EFFECTIVENESS OF FUNCTIONAL VIBRATORY STIMULATOR ON OCCUPATIONAL PERFORMANCE IN POST OPERATIVE IMMOBILIZED COMPLEX HAND INJURIES.

DISSERTATION SUBMITTED FOR MASTER OF OCCUPATIONAL THERAPY

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CERTIFICATE

This is to certify that the research work entitled "EFFECTIVENESS OF FUNCTIONAL VIBRATORY STIMULATOR OCCUPATIONAL PERFORMANCE IN POST OPERATIVE IMMOBILIZED COMPLEX HAND INJURIES. " was carried out by (Reg.No. 41101151), KMCH College of Occupational Therapy, towards partial fulfillment of the requirements of Master of Occupational Therapy (Advanced OT in Orthopaedics) of the Tamil Nadu Dr.M.G.R. Medical University, Chennai.

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Abstract:

Purpose: The aim of the study was to find out the effects of functional vibratory stimulation in recovery of hand functions in post operative immobilized complex hand injuries.

Methodology: The study was done at the Ganga hospital, Coimbatore in the outpatient unit. The study population included 28 clients with complex hand injuries who were at the 4th week post op. rehabilitation. The population was divided into two equal groups by random sampling through lot system. The outcome measures used were COPM for occupational performance, BBT for dexterity, VAS for pain and MODIFIED sphygmomanometer for grip strength. The tests were conducted in which the pre test, immediate and late effects were recorded. Assessor blinding was followed for the pre test and immediate effect. The intervention time was for 4 weeks and then later the results were collected and computed for statistics.

Results: The results were determined with the statistical analysis through "t" test and comparison of mean scores across each group. The results showed improvement in function and all other domains in both the groups, the experimental group showed a extreme significant difference in all the domains when compared to the post test. The significance was according to the p value $P<0.0001$

Conclusion: The pain levels in the experimental groups showed a drastic decrease both immediately and later in the intervention phase. The grip strength and dexterity also changed at the final stage of intervention. The client based hand function training was more effective along with the FVS. The FVS has shown positive effects on all 4 domains of assessment and can be used as an adjunctive modality of treatment for hand joint stiffness.

Key Words: Occupational Performance, Grip Strength, Dexterity

CONTENTS

INTRODUCTION

The incidence of finger joint stiffness is inevitable as it becomes the most important issue addressed in treatment of complex hand injuries. The term *stiff* is used commonly when describing the hand lacking full mobility. Although it is usually a term reserved to describe the physical property of matter whose close molecular structure makes it rigid, resisting deformation when an external force is applied, stiffness of the hand is not an increased rigidity of the tissue themselves (Watson et al1994). Rather, stiffness is the constraint created by cross linking the previously elastic configuration of the collagen fibers (Franck et al 1984).

Tissue injury creates a relatively extended period of heightened collagen synthesis, degradation and deposition within a wound compared with normal tissue. Healing tissue progresses through 3 stages: inflammatory, fibroplastic and remodeling (or maturation). During the inflammatory, the wound prepares to heal, the tissue structure is rebuilt during the fibroplastic stage, and the final tissue configuration develops during the remodeling stage (Hardy et al 1989).

In the uncomplicated wound, the maturation stage begins between 3 and 6 weeks. In the hand with delayed healing infection, multiple tissue traumas, or multiple surgeries, the maturation phase may be delayed many weeks or months. As the cell population decreases, scar collagen fibers increase. The total collagen, accumulation then stabilizes and remains constant. At this stage, collagen deposition is accompanied by collagen degradation, creating equilibrium. Alternations in the architecture of scar collagen fibers occur as the scar matures. These physical changes are caused by changes in the number of covalent bonds between collagen molecules. Scars remain metabolically active for years, slowly changing in size, shape, color, texture, and strength (Madden JW et al 1976).

The primary factors behind stiffening of the hand are 1) edema 2) fibrosis 3) collagen alteration 4) anatomic factors, and 5) disease.

Conservative managements available are

- *Elevation*
- *Dynamic splints and traction*
- *Serial casting*
- *Intermittent compression unit*
- *Constant compression*
- *Local heat therapy*
- *Active exercise*
- *Passive exercise (Continuous passive movement)*

Surgical management

- *Capsulectomy*
- *Arthroplasty*
- *Ankylosis in extension*
- *Ankylosis in flexion*

Muscle stiffness can be defined as the change in force a muscle has to an increase in length (Wilson, Wood, & Elliott, 1991). This can be assessed in either an active or passive state, as stiffness is found within the contractile (cross-bridges) and passive visco elastic elements of a muscle (Wilson et al., 1991; Wilson, Elliott, & Wood, 1992; Wilson, Murphy, & Pryor, 1994).

Realizing this, it is very likely vibratory stimulation has the potential to affect these structures. For example, vibration causes small length changes in muscle fibres, and its spindles activate neural pathways via Ia afferent fibres causing agonist muscle contraction, and decreasing action potential activity to the antagonist. The net result would be increased stiffness due to greater cross bridges interaction (Bosco et al., 1999a). If vibration results in vaso dilation and increased blood flow, this also is likely to increase stiffness by increasing blood volume within the working muscle. However, if increased muscle temperature also occurs, it is quite likely that the visco elastic and hence damping properties of muscle are altered resulting in a decrease in stiffness.

Therapists treating complex injuries cannot follow the chronology of a wound and assume a certain stage, but rather must be able to evaluate the characteristics of the wound or healing scar and determine its stage to devise appropriate therapy.

The effects of vibration on the human body have been documented for many years. In fact, a drive along a rough road was once prescribed for individuals suffering from kidney stones due to the therapeutic effects of the bumpy ride. Many positive effects of vibration on the human body have also been reported in therapeutic and clinical settings in which vibration has been used for pain management and to elicit muscle contractions in spastic and paretic muscles. Recently, the use of vibration for improving the training regimes of athletes has been investigated. Vibration has been used during strength-training movements such as elbow flexion and vibration has also been applied to the entire body by having subjects stand on vibration platforms (Mester J, Spitzenpfeil P et al 2002).

Vibration is a mechanical oscillation that can be defined by frequency and amplitude. Frequency is defined as the cycles per unit time and is generally measured in the unit of hertz (Hz) [cycles per second. Amplitude is defined as the half difference between the maximum and the minimum value of the periodic oscillation Dimarogonas A.et al 1996

Vibration of a muscle stimulates the primary endings of the muscle spindle (Ia afferents), which excites a-motor neurons, causing contraction of homonymous motor units, and this results in a tonic contraction of the muscle, referred to as the tonic vibration reflex (Humphries B, Warman G, Purton J, et al 2004). During an exposure to vibration, the stretch reflex and the Hoffman-reflex (H-reflex) are inhibited, and this has been referred to as the vibration paradox—vibration induces the tonic vibration reflex but inhibits the stretch VIBRATION TRAINING 461 reflex and the H-reflex (von Gierke HE, Goldman DE et al 1988).

Vibration has been widely used as a therapeutic tool for rehabilitation, pain management and therapy. Early research reported the prescription of vibration for the treatment of 'acute neuralgic pain' (Granville, 1881). Therapists have used vibration for many years both in the treatment of pain and in the acute relief of spastic rigid muscle (Bishop, 1974).

Although vibration has such therapeutic influence on muscle tissue and collagen not many studies have described the effects of mechanical vibration on reducing joint stiffness and also its relationship with client based functional recovery of the hand. Thus our study aims at finding out the effectiveness of functional vibratory stimulatory on reducing joint stiffness in complex hand injuries post operative rehabilitation and client centered functional recovery.

RELATED LITERATURE:

PATHOPHYSIOLOGY OF JOINT STIFFNESS

Tissue injury creates a relatively extended period of heightened collage synthesis, degeneration, and deposition within a wound compared with normal tissue. In the ideal circumstance, a healing wound progresses in stages in an orderly manner. Wounds resulting in massive tissue injury infection, delayed healing, repeated surgery, or poor wound toileting extend these stages of healing far beyond the healing time frame.

In the uncomplicated wound the initial inflammatory phase of wound healing is completed within a few days. Because the intercellular forces are weak wounds may be disrupted with ease during this stage and most surgical wounds are rested via immobilization until the wound healing has begun. Randomly oriented, matted collagen fibrils unite the injured structures during the early phase of healing, although fibrils cannot be visualized through the light microscope.

About two days later the fibroblasts begins the process of collagen synthesis and outnumber the granulocytes and macrophages in the wound. The fibroblasts evolve into myofibroblasts and are responsible for fiber synthesis and concurrent contraction of the wound edges. Capillaries re establish within the wound, forming a dense network. Collagen fibers are laid down between the capillaries, forming scar needed to keep the wound closed.

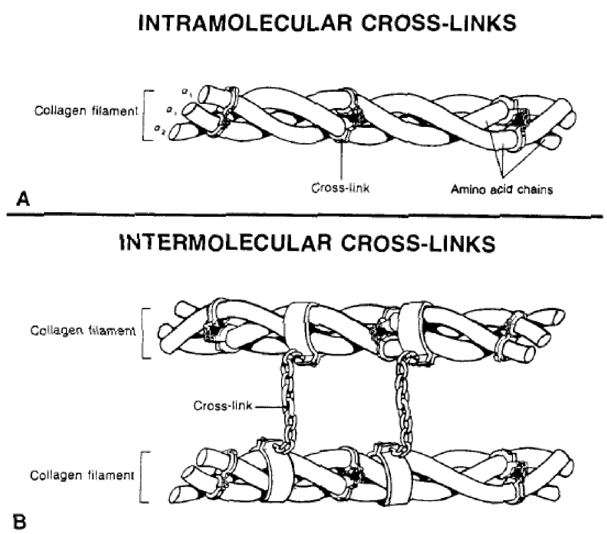


Fig. 61-1. Collagen cross-linking occurs between amino acid chains within one collagen filament (weak cross-links) **(A)** and between collagen filaments, locking them to one another (strong cross-links) **(B)**. (From Hardy MA: *Phys Ther* 69:1014, 1989.)

Joint stiffness and tissue adherence palpated during this stage can be described by a soft end feel at the limitation of motion. This tissue responsiveness occurs because the cross linking of the collagen fibers is weak and stress causes the collagen fibers to align themselves with the direction of stress. Because of the diminished strength of healing tissue, excessive force can tear the fibrils, causing more injury and reviving the inflammatory process. Any force applied must be slow, gentle, and sustained. In the fibro-plastic stage, intermittent active motion is ideal means of applying stress to the disorganized collagen to encourage it to realign.

In hand with delayed healing the maturation phase may take more time. Here as cell population decreases scar collagen fibers increase. The total collagen accumulation then stabilizes and remains constant. At this stage the collagen deposition is accompanied by collagen degradation, creating equilibrium. Alterations in the architecture of the scar occur. These physical changes are caused by the number of covalent bonds between collagen molecules. Wounds at this stage exhibit a hard end feel to PROM. The joint feels as if it will not yield to force, but stops abruptly. This type of response to palpation requires more consistent application of force.

THE MANAGEMENT OF JOINT STIFFNESS

The management of joint stiffness depends on the stages involved. And the type of injury the root causes has already been discussed earlier. The main aim of management will be based on

- Edema control
- Prevention of contractures
- Passive exercises
- Maintain function

The edema management with the vibratory stimulus can be done at the early stages of healing and this is supported with S. Johnson, RN et al who conducted a study on the topic "Can cycloidal vibration plus standard treatment reduce lower limb cellulitis treatment times?".This single-centre non-blind randomized controlled trial aimed to compare clinical outcomes in terms of recovery time of standard treatment of lower limb cellulitis versus standard treatment combined with cycloidal vibration (Vibro-Pulse) therapy. In this study thirty-six patients (18 per group) with lower limb cellulitis were randomized to receive either standard treatment (intravenous or oral antibiotic therapy) and bed rest or standard treatment combined with cycloidal vibration treatment three times per day, 30 minutes per treatment. The outcome measure was the daily amount of reduction in erythema/cellulitis and oedema reduction against time for up to seven days of treatment and the resources required. And results showed that there was a clinically significant difference between the two groups, with 66% of the study group fully recovering within the seven days compared with 11% of the control group. Which concludes Cycloidal vibration combined with standard therapy can significantly reduce cellulitis treatment time. This can reduce both hospital bed days and the resources required.

Prevention of contractures can be achieved through various techniques

- Gentle external massage
- Early hand mobilization
- Continuous passive motion
- Low load prolonged stress
- Static and dynamic splinting
- Serial casting
- Static progressive mobilization splints

Laupattarakasem W. Conducted a study on "Short term continuous passive motion. A feasibility study". From which he conclude that Continuous passive motion (CPM) is an established method of preventing joint stiffness and of overcoming it. The optimum duration of treatment, however, is not known, though a period of one to three weeks is usual.

The conventional activities based on the COPM measurement were given as a part of the intervention these activities were based on the biomechanical principle which is well supported by Thomas E. Trumble et al conducted a "A Randomized Prospective Trial of Active Place and Hold Therapy Compared with Passive Motion Therapy Zone-II Flexor Tendon Re pair'. The study aimed to improve digit motion after zone-II flexor tendon repair, their objective was to compare the results of patients treated with an active therapy program and those treated with a passive motion protocol following zone-II flexor tendon repair. Between January 1996 and December 2002, 103 patients (119 digits) with zone-II flexor tendon repairs were randomized to either early active motion with place and hold or a passive motion protocol. Range of motion was measured at six, twelve, twenty-six, and fifty-two weeks following repair. Dexterity tests were performed, and the Disabilities of the Arm, Shoulder, and Hand (DASH) outcome questionnaire and a satisfaction score were completed at fifty-two weeks by ninety-three patients (106 injured digits). At all time points, patients treated with the active motion program had greater interphalangeal joint motion. At the time of the final follow-up, the interphalangeal joint motion in the active place-and-hold group was a mean (and standard deviation) of 156 ± 25 compared with 128 ± 22 ($p < 0.05$) in the passive motion group. The active motion group had both significantly smaller flexion contractures and greater satisfaction scores ($p < 0.05$).

Aims and objectives

Aims:

To find out the effectiveness of functional vibratory stimulator in recovery of hand functions in post operative immobilized complex hand injuries.

Objectives:

- To find out the effect of functional vibratory stimulator on grip strength in clients with post op 4th week rehabilitation for complex hand injuries.
- To find out the effect of functional vibratory stimulator on dexterity in clients with post op 4th week rehabilitation for complex hand injuries.
- To find out the effect of functional vibratory stimulator on pain due to therapy in clients with post op 4th week rehabilitation for complex hand injuries.
- To find out the effect of functional vibratory stimulator on occupational performance in clients with post op 4th week rehabilitation for complex hand injuries.

Null Hypothesis

- There is no significant effect of functional vibratory stimulator on dexterity in clients with post op 4^{th} week rehabilitation for complex hand injuries.
- There is no significant effect of functional vibratory stimulator on grip strength in clients with post op 4^{th} week rehabilitation for complex hand injuries.
- There is no significant effect of functional vibratory stimulator on pain in clients with post op 4^{th} week rehabilitation for complex hand injuries.
- There is no significant effect of functional vibratory stimulator on occupational performance in clients with post op 4^{th} week rehabilitation for complex hand injuries.

Alternative Hypothesis

- There is significant effect of functional vibratory stimulator on dexterity in clients with post op 4^{th} week rehabilitation for complex hand injuries.
- There is significant effect of functional vibratory stimulator on grip strength in clients with post op 4^{th} week rehabilitation for complex hand injuries.
- There is significant effect of functional vibratory stimulator on pain in clients with post op 4^{th} week rehabilitation for complex hand injuries.
- There is significant effect of functional vibratory stimulator on occupational performance with post op 4^{th} week rehabilitation for complex hand injuries.

Review of Literature

Shirahashi I, Matsumoto S et al in the year December 2004 from the Department of Rehabilitation and Physical Medicine, Kagoshima University Graduate School of Medical and Dental Sciences, Kirishima-shi, Kagoshima, Japan. Conducted a study on “Functional vibratory stimulation on the hand facilitates voluntary movements of a hemiplegic upper limb in a patient with stroke.” They used a new device consisting of a small vibrator to deliver functional vibratory stimulation (FVS) to the arm which resulted in improvements of flexion of the hemi paretic shoulder in a man with thalamic bleeding. FVS delivered to the palm enabled the patient to repeat flexing his hemi paretic shoulder to manipulate objects with his hand. The functions of the patient's hemi paretic shoulder and fingers improved after treatments using FVS for 1 month. They examined whether FVS of the hemiplegic upper limb could facilitate voluntary movements of the limb by increasing the excitability of the motor cortex or the spinal motor neurons using somato sensory-evoked potentials, transcranial magnetic stimulation, F-wave, and single photon emission computed tomography. And their results did not detect an increase of excitability in the motor cortex or in spinal motor neurons.

Kazumi et al November 1981 conducted a study on “New functional vibratory stimulation device for extremities in patients with stroke”. Here the utility of a new device that delivers functional vibratory stimulation to the extremities was studied in 13 patients with stroke. They hypothesized that vibratory stimulation of the hemiplegic lower limb would increase gait speed in these patients. The device consisted of one battery, two small vibrators and a connecting wire. The small vibrators were stabilized on the anterior tibial muscle and gluteus medius muscle by a bandage. An analysis of the effects of functional vibratory stimulation on hemiplegic lower limb on gait speed indicated that gait speed was greater during stimulation than without. These results suggest that the new device of functional vibratory stimulation is useful for treatment in patients with stroke.

M. Christova D. Rafolt et al in September 2009 conducted a study on "Vibration stimulation during non-fatiguing tonic contraction induces outlasting neuroplastic effects" The objective of the study was to explore if vibration superposed to tonic contraction induces plastic changes in the contra- and ipsilateral motor cortex. Healthy subjects (*n* = 12) abducted the right index finger with a force 5% of maximal voluntary contraction (MVC) against the lever of a torque motor while a 60 Hz vibration stimulus of 10 min was delivered. Motor evoked potentials (MEPs) after single and paired-pulse transcranial magnetic stimulation (TMS) were recorded from the first dorsal interosseous muscle of right and left hand pre, during, post and 30 min post-stimulation. The TMS assessments were employed with tonic contraction alone (TONIC) and with superposed vibrostimulation (VIBRO), each for the ipsi- and contralateral cortex separately. In the contralateral cortex: resting motor threshold (rMT) decreased, MEP amplitudes increased, short-interval intracortical inhibition (SICI) reduced and intracortical facilitation (ICF) increased post VIBRO, while no changes occurred post TONIC. In the ipsilateral cortex: rMT decreased, MEP amplitude increased and SICI reduced during TONIC, while no changes occurred post TONIC, during and post VIBRO. Vibration superposed to tonic contraction, induces lasting (30 min) plastic changes, whereas contraction alone caused no outlasting effects. Mainly intrinsic intracortical mechanisms are involved because spinal adaptation could be excluded (*F*-wave assessments). These findings have a therapeutic potential in the functional recovery of motor deficits with robot-aided devices.

Steven Rees, Aron Murphy, and Mark Watsford conducted a study on the "Effects of Vibration Exercise on Muscle Performance and Mobility in an Older Population". This study was designed to investigate the effects of vibration on muscle performance and mobility in a healthy, untrained, older population. Forty-three participants (23 men, 20 women, 66–85 y old) performed tests of sit-to-stand (STS), 5- and 10-m fast walk, timed up-and-go test, stair mobility, and strength. Participants were randomly assigned to a vibration group, an exercise-without vibration group, or a control group. Training consisted of 3 sessions /wk for 2 months. After training, the vibration and exercise groups showed improved STS (12.4%, 10.2%), 5-m fast walk (3.0%, 3.7%), and knee-extension strength (8.1%, 7.2%) compared with the control ($p < 0.05$). Even though vibration training improved lower limb strength, it did not appear to have a facilitatory effect on functional performance tasks compared with the exercise-without-vibration group. Comparable mobility and performance changes between the experimental groups suggest that improvements are linked with greater knee-extension strength and largely attributed to the unloaded squats performed by both exercise groups.

Johanne Higgins et al who conducted a study on "Upper-limb function and recovery in the acute phase post stroke" This study evaluated stroke patients with upper-limb (UL) motor deficits using measures of impairment and "activity limitation" to quantify recovery of UL function post stroke and to identify predictors of UL function and predictors of UL recovery following stroke. The study also compared the recovery of UL function with that of the lower limb (LL). Measures of impairment and "activity limitation" of the UL and LL improved over the first 5 weeks. The Box and Block Test performance improved the most over 5 weeks (standardized response mean [SRM] = 1.34), followed closely by the 5-meter walk test (SRM = 0.97).

John B. Cronin in the year April 2003 conducted a study on "Muscle stiffness and injury effects of whole body vibration". The aim of this study was to determine whether whole body vibration had an effect on the stiffness of the triceps surae muscle group. The stiffness of the right and left leg of 11 relatively untrained subjects was measured prior to a warm-up, post-warm-up and post vibration using a damped oscillation technique. After warm-up, one leg was vibrated (frequency 26 Hz, amplitude 6 mm) whilst the other leg acted as a control. The subjects were exposed to the vibration five times for duration of 60 s with a 60 s rest between each repetition. The results showed no significant differences ($P < 0.05$) in stiffness were found between the baseline measures and the post-warm-up and post vibration measures of stiffness. Following vibration a number of subjects experienced pain to the lower leg muscles and a loss of function. In some subjects, the pain was experienced at the jaw and the neck. These symptoms required treatment in six subjects but the pain had resolved within 7–10 days in all subjects. In conclusions it appeared that vibratory stimulation loading parameters used to enhance performance do not significantly alter muscle stiffness in untrained individuals. Considering the injury potential associated with whole body vibration further research into safe dose response relationships is recommended.

Lundeberg TC in the year 1983.conducted a study on "Vibratory stimulation for the alleviation of chronic pain." In this study the pain relieving effect of vibratory stimulation was studied in 731 patients suffering from acute pain (135 patients) or chronic pain (596 patients). Most of the patients had previously undergone treatments of various kinds without sufficient pain relief. The effect of vibratory stimulation was assessed before, during and after stimulation using different rating scales. About 70% of the patients reported reduction of pain during vibratory stimulation. In many patients there was a clear relation between the degree of reduction of pain and the intensity of pain before the beginning of stimulation. In general, relief of pain by more than 50% during stimulation was obtained in the patients who reported light, light to moderate, or moderate pain. The patients with moderate to severe, or severe pain before stimulation generally reported a reduction of pain of 50% or less. The best pain reducing site was found to be either the area of pain or close to it, the antagonistic muscle or a trigger point near the painful area. In most patients suffering from musculoskeletal pain the best pain reducing effect was obtained when the vibratory stimulation was applied with moderate pressure (at which contact was achieved with underlying bone) at a frequency of 50-150 Hz. To obtain a maximal duration of pain relief the stimulation had to be applied for 30-45 minutes. Many of the patients experienced pain relief lasting for more than 3 hours. It may be noticed that in many patients the pain relief lasted for 12 hours or more. There was a good correlation between the degree of pain relief and its duration. In the patients who experienced a pain reduction of 50% or less the pain relief generally lasted for less than 6 hours while in the patients who experienced pain relief of more than 50% it lasted for more than 6 hours. In comparison with high or low frequency TENS, vibratory stimulation was found to be as effective and in some patients even more effective in reducing chronic musculoskeletal or oro facial pain. The effect of 20 Hz, 100 Hz and 200 Hz vibratory stimulation, high frequency TENS, low frequency TENS and "placebo" vibratory stimulation was examined in various chronic musculoskeletal pain syndromes. 82% of the patients experienced a relief of pain with any of the above mentioned methods; 47% of the patients experienced a reduction of pain with vibratory stimulation or TENS stimulation.

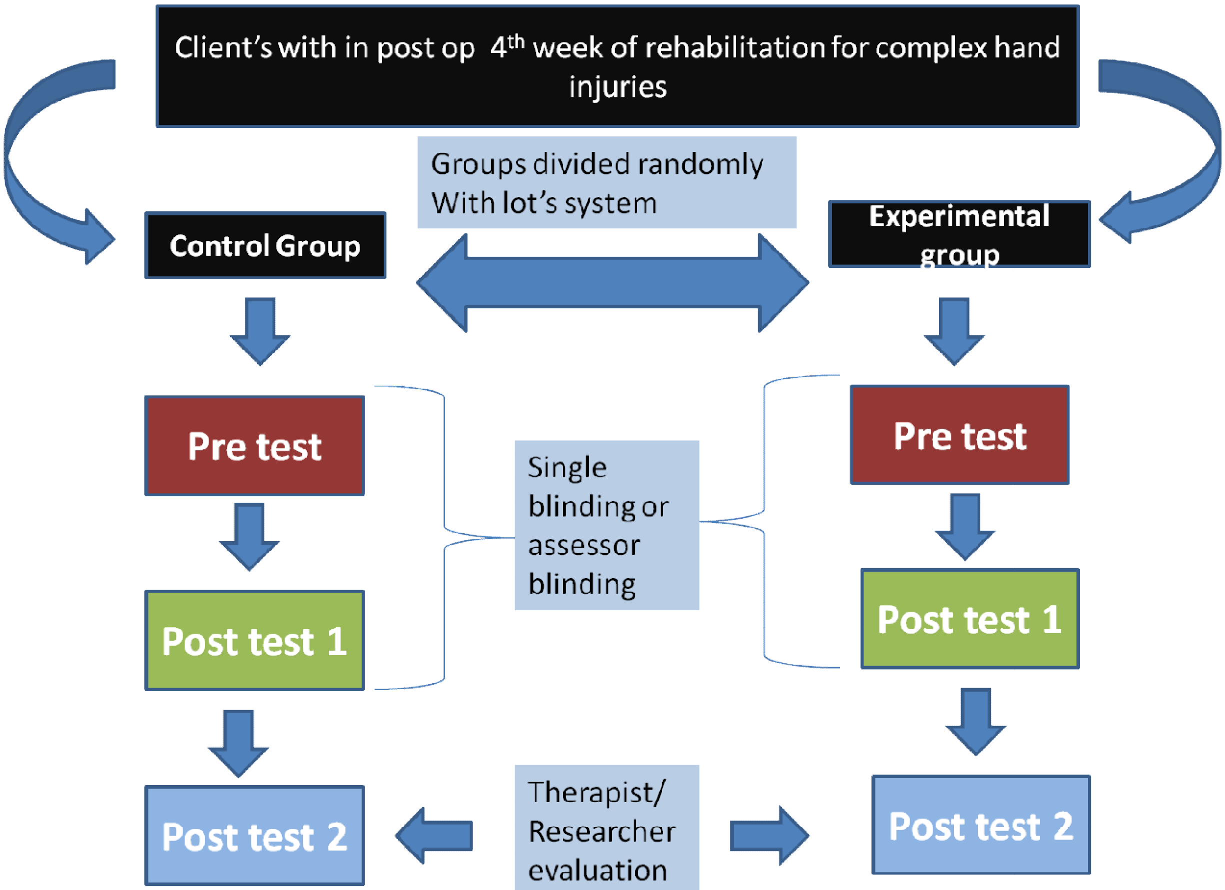
V.B. Issurin*And G. Tenenbaum in the year January 1998 at the Ribstein Centre for Research and Sport Medicine Sciences conducted a study on "Acute and residual effects of vibratory stimulation on Explosive strength in elite and amateur athletes". In which 14 elite and 14 amateur athletes were subjected to vibratory stimulation during bilateral biceps curl exercises of explosive strength exertion. The athletes performed two separate series of three sets of exercises in random order. The second set of one series was administered with superimposed vibration of 44 Hz and an acceleration of about 30 m/s- 2 transmitted through the two-arm handle to the arm muscles. The mechanical power of each repetition was measured by the `Power Teach' instrument. The maximal and mean power values for each set were automatically recorded and shown on the screen. The acute effect was evaluated as the difference between the mean and peak power output in the second (with vibratory stimulation) and (without vibratory stimulation) sets. Similarly, the residual effect was taken to be the difference between the power values of the third (after vibratory stimulation) and (before vibratory stimulation) sets. The results were subjected to a repeated-measures analysis of variance with group as a between-participants factor. The results showed that exercise mode (with vs. without vibratory stimulation) resulted in a significant immediate effect for mean power and for maximal power. The factor group (elite vs amateurs) resulted in a significant effect for maximal power only. The increase in explosive strength exertion attributed to vibratory stimulation was 30.1 and 29.8 W (10.4% and 10.2%) for maximal and mean power respectively in the elite group, and 20.0 and 25.9 W (7.9% and 10.7%) respectively in the amateur athletes. Vibratory stimulation resulted in a significant residual effect.

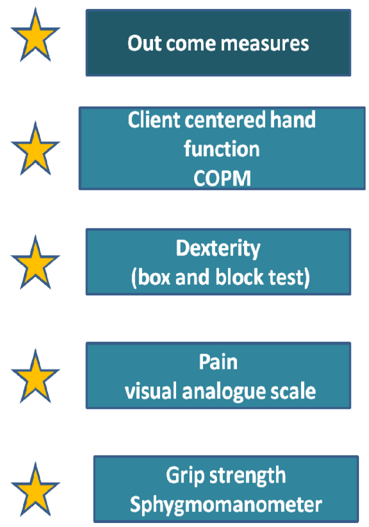
Thomas E. Trumble et al conducted a "A Randomized Prospective Trial of Active Place and Hold Therapy Compared with Passive Motion Therapy Zone-II Flexor Tendon Re pair'. The study aimed to improve digit motion after zone-II flexor tendon repair, their objective was to compare the results of patients treated with an active therapy program and those treated with a passive motion protocol following zone-II flexor tendon repair. Between January 1996 and December 2002, 103 patients (119 digits) with zone-II flexor tendon repairs were randomized to either early active motion with place and hold or a passive motion protocol. Range of motion was measured at six, twelve, twenty-six, and fifty-two weeks following repair. Dexterity tests were performed, and the Disabilities of the Arm, Shoulder, and Hand (DASH) outcome questionnaire and a satisfaction score were completed at fifty-two weeks by ninety-three patients (106 injured digits). At all time points, patients treated with the active motion program had greater interphalangeal joint motion. At the time of the final follow-up, the interphalangeal joint motion in the active place-and-hold group was a mean (and standard deviation) of 156 ± 25 compared with 128 ± 22 ($p < 0.05$) in the passive motion group. The active motion group had both significantly smaller flexion contractures and greater satisfaction scores ($p < 0.05$). They could identify no difference between the groups in terms of the DASH scores or dexterity tests. When the groups were stratified, those who were smokers or had a concomitant nerve injury or multiple digit injuries had less range of motion, larger flexion contractures, and decreased satisfaction scores compared with patients without these co morbidities. Treatment by a certified hand therapist resulted in better range of motion with smaller flexion contractures. Two digits in each group had tendon ruptures following repair. Active motion therapy provides greater active finger motion than passive motion therapy after zone-II flexor tendon repair without increasing the risk of tendon rupture. Concomitant nerve injuries, multiple digit injuries, and a history of smoking negatively impact the final outcome of tendon repairs.

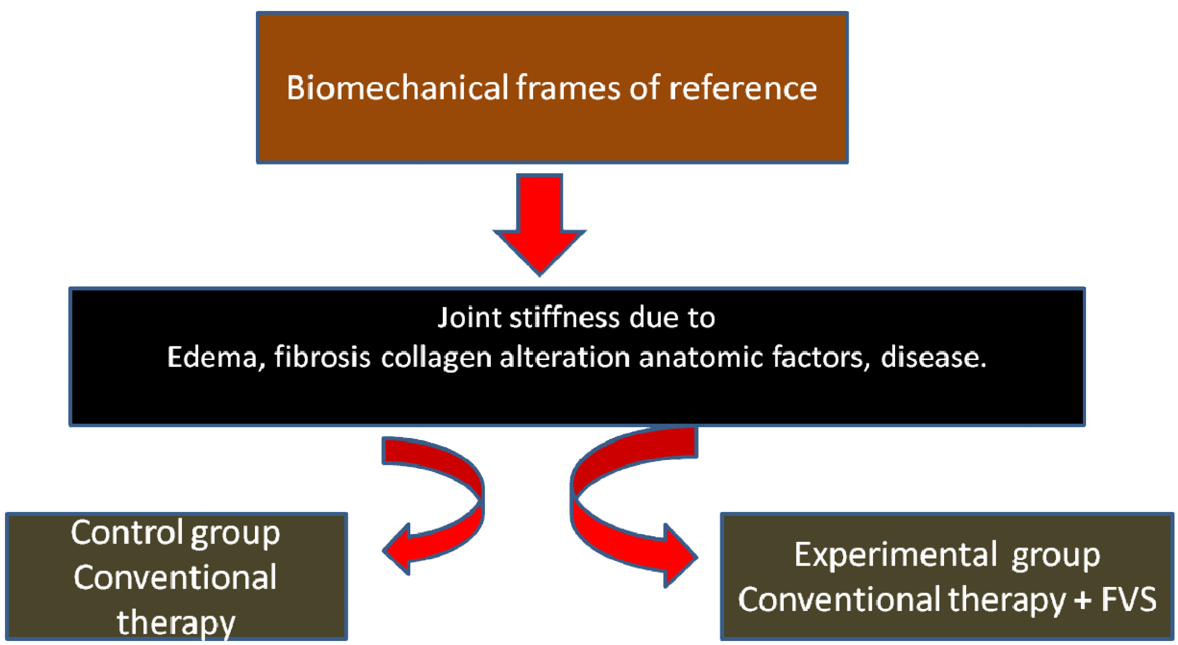
Nancy W. Hochreiter, Martha J. Jewell Et Al, conducted a study on the "Effect of Vibration on Tactile Sensitivity". The purpose of this study was to determine if vibration has an effect on tactile threshold and if so to determine the duration of that effect. Mean tactile thresholds were determined for 24 healthy adults by means of a pressure aesthesiometer. The experimental group (6 men, 6 women) received 10 minutes of vibration. Mean tactile thresholds were re determined at the end of the 10-minute treatment period in the experimental group and after a 10-minute rest period in the control group (6 men, 6 women). Thresholds were also re-determined at 5-minute intervals for the next 20 minutes in all subjects. The experimental group showed a significant change in mean tactile threshold after 10 minutes of vibration ($p < .001$). This difference remained at 5 ($p < .001$) and 10 ($p < .05$) minutes post vibration but not at 15 and 20 minutes. No significant change in mean tactile threshold was found in the control group. The results indicate that vibration does increase tactile threshold in "normal" hands and that the effect lasts for at least 10 minutes. The application of this information to the clinical setting is discussed.

Colleen Maloney – Hinds Et Al in the Year 2008 conducted a study on "The effect of 30 Hz vs.50Hz passive vibration and duration of vibration on skin blood flow (SBF) in the arm" 2 studies were conducted to Determine 1) if there is a difference in SBF due to passive vibration in forearm at 30 hz vs 50 Hz if one frequency is superior, and 2) if there is an optimal duration. In the first study,18 subjects (mean age 20) were randomly placed into 30Hz or 50 Hz vibration group, and in the second,7 subjects (mean age 23)participated in both 30 and 50Hz vibration. Each subject's arm was passively vibrated for 10 minutes SBF was examined during vibration and for 15 minutes of recovery. The results showed that both frequencies produced significant increases in SBF (0.05). So the study was finally concluded that 5 minutes vibration of 30 or 50Hz produced significant change in the SBF.

CONCEPTUAL FRAME WORK







The conceptual frame wok of reference was designed based on the biomechanical frames of reference. The study population consisted of 28 clients' with complex hand injuries who underwent therapy at the outpatient unit for the 4th week rehabilitation

Here the study population is divided into two groups through the lot's system and are intervened with conventional therapy and functional vibratory stimulation.

The conventional therapy includes patient's prioritized activities which are continued as therapeutic activities in the treatment session also the de'lormes regimen for passive mobility and strengthening activities is used. The functional vibratory stimulator is provided as an adjunctive along with the conventional therapy in experimental group

The conventional therapy and the intervention therapy both are based on the principles of biomechanical approach and aim's to fulfill the criteria responsible to reduce joint stiffness in the client's under study

The basic principle's assumed here for theoretical basis are Structural stability, low-level endurance, Edema control Passive range of motion (PROM), Strength and High-level endurance

The biomechanical frame of reference is typically identified with remediation, or improvements in strength, ROM, or endurance. However, the principles include the management of weight-bearing against gravity and, thus, guide the design of splints, adaptive seating, and the design and use of prosthetic devices.

Which is supported by Colangelo C (1999) uses biomechanical principles for positioning children with motor and postural difficulties to enable their engagement in the normal occupations of childhood. The same applies to adults with Cerebral Palsy

Also on the basis of biomechanical principles the joint stiffness in hand is usually treated with splinting either dynamic or static. Also plaster of Paris is used on the same basis for serial casting which is supported by Judy C Colditz who conducted a study on he topic "plaster of Paris a forgotten hand splinting material " and concluded that with conventional therapy serial casting is a reliable mode of treatment

Methodology

The research methods applied by the investigator to test the hypothesis are as follows.

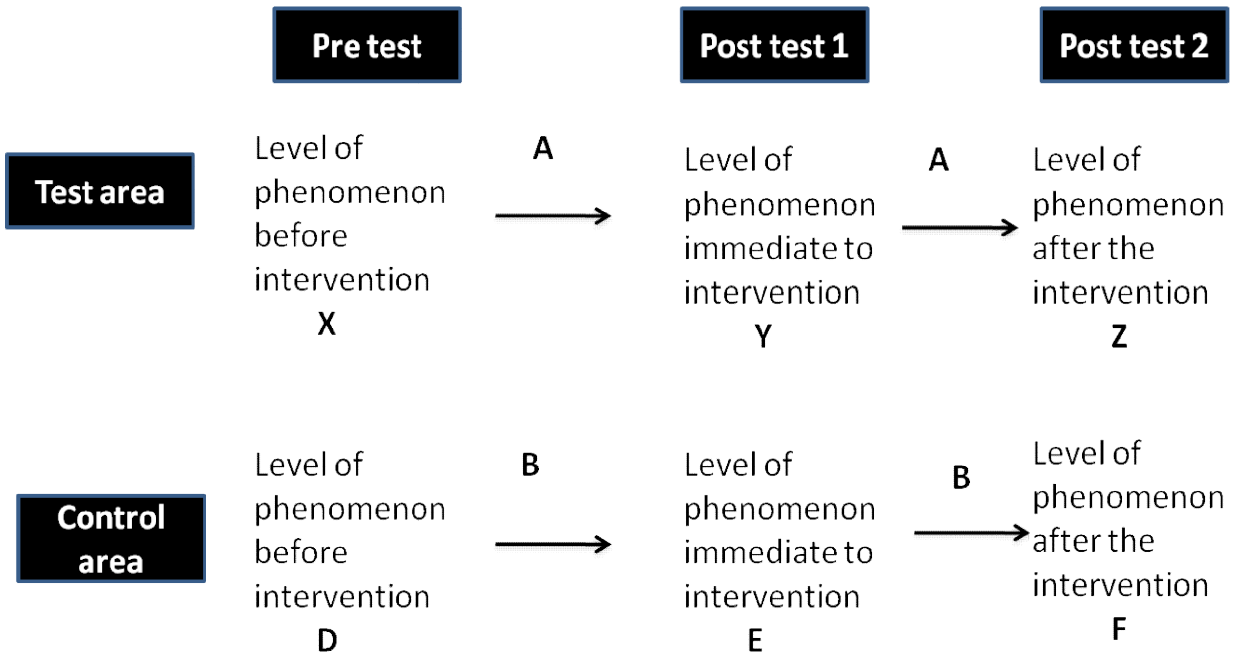
Research approach

An experimental approach was used to determine the effectiveness of functional vibratory stimulation in reducing joint stiffness in patients post op complex hand injuries.

Research design

Two group pre test-post test experimental designs were adopted for this study. Randomization of sampling and single or assessor blinding was followed and so a primary Randomized control trial was done.

Schematic representation of the study design



- A- conventional therapy + client based hand function intervention + functional vibratory therapy
- B- Conventional therapy + client based hand function intervention.

$$\text{Treatment effectiveness} = \{(Y-X)-(Z-X)\} - \{(E-D)-(F-D)\}$$

Variables

The functional vibratory stimulator along with the conventional therapy techniques used and also the client centered functional hand function training were the independent variables. The grip strength, dexterity, range of motion and hand function were the dependent variables.

Setting and duration of the study

The study was done over a period of 5 months. The study was conducted at the hand therapy outpatient in Ganga hospital Coimbatore.

Population

A total of 28 patients attending the outpatient unit post op 4th week of rehabilitation for complex hand injuries and with joint stiffness.

Selection of population

The subjects were selected based on these criteria

Inclusion criteria

- Both gender
- Clients within the age group of 20 to 50
- Clients in Post op surgery 4th week rehabilitation of hand. Irrespective of basic pathologic and traumatic cause.
- Clients with post op 4th week rehabilitation for zones flexor tendon repair.
- Clients with post op 4th week rehabilitation for extensor tendon repair.
- Clients with post op 4th week rehabilitation for base of MCP fracture ORIF.
- Clients with post op 4th week rehabilitation for carpel bone fracture ORIF.
- Clients with post op 4th week rehabilitation burns injury with scar release and Escharotomy.
- Clients with post op 4th week rehabilitation for Volkmann's Ischemic contracture.

- Clients with post op 4th week rehabilitation for partial digit amputation and immobilization.

Exclusion criteria

- Clients before 4th week of rehabilitation Post op
- Acute infectious wound
- Multiple sites of injury
- Non surgically managed clients with hand injuries
- Repetitive strain injury

Sample size

A total of 28 clients divided into two groups randomly by lot's system

Sampling method

Random sampling by lot's system

Tools used

Assessment tools

Grip strength (Modified sphygmomanometer)

Apparatuses used in this experiment were an aneroid type adult sphygmomanometer which measures force in units of mmHg the sphygmomanometer cuff was evenly rolled; forming a circumference of approximately 7 in to conform to a normal functional hand position for grip. A rubber band was placed around each end of the cuff to hold it in position. The cuff was inflated to 20 mmHg, which was the starting position for measurement of each subject. The value for normal adults from 20-50 years of age being 110mm of hg

The American Society of Hand Therapists' standardized arm position for hand strength testing was utilized (Fess EE, Moran CA et al 1981) each subject was positioned in a straight back chair with both feet flat on the floor. Arm positioning was demonstrated by the operator, and assumes a position of adducted and neutrally rotated shoulders. For the arm to be tested, the elbow was flexed to 90". The forearm and wrist were in neutral positions, and the fingers were flexed as needed for a maximal contraction. Each subject was instructed to breathe in through her nose and blow out through pursed lips as a maximum grip effort was made. At this time, a verbal command of "Squeeze! Harder! Harder! Relax!" was given by the examiner. Demonstration of maximum hand grip performance was given prior to the first session, and re-instruction was given prior to the other two sessions as needed. The mean score among three trials of each instrument was recorded for data calculations.

A Spearman Rho correlation coefficient test utilized in measuring within-instrument reliability showed a high correlation for each instrument at .85 for the sphygmomanometer and .82 for the Jamar dynamometer. Construct validity testing performed to determine validity of the measurements by the sphygmomanometer compared with the Jamar dynamometer produced a .75 correlation (George F. Hamilton, et al., 1992)

Dexterity (box and block test)

Assesses unilateral gross manual dexterity

- Individuals are seated at a table, facing a rectangular box that is divided into two square compartments of equal dimension by means of a partition.

- One hundred and fifty, 2.5 cm, colored, wooden cubes or blocks are placed in one compartment or the other.
- The individual is instructed to move as many blocks as possible, one at a time, from one compartment to the other for a period of 60 seconds.
- Standardized dimensions for the test materials and procedures for test administration and scoring have been provided by Mathiowetz et al. (1985).
- To administer the test, the examiner is seated opposite the individual in order to observe test performance.
- Test is done for the non dominant hand first followed by the dominant hand.
- The BBT is scored by counting the number of blocks carried over the partition from one compartment to the other during the one-minute trial period.
- Patient's hand must cross over the partition in order for a point to be given, and blocks that drop or bounce out of the second compartment onto the floor are still rewarded with a point
- Multiple blocks carried over at the same time, count as a single point
- Higher scores on the test indicate better gross manual dexterity

Time required for testing is 2-5 minutes.

Equipment required

- Stopwatch
- Wooden box dimensioned in 53.7 cm x 25.4 cm x 8.5 cm.
- Partition (should be placed at the middle of the box, dividing it in two containers of 25.4 cm each)

150 wooden cubes (2.5 cm in size)

(Mathiowetz et al., 1985-1)Excellent inter-rater reliability; right hand, r = 1.00; left hand, r = 0.99 in normal healthy adults

Pain (Visual Analogue scale)

VAS is a 10 point graded scale. It is a self rated scale which analyses the level of perception of pain. The grading starts from 0 meaning no pain and ends with 10 which mean s intolerable extreme pain.

(Boonstra, Anne M et al. 2008) Reliability study: Spearman's correlation coefficients (_ values) of the test and retest data of the VAS for disability; validity study: _ values of the VAS disability scores with the scores on four domains of the Short-Form Health Survey (SF-36) and VAS pain scores, and with Roland-Morris Disability Questionnaire scores in chronic low back pain patients. Results were as follows: in the reliability study _ values varied from 0.60 to 0.77; and in the validity study _ values of VAS disability scores with SF-36 domain scores varied from 0.16 to 0.51, with Roland-Morris Disability Questionnaire scores from 0.38 to 0.43 and with VAS pain scores from 0.76 to 0.84. The conclusion of the study was that the reliability of the VAS for disability is moderate to good. Because of a weak correlation with other disability instruments and a strong correlation with the VAS for pain, however, its validity is questionable.

Canadian Occupational Performance Measure (COPM)

The COPM (Law et al, 1998) is designed to develop individualized client centered goals, and to serve as an outcome measure in client centered occupational therapy practice. When using the COPM, the therapist and client together identify occupational performance problems and goals in personal care, functional mobility, community management, work, household management, and leisure. The client rates his or her performance and satisfaction with performance using 1 – to – 10 point scale with 1 representing "notable" or "not satisfied" and 10 representing "able to do well "and "extremely satisfied." Each client's mean scores across all goals were used in analysis.

In a study by Sanford, Law, Swanson and Guyant (1994) test – retest reliability within a 2 week intervention for 27 clients was ICC = 0.63 for performance and ICC = 0.84 for satisfaction. Validity was estimated by correlating COPM change scores with changes in overall function as rated by caregivers (*r=0.55, r=0.56*), therapists *(r=0.30, r=0.33)*, and clients *(r=0.26, r=0.53).* COPM performance scores highly relate to life satisfaction (McColl et al., 2000) and quality of life measured by the SF – 36 (Law et al., 1994)

Intervention tool

Functional vibratory stimulator

This is a portable low cost vibratory device with a dual channel mechanical vibratory stimulator. The vibratory stimulator has the following parts

- Power chord
- Power transmission device
- Programmed ICU
- Dual mode programme board
- Mode 1-160Hz continuous mode
- Mode 2-50 Hz intermittent mode 5 secs on and 5 secs off
- Digital Display
- Dual channel
- Control switches – on off switch, mode change, and reset alarm
- Cell phone vibrators

Other things required

- Methylated spirit to clean and prepare skin before application
- Adhesive tape to hold the vibrator in position

Method of application

- Clean area of application with spirit
- The area of application are the MCP,PIP and DIP joints of the hand
- Two vibrators are attached simultaneously in a single joint adjacently with the adhesive tape
- The alarm is set for 5 minutes in intermittent mode
- Then a session of passive stretching along with the vibratory stimulation is done and later followed by 3 to 5 sessions of hand function activity along with the FVS
- Once the alarm if off a rest period of 2 mins is given before the next session is started

COST ANALYSIS:

The cost of functional vibratory stimulator when compared to other local therapeutic vibrators is lesser.

The other therapeutic vibratory devices commonly used as physical agent modality and their average cost

- Ultra sound. Rupees 1 lakh
- Interferential therapy Rupees 1 lakh
- Shock wave therapy Rupees 1 lakh fifty thousand

The cost of one session for these above mentioned therapy tools would be on an average Rupees 200 The cost of device is Rupees 2100 including the cost of spares and making charges.The device was designed and produced at the Crisp systems and solution. Engineering project centre. Coimbatore.The FVS is also a compact portable device which can be carried easily. Also it could be taught to the patient to practice at home

Client based conventional occupational therapy hand function activities

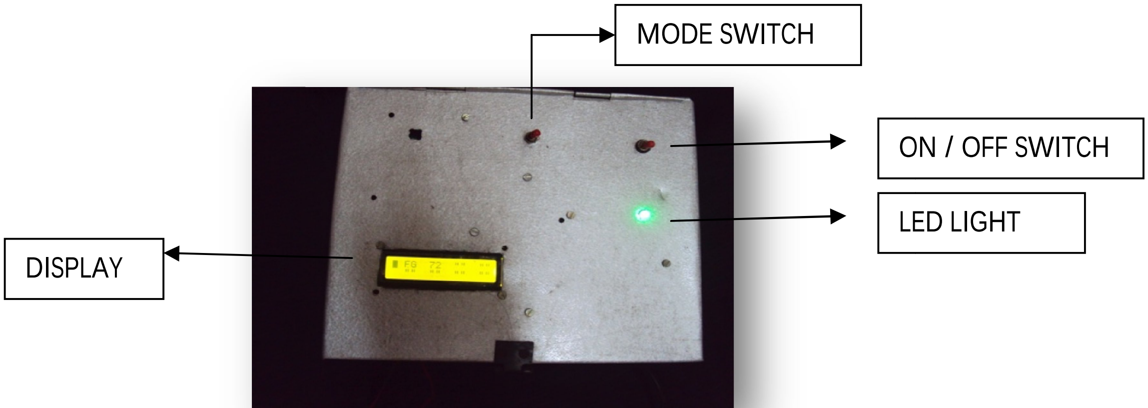
These were activities chosen according to the priority and need of the clients. These activities were either simulated or done in actual setting according to convenience and comfort of the client

Most of the activities included

- Eating
- Grooming
- Writing
- Picking up small common objects
- In hand manipulation skills

Passive stretching exercises

This was done by the primary therapist, stretching was done at the respective joints which was assessed as stiff and it was done for 25 repetitions.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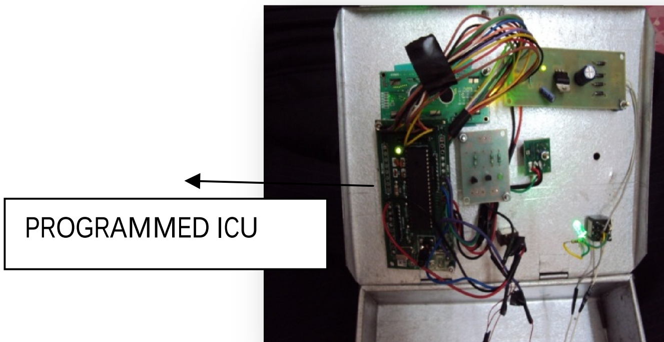
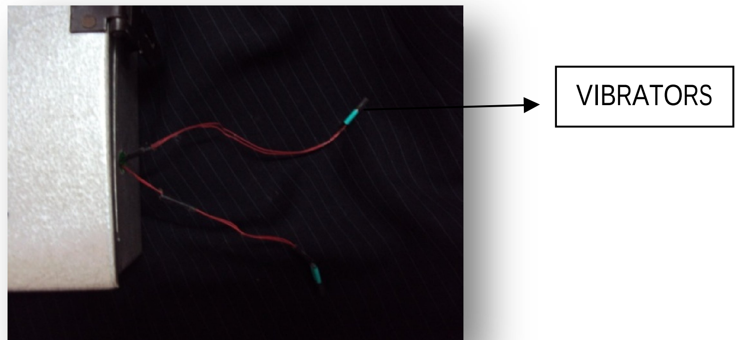

PROGRAMMED ICU


VIBRATORS

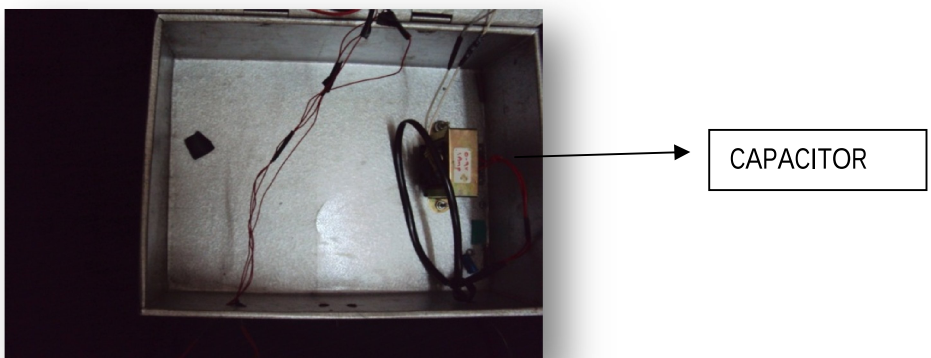

CAPACITOR

TABLE 1 COMPARISON OF PRE TEST AND POST TEST MEAN COPM PERFORMANCE SCORES WITHIN THE CONTROL GROUP.

CONTROL GROUP COPM PERFORMANCE	MEAN	SD	T VALUE	P VALUE
PRE TEST	1.857142857	1.175201643	0.6465	<0.5236
POST TEST	3.028571	1.295809		

The above table shows the comparison of pre test and post test mean COPM performance scores within the control group. Which according to "t" test. Statistically showed no significant difference between both the groups the t value being 0.6465 and the p value being <0.5236

TABLE 2 COMPARISON OF PRE TEST AND POST TEST MEAN COPM PERFORMANCE SCORES WITHIN THE EXPERIMENTAL GROUP.

CONTROL GROUP COPM PERFORMANCE	MEAN	SD	T VALUE	P VALUE
PRE TEST	1.814286	1.26117	t = 9.8967	<0.0001
POST TEST	6.45	1.217027		

The above table 2 shows the comparison of pre test and post test mean COPM performance scores within the experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 9.8967 and the p value being <0.0001

TABLE 3 COMPARISON OF PRE TEST AND POST TEST MEAN COPM SATISFACTION SCORES WITHIN THE CONTROL GROUP.

CONTROL GROUP COPM SATISFACTION	MEAN	SD	T VALUE	P VALUE
PRE TEST	1.28571429	1.268814451	t = 1.8312	<0.0785
POST TEST	2.578571	1.185929		

The above table 3 shows the comparison of pre test and post test mean COPM satisfaction scores within the experimental group. Which according to "t" test. Statistically showed weak significant difference between both the groups the t value being 1.8312 and the p value being <0.0785

TABLE 4 COMPARISON OF PRE TEST AND POST TEST MEAN COPM SATISFACTION SCORES WITHIN THE EXPERIMENTAL GROUP.

CONTROL GROUP COPM SATISFACTION	MEAN	SD	T VALUE	P VALUE
PRE TEST	1.385714	1.528125	t = 0.7348	<0.5180
POST TEST	1.292857	1.17176		

The above table shows the comparison of pre test and post test mean COPM satisfaction scores within the experimental group. Which according to "t" test. Statistically showed no significant difference between both the groups the t value being 0.7348 and the p value being <0.5180

TABLE 5 COMPARISON OF POST TEST MEAN COPM PERFORMANCE SCORES BETWEEN CONTROL AND EXPERIMENTAL GROUP.

CONTROL VS EXPERIMENTAL GROUP COPM PERFORMANCE	MEAN	SD	T VALUE	P VALUE
POST TEST	3.028571	1.295809	t = 7.2013	<0.0001
POST TEST	6.45	1.217027		

The above table 5 shows the comparison of post test mean COPM performance scores between control and experimental group. Which according to "t" test. Statistically showed extreme significant difference between both the groups the t value being 7.2013 and the p value being <0.0001

TABLE 6 COMPARISON OF POST TEST MEAN COPM SATISFACTION SCORES BETWEEN CONTROL AND EXPERIMENTAL GROUP.

CONTROL VS EXPERIMENTAL GROUP COPM PERFORMANCE	MEAN	SD	T VALUE	P VALUE
POST TEST	2.578571	1.185929	t = 8.3360	<0.0001
POST TEST	6.292857	1.17176		

The above table 6 shows the comparison of post test mean COPM satisfaction scores between control and experimental group. Which according to "t" test. Statistically showed extreme significant difference between both the groups the t value being 8.3360 and the p value being <0.0001

TABLE 7 COMPARISON OF GRIP STRENGTH SCORES BETWEEN PRE TEST AND IMMEDIATE EFFECT WITHIN CONTROL GROUP

CONTROL PRE AND IMMEDIATE GRIP STRENGTH	MEAN	SD	T VALUE	P VALUE
PRE TEST	21.14286	2.143223	t = 3.6264	<0.0012
POST TEST1	25.14285714	3.526976104		

The above table 7 shows comparison of grip strength scores between pre test and immediate effect within control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 3.6264 and the p value being <0.0012

TABLE 8 COMPARISON OF GRIP STRENGTH SCORES BETWEEN PRE TEST AND LATE EFFECT WITHIN CONTROL GROUP

CONTROL PRE AND IMMEDIATE GRIP STRENGTH	MEAN	SD	T VALUE	P VALUE
PRE TEST	21.14286	2.143223S	t = 10.6961	<0.0001
POST TEST1	39.14285714	5.920721667		

The above table 8 shows comparison of grip strength scores between pre test and late effect within control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 10.6961 and the p value being <0.0001

TABLE 9 COMPARISON OF GRIP STRENGTH SCORES BETWEEN IMMEDIATE AND LATE EFFECT WITHIN CONTROL GROUP

CONTROL PRE AND IMMEDIATE GRIP STRENGTH	MEAN	SD	T VALUE	P VALUE
PRE TEST	25.14285714	3.526976104	t = 7.6010	<0.0001
POST TEST1	39.14285714	5.920721667		

The above table 9 shows comparison of grip strength scores between immediate and late effect within control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 7.6010 and the p value being <0.0001

TABLE 10 COMPARISON OF GRIP STRENGTH SCORES BETWEEN PRE TEST AND IMMEDIATE EFFECT WITHIN EXPERIMENTAL GROUP

EXPEIRMENTAL PRE AND IMMEDIATE GRIP STRENGTH	MEAN	SD	T VALUE	P VALUE
PRE TEST	21	1.839732	t = 11.7180	<0.0001
POST TEST1	30.57143	2.440501		

The above table 10 shows comparison of grip strength scores between pre test and immediate effect within experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 11.7180 and the p value being <0.0001

TABLE 11 COMPARISON OF GRIP STRENGTH SCORES BETWEEN PRE TEST AND LATE EFFECT WITHIN EXPERIMENTAL GROUP

EXPERIMENTAL PRE AND LATE GRIP STRENGTH	MEAN	SD	T VALUE	P VALUE
PRE TEST	21	1.839732	t = 17.4062	<0.0001
POST TEST2	75.85714	11.64776		

The above table 11 shows comparison of grip strength scores between pre test and late effect within experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 17.4062 and the p value being <0.0001

TABLE 12 COMPARISON OF GRIP STRENGTH SCORES BETWEEN IMMEDIATE AND LATE EFFECT WITHIN EXPERIMENTAL GROUP

EXPERIMENTAL IMMEDIATE AND LATE EFFECT GRIP STRENGTH	MEAN	SD	T VALUE	P VALUE
POST TEST1	30.57143	2.440501	t = 14.2381	<0.0001
POST TEST2	75.85714	11.64776		

The above table 12 shows comparison of grip strength scores between immediate and late effect within experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 14.2381 and the p value being <0.0001

TABLE 13 COMPARISON OF IMMEDIATE EFFECT BETWEEN EXPERIMENTAL AND CONTROL GROUP.

CONTROL VS EXPERIMENTAL	MEAN	SD	T VALUE	P VALUE
POST TEST1 CONTROL	25.14285714	3.526976104	t = 4.7358	<0.0001
POST TEST1 EXPERIMENTAL	30.57143	2.440501		

The above table 13 shows comparison immediate effect between experimental and control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 4.7358 and the p value being <0.0001

TABLE 14 COMPARISON OF LATE EFFECT BETWEEN EXPERIMENTAL AND CONTROL GROUP.

CONTROL VS EXPERIMENTAL	MEAN	SD	T VALUE	P VALUE
POST TEST2 CONTROL	39.14285714	5.920721667	t = 10.5136	<0.0001
POST TEST2 EXPERIMENTAL	75.85714	11.64776		

The above table 14 shows comparison late effect between experimental and control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 10.5136 and the p value being <0.0001

VISUAL ANALOUGE SCALE (PAIN)

TABLE 14 COMPARISON OF VAS SCORES BETWEEN PRE TEST AND IMMEDIATE EFFECT IN CONTROL GROUP

CONTROL GROUP VAS	MEAN	SD	T VALUE	P VALUE
PRE TEST	5.642857	1.215739	t = 2.1926	<0.0375
POST TEST1	6.571429	1.01635		

The above table 14 shows comparison of vas scores between pre test and immediate effect in control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 2.1926 and the p value being <0.0375

TABLE 15 COMPARISON OF VAS SCORES BETWEEN PRE TEST AND LATE EFFECT IN CONTROL GROUP

CONTROL GROUP VAS	MEAN	SD	T VALUE	P VALUE
PRE TEST	6.571429	1.01635	t = 5.5537	<0.0001
POST TEST2	3	1.300887		

The above table 15 shows comparison of vas scores between pre test and late effect in control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 5.5537 and the p value being <0.0001

TABLE 16 COMPARISON OF VAS SCORES BETWEEN LATE AND IMMEDIATE EFFECT IN CONTROL GROUP

CONTROL GROUP VAS	MEAN	SD	T VALUE	P VALUE
POST TEST1	5.642857	1.215739	t = 8.0947	<0.0001
POST TEST2	3	1.300887		

The above table 16 shows comparison of vas scores between late and immediate effect in control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 8.0947and the p value being <0.0001

TABLE 17 COMPARISON OF VAS SCORES BETWEEN PRE TEST AND IMMEDIATE EFFECT IN EXPERIMENTAL GROUP

EXPERIMENTAL GROUP VAS	MEAN	SD	T VALUE	P VALUE
PRE TEST	5.5	1.286019	t = 6.1949	<0.0001
POST TEST1	2.642857	1.150728		

The above table 17 shows comparison of vas scores between pre test and immediate effect in experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 6.1949 and the p value being <0.0001

TABLE 18 COMPARISON OF VAS SCORES BETWEEN PRE TEST AND LATE EFFECT IN EXPERIMENTAL GROUP

EXPERIMENTAL GROUP VAS	MEAN	SD	T VALUE	P VALUE
PRE TEST	5.5	1.286019	t = 11.5198	<0.0001
POST TEST2	1.285714	0.468807		

The above table 18 shows comparison of vas scores between pre test and late effect in experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 11.5198 and the p value being <0.0001

TABLE 19 COMPARISON OF VAS SCORES BETWEEN IMMEDIATE AND LATE EFFECT IN EXPERIMENTAL GROUP

EXPERIMENTAL GROUP VAS	MEAN	SD	T VALUE	P VALUE
POST TEST1	2.642857	1.150728	t = 4.0867	<0.0004
POST TEST2	1.285714	0.468807		

The above table 19 shows comparison of vas scores between pre test and late effect in experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 4.0867 and the p value being <0.0004

TABLE 20 COMPARISON OF VAS IMMEDIATE SCORES BETWEEN CONTROL AND EXPERIMENTAL GROUP

CONTROL VS EXPERIMENTAL GROUP VAS	MEAN	SD	T VALUE	P VALUE
POST TEST1 CONTROL	6.571429	1.01635	t = 9.5743	<0.0001
POST TEST1 EXPERIMENTAL	2.642857	1.150728		

The above table 20 shows comparison of vas immediate scores between control and experimental group Which according to "t" test. Statistically showed significant difference between both the groups the t value being 9.5743 and the p value being <0.0001

TABLE 21 COMPARISON OF VAS LATE SCORES BETWEEN CONTROL AND EXPERIMENTAL GROUP

CONTROL VS EXPERIMENTAL GROUP VAS	MEAN	SD	T VALUE	P VALUE
POST TEST2 CONTROL	3	1.300887	t = 4.6387	<0.0001
POST TEST2 EXPERIMENTAL	1.285714	0.468807		

The above table 21 shows comparison of vas late scores between control and experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 4.6387 and the p value being <0.0001

DEXTERITY

TABLE 22 COMPARISON OF BOX AND BLOCK TEST SCORES BETWEEN PRE TEST AND IMMEDIATE EFFECT IN CONTROL GROUP

CONTROL GROUP DEXTERITY	MEAN	SD	T VALUE	P VALUE
PRE TEST	24.85714	4.4003	t = 2.4950	<0.0193
POST TEST1	28.92857	4.232917		

The above table 22 shows the comparison of box and block test scores between pre test and immediate effect in control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 2.4950 and the p value being <0.0193

TABLE 23 COMPARISON OF BOX AND BLOCK TEST SCORES BETWEEN PRE TEST AND IMMEDIATE EFFECT IN CONTROL GROUP

CONTROL GROUP DEXTERITY	MEAN	SD	T VALUE	P VALUE
PRE TEST	24.85714	4.4003	t = 12.0527	<0.0001
POST TEST2	42.57143	3.298351		

The above table 23 shows the comparison of box and block test scores between pre test and late effect in control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 12.0527 and the p value being <0.0001

TABLE 24 COMPARISON OF BOX AND BLOCK TEST SCORES BETWEEN IMMEDIATE AND LATE EFFECT IN CONTROL GROUP

CONTROL GROUP DEXTERITY	MEAN	SD	T VALUE	P VALUE
POST TEST1	28.92857	4.232917	t = 9.5126	<0.0001
POST TEST2	42.57143	3.298351		

The above table 24 shows the comparison of box and block test scores between immediate and late effect in control group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 9.5126 and the p value being <0.0001

TABLE 25 COMPARISON OF BOX AND BLOCK TEST SCORES BETWEEN PRE TEST AND IMMEDIATE EFFECT IN EXPERIMENTAL GROUP

EXPERIMENTAL GROUP DEXTERITY	MEAN	SD	T VALUE	P VALUE
PRE TEST	23.35714	4.861262	t = 6.1027	<0.0001
POST TEST1	34.64286	4.92415		

The above table 25 shows the comparison of box and block test scores between pre test and immediate effect in experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 6.1027 and the p value being <0.0001

TABLE 26 COMPARISON OF BOX AND BLOCK TEST SCORES BETWEEN PRE TEST AND LATE EFFECT IN EXPERIMENTAL GROUP

EXPERIMENTAL GROUP DEXTERITY	MEAN	SD	T VALUE	P VALUE
PRE TEST	23.35714	4.861262	t = 12.0762	<0.0001
POST TEST2	51.35714	7.185532		

The above table 26 shows the comparison of box and block test scores between pre test and late effect in experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 12.0762 and the p value being <0.0001

TABLE 27 COMPARISON OF BOX AND BLOCK TEST SCORES BETWEEN IMMEDIATE AND LATE EFFECT IN EXPERIMENTAL GROUP

CONTROL GROUP DEXTERITY	MEAN	SD	T VALUE	P VALUE
POST TEST1	34.64286	4.92415	t = 7.1794	<0.0001
POST TEST2	51.35714	7.185532		

The above table 27 shows the comparison of box and block test scores between immediate and late effect in experimental group. Which according to "t" test. Statistically showed significant difference between both the groups the t value being 7.1794 and the p value being <0.0001

TABLE 28 COMPARISON OF BOX AND BLOCK IMMEDIATE SCORES BETWEEN CONTROL AND EXPERIMENTAL GROUP

CONTROL VS EXPERIMENTAL GROUP BOX AND BLOCK	MEAN	SD	T VALUE	P VALUE
POST TEST1 CONTROL	28.92857	4.232917	t = 3.2927	<0.0029
POST TEST1 EXPERIMENTAL	34.64286	4.92415		

The above table 28 shows the comparison of box and block immediate scores between control and experimental group Which according to "t" test. Statistically showed significant difference between both the groups the t value being 3.2927 and the p value being <0.0029

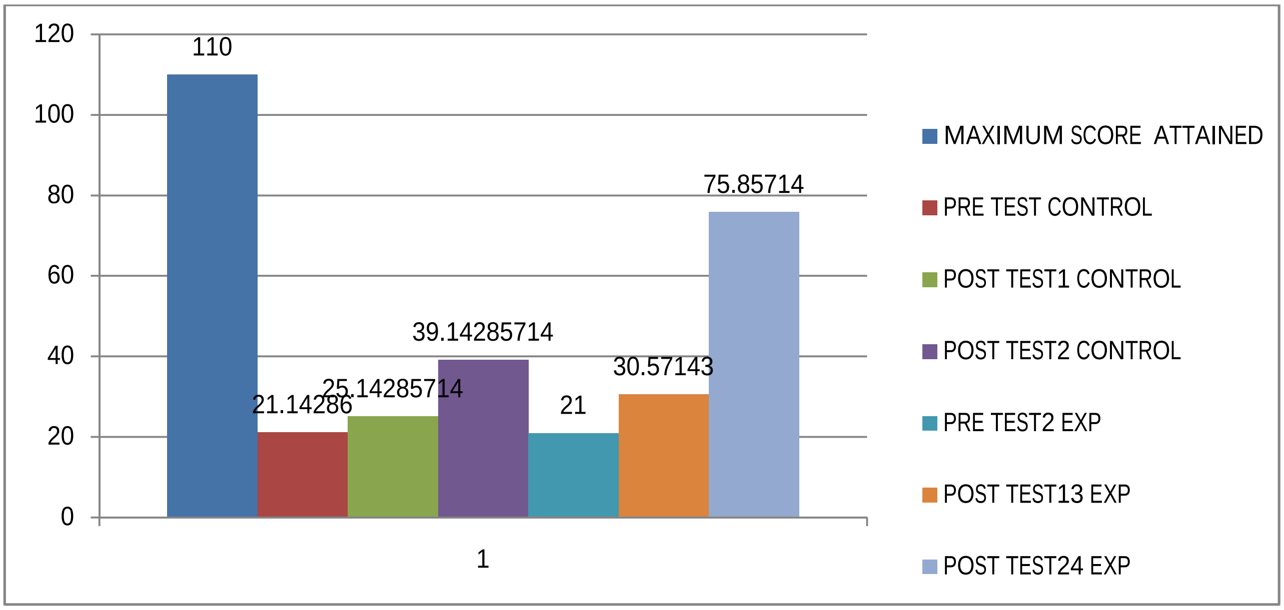
TABLE 29 COMPARISON OF BOX AND BLOCK IMMEDIATE SCORES BETWEEN CONTROL AND EXPERIMENTAL GROUP

CONTROL VS EXPERIMENTAL GROUP BOX AND BLOCK	MEAN	SD	T VALUE	P VALUE
POST TEST2 CONTROL	42.57143	3.298351	t = 4.1578	<0.0003
POST TEST2 EXPERIMENTAL	51.35714	7.185532		

The above table 29 shows the comparison of box and block immediate scores between control and experimental group Which according to "t" test. Statistically showed significant difference between both the groups the t value being 4.1578 and the p value being <0.0003

GRIP STRENGTH

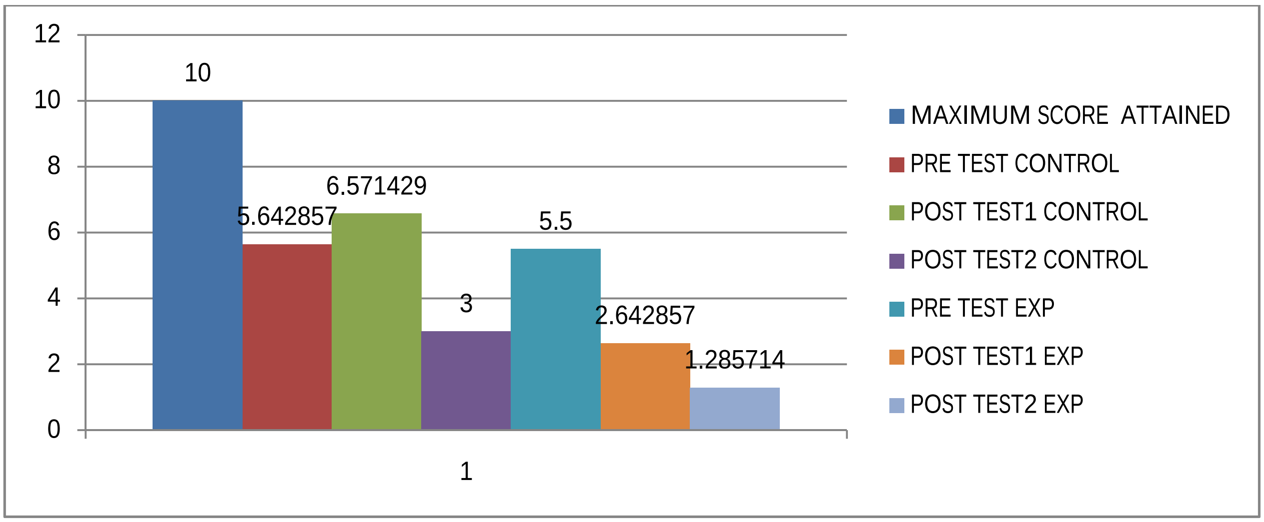
AVERAGE SCORE ATTAINED	PRE TEST CONTROL	POST TEST1 CONTROL	POST TEST2 CONTROL	PRE TEST EXP	POST TEST1 EXP	POST TEST2 EXP
110	21.14286	25.14285714	39.14285714	21	30.57143	75.85714



The above table and graph shows the comparison of mean scores achieved on grip strength across the whole study population. The average score achievable for the study population is 110mm of Hg. Here in this graph it is evident that regardless of the groups both categories have shown a considerable increase at the final test, but the immediate effect of FVS in the experimental group has proven to be statistically more significant and the also the late effect of FVS has markedly shown statistical difference the experimental group showing better progress than the control.

VISUAL ANALOUGE SCALE

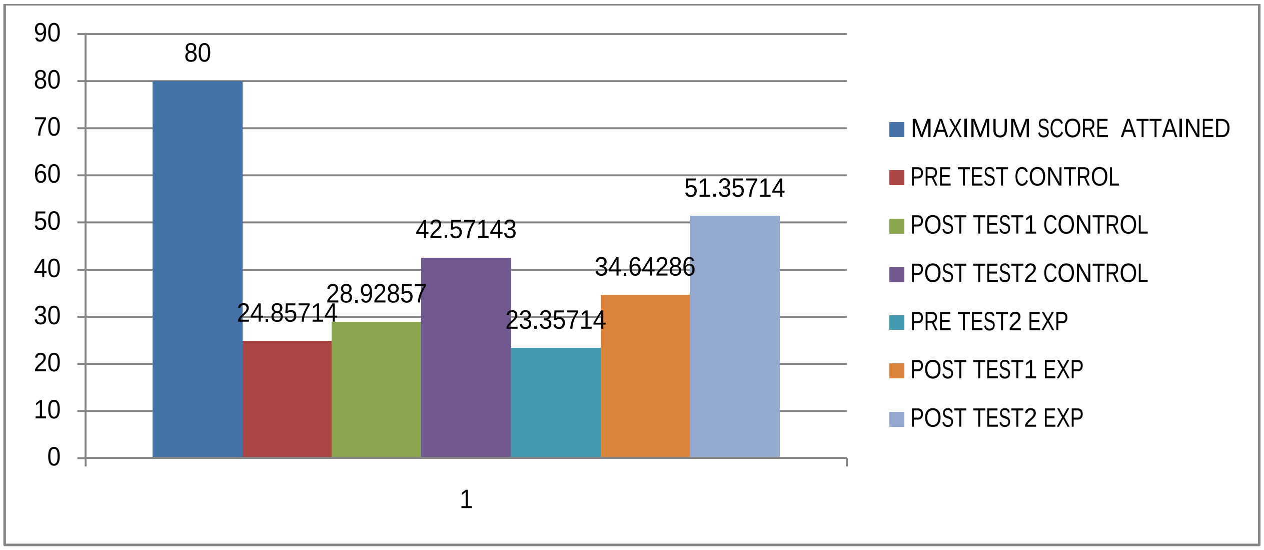
MAXIMUM SCORE ATTAINED	PRE TEST CONTROL	POST TEST1 CONTROL	POST TEST2 CONTROL	PRE TEST EXP	POST TEST1 EXP	POST TEST2 EXP
10	5.642857	6.571429	3	5.5	2.642857	1.285714



The above table and graph shows the comparison of mean scores across the whole study population. In the graph and table it is evident that regardless of group variations both the groups have shown considerable amount of decrease in pain. In which the post test 1 and post test 2 in the experimental group showed a drastic change which were also statistically very significant.

DEXTRITY

MAXIMUM SCORE ATTAINED	PRE TEST CONTROL	POST TEST1 CONTROL	POST TEST2 CONTROL	PRE TEST EXP	POST TEST1 EXP	POST TEST2 EXP
80 BLOCKS	24.85714	28.92857	42.57143	23.35714	34.64286	51.35714



The above table and graph shows the comparison of mean scores of box and block test across the whole study population. Here it is evident from the table and graph that both the groups showed statistically significant difference dexterity at the post test. The immediate effect i.e. the post test1 and the post test2 scores were better in experimental group the when compared to the control group which also showed statistically significant diffrence

ACTIVITIES CHOSEN BY CLIENTS ACCORDING TO CHOICE AND THE DIFFICULTY IN PERFORMANCE

S. NO	Components	N (28)	1	2	3	4	5
1.	Eating	16 / 57%	8	3	----------	4	1
2.	Carrying weight	15 / 53%	10	2	1	2	-------
3.	Buttoning and using hooks	12 / 42%	5	2	4	-------	1
4.	Holding an object for a prolonged time	12 / 42%	6	---------	6	--------	-------
5.	Toileting	10 / 35%	---------	9	1	---------	-------
6.	Travelling in a bus	10 / 35%	7	2	-------	1	-------
7.	driving	10 / 35%	4	-----	-------	3	3
8.	Going back to work	8 / 28%	7	------	1	-------	-------
9.	Signing and writing	8 / 28%	8	---------	-------	------	-----
10.	Cooking	5 / 17%	--------	-------	5	-------	-------
11.	Combing	3 / 11%	------	-------	3	------	--------

The above table is an illustrative chart which shows the activities chosen by the client's under the study. These activities are chosen according to the client's priority and rated according to the difficulty. Here in the table it is evident that the most important and commonly chosen activity is eating 16 out of 28 which is 57% and 8 out of these 16 ,8 chose it as the 1st priority from the whole study population who showed considerable difficulty in performance of eating likewise the other activities are also listed.

Discussion:

The aim of our study was to evaluate the effect of functional vibratory stimulation in the recovery of hand functions in post op complex hand injuries. The study was conducted at the outpatient unit hand therapy Ganga hospital Coimbatore over a period of 4 months

The total study population was 28 who were divided into 2 equal groups according lot system through random sampling. Assessor blinding was followed for the early pre test and immediate effect which was done by the primary therapist. They measured the grip strength, dexterity and pain the client centered hand function evaluation was done by the researcher

The results of the study conducted showed that the client centered hand therapy showed better performance in hand functions in both the groups. The table s from (1 to 6) showed that the performance and satisfaction scores have changed considerably in both groups when considering the pre test scores, but the comparatively the experimental group has a statistically significant p value <0.0001 difference in both performance and client satisfaction. One of the most interesting finding is that although the performance for the whole study population increased comparatively from the pre test the satisfaction remained lower than the performance scores in both the groups which indicates that even though the client is able to perform better in function it does not imply that the client is satisfied there could be many other underlying factors to determine this change.

The results from our study are well supported with similar results attained by Jane Case Smith who conducted a study on "Outcomes in hand rehabilitation using occupational therapy services" in the year October 2003. In her study the clients received a mean of 13 hours of outpatient occupational therapy services and no other rehabilitation service. Two outcome measures were used for evaluation and setting treatment goals they were COPM and DASH. The results showed a functional performance gain following 6 to 8 weeks of services which were significant at the p value p<0.001 and COPM was more sensitive than DASH and client centered therapy was more successful than the other therapist centered method.

The other variables measured in the present study were grip strength, dexterity and pain.

The results for grip strength from the tables (8 to 14) have showed that the grip strength has increased in the whole study population regardless of the groups, but the experimental group has shown considerable increase in the immediate effect and a significant improvement when compared with the control. The results showed statistically significant difference between both the groups with the p value being p<0.0001

These results are well supported by Jin Luo, Brian McNamara2 and Kieran Moran who presented a review article on "The Use of Vibration Training to Enhance Muscle Strength and Power" from the study it was conclude that Vibration amplitude and frequency determine the load that vibration imposes on the neuromuscular system This vibration load should be in an optimal range to elicit strength and power enhancement To activate the muscle most effectively, vibration frequency should be in the range of 30–50Hz. Obvious changes in muscle strength can be achieved regardless of type of stimulation, Whole Body Vibration or localized stimulation.

The results for dexterity from the tables (23 to 30) showed similar results like the other variables the late scores in the experimental group showed statistically significant difference when compared with the control group, with a p value of p<0.0001 the total increase in scores in the experimental group was about 50% more than the control group. This is well supported by Johanne Higgins et al who conducted a study on "Upper-limb function and recovery in the acute phase post stroke" This study evaluated stroke patients with upper-limb (UL) motor deficits using measures of impairment and "activity limitation" to quantify recovery of UL function post stroke and to identify predictors of UL function and predictors of UL recovery following stroke. The study also compared the recovery of UL function with that of the lower limb (LL). Measures of impairment and "activity limitation" of the UL and LL improved over the first 5 weeks. The Box and Block Test performance improved the most over 5 weeks (standardized response mean [SRM] = 1.34), followed closely by the 5-meter walk test (SRM = 0.97).

The pain levels on the VAS scale from the tables (15 to 22) have shown a significant decrease in both the groups at the end of intervention period but, the study shows a marked finding that the immediate effect of FVS has decreased pain in the experimental group while the immediate scores in control group after a session of therapy has shown an increase in pain rather than a decrease. Our study proved that the use of vibration can be an useful modality in the treatment of pain and also can be used as an adjunctive in therapy. These results are well supported and the therapeutic effects of the vibratory stimulation have been proven to be effective T. Lundeberg[a], R. Nordemar[a] et al Conducted a study on Pain alleviation by vibratory stimulation in the year June 1983 in which 366 patients suffering acute or chronic musculoskeletal pain of different origin were given vibratory stimulation for the pain. Many of the patients had previously had treatments of various kinds without satisfactory relief. The effect of vibratory stimulation was assessed during and after stimulation using a graphic rating scale. Sixty-nine per cent of the patients reported a reduction of pain during vibratory stimulation. The best pain reducing site was found to be either the area of pain, the affected muscle or tendon, the antagonistic muscle or a trigger point outside the painful area. In most patients the best pain reducing effect was obtained when the vibratory stimulation was applied with moderate pressure. To obtain a maximal duration of pain relief the stimulation had to be applied for about 25–45 min.

Conclusion:

- The entire null hypothesis stated in the study has been disproven and the results have shown a significant change in all domains of outcome measures.
- Client centered hand therapy shows a significant increase in functional performance although the clients have shown a mild decrease in their respective satisfaction levels.
- Functional vibratory stimulation from the study has proven that it could be used as a modality for relieving pain during conventional therapy and it could be used as an adjunctive treatment in relieving factors responsible for pain.
- From the study FVS also has proven that the use of FVS during therapeutic activities can enhance dexterity of the hand which could be well related with the reduction of pain.

Limitations and recommendations:

- The study population can be increased in future for better reliability of results.
- The changes in range of motion can also be computed for further studies.
- Path physiological evidences could be determined for the effect of vibration at the collagen level.
- Also homogeneity of population can maintained for further research.

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COMPARISON OF MEAN SCORES COPM PERFORMANCE AND SATISFACTION IN BOTH GROUPS

MAXIMUM SCORES ATTAINED	PRE TEST PERFORMANCE CONTROL GROUP	PRE TEST PERFORMANCE EXPERIMENTAL GROUP	POST TEST PERFROMANCE CONTROL GROUP	POST TEST PERFORMANCE EXPERIMENTAL GROUP	PRE TEST SATISFACTION CONTROL GROUP	PRE TEST SATISFACTION SCORES EXPERIMENTAL GROUP	POST TEST SATISFACTION SCORES OF CONTROL GROUP	POST TEST SATISFACTION SCORES OF EXPERIMENTAL GROUP
10	1.857142857	1.814286	3.028571	6.45	1.728571429	1.292857	2.578571	6.292857