Original Study

Efficacy of Modified Constraint Induced Movement Therapy in Post-Surgical Ulnar and/or Median Nerve Repair Patients

Smati Sambyal[1], Sandeep Kumar[2], Manisha[3]

[1,2]Lecturer, [3]MPT (Neuro), University College of Physiotherapy, Faridkot, India.

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Abstract

Background: After upper extremity nerve repair, there occurs impairment in hand functions which represents a major problem in activities of daily living (ADL) for the patient. Therefore, the patients after peripheral nerve repair needs rehabilitation to improve their functional status. This study was conducted to determine the efficacy of modified constraint-induced movement therapy in subjects after nerve repair in upper extremity.

Methodology: 27 post-surgical subjects of ulnar and/or median nerve repair, aged 18-60 years, were included in the study as per the selection criteria. The subjects were randomly divided into two groups, Group A (n=14) and Group B (n=13) and were assessed for functional disability, integrated hand function, pain and muscle strength using DASH questionnaire, SHFT, VAS and BMRC muscle strengthening grading system respectively. Group A received Modified constraint-induced movement therapy along with conventional therapy. Group B received Conventional therapy alone. The subjects were given a total duration of intervention of 8 weeks, with 5 weekly sessions and were reassessed after 8 weeks.

Conclusion: The results of this study conclude that modified constraint induced movement therapy combined with Conventional physiotherapy is more effective when compared to Conventional therapy alone in improving muscle strength and integrated hand function, reducing pain and disability in subjects with nerve repair in upper extremity.

Keywords: Modified Constraint Induced Movement Therapy; Nerve Repair; Peripheral Nerve Injuries.

Introduction

Traumatic peripheral nerve damage is a significant clinical and public health issue that frequently results in severe functional loss and permanent disability[1]. Penetrating damage, crush, traction, ischemia, and less common mechanisms like heat, electric shock, radiation, blunt injury, and injuries from sharp objects are among the causes of traumatic peripheral nerve injury[1]. About 30% of major nerve injuries are caused by lacerations such as those caused by glass, knives, fans, saw blades, metal, or long bone fractures[2].

Epidemiological reported prevalence is 16.9 per 100,000 persons annually with an average age of 38.42 years and 68.20% incidence of males. The incidence of Ulnar nerve injuries is reported most common (3.86 per 100,000)[3].

The degree and location of the nerve injury as well as patient-related variables, all play a role when nerve function can be restored after injury[4]. Depending on

Corresponding Author: Smati Sambyal, Lecturer, University College of Physiotherapy, Faridkot, India.

Email ID: Smatisambyal@gmail.com

the origin and extent of the injury, various peripheral nerve injuries exhibit varying effects. These include pain ranging from tingling to strong burning pain, numbness or altered sensations, muscle weakness in the affected body part, loss of function (such as difficulty using a hand or leg to complete tasks), and loss of active movement; Skin rashes, joint stiffness, and finally stress-related symptoms[5].

The simplest and most effective surgical option for severe axonotmesis and neurotmes is damage is still direct nerve repair with epineural micro sutures. A nerve repair is typically immobilized for up to 3 weeks post-operatively[6,7]. Even after surgical nerve repair following peripheral nerve injuries, the patients lack good recovery of functions. The resulting impairment in hand function after nerve repair represents a major problem in activities of daily living (ADL) for the individual patient. A multitude of physical therapy interventions have been proposed to be effective in post-operative management of epineural nerve repair, including therapeutic exercises, modalities, motor and sensory re-education of affected extremity. However, the purpose of this study was to investigate the utility of modified constraint-induced movement therapy in hand rehabilitation after median and ulnar nerve repair.

The focus of constraint-induced movement therapy is to improve the "learned non-use" condition suffered by individuals with central nervous system injuries such cerebral palsy or stroke. But there are limited sources available regarding the clinical evidence of role of modified constraint induced movement therapy in post-surgical nerve repair patients of upper extremity. In order to address this issue, this study was carried out to investigate if deafferentation of the healthy hand combined with intense, significant, and intentional use of the damaged hand can enhance hand function in these patients. This study also determines an effective rehabilitation technique in post-surgical nerve repair patients of upper extremity.

Methodology

This was a quasi-experimental study conducted at Outdoor Patient Department (OPD) of University College of Physiotherapy, Faridkot in the period between June 2022 to March 2023. A total of 27 post-operative subjects, both males and females, aged between 18-60 years, with unilateral ulnar and/or median nerve repair below elbow level due to road side accident, glass cut injury or assault were included and the subjects with brachial plexus injury, amputation of contra-lateral upper extremity, any previous history of peripheral nerve injury of upper extremity, reconstructive surgery procedure including nerve tube or grafts and nerve transfer surgery, nerve repair post neuroma formation, and mal-united or non-united fractures with segmental nerve loss or entrapped nerve of upper extremity were excluded from the study. The demographic data and informed consents were collected from each subject.

The subjects were assessed for muscle strength, integrated hand function, pain and functional disability using British Medical Research Council (BMRC) muscle strengthening grading system, Sollerman hand function test (SHFT), Visual Analogue Scale (VAS) and Disability of the Arm, Shoulder, and Hand (DASH) questionnaire respectively before and after the intervention. The subjects were randomly divided into two groups that is Group A (n=14) and Group B (n=13) and they were administered different programmes for rehabilitation after surgery. The duration of intervention programmes for both groups was eight weeks.

Interventions

The subjects in Group A were given Modified constraint-induced movement therapy along with conventional therapy. The subjects in Group B were given Conventional therapy alone. The techniques are mentioned below:

1. **Modified constraint-induced movement therapy:** After early immobilisation phase (1st to 3rd week post-operatively), the subjects in Group A were administered modified constraint-induced movement therapy 1 hour daily, 5 days per week for 4 weeks[8] (from 4th week to 8th week post-operatively) along with conventional therapy. Over the duration of the four-week intervention, subjects wore the splint/ binder to immobilise the healthy hand for the majority of their waking hours, with the exception of brief rest times or for hygiene reasons. During intervention sessions,

patients received training in reaching, grabbing, and manipulating essential items in daily living, as well as in dressing and undressing, using a spoon and fork to eat, grooming, and other crucial tasks with the use of affected hand while patients' healthy hand was immobilised with the splint/ binder.

2. **Conventional therapy**[9] Conventional therapy was done 5 times a week for 8 consecutive weeks (Table 1). Electrical stimulation, with exponential momentum, of the muscles that were partially or totally denervated, was started after 1 week of nerve repair for 15-20 min/day, 5 times a week for 8 consecutive weeks[10,11,12].

Table 1: The protocol for conventional therapy followed in both the groups.

A) Early post-operative phase (Week 1 – week 3)	
1. Protecting the sutures.	Immobilisation: - Bulky dressing for 2-3 days post-op. Splinting / Plaster of Paris for 3 weeks
2. Reducing post-op swelling	Positioning and elevation of affected upper extremity.
	Active assisted flexion/active extension of digits of affected upper extremity.
3. Managing pain	Positioning the affected upper extremity.
	TENS application proximal to site of nerve repair[13].
	Thermal modalities for decreasing muscle tone proximal to injured site.
4. Maintainingfunction in adjacent non-injured joints.	Active range of motion exercises of adjacent non-injured joints.
5. Maintaining and/or re-awakening cortical representation	Mirror therapy[14]
B) Early Intervention phase (Week 4 – week 6)	
1. Regaining motor function	Passive range of motion exercises of elbow, wrist and digits of affected upper extremity.
	Active assisted/Active range of motion exercises of elbow, wrist and digits of affected upper extremity.
	Active exercises of shoulder of affected side
2. Regaining sensory function	Sensory re-education[14,15]
3. Managing pain	Positioning of affected body part.
	TENS application.
4. Preventing contractures or correcting deformities	Splinting of affected hand according to need of the patients[16].
5. Improving function and activities of daily living	Displacing peg-boards with different sizes.
	Integration of affected hand in activities of daily living.
6. Optimizing the scar	Massaging the scar
C) Strengthening phase (Week 6 – week 8)	
1. Strengthening exercises	Progressive resistance training.

Results

The Statistical Analysis was done using SPSS (version 19) and Microsoft Excel 2010. The dependent variables were expressed by arithmetic means and standard deviation and tested using paired t-test within the group and unpaired t-test between the groups. The p-value of less than 0.05 was considered as significant.

Table 2: The Demographic profiles of subjects of both groups.

Demographic characteristic	Group A (n =14)	Group B (n = 13)
Age (in years) (Mean± SD)	27.64±7.948	31.62±15.591
Males, (n) %age	100%	85%
Ulnar nerve involvement, (n) %age	42.85%	46.15%
Median nerve involvement, (n) %age	28.57%	30.76%
Both nerves involvement, (n) %age	28.57%	23.07%

Table 3: Comparison of Scores of DASH, SHFT, VAS and MMT between two groups at baseline & follow-up (at 8th week).

Outcome Measure	Group-A (n=14)			Group-B (n=13)			Between groups	
	Pre-test	Post-test	Within group P-value	Pre-test	Post-test	Within group P-value	Pre-test P-value	Post-test P-value
DASH Score Mean±SD	84.81± 5.406	30.24± 7.960	<0.001	87.83± 5.717	49.27± 11.612	<0.001	0.1711, NS	<0.001
SHFT Score Mean±SD	16.57± 9.629	59.07± 11.256	<0.001	10.38± 6.063	26.62± 8.977	<0.001	0.0589, NS	<0.001
VAS Score Mean±SD	6.21± 1.477	2.64± 1.082	<0.001	7.00± 0.577	4.46± 0.967	<0.001	0.0851, NS	0.0001
MMT Score (Palmar abductors of thumb) Mean±SD	1.64± 1.151	4.29± 0.726	<0.001	1.38± 1.193	3.46± 0.877	<0.001	0.5721, NS	0.0132
MMT Score (Abductors of Digit 2) Mean±SD	1.50± 0.855	4.29± 0.469	<0.001	1.31± 0.480	3.46± 0.660	<0.001	0.4826, NS	0.0009
MMT Score (Abductors of Digit 5) Mean±SD	1.07± 1.207	3.71± 0.469	<0.001	0.85± 1.068	3.31± 0.947	<0.001	0.6131, NS	0.1651, NS
MMT Score (Adductors of Digit 5) Mean±SD	1.08± 1.038	3.08± 0.760	<0.001	1.08± 1.038	3.08± 0.760	<0.001	0.4116, NS	0.1606, NS

DASH- Disability of the Arm, Shoulder, and Hand (questionnaire); SHFT- Sollerman hand function test; VAS- Visual Analogue Scale; MMT- Manual Muscle Testing; SD- Standard Deviation; NS- Non-Significant.

Discussion

Following peripheral nerve injuries and repair, patients experience motor and sensory impairments that cause disability to use their upper limbs for daily activities. Even after surgical nerve repair following peripheral nerve injuries, patients lack good recovery

of function. This emphasizes the importance of effective treatment options in rehabilitation of post-surgical nerve repair patients that increases the recovery rate and decreases the disability. The aim of the study was to determine the efficacy of modified constraint-induced movement therapy in improving muscle strength and integrated hand function, reducing pain and disability in patients with nerve repair in upper extremity.

The findings of the present study indicated marked reduction in functional disability, pain as well as improvements in integrated hand function and muscle strength in terms of statistically significant difference (p value <0.001) DASH score, SHFT score, VAS score, MMT score of Thumb palmar abductors, Digit 2abductors, Digit 5 abductors and adductors on comparing the mean values of pre-intervention to post-intervention in both different interventional groups.

However, on comparing Group A and Group B, the results demonstrated that the performance of Modified Constraint Induced Movement Therapy along with conventional therapy in Group A was more efficient in reducing functional disability, pain as well as improving the integrated hand function and muscle strength of Thumb palmar abductors, Digit 2 abductors at the end of eight weeks than the performance of Conventional therapy alone in Group B. But none of the interventional program proved to be better than the other in improving muscle strength of Digit 5 abductors and adductors in Group A when compared with Group B. The findings of various previous studies done in similar area support the results of our study and are discussed below.

The statistically significant reduction in functional disability in terms of DASH score and improved hand manual dexterity with the use of Modified Constraint Induced Movement Therapy has been documented in the studies[8,17]. The reasons for the improvement may include, the use of injured limb for daily tasks and engaging in meaningful works. Paying more attention to the injured limb, and increasing environmental feedbacks from the injured limb to the brain are also considered for reducing functional disability in patients with nerve repair in upper extremity.

The role of maintaining engagement in meaningful home and work roles in reducing pain and disability in post-surgical upper extremity peripheral nerve repair due to better emotional and psychological status as well as improved grip, pinch, and functional evaluation outcomes is also addressed in previous researches[18,19].

The findings of different studies[18,19,20] showed the improvement in muscle strength with the use of physiotherapeutic rehabilitation programs in post-surgical median and/or ulnar nerve repair patients. Increased motor unit synchronisation, cross-transference, and higher motor unit activation are some of the proposed processes for increased muscle strength. Various researchers[12,14,21] also documented the use of low-frequency electrical stimulation in accelerated nerve regeneration and increased muscle strength. Electrical stimulation of denervated or partially denervated musculature delay the onset, and perhaps minimize the ultimate degree of denervation atrophy.

The studies done by various other researchers[18,23,24] also documented the reduced recovery in intrinsic hand muscles supplied by ulnar nerve. This may be because of the longer regeneration time of the injured ulnar nerve than that of the median nerve.

Our study has opened an interesting perspective for future clinical application and research in respect to hand rehabilitation in post-surgical upper extremity nerve repair patients. However, this study has limitations such as small sample size, no follow-up, evaluation of effect of modified constraint induced movement therapy on motor domains only and acute situation of the patients. Future studies with a larger sample size, a longer duration of treatment, patients with post-surgical management of nerve grafting or nerve transfer procedures, along with control comparison subjects, are necessary to determine the best scheme of rehabilitation for patients after nerve repair of upper extremity.

Conclusion

The present study concludes that Modified constraint induced movement therapy combined with Conventional physiotherapy is more effective in reducing disability and pain as well as in improving

integrated hand function and muscle strength, in patients with nerve repair in upper extremity than Conventional therapy alone.

Consent: Informed consent was received from all subjects in the study for the publication work in the journal.

Ethical Clearance: This study was approved by our institutional ethical committee.

Source of Funding: Self.

Conflict of Interest: Nil.

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