**MEDICAL REHABILITATION IN PATIENT WITH LEFT MEDIAN NERVE PALSY, FLEXOR CARPI RADIALIS RUPTURE, BILATERAL FLEXOR DIGITORUM PROFUNDUS RUPTURE, AND LEFT FLEXOR POLLICIS LONGUS RUPTURE**

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**ABSTRACT:** The flexor tendons of the hand are quite vulnerable to laceration and rupture.1,2 The injuries are most commonly seen in individuals whose work involve being around moving equipment, using knives or washing glass dishes.3 Flexor tendon injuries are a challenging problem for both the orthopedic surgeon and PM&R Physician due to 3 main reasons. Firstly, flexor tendon injuries of the hands are a clinical problem because they cannot heal without surgical treatment. Secondly, post-operative management needs to be carefully planned as mobilization has shown to be essential to prevent adhesions and improve gliding but this can risk rupture. Lastly due to the unique anatomy of the tendons of the tendons running through flexor tendon sheaths to function, surgeons need to plan preventing increasing the bulkiness of the tendon through its sheath. The aim of rehabilitation after tendon repair is to achieve function and gliding but avoiding rupture of the tendon.1,4 We report the rehabilitative course of a middle-aged male patient who had undergone reparative surgery of the hand that has shown good outcome.

*Key Words: flexor tendons, rupture, post-operative management*

**ABSTRAK:** Tendon fleksor tangan cukup rentan terhadap robekan dan kerusakan.1,2 Cedera-cedera ini paling sering terjadi pada individu yang pekerjaannya melibatkan keberadaan di sekitar peralatan-peralatan bergerak, menggunakan pisau atau mencuci piring kaca.3 Cedera tendon fleksor merupakan masalah yang sulit bagi spesialis ortopedi dan spesialis kedokteran fisik dan rehabilitasi medic oleh sebab 3 alasan utama. Pertama, cedera tendon fleksor tangan merupakan masalah klinis karena tidak dapat sembuh tanpa perawatan bedah. Kedua, manajemen pasca operasi perlu direncanakan dengan hati-hati karena mobilisasi terbukti penting untuk mencegah perlekatan dan meningkatkan *gliding*, tetapi ini dapat berisiko kerusakan. Yang terakhir karena anatomi unik dari tendon-tendon yang berjalan melalui selubung tendon fleksor berfungsi, ahli bedah perlu merencanakan untuk mencegah pembesaran tendon melalui selubungnya. Tujuan rehabilitasi setelah perbaikan tendon adalah untuk mencapai fungsi dan *gliding*, tetapi menghindari kerusakan tendon.1,4 Kami melaporkan proses rehabilitasi pasien pria paruh baya yang telah menjalani operasi reparatif pada tangan dan menunjukkan hasil yang baik.

*Kata Kunci: tendon fleksor, ruptur, manajemen post operasi*

**BACKGROUND**

Flexor tendon injuries are a common event as the tendons lie close to the skin and so are usually the result of either laceration such as those from knives or glass, from crush injuries. 1,2 Flexor tendon injuries are a challenging problem for both the orthopedic surgeon and PM&R Physician due to 3 main reasons. Firstly, flexor tendon injuries of the hands are a clinical problem because they cannot heal without surgical treatment. Secondly, post-operative management needs to be carefully planned as mobilization has shown to be essential to prevent adhesions and improve gliding but this can risk rupture. Lastly due to the unique anatomy of the tendons of the tendons running through flexor tendon sheaths to function, surgeons need to plan preventing increasing the bulkiness of the tendon through its sheath.

The aim of rehabilitation after tendon repair is to achieve function and gliding but avoiding rupture of the tendon. All rehabilitation methods vary in their protocol but 3 are main methods. Firstly there is active extension with rubber band flexion, also called the active extension–passive flexion method. Secondly there is passive motion methods, which uses a range of 3-5 mm of passive motion in the involved tendon and then lastly there in controlled passive motion with patient actively flexing the digit.1,4

The median nerve is derived from a combination of the lateral and medial cords of the brachial plexus. Motor innervation is supplied to forearm muscles and to muscles of the thenar eminence. Sensation is supplied to the thenar eminence by the palmar cutaneous sensory branch (1) and to the first three and one-half digits by several digital sensory branches (2).5

**CASE PRESENTATION**

INITIAL PRESENTATION

A 45-year-old man presented with pain and ROM limitation of his left wrist and fingers, he was found unable extend his wrist and fingers. The patient was consulted to the PM&R department after receiving reparative surgery 3 days prior following a workplace accident where his left hand and wrist was lacerated by a large piece of falling glass. His surgery involved reparation of the left radial & ulnar artery, flexor carpi radialis tendon, flexor policis longus tendon, flexor digitorum superficialis tendon, flexor digitorum profundus tendon and approximation of the median nerve. On admission, the patient presented with a Karnofsky performance scale of 80,

Local Status (left wrist & fingers)

Inspection: Back slab is attached to the left wrist, wound covered with verban, odem (+), stitch marks (+)

Palpation: Pain at wrist (VAS 9) and hypoesthesia in the median nerve region. The pulse in radial and ulnar artery (+), Calor (-).

Movement: ROM Limitation at wrist, MCP, PIP and DIP due to pain.

Muscle strength tested by using manual muscle testing (MMT), detailed measurement shown on table 1.

Table 1. Manual Muscle Testing Scores

|  |  |  |
| --- | --- | --- |
|  | Dextra | Sinistra |
| **Elbow Flexion** |  |  |
| * Biceps Brachii
 | 5 | 5 |
| Elbow Extension |  |  |
| * Triceps
 | 5 | 5 |
| **Wrist Flexion** |  |  |
| * Flexor carpi radialis
 | 5 | dte (pain) |
| * Flexor carpi ulnaris
 | 5 | dte (pain) |
| **Wrist Extension** |  |  |
| * Extensor carpi radialis longus et brevis
 | 5 | dte (limited by backslap) |
| * Extensor carpi ulnaris
 | 5 | dte (limited by backslap) |
| **Thumb abduction** |  |  |
| * Abductor pollicis longus et brevis
 | 5 | dte (pain) |
| **Thumb flexion** |  |  |
| * Flexor pollicis brevis
 | 5 | dte (pain) |
| **Thumb extension** |  |  |
| * Extensor pollicis brevis et longus
 | 5 | dte (pain) |
| **Second to fifth digit flexion** |  |  |
| * Flexor digitorum superficialis et profundus
* Lumbricals
* Interossei
 | 555 | dte (pain)dte (pain)dte (pain) |
| **Second to fifth digit extension** |  |  |
| * Extensor digitorum communis
* Extensor indicis
* Extensor digiti minimi
 | 555 | dte (limited bybackslap)dte (limited by backslap)dte (limited by backslap) |
| **Second to fourth digit abduction, first to fifth digit adduction** |  |  |
| * Dorsal or palmar interossei
 | 5 | dte (pain) |
| **Fifth digit abduction** |  |  |
| * Abductior digiti minimi
* Flexor digiti minimi
 | 55 | dte (pain)dte (pain) |

Table 2. ROM examination results

|  |  |  |
| --- | --- | --- |
|  | Dextra (degree) | Sinistra (degree) |
| **Elbow ROM** |  |  |
| * Extension – Flexion
 | 0 – 0 – 140 | 0 – 0 – 140 |
| **Wrist ROM** |  |  |
| * Extension – Flexion
 | 70 – 0 – 80  | dte – 0 – 15 |
| **Finger ROM** |  |  |
| MCP 1 |  |  |
| * Extension - Flexion
 | 0 – 60 | dte – 30 |
| MCP 2 |  |  |
| * Extension - Flexion
 | 0 – 90  | dte – 50  |
| MCP 3 |  |  |
| * Extension - Flexion
 | 0 – 90 | dte – 45 |
| MCP 4 |  |  |
| * Extension - Flexion
 | 0 – 90 | dte – 45 |
| MCP 5 |  |  |
| * Extension - Flexion
 | 0 – 90 | dte – 60 |
| MCP 2 (Hyperextension) | 0 – 20 | dte |
| MCP 3 (Hyperextension) | 0 – 20 | dte |
| MCP 4 (Hyperextension) | 0 – 20 | dte |
| MCP 5 (Hyperextension) | 0 – 20 | dte |
| Interphalangeal 1 |  |  |
| * Extension – Flexion
 | 0 – 90 | 0 – 60 |
| PIP 2 |  |  |
| * Extension – Flexion
 | 0 – 100 | dte -70 |
| PIP 3 |  |  |
| * Extension – Flexion
 | 0 – 100 | dte – 80 |
| PIP 4 |  |  |
| * Extension – Flexion
 | 0 – 100 | dte – 50 |
| PIP 5 |  |  |
| * Extension – Flexion
 | 0 – 100 | dte – 60 |
| Distal Interphalangeal (DIP) 2 |  |  |
| * Extension – Flexion
 | 0 – 80 | dte – 50 |
| DIP 3 |  |  |
| * Extension – Flexion
 | 0 – 80 | dte – 40 |
| DIP 4 |  |  |
| * Extension – Flexion
 | 0 – 80 | dte – 45 |
| DIP 5 |  |  |
| * Extension – Flexion
 | 0 – 80 | dte – 50 |

REHABILITATION COURSE

The patient had several rehabilitation problems, including left median palsy, muscle weakness (wrist flexion, thumb abduction, thumb flexion, and second to fifth digit flexion), Paresthesia on left median-innervated area (Dorsal and palmar part of left hand), pain and edema on left wrist to fingers (VAS: 8), limitation on left ROM wrist to fingers limitation on functional activity with her left hand, inability to perform work due to his left hand’s condition, and anxiety due his condition.

The Main objectives is to educate the problem that patient is facing at this time and also give a counseling to reduce anxiety, and to tailor a recovery program involving physiotherapy, occupation therapy, orthotic prosthetic, psychology, and social medical worker.

Programs from the physiotherapy department include TENS at left wrist, active ROM exercise for finger extensions 10 x/hrs, passive ROM exercise for flexion left wrist, MCP, PIP,DIP (digiti I-V), active ROM exercise to shoulder and elbow

*Figure 2. Patient was given TENS on the 1st, 2nd and 3rd follow up*

A dorsal dynamic protection splint is provided by the orthotic prosthetic department.

*Figure 4. Anatomy of distal motor and sensory branches of the median nerve*

*Figure 3. Left : A. Dorsal dynamic protection splint; fingers in resting position B. Dorsal dynamic protection splint; active extension exercise. Right : Dorsal wrist splint*

Programs from the psychology department is to support the patient mentally to reduce anxiety in coordination with family members and to give cognitive-behavioral therapy.

Programs from the medical social worker is to give motivation to the patient and patient’s family to follow the therapy given by the physician and the rehabilitation team and further evaluation on her vocational, especially discussing about activities that he can’t join in his job.

 The patient was scheduled for weekly evaluation and on the fourth appointment, there was significant improvement on muscle strength and ROMs although the patient have not yet recovered full muscle strength and ROM, the patient is able to resume work at this point. The patient also reported diminished pain (VAS 0) and had a Karnofsky score of 90.

DISCUSSION

The median nerve innervates the pronator teres muscle, pronator quadratus, palmaris longus, flexor carpi radialis, flexor policis longus, flexor policis brevis (1,2), flexor digitorum superficialis, flexor digitorum profundus (1,2), abductor policis brevis, oponen policis and lumbricalis (1,2).5,6 In this case, weakness was found in almost all the muscles innervated by the median nerve except the pronator teres muscle, pronator quadratus and palmaris longus. All of these last 3 muscles are innervated by a branch of median nerve around the antecubital fossa, while the injury happened on the wrist.

Regions of potential tendon injury are divided into five zones (figure 5). Zone I is from the tendon insertion at the base of the distal phalanx to the midportion of the middle phalanx. Laceration or injury in this zone results in disruption of the FDP tendon and the inability to flex the distal interphalangeal (DIP) joint. Zone II extends from the midportion of the middle phalanx to the distal palmar crease. This zone is known as no man’s land because of the poor functional results after tendon repair. Tendon injury in this zone usually involves both FDP and flexor digitorum superficialis (FDS) tendons and results in inability to flex the DIP and proximal interphalangeal (PIP) joints. Zone III is located from the distal palmar crease to the distal portion of the transverse carpal ligament. This zone includes the intrinsic hand muscles and vascular arches. Zone IV overlies the transverse carpal ligament in the area of the carpal tunnel. In this zone, injuries usually involve multiple FDP and FDS tendons. Zone V extends from the wrist crease to the level of the musculotendinous junction of the flexor tendons. Injuries in this region most often result from self-inflicted laceration (suicide attempts)1,3. In this case, patient injuries entered in zone V extends from the wrist crease to level of the musculotendinous junction of the flexor tendons. Injuries in this region most often result from self-inflicted laceration (suicide attempts)



*Figure 5. Zones of Flexor Tendons*

*Figure 6. Flexor tendon injuries rehabilitation protocols*

The way in which tendon heals has been researched over the years. In summary tendon healing involves and inflammatory stage in 48 to 72 hours where erythrocytes and inflammatory cells including neutrophils enter the site of injury to initiate angiogenesis increase vascular permeability and stimulate tenocyte proliferation and recruitment of other inflammatory cells. Then a proliferation stage occurs where repairing fibroblastic and collagen producing cells enter from 5 days to 4 weeks. Lastly the remodelling takes place for approximately after 6 weeks where the tissue repair changes from cellular to fibrous. The tenocytes metabolism remains high and the tenocytes and collagen fibres become aligned. Later in this stage there is a gradual changes of the fibrous tissue to the scar like tendon tissue over approximately 1 year.2,5 In this case, the patient was consulted after 3 days postoperatively and still entered the stage of inflammation of the tendon healing phase.

The flexor tendons heal by both intrinsic and extrinsic mechanism. The intrinsic method includes the nutriens that are supplied by the sinovial fluids and the proliferation of the epitenon and endotenon tenocytes. The extrinsic part is the fibroblastic response of the sheath and the tissue and the cells surrounding the tendon. The relative contribution from each part depends on the region of origin of the tendon, the trauma and the amount of stress induced by motion after repair as occured. The weakest poin of tendon healing is 5 to 10 days postoperative, which should be thought out in postoperative management plans.8,9.

The treatments for this condition are physical therapy to help maintain muscle strength and avoid contracture, wrist splint, and nerve graft or repair15. In this case, the examiner did not know exactly about the surgery (there was no surgery report just approximation median nerve and repair tendon flexor). However, the examiner did several physical therapy and suggestion to use dorsal dynamic protection wrist. There are several procedures that can be used to treat rehabilitation therapy post tendon flexor repair which can be seen in the Figure 6.

Psychologic subunit has an important role for this patient. The patient had anxiety due to his left lower arm problem. Psychologist could do 2 things for this patient: mental support and cognitive – behavioral therapy. Mental support here was designed to support the patient in dealing with the condition he had. Hopefully, by this effort the anxiety of patient would reduce and make this patient focus on her treatment. Cognitive behavior therapy (CBT) is a type of psychotherapeutic treatment that helps patient understands the thoughts and feelings that influence behaviors. Most patients have negative statement inside their mind about their disease. They may not be able to stop physical problem from happening, but with practice they can control how their mind manages the problem. An example is changing a negative thought, such as “I can’t do anything anymore,” to a more positive thought, such as “I dealt with this before and I can do it again.”13,14

In the follow up on January 30th 2018, the examiner found there was an improvement on ROM at wrist, MCP, fingers flexion. Pain and paresthesia were also decreasing. Muscle strength cannot be evaluated because of the 15th day postoperatively, at this phase, wrist flexion is used to produce less tension on the flexor tendon during passive exercise. In this condition, the physiotherapist continued gave TENS and still gave passive ROM exercises for left wrist and fingers flexion and active ROM exercise for extension fingers. Elevation of left hand was also given to reduce odem. For dorsal wrist splint, this patient were still considering about it. Subunit orthotic prosthetic together with the physiatrist gave education more about the importance of this splint. In psychology, patient had less anxiety and therefore the previous psychology program was continued. Meanwhile, medical social worker had several data about patient’s activity. The program that could be given here was support the patient to follow all the instruction given by the doctor and the rehabilitation team.

In the follow up on February 6th 2018 , the examiner found that pain was decreasing, pain only when he maximally flexed his left wrist-fingers. There are improvement on wrist, MCP and finger flexion. Paresthesia and odema was also decreasing. In this condition, the physiotherapist continued gave TENS and still gave passive ROM exercises for left wrist and fingers flexion. For dorsal wrist splint, patient already wear dorsal wrist spint. In psychology, patient had less anxiety and therefore the previous psychology program was continued. No additional program in subunit medical social worker. The program that could be given here was support the patient to follow all the instruction given by the doctor and the rehabilitation team.

In the follow up on March 1st 2018, the examiner found there was more improvement on his hand. No pain at this time. Paresthesia was still exist but only limited to web skin area between thumb and index finger. The strength of muscles increasing to 4-5, the ROM also was markedly increase. In this condition, the physiotherapy gave active ROM exercise for left wrist and fingers flexion muscles, isometric exercise and nerve & tendon gliding exercise17,18. For orthotic prosthesis, pateint may discontinue splint and focuses for exercise and grip strengthening. For occupational therapy, the physiatrist had a plan to give strenghtening exercise for his wrist and fingers flexion and re-education sensories.



Figure 7. Nerve and tendon gliding exercise

Until the last follow up, all patient’s complains are already improved. He could flexed his wrist and fingers even though haven’t reach full strength and almost of full ROM. The patient has started working as a vendor at the PLN and starts the activity, even though the exercises are still carried out at home such as nerve and tendon gliding exercise, hand prehension. Overall, almost of our short term goals in rehabilitation already achieved and patients has no complaint about her condition and no limitation in doing all his activities.

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