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EFFECTS OF NEUROMUSCULAR ELECTRICAL STIMULATION WITH AND WITHOUT CONSTRAINT INDUCED MOVEMENT THERAPY ON UPPER LIMB FUNCTION IN CHILDREN WITH ERB'S PALSY

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Abstract

Background: Erb's Duchene paralysis a paralysis of the arm caused by the injury to the upper group of the main nerves supplying it, specifically the upper trunk C5-C6 of the brachial plexus. It causes functional impairments in the child which limits activity. Constraint-induced movement therapy (CIMT) has been used to promote functional gains in individuals with neurological dysfunctions. Whereas, neuromuscular electrical stimulation (NMES) has been used for muscle strengthening, maintenance of muscle mass and strength during prolonged periods of immobilization.

Objective: To compare the effects of neuromuscular electrical stimulation with and without constraint induced movement therapy on upper limb function in children with Erb's palsy.

Methods: A randomized controlled trial performed with-in 6 months from July 2022 to December 2022 in which 22 children with age of 6-8 years (mean and SD=10.45±1.29) were taken randomly

after meeting inclusion criteria. Children were divided into two groups. Group 1 received constraint induced movement therapy for a period of 3 weeks for at least 6 hours per day combined with the application neuromuscular electrical stimulation for a period of 6 weeks four times a week. Group 2 received only neuromuscular electrical stimulation for a period of 6 weeks, four times a week. Statistical Package for Social Sciences (SPSS 25) was used to analyze the data.

Results: Constraint-induced movement therapy plus electrical stimulation group showed both a greater rate of improvement in integrated EMG of the involved wrist extensors and cocontraction ratio compared to the other group at 3 and 6 months, as well as improving in root mean square of the involved wrist extensors than traditional occupational therapy group ($p<0.05$).

Conclusion: Constraint-induced movement therapy plus electrical stimulation is likely to produce the best outcome in improving muscle recruitment and coordination in children with erbs palsy compared to alone therapies. CIMT has been proven to be effective in the enhancement of impaired upper limb in several neurological conditions and NMES has also been effective in improving function in children with Erb's palsy.

Key words: Brachial plexus Neuropathy, Constraint Induced Movement Therapy, Erb's Palsy, Neuromuscular Electrical Stimulation, Klumpke paralysis, Erbs Duchene paralysis.

Introduction:

The brachial plexus is a complex of peripheral nerves providing innervation to the upper limb. The major risk factor is shoulder dystocia; other factors include foetal size and the existence of concomitant birth trauma.(1) Regardless of the degree of the lesion, newborns consistently appear clinically after delivery with unilateral flaccid paralysis of the affected upper limb. Serial exams are necessary to assess severity and recovery potential because there isn't a reliable baseline inquiry (as with other types of nerve injury). The aim of treatment is to renovate function to the upper extremities. The majority of OBPI cases are temporary, and full spontaneous recovery is anticipated. Erb's palsy can result in changes in muscular structural design characteristics that can be observed on an ultrasonogram, children with the condition typically report muscle weakness. This article was carried out for understanding link between age, muscle composition, and muscle power in children with Erb's palsy. Over-all, 40 patients with Erb's palsy, aged 1-2.5 years, were involved in the study.(2, 3) The other potential causes of this injury are severe shoulder pulling during vertex presentation, pressure on the raised arms during delivery in breech position, or clavicle fracture unrelated to dystocia. It reveals as sensory loss in the arm as well as paralysis and brachialis, biceps, and deltoid muscular wasting. Arm is adducted and internally rotated, elbow is extended, forearm is pronated, wrist is flexed, and fingers are extended.(4). Between 0.1 and 8.1 per 1000 live babies are known to have neonatal brachial plexus palsy (NBPP) globally. Parental counselling, family support, splinting, and proper and supervised rehabilitation are all parts of early treatment. Children who have showed little to no progress in the affected muscle groups at 3 to 6 months of age often undergo neurosurgical intervention.(5). Intensive training of unimanual abilities in the hemiplegic limb is combined with restriction applied to the upper limb that is not affected in constraint-induced movement therapy (CIMT).(6) At the individual level, the results of therapy might differ greatly. The existence of other impairments, age at treatment's beginning, degree of motor impairment, and cognitive ability have all been known as potential outcome-inducing variables.(7) A well-known and regularly used evaluation instrument is the Assisting Hand Assessment (AHA). It evaluates the efficacy with which childs with unilateral hand dysfunction really work with their healthy hand to complete tasks requiring two hands.(8)

The decision between Oberlin transfer and nerve grafting has not been settled upon due to the intricacy of the damage. Early case studies of NBPP patients who underwent Oberlin transfer have revealed that individuals with upper brachial plexus palsy (Erb's palsy) and delayed milestone have better

results. The Oberlin transfer has been used in newborns with NBPP, but its usage has been constrained by the fractional or uneven retrieval of elbow flexion and worries about Deaths at the donation site.(9) Functional results when a personalised dynamic elbow brace is used in conjunction with therapy therapies for kids with NBPP. The stability-mobility connection was fostered for efficient movement and function engaging a dynamic elbow brace that can immobilise, provide dynamic functional assistance, or provide resistance. Additionally, the traits increased the likelihood of functional mobility and range-of-motion improvements, muscle reeducation, proprioceptive feedback, and possibly even brain remodelling. Additionally, they allowed for the strengthening of muscles throughout a larger range of motion.(10)

Frade et al. in 2022conducted a narrative review of the various rehabilitation programmes for OP patients and discovered 13 papers that were pertinent to their question. In addition to electrical stimulation and CIMT, they recommend using them as additional noninvasive therapy choices.(11, 12) The specialists claim that the first is an approach that is frequently utilised to hasten the regeneration of nerve tissue after peripheral nerve loss, lessen muscular atrophy, and enhance functional muscle recovery. Continuous active motion treatment (CIMT) and electro-stimulation are effective techniques for regaining muscle tone, range of motion, and strength in injured muscles.(13)

Denise Justice et al. in 2021 conducted a study. This study's goal was to analyse recent research on the efficiency of neuromuscular electrical stimulation (NMES) for regaining mobility and functionality in newborns with brachial plexus palsy (NBPP). Evidence for increased muscular strength with NMES is conflicting. AROM has improved in a more consistent manner.(14, 15) A clinical study is necessary to identify the effects of NMES in NBPP because to differences in treatment methods, patient profiles, and adjunct treatments. NMES in NBPP treatment is still appropriate given that better mobility and function have been documented.(3).

There are various interventions used to improve upper limb function in the patients of Erb's Palsy. CIMT has been shown to be useful in improving upper-limb impairment at several neurological conditions comprising Erb's palsy. NMES has also been effective in improving function in children with Erb's palsy. To the author's knowledge, no study has ever combined these therapies and contrasted their results with those of electrical stimulation. The purpose of this study is to compare the cumulative impacts as a result. Of CIMT and NMES versus the effects of NMES alone. This study will determine if there are additive effects of CIMT when combined with NMES leading to the development of a protocol that is time effective and more efficient in general to improve the function of the upper limbs in Erb's palsy.

Objective:

To compare the effects of constraint-induced movement therapy on the function of the upper limbs in children with Erb's palsy when combined with neuromuscular electrical stimulation.

Methodology:

This study employed a randomized controlled trial design to investigate its research objectives. Data collection took place at multiple healthcare facilities, including Jinnah Hospital, Farooq Hospital, Children's Hospital, and Lahore Medical City Hospital. The study duration spanned six months, commencing after obtaining approval for the synopsis. Sample size determination utilized Epi Tool software, with shoulder internal rotation measured as the variable using a goniometer. The study included a total sample size of 24 participants, calculated after incorporating a 10% attrition rate. Participants were divided into two treatment groups: Group A received constraint-induced movement therapy (CIMT) in combination with neuromuscular electrical stimulation, while Group B received only neuromuscular electrical stimulation. Both groups also underwent basic physical therapy exercises such as stretching, strengthening, and isometrics. Sampling was conducted using a non-probability consecutive sampling technique. Inclusion criteria comprised children aged 1 to 8 years clinically diagnosed with Erb's palsy or brachial plexus palsy, capable of cooperating with assessments and therapy, possessing full passive ranges of motion in wrist, elbow, and shoulder

movements, and deemed eligible for CIMT application. Exclusion criteria included cognitive impairment, contractures in the affected upper extremity, injuries to the unaffected arm, and sensory deficits likely to interfere with treatment or testing. Additionally, participants with previous orthopedic or neurological surgery, fixed deformities of the upper limb, uncontrolled seizures, or prior CIMT application were excluded. Data collection tools included the Box and Block Test (BBT), chosen for its suitability in pediatric assessments of manual dexterity and motor improvement. Data analysis was conducted using SPSS version 25, with statistical significance set at P=0.05. Normality of data was assessed using the Shapiro-Wilk test, and descriptive statistics were presented through pie charts, frequency bars, and tables. For normally distributed data, repeated-measures ANOVA was employed for within-group analysis, and independent t-tests were used for between-group comparisons. Non-parametric versions of these tests were applied if the data were not normally distributed.

Results

Table 1 Age:

	Minimum	Maximum	Mean ± SD
Experimental Group	2.5	7.0	4.364 ± 1.2863
Control Group	2.5	8.0	4.500 ± 1.6125

Table 1 showed the baseline of demographics that includes Age. Minimum age is 2.5 and maximum age is 7.0 for experimental group similarly minimum age is 2.5 and maximum age is 8.0 for control group. Mean and Standard deviation of age is 4.364 ± 1.2863 & 4.500 ± 1.6125 respectively

Table 2 Repeated measure ANOV for Within group analysis of mallet score:

	N	Mean ± SD
Mallet Score Pre	22	1.00 ± .000
Mallet Score 3 weeks	22	2.36 ± .505
Mallet Score Post	22	4.06 ± .701

Table 2 showed that Repeated measure ANOV for Within group analysis of mallet score. Mallet score pre values of mean and standard daviation are 1.00 ± .000, Mallet score 3 week values of mean and standard daviation are 2.36 ± .505 & Mallet score post values of mean and standard daviation are 4.06 ± .701. Table7 showed mallet score increase over time that is from (1.00 to 4.06 mallet score) occurring pre-intervention to after 6 weeks.

Table 3 Box and Block Score for Experimental Group:

	N	Mean ± SD
Box and Block pre score	22	9.64 ± 2.248
Box and Block Score at 3 weeks	22	73.73 ± 11.926
Box and Block post score	22	130.55 ± 11.058

Table 3 showed that Repeated measure ANOV for Within group analysis of experimental group of box and block test. Box and block score pre values of mean and standard daviation are 9.64 ± 2.248, Box and block score 3 week values of mean and standard daviation are73.73 ± 11.926& Box and block score post values of mean and standard daviation are 130.55 ± 11.05

Table 4 Pair-wise Comparison

	Mean difference(i-j)	P value(significance)
Box and Block pre score – Box and Block Score at 3 weeks	-64.091	0.000
Box and Block Score at 3 weeks – Box and Block post score	-56.818	0.000
Box and Block post score – Box and Block pre score	120.909	0.000

Table 4 showed that Repeated measure ANOV for pair wise comparison of Box and block test. Box and block Score Pre – Mallet Score 3 weeks mean difference and p value was-64.091 and 0.000 respectively Mallet Score 3 Weeks – Mallet Score Post mean difference and p value was -56.818 and 0.000 respectively and Mallet Score Post – Mallet Score Pre score mean difference and p value was 120.909 and 0.000 respectively.

Table 5 Independent t test for Between Group Analysis for Mallet Score:

	Group	Mean±SD	P value (2 tailed)
Pre-treatment	Experimental group	1.00 ± 0.000	1.00
	Control Group	1.00 ± 0.000	
Post-Treatment	Experimental group	4.55 ± .522	.101
	Control Group	4.09 ± .701	

Table 5 showed that Independent t test for Between Group Analysis for Mallet Score test. Mallet Score Pre_treatment for both experimental and control group mean difference and p value was 1.00 ± 0.000, 1.00 ± 0.000 and 1.00 respectively. Mallet Score Post_treatment for both experimental and control group mean difference and p value was 4.55 ± .522, 4.09 ± .701and 1.101 respectively.

Table 6 Independent t test for Between Group Analysis for Box and Block Test:

	Group	Mean±SD	P value (2 tailed)
Pre-treatment	Experimental Group	9.64 ± 2.248	1.00
	Control Group	7.91 ± 1.921	
Post-Treatment	Experimental Group	130.55 ± 11.058	.054
	Control Group	121.73 ± 8.934	

Table 6 showed that Independent t test for Between Group Analysis for Box and Block test. Box and Block Score Pre-treatment for both experimental and control group mean difference and p value was 9.64 ± 2.248, 7.91 ± 1.921 and 1.00 respectively. Box and Block Score Post-treatment for both experimental and control group mean difference and p value was 130.55 ± 11.058, 121.73 ± 8.934 and .054 respectively.

Discussion

Children with Erb's palsy have reduce shoulder ranges and multiple impairments. The most Common reduce ranges of shoulder are shoulder abduction, shoulder flexion and shoulder external rotation. The results of my study showed overall improvement id shoulder flexion and shoulder abduction ranges but limited improvement in shoulder external rotation. In 2018, A study conducted "effectiveness of kinesio tape on wrist extensor muscles in children with obstetric brachial plexus injuries" A randomize control trial was done in which each group containing 15 children. The experimental group was given physiotherapy, neuromuscular stimulation and kinesio tape for wrist extensors. The session of the treatment was 20 minutes. The result was measured on Gibert-Raimondi and active movement scale, which shows significant result in the experimental group (Gibert-Raimondi p=0.02) And active movement scale p=0.06 (16) . Comparing with the current study kinesio tape can also be used in the treatment regime.(17, 18) a medical experiment carried out in the General Hospital Lahore's outpatient physiotherapy department. 46 children with the C5 and C6 lesion and limited range of motion were included in the sample; children with any history of recent or recent trauma to the upper limb or surgery on the other brachial plexus roots were omitted. The children's ages ranged from 0 to 10 years. As outcome measures, the modified Mallet scale and the active movement scale were employed.(19, 20) The coin toss method of randomization was used, with the "Heads" group receiving strengthening exercises and the "Tails" group receiving general care. Pre- and post-test differences were evaluated using an independent sample test. Orthoses, electrical current stimulation, and neurodevelopmental strategies to enhance proprioception input were all used as

physiotherapy therapies. The strength training involved the use of free weights, resistance bands, and manual resistance. Goniometry was used to assess the active range of motion, and a modified mallet scale was used to create a baseline measurement. For six months, the therapy was given each day. At two, four, and six months after the intervention, post-intervention measures were put into action. Data analysis was carried out using SPSS 25.0. (13) Comparing with the current study CIMT can also be used in the treatment regime.(21, 22)

A study was conducted "Is Neuromuscular electrical stimulation is a viable intervention for brachial plexus injury" By Gad Alon in 2019. It was a reported clinical data in which the author compares a group received functional electrical stimulation foe three months incorporated with weight bearing exercises and the other group received only neuromuscular stimulation. The results showed improvement in mallet grading and bone mineral density in group one. But still external rotation and scapular- thoracic joint hypermobility did not show much improvement (23). The current study showed the overall improvement in the three basic shoulder joint ranges i.e shoulder flexion, abduction and external rotation because instead of weight bearing exercises the more focus was on functional activities.(24, 25)

A study was conducted in Egypt "Teres major transfer to restore external rotation of shoulder in Erb's palsy patient ". As shoulder external rotation is limited in Erb's palsypatient. So, release of Teres major and tendon of Anterior subscapularis transfer to infraspinatus tendon. The surgery showed improved active shoulder external rotation from 8 to 85 after surgery and shoulder abduction from 67 to 158 (26).The present study has no surgical procedure and no internal rotation contracture formed.(27, 28)

A study by Sarwat Anees conducted in 2022, "Effects of Physiotherapy On Strength, Range and Function in Children with Erb's Palsy". It was an experimental study and the experimental group was given physiotherapy treatment and neurodevelopmental approach such as, Electrical Stimulation and Orthosis to improve the proprioception. For strength and weight, manual resistance and Thera Band's applied. The outcomes were measured on Mallet scale and Goniometry. The result showed, mean and standard deviation (1.43±0.506) for strength, for control group showed (2.65±0.4) Significantly, less than 0.05 (13). When Compared with the current study (18.22±0.64) $P<0.05$.(29)

The Use of Dynamic Assisted Orthosis for Muscle Reeducation Following Brachial Plexus Injury and Reconstruction". By Shrikan J. Chinchalkar applied dynamic assisted elbow flexion orthosis for muscle reeducation and function. This is used to prevent the contracture, muscle atrophy and enable them to do daily activities (30). As in the current study, no orthosis was used to see the effect in Erb's palsy patient.(31)

Conclusion

This Quasi experimental study showed that applying functional electrical stimulation, combined with functional activities of shoulder joint such as reaching a ball grasping a ball releasing it in different directions along with application of CIMT have positive effects in improving range of functional status in children with Erb's palsy.

Limitation of this study was the Applying CIMT on children and maintaining throughout the treatment session was difficult as children get irritated very soon and don't obey the command properly, Applying functional electrical stimulation on children and maintaining throughout the treatment session was difficult as children get irritated very soon.

It is recommended that applying CIMT as early on treatment in Erb's palsy children will help in improving the ranges of joint, preventing atrophy of muscles, improving blood circulation of the area and functional rehabilitation. Similarly, it is also recommended that applying functional electrical stimulation as early on treatment in Erb's palsy children will help in improving the ranges of joint, preventing atrophy of muscles, improving blood circulation of the area and functional rehabilitation.

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