outcomes for an active postoperative rehabilitation protocol with simultaneously equal or reduced tendon rupture rates. We have been able to show that the primary two-strand suture combined with immediate postoperative physiotherapy in terms of an "Early Passive Movement" achieved an "excellent" clinical outcome and a low complication rate. Comparing our results with the active protocol we had lower rates of tendon rupture but a higher rate of decreased range of motion in the Strickland Score. [22] Owing to the limitations of this study (no control group, retrospective data analysis) one cannot definitively concluded that these differences would be

significant. Therefore, further studies, especially prospective randomized trials, are needed to prove or disprove these findings. But besides type, number of core sutures and rehabilitation protocol, equally important for the functional outcome is a specialised team under optimal surgical conditions, accompanied by a specifically trained physiotherapy and occupational therapist from the first postoperative day.

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