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## Occupational Therapy rehabilitation of postoperative hand injury cases and their functional independency

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### ABSTRACT

*Occupational Therapy (OT) after revascularization/replant of hand injury is not available in all centre. The prevalence of hand injury cases in India from road traffic incidences is about 30% and the total number of hand injuries would go higher upon adding the industrial injury cases. When primary repair isn't possible, tendon reconstruction is done. Kleinert (active extension, passive flexion) is a basic early motion program for rehabilitation of hand injuries. There have been significant innovations in therapy programme in different zones of tendon injuries in past. The aim of this study was to analyze the functional improvement after a postoperative regimen with the use of splints and Occupational Therapy. To determine the improvement in the Range Of Motion (ROM) and muscles strength with Occupational Therapy (OT) along with home-based activities in hand reconstruction cases. Thirty-two patients with different tendon injuries were retrospectively enrolled in this study from one and a half year of routinely collected data. Gross grip, fine grip and range of motion were measured using JAMAR, pinch O meter and finger goniometer respectively. Statistically and clinically significant improvement was observed in muscle strength (gross and fine) and range of motion in these patients' hands after modified Kleinert splint, custom made splint and home base exercise in all patients ( $p < 0.001$ ). With OT, patients with hand reconstruction surgeries can recover their muscle strength and range of motion to a great extent under supervised therapy and make them self independence in all activities. This can be done through the use of simple home-based tools and occupational therapy exercises.*

**Keywords**— Splinting, Tendon injury, Hand injury

### 1. INTRODUCTION

Occupational therapy is a discipline that aims to promote health through meaningful and purposeful activities. Occupational therapists work with individuals with mental, physical, developmental, and/or cognitive disabling conditions by utilizing treatments that develop, recover, or maintain their ability to perform activities of daily living. The goal of occupational therapy is to help clients have independent, productive and satisfying lives, so they can do things they need and want to do. The trauma related to tendons is very common in hand injury cases. [1,2,3,4] Occupational therapy has significant contribution in rehabilitation and restoration of digital function of affected finger and hand with a tendon injury. Since the past several years, there have been significant innovations in tendon repair and rehabilitation of patients sustaining different zones of flexor injuries. Based on improvements the mechanism of repair, new differentiated concepts have been developed although active extension, passive flexion, as introduced by Kleinert, is still the standard treatment in flexion tendon injury.[5] As per the Kleinert protocol and splinting, the dorsal part of the splint blocks the wrist at 45 degrees of flexion and Metacarp Pophalangeal (MP) joint at 10-20 degree. Dynamic traction is provided by rubber band between fingertips and volar aspect of the wrist to maintain the involved digits' flexion to further relax and also to prevent inadvertent active flexion of the tendon. Active extension and passive flexion have been subjected to several modifications over years. These are now well-established treatment techniques for flexion tendon injuries as demonstrated in several studies. [6,7,8,9] The standard Kleinert splint utilized for the purpose of rehabilitation is costly for the poor to afford. [8,9,10]

India is a developing country with many patients coming to the centres for treatment being non-affording.

The current study was done in the occupational therapy unit of a tertiary care centre catering mainly to the rural region. The large proportion of patients coming to this centre are from the lower or lower-middle socio-economic class. Majority of the patients visiting the hospital for therapy do not have the capacity to pay for the costly splints which are usually used in cases of tendon injuries after surgery, to maintain the position. In the current study, the authors have tried to document the effectiveness of simple home-based exercises and custom made low-cost splints to improve the functional movement in tendon injury cases.

The purpose of the study is to document the role of occupational therapy intervention in hand reconstruction surgery by assessing the change/ improvement in range of motion and the muscle strength in hand with a reconstruction surgery after receiving occupational therapy intervention at a tertiary care centre. The highlight of the study is the observed effect of the combination of OT along with home base exercises and the use of simple and low-cost splints made from things generally available at home.

## **2. MATERIALS AND METHODS**

This is a retrospective study done from the data routinely collected for the hand injury cases since February 2014 till July 2016 at the Occupational therapy unit in KMPIP Karamsad Anand Gujarat India. Data of thirty-two (32) patients with hand injuries were analysed for the study purpose. Age, gender and dominant hand, Occupation, type of surgery of the patients were recorded. The research project was conducted after getting clearance from the Human Research Ethics Committee (HREC) of the institution. Waiver of informed consent from the participants was sought from the HREC because the participants were not accessible for obtaining the same. Besides, the data being used in the study were collected as a part of the standard of care. Assurance about the confidentiality and anonymity of data at every stage of the study was given to the HREC.

All the patients referred from the Orthopaedic department after surgery were checked for the fulfilment of the inclusion criterion of the study. Tendon was repaired by use of different techniques, both profound and superficial tendon were repaired. The patients taking occupational therapy regularly for more than 3 weeks were only included in the analysis.

### **2.1 Post-Operative management**

After the reconstructive surgery of flexion tendon injury, three approaches were used for rehabilitation of the patients through Occupational therapy.[11]

1. Immobilization for two to three weeks before starting active and passive mobilization. [12]
2. Early Passive and Active mobilization.
3. Early passive and active mobilization along with the activities of daily living (ADL) training program.

All the patients visiting for OT were assessed for their baseline readings (after the immobilization phase) for gross grip and fine grip strengths along with their range of motion of the affected hand. After collecting all the relevant baseline information from the participants, the therapy was given to the individuals.

The modified Kleinert splint made by low-cost plastic and rubber band were fitted on all the patients. This splint was placed on the forearm up to the palmar aspect of the hand, with the wrist positioned at 30-35 degree of flexion, MP joint positioned at 50-60 degree of flexion. The inter-phalangeal (IP) joints were allowed the complete active extension. After application of the palmer modified splint, four different strength rubber loops were attached with the fingers for passive flexion (Figure 1). Early controlled active extension exercise was initiated after the application of the splint if the patient was not able to extend the digits, the tension of the rubber bands was changed suitably.

The patients were instructed to actively extend the involved digits against the tension of the rubber band 10 times per hour. After 4 weeks, the palmer modified splint was removed and active finger exercises were started by applying the wire splints (Figure 2,3). Also, the patients were instructed to do some home based activities using simple and easily available things at home by themselves. For example:

- (a) For strengthening of the small muscles the patients were taught and suggested use of dough of wheat flour (commonly used for preparing Indian bread) at home.
- (b) For pronation and supination, the patients were taught and advised to run the water tap by stabilizing the elbow joint.
- (c) Lifting and releasing of small grains from one bowl to another was advised for improving fine movements and coordination at home.
- (d) To improve the range of motion of the wrist joint, the motion of twisting the accelerator of the motorbike was advised.

### **2.2 Functional evaluation**

Gross grip strength was assessed by JAMAR hand dynamometer while fine grip strength was measured using Pinch O Meter. Finger Goniometer and beadboard were used for assessing the range of motion and 'grasp and release' respectively. The two-point discrimination (2PD) test was documented with the help of a compass aesthesiometer.

During the treatment sessions, if oedema was present in the affected hand of any patient, ice immersion followed by oil massage was applied. If the sensory loss was present in the affected hand, stimulations by vibration and different tactile were given.[13] Clay of different consistencies was used for strengthening of the small muscles of hand at the hospital and the patients were recommended to do the same exercise at home with the help of wheat dough used to prepare bread (chapatti) at home. The exercises with weighted blocks were made to perform for improvement of gross grip and strengthening of the whole limb.

After 15 days all the patients were assessed again on the same method and the improvement was documented for the data collection.

After some recovery, the patients, if observed necessary (The patients who were grossly ready for their regular activities but with some modifications required in their work area for support), were advised for tool modification to help them do or simplify their work. Also, as per individual needs, the patients were advised customized modification in their workstations, so that they could become independent in their life faster.

The splint that was made for use in these patients was made using the rubber band, simple hooks, adhesive and simple plastic material all of it together will cost around Rupees eight or lesser. The splint so prepared works on the same principles as that of the Kleinert’s splint which costs around thousand rupees or more. The other type of splint which was made by the hanger (Aluminium) wire used for the strengthening programme which was advised in their home base activities and the cost is not more the 10 rupees (INR).

The readings for the muscle strengths (both fine and gross), range of motion and sensory assessment by 2PD test were again taken at the end of one month of therapy for comparison with the initial reading.

Though the patients were presenting with different conditions and also accordingly their OT treatments also differed, yet for analysis purpose, all the patients have been considered together for we are interested in the difference between the pre-OT and post OT conditions for the parameters.

**2.3 Plan of statistical analysis**

The distribution of the participants by gender, dominant hand and affected hand etc are presented by frequencies. The difference of the initial assessment from the final readings for the recovery parameters such as range of motion, muscle strength for gross grip and fine grip for both active and passive movements and 2PD test are analysed using paired 't' test. The final p values were adjusted for the multiple comparisons using Bonferroni correction.

**3. RESULTS**

There were 32 participants in the study. One of the participants discontinued treatment here and went to her husband’s place for the continuation of treatment there as she could not stay at her maternal home for long In this study there.

The overall range of motion (calculated by adding all the range of motions of different fingers and thumb) was found to be statistically highly significant in the patients after Occupational therapy intervention than before (p<0.0001)

The overall gross motor power was found to be statistically highly significant in the patients after Occupational therapy intervention than before (p<0.0001).

There was very good improvement observed in the dynamometer, pinchometer and wrist functions in both the groups independently. Implying that both the methods improve the strengths both gross, fine as well as the different ranges of motion table 1.

**Table 1: Before-after comparison of dynamometer, pinchometer and wrist range of motion**

	Participants		P value con.
	Baseline	Endline	
<b>Dynamometer</b>	5.41(3.97)	15.56(5.79)	<0.0001
<b>Pinchometer</b>	7.09(5.06)	14.06(5.27)	<0.0001
<b>Wrist ext</b>	12.76(7.47)	33.93(9.29)	<0.0001
<b>Wrist flex</b>	15.30(6.27)	36.43(11.63)	<0.0001

There was no association found between a patient being functionally dependent or independent to their affected hand status whether dominant or otherwise (a chi-square p-value was >0.001). Table 2

**Table 2: FIM category distribution by the status of affected hand whether dominant or not**

Group		Affected hand status		Total
		The affected hand not dominant	Affected hand dominant	
Participants	Dependent(<52)	2	5	7
	Independent(>=52)	7	19	26
	Total	9	24	33

**Table 3: Muscle strength and sensation**

		Baseline Measurement mean (SD)	Measurement After 20 days mean (SD)	P value
Dynamometer (Kg)	F	1.15(0.55)	2.23(0.44)	<.0001*
	M	1.06(0.26)	2.33(.49)	<.0001*
Pincho meter (lb)	F	14.00(9.19)	19.77(9.26)	<.0001*
	M	14.47(10.66)	24.57(12.70)	<.001*
2PD Test (mm)	F	7.93(1.98)	6.29(0.81)	0.01
	M	7.41(2.01)	6.98(1.59)	0.066
ROM (for single digit = CP+PIP+DIP)	F	205.23(81.56)	225.86(55.64)	0.022
	M	173(58.77)	210.93(38.39)	<0.001*

\* Statistically significant at 5% LOS (adjusted for the multiple comparisons).

The overall fine motor power (calculated by adding all the fine motor power) was found to be statistically highly significant in the patients after occupational therapy intervention than before ( $p < 0.0001$ )

#### **4. DISCUSSION**

Early mobilization in postoperative flexion tendon injury would get the good result even in small sample size.

Palmer support Kleinert splint, aluminium wire splint and home base exercise programme were used in the current study. After flexion tendon injury Kleinert approach and Kleinert's splints are generally used for proper positioning. After 19 days supportive splint was removed and the active flexion was started as done in the study by Groth GN.[14] Different studies have used different materials for making the splint.[15,16], In this study splints were made by simple rubber and Velcro and hooks which kept the hand in active extension and passive flexion in flexion tendon injury. The reason for using these materials for the splint making was to make the cost of the splint lesser so the poor patients visiting the hospital with such injuries could also afford them and get benefited. The things used in making these splints are easily available and affordable compared to the readymade splints available in the market.

Through all the different ways used in the current study for regaining the range of motion and muscle strength the patients could reach their near baseline values within a month and could be integrated into their normal routine life fast.

#### **5. CONCLUSION**

Occupational therapy with home-based exercises and simple splints produces clinically acceptable improvement in tendon injury cases of hand, comparable to other standard splints used for the purpose. It is the limitation of this study that there is no control group employed to attribute the improvement to the new regime alone. But it was felt that having a control group for this study was not feasible in the setting where the study was conducted because depriving the tendon injury patients of the occupational therapy was considered to be unethical. Therefore, to produce stronger evidence, although the effect of this combination therapy can be subjected to further research with different study design from the current study, it can be expected to be as effective as conventional therapy.

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