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Superficial Digital Flexor Tendon Transfer in Leprosy Patient with Claw Hand : A Case Report

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Abstract: Leprosy is often accompanied by ulnar nerve lesion, this lesion is marked by the presence of claw hand, which in turn affect negatively the quality of life of the patient. The management of leprosy with claw hand is by doing the tendon transfer technique. There are several techniques that can be utilized when conducting tendon transfer, however in leprosy patient with claw hand, the most routinely used techniques are the FDS-4T (Four Tailed Superficial Digital Flexor) and ZLP (Zancolli's Lasso Procedure). Patients with leprosy and bilateral claw hands is being operated on using the FDS-4T and ZLP techniques. Each hand is operated using the same technique but different tendon transfer insertion. The patient is then evaluated based on the deformity and function to then compare between the two techniques. We found that the right hand that evaluated within 1 year post procedure, and the left hand is evaluated within 1 month post procedure. The result yielded a difference in the aspect of deformity yet there is no difference in the aspect of function. As a conclusion, tendon transfer procedure was done in leprosy patient with claw hand deformity yielded a good result in correcting deformity and restoring function.

Keywords: Claw hand, Tendon transfer, Leprosy

I. INTRODUCTION

Leprosy disease has been almost eradicated in most parts of the world. Leprosy used to be able to be frequently encountered, but rarely outside of Southern Asia, Africa, Latin America, and the Pacific Islands. In this modern times, leprosy is often can be found in India, Brazil, Myanmar, Madagascar, Mozambique, Nepal, Tanzania, and also Indonesia with the prevalency of 1:10000. Based on WHO data the proportion of patient with leprosy compared to leprosy patient with deformity is 1,44%. [1]

Leprosy is an infectious disease which involved the chronic inflammation caused by the Mycobacterium leprae bacteria. The characteristics of leprosy disease is a granulomatous lesion in the peripheral nerve, skin, and upper respiratory tract mucosal layer. Leprosy disease in itself is a treatable infection which can be managed using medication, but in some people it can cause disability. Leprosy can be transmitted by the means of droplets, skin contact wouldn't necessarily induce an infection providing the skin part doesn't have any lession. This infection can remit for several years before emitting any outwards clinical. [2]

The peripheral nerve is always involved in leprosy infection, the nerve would thicken as a result of granuloma and epineurium hypertrophy and perineurium, it would demyelinate, the axon would degrade and fibrosis process would occur on the endoneurium. The nerve thickening was possible due to strangulation by the nerve sheathing itself or by the rigid wall of the fibro-osseus tunnel where the nerve run its course. Often, the tuberculoid granuloma is where the casseous granuloma is. The contributive factor towards nerve damage is the failure of the given medication to reach the ischemic nerve segment. [2]

Neuropathy in leprosy is described as an ascending neuritis, on the cutaneous nerve it started on the skin lesion which then propagate to the subcutaneous nerve layer, and continuously spread towards the proximal direction and involve even bigger nerves system on the trunk level and its branches. The presence inflammatory reaction in the perineural and intraneural, is a characteristic sign of leprosy. The presence of M.leprae bacteria in the Schwann cells and intraneural macrophages. M.leprae bacteria found in

the intraneural area is a pathognomonic sign of leprosy. The inflammation in perineural part usually occur during the beginning of the lesion (indeterminate). [3]

Deformities in leprosy cases is divided into two categories. Primary deformity, which consists of sensoric and motoric disturbance, and secondary deformity, which is the contracture of the surrounding soft tissue due to the primary deformity. The fundamentals of leprosy management is to treat the primary disability and to prevent the secondary deformity. The deformity of the motoric function in ulnar nerve paralysis causes the claw hand deformity, the loss of synchronization when moving the fingers, and the loss of grasping and pinching strength. Tendon transfer is the recommended management in treating this paralysis, but it can undo all of the deformities. [4]

Surgical operation has a vital role in managing motoric imbalance, chronic infection and ulcer, and soft tissue and bone deformities correction. Nerve decompression in early phase can prevent the occurrence of paralysis. Steroid medication can also be given in order to reduce inflammation. Permanent claw hand can be treated using tendon transfer. This procedure should be done within 6 months after consuming anti-leprosy medication and after the neuritis acute phase. [5]

Surgical operation can be done if there is inability in doing grasp, grip, pinch, greeting, eating, and in the event of flat hand, also when the deformities due to intrinsic muscle paralysis causes stigmatized views from society and disability. Even if the median nerve is intact, then the lumbrical muscle of the fore finger and the middle finger can maintain the MCP extension, albeit weakly. Thereby, tendon transfer has to be done on all four fingers even if the paralysis only occurs in the ulnar nerve. [6]

Tendon transfer is a reconstruction procedure which involve removing the muscle-tendon unit (MTU) insertion and re-insert it in the bone or other tendon with the intention of replacing the lost function. The innervation and vasculature of the MTU will remain intact. Before doing the tendon transfer procedure, it is recommended to evaluate which functions of the hands that had been lost and which have remained intact. [7,8]

Tendon transfer is indicated when it is intended to replace untreatable muscle or tendon damage, to replace paralyzed muscles function, and to restore hand function balance. The timeline to execute tendon transfer is still to be debated, depending on the age, indication and prognosis. Tendon transfer is usually executed when passively mobilizing the joint is no longer possible, without contracture, and an adequate donor can be found. [9]

Grasping weakness is one of the most significantly felt disability and it can be reduced up to 60-80% in high ulnar palsy and 38% in low ulnar palsy. Restoring grip strength after tendon transfer depends on how much motor units are left. Distal insertion area in tendon transfer is an important factor in determining the flexion strength of the fingers. By using superficial digital flexor tendon, it is possible to place the distal insertion in five different places, which are: the proximal phalanx, the lateral band, the Common Digital Extensor tendon, A1 pulley, and A2 pulley. A biomechanics study has shown the traction from the A1 pulley resulted in higher strength in flexion, followed by the lateral band, the proximal phalanx, and the interossesus tendon. [4]

2. CASE REPORT

A 25-years old female was diagnosed with leprosy in July 2005, and was given the medication but dropped out. Then she was again given the medication on November 2007 and followed through. The complaints started on June 2007, patient started to feel pain and weakness on the ulnar side of both the right and left hand, and also felt the 4^{th} and 5^{th} finger started to bend.

Physical examination on the right hand showed flexion deformity on the 4^{th} and 5^{th} fingers accompanied by hypoesthesia and limited range of movement on the 4^{th} and 5^{th} fingers, the hand showed inability to function normally due to the mentioned deformities. The examination on the left hand also showed flexion deformity on the 4^{th} and 5^{th} fingers, hypoesthesia, and limited range of movement, also disturbance in normal function of the hand. Patient is then diagnosed with claw hands on both the right hand and the left hand, tendon transfer is then done to the patient in order to correct the claw hand deformity.

The right hand of the patient was operated on September 2011 using the FDS-4T (*Flexor Digitorum Superficialis Four Tail*) and ZLP (*Zancolli's Lasso Procedure*) techniques to correct the claw hand deformity and restore its function (Figure 1; A-L).

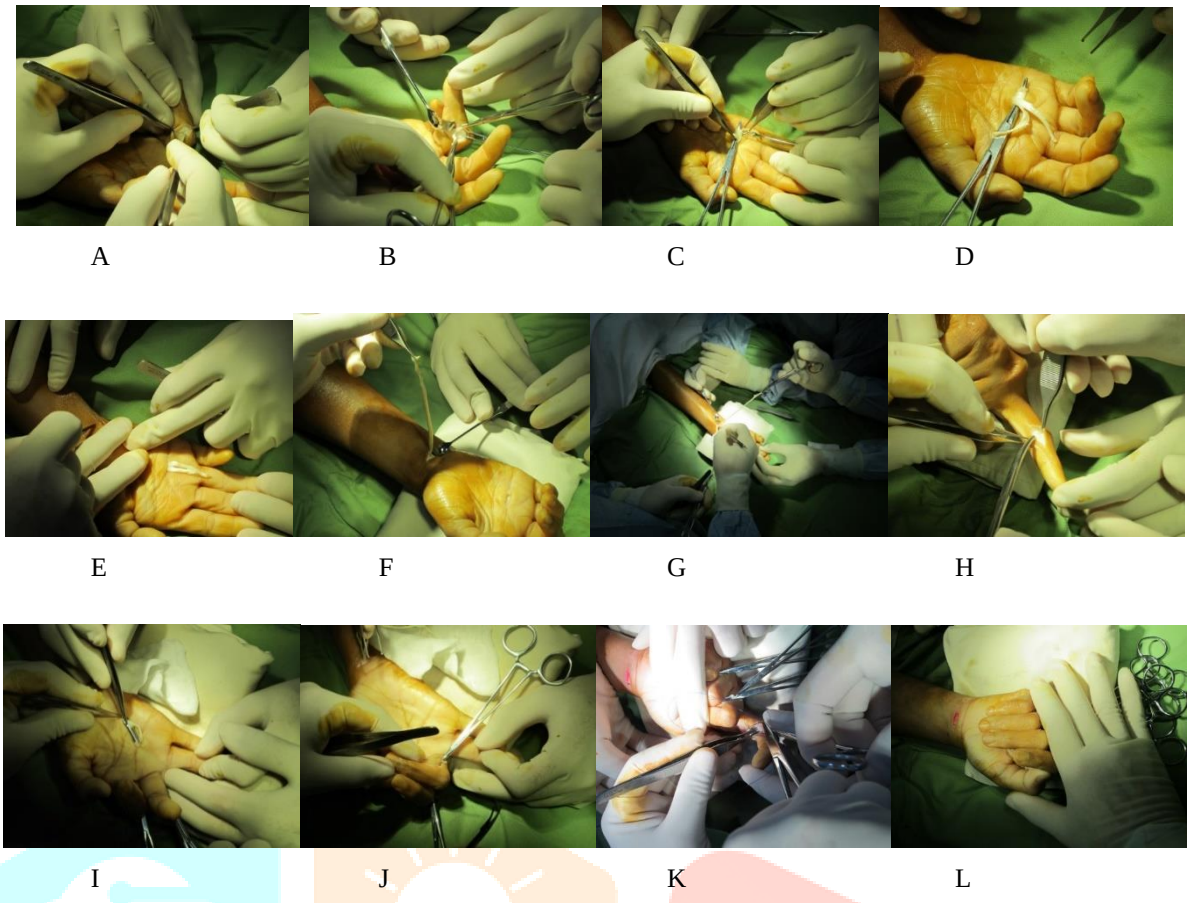

Figure 1. Surgical procedure on the right hand

A. Donor site incision; B. Tendon detachment; C. Zone II Incision; D. Tendon pull-out; E. Zone V Incision; F. Pull-out to zone V; G. four tail tendon split; H. Insertion site incision; I . Re-route to zone II; J. Re-route to insertion site; K. Stitching using the Zancolli's lasso procedure; L. Fingers Tensioning

The right hand was evaluated 1 year after the surgery. On evaluation, there were no deformity to be found on the right hand (Figure 2), no disturbance in doing daily activities and range of movements was within normal limits (Table 1), patient was able to do daily activities using the right hand, such as raising a cup, writing, and even sewing. However the interdigital space between the 3rd and 4th finger appeared to be smaller and there was disturbance when abducting the 3rd and 4th fingers.

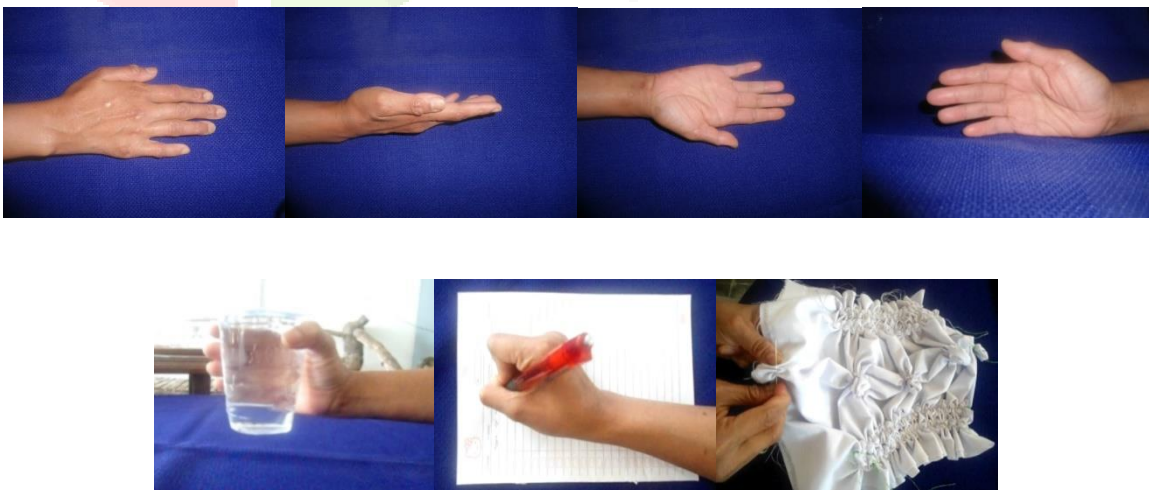

Figure 2. Post surgery evaluation of the right hand

Table 1. Active range of movements of the right hand after surgery

Digits	Active ROM of MCP	Active ROM of PIP	Active ROM of DIP	Muscle Contraction
IV	0 – 90	0 – 90	0 – 70	5
V	0 – 90	10 – 90	0 – 70	5

1 year after the first surgical procedure on the right hand, the left hand is operated on. Primarily, the procedure of the left hand is similar to the right hand, but with difference in the tendon insertion area. In the right hand, the tendon was inserted in the ulnar side of the 2nd and 3rd fingers, and in the radial side of the 4th and 5th dingers. While in the left hand, the tendon was inserted on the radial site of the 2nd, 3rd, 4th, and 5th fingers (Figure 3, A-L).

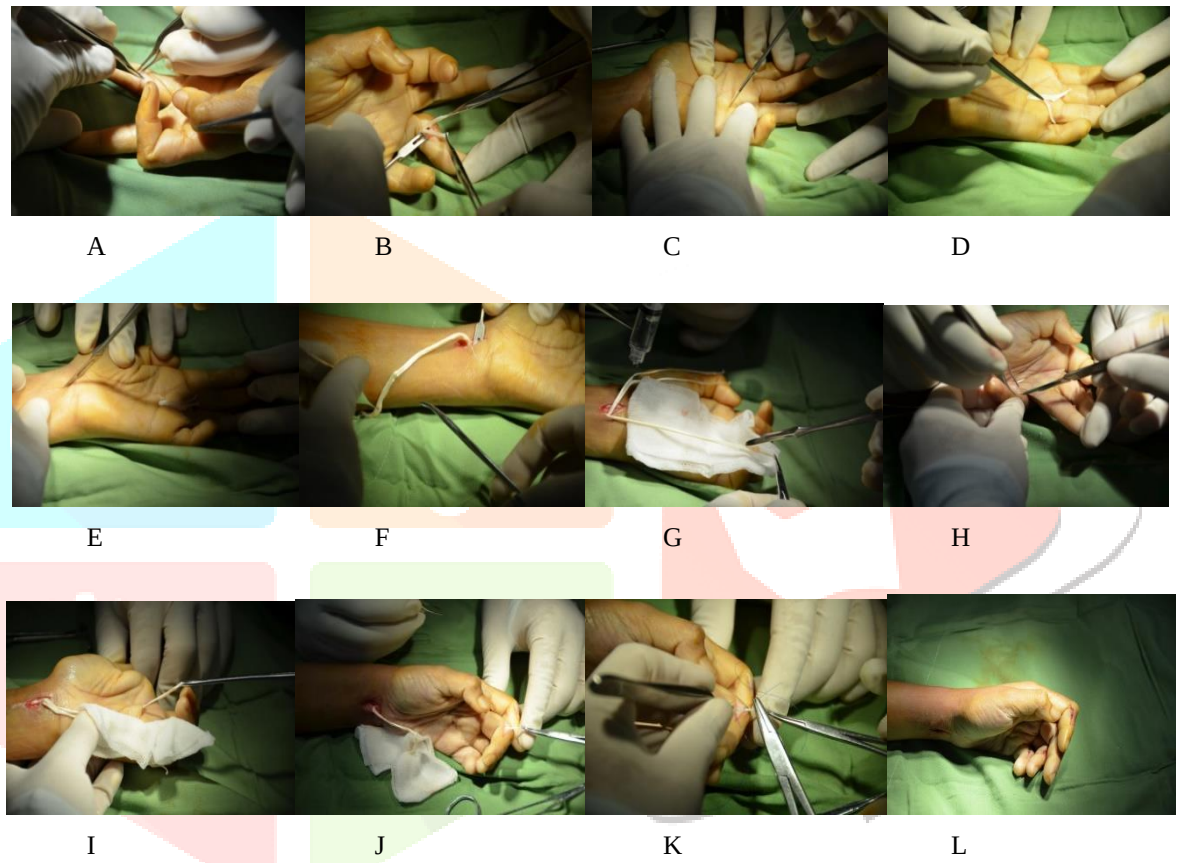

Figure 3. Surgical procedure on the left hand

A. Donor site incision; B. Tendon detachment; C. Zone II Incision; D. Tendon pull-out; E. Zone V Incision; F. Pull-out to zone V; G. four tail tendon split; H. Insertion site incision; I . Re-route to zone II; J. Re-route to insertion site; K. Stitching using the Zancolli's lasso procedure; L. Fingers Tensioning

Evaluation was done 1 month after the surgical procedure. On evaluation, there was still some swelling on the left hand, the flexion deformity on the PIP of the 4th finger was still found, the left hand has regained its normal function for daily activities but is not yet optimal (Figure 4)

Figure 4. Post-surgery evaluation of the left hand

Table 2. Active range of movements of the left hand post-surgery

Digits	Active ROM of MCP	Active ROM of PIP	Active ROM of DIP	Muscle Contraction
IV	0 – 90	30 – 90	0 – 70	4
V	0 – 90	0 – 90	0 – 70	4

3. DISCUSSION

People that have been infected by *M.leprae* would develop protective immunity against the infection. On several people, there would occur a skin lesion in the form of hypopigmented macule (*indeterminate leprosy*), which can heal spontaneously. If the infection process continue, it can develop into several types depending on the immune response of the infected person, which are Tuberculoid leprosy, Lepromatous leprosy and Borderline as the intermediate type. [2]

Out of the upper extremities nerves, the ulnar nerve is more prone to damage from leprosy. The medial nerve is more rarely damaged, even if it was, it's more often in the form of combination with the ulnar nerve. The radial nerve is the most rarely damaged. The paralysis of the intrinsic nerves causes clawing, in the beginning it's often just the 4th and 5th fingers, but it would damage all fingers in the end. Latent or hidden clawing sometimes occurs in the fore and middle finger due to lesion in the ulnar nerve. The loss of sensoric function on the ulnar nerve occurs the border of the ulnar nerve innervation. This would seem insignificant at first, but daily activities need good feed back from the 4th and 5th fingers, where these fingers are the ones that would first explore the area that would be reached by the hand. The loss of sensibility on the 5th finger would result in hand disability. [6]

Lession on the ulnar nerve would cause: Extreme hyperextension on the 4th and 5th *metacarpophalangeal* (MCP) joint due to the loss of the *interosseus* dan *lumbricales* muscles on the 4th and 5th fingers. Moderate hyperextension on the 2nd and 3rd *metacarpophalangeal* (MCP) due to the loss of the *interosseous* muscle. The *lumbricales* muscles of the 2nd and 3rd fingers would remain functional due to the innervation supply from the median nerve . The abduction of the 4th and 5th fingers. The loss of function of the interosseous muscle causes ulnar deviation due to the digital extensor muscle. Hyperextension of the 1st *metacarpophalangeal* (MCP) joint due to the loss of the *flexor pollicis brevis* muscle's functions. The inability of abduct the fingers due to the loss of function of the dorsal and palmar interosseous muscle . Impairment of pinching function of the 1st and 2nd fingers due to the loss of *adductor pollicis* muscle, also atrophic 1st *interdigital space*. The function is overtaken by the *flexor pollicis longus* muscle which is innervated by the median nerve, it can be seen using positive Froment's sign (flexion of the 1st *interphalangeal* joint). Patient would be unable to flex the distal phalanges of the 4th and 5th fingers due to the loss of *flexor digitorum profundus* muscle on the 5th and 5th fingers. [10]

The normal curving in the distal palmar area would cease or even inverted in the event of ulnar nerve lesion due to the loss of hypothenar muscles. This would result in the inability to do cupping or to close the fingers within themselves. The fine motoric

coordination and the normal joint movements would disappear due to the intrinsic muscle paralysis. The normal hand movement should begin with the MCP flexion, then PIP, and then DIP. In the event of ulnar nerve lesion, the order would be jumbled [6].

Claw hand causes high pressure on the fingertips and the ends of the metacarpal. Flexed contracture could cause fissures when trying to relax the fingers, which in turn would cause wounds and infection which made worse by the existence of loss of sensation on the hand. Hence, by correcting claw hand, the scarring could be prevented. [6]

It is important to prevent the development of nerve paralysis. The primary prevention is by early detection and administration of anti-leprosy medication. The secondary prevention would be educating the patient, specifically regarding the disease and the importance of hygiene. It is also important to consider physiotherapy in case of rigidity on the fingers. Physiotherapy with active exercises, massage, and passive stretching should be executed first before considering for tendon transfer. [5]

There are several techniques to utilize in doing tendon transfer. In this particular case, the FDS-4T (*Flexor Digitorum Superficialis Four Tail*) and ZLP (*Zancolli's Lasso Procedure*) is chosen because FDS-4T has shown to be more effective in correcting claw hand, while ZLP is better in restoring grip strength. It is hoped that the combination of these two techniques would result in regaining better normal function of the hand.

Flexor Digitorum Superficialis Four Tail (FDS-4T) (*modified Stiles – Bunnel transfer*)

The technique is done by doing mid-lateral incision on the radial side of the 3rd *Proximal Inter Phalanx* (PIP) joint. *Radial slip* tendon FDS is dissected near its insertion on the medial phalanx. A transversal incision is then made on the distal palmar crease then the Superficial Digital Flexor tendon is pulled towards the palm. The tendon is then divided into four parts of equal longitudinal length and size. Afterwards, the surgeon would make a dorsolateral incision on the radial side of the proximal 4th and 5th fingers, and on the ulnar side of the 2nd and 3rd fingers. Each of the splitted tendon is then followed-through through the lumbrical canal of each finger. The wrist joint should be in 45° dorsiflexion position, the *metacarpophalangeal* (MCP) should be flexed 70° and the *interphalangeal* (IP) should be extended fully, the tendon is then inserted to the lateral band of the 3rd, 4th, and 5th finger; whereas in the 2nd finger it is inserted to the ulnar lateral band. This position is to be maintained until after 4 weeks post-surgery. [11, 12]

Flexor Digitorum Superficialis Lasso Transfer (Zancolli's Lasso Procedure)

First, a transversal incision is made on the volar side of the distal palmar crease of the MCP joint. Then, the surgeon should identify superficial digital flexor tendon of each finger. The fibrous tunnel which sheath the flexor tendon is then unsheathed using an L-shaped incision and the superficial digital flexor tendon is dissected on the level of the proximal phalanges. The proximal stump from each tendon is then pulled backwards, then circled on the A1 pulley and stitched into the tendon itself on the level of the palm. The tension can be made from the extension of the neutral fingers so that it would result in maximum tension from the superficial digital flexor tendon. The same position as the FDS-4T technique is to be maintained for 4 weeks. [11, 12]

The importance of the 4th and 5th *flexor digitorum profundus* muscles is significant when doing a grasping motion, as well as the *flexor carpi ulnaris* muscle in stabilizing the hand on the ulnar deviation position. These muscles are innervated by the ulnar nerve and are often partially or even completely paralyzed. If the PIP and the DIP if severely contracted before surgery, then it is important to keep the splint for a while after the surgery in order to prevent recurrence. [6]

Theoretically, the insertion site when doing the FDS-4T technique should be on the ulnar side of the 2nd fingers and on the radial side of the 3rd, 4th, and 5th fingers. The radial insertion on the 3rd, 4th, and 5th, fingers is intended to direct the fingers towards the scaphoid bone, while the ulnar insertion site of the 2nd finger is to prevent over-correction. With this theory in mind, it is hoped to correct the existing deformity as close to the normal anatomy and in turn, regain the function as normal as possible,

The surgical management of bilateral claw hand was done to patient Sri Rahayu using two different surgical technique. On the right hand the insertion site of the 2nd and 3rd superficial digital flexor tendon is on the ulnar side, while the insertion site of the 4th and 5th fingers are on the radial side. This technique was done with the intention of correcting the claw hand deformity which only occurred on the 4th and 5th finger. Which is why the insertion site on the 3rd finger was done on the ulnar side because there was no deformity to be found on that finger.

The follow up result 1 year after the surgery has shown no deformities on the 4th and 5th fingers, as well as normal hand function on the right hand. However, the space between the 2nd and 3rd finger seemed to be tighter and there appeared to be difficulty when performing abduction movement using the 2nd and 3rd fingers. The patient had not complained anything regarding any function disturbance due to the mentioned difficulty.

On the left hand, the insertion site of the superficial digital flexor of the 2nd, 3rd, 4th, and 5th fingers was done on the radial side. This technique was intended to direct the fingers toward the scaphoid bone, as to reconstruct the anatomy as close to normal as possible and to regain normal function. In addition, the result of the previous surgery was also considered, which yielded a difficulty in doing the abduction movement in the 3rd and 4th fingers due to the insertion site being on the ulnar side of the 3rd fingers and radial side of the 4th fingers. Hence, the surgery on the left hand was done by inserting the tendon in the radial side in all fingers.

According to the follow up result after the surgery, there are no significant difference between the two different operation techniques. However, in term of strength, the left hand has yet to be evaluated clinically due to the procedure was only done 1 month before, whereas strength could only be evaluated 3 months after surgery. Therefore, it is recommended to schedule the next follow up 3 months after surgery, in order to use a tensiometer to evaluate the motoric strength.

4. CONCLUSION

A leprosy patient with bilateral claw hand deformity was operated using FDS-4T (*Flexor Digitorum Superficialis Four* Tail) dan ZLP (*Zancolli's Lasso Procedure*) tendon transfer techniques, which yielded an adequate result in correcting the deformities and restoring normal hand function. Despite the fact that the insertion area of the Superficial Digital Flexor Tendon between both hand, there was no significant difference within the functional aspect.

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