Forced use therapy to improve hand function in spastic cerebral palsy children

*C Elanchezhian¹, P SwarnaKumari²

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Abstract

Introduction: Prehension, the ability to grasp, hold and manipulate objects is an important hand function. Impairment in hand function makes it difficult to fulfill activities of daily living.

Objectives: To assess the effect of forced use therapy (FUT) in improving hand function of hemiplegic cerebral palsy children.

Outcome measures: Modified Ashworth scale, Fegl Meyer assessment upper extremity, 9-hole peg board, upper extremity functional index and caregiver functional use survey are the outcome measures.

Method: Fifty two children with cerebral palsy were divided into 2 groups A and B, 26 in each group. Group A was given conventional hand function exercise whilst group B was given forced hand use therapy. Both groups received treatment for 45 minutes for the affected limb for 5 days a week. However, the FUT group was administered with gloves to constraint the hand movement for 6 hours daily. They were administered with the protocol for 4 weeks and outcomes were measured pre- and post-treatment duration.

Results: FUT showed significantly better improvement over the conventional group in outcome measures (p <0.05)

Conclusions: FUT caused reduction in spasticity and increased functional ability in children with spastic hemiplegic cerebral palsy.

1Research Scholar, ²Associate Professor, Department of Rehabilitation Science, Holy Cross College, Affiliated to Bharathidasan University, Tiruchirapalli, Tamil Nadu, India.
*Correspondence: elanchezhianrehab@gmail.com

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(Key words: Cerebral palsy, spasticity, hemiplegia, hand function, forced use therapy)

Introduction

Cerebral palsy (CP) differs in clinical presentation and severity of impairment¹. CP is the most common cause of childhood disability and is seen in 2–2.5 per 1,000 births². According to studies, 29% of children with CP have hemiplegia³. Evolutionary thumb specialization as an opposing digit makes it vital in that it provides exceptional motor skills⁴. Affected kids can have thumb adduction and/or flexion with limited wrist extension, as well as more proximal abnormalities of upper limb tone, posture, and function affecting usage of hand⁵. Many daily activities require the hands to carry out various movements simultaneously in a coordinated manner².

Spasticity is the most common symptom in CP. Spasticity may cause problems with gait, feeding, washing, toilet use and dressing⁶. CP impairs motor function and eventually causes osteo-articular malformation⁷. Upper limb training involves purposeful outdoor training activities. This is supported by motor control and motor learning theories⁸. Forced use therapy (FUT) is a recovery technique intended to force the use of the most impaired limb through rigorous application of task-oriented behavioural exercises and was originally developed for upper extremity stroke rehabilitation⁹. FUT is similar to constraints induced movement therapy. An aim of FUT is encouraging spontaneous use of affected limb in daily activities¹⁰.

Objectives

To assess the effect of FUT in improving hand function in hemiplegic cerebral palsy children.

Method

Outcome tools

• Modified Ashworth scale: This is an important test in rehabilitation for physical examination of spasticity⁷.
• Fegl Meyer assessment upper extremity (FMA-UE): This tool assesses the upper extremity sensorimotor function¹¹.
• 9-hole peg board: This tool is used in measuring unilateral dexterity of the
finger to determine the extent of fine motor impairment in people with functional performance difficulties. 

- **Upper extremity functional index (UEFI):** This is used in individuals with hand and upper extremity disorders to measure upper extremity function. This distinguishes between “Extent of limitations” and “Quality of Life” categories.

- **Caregiver functional use survey:** Bimanual tasks and scoring guidelines in the caregiver survey are used for measuring the frequencies of usage of children’s upper extremity in real-life situations.

**Inclusion Criteria:** Both left and right spastic hemiplegia, both male and female children, children with age between 4-12 years, Modified Ashworth scale 4-1 and Classification –hemiplegia using Manual ability classification system (MACS) I to III.

**Exclusion Criteria:** Classification -hemiplegia, MACS IV to V children, deformity in hand, antispasmodic drugs, children undergone surgical procedure in hand.

**Procedure:** Study was carried out at the Department of Rehabilitation Sciences, Holy Cross College, Tiruchirapalli, after research ethical approval. Trial registration number TCTR 20191211003. For this research, children were chosen, diagnosed with spastic hemiplegic and met the requirements for inclusion criteria. Informed consent was obtained from the parents or guardians of children before commencement of study, educating them regarding the benefits and adverse effects that might be caused by the treatment.

For the study, a total of 67 subjects with spastic hemiplegia were assessed physically among which 11 were excluded and 4 were unwilling to participate in the study. Fifty two children with left or right hemiplegia were recruited for the study randomly. They were divided into two groups A and B with 26 subjects in each group. Group A was administered conventional therapy and Group B was administered FUT.

**Conventional group (Group A):** Children were given hand function activities for both hands without any constraint. Conventional therapy was administered for 45 minutes as directed.

**Experimental group (Group B):** A glove was used to restrain the child’s less affected upper extremity and the sling was secured with a belt to his/her body. Forced used during the weekend intervention were not given but still the hands were restrained for 6 hours where the child does all the functional activity with the affected hand. The intervention consisted of play and self-care activities to enable the child to practise the use of the most affected upper extremity (Figures 1 and 2). Child is given hand manipulation and prehension movements for 45 minutes for affected hand. Movements and activities were focused only on affected hand. The following activities were included and monitored closely to analyse the performance:

**Somato-sensory stimuli**

Finding objects in beans, rice, or sand (graded finger movements are used to get the grains of rice or sand off the object), pulling pieces of clay off a ball of clay, pushing fingers into therapy putty or clay, stretching rubber bands around fingers.

**Reaching**

1. By using water mat game, have sponged objects floating within, encourage reaching and touching to make the object move.
2. Busy boxes and rattles attached to playpen some of them are secured with table top with suction cup reaching are rewarded with sound movement.
3. All exercises for grasping and reaching.

**Bilateral hand use training**

Bilateral skills such as holding object with two hands, clapping, banging objects together, then stabilize objects with one hand while the other is manipulating (holding paper while colouring, holding a container while putting objects in), then manipulate objects with both hands simultaneously (stringing beads, tying a knot).
Gross motor – activities
Elbow flexion and extension, Forearm pronation and supination, Wrist flexion and extension, Wrist ulnar deviation and radial deviation, Fingers flexion and extension, Finger numbering, Opposition of thumb.

Fine motor – activities
Moving beans from one cup to another, Putting pegs in a pegboard, Squeezing a stress ball, Stacking pennies, Rubber band stretching with fingers, Knobs & Screws- clock wise and anti-clock wise, Clip clothes pins or kitchen clips to the edge of a container. Spreading of fingers apart, Roll ball from tip of fingers to palm on a table.

Both groups were administered hand function activities for six hours per day, 5 days per week for 4 weeks.

Results
Statistical analysis was done utilising the SPSS version 21. Values were presented as mean ± SD; paired Student t-test was used to analyse the efficacy of pre- and post-treatment values of modified Ashworth scale, FMA-UE, 9-hole pegboard, UEFI, caregiver functional use survey. Significant p value was considered to be <0.05. Fifty two children with hemiplegic CP were recruited for the study.

Descriptive data of the conventional and experimental groups are shown in Table 1.

Comparison of conventional and experimental groups is shown in Table 2. To compare the pre and post values of conventional group and experimental group, paired sample t-test was used and to compare Ashworth scale scores among groups, the Wilcoxon signed rank test was applied.

Comparison between conventional and experimental group is shown in Table 3. Analysis of co-variance is used to compare the mean value of experimental and control groups of all the variables including pre measurement as a co-variate to nullify the initial effect. The results of all the variables show there is a significant improvement in the experimental group when compared with the conventional group.

Table 1: Descriptive data of the conventional and experimental groups (n=52)

| Groups          | Sex  | Mean | SD  |
|-----------------|------|------|-----|
|                 | Male | Female |     |     |
| Conventional    | 10   | 16    | 7.08| 2.38|
| Experimental    | 8    | 18    | 6.42| 2.70|
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Table 2: Pre-test and Post-test values in different assessments in conventional and experimental groups

| Assessment                                | Pre-test value | Post-test value | T value |
|-------------------------------------------|----------------|-----------------|---------|
|                                            | Mean (SD)      | Mean (SD)       |         |
| Fegl Meyer assessment upper limb          |                |                 |         |
| Conventional group                        | 37.64 (8.52)   | 40.44 (8.87)    | -9.00   |
| Experimental group                        | 42.23 (8.24)   | 55.96 (7.28)    | -10.70  |
| 9 hole peg board                          |                |                 |         |
| Conventional group                        | 155.56 (38.04) | 139.80 (25.39)  | 4.82    |
| Experimental group                        | 180.54 (45.82) | 150.85 (42.82)  | 5.08    |
| Upper extremity functional index          |                |                 |         |
| Conventional group                        | 30.56 (12.25)  | 33.76 (11.97)   | -12.71  |
| Experimental group                        | 24.54 (7.47)   | 38.42 (9.26)    | -8.38   |
| Caregiver functional use survey           |                |                 |         |
| Conventional group                        | 95.82 (16.06)  | 102.60 (17.32)  | -8.35   |
| Experimental group                        | 86.98 (8.25)   | 107.55 (8.76)   | -15.38  |
| Modified Ashworth scale                   |                |                 |         |
| Conventional group                        | 2.44 (0.71)    | 2.00 (0.50)     | -4.56   |
| Experimental group                        | 2.92 (0.62)    | 1.31 (0.47)     | -3.31   |

Table 3: Comparison between conventional and experimental group

| Assessment                                | Mean ± SE | 95% confidence interval | p-value |
|-------------------------------------------|-----------|-------------------------|---------|
|                                            |           | Lower Bound             | Upper Bound |         |
| Fegl Meyer assessment upper limb          |           |                         |           |         |
| Conventional group                        | 42.31±0.92| 40.45                   | 44.18     | 0.000   |
| Experimental group                        | 54.15±0.90| 52.32                   | 55.98     |         |
| 9 hole peg board                          |           |                         |           |         |
| Conventional group                        | 148.56±4.18| 140.15                 | 156.96    | 0.003   |
| Experimental group                        | 142.56±4.09| 134.19                 | 150.65    |         |
| Upper extremity functional index          |           |                         |           |         |
| Conventional group                        | 31.06±1.23| 28.58                   | 33.55     | 0.000   |
| Experimental group                        | 41.01±1.20| 38.58                   | 43.44     |         |
| Caregiver functional use survey           |           |                         |           |         |
| Conventional group                        | 98.18±1.17| 95.82                   | 100.11    | 0.000   |
| Experimental group                        | 111.80±1.15| 109.48                 | 114.11    |         |
| Modified Ashworth scale                   |           |                         |           |         |
| Conventional group                        | 2.00±0.50  | 1.79                    | 2.21      | 0.000   |
| Experimental group                        | 1.31±0.47  | 1.12                    | 1.50      |         |

Discussion

In the current study, the differences in physical performance of FUT group by using FMA-UE, 9-hole peg board, upper extremity functional index, care giver functional user survey and modified Ashworth scale were compared. Also the physical performances of the two groups were investigated before and after the treatment. From the comparison results, it was found that FUT group had significantly improved with higher scores (p<0.05).

Luigi Tesio et al. carried out a study on FUT to improve crouch gait in adult hemiplegics. They compared the effectiveness of FUT with no constraints exercise. The results of the study showed that there was an effective improvement for the patients who underwent ‘forced use’ exercise for the paretic lower limb17. Laurent Ballaz et al. conducted a study on postural asymmetry using FUT on spastic hemiplegic children. They carried out studies using an upper limb constraint for 3-week, 6 hours per day on 12 non-consecutive days. During the intervention, the children wore a sling on the non-involved upper limb. After FUT, upper limb functional scores improved significantly, and postural asymmetry tended to decrease, compared with the pre-therapy values10. Wen-Hsiu Yu et al proposed that FUT can be used on lower extremity on gait performance and mobility of post-acute stroke patients. They carried out a study comparing the conventional studies and FUT and the study was carried out for 2 weeks. After the conclusion of the study, they found that the outcome measures had improved in the gait performance and mobility. They concluded that FUT can be used to improve gait parameters9. Hammer AM et al. conducted a study on adult
stroke participants where one group received a standard rehabilitation programme with training of 5 days per week for 2 weeks as inpatients or outpatients. The FUT group also wore a restraining sling on the non-paretic arm with a target of 6 hours per day. After 3 months of follow up the subjects with restraint sling had remarkable improvement in their functional activities. They suggest that constraints can improve in paralytic patients.

Conclusions
FUT caused reduction in spasticity and increased functional ability in children with spastic hemiplegic cerebral palsy.

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