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SVNIRTAR...

The Swami Vivekanand National institute of Rehabilitation Training and Research is one of the most prestigious and premier institute in the field of locomotor rehabilitation, under the Department of Disability Affairs, Ministry of Social Justice and Empowerment, Government of India. It is situated in Olatpur at the banks of holy river Prachi, a remote village in the Cuttack district of Odisha state. This institute is rendering services in the field of locomotor disability since 1975. Moreover the institute has taken the responsibility towards development of human resources and public services to the person with disabilities in consultation with Physical Medicine and Rehabilitation, Occupational Therapy, Physiotherapy, Prosthetics and Orthotics, Clinical Psychology, Speech and Hearing, Social work and vocational counselling. The institute conducts a series of specialized Bachelor‘s and Master‘s Degree courses under the affiliation of Utkal University: Bachelor of Physiotherapy (4.6 years duration), Bachelor of Occupational Therapy (4.6 years duration), Bachelor of Prosthetics and Orthotics (4.6 years duration), Master of Physiotherapy (2 years duration), Master of Occupational Therapy (2 years duration), Master of Prosthetics and Orthotics (2 years duration), DNB (PMR) and recently a new diploma course is added to the course hierarchy as post diploma in orthopedic nursing and many periodical seminars and workshops.

The institute has a good infra-structure for direct sample testing and its value based research work is also acclaimed nationally and inter-nationally. Moreover the design of modular prosthesis developed by SVNIRTAR has been dedicated to the whole nation by the then president of India. SVNIRTAR is a good knowledge hub for researchers, educators and practitioners for enquiring a new quest of life through advancement of technology.

Journal of Rehabilitation

GENERAL INFORMATION

About this Journal

Journal of Rehabilitation (JOR) is the official journal of the Swami Vivekanand National Institute of Rehabilitation Training and Research (SVNIRTAR). The main objective of the journal is to promote multidisciplinary practice in the field of rehabilitation by collaborating with academicians, clinicians, researchers and educators from India and abroad. JOR is dedicated to the publications of research activities undertaken by the various departments of SVNIRTAR to foster education, research and professionalism in the field of rehabilitation of persons with disabilities. The journal is also open to publication of review articles, rehabilitation teaching methodologies, special articles, commentary in the field of disability and letters to the editor. JOR is published biannually in January and July. The journal will be indexed shortly.

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Content

Editorial

From the desk of Editor-in-chief………

After a long interruption of the journal of Rehabilitation, it is once again publishing for the technical, professional benefits of locomotors rehabilitation professionals. It is a technical mouth front of Swami Vivekanand National Institute of Rehabilitation Training & Research pertaining to different ongoing research for the betterment cause of persons with disabilities from the department of PMR, PT, OT, & PO. This Journal always has an instinct vision towards the peer study of different problems and conditions surfaced during the practices in relation with theory & concepts and also committed to document all such findings for future use of educators, researchers, clinical practitioners and students. Research is one of the fundamental needs for any branches of the technology, and without this the development cannot be sustained for long time and research is one of the prime ethics of SVNIRTAR since of its inception. Clinical research is one of the most practical areas where inputs can alter the entire direction of the problems and for which JOR always ready for due documentation and dissemination to appropriate front. The current issue has includes (Volume-III: Issue-1) articles of different technical studies of the subject and my editorial board has invests their maximum efforts to make it organize and readable and for which the appreciation also to be credited. In this context I must immensely complimenting all contributors for their great efforts.

At last, I solicit your valuable suggestions to make this journal more purposeful. And it is requested to all the experts, professionals in the area of locomotors disability rehabilitation to contribute the valuable study in the form of comprehensive manuscript for the benefits of PwDs.

Dr. P. P. Mohanty
(Editor-n-chief)

EFFECT OF BALANCE TRAINING USING BUNGEE CORDS AND TRAMPOLINE FOR FUNCTIONAL BALANCE

Type of manuscript: Observational study

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ABSTRACT

Purpose: To see the effect of trampoline jumping using bungee cords with conventional therapy on functional balance in children with spastic diplegic cerebral palsy. **Methodology:** A total of 40 children diagnosed with spastic diplegic cerebral palsy were recruited and randomly distributed in two groups. Group 1 received Trunk supported trampoline jumping along with conventional therapy and Group 2 received Conventional therapeutic exercises. **Outcome Measures:** PBS (Pediatrics Balance Scale) and GMFM-88 (Dimension- Standing & Walking). Measurements were taken before, and at the end of six weeks of treatment. **Results:** Overall results of the study showed that both Group 1 and Group 2 improved in balance after six weeks of intervention. However, Group 1 improved significantly to a greater extent than the Group 2. **Conclusion:** Children with spastic diplegia when treated with trunk supported trampoline jumping with functional training with conventional therapeutic exercises improved balance and gross motor function more than conventional therapeutic exercises alone.

Key words: Spastic diplegic cerebral palsy, trampoline, jumping.

INTRODUCTION

Cerebral palsy [CP] is a group of permanent and non-progressive disorders of posture and movement caused by brain lesion or dysfunction occurring early in life [1]. The worldwide incidence of CP is approximately 2 to 2.5 cases per 1000 live births. In India, it is estimated at around 3 cases per 1000 live births; however, being a developing country the actual figure may be much higher than the probable figures. There are about 25 lakhs CP children in India as per the last statistical information.

Spastic diplegia is one of the most common clinical subtypes of cerebral palsy. It involves more motor impairment in the lower extremities than the upper extremities. Most of the children have significant weakness in the trunk and spasticity of the extremities [2]. Spastic diplegia accounts for about 44% of the total incidence of CP. It represents 80% of preterm infants and in a recent series it represents 18% of the overall CP children [3].

Cerebral palsy is a primarily a disorder of movement and posture. It is the most common cause of severe physical disability in childhood. The large majority of children with CP have difficulty in walking. Most common type of CP is spastic diplegic, who demonstrate poor balance control: that leads to poor gait and reaching movements as the maintenance of stability is critical to all movements [4]. Instability in ambulation, higher incidence of falls also causes extra muscle tension development which usually develops in the shoulders, chest and arms due to compensatory stabilization movements, although the upper body itself is not directly affected by the condition. Initiation of activity is difficult, child cannot move from one posture to another hampering performance of voluntary movement, increased cost efficiency of gait, early fatigue. Child becomes fixed in a stereotyped pattern of movement, showing loss of flexibility and adaptability and hence demonstrates poor walking abilities and manipulation skills. Balance problems in gait can range from being barely noticeable to misalignments so pronounced that the child needs crutches or a cane / walking stick to assist in ambulation. In severe cases limiting the child to bed or wheelchair.

Individuals with cerebral palsy have difficulties with maintaining and establishing balance. These difficulties can be associated with poor proprioception as well as visual deficits [5].

Classic motor development theory holds that the development of motor patterns is influenced by certain innate reflex responses. As the brain matures, higher levels of control inhibit some motor behaviors. For individuals with CP, reflex responses often persist for longer periods of time. If certain reflexes are not inhibited, the development of more voluntary movements will likely be delayed. [6]

Balance involves a variety of mechanisms working cooperatively in order to maintain adequate posture and stability. Individuals with cerebral palsy often have problems with balance due to difficulties in muscular strength, muscle tone, and/or difficulties within the sensory systems. Postural control, specifically postural stability, is a fundamental prerequisite for the motor development in children. [7]

The delicate integration of vision, vestibular and proprioceptive sensations and commands from the central nervous system and neuromuscular responses, particularly muscle strength and reaction time is fundamental for the postural control. [8]

Postural control abnormalities are a major limitation to the motor development in children with CP. These children demonstrate a number of limitations caused by instability on the performance of static and dynamic tasks, such as sitting, standing and walking. [9]

The clinical picture of CP includes neuromuscular dysfunctions, such as the loss of selective motor control and muscle tone disturbance, leading to an imbalance between agonist and antagonist muscles, coordination disturbance, sensory alterations and weakness. [10]

Postural unsteadiness of children with CP is evident from the greater oscillations of the centre of pressure [COP] in the antero-posterior [AP] and medio-lateral [ML] directions, even with the use of the lower limb braces. [11] Different methods have been used to improve postural control in CP children. [12]

Postural control and the ability to maintain static and dynamic balance involves the interaction of a number of sensory systems. These sensory systems include the vestibular apparatus, somatosensory and visual systems. According to Woollacott, vestibular system is one of the main structures to maintain balance, as it serves as an absolute reference in relation to the others, such as visual and somatosensory systems. Adequately administered vestibular stimulation has been reported to improve balance; the vestibular-spinal reflex generates body motion compensation, to maintain head and postural stability and thus preventing falls. Bobath technique relies on vestibular mechanism (labyrinthine, righting, equilibrium reactions) to facilitate normal development patterns & those without adequate control of labyrinthine reactions of the head, the development of motor sequences is nearly impossible or greatly inhibited. [13]

AIM OF THE STUDY

The purpose of the study was to find the effect of trampoline and bungee cords on functional balance in children with spastic diplegic cerebral palsy.

METHODOLOGY

Study design: Two groups, [Group 1- Experimental Group, Group 2 - Conventional Group] experimental design.

Study population: 40 children recruited for the study from pediatric section of physiotherapy department of Swami Vivekanand National Institute of Rehabilitation Training and Research (SVNIRTAR).

Inclusion criteria: Children diagnosed as spastic diplegic cerebral palsy, age 3 to 8 years, GMFCS level II to III, MAS SCORE above 1-2, psychologically good, follows command.

Exclusion criteria: Uncontrollable Seizures, hemiplegia, athetoid, ataxic and flaccid CP, cardio vascular illness, visual and cognitive deficits, complicated systemic disorders, subluxation & dislocation of hip exceeding 33%, non-cooperative children, recent Botulium toxin injections.

Outcome measures:

1. PBS (Paediatrics Balance Scale):- Berg Balance Scale was modified into the Pediatric Balance Scale to be used as a balance measure with mild to moderate motor impairment for school-age children between 5 and 15. The modifications include: sequence of test, test instructions and the time for maintaining static posture. This test can be administered and scored within fifteen minutes. The fifty-six point is the maximum score [13]. This scale evaluates the performance of fourteen activities common in everyday life, indicating the ability to maintain sitting and standing positions of increasing difficulty. Evaluation of standing balance was carried out by providing progressively smaller BOS. This test was used to assess subjects with neurological disorders [14].

2. GMFM-88 (dimension- Standing & Walking):- Gross motor functional measure (GMFM) is a quantitative measurement, which measures amount of a task the child can accomplish, rather than how well the task is completed. It is appropriate for children with CP at the age of five months to sixteen years. It contains eighty-eight items in five gross motor dimensions (Lying and rolling – Crawling and kneeling – sitting – standing – walking, running and jumping). They may be tested in

any order. A maximum of three trials for each item and it scores as given below:

0- Does not initiate the task, 1- Initiates the task (< 10 %), 2- Partially completes the task (10-99 %), 3- Completes the task (100 %)

Procedure:

Screening of the subjects were done by Gross Motor Function Classification System levels II to III. After meeting the inclusion and exclusion criteria through an assessment Performa. Informed consent was taken from the parents/ caregivers of the children and then they were randomly allocated to the two groups: Group 1: Experimental group, and Group 2: Conventional group.

All participants underwent an initial baseline assessment of Paediatric Balance Scale, and the Gross Motor Function Measure (dimension Standing & Walking). Both groups received conventional physiotherapy. The experimental group in addition, received trunk supported trampoline jumping.

Conventional therapy consisted of bridging, quadruped, kneeling, bilateral and unilateral sit to stand, functional reaching and ball throwing-keeping exercises in various directions.

- Bridging - 10 reps with 10 sec hold each time
- Quadruped – 5 minutes
- Kneeling – 5 minutes
- Bilateral Sit to Stand – 1 set of 10 reps.
- Ball Throwing and Keeping – 1 set of 10 reps.
- Time period and repetition was increased for progression.

Experimental group was treated with trunk supported trampoline jumping in addition to conventional therapy. The child was made to stand on the trampoline, wearing waist belt which was attached to the trampoline frame through bungee cords. The child and mother were explained about the activities to be performed.

- The protocol included jumping activities for 10 minutes followed by 5 minute rest period.
- After that the child performed half kneeling to stand followed by bilateral sit to stand and reaching activities. 1 set of 10 repetitions of each activity.
- Time period and repetition was increased for progression. The treatment was given for 5 days/ week for 6 weeks.

DATA COLLECTION

Measurements for all dependent variables were taken prior to the beginning of treatment and were repeated again at the end of 6 weeks of intervention.

DATA ANALYSIS

Statistical analysis was performed using SPSS version 23.0.

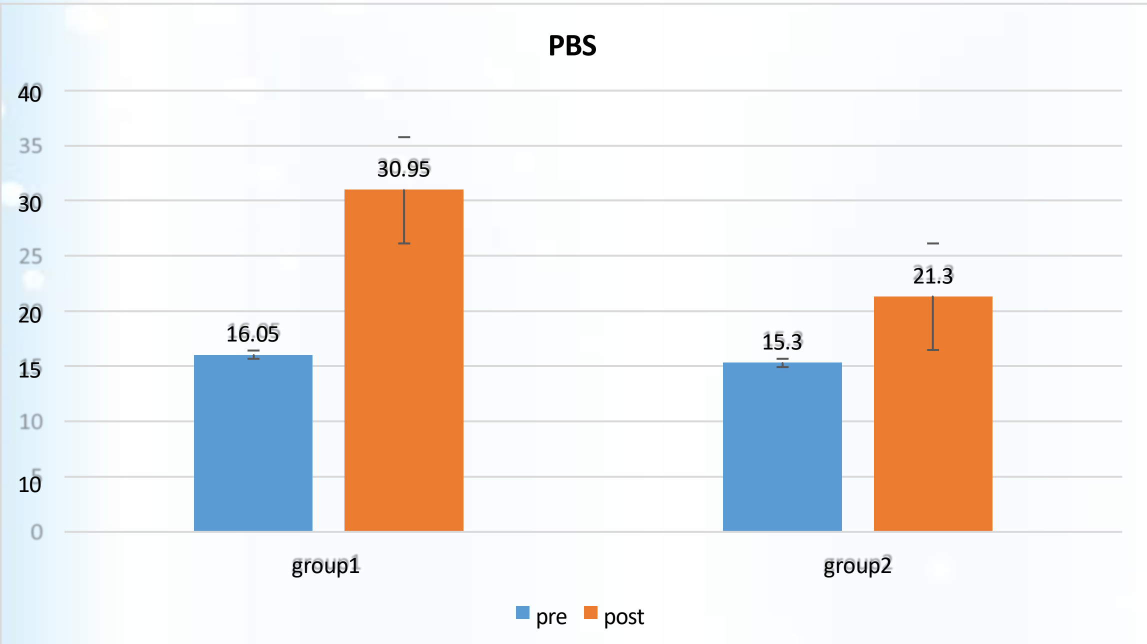
The Balance was analyzed using an ANOVA, 2x2 with 2 as time factor and 2 as group factor. There was one between factor (group) with two levels [Group: 1 and 2] and one within factor (time) with two levels [time: Pre and Post]. All pair wise post hoc comparisons were analyzed using a 0.05 level of significance.

The effect between the groups was analyzed with Mann-Whitney U test by calculating the median of GMFM-88 [post minus pre scores]. Separate comparisons between the groups were obtained and tabulated.

All pair wise post-hoc comparisons were analyzed using a 0.05 level of significance.

RESULTS

Graph-1: Pediatric Balance Scale (PBS)



Graph-1 illustrated that there was improvement in balance in the Paediatric Balance Scale in both the groups following treatment for 6 weeks. The Experimental Group showed greater improvement as compared to the Conventional group at the end of 6 weeks.

Gross motor function measures [GMFM - 88] goal area: standing & walking

Mann Whitney U test between changed scores of pre and post GMFM dimension, Standing‘ and_ Walking‘ between Experimental Group and Conventional Group showed that Experimental Group had a more significant improvement over the Conventional Group with p = .000.

DISCUSSION

Overall results of the study showed that both the groups improved significantly for Pediatric Balance Scale after 6 weeks of intervention but the experimental group had significantly more improvement than conventional group. Similarly the experimental group showed significantly more improvement in gross motor function measure.

Balance: Balance was measured by Pediatric Balance Scale (PBS). The result after 6 week of intervention suggested that, both the groups improved significantly. But experimental group improved more significantly than conventional group.

The subjects in Conventional group treated with conventional therapy consisted of bridging, quadruped, kneeling, bilateral and unilateral sit to stand, functional reaching and ball throwing keeping exercises in various directions following 6 weeks of interventions.

Improvement in conventional group could be due to the involved activities like Bridging and Quadruped which helps to maintain a neutral pelvic and spinal posture. All back muscles, core and hip muscles contribute in a similar way to control spine positions and movements.

Veerle K Stevens et al. studied the relative muscle activity and the ratios of the back muscles support the assumption that during these single bridging, ball bridging and unilateral bridging exercises, all back muscles contribute to control spine positions and movements in a healthy population. [14]

In quadruped exercise both _global and local muscles function together to stabilize the spine and performance of core stabilization exercises to improve trunk control could be responsible for an improvement in gross motor function. [15]

Kneeling position is important as it integrates contraction of hip muscles especially gluteus maximus along with trunk in against gravity which is more functional and help in development of kneeling as well as standing. Sit to stand improves the strength of trunk and leg muscles. This task might be helpful in improving balance and provides stability in standing. **Lederman E** reported that sit to stand exercises were done to simulate the motor control tasks as ideal neuromuscular organization to movement occurs when the movement is in similar pattern to the goal movement and practiced in context of the particular movement. [16]

Practice of functional activities like reaching in various directions while sitting upright have the potential to train aspects of muscle performance such as coordination, strength, endurance, physical conditioning as well as motor learning as reaching tasks resembled items of PBS. [4] Since the exercises stimulated the goal movement and context of movement, neuromuscular organization of the movement occurs. [16] Thus, this can be transformed as an improved performance on pediatric balance scale.

The experimental group showed significantly more improvement in balance and function than conventional group, possibly due to addition of vestibular and proprioceptive stimulation along with conventional exercises. With repeated vestibular stimulation neuroplasticity and activation of dormant synapses occurs as stated by **Ayres**, leading to an improvement in the CNS. [17] Vestibular stimulation helped in developing feed forward mechanisms, development of balance & equilibrium which formed the basis for gaining new functional skills. Also, active involvement & exploration by the child enables him to become a mature, efficient organizer of sensory information. [18-19]

Sabnam Chettri et al did a study on the effect of vestibular stimulation on standing balance in spastic diplegic cerebral palsy. The study was done in the age group 6 – 14 yrs. Experimental group treated with vestibular stimulation by Mc keone protocol (spinning, sliding and jumping on a trampoline) and conventional exercises and Control group only with conventional exercises for 4 weeks of intervention. GMFM and PBS are used for measuring standing balance. They concluded that vestibular stimulation incorporated with conventional exercises brings about better standing balance, and overall function than conventional exercises. [20]

Levinson et al reported that trunk supported floor jumping (suspension therapy) is an innovative and effective modality for rehabilitation of cerebral palsy childs significantly improves balance, coordination of the body and the performance and it allows full use of the children strength and abilities that can be successfully combined with most of rehabilitation equipment to give postural stability while promoting independence with security. [21]

Rami M. Gharib did a study on the effect of whole body vibration and trunk supported floor jumping (suspension therapy) on balance in children with spastic diplegia. Thirty children from both sexes who were ranging in age from eight to ten years old were assigned into two groups of equal number. Group I received whole body vibration in addition to a designed exercise therapy program and group II received suspension therapy in addition to the same exercise program given to group I and the treatment session was three times/week for three months successively. Both the groups, whole body vibration and trunk supported floor jumping, significantly improved in balance, and the improvements were significantly greater in the trunk supported floor jumping (suspension therapy) group than in whole body vibration group similar to our study. [22]

The effect of trunk supported trampoline jumping (suspension therapy) and other activities performed inside the trampoline frame, improving lower limb proprioceptive sense comes in agreement with **Khaled A. Olama 2012** who did a study on standing balance in 30 children with hemiparetic cerebral palsy both sexes from 8-10 years divided into 2 groups. Trunk supported floor jumping (Suspension therapy) was given to one group & the other received vibration training. Significant difference was observed when post treatment results were compared, which favoured in favor of trunk supported floor jumping (suspension therapy). This was attributed to the effect of trampoline on improving function of vestibular system through development of equilibrium reactions to maintain and regain balance during standing. Loading and unloading by using trunk supported floor jumping (suspension therapy) through alteration of the proprioceptive sense lead to improvement of weight bearing activities. [23]

The improvement in balance is attributed to improvement of trunk control by transfer of body weight to right and left and dynamic balance by using bungee cords and trampoline, as it helps in stabilization of the patient allowing minimal displacement of centre of pressure (COP) and maintaining the centre of pressure close to the midline to decrease the postural sway which reflected a good balance. **Keen et. al** reported that training with the use of trunk supported floor jumping helped the patient to overcome the effect of gravity on their static and dynamic movements and helped in keeping the body from collapsing. [24]

Gross motor function measure (GMFM - 88):

Gross motor function measure showed significantly more improvement in experimental group than conventional group.

In conventional group the improvement in gross motor function was 30.98%. It might be because of the activities involved in the conventional group like sit to stand task, functional reaching and ball throwing – keeping in various direction. These activities improved the balance and function. Shumway cook defined that task oriented programs are necessary for motor learning to occur, functional reorganization and the participation is enhanced when the task is meaningful. In our study patient performed task specific activity, ball throwing-keeping. Optimal training effect occurs when the training is similar to that of the real – life task. The carry over effect was sustained in terms of functional activities.

In experimental group the improvement in gross motor function was 77.81%. These therapeutic interventions were challenging and rewarding for children in order to enhance motivation and willingness to participate in therapy.

In support of the result of our study, there is one study done by **Mohamed FE, et al** on 12 spastic diplegic cerebral palsy children of both sexes with ages ranged from 6 to 9 years old. The control group treated with specially designed physical therapy program and study group treated with trunk supported floor jumping (suspension therapy) and same program given to the control group but inside the suspension therapy. The treatment session was 1 hour for each child and conducted 3 times/ week for 8 successive weeks. Outcome measures were pediatric balance scale (PBS) and gross motor function measure (GMFM-88) .They concluded that the performing balance exercises by using trunk supported floor jumping (suspension therapy) was more effective in improving gross motor function and balance in children with spastic diplegic cerebral palsy. [25]

The studies of **Causgrove DJ** and **Nielsen JB** et al showed that therapeutic interventions must be appealing, challenging and rewarding for children in order to enhance motivation and willingness to participate in therapy. The clinical impression in our study suggests that when therapy is too challenging, it‘s rewarding and thus motivational for children. The children enjoyed while performing the activities inside the trampoline frame. [26-27]

Joohee Hahn et al did a study on the effects of modified trampoline training on the balance, gait, and fall efficacy of stroke patients. There was two groups, both groups participated in conventional physical therapy for thirty minutes per day, three times a week for six weeks. The trampoline group also took part in trampoline training for thirty minutes per day, three times a week for six weeks. In our study trampoline training was given for 40 minutes, 5 times in week for 6 weeks. Both trampoline and the control group showed significant improvements in balance, gait, and fall efficacy compared to before the intervention, and the improvements were significantly greater in the trampoline group than in control group similar to our study. They concluded that Modified trampoline training resulted in significantly improved balance, dynamic gait, and fall efficacy of stroke patients compared to the control group. [28]

CONCLUSION

Children with spastic diplegia treated with trunk supported trampoline jumping with functional training when incorporated with conventional therapeutic exercises improved balance and gross motor function more than conventional therapeutic exercises alone, after 6 weeks of intervention.

LIMITATIONS

Carry over effect of the study has not been studied, energy expenditure index was not calculated for endurance parameter, effect on tight structures and muscle strength were not measured, EMG analysis can be used to detect minor and precise changes in function of muscles, usage of functional MRI and advanced investigatory procedures are recommended to prove the neuronal reorganization.

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PROTEUS SYNDROME
- A CLINICAL CASE REPORT

Type of manuscript: Case Report

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Proteus syndrome is a rare disorder with varied and protean manifestations (1) causing disturbance of cellular growth involving all the three germ layers(1), representing cellular mosaicism. The genetic defect is a mutation in the AKT1 gene(2). Proteus syndrome also manifests as an asymmetric overgrowth of the extremities consisting of macrodactyly with or without hemihypertrophy, thickening of the skin, lipomas and subcutaneous tumors, verrucous epidermal nevi, and macrocephaly(1), angiomas of various types, thickening of bones, and excessive growth of muscles without weakness(3). Histologically, the muscle demonstrates unique muscular dysgenesis. Zones of normal muscle are seen adjacent to Abnormal zones and they do not follow anatomic boundaries(3)

New-borns with Proteus syndrome usually do not present with clinical signs of the disorder. The excessive growth becomes apparent by the age of 6 to 18 months and increases in severity with age. Some people with Proteus syndrome have neurological abnormalities, including intellectual disability, seizures, and vision loss, as well as distinctive facial features.

The Glu17Lys mutation leads to the production of an overactive AKT1 kinase. The abnormally active protein disrupts a cell's normal ability to regulate its growth, which allows the cell to grow and divide unregulated. Increased cell proliferation in various tissues and organs leads to the overgrowth characteristic of Proteus syndrome and to an increased risk of developing tumors.

Management of Proteus Syndrome often requires a multidisciplinary team of specialists. (4)

Case Report

We reported a case of 1year 6 months old male child who was born at 36 weeks of gestation with a C-section due to prolonged labor. The child had an immediate cry after birth. Birth weight was 2.5kg. He presented with an enlarged right upper limb with macrodactyly of the Right Thumb and Index finger along with the left thumb. The patient's right thumb kept on gradually increasing in size with increasing age which led to difficulty in holding objects between the right thumb and index finger and grasping objects. The thumb on the left hand also started increasing in size after birth and now the patient was unable to use his left thumb. There was a marked size discrepancy between the right and left upper extremities. Lower extremities did not show any growth abnormality. Developmental history was suggestive of no abnormality in gross motor, Social, and language milestones but the fine motor milestone was delayed owing to enlarged 1st digit and thumb of the right hand with the left thumb.

Figure 1: Overgrowth of thumb and index finger of the right hand and index finger and left thumb at 1 year 3 months of age

According to the auxiliary examinations, normal findings were obtained from the blood and urine routine tests and after taking consent stabilization of right thumb with soft tissue debulking surgery of right thumb was done with a view of restoring thumb function.

The child reported after 3 months with enlarged right index finger and thumb. However, still right thumb function was not restored completely. Patient was subjected for revision surgery. Racket shaped incision was given around 2nd digit. Ray amputation of the right index finger was done. Intra operatively enlarged median nerve neuroma was identified extending from thumb to wrist which was partially excised. Thumb was approximated to achieve opposition with 3rd digit.

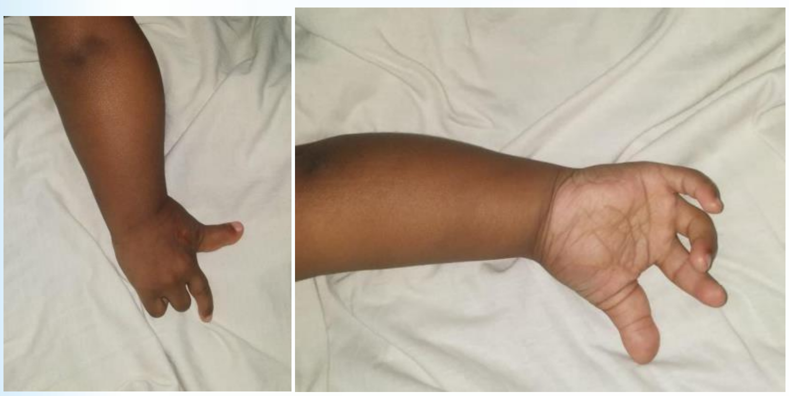

Figure 2: Hand after 1 year of 2nd ray amputation

Discussion:

Proteus syndrome is a rare condition characterized by overgrowth of the bones, skin, and other tissue with an estimated incidence of 1 in one million. Relatively more comprehensive diagnostic criteria were proposed by turner et.Al(5) that includes general and secondary criteria. For Diagnosis of Proteus syndrome, one must fulfill general criteria along with either One criterion from category A or two Criteria from category B or three criteria from category C.

General Criteria	Specific criteria
All of the following:	Either:
Mosaic distribution of lesions	Category A or,
Sporadic occurrence	Two from category B or,
Progressive course	Three from category C
Specific criteria categories	C 1 Dysregulated adipose tissue: Either one:
A Cerebriform connective tissue nevus	a.Lipomas
B 1 Linear epidermal nevus	b.Regional absence of fat
2 Asymmetric, disproportionate overgrowth One or more:	2 Vascular malformations- One or more:
a.Limbs: Arms/legs, Hands / feet / digits, Extremities	a.Capillary malformation
	b.Venous malformation
	c.Lymphatic malformation
b.Hyperostoses of the skull	3 Lung cysts
c.External auditory meatus	4 Facial phenotype- All
d.Megaspondylodysplasia	a.Dolichocephaly
e.Viscera: Spleen/thymus	b.Long face
3 Specific tumors before 2nd decade: One of the following:	c.Down slanting palpebral fissures and/or minor ptosis
a.Ovariancystadenoma	d.Low nasal bridge
b.Parotid monomorphic adenoma	e.Wide or anteverted nares
	f.Open mouth at rest

[Copied from Turner JT, Cohen MM, Biesecker LG. Reassessment of the Proteus syndrome literature]

The Earliest Clinical manifestation in the case discussed herein was suggestive of asymmetrical growth wherein there was enlarged right thumb presentation at birth which increased in size progressively as age along with the right index finger increasing in size after birth along with the left thumb. The patient's parents also noticed a gradual increase in the size of the right upper extremity in comparison to the left extremity. No one in the family had a similar history of overgrowth abnormalities. The presence of all these clinical findings satisfies all the general criteria (Mosaicism, Sporadic, Progressive course) for Proteus syndrome. Moreover, it also meets asymmetrical overgrowth criteria of Category B. However, for the establishment of Proteus syndrome diagnosis other associated findings were not present.

On general examination facial phenotype was absent. There was no evidence of vascular malformation superficially. Cribriform nevus lesion was also not present to meet the criteria of category A but since necessary investigation to exclude other criteria was not done it is difficult to exclude the diagnosis of Proteus syndrome in this case.

Macrodystrophialipomatosais a differential diagnosis for this condition. This includes a form of macrodactyly that affects mainly the hands and feet, commonly involving the middle and index fingers along the area that is supplied by the median nerve or sometimes ulnar nerve distribution (6).

In this case, as it was not able to fulfill all the necessary criteria for clinical diagnosis of Proteus syndrome molecular genetic testing for AKT1 gene mutation was necessary but due to the unavailability of the genetic testing facility nearby and financial constraints, it was not done.

Conclusion: Deformity in Proteus syndrome being a progressive condition, proper clinical and functional evaluation is required to outline the plan of management. Early intervention with a multidisciplinary approach will ascertain a better outcome.

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A STUDY ON VISUAL PERCEPTUAL PROFILE IN CHILDREN WITH SPASTIC DIPLEGIC CEREBRAL PALSY

Type of manuscript: Qualitative Study

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Abstracts

Aim: Visual perceptual dysfunction is common in children with diplegic cerebral palsy. The aim of this study was to examine the profile of visual perception in children with spastic diplegic cerebral palsy

Method: A total of 47 spastic diplegic cerebral palsy children with age range from 4.6 years to 8.6 years were assessed using Test of Visual Perceptual Skills – Revised (TVPS-R) and the child‘s performance on the test were recorded and analysed using descriptive statistical analysis.

Results:

Visual spatial relationship and visual sequencing memory shared the mostly affected visual perceptual component constituting 25% each, followed by visual memory (23%) and visual closure (12%). Visual figure ground was the most commonly spared visual perceptual component constituting 34%, followed by visual form constancy (23%) and visual discrimination (17%). Visual memory and visual sequencing memory stands at 8% each. The mean visual perceptual quotient of was 81 for all the subjects and 79 & 85 for preterm and full term respectively.

Conclusion:

This study found that visual spatial relationship, visual sequencing memory and visual memory were the most commonly affected visual perceptual components. Whereas visual figure ground, visual form constancy and visual discrimination were the mostly spared components in children with spastic diplegic cerebral palsy.

INTRODUCTION

Cerebral palsy (CP) is described as a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, and behavior; by epilepsy, and by secondary musculoskeletal problems [1].

Spastic diplegia is a condition in which lower limbs are more severely affected then the upper limbs. Mild cases of spastic diplegia may present with toe walking due to impaired dorsiflexion of the feet with increased tone of the ankles. In severe cases, there is flexion of the hips, knees and to a lesser extent elbows. When the child is held vertically, rigidity of lower limbs is most evident and adductor spasm of the lower extremities causes scissoring of the leg [2].

Owing to the nature of the underlying cerebral lesions, children with CP can be expected to develop a wide array of cognitive impairments such as deficits in attention and executive functions, language, memory, and visual perception. These impairments are the endpoints of complex processes and have various expressions and consequences in daily activities [3].

Visual perception is defined as a total process responsible for extracting and organizing information from the environment and to organize, structure, and interpret visual stimuli, giving meaning to what is seen. Visual perceptual skills include the recognition and identification of shape, objects, colors and other qualities which allow a person to make accurate judgments of the size, configuration, and spatial relationships of objects [4].

There is no accepted prevalence rate of visual perceptual problems among children with CP, but recent studies have suggest that visual perceptual impairment in children with cerebral palsy could be around 40% to 50% and with a mean visual impairment quotient ranging from 70 to 90. Visual perceptual deficits are common in preterm children with spastic diplegic CP. And in children born preterm, visual perceptual impairment is associated with periventricular leukomalacia (PVL) and the severity of visual perceptual impairment is found to correlate with PVL severity, in particular with anoxic-ischemic damage to the peritrigonal region [3, 5, 6].

The two principal higher visual pathways for visual information processing have been described, namely the dorsal stream and the ventral stream. The ventral stream connects the occipital area with the inferior temporal lobe and is concern with visual objects recognition (what object is), route finding and visual memory. The dorsal stream connects the occipital lobe with the parietal lobe and it provides the information about the location of the objects (where object is) in relation to the body and in relationship to each other and also to visually guide the movement [7, 8, 9].

Visual-perceptual dysfunction can have a negative impact on a number of occupational performance and functional skill areas for children including difficulties in reading, spelling, cursive and manuscript written output, mathematics, visual-motor integration, difficulties with eating, dressing, locating objects, participation in play/recreational/leisure activities, and completion of school related work [4,10].

Occupational therapists are frequently the designated professionals responsible for assessing and treating visual-perceptual skills in children with CP. However, it is one of the least understood areas of evaluation and intervention[11]. Therefore, further knowledge of visual-perceptual functioning of the children with spastic diplegic CP can lead to better understanding of the problems, and it can contribute to the theoretical foundation which will enable occupational therapists for more appropriate evaluations and to develop better remediation strategies.

The ample of literature on spastic diplegic CP have been established that children with spastic CP have impairment in visual perceptual skills as compared with the normal children. Yet, no studies have been done specifically to examine which components of the visual perceptual skills are affected more in children with spastic diplegic CP. The purpose of this study was to investigate visual perceptual profile in children with spastic diplegic cerebral palsy.

METHODS

The study was conducted at Swami Vivekananda National Institute of Rehabilitation Training and Research, Cuttack Odisha, between October 2015 to July 2016. A total of 47 subjects with spastic diplegic cerebral palsy were recruited from occupational therapy department of Swami Vivekananda National Institute of Rehabilitation Training and Research for the study. Convenient sampling was used for the selection of the subjects. Out of total 47 subjects, 39 were male and 15 were female. 26 subjects were born preterm as opposed to 21 subjects who were born at full term.

Inclusion criteria:-

- Children with spastic diplegic cerebral palsy
- Children of age between 4.6 years to 8.6 years
- Sex - both female and male

Exclusion criteria:-

- Visual deficits due to any underlying pathological conditions
- Children who cannot follow commands

Instrumentations:-

1. Modified Modified Asworth Scale
2. Test of Visual-Perceptual Skills – Revised (TVPS-R)

Procedure

Cerebral palsy diagnosed children who came to occupational therapy department for interventions were screened using Modified Modified Asworth‘s Scale to find out the tone of upper extremity and lower extremity. Those subjects with lower muscle tone in upper extremity than the lower extremity were selected. Children who cannot follow commands were excluded. 47 subjects who fulfilled the inclusion criteria were selected for the study. The parents of the patient were explained about the purpose of the study and consent of participation in written form were obtained from the child‘s parents prior to the study. Each subject‘s information including date of birth and date of administration were recorded. The TVPS-R was individually administered to each subject in a standardized manner described in the test manual. Each subject were seated comfortably while taking the test, with the test plates lying flat on a table placed directly in front of the child. The child answered the test questions by pointing to the answer or giving a verbal response. Clear instructions and directions were given to the subjects to make sure that they fully understood of how to perform the test before the beginning of each subtest. Repeated instructions and directions were provided whenever it was necessary. Each subtest was started with the first test item and ended when the subject reaches the ceiling for the subtests. The ceiling is established when a subjects failed three out of four consecutive items on those subtests on which there are four choices, and four out of five failures on those subtests in which there are five choices. It took approximately 30 to 45 minutes to administer the test to each child. The child‘s performance of the test were recorded and individual‘s visual perceptual age for each components were determined and were arranged in order of least to highest visual perceptual age and the median visual perceptual ages were determined. Percentile rank and median visual perceptual quotient were also determined.

RESULT

Descriptive statistical analysis was used to investigate the collected data. The analysis of the data gives the following tables showing the descriptive characteristics of the result.

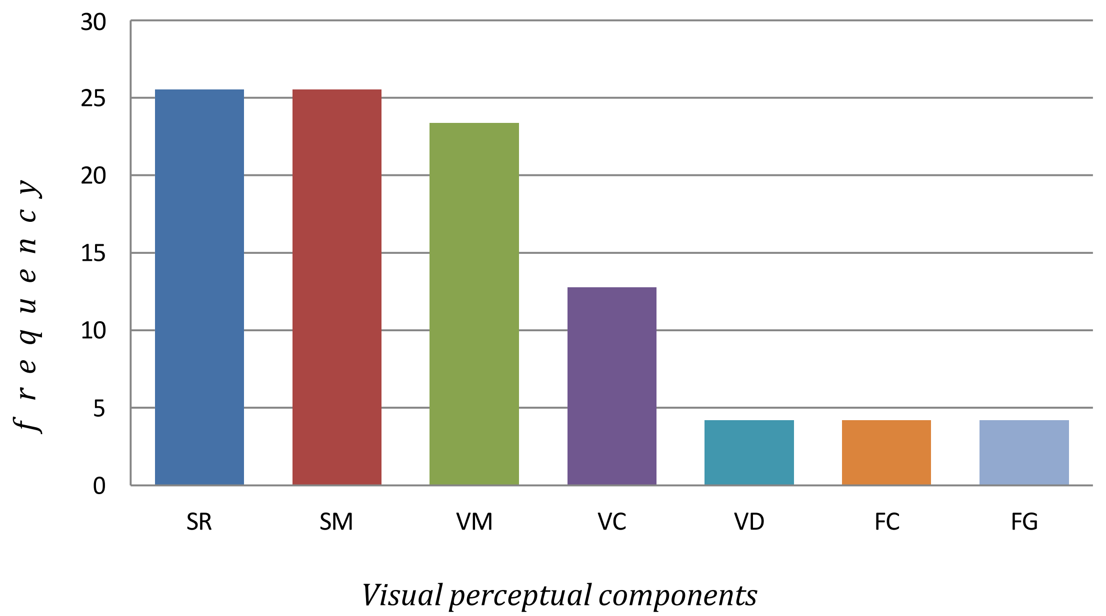
Table – 1: Showing Demographic and Descriptive Statistics

Characteristic		All	Preterm	Full term
No. of participants		47	26	21
Mean Age (year)		6.8	6.3	7.3
Standard deviation		1.3	1.2	1.1
Mean visual perceptual age (year)		5.3	4.6	6
Mean visual perceptual quotient		81	79	85
Sex	Male	32	16	16
	Female	15	10	5

Out of all 47 participants, 26 subjects were preterm and 21 subjects were full term. The mean age for all the children, preterm children and full-term children were 6.8 years, 6.3 years and 7.3 years with standard deviation of 1.3, 1.2, and 1.1 respectively. The mean visual perceptual age for all the subjects was 5 years 3 month with mean visual perceptual quotient of 81. The mean visual perceptual age for preterm and full term was 4 years 6 months and 6 years, with mean visual perceptual quotient of 79 and 85 respectively.

All individual‘s visual perceptual age for each visual perceptual component on TVPS-R were arranged in order of lowest to highest perceptual age and were plotted in a table. To find out which visual perceptual components were mostly affected and mostly spared, the lowest and the highest component in the order for all the participants were taken for the analysis. The following tables and graphs show the descriptive characteristic of the results.

Figure 1: **Bar graph showing the frequency of mostly affected visual perceptual components in all the subjects of spastic cerebral palsy.**



FG- *Figure ground,* ***FC***- *Form constancy,* ***VD***- *Visual discrimination,* ***VM***- *Visual memory,* ***SM***- *Sequencing memory,* ***SR***- *Spatial relationship,* ***VC***- *Visual closure*

As shown in the above graph, visual spatial relationship and visual sequencing memory shared the mostly affected visual perceptual component constituting 25 % each, followed by visual memory (23%) and visual closure (12%).

There was also a similar trend in both preterm and full term subjects as shown in figure-2 and figure- 3. In preterm subjects, the frequency of impairment was highest in visual sequencing memory (27%) followed by spatial relationship (23%), whereas in full term subjects, the highest impairment was seen in spatial relationship (32%) followed by visual memory (23%). Visual closure and visual sequencing memory were moderately affected in both preterm and full term subjects. Visual closure, figure ground, and form constancy scores were the lowest, constituting 4 % each.

Figure 2: Pie graph showing the percentage of mostly affected visual perceptual components in preterm subjects

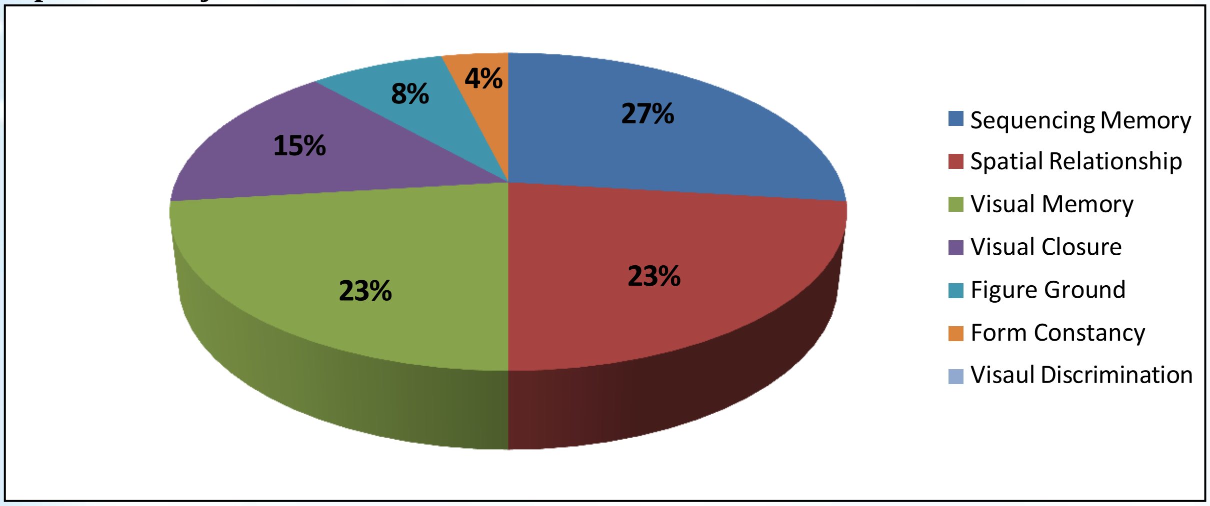


Figure 3: Pie graph showing the percentage of mostly affected visual perceptual components in full term subjects

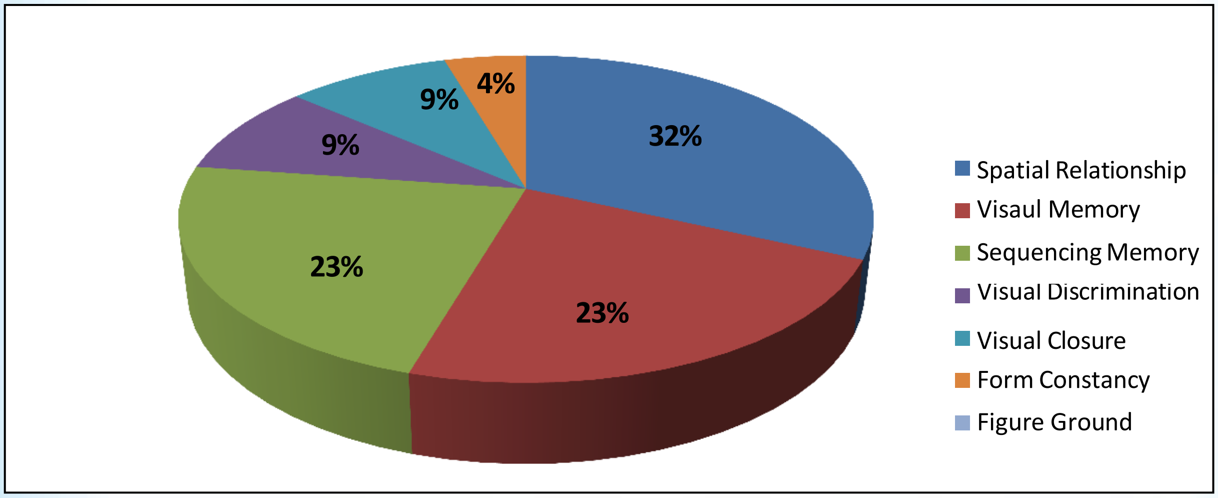
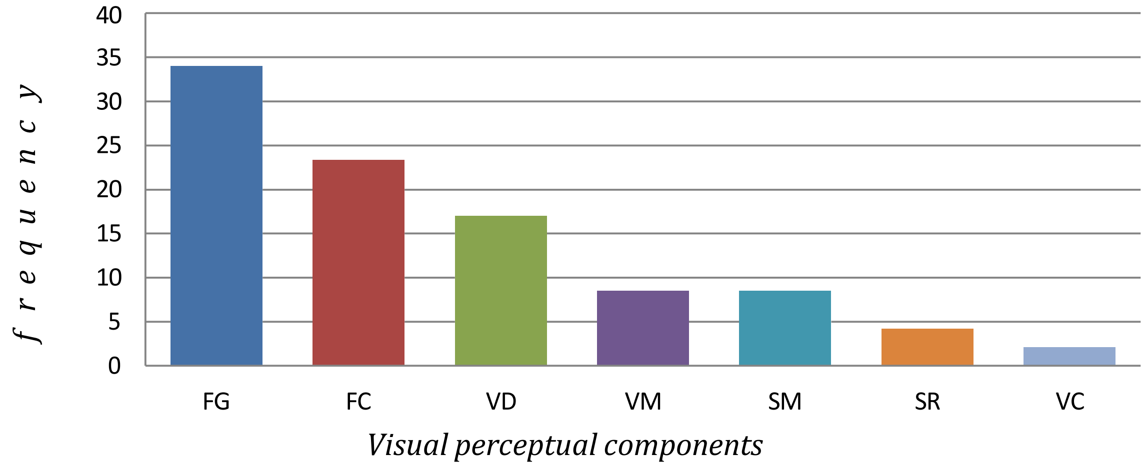


Figure 4: **Bar graph showing frequency of mostly spared visual perceptual components in all the subjects of spastic diplegic cerebral palsy**



FG- *Figure ground*, ***FC***- *Form constancy*, ***VD***- *Visual discrimination*, ***VM***- *Visual memory*, ***SM***- *Sequencing memory*, ***SR***- *Spatial relationship*, ***VC***- *Visual closure*

Visual figure ground was the most commonly spared visual perceptual component constituting 34% of all the participants, followed by visual form constancy (23%) and visual discrimination (17%). Visual memory and visual sequencing memory stands at 8% each. Visual spatial relationship and visual closure were at the bottom constituting 4% and 2% respectively.

The frequency of visual perceptual components which were least affected in preterm and full term subjects are given in figure- 5 and figure- 6 respectively. In preterm, visual form constancy appears to be the mostly spared components followed by visual figure ground constituting 31% and 27% respectively. However in full term, visual figure ground was the most commonly spared components for 45% of all the subjects, followed by visual discrimination, visual form constancy and visual sequencing memory (15%). 19% of the preterm subjects were spared in visual discrimination, 7.5% for visual memory and visual spatial relationship. As comparing to other components, visual sequencing memory and visual closure were the least spared components in preterm constituting 4% each. 10% were spared in visual memory in full term and visual spatial relation and visual closure were spared in zero percent of all full term subjects.

Figure 5: Pie graph showing the percentage of mostly spared visual perceptual components in preterm subjects

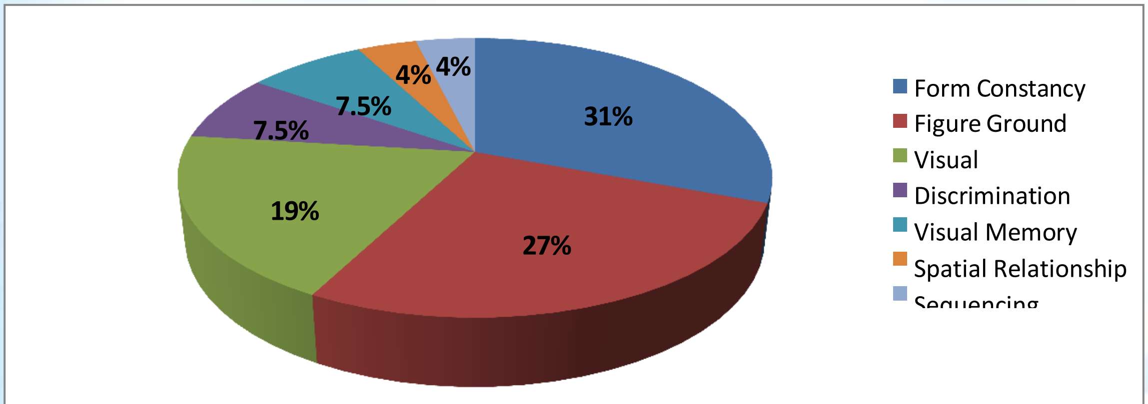
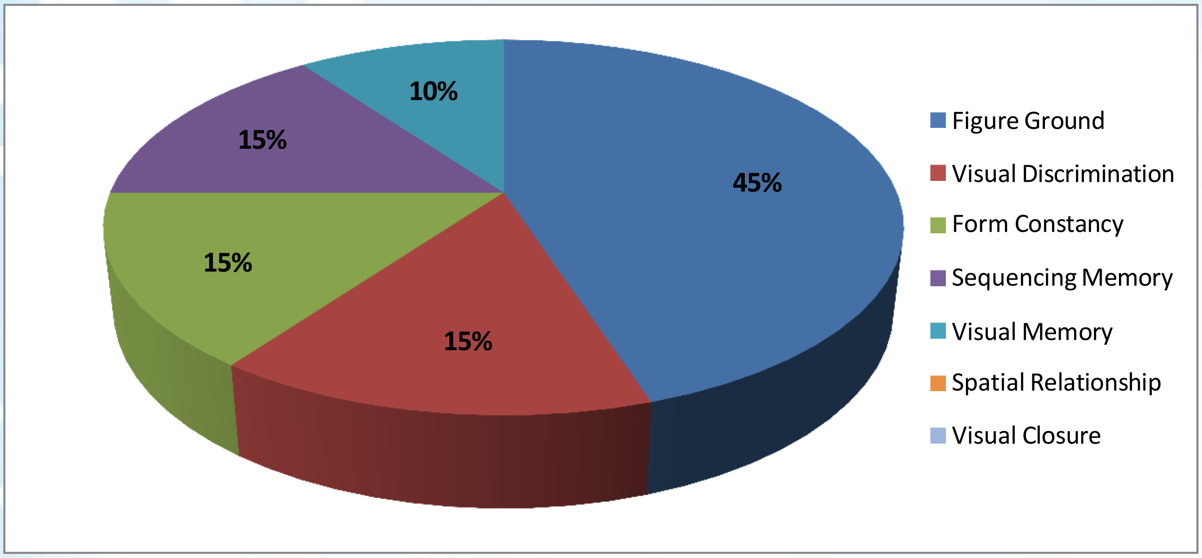


Figure 6: Pie graph showing the percentage of mostly spared visual perceptual components in full term subjects



DISCUSSION

Visual perceptual dysfunction is a common problem in children with cerebral palsy which is mostly associated with spastic type. It is also one of the mostly overlooked problem areas in cerebral palsy due to its not obvious and subtle problem which are frequently over shadowed by the dominant motor problems. Visual perception enables us to obtain firsthand information about the world around us and give meaning to what is seen. Impairment of visual perception can have a negative impact on a numbers of occupational performance and functional skill areas for children. This study attempted to measure the visual perceptual profile in 47 children 4.6 years to 8.6 years with spastic diplegic cerebral palsy on a motor free test of visual perception.

Although a small sample size was used, the statistical analysis results support the hypothesis that there will be variation in the visual perceptual profile in children with spastic diplegic cerebral palsy. The present study indicates that visual spatial relationship, visual sequencing memory and visual memory were the mostly affected visual perceptual components in children with spastic diplegic cerebral palsy, whereas visual figure ground, visual form constancy and visual discrimination were the most commonly spared components.

Not much unequivocal differences between preterm and full term was found in the study. The mean visual perceptual age and visual perceptual quotient in this study was more in children with full than in preterm children. The finding of the study was inconsistent with many previous studies which points out the more vulnerability of visual perceptual impairment in preterm CP children. Visuoperceptual deficits were common in preterm children with spastic diplegia, and their severity has been found to correlate, in many studies, with periventricular leukomalacia severity and in particular with anoxic-ischemic damage to the peritrigonal region [3,5,12].

Koeda and Takeshita found that visuoperceptual impairment was associated with reduced parietal and occipital peritrigonal white matter. Similarly, *Ito et al (1996)* found a significant correlation of visuoperceptual deficit with the ratio of the areas of the posterior horns to the anterior horns, as determined from magnetic resonance images.[13]

The modified 2-visual-system model originally proposed by Schneider has gained considerable consensus. This posits that visual experience is fed by 2 main systems: the occipital-temporal system (―ventral stream‖ or ―what‖ pathways), concerned with the recognition of shape, and the occipital-parietal system (―dorsal stream‖ or ―where‖ pathways), concerned with the perception of space. Many studies have showed that the inferotemporal cortex in the region of the fusiform gyrus (area 37) was activated during the retrieval of object identify information, while the inferior parietal lobule, in the region of the supramarginal gyrus (area 40), was activated during the retrieval of spatial localization information [5].

In the present study, visual spatial relationship which comes under dorsal stream was the most affected visual perceptual component. The result of this study was consistent with other studies which suggested the vulnerability of dorsal stream more than the ventral stream in children with diplegic cerebral palsy especially with preterm children [8, 14]. The dorsal stream vulnerability was also found in the children with William syndrome [15]. Gunn et al 2002 studied form and motion coherence thresholds to provide measures of global visual processing in the ventral and dorsal streams respectively. They found that in children with hemiplegic cerebral palsy, the dorsal stream was more vulnerable to early neurological impairment [16]. Visual figure ground, visual form constancy and visual discrimination which are all served by ventral stream were the mostly spared components. This suggests the less vulnerability of ventral stream in children with spastic diplegic cerebral palsy.

The striking difference in visual–perceptual outcome after PVL as opposed to IVH is worthy of consideration. The preferential site of the lesions in PVL and in severe cases of IVH is more or less the same region of white matter alongside the body and posterior part of the lateral ventricle. But in the case of PVL the lesions are mostly bilateral and often symmetrical, whereas the lesions associated with IVH are mostly unilateral. Thus, at least for term infants it seems that unfavorable visual outcome is associated with bilateral lesions, while extensive focal infarction has a relatively good prognosis [12].

Elisa Fazzi et al. 2009 examined the cognitive visual dysfunction in preterm children with periventricular leukomalacia and found that there was widespread impairment of higher visual processing, involving both ventral and the dorsal visual system. They suggested the deep integration between the two visual pathways [7]. GN Dutton et al (2004) supports that the ventral stream thus provides a conscious analysis and understanding of the visual world, while the dorsal stream facilitates and brings about accurate movement of the body through visual space, ostensibly at a subconscious level. He also proposed that the two systems are closely integrated [8].

Visual sequencing memory and visual memory which are served by ventral stream[8] appeared to be mostly affected in the present study after visual spatial relationship. The problem in these two components could be due to the close integration of ventral stream and dorsal stream pathway. Visual short term memory has a highly limited storage capacity and creates largely schematic representations very rapidly. Inability to extract full information about the figure with regards to positions and in relations with adjunction figures and the sequences of the figures could possibly hamper forming a clear mental representation about the figure shown [16]. This could lead to confusion when asked to recall and match or identify the shown figures, and eventually make mistakes. Robert H 2002 explores the interference with visual short term memory. In his experiment he found the entirely consistent role of a specialized visuo-spatial mechanism in working memory[17]. Alumit Ishai suggests that short term memory maintains surface feature and activity in the intraparietal sulcus is closely tied with visual short term memory performance. *Jiang,* *Olson, & Chun, 2000* also suggest that disruptions in the spatial organization of objects can influence object visual short term memory [18].

CONCLUSION

The result of this study suggests that dorsal stream dysfunction may be common in children with spastic diplegic cerebral palsy and both the visual pathways may be closely interrelated. This study found that visual spatial relationship, visual sequencing and visual memory may be the most commonly affected visual perceptual components whereas visual figure ground, visual form constancy and visual discrimination may be the mostly spared components in children with spastic diplegic cerebral palsy. From the above study it can be concluded that in the holistic approach to cerebral palsy children, emphasis should also be given to visual perception for the better outcomes.

Limitations and recommendations

- Small sample group.
- Only one type of cerebral palsy was taken for the study.
- Further investigations with large sample size.

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EFFFFICACY OF SVNIRTAR-DEVELOPED SURFFACE RESPONSE KINETIC FOOT

Type of manuscript: Observational Study

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Background

More than 2.7 crores disabled people are present in India. Out of which 55 lakh are disabled in movement, among those approximately 10%-12% are amputees[1]. 75% of amputees are belonging to rural areas. Successful rehabilitation of the amputee requires the prosthesis be acceptable to him or her. Prosthesis acceptability depends on several factors including cosmoses, mass properties of the prosthesis, comfort, and function. Comfort and function are directly proportional to the quality of socket fit, characteristics of foot, the quality of suspension, the type of other components used and the relative geometrical orientation of these components with respect to each other in reference of spatial present body mechanics.[2]

Prosthetic foot is the major device of a prosthesis which is replacing important functions of the biologic human foot and ankle-foot module.[3]The physiologic ankle-foot system is amazingly complex and no mechanical device currently exists in the market that can replicate all of its functions using the same volume of space and at the same weight. The physiologic system has bones, joints, tendons and muscles with very intelligent neural network that allow it to adapt its flexibility and it‘s positioning for a variety of tasks, providing stability at times and flexibility at other times to promote coordinated movement. Regular prostheses are much less sophisticated than the physiologic systems they replace and offer limited functions for a variety of tasks. Walking with lower limb prosthesis resulted in higher metabolic energy cost than walking with two intact limbs[4]. Previous Studies also have shown that, below knee amputees have a higher energy cost than a normal individual.[5] Young adult traumatic amputate while expensing energy at 25% greater rate than normal walking, accomplished only 87% of normal velocity.[3]Thus designing prosthetic ankle-foot systems is no doubt a critical phenomenon. There are a large number of prosthetic feet currently available in the world market along with advancement in technology. In current aegis of prosthetics foot has gone through tremendous transformation in terms of design and materials used.[3]Below knee amputation causes loss of plantar sensation with free ankle foot mobility. Below knee prosthesis with SACH foot restore a probable walking ability. SACH foot designs were modified by new materials which provide controlled mobility by their capacity to store and release energy as a dynamic elastic response character.[3]Choosing an appropriate foot for a specific individual is a complex process characterized by functional ability that are based on the functional level of the prosthetic user. The choice is also influenced by the professional judgment of the prescribing prosthetist, by user preference as well as the socioeconomic conditions of the amputee.[6]

Prosthetic feet that can store and release energy during gait can be beneficial to lower-limb amputees. Current prosthetic foot differs in material and structural designs are in regular clinical use. They provide a wide range of choices and can improve the comfort and performance of a prosthetic limb when fit appropriately.[3, 7]Surface Response Kinetic Foot (SRKF) were designed to address reduced prosthetic limb push-off and work by returning mechanical energy absorbed from mid stance to late stance, rather than dissipating it through viscoelastic deformation as with non-SRKF prosthetic feet[8].

Significance of the study:

This study will introduce readers with a very low cost new dynamic prosthetic foot design and its effect on gait characteristics and energy expenditure of a transtibial amputee. This study will also provide readers the comparative analysis of the new dynamic foot with SACH foot regarding the gait parameters and energy expenditure. The findings of this study will help in improving the design and quality of the newly designed dynamic prosthetic foot in coming future. In future this study may help lower limb amputee population to be benefitted with a very effective and efficient dynamic foot at much reasonable cost.

About Prosthetic foot:

The prosthetic foot is designed to replace many function of anatomical foot. As it‘s an interface between the prosthesis and ground, it must mimic the biomechanical characteristics of the human foot as much as possible.[9]Traditional prosthetic feet were separated components that were bolted to the shank of the prosthesis but many current designs incorporate the shank ankle and foot as a continuous unit.

The institute of the U.S. Artificial Limb Program in 1945 developed articulated single-axial ankle foot assemblies. Early versions were relatively unsuccessful but later this design found commercial success.[10]The articulation of single axis foot allows motion in sagittal plane only. Single axis foot provides excellent shock absorption during initial contact and loading response due to combined compression of heel cushion and plantar flexion bumper. The primary advantage of single axis foot is its ability to reach a stable foot flat position quickly in early stance.

Fort and Radcliff in the early 1950s used different approach to achieve the functional goals of earlier prosthetic feet rather than custom fabricated single axis feet and develop the early prototype of solid-ankle cushioned-heel (SACH) feet. This commercially available, simple light weight design was a significant improvement and provided acceptable function for most people with amputation. Early SACH feet were maintenance free and considerably lighter than the earlier conventional, individually created or manufactured articulating wooden feet. It continues to be prescribed because of its simplicity low cost and durability. It has no articulations and relies on flexibility of its structure for joint motion simulation.[11,12]

Campbell 1970s introduced the stationary-ankle flexible endoskeleton foot (SAFE). This foot maintained the basic characteristic of the SACH foot, adding a component of flexibility that was missing in previous design.[9]Although heavier than SACH foot, it allows some multiaxial motion that substituted for the accommodation to uneven surfaces, as in anatomical ankle foot complex.

Prosthetic Research Study at University of Washington foot (Seattle Systems, Inc., Poulsbo, Wash) developed Seattle foot in early 1980. This was the first in the class of dynamic-response energy storing foot that provides elastic keel for use in higher activities as running and jumping. Many feet design uses the Seattle foot principal of elastic keel which offers a higher level of performance to a prosthetic user who are involved in athletics and other functional activities.[13]The foot has one-piece keel of synthetic composite material embedded in a foam foot shape. The keel provides a unique combination of stiffness and flexibility to absorb the force applied early in the gait cycle. As cadence increases from walking speed towards running the amount of time spent on forefoot increases. The increasing amplitude of dorsiflexion moment is accommodated during the terminal stance by greater distortion in the keel as it compresses, and absorbs more and more energy. As the foot is unloaded in pre-swing this energy is released quickly, simulating push-off and adding forward propulsion of body during swing. Most current design uses similar principal but differs in material used for keel. Carbon graphite composites are the main choice due to its inherent strength, durability, and light weight. Examples are Carbon Copy and Carbon Copy *II* Feet (Ohio Willow Wood,Mt. Sterling, Ohio), Springlite (Otto Bock Healthcare Minneapolis).

Introduction:

Hundreds of times a day with every step we take, we crash down upon our heel with a force that after reaches several times our total weight (Nigg, 1986 A). Each heel strike sends shock waves through the body causing accelerations of over 3g (g= 9.81 met/sec^2) during walking (voloshin and wosk 1982) to as high as 15g during running (ngis – 1986 A). The foot sustains these impacts and reduces potential injury to the body by deforming upon striking the ground. If the foot were extremely rigid, the ground reaction force would be great magnitude and short duration. Through in normal biologic foot however is restrained by flexible tendons. As its many bones is hold together by flexible ligaments. In-fact when the foot deforms the ligaments and tendons stretch, absorbing much of shock impulses more pain with smaller amplitude and reducing the potential for injury to the body. But, such mechanism not available in most of the prosthetic foot.

In India more than 2.7 crores of people are affected by disability and out of which 55 lakhs mass have loco motor (movement) disability among those approximately 10 % to 12 % are amputees. 65 % of amputees are belongs to rural dweller and those 10 % to 12 % requires a successful Prosthetic rehabilitation with good socket, good component and good foot system. As the successful Prosthetic rehabilitation depends on three cardinal specialty of i) comfort, ii) function, iii) cosmoses and the comfort is directly proportional to function in-favor of the physiological aspect of the body. The physiologic foot of the body is amazingly intelligent and fine-tuned with different constants like (gravitational constant, Reynolds constant, etc) and none of mechanically designed foot can replicate the function of biologic foot under purview of volume, space, weight intricacy etc. In current practice many companies have worked over the concept and also justified the function within their product with high cost. No doubt such products like – Stenfoot, carbon copy foot, blade foot, cheetah foot etc. reduces the metabolic energy cost with proficient high market cost. In-fact in the boundary condition, availability of energy storing foot for poor and normal groups is becomes a dream which can only be seen not to in use as for as the socioeconomic conditions is concerned.

Though, the phenomenon of foot development is very primitive, throughout the centuries; attempts have been made to create the intricate anatomy and physiology of the ankle foot system.

The use of ground reaction force is one of the very fundamental resources of energy to invest in future event off function by reflecting dynamic character through a mechanical network. Energy storage and return (ESAR) or re-entry energy exploration (REX) can address reduction of limb push-off energy expenditure by returning of potential energy absorbed from mid to late stance as if replacing the modality behavior of gastro soleus and plantaris as in viscoelastic energy deformation dissipating in (NON-REX) or (NON-ESAR) system. Therefore, this is an important area of research where attempt can be taken to design as surface response kinetic (Dynamic/ESAR/REX) foot at low cost within the indigenous materials and technology.

BUFFERS,ATTENUATORS, AND SHOCKABSORBERS

Several different terms have been applied to describe the mechanical role of tendons during muscle energy absorption, including a __mechanical buffer,‘‘ __shock absorber,‘‘ and _power attenuator‘‘ (8,10,19,20). Exploring the extent to which physical analogous are or are not accurate can be instructive and can serve our understanding of how the mechanism works. Both the terms __buffer‘‘ and __shock absorber‘‘ accurately describe the observation that tendon stretch initially absorbs the energy of impact, thereby reducing, at least for this initial period, the energy that must be absorbed by muscle. Engineered mechanical buffers and shock absorbers, such as the shock absorbers on automobiles, also tend to blunt the force of impact because they slow decelerations. Likewise, our results for turkey gastrocnemius indicate that force of contraction is reduced because of the influence of tendon elasticity on muscle speed of shortening or lengthening. However, the analogy of a buffer or shock absorber is somewhat problematic because engineered devices not only absorb impact energy, they also dissipate it vis a vis damping mechanisms. Tendons dissipate only a small fraction (G10%) of the energy they absorb, and the __shock‘‘ that they absorb at impact must be released to the muscle eventually, which dissipates the energy. In the turkey gastrocnemius, the temporary storage and release of energy from tendon to muscle can result in a reduction in the rate at which energy is dissipated by the muscle fascicles.

We have referred to this role of tendon as that of a power attenuate or because the peak rate of power input to the muscle is reduced. This terminology is appealing because it serves as an intuitive counterpart to the more familiar analogy of tendon as a __power amplifier,‘‘ where the storage and release of muscle work by tendon allow for power outputs that exceed the maximum power output of the muscle (e.g., Alerts (1) and Vogel(24)). Both terms have been criticized reasonably because familiar electronic amplifiers work by adding energy to a signal. Tendons neither add nor subtract significant energy;

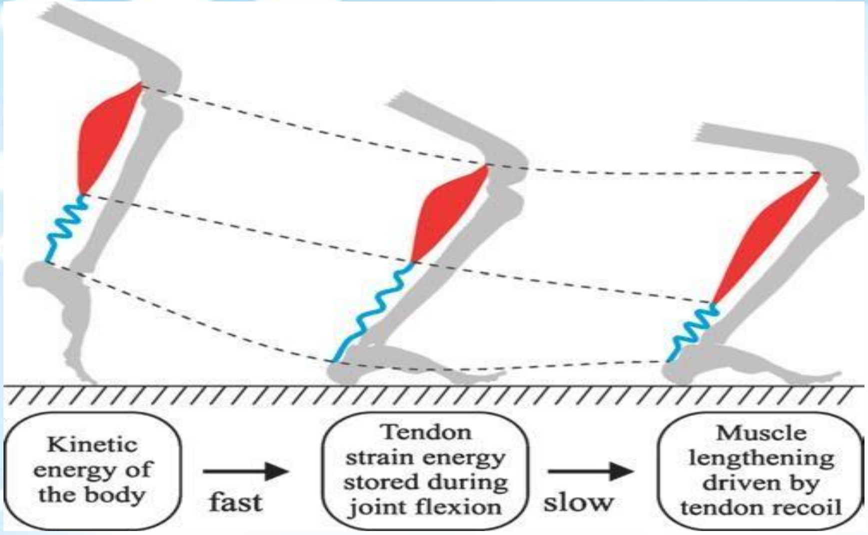


Figure -. Schematic summary of the tendon buffering mechanism. Energy is absorbed initially by the tendon during a brief and rapid event, followed by a relatively slow flow of energy from the tendon to the muscles fascicle lengthens and dissipates energy.

It is often said that design is the essence of engineering (George E. Director et.al.) in new design to arrange existing things in a new way to satisfy the recognized need of society and an elegant word for ―Pulling together‖ is synthesis. Therefore it is a contribution to the existing stock of knowledge making for advancement in the field of foot development and under the pursuit of truth the observation, comparison will be established.

BASIC DESIGN OF THE FOOT (SRKF)

The basic design of the foot (SRKF) is based on the simple structural mechanism with high yielding advantage. It includes,

1. Inertial guidance frame.
2. Spring element (Kinetic spring plate 220 GPa)
3. Potential Sheath
4. Deflection moderator
5. Rear deflection control Unit
6. Foot plate

Description in brief of the mechanism members:

1. Inertial guidance frame: It is single supported structure capable of accommodating kinetic cantilever spring plate acts as an elastic body for loading and vis-a-vis energy story with reference to different gait phase.
2. Kinetic Sprint Plate (220 GPa): The Spring plate is the prime deflexion element to absorb and release energy during consecutive gait parameters.
3. Potential sheath: it is prepared from resilient PU materials with modulus value 30 GPa it absorbs unwanted shocks and helps to restore the quantised energy.
4. Deflection moderator: The unwanted deflection is duly directed or moderated by regulating alternation factor.
5. Rear deflection control unit: Rear deflection of spring element is duly control through the simple bar unit.

6.Foot Plate: The entire Mechanism is aligned over the such foot shape plate along with corresponding plantar foot geometry.

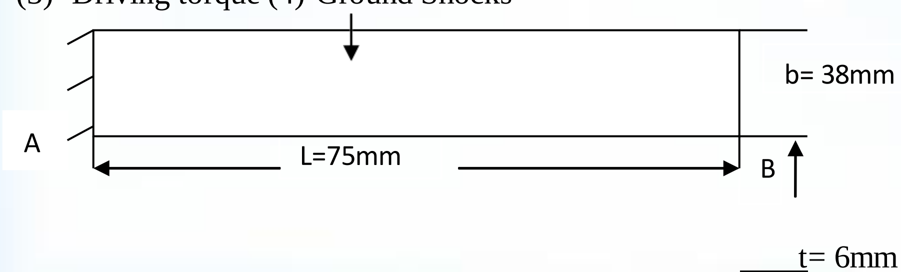
(Various component of SRKF foot)

MATHMETICAL QUANTISITION

- Any design always requires pre-mathematical work analysis and quantification for vertical. In this case it is also very much essential to estimate the forces, material selection and structural configuration. Such that it results the approximate findings with reference to material and structural configuration. Hence, the end result is derived by using simple mechanical mathematics.

QUANTITATIVE ANALYSIS

- The inertial guidance frame is made out of t= 6mm, b= 16mm, Aluminum bar of E=80GPa which acts as a structural base member.
- Kinetic plate is made out of steel t=6mm, l=75mm b=38mm , E= 200 GPa acting as a single spring leaf and capable of carrying.
  - (1)- Lateral load
  - (2)- Braking torque
  - (3)- Driving torque (4)-Ground Shocks



Now maximum bending moment at A –M =W x L

So,

Section modulus (Z) = $\frac{I\ (Inertia)}{Y\ (Radius\ gyration)}$

$$z = \frac{bt^3/12}{t/2}$$

$$z = \frac{1}{6} bt^2$$

Max. Bending stress (σ) = $\frac{M}{Z}$ $\frac{WL}{1/6\, bt^2}$ $\frac{6WL}{bt^2}$

Max.deflection(δ) = $\frac{WL^3}{3EI}$ = $\frac{WL^3}{3E \times bt^3 / 12}$

$$= \frac{4WL^3}{Ebt^3} \quad \frac{WL}{bt^2} \quad \frac{4L^2}{Et}$$

$$= \frac{6WL}{bt^2} \quad \frac{4L^2}{6Et} \quad \frac{2L^2}{3Et}$$

$$= \frac{2}{3} \quad \sigma \quad \frac{L^2}{Et}$$

Energy stored (U) = $\frac{1}{2}$ W.δ

= $\frac{1}{2}$ (weight) x (Deflection)

⇨ U = $\frac{1}{2}$ W $\frac{2}{3}$ σ $\frac{L^2}{Et}$ $\frac{W\sigma L^2}{3Et}$

Now substituting the value W, L, σ , E and t

Value derived for a patient of 60kg –

U = $\frac{1}{2}$ x 60 kg x δ | σ = $\frac{6WL}{bt^2}$ $\frac{6x60x75}{38x36}$ = 19.86 kg/mm2

U = $\frac{1}{2}$ x 0.061875 | δ = $\frac{2\,\sigma L^2}{3Et}$ $\frac{19.8x2x(75)2}{3x200x(10)3x6}$ = 0.061875mm

= 1.86N / mm2

Energy stored and released = 1.86N/mm2 (As E=200GPa = 200x(10)3 MPa)

ANALYSIS THROUGH BTS MOTION ANALYSIS LAB

The temporal parameters analysis has been carried out for both Prosthesis with SACH foot and SRKF foot through BTS motion analysis reveals that

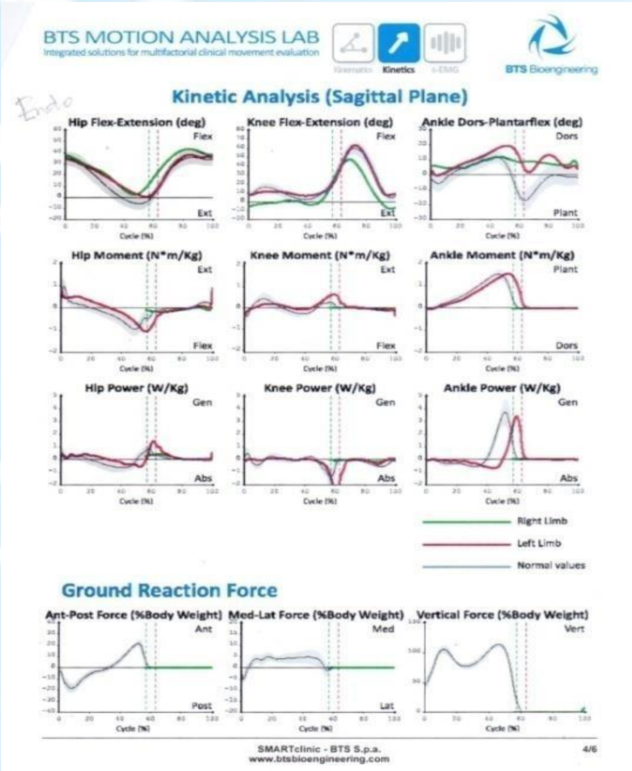
Character	SRKF (Rt.) Endoskeltal	SACH Foot (Rt.)
Stride times	all most normal to mean value	just more than 50%
Stance times	very equal	large difference
swing time	decimally higher	appreciably higher
stance phase %	very approachable	No Similarity
Swing Phase %	Less Difference	Appreciable difference
Double support	more contact to ground	less contact to ground
mean velocity	good	poor
cadence (step/min)	very good (98.5)	approximately PwDs 45.3

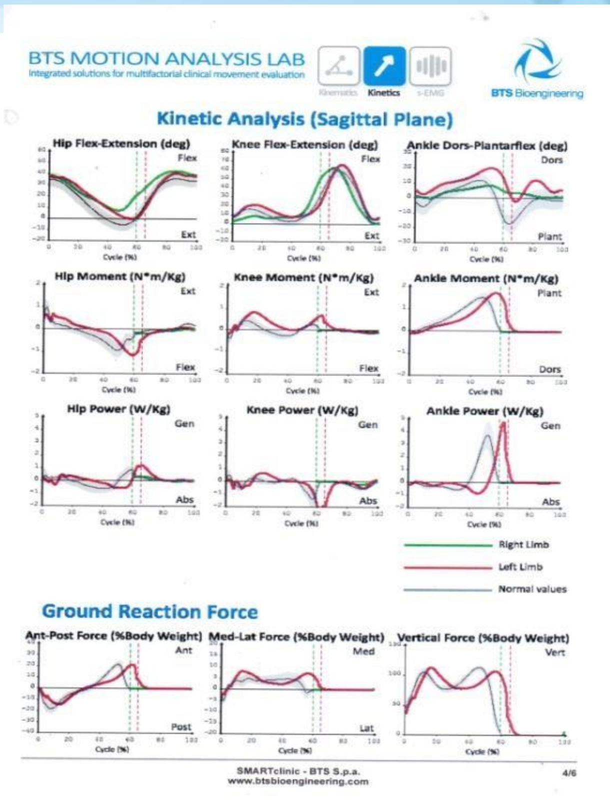
Spatial Parameters		
CHARACTER	**SRKF (Rt.) leg**	**SACH Foot Rt. Leg**
stride length (m)	all most equal to normal limb	Approximately 50 % of normal limb
stride length (%) height	very good	Moderate
step length (m)	very good	Poor
step width (m)	Both shows	Equal Value
standing angles characters	Rt. Limb SRKF	Rt. Limb (SACH foot)
Pelvic obliquiting	None	Less
pelvic tiltl deg	Less	More
pelvic rotation deg	Less	More
hip ab -adduction deg	More	Less
Hip Flex-Extension (deg)	Less	more
Hip Rotation (deg)	Less	more
Knee Flex-Extensional (deg)	More	Less
Ankle Dors-plants Flex (deg)	Controlled	lyper
Foot Progression (deg)	Less	more

Graphical findings through BTS Motion Analysis Lab

(with SRKF Foot)

(with SACH Foot)





CONCLUSION

The laboratory and mathematical study reveals that, stride length, cadence and velocity with respect to the SACH foot shows better proficient result in consonance with energy absorption and release, also we can conclude that the new dynamic foot (SRKF)is more energy efficient than the SACH foot as there was a significant difference found in PCI among these two feet during normal walking and theoretically it releases (1.86 N/mm of energy). Thus, proving the experimental hypothesis is true. So we can say that new SRKF foot could be a better option for lower limb amputee in future at very low cost.

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THE EFFECT OF CYCLIC STRETCHING WITH VARIABLE REST PERIOD BY USING LEG ABDUCTOR DEVICE TO IMPROVE THE FLEXIBILITY OF HIP ADDUCTORS and MEDIAL HAMSTRING MUSCLE IN CASE OF CHILDREN WITH SPASTIC DIPLEGIC CP.

Type of manuscript: Clinical Trail

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ABSTRACT

Introduction- Tightness in the hip adductors along with medial hamstring becomes a challenging problem for children with spastic diplegic CP because it not only impairs ambulation, balance and ADLs but also risk for hip dislocation if it is converted into contracture. As per literature, various types of stretching techniques are used for the management of hip adductor tightness, but the evidence for effectiveness of cyclic stretching with variable rest periods using leg abductor device remains week.

AIM OF THE STUDY- The aim of the study is to know the effects of cyclic stretching with variable rest period and to compare the rest periods for improvement of flexibility in hip adductor muscles and medial hamstring in spastic diplegic CP.

METHODOLOGY- A total no of 17 subjects both male and female were taken for this experimental study and were randomly assigned in to 3 groups with age 3-10 years. Cyclic stretching using leg abductor device given for all the 3 groups was similar i.e. 5 minutes with 4 repetitions, total of 20 minutes of stretching per day, but the variable rest periods for group-1, group-2 and group-3 was 30 seconds, 1 minute, and 2 minutes respectively. The total duration of protocol was 8 weeks. Inter malleolar distance, active and passive range of motion of hip abductor, popliteal angle data were taken before and after 8 weeks of protocol.

CONCLUSION- Cyclic stretching with rest in between stretch is effective. However, cyclic stretch for 5 minutes duration with variable rest in between have similar effect on extensibility of tissue.

KEY WORDS- Cerebral palsy, intermalleolar distance, active range of motion, passive range of motion, popliteal angle.

INTRODUCTION:

―Cerebral palsy‖ is an umbrella term which describes a group of permanent disorder of the development of movement and posture, causing activity limitations that are attributed to non-progressive disturbances that occurred in the developing foetal or infant brain. Secondary musculoskeletal problems such as muscle or tendon contracture, bony torsion, hip displacement, spinal deformity can contribute to functional deterioration. Cerebral palsy is a common problem, the worldwide incidence being 2-2.5 per 1000 births. In India, its incidence is up to 3 cases per 1000 live births.[1] The disorder in CP are characterized by poor control of movement, adaptive length change in muscles, in some cases, skeletal deformity and other associated deficits like mental retardation ,speech and language disorders, visual and hearing impairments, epilepsy etc. CP has been classified in to various types such as i) Spastic ,ii) Athetoid, iii) Ataxic, iv) Hypotonic, v) Mixed.[2] The term diplegic is used to describe CP which affects the lower extremities primarily, with relatively normal upper extremity function. Tightness in the adductor becomes a challenging problem for children with spastic diplegic CP because it not only impairs ambulation but also risk for hip dislocation if it is converted into contracture. [3]

Studies have found prevalence of hip subluxation or dislocation in these children varying from 2.6 to 45% secondary to contractures of the adductor muscles. It may also produce pain that may persist into adult life. It also affects hygiene care, makes dressing difficult and contributes to the structural and biomechanical abnormal changes. In spastic diplegic leg tightness often leads to instability in ambulation, extra muscle tension usually develops in the shoulder, chest, and arms due to compensatory stabilization movements. Adductor tightness leads to scissoring gait.[4] William M Cruickshan et al[5] mentioned that the main physical problem of diplegic CP is spastic gait, characterized by flexion, adduction, and medial rotation at the hips, flexion at the knees, valgus at the hind foot with tight achilles tendon with supination and abduction at the fore foot.

Clinicians and researchers have attempted to alter motor neuron excitability through variety of methods such as - stretching, cryotherapy, casting, biofeedback, electrical stimulation, stretching in combination with others like vibration, muscle taping, massage etc. Among all, stretching is applied widely in clinics as it is safe, conventional and economical.[6] There are various types of stretching techniques among which the cyclic stretching is a type of stretching, otherwise known as intermittent stretching. It is a form of passive stretching which is relatively short duration stretch force that is repeatedly but gradually applied, released and then reapplied is described as a cyclic stretching. Cyclic stretching, by its very nature, is applied for multiple repetitions (stretch cycles) during a single treatment session. With cyclic stretching the end range stretch force is applied at a slow velocity, in a controlled manner at a relatively low intensity. When the total duration of stretch is equal, cyclic stretching is equally effective and possibly more comfortable than static stretching.[7] Starring, DT et al, 1988- the authors speculated that heat production might occur because of the movement inherent in cyclic stretching and cause soft tissues to yield more readily to stretch. The authors of the later study also concluded that cyclic stretching was more comfortable than a prolonged static stretch.[8]

Literature has mentioned about the fabrication of mechanical device for stretching of adductor spasticity, no study has been conducted with a mechanical device that specially stretches the hip adductor with cyclic stretching. In literature there are limited studies for cyclic stretching duration and the number of repetition, as well as the interval between stretches. Also, there are no studies about how the adductor and medial hamstrings tightness were affected by cyclic stretching. Therefore, the current study might help in determining the effect of cyclic stretching with respect to interval between stretches in spastic diplegic CP. It can be expected that this stretching method should increase the flexibility of adductors and hamstrings without any negative effect.

METHODOLOGY and PROCEDURE-

Study Design- Experimental Study.

Children with spastic diplegic CP were evaluated and those who fulfilled the inclusion and exclusion criteria were recruited for the study and randomly assigned in to 3 groups

Inclusion criteria: Spastic diplegic CP, age- 3-10 years, children who follow the command, passive abduction possible 20^0 with knee extension possible 20^0 passive abduction with knee extension.

Exclusion Criteria- hip dislocation, surgical intervention, convulsion, children with athetoid, ataxic, flaccid and quadriplegic type of CP.
A total of 17 subjects were included for the study.
Study Duration-8 weeks
Group 1 received- Cyclic stretching was given to adductor muscles for 5 minutes and 30 seconds rest period in between stretch. Again stretch for 5 minutes and release 30 seconds, in similar manner 4 repetitions i.e. 5 X 4 total of 20 minutes of stretching per session, 5 day per week for 2 weeks was given. After 2 weeks, 1 week rest period was given to the patients, again the group 1 received same duration of stretching i.e. 5 minutes but the rest period was variable that is 1 minute in similar manner, for 2 weeks, followed by 1 week rest period. Later, the group I received 5 minutes of stretching with 2 minutes of rest period for 2 weeks. Stretching duration is similar for all the groups but the variable rest periods were given in an orderly manner. For group 1 the orderly manner of variable rest period was 30 seconds, 1 minute, 2 minutes. Group 2 received- Cyclic stretching for 5 minutes given in a similar manner as group 1 received and the orderly manner of rest periods in between stretch was 1 minute, 2 minutes, 30 seconds.
Group 3 received- Cyclic stretching of adductor muscles for 5 minutes in similar procedure with orderly manner for variable rest period was 2 minutes, 30 seconds, 1 minute.
PROCEDURE- AROM, PROM, Popliteal angle were measured before and after the stretching intervention with the help of goniometer, and the intermalleolar distance (IMD) was measured with the help of inch tape. Patient was in supine lying on the couch. The pre data such as IMD AROM, PROM, POP R1, POP R2 were measured. Then the leg abductor device was applied for the cyclic stretching. Initially the adductor muscles of hip and medial hamstring were stretched for 5 minutes within a pain free range. Child complaint of little discomfort but no pain. After 5 minutes of stretching rest period was given for 30 sec by unscrewing of the device. Again the muscle was stretched for 5 minutes and rest was given for 30 sec, likewise 4 repetitions were given i.e. 5 X4= 20 minutes per day for 5 days per weeks. The total duration was 8 weeks; after the protocol was completed post data were taken.
The active hip abduction ROM was measured in 2 ways , in one method goniometer was used to measure the hip abduction angle and another method was by using the inch tape, the intermalleolar distance was measured. For the intermalleolar distance measurement the subjects were in supine position with hip in neutral and knee in extended position. The subject actively abducted the hips, then with the help of an inch tape the distance from one malleolus to another malleolus was measured.

Subjects were positioned in supine with the hip in neutral, the knees in extended position. Anatomical landmarks like ASIS and the midpoint of patella of both side was marked with skin marker. Then the active ROM, was measured by placing the center of fulcrum of goniometer over ASIS of the hip to be measured and stationary arm aligned with the ASIS of the another side, the movable arm aligned with ASIS to midpoint of patella. Subject abducted the limb actively and ROM was measured. Passive hip abduction was also measured in the similar way as the active ROM. In this case subject kept their limbs in relaxed position and limbs were passively moved within the pain free range by the therapist.

In all 3 groups the cyclic stretching was given by using leg abductor device. The device placed in between both the legs was gradually screwed to abduct the limbs to the point of maximum available range and patient‘s comfort. This position was maintained for 5 minute similarly for all 3 groups. The stretching was given 4 times i.e. 5X4= 20 minutes and the release time was variables for all 3 groups like 30 seconds, 1 minute, and 2 minutes respectively .

Similarly, popliteal angle was also measured with the subject positioned in supine lying with hips in neutral position and the knees in the extended position. The pelvis was stabilized to prevent rotation and pelvic tilting as described by Norkin and White. The anatomical land marks like greater trochanter, lateral condyle of the femur and lateral malleolus on both sides was marked with marker. Then the subject‘s both hips and knees were flexed to 90 degree. To ensure that hip is at 90 degree, the long axis of femur was aligned with a plumb line. The subject‘s lower leg was extended by giving sudden stretch by therapist‘s other hand. That was the resistance 1 (R1), the range was measured. Then it was further moved to another new barrier called the resistance 2 (R2) and measurement was taken. With the range maintained, the measurement was done by placing the fulcrum of goniometer over the lateral condyle of the femur, stationary arm aligned with greater trochanter to the lateral femoral condyle and the movable arm aligned with lateral malleolus. The angle formed by long axis of femur and tibia was measured as popliteal angle i.e. the outer angle. [9]

DATA ANALYSIS- The data were analyzed by using SPSS 24 version, 3X3 ANOVA, where 2 between factor (group) and 2 with in factor (time) with 2 levels test was applied the p value of 0.05 indicated the level of significance, and it was used for all the variables.

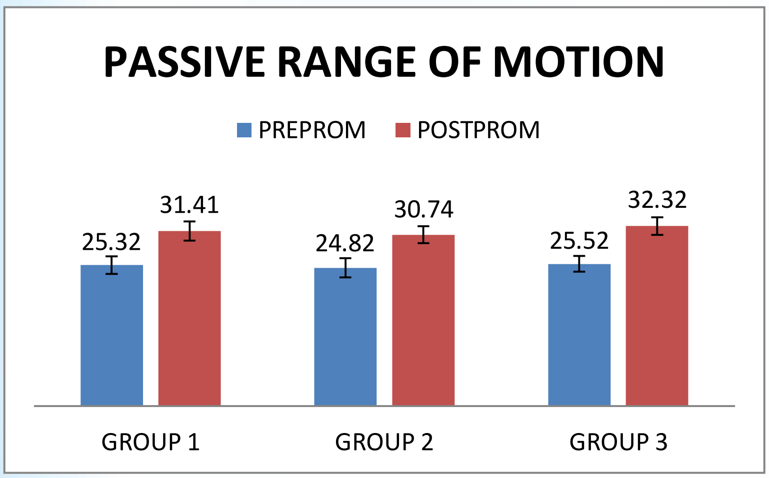
RESULTS- Graph-1:

The graph-1 showed an improvement in IMD in all three groups from pre to post score after cyclic stretching. There was a main effect for group (Df 2, F= .011, p= .989). There was a main effect for Time (Df= 1, F=101.340, p= .000). Time x group interaction was (Df= 2, F= .152, p= .860).

Graph-2:

Graph -2 showed there was an improvement in AROM from pre to post score in all the 3 groups in all 3 groups. There was a main effect for Group (Df=2, F= .293, p=.748). There was a main effect for Time (Df=1, F = 119.220, p=.000). Time x group interaction was (DF=2, F= .217, p= .806).

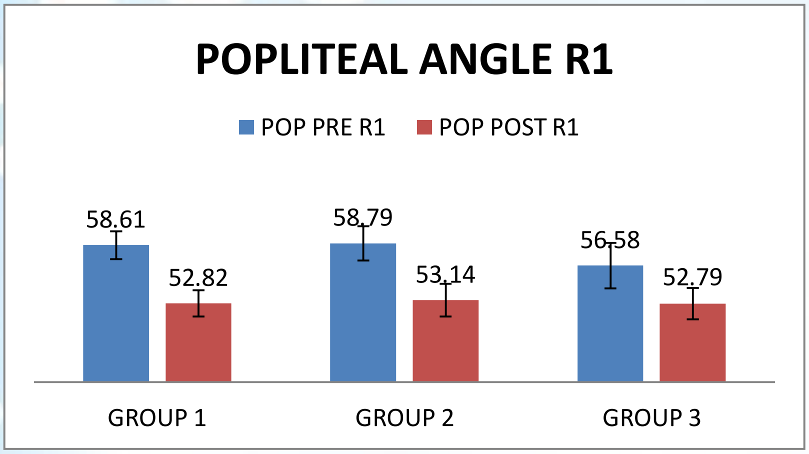
Graph-3:



Graph -3 showed an improvement in PROM from pre to post score in all the 3 groups. There was no main effect for Group (Df= 2, F= .138, p= .871). There was a main effect for

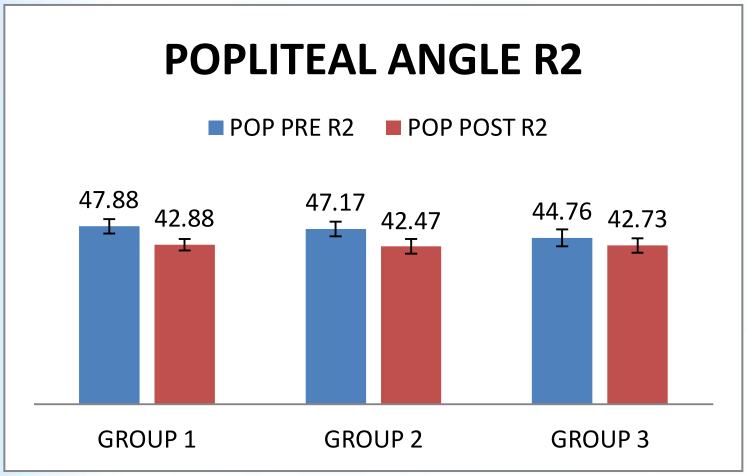
Time (Df=1, F= 122.086, p=. 000). Time x group interaction was (Df= 2, F =. 204, p=. 816).

Graph-4:



Graph -4 showed there was reduction in the pop angle resistance 1 in all the 3 groups from pre to post score. There was a main effect for Group (Df= 2, F= . 184, p= .832). There was a main effect for Time (Df= 1, F= 69.042, p= .000).Time x group(Df= 2, F= 1.109, p= .338).

Graph-5:



Graph -5 showed there was reduction in the pop angle resistance 2 in all the 3 groups from pre to post score. There was no main effect for Groups (Df=2, F= .198, p= .821). There was a main effect for Time (Df=1, F = 32.837, p= .000). Time x group interaction was (Df=2, F= 1.916, p= .158).

DISCUSSION-

The overall results of this study showed that all the three groups have improved over 8 weeks period of protocol of cyclic stretching with variable rest periods. The extensibility increased was measured through the dependent variables such as intermalleolar distance, passive range of motion, popliteal angle and active range of motion.

PASSIVE RANGE OF MOTION- Result shows that improvement in passive range of motion in all the 3 groups from pre to post-test value. From pre to post percentage change in group1- was 24.05%, group2- 24.05%, and group3- 26.64%.

The possible causes of improvement of hip abduction passive range of motion in all the 3 groups following 8 weeks of protocol of cyclic stretching with variable rest periods may be due to- i) creep, ii) change in active muscle stiffness due to number of cross bridges attached during contraction[10], iii) stretch induced hypertrophy that occurs at the end of muscle resulting in addition of sarcomeres in series and hence an increase in muscle length and permanent deformation occurs[11]. iv) Protein synthesis would have possibly caused an increase in muscle length that leads to increase in passive range of motion. [12]

The mechanical creep is the primary mechanism by which the skin is acutely stretched and increase in surface area during intraoperative tissue expansion. The mechanical creep explained by four factors such as-i) displacement of fluids and ground substance out of collagen networks leads to relative dehydration of tissue. ii) Collagen fibers realign in a parallel fashion, iii) elastic fibers micro fragment, iv) adjacent tissue migrates in to the expanded field as a result of stretching force. The most effective way to recruit tissue via mechanical creep is by cyclic loading or stretching of the skin.[13]

Dontatelli, (1981)[14] in a systemic review suggested that stretching changes the viscoelastic properties, increase the mobility due to destruction of cross linkage, increase the length of muscle and periarticular connective tissue. So the muscle adapt to new functional lengths by changing the number and length of sarcomeres in series in order to optimize the force production at the new functional length. Research suggest that 3-8 weeks human stretching regimens cause similar increased sarcomeres in series and concurrent increase in length of stretched muscles. Neuronal nitric oxide synthesis particularly concentrated at the muscle tendon junction and is positively regulated by the mechanical stimuli such as static stretching, thus possibly acting as a mechano-transducer for serial sarcomere. These study favours the adding of sarcomere due to the stretch induced hypertrophy resulting in increase in muscle length. Another concept is that when there is lack of mobility there occurs adaptive shortening of structures and excessive intramuscular collagen formation, which leads to inhibition of the movement and decrease in the length. With stretching the collagen formation breaks down and increases the passive range of motion. The result of the current study demonstrated that 8 weeks of cyclic stretching of the hip adductor muscles resulted in an increase in passive hip abduction range of motion. A study done by DA Reid and Peter J MC Nair et al, 2004 [15] has examined changes in ROM on 43 school age subjects. Hamstring extensibility was assessed by a passive knee extension test by using a KIN-COM isokinetic dynamometer. Intervention group participated in a 6 weeks hamstring stretching program. Stretches were performed 5 day per week, once a day, held for 30 seconds, for 3 repetitions. Control group did not stretch over the 6 weeks intervention period. The result showed that significant increase in knee extension range of motion; passive resistive force and stiffness were observed in intervention group, no significant increase in the similar variables in the control group. So, it provides some evidence that some structural changes occur after the stretching protocol that leads to increase in the range of motion.

Williams and Goldspink et al [16,17] demonstrated that a muscle immobilized in a lengthened position had increased mass and added sarcomeres in series, and that this event occurred primarily at the distal end of the contractile elements. Gajdosik[18] suggested that the increase in hamstring length in human tissue may be due to the possible increases in the number of sarcomeres in series, and this may explain the increase in the passive length of the muscles after a stretching regimen.

Taylor et al[19] developed a model to evaluate biomechanical properties of the rabbit extensor digitorum longus and tibialis anterior muscle-tendon units during simulated clinical stretching. The data demonstrated that four static or cyclic stretches altered the viscoelastic properties of the muscle-tendon unit, whereas no further change could be shown with the subsequent stretches. In case of CP children there is lack of mobility due to various factors that causes adaptive shortening of the structures and excessive intramuscular collagen formation which leads to decrease in the length of muscle, and inhibits the movement. Akeson WH, after 9 weeks of immobilization of the rabbit knee found that there was increase in the collagen cross linkages that leads to decrease in the flexibility of the muscles and periarticular structures of the connective tissue. This cross linkages can be destructed through stretching which helps to increase the length of muscle. [20]

Proske et al (1999) [21] and Whitehead et al, (2001) [22] suggested that after cyclic stretching the bonds between actin and myosin filament contributed to the muscle passive tension, and these bonds were broken by increasing muscle length on using short range experiment in isolated muscles. In addition changes in structural arrangement of muscle could possibly occur during motion and muscle thixotropy properties (e.g. - collagen, water, proteoglycans) may become less viscous during cyclic stretching. More mobile constituents such as polysaccharides and water might be redistributed during cyclic stretching (MC Nair et al, 2001).[23] As the sarcomere contracts, the area of overlap between the thick and thin myofilaments increases, the area of overlap decreases, allowing the muscle fiber to elongate.

ACTIVE RANGE OF MOTION AND INTERMALLEOLAR DISTANCE - Results shows that improvement in active range of motion in all the 3 groups from pre to post-test value. From pre to post percentage change in group1- was 29.50%, group2- 35.05%, and group3- 32.40%. Similarly the intermalleolar distance also increased from pre to post value. The percentage changes in group1- 17.48%, group2-18.2%, group3-21.06%.

When the hip adductor muscles are tight, the excursion and function of the hip abductor muscles is inhibited. After 8 weeks of cyclic stretching protocol the hip adductors are relaxed and that helps to improve the work efficiency of hip abductor muscles. This is due to the reciprocal inhibition of muscle, which might be the cause for increase the active range of motion and intermalleolar distance. This phenomenon is called reciprocal inhibition.

Kuen-Horng Tsai et al (2002) [24] in their study on 17 spastic hemiplegics patients who underwent prolonged muscle stretch of tricep surae by standing with feet dorsiflexed on a tilt table for 30 minutes. The result indicated that reduced the motor neuron excitability of the tricep surae significantly increased the activity of tibialis anterior. Clark frank and Robert Lardna (2010) [25] showed that stretching causes reciprocal inhibition and there by causes an increase in range of motion of muscle as well as joint. Ingrid Odeen et al (1981) [26] in his study have shown that 30 minute of mechanical stretching 2-5 times a day is more effective in reducing spasticity and increase in voluntary range of motion.

Following stretching, there occurs: i) release of mechanical factor that inhibits active movement of the hip abductors ii) decreased motor neural excitability of hip adductors via inverse stretch reflex. These two factors might have helped to obtain adductor range with less resistance from antagonist muscle; and that might be the cause for an increase in active range of motion. Berta Bobath (2002). [27]

POPLITEAL ANGLE- Both Popliteal angle resistance 1 and 2 showed decreased from pre to post value after the 8 weeks of stretching protocol. Popliteal angle resistance 1 percentage changes in group1-9.87%, group2- 9.98%, group3- 6.69%. Similarly popliteal angle resistance 2 percentage changes in group1-10.44%, group2-9.96% and group3- 4.53%.

The possible causes for reduction of popliteal angle might be – i) medial hamstring act as a hip adductor, ii) reduce tone of the muscle. In current study along with the adductors the hamstrings length was also increased. The hip adduction is not only caused by the hip adductors but also by the medial hamstrings. Adduction by these two muscles leads to hip adduction and internal rotation during stance as well as in swing phase of gait that causes scissoring gait in CP children.[8] Hamstring flexibility also increased after the stretching protocol probably because of the anatomical and functional relationship between these two muscles. Due to its common embryonic origin, innervations and action, the ischiocondylar portion of adductor magnus (AM) is often considered part of the hamstring group of muscles, whereas pubofemoral portion of the adductor magnus is considered as muscle of the medial compartment that acts as powerful adductor of thigh. Németh and Ohlsén reported that the AM muscle-moment arm length for hip extension was just 1.5 – 2.4cm in the anatomical position, compared to 6.1 – 6.8cm for the hamstrings, and 7.5 – 8.1cm for the gluteus maximus.[28]

Meanwhile Dostal et al reported muscle-moment arm lengths of 3.9cm and 5.8cm for the middle and posterior portions, respectively.[29] The muscle moment arms for the AM in adduction exceed those of hip extension, showing that this muscle is still definitively a hip adductor as well as a hip extensor. adductor magnus adduct the femur in relation to the pelvis along the frontal plane. Study done by RD Leighton (2006) also closely supported the assumption of current study.[30]

Gajdosik suggested that the increase in hamstring length in human tissue may be due to the possible increase the number of sarcomeres in series and this may explain the increase in the passive length of the muscles after a stretching regimen.[18]

MC Pherson et al also found that application of stretching, there occurred reduction of tone.[31] Similar findings were also obtained by Micdanar et al and Tremblay et al [32,45] with their study on tricep surea stretching. During stretching tension increased, golgi tendon organ inhibit muscle contraction and induce relaxation. In other way descending influences on monosynaptic reflex between muscle spindle, afferent and alpha motor neuron reduces tone following stretch.

Henrique Santos Gama et al [33] (2017) in a review article suggested that Shin and Mirka (2009), in a study with 10 healthy individuals compared the effects of rest intervals between stretching repetitions on the viscoelastic responses of skeletal muscle. The stretching exercise was performed for lumbar flexion for 10 minutes, with or without 30s of rest, and it was observed that 30s of resting were important to modify the viscoelastic responses. This may reduce the risk of injury due to the acute decrease in muscle force after stretching exercise. In general, it is common to use rest intervals of 10s (Cipriani et al., 2012)[34], 15s (Robbins; Scheuermann, 2008)[35] and 30s (Gurjão et al., 2010; Gallo et al., 2013, 2015)[36, 37] between each stretching repetition.

Overall stretching protocol showed that the dependent variables for all the 3 groups remain same with the stretching force to the limit of discomfort but no pain for constant duration of 5 minutes. After 5 minutes of constant stretch a rest period of variable duration was given to different groups, during which there might have occurred variable degree of relaxation followed by further stretch to the limit of discomfort for a period of 5 minutes which might have caused further elongation due to creep in all the 3 groups. It was again followed by rest of variable duration followed by stretching to the limit of discomfort to all the 3 groups for another 5 minutes. Therefore all the variable rest periods such as 30 second, 1 minute, 2 minute have similar effect on elongation/ extensibility tissue.

CONCLUSION: - Cyclic stretching with rest in between stretch is effective. However, cyclic stretching for 5 minutes with rest between of different duration has similar effect on elongation/ extensibility of tissue.

LIMITATIONS: - Small sample size, effects on function and gait was not included.

CLINICAL UTILIZATION- Hip adductor stretching device not only improve the flexibility of the hip adductor muscles and medial hamstring muscles but also it saves time and energy for therapist.

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TO DEVELOP A QUESTIONNAIRE TO FIND THE SPECIFIC CAUSATIVE FACTOR OF FEEDING DISORDER IN CHILDREN WITH ASD – A QUALITATIVE

Type of manuscript: Qualitative Study

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Abstract

Feeding problems are commonly exhibited by children with autism. A feeding disorder is characterised by the failure of an infant or child less than six year of age to eat enough food to gain weight and grow normally over a period of one month or more. Number of studies are targeting on the treatment of feeding problems, assessment of feeding disorders, interventions for food refusal, eating behaviours etc but no evidence was found regarding the specific causative factor of feeding disorder in children with ASD. However, there is a gap in the literature regarding the assessment of specific cause of feeding disorder in children with ASD. The participants were 80 parents of children (1-6 years) with ASD. The purpose of the study is to develop a questionnaire for assessing the specific causative factor of feeding problem and to qualitatively explore the relationship between the specific cause of feeding problems and autism spectrum disorder using a questionnaire with the parents of children diagnosed with ASD.

Keywords:- Autism Spectrum Disorder , Feeding disorder , Specific Causative Factor

Introduction

Autism spectrum disorder is a condition that affects social interaction, communication, interests and behaviour. Certain medical and mental health issues frequently accompany autism. They include seizures, sleep disturbances gastrointestinal disorders leading to feeding problems, attention deficit and hyperactivity disorder, anxiety and phobias. The estimated prevalence of feeding problems in children with autism has been reported to be as high as 90% with close to 70% of children described as selective caters (Twatchman – Reilly, Amaral and Zebrowsla, 2008) Children with ASD who have feeding problems may engage in food refusal, food selectivity and mealtime rituals (Twatchman-Reilly et.al.2008). A number of reasons have been suggested for the prevalence of feeding problems in children with ASD, including a concentration on detail, perseveration, impulsivity, fear of novelty, sensory impairments, and deficits in social compliance and biological food tolerance (Cumin, Leach and Stevenson, 2000). These behaviours are brought about by many numbers of complex factors including physiological disorders, behaviourally based challenges and week executive functioning skills (Twatchman-Reilly, 2008). Schwarz (2003) concluded that most of the feeding problems in children with ASD can be categorized as behavioural feeding disorders, including aversive eating behaviours (food refusal, choking, gagging and expulsion with no of medical) and sensory based feeding problems (textural aversion to specific kinds of foods usually involving the refusal of foods with greater texture). Researchers have conducted a number of studies regarding feeding problems in children without ASD. The most commonly reported and researched feeding problem in children with ASD is food selectivity (Williams and Seiverling 2010) the insistence on eating a narrow range of food (Williams and Foxx 2007). Children develop problems with feeding, eating and swallowing as a result of medical, oral, sensorimotor and behavioural factors, either alone or in combination. Medical conditions include prematurity, neuromuscular abnormalities, structural anomalies, gastroesophageal diseases, food allergies and tracheostomy. Clinical findings may include food refusal/selectivity, vomiting swallowing difficulty, prolonged mealtimes, poor weight gain and failure to thrive. Behavioural problems are very common in children with feeding disorders,

Developmental Aspects of Feeding

For infants and toddlers, changes occur in feeding as oral motor skills become more sophisticated, as maturational changes take place in the relationship between breathing and swallowing and as anatomic growth occurs.

Anatomy

The structures that are involved in feeding, swallowing and breathing are physically close in proximity and frequently share overlapping functions.

The mouth, pharynx & oesophagus helps in moving food to the stomach.

The overlapping physical and functional arrangement in the pharynx often underlies the feeding disorders encountered in infants and toddlers.

Anatomic Maturation

With growth changes occur in the size and anatomic relationship of the oral, pharyngeal & laryngeal structures.

These changes are rapid during first 12-18 months of life, and then progress slows throughout the reminder of childhood resulting in less functional impact.

With anatomic changes, the manner by which stability is achieved also changes.

Oral motor development associated with eating skills;-

Sucking, drinking biting & chewing are closely linked to the child's overall motor development.

Oral patterns evolve along with the child's changing nutritional needs, growing desire for self-feeding and increasingly greater ability to communicate.

Coordination of Sucking, Swallowing and Breathing

The sucking reflex is present in the foetus and is the predominant method of feeding during the first to 8-10 months of life. Sucking can be either non nutritive or nutritive and each one is different.

Non-nutritive sucking, the goal of which is not to feed but rather to calm, occurs when a child is sucking on a pacifier. It is marked by rapid, rhythmic move occurring at a speed of about two sucks per second.

By contrast, the nutritive pattern occurs when a child is sucking on a source of nutrition such a bottle nipple. It is rhythmic, but it's rhythmic marked by alternating bursts with pauses, which allows the infant to breathe & rest between sucking bursts.

Premature infants of 33 weeks gestational age or less are typically fed by non-oral methods such as an intravenous line or a nasogastric tube.

A 35 week old healthy premature baby typically has sufficiently strong jaw & tongue mouths to be fed oral at least part of the time.

The full term infant (37 to 42 weeks gestation) has strong oral-reflexes that enable him or her to take in liquid nutrition without difficulty.

The infant also exhibits gag & cough reflexes prevent liquid from entering the airway.

Each infant has a unique sucking pattern that may vary from feeding to feeding depending on factors such as fatigue and hunger.

Sucking is the predominant sucking pattern during the first 4 months of life. At 1 month of age, a hungry infant usually performs one such per swallow.

Slight liquid loss and air intake may occurs with sucking and are primarily observed in the 2^{nd} & 3^{rd} months, after the infant's physiological flexion has disappeared but before the infant has acquired mature oral motor control.

At 4 months of age, the tongue begins to move up and down, the hallmark mouth of true sucking. The infant is capable of talking in 20 or more sucks from the breath or bottle before pausing.

Swallowing occurs intermittently (after 4 to 5 sucks) and without pausing. Breathing slows during sucking and occurs within & between sucking sequences.

The 6 months old infant demonstrates strong up and down tongue mouth with minimal jaw excursion during sucking.

An infant's early attempts at cup feeding may be accompanied by some coughing.

At 9 months of age, the infant continuous to feed from the bottle nipple using strong sucking pattern.

At 12 months of age, many infants make a full transition from bottle to cup for drinking during mealtime but may continue to bottle feed at other times.

By 12 months of age, sequence of three suck swallows occurs during cup drinking.

By 15 to 18 months of age, the infant has excellent coordination of sucking, swallowing & breathing.

At 24 months of age, the child can efficiently drink from a cup. Lengthy suck-swallow sequence occur as the infant gains more control of jaw, tongue and lip mouth, he or she also learns to coordinate and arrange oral mouths into rhythmic patterns of sucking, swallowing and breathing.

Development of Feeding Pattern

0-3 months-

Rooting reaction, sucking-and-swallowing reflex. The mouth and gag are sensitive, having normal cardinal points reflexes. The tongue moves out and there is often an open mouth and dribbling. When sucking, the tongue moves forward and back together with the up and down movement of the jaw. A baby rests a hand on the breast or bottle, and sucks hands.

3-6 months-

Sucking dissociates from swallowing as child transfers liquids for swallowing. All reflexes disappeared. Bite response followed by release. Takes liquids or later, liqiuidised food from spoon. Recognises bottle. Cup may be accepted for drinking. Experiences many tastes before textures. Mouthing hands, objects, clothes and later feet. Begins to temporarily grasp and suck a biscuits

6-9 months-

Takes mashed foods and semi solids. Bites food if placed in the two sides of mouth, and sucks if centrally placed. Picks up and holds a biscuits, may drop it or crumble it in his hand. Around 8-9 months some guide mother‘s/carer‘s hand on spoon or cup to their mouth and can hold the bottle. Likes to feel food. Up and down jaw motion in chewing, tongue movements changing and less associated with jaw action. Swallows with mouth closed. Gags on textures but gag response is much less sensitive. Babbles with mouthful of food. During drinking, loses liquids and tongue protrusion is slight. Mouthing continues to explore toys and objects.

9-12 months-

Wants control eating and drinking. Enjoys prodding, squeezing and smearing food. Finger feeds, and more varieties held in hand. Firmer foods are chopped, textures accepted and chewing with lateral tongue motion. Holds and drinks from bottle and with help holds, lifts and drinks from cup. Helps parent with filled spoon to mouth but cannot do this alone. Plunges spoon into food and bangs spoon on the table. Lips used remove food from spoon held by adult.

12-18 months-

Feeds self clumsily with a spoon and variety of foods increases. Uses spoon but turns it upside down before reaching mouth or within mouth. A child cannot scoop food so uses other hand to push food onto spoon with much spilling. Holds and drinks from cup, may bite on cup edge, often spills. Controls bite on biscuit. Chewing established. Lateral and rotary jaw motion. Pretends to feed another person and dolls.

18 months – 2 years-

Loads and uses spoon correctly, occasional spilling. Holds glass and cup for drinking without biting edge but may suck edge or tip cup and spill. Drops saliva or food while chewing. Understands what is edible and inedible. Begins straw drinking but bites edge. Imitates other children.

2-3 years-

With small amounts, feeds self completely with spoon, later with fork. Pours liquids, obtains own drink from tap. Prefers little amount to drink, using one hand. May be fussy about food, have variable appetite and imitates other children about likes and dislikes and being independent.

3-4 years

Serves self at table, spreads butter, cuts food. Pours from different jugs. From 4 years onwards a child is learning to use knife and fork. A child learns to hold a fork with pressure by the index finger isolated from the others grasping the handle. There is increasing experience of new mealtimes in new situations. Enjoys help with cooking and more complex imaginative play such as with toy tea sets, dolls shops, toy kitchens.

Methods

A cross-sectional survey design was used and participants were selected by convenience sampling. A total of 80 subjects diagnosed with autism spectrum disorder were recruited from Occupational therapy department of SV NIRTAR and a few from private clinics for the study.

The inclusion criteria were as follows (1) parents of children having feeding problem diagnosed with ASD (2) parent‘s whose child‘s age is between 1-6 yrs.(3) parent’s of children of both sexes (4) parent‘s those will cooperate for the queries.

Procedure

A questionnaire was developed on the basis of neurophysiological evidence and is based on various factors under 5 headings such as sensory processing, oral-motor dysfunction, gastrointestinal dysfunction, repetitive and ritualistic behaviour and fear or executive function difficulty.

Face validity- A copy of the developed questionnaire was sent to 12 various professionals with at least 5yrs of experience for their feedback. Only eight professionals returned the completed form within the time limit given .There opinion and suggestions were taken to modify the questionnaire.

Then,the final modified questionnaire was used to collect data‘s from the parents by the researcher herself.

Content validity – The questionnaire was checked based on the responses received from 80 participants,who all were parents of children diagnosed with ASD

The interview was under taken in the therapy sessions at SV NIRTAR and in few private clinics .Before an interview each patient signed a consent form. The selected parents were explained about the study and the purpose of the study in details. The researcher was in regular contact with the participants to determine the most convenient time to conduct the interviews, based on scheduling and availability of appropriate participants to be interviewed. All the interviews were conducted on one on one basis and it takes approximately 40-45 minutes. During each questions the parents were asked to make additional comments if they wish.

The developed questionnaire include general information ,birth information , medical history and information regarding factors causing feeding dysfunction .The scoring pattern was done based on the response of the parents as A- Always, F-Frequently ,O-Occasionally, S-Seldom and N-Never and the response was converted into objective score such as 1,2........10 ,however the questions were also divided into high strength and low strength questions on professional opinions .The high strength scoring pattern is 10,8,6,4,2 and the low strength scoring pattern is 5,4,3,2,1 .The objective scoring of the questionnaire were taken for data analysis.

Data Analysis and Results

The semi-structured interviews from all the 80 interviewees formed the database of the study .Descriptive statistics was used to analyze the collected data.

The primary analysis in the study was to find the commonest factor that is responsible for feeding disorder.

The analysis of the data gives the following tables showing the descriptive characteristics of the result.

Table1 : Shows mean percentage score of 80 subjects in each factor

FACTORS	MEAN % SCORE
1)Sensory processing	52.7%
2)Oral-motor dysfunction	50%
3)Gastrointestinal dysfunction	43.6%
4)Repetitive and ritualistic behaviour	47%
5)Fear or executive difficulty	48.8%

It reveals that the subjects having more score in sensory processing as compared to all other 4 factors.

All 80 subjects were categorized under mild, moderate and severe feeding disorder based on their weight, amount of food intake and the kind of food they are taking. Scoring of all the factors in mild, moderate and severe were categorized and the mean score of each factor in different category in feeding disorder were calculated. The range between the highest and the lowest score in each factor was also calculated.

Table 2: Shows the mean percentage score of all the factors in mild ,moderate and severe feeding disorder

Factors	Mild n=17		Moderate n=39		Severe n=24	
	Mean% score	Range	Mean % score	Range	Mean % score	Range
1	375.8	48-74	193.3	45-98	296.2	50-112
2	170.5	19-43	82.3	15-49	148.7	23-51

3	138.8	16-47	69.7	13-59	135	17-57
4	250	30-62	120.5	28-73	210.8	32-75
5	176.4	17-44	86.6	18-48	153.3	16-57

Table 2 reveals that in all 3 categories of feeding disorder have the highest mean % score in sensory processing.

As the total scores of each factor were different, it was difficult to calculate the correct frequency distribution among 80 subjects . So, the total scores of each factor was converted to 100. Frequency distribution were calculated among the 80 subjects to find out what is the frequency of the subjects having the highest score in different factors.

The highest score among the 5 factors of each subject were observed and calculated .and the number of subjects having the highest score in each factor were observed and categorized.

Table 3 : Shows the frequency distribution of 80 subjects in all 5 factors .

FACTORS	NUMBER OF SUBJECTS AFFECTED
1) Sensory processing	27
2) Oral-motor dysfunction	19
3) Gastrointestinal dysfunction	13
4) Repetitive and ritualistic behaviour	9
5) Fear or executive function difficulty	23

This reveals that the highest number of subjects fall into sensory processing as compared to all other 4 factors however the number of subjects fall under fear or executive function difficulty is also nearby normal to factor 1 (sensory processing) .

Bar graph: Showing the frequency distribution of 80 subjects

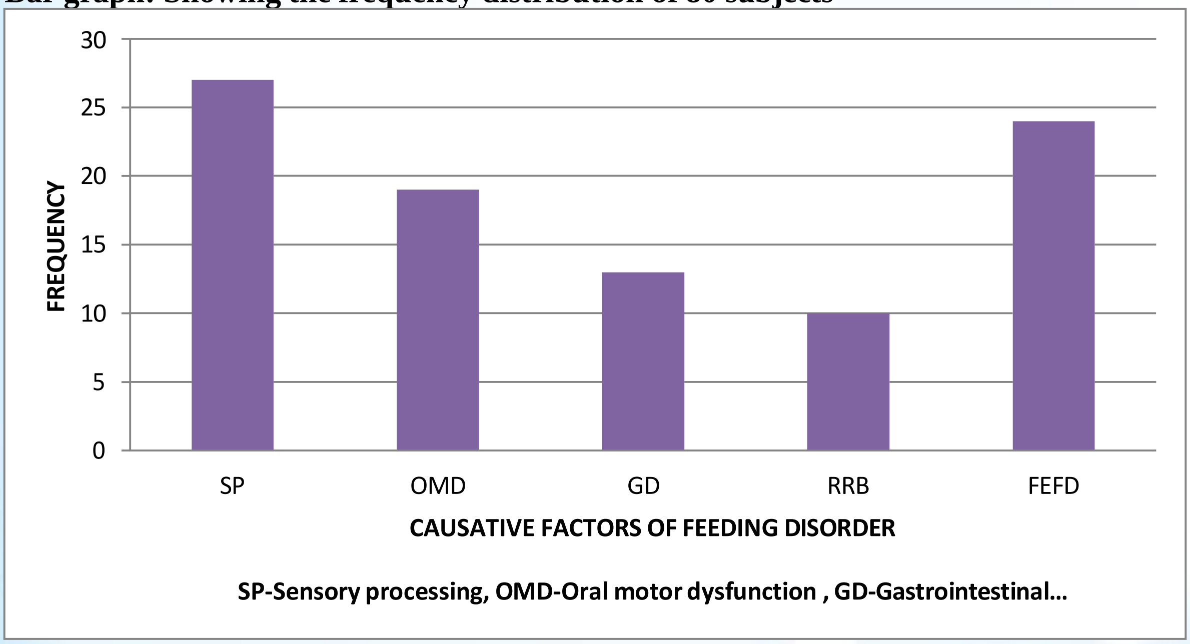
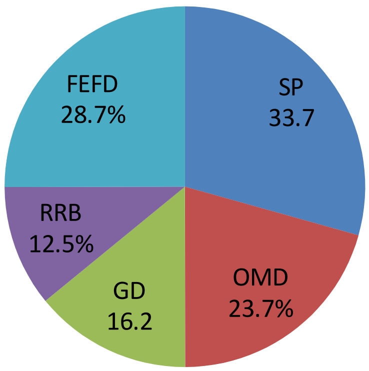


Table 4 : Shows the percentage of subjects fall into different factors.

FACTORS	% OF SUBJECTS
1) Sensory processing	33.7%
2) Oral-motor dysfunction	23.7%
3) Gastrointestinal dysfunction	16.2%
4) Repetitive and ritualistic behaviour	12.5%
5) Fear or executive function difficulty	28.7%

Pie graph: Percentage score in each factor



Discussion

Feeding problems are commonly exhibited by children with autism. In 1943, Kanner first described feeding difficulties among children with ASD. Parents of children with ASD frequently report child food refusal based on characteristics of food. Children with ASD experience significantly more feeding problems than typically developing children and food selectivity is particularly problematic (Hubbard et al). In this research, a questionnaire was developed to find out the specific causative factor related to feeding dysfunction in ASD. The questionnaire assessed the feeding dysfunction of ASD children on 5 factors such as sensory processing, oral-motor dysfunction, gastrointestinal dysfunction, repetitive and ritualistic behaviours and fear or executive function difficulty. The content of the questionnaire is substantially supported by the research paper of Allen Rae (2013) who found these factors and its effect on feeding in children with ASD.

Limitations & Recommendations

An important limitation of this study was the sample size which was very small for a qualitative study. Further investigations can be done with large sample size. Effective intervention strategies can be developed to reduce sensory sensitivity around the mouth. Studies can be done on feeding dysfunction as an indicator for ASD.

Conclusion

Although, a small sample size was used for this survey, the descriptive analysis support that sensory processing is the most common cause of feeding problem and another factor i.e. fear or executive function difficulty was also showing nearby equal result as sensory processing. In this present study, the other factors were comparatively less responsible for feeding problems in ASD. This study found that fear/executive function difficulty has also effect on feeding of ASD children as sensory processing which may be due to the poor planning skills which is always associated with executive function of feeding which enhance the children‘s ability on eating the same food in a highly ritualistic manner that is supported by Twachtman-Reilly et al., 2008.

The purpose of the study was to develop a questionnaire which will help to find out the specific causative factor responsible for feeding problem in ASD children. Therefore, from the above study, it is concluded that autism can have an adverse effect on a child’s ability to tolerate the sensory properties of food and that leads to food selectivity, food refusal and aversion to oral care.

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EFFECTS OF DEEP SOFT TISSUE MANIPULATION IN LOW BACK

Type of manuscript: Clinical Trail

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Abstract

Introduction: The most common symptom in musculoskeletal pathologies is low back pain. Abnormal connective tissue structure or a consequence of injury leading to change in movement patterns may be a predisposing factor for low back pain. **Aim of the Study:** To investigate the effect of deep soft tissue manipulation of parascapular and paraspinal muscles to reduce symptoms in subjects with low back pain. **Methodology:** A total of 84 subjects having low back pain with or without radiation for more than 3 months and stretching of parascapular muscles reproduce/aggravate the original symptom were recruited and randomly distributed in two groups. Group 1 received conventional exercises (disease specific treatment) and Group 2 received deep soft tissue manipulation of parascapular and paraspinal muscles. **Outcome Measures:** Visual analog scale and Modified Schober's Test. Measurements were taken before, at the end of two weeks and at four weeks of treatment. **Results:** Overall results of the study, both Group 1 and Group 2 showed improvement in pain and lumbar range of motion after four weeks of intervention. However, Group 2 improved significantly to a greater extent than Group 1. **Conclusion:** Deep soft tissue manipulation of parascapular and paraspinal muscles is found to be effective for the management of low back pain.

Key words: Deep soft tissue manipulation; Low back pain; Myofascial pain syndrome; Parascapular and paraspinal muscles; Thoracolumbar fascia;

Introduction

The commonest symptom in musculoskeletal pathologies is low back pain and is considered as the most common health disorder in modern society. [1] The causes include a wide variety of pathologies of lumbar spine and surrounding structures. Research by Anderson suggests that 70% to 85 % of the population will come across low back pain at least once in their lives. Almost 90% of the acute low back pain shows better improvements regardless of the therapy; the remaining 10% are prone to develop chronic low back pain. [2] First symptoms occur mainly in the ages of 20–39 years. Once individuals are over 35 years old, the elasticity of ligaments and joints around the vertebrae is reduced and restricted, giving rise to low back pain. [3]

Skeletal changes could be due to primary or secondary to myofascial pain syndrome. Altered posture may increase the tensile stress over certain muscles resulting in microtrauma and myofascial pain syndrome. [4] There is loss of extensibility and muscle weakness which secondarily may result in skeletal changes, impairment of motion, and pain. [5] Langevin HM et al. (2006) hypothesize that connective tissue remodeling occurs in chronic low back pain as a result of emotional, behavioral and motor dysfunction and increased connective tissue stiffness due to fibrosis is an important link in the pathogenic mechanism leading to the chronicity of pain, fear avoidance, and further movement impairment. [6]

Thoracolumbar fascia has been the subject of recent attention as a potential pain-generating structure in the back, its role in low back pain pathophysiology is poorly understood. [7] In a previous study using ultrasound, we found that human subjects with chronic LBP of more than 12 months duration had increased thickness and echogenicity of the perimuscular connective tissues forming the thoracolumbar fascia in the low back. [8]

Abnormal connective tissue structure may be a predisposing factor for LBP or a consequence of injury and/or changes in movement patterns occurring as a result of chronic pain. Both increased stress due to overuse, repetitive movement and/or hypermobility, and decreased stress due to immobilization or hypomobility can cause changes in connective tissue. [9] A chronic, local increase in stress can lead to microinjury and inflammation (overuse injury, cumulative trauma disorder). [10] A consistent absence of stress, on the other hand, leads to connective tissue atrophy, architectural disorganization, fibrosis, adhesions, and contractures. [11] During the early phase of immobilization, loss of muscle length is primarily due to the shortening of muscle-associated connective tissue, which is only later followed by the actual shortening of muscle fibers. [12]

More recently, a high density of sympathetic neurons was found in the thoracolumbar fascia of both rats and humans. [13] If some of these fibers are ergoreceptors (group III or IV muscle afferents) or other mechanoreceptors (senses physical movement), which are sensitive to muscle contraction, it is possible that they could exert a modulating effect on vasomotor activity and sympathovagal balance systemically in response to movement. Stimulation of those vasomotor fine nerve endings could serve as a cause of ischemic pain. [14]

It can be concluded that there may be fascial involvement i.e. tissue stiffness due to adhesion & fibrosis, altered sensory input in the thoracolumbar fascia, and hypomobility in the thoracic and thoracolumbar spine in a low back pain patient. [6] Evidence suggests that fascial stretching may alleviate these secondary changes in the fascia and spinal mobilization may increase spinal mobility. [15]

Aim of the study

My purpose of the study is to see the effect of deep soft tissue manipulation of parascapular and paraspinal muscles to reduce pain in various functional activities and improvement of the Lumbar spine range of motion in sagittal plane (flexion+extension) in subjects with low back pain.

Methodology

Study Design: The Pre-Test, Post-Test Control Group Study Design which is experimental in nature.

Research Setting: The study was conducted at the musculoskeletal unit of the Physiotherapy department of Swami Vivekanand National Institute of Rehabilitation Training and Research (SVNIRTAR).

Inclusion Criteria: Subjects having low back pain with or without radiation for more than 3 months, stretching of parascapular muscles reproduce/aggravate the original symptom, age between 25 - 50 years in both the sex.

Exclusion Criteria: Age above 50 years, low backache due to tumor, low backache due to Spondylolysis, Spondylolisthesis, Osteoporosis, previous back surgery, known Rheumatic, neurological, or mental disease, Fracture, any contraindication to manual therapy.

Outcome measures:

- **Modified Schober's Test (MST):** It is a reliable clinical measurement method of lumbar flexion range of motion. The modified Schober‘s method of determining lumbar spinal motion was the most reliable than the fingertip-to-floor method and two-inclinometer method for a routine, non-invasive, clinical evaluation of lumbar spinal motion. [16]
- **Visual analog scale (VAS):** The visual analog scale is a psychometric response scale that can be used to quantify pain. It is a numerical rating scale. The simplest VAS is a straight line of fixed length, usually 100mm. The ends are defined as the extreme limits of pain oriented from left to right. [17]

Subjects/Participants: A total of 84 subjects with low back pain were recruited randomly. Group 1 (Conventional group) – 42 subjects, group 2 (Experimental group) – 42 subjects.

Procedure:

After meeting the inclusion and exclusion criteria through an assessment proforma, informed consent was taken and subjects were randomly allocated to either of the two groups. All participants underwent an initial baseline assessment of Modified Schober‘s Test and Visual Analogue Scale. 84 subjects both males and females (52 males and 32 females), were evaluated with the mean age of (40.16 ± 1.11) years and average duration of low back pain (17.70 ± 2.71) months.

Group 1 (Conventional group) – 42 subjects (28 males and 14 females) with a mean age of 39.78 ± 1.16 received disease-specific treatment. Out of 42 subjects of conventional group 13 subjects were diagnosed as Non-specific low back pain (low back pain not attributable to recognizable, known specific pathology). Depending on their physical examination findings; i.e. stretching of tight structure, strengthening of weak muscles, mobilization of hypomobile spine and combination of stretching, strengthening, Maitland mobilization were given. For tightness of piriformis, hip flexor stretching was given as per Muscle Energy Technique; for the weakness of abdominals, back extensors strengthening exercises was given; for hypomobile segments, Maitland mobilization was given. 10 subjects were diagnosed as derangement syndrome characterized by centralization of pain with repeated extension as per Mckenzie concept had received Mckenzie repeated extension exercise. 11 subjects were diagnosed as soft disc legion characterized by flexion, extension, side flexion to the affected side hurts the subject more as per Cyriax concept had received Cyriax listing correction – I. 08 subjects were diagnosed as spondylosis characterized by limitation of lumbar spine range of motion in capsular pattern i.e. extension and side flexion are grossly limited, decreased lumbar lordosis, hypomobility present in Maitland‘s central posterior-anterior pressure over lumbar spine had received Maitland posterior-anterior pressure. The intervention was given for 5 days a week for 4 weeks.

Group 2 (Experimental group) – Among 42 subjects (24 males and 18 females) with a mean age of 40.54 ± 1.07, 12 subjects were diagnosed as Non-specific low back pain characterized by the tightness of piriformis, hip flexor and weakness of abdominals, back extensors, 11 subjects were diagnosed as derangement syndrome characterized by centralization of pain with repeated extension as per Mckenzie concept, 10 subjects were diagnosed as soft disc legion characterized by flexion, extension, side flexion to the affected side hurts the subject more as per Cyriax concept, 09 subjects were diagnosed as spondylosis characterized by limitation of lumbar spine range of motion in capsular pattern i.e. extension and side flexion are grossly limited, decreased lumbar lordosis, hypomobility present in Maitland‘s central posterior-anterior pressure over the lumbar spine. All 42 subjects treated by deep soft tissue manipulation of parascapular and paraspinal muscles for 5 days in a week for 4 weeks. Measurements for all dependent variables were taken prior to the beginning of treatment (0 weeks) and were repeated again at the end of 2 weeks and 4 weeks of intervention.

Data analysis

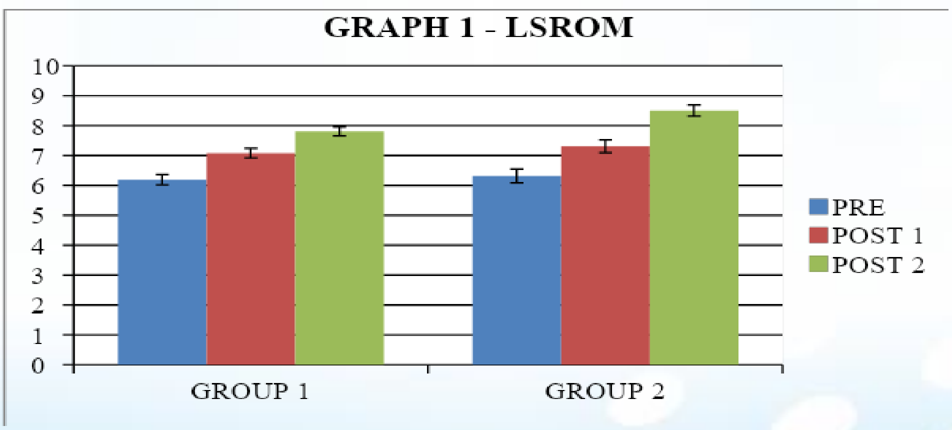
Statistical analysis was performed using SPSS version 25.0, the dependent variables were analyzed using repeated-measures ANOVA.

There was one between factor (Group) with two levels (Groups: Deep soft tissue manipulation and Disease-specific treatment) and one within factor (time) with three levels (Pre-test, Post-test-I and Post-test-II).

All pairwise posthoc comparisons were analyzed using a 0.05 level of significance.

Results

Graph – 1: Lumbar Spine Range of Motion in Sagital Plane (LSROM)

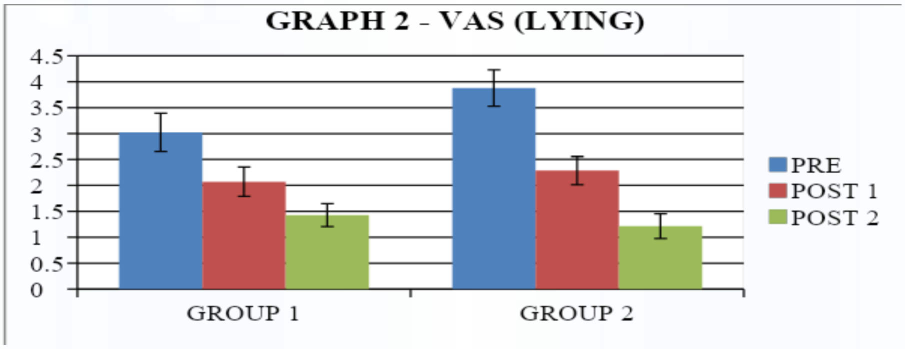


Graph 1 illustrates that there was an improvement in the lumbar spine range of motion in both the groups from pre-treatment to post-treatment but the experimental group showed greater improvement in the post-treatment measurements as compared to the conventional group at the end of 4 weeks of the treatment session.

There was the main effect for time F (248.114), df (2), p = 0.000. There was also a main effect for group F (2.015), df (1), p = 0.003. The main effects were qualified into time X group interaction F (6.161), df (2), p = 0.160.

Tukey‘s Post Hoc analysis shows that there was a significant improvement in scores for both groups. However, the experimental group showed significantly greater improvement than the conventional group at the end of 4 weeks.

Graph – 2: Visual Analogue Scale (Lying)

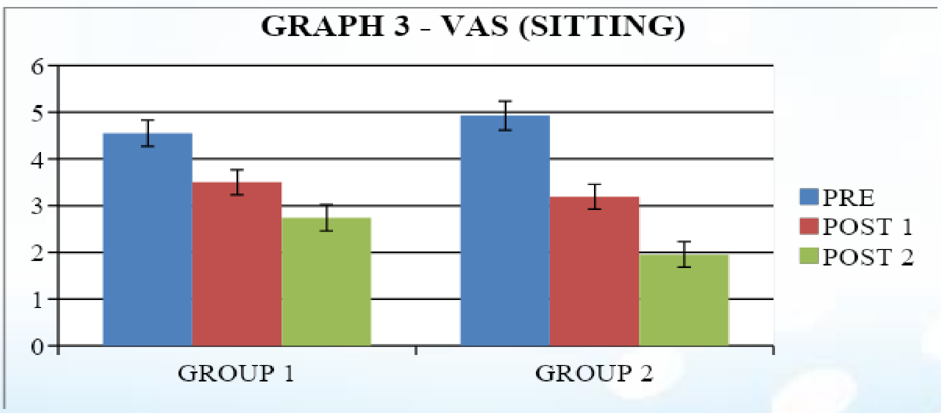


Graph 2 illustrates that there was a reduction of pain in lying in both the groups from pre-treatment to post-treatment but the experimental group showed greater improvement in the post-treatment measurements as compared to the conventional group at the end of 4 weeks of the treatment session.

There was a main effect for time F (136.575), df (2), p = 0.000. There was also a main effect for group F (0.538), df (1), p = 0.465. The main effects were qualified into time X group interaction F (8.637), df (2), p = 0.000.

Tukey‘s Post Hoc analysis shows that there was a significant reduction in pain in lying for both groups. However, the experimental group showed significantly greater improvement than the conventional group at the end of 4 weeks.

Graph – 3: Visual Analogue Scale (Sitting)

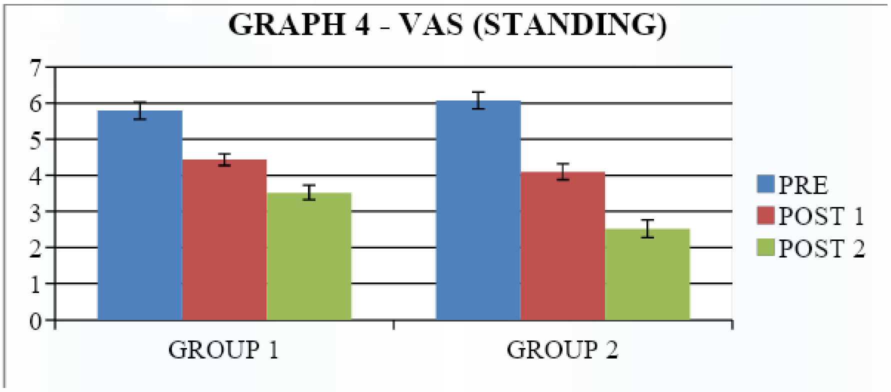


Graph 3 illustrates that there was a reduction in pain in sitting in both the groups from pre-treatment to post-treatment but the experimental group showed greater improvement in the post-treatment measurements as compared to the conventional group at the end of 4 weeks of the treatment session.

There was a main effect for time F (181.587), df (2), p = 0.000. There was no main effect for group F (0.418), df (1), p = 0.520. The main effects were qualified into time X group interaction F (10.816), df (2), p = 0.000.

Tukey's Post Hoc analysis shows that there was a significant reduction of pain in sitting for both groups. However, the experimental group showed significantly greater improvement than the conventional group at the end of 4 weeks.

Graph – 4: Visual Analogue Scale (Standing)

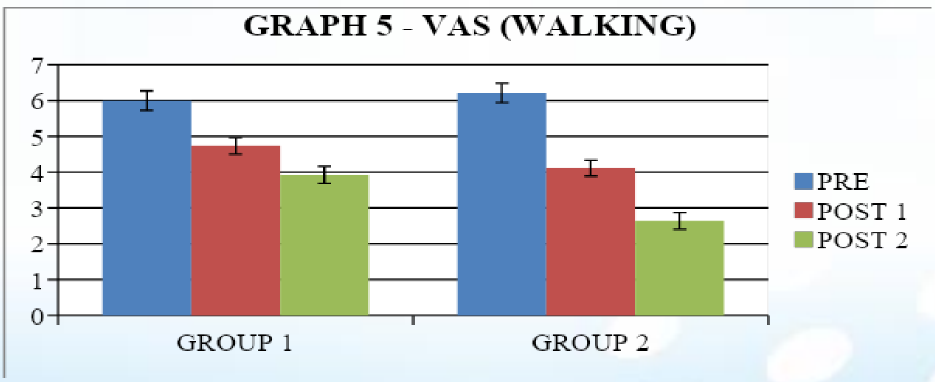


Graph 4 illustrates that there was a reduction of pain in standing in both the groups from pre-treatment to post-treatment but the experimental group showed greater improvement in the post-treatment measurements as compared to the conventional group at the end of 4 weeks of the treatment session.

There was a main effect for time F (241.870), df (2), p = 0.000. There was no main effect for group F (1.704), df (1), p = 0.195. The main effects were qualified into time X group interaction F (11.767), df (2), p = 0.000.

Tukey's Post Hoc analysis shows that there was a significant reduction of pain in standing for both groups. However, the experimental group showed significantly greater improvement than the conventional group at the end of 4 weeks.

Graph – 5: Visual Analogue Scale (Walking)

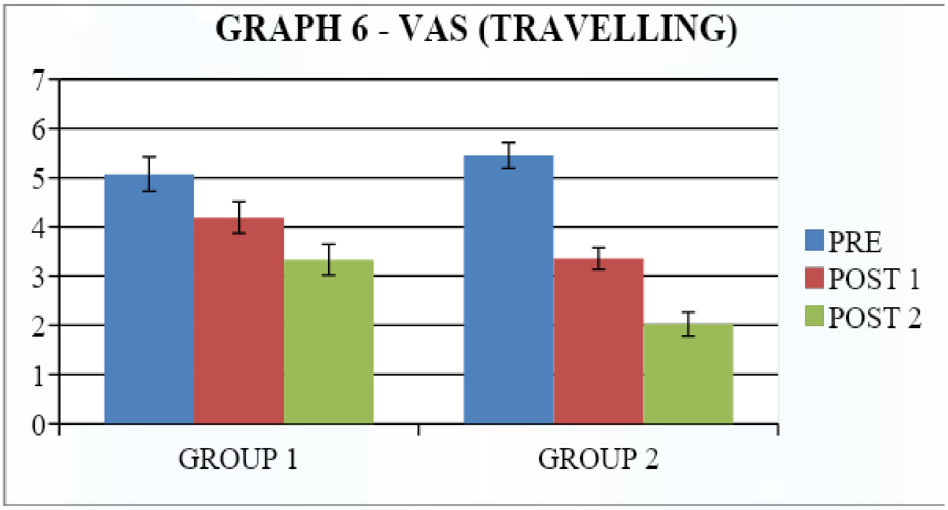


Graph 5 illustrates that there was a reduction of pain in walking in both the groups from pre-treatment to post-treatment but the experimental group showed greater improvement in the post-treatment measurements as compared to the conventional group at the end of 4 weeks of the treatment session.

There was a main effect for time F (249.387), df (2), p = 0.000. There was no main effect for group F (3.237), df (1), p = 0.076. The main effects were qualified into time X group interaction F (17.485), df (2), p = 0.000.

Tukey‘s Post Hoc analysis shows that there was a significant reduction of pain in walking for both groups. However, the experimental group showed significantly greater improvement than the conventional group at the end of 4 weeks.

Graph – 6: Visual Analogue Scale (Travelling)



Graph 6 illustrates that there was a reduction of pain in traveling in both the groups from pre-treatment to post-treatment but the experimental group showed greater improvement in the post-treatment measurements as compared to the conventional group at the end of 4 weeks of the treatment session.

There was a main effect for time F (207.472), df (2), p = 0.000. There was no main effect for group F (2.382), df (1), p = 0.127. The main effects were qualified into time X group interaction F (23.441), df (2), p = 0.000.

Tukey‘s Post Hoc analysis shows that there was a significant reduction of pain in traveling for both groups. However, the experimental group showed significantly greater improvement than the conventional group at the end of 4 weeks.

Discussion

Overall results of the study, experimental group (treated with deep soft tissue manipulation) and conventional group (underwent disease-specific treatment) showed improvement in lumbar spine range of motion in the sagittal plane (Flexion+Extension) measured by modified Schober's test and pain during various functional activities measured by visual analog scale after 4 weeks of intervention in patients with low back pain. However, the experimental group improved to a greater extent in pain, a lumbar spine range of motion than the conventional group.

Lumbar spine range of motion in sagittal plane:

In this study both the groups showed significant improvement in lumbar spine range of motion in the sagittal plane (Flexion+Extension) over time, but the experimental group showed more improvement than the conventional group in lumbar spine range of motion in the sagittal plane (Flexion+Extension) at the end of 2 weeks and 4 weeks of intervention. The conventional group received disease-specific treatment.

Muscle-tendon units are considered to be the limiting structures preventing greater ranges of joint motion. [18] The viscoelastic nature of muscle suggests that stretching will result in greater flexibility. Improved flexibility is considered to be related to an increased range of motion of a particular joint. [19] In stretching muscle-tendon units respond viscoelastically to tensile loads. Muscle is considered to have both elastic and viscous properties. Elasticity implies that length changes, or deformations, are directly proportional to the applied forces, or loads. Viscous properties are characterized as time-dependent and rate change-dependent, where the rate of deformation is directly proportional to the applied forces. [20]

A large proportion of patients who fit the derangement classification demonstrate a limitation of extension range, which improves when treatment procedures that cause a reduction, abolition, or centralization of symptoms, are applied. The performance of repeated movements in the same direction would result in a reduction of the derangement and reduction or centralization of pain and in this way facilitates spinal extension and gain in extension range. [21] Reduced lumbar range of motion might be the result of shortened soft tissue i.e., adaptive shortening of soft tissue and a partial loss of movement of the lumbar spine due to poor posture adopted by the chronic low back pain patients due to prolapsed intervertebral disc. McKenzie passive lumbar extension exercises accentuate momentarily the lordosis and by stretching the shortened periarticular tissues and restore the soft tissue to their original length, thus correct the dysfunction and increase the range of motion. [22]

Mobilization techniques improve the normal extensibility of the joint capsule and stretch the tightened soft tissues to induce beneficial effects. Maitland mobilization also provides the necessary translational movements required to gain normal physiological movements. The mechanical changes may include breaking up of adhesions, realigning collagen, or increasing fiber glide when specific movements stress the specific parts of the capsular tissue. [23] Furthermore, mobilization techniques are supposed to increase or maintain joint mobility by inducing rheologic changes in synovial fluid, enhanced exchange between synovial fluid and cartilage matrix, and increased synovial fluid turnover. [24] Immediate effects of the forces used in mobilization results in temporary length changes due to creep. [15]

The experimental group showed more improvement in the lumbar spine range of motion in sagittal plane (Flexion+Extension) at the end of 2 weeks and 4 weeks of intervention than the conventional group. The experimental group received deep soft tissue manipulation of parascapular and paraspinal muscles. Effects of deep soft tissue manipulation of parascapular and paraspinal muscles and facet joint mobilization may be responsible for the additional improvement in the lumbar spine range of motion in sagittal plane (Flexion+Extension).

Deep soft tissue manipulation of parascapular and paraspinal muscles are used to affect the sub-layer of musculature the deeper layers of muscle along with fascia and the underlying facet joints. Deep tissue manipulation might have an effect of stretching over soft tissues, mobilizing effect over the underlying facet joint, remodeling effect over the fascia.

Deep soft tissue manipulation is thought to increase circulatory flow to dehydrated tissues by the stretching effect. Research of fascia under tension and stretch has described simple modeling of the system as coupled time-dependent molecular gliding within fibrils and between fibrils within a fiber that produces an overall viscoelastic response. To summarize, the colloidal nature of connective tissue means that hydrodynamics is a crucial element in the results of tissue stretching, both in reducing edema and in increasing the water supply to underserved proteins, so increasing the extensibility of the tissue. Increase hydration of thoracolumbar fascia due to upper back fascia stretching performed in this study may help to increase the extensibility of thoracolumbar fascia and in turn contribute to an additional increase in spinal range of motion in the experimental group. [25]

In this study, deep soft tissue manipulation over the paraspinal and parascapular muscles, so deep that it might mobilize the underlying facet joints, which was characterized by crepitus produced. Perhaps during the deep soft tissue manipulation, there might occur fascia stretch of upper back and mobilization of facet joint which might be enough for improvement of lumbar spine range of motion.

Similar results have been found by Sung et al. (2014) i.e. application of mobilization or manipulation to thoracic lumbar vertebrae has a positive effect on function, mental state, and range of motion in patients with lower back pain. [26]

A case study by Chunco R (2011) was found to show the effect of a massage protocol that includes Swedish strokes, stretching with myofascial release, and trigger point therapy for 28 days on a 47-year-old woman. A total of 7 sessions were completed, had an improvement of stiffness in the visual analog scale to 1.2 from 3. Forward and lateral (left and right) Finger to floor distance had decreased to 4inch, 16.5inch and 16.5inch respectively whereas the initial values were 6inch, 21inch and 20.5inch respectively. [27]

Pain during various functional activities:

In this study both the groups showed a significant reduction of pain during various functional activities over time, but the experimental group showed more improvement than the conventional group in the reduction of pain during various functional activities at the end of 2 weeks and 4 weeks of intervention. The conventional group received disease-specific treatment.

Reduction of trunk muscle strength and endurance leads to muscle fatigue and increased pressure on the soft tissues and inactive structures of the spine. It may cause inappropriate pressure on the spine and leads to low back pain. [28] Therefore trunk muscle strengthening exercises are commonly recommended not only for patients with low back pain as a method of treatment but also for the healthy population as a possible preventive measure for low back pain. [29] Strengthening the muscles of the back, enhance coordination, enhance trunk stabilization, and reduce the pressure on the spine and subsequently reduce the low back pain. [30] Effects of strengthening exercises on muscles of the lower trunk which leads to increased spinal stability, restrain aberrant micro-motion, and reduced associated pain.

With the movement of the vertebral column, the nucleus can alter its shape, and with sustained positions or repeated movements, it would eventually alter its position. Clinically this manifested itself in the derangement syndrome by a change in intensity or site of the symptoms. [21]

In derangement, the performance of repeated movements in the opposite direction which increases the accumulation of nuclear material would result in a progressively increasing derangement and increasing or peripheralizing pain. The performance of repeated movements in the direction of derangement would result in a reduction of the derangement and reduction or centralization of pain. [21]

Mobilization has an effect on fluid flow as blood flow in the vessels supplying the nerve fibers and synovial fluid flow surrounding the avascular articular cartilage. This, by a pressure gradient, is generated which helps in facilitating the exchange of fluid, that is, increased venous drainage and dispersing the chemical irritants. This causes a reversal of the ischemia, edema, and inflammation cycle and reduces joint effusion and relieves pain by reducing the pressure over the nerve endings. The neurophysiologic effect is based on the stimulation of peripheral mechanoreceptors and inhibition of nociceptors [31]. Passive oscillatory movements are effective to reduce pain because of the neuro-modulation effect on the mechanoreceptors within the joints. [32] Maitland joint mobilization controls pain through neurophysiological effects by stimulating type II mechanoreceptors while inhibiting type IV nociceptors. Passive joint mobilization provokes Golgi tendon organ activity at the end of the joint mobilization and causes reflex inhibition of the muscle. Decreased muscle activity after joint mobilization decreases joint concentric activation, alleviating pain, and muscle tension in periarticular tissue. [33]

The experimental group showed more reduction of pain during various functional activities at the end of 2 weeks and 4 weeks of intervention than the conventional group. The experimental group received deep soft tissue manipulation of parascapular and paraspinal muscles. Effects of deep soft tissue manipulation of parascapular and paraspinal muscles and facet joint mobilization may be responsible for the additional reduction of pain during various functional activities.

A deep layer of thoracolumbar fascia comprises a variety of both free and encapsulated nerve endings, especially Ruffini and Pacini corpuscles, suggesting a proprioceptive capacity of the deep fascia. [34]

The manual stretch through deep soft tissue manipulation stimulated some Ruffini endings which then triggered the central nervous system to change the tonus of some motor units in muscle tissue which was mechanically connected to the tissue under the therapist‘s hand and results in the more reduction of pain in the experimental group. [34]

The thoracolumbar fascia is densely innervated by mechanoreceptors which are responsive to manual pressure. These receptors mediate muscle response via the spinal cord and higher center mechanisms. Stimulation of these sensory receptors by deep soft tissue manipulation has been shown to lead to a lowering of sympathetic tonus as well as a change in local tissue viscosity and relieving pain. [35]

In deep soft tissue manipulation, there occurs facilitation of the receptors that is located in the fascia during the application of the stretch which inhibited the sympathetic facilitation. [36] This inhibition of sympathetic tone further reduced the perception of pain in the experimental group. [37]

Soft tissue techniques lead to connective tissue remodeling, encouraging circulation, enhancing venous and lymphatic return, and also showing neurologic effects of the release of endogenous opioids thus relieving musculoskeletal pain. [38] Deep soft tissue manipulation encourages the removal of cellular waste products as circulation increases, alleviating chemical pain. [39]

Deep soft tissue manipulation over the paraspinal and parascapular muscles, was considerably deep that it might mobilize the underlying facet joint, which was characterized by crepitus produced, helps in reducing pain during various functional activities by increasing thoracic extension and providing an even distribution of load to the whole spine. [40]

Clinical implications

As the lumbar spine is the site of pathology. Manual therapy application directly over the lumbar spine will not be safe as it may further aggravate the pathology. Manual therapy techniques applied to a distant part which is connected to the lumbar spine that reduces the symptoms would be safe and beneficial to the patient. So Deep soft tissue manipulation of parascapular and paraspinal muscles of the upper back can be a treatment of choice in addition to conventional physiotherapy in patients with low back pain with or without radiation to lower extremity to improve in lumbar spine range of motion in sagittal plane (flexion + extension) and reduce pain in various functional activities.

Limitations

The sample size was small, short duration of the study, no follow up to see long term effects.

Conclusion

Low back pain with or without radiation to lower extremity is often associated with a myofascial pain syndrome of parascapular and paraspinal muscles. Deep soft tissue manipulation of parascapular and paraspinal muscles is found to be effective for the management of low back pain by:

- Inhibition of sympathetic tone and restoration of increased relative movement between the adjacent planes of fascia due to stretching of upper back fascia, and
- Modulation of the peripheral terminals of nociceptors, restoring uniform spinal mobility, and correction of abnormal posture due to mobilization of underlying facet joints which was characterized by crepitus produced.

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COMPARATIVE STUDY BETWEEN BILATERAL ARM TRAINING AND USE OF AUGMENTED FEEDBACK TO DEVELOP MOTOR PERFORMANCE IN UPPER EXTREMITY IN STROKE SURVIVORS

Type of manuscript: Observational Study

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Abstract:

Aim: To compare the effectiveness of Augmented feedback and Bilateral Arm Training in developing motor performance in upper extremity in stroke survivors.

Subjects and Method: Sample size taken for study included 45 adults (15 in each group) with history of stroke who were attending the department of occupational therapy in SVNIRTAR. Each subject was randomly allotted into 3 groups that is Augmented feedback group, Bilateral Arm Training group, Control group. Each group received 80 hours of therapy over a period of 4weeks.

Result: Overall result of the study shows that there was significant difference between the three groups at the end of 4 weeks and there was significant improvement within the two experimental groups at the end of 4 weeks where Augmented feedback showed greater improvement in motor performance than Bilateral Arm Training.

Conclusion: it can be concluded that augmented feedback is more effective than bilateral arm training in improving motor performance in stroke patients.

Key Words: Stroke, Augmented feedback, Bilateral Arm Training, Motor Performance

INTRODUCTION

Stroke is characterized by partial paralysis of one side of the body induced by a mono-hemispheric cerebral vascular accident (CVA). It results in an important chronic functional limitation of upper limb and daily living functions, even after several months of rehabilitation[1].

There is growing evidence from human brain imaging studies that movement of an affected limb with partial recovery after stroke is associated with altered activity in motor cortical regions. Evidences for repetitive massed practice can also be seen by the increasing use of advanced technology rehabilitation tools such as robotics as an adjunct to traditional therapy[4]. Rehabilitation aims to optimize motor, sensory, and cognitive performance to allow the patient to better perform everyday functional and occupational tasks and improve quality of life. To achieve improvement it is necessary to work on the impairment. In addition to the patient needs feedback in order to achieve optimum outcome[4].

There are two types of feedback – intrinsic and extrinsic feedback. Intrinsic feedback is derived from the patient‘s visual, auditory, tactile, and proprioceptor receptors. Extrinsic feedback is derived from an external source to the patient. Extrinsic feedback is required not only for the patient who has impairment in sensory motor system but also if the sensory motor system is not sensitive enough to provide feedback to the patient [4]. Feedback, along with practice, is considered to be a potent variable affecting motor skill learning which influences on motor performances and learning of motor skills[5]. Feedback can enhance motor learning in healthy subjects. During training the performer uses feedback to detect errors in performance by comparison of their movement to the expected goal in order to improve the next attempt. Careful planning of content scheduling and attention focus induced by the feedback can enhance the effectiveness of training considerably. However research examining these issues in stroke patient is scarce[6]. A primary reason to use bilateral arm training is that much what we perform everyday involves the use of both hands and therefore bilateral training is necessary. Bilateral arm training involves repetitive practice of symmetrical bilateral movement to improve motor performance of the affected limb[8]. Many studies have been done on bilateral arm training and unilateral arm training showing better motor performance in bilateral arm training. Similarly augmented feedback studies shows improvement in motor learning which leads to improvement in motor performance. Therefore a comparative study of bilateral arm training and augmented feedback can be done with stroke patients to find further effectiveness of the intervention. It can provide relevant contribution to the field as evidence regarding effectiveness of augmented feedback based interventions in stroke patients is quite limited.

AIM OF THE STUDY:

To compare the effectiveness of augmented feedback and bilateral arm training in developing motor performance in upper extremity in stroke survivors.

METHODOLOGY:

STUDY DESIGN:

A pretest-posttest experimental group design was used. The study was conducted between November 2015 to July 2016 in Department of Occupational Therapy, SVNIRTAR.

SAMPLING SIZE & SAMPLING METHOD:

Sample size taken for study included 45 adults (15 in each group) with history of stroke who were attending the department of occupational therapy in SVNIRTAR. Each subject was randomly allotted into 3 groups.

Study design

3 groups – 1.Augmented feedback group

2. Bilateral arm training group

3. Control group

Pre test----one month intervention-----Post test.

Inclusion criteria-

• Patients aged between 18 to 80 years.

•Brunnstorm stage above 3

•Modified Asworth scale ≤2

•MMSE score minimum 24 points

•Lack of participation in any other experimental studies.

Exclusion criteria –

•other medical complication that may interfere in performing required task (late stage PD, MS, RA, complete or severe spinal cord injury).

OUTCOME MEASURE: The Chedoke Arm and Hand Activity Inventory

PROCEDURE:

45 patients with stroke fulfilling the inclusion criteria were selected and formal consent was taken from patients after explaining the treatment protocol.

Pre-test was taken for all the adult patients included in the study. Patients were randomly allotted into 3 groups that is augmented feedback group, bilateral arm training group, control group.

Augmented feedback group and Bilateral Arm Training received 80 hours of therapy over a period of 4weeks.

Conventional therapy group received 80 hours of therapy over a period of 4weeks for hand function, coordination movements of affected upper limb, compensatory practice on functional tasks with unaffected limb or both upper limbs.

DATA ANALYSIS:

After completion of post treatment evaluation results were collected and data was analysed by using SPSS version 23.0. The raw score of pre- treatment and post treatment data of outcome measure (The Chedoke Arm And Hand Activity Inventory) were analysed using non parametric statistics; KRUSKAL WALLIS test to determine mean values and difference between three groups and WILCOXON test to determine significant changes in pre and post treatment within the group.

RESULTS:

The demographic characteristics of subjects of both groups and the statistical analysis results are shown in the following tables.

Table 1. Showing demographic data of patients

Sl. No.	Baseline Characteristics	Augmented Feedback	Bilateral Arm Training	Control Group
1	No. Of subjects			
	Male	10	9	10
	Female	5	6	5

2	Age Range(months)	19-60	19-60	19-60
3	Mean Age	41.8	43.93	45.93

Table 1 shows mean age of participants in all three groups, the mean age for group 1 being 41.8, group 2 is 43.93 and group 3 being 45.93 .

Table 2 shows Wilcoxon rank test of three groups.

Sl.no	groups	No of subjects	*z* value	*p* value	Confidence interval
1	Augmented feedback	15	-3.411	.001	0.05
2	Bilateral arm training	15	-3.412	.001	0.05
3	Control group	15	-3.414	.001	0.05

Table 3 shows mean rank of all 3 groups

Sl no	group	Mean rank	*p* value
1	Augmented feedback	34.83	.000
2	Bilateral arm training	19.50	.000
3	Control group	14.67	.000

Table 4 showing the pre and post improvement in augmented feedback, bilateral arm training and control group

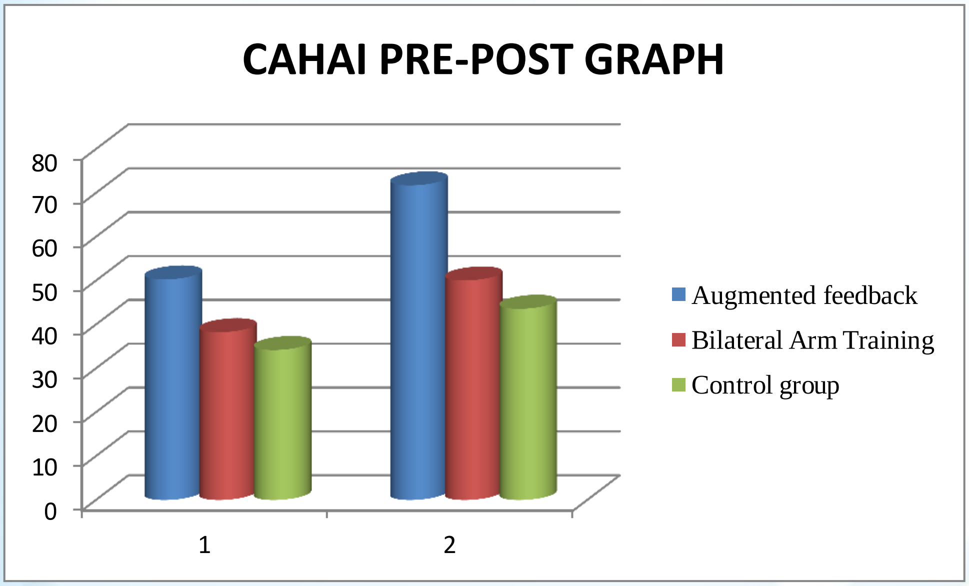
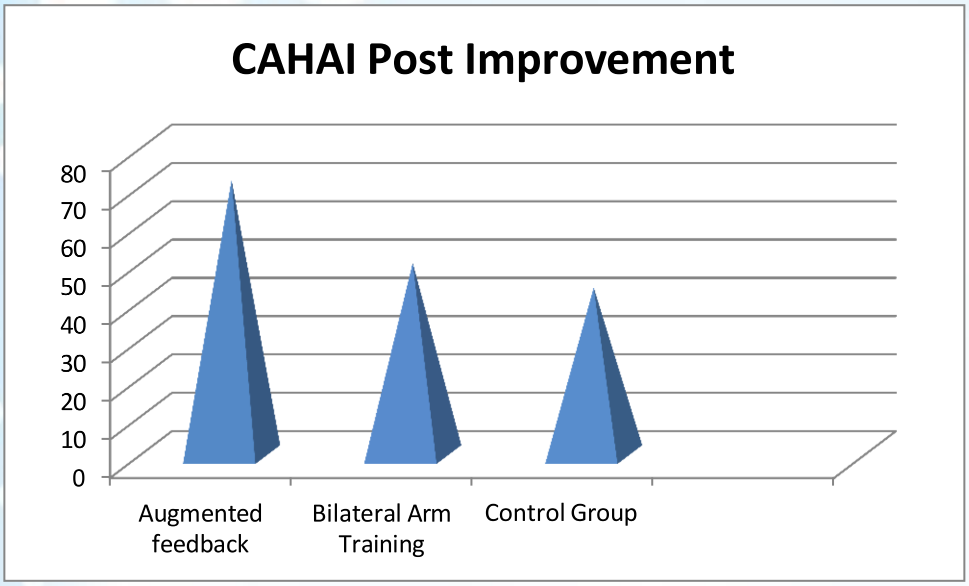


Table 5 showing the post improvement in augmented feedback, bilateral training and control group using The Chedoke's Arm and Hand Activity Inventory.



DISCUSSION:

Overall result of the study shows that there was significant difference between the three groups at the end of 4 weeks and there was significant improvement within the two experimental groups and control group at the end of 4 weeks. Augmented feedback and bilateral arm training are two interventions which can be effective in facilitating upper limb motor function in stroke patients. The aim of the study was to compare between bilateral arm training and augmented feedback to develop motor performance in upper extremity in stroke patients.

Feedback can be given to enhance knowledge of how task is performed that is knowledge of performance and regarding goal achievement that is knowledge of result. After stroke intrinsic feedback mechanisms are frequently compromised , the provision of extrinsic feedback which uses auditory and visual feedback appear to be beneficial which suggest the provision of specific impairment related feedback that may elicit motor learning and affect motor recovery after chronic stroke[22].

Alma et.al, 2002-The computerized technology has a capability to create an exercise environment where the intensity of practice and positive feedback can be manipulated and enhanced to create individualized motor learning approach. The virtual reality capabilities are added to computerized motor learning activities which provide a 3D spatial correspondence between degree of movement in the real world and degree of movement seen in computer screen. This exact representation allows for a visual feedback and guidance for the patient which exercises in a virtual reality as a therapeutic intervention for retraining coordinated movements. When the visual input is given by mirror neuron directly to primary motor area it enhances learning called as learning by imitation[46].

Giulio Rosati et.al, 2013—studies suggest that auditory stimulation can enhance brain plasticity by affecting specific mechanisms which contribute to recovery from neurological damage. There is a rapid plastic adaptation due to auditory stimulation and is not restricted to cortical motor areas and also involves auditory and integrative auditory sensorimotor circuits[21].

Xiao Bao et.al 2013—it suggested that while clenching movement of hand occurs it activates the primary sensorimotor cortex which controls speed, extent , direction and force of movements , the supplementary motor area involved in both producing and mental rehearsal of sequences of movements and cerebellum involved in coordination of voluntary movements and motor learning[56].

In a given study of mechanism of Kinect based virtual reality training for motor functional recovery of upper limb after stroke suggested there could be a increase in patients motivation to participate in rehabilitation. It may be due to auditory and visual stimulation in the games is attractive, when patients win or lose they obtain feedback information and inspiring sounds that encourage them to repeat the same motion[56]. Microsoft released an AVG console- the Xbox Kinect™ – in 2010, which is a commercial video game system, provides full body control of animated virtual characters, and is a noninvasive, inexpensive virtual reality technique used to encourage people with motor disabilities to exercise repeatedly and actively[58-59].

There is a significant improvement in bilateral arm training. Studies suggest there is a rendering Trans callosal disinhibition allowing ipsilateral cortex and descending pathways to contribute improvement and performance in stroke[31].

CONCLUSION:

From the obtained results of the study it can be concluded that augmented feedback is more effective than bilateral arm training in improving motor performance in stroke patients. Stroke patients showed increased improvement in both augmented feedback and bilateral arm training. So further studies are required to find which therapy or combination of therapy would be more beneficial in obtaining maximum functional gain in activities of daily living.

LIMITATIONS:

1. There was a small sample size.

2 .The follow up for effects of interventions were not done.

3. The duration of study was very short.

RECOMMENDATIONS:

1. The combined effect of augmented feedback and bilateral arm training can be observed in future studies.

2. The follow up after intervention should be done for better results.

3. The same study can be done by taking chronic and acute stroke patients also.

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EFFECT OF REPEATED MUSCLE VIBRATION ON TRICEP SURAE MUSCLE IN GAIT IN STROKE SURVIVORS.

Type of manuscript: Observational Study

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Abstract

Aim: The aim of the study was to find out repeated muscle vibration on triceps surae muscle is effective in gait in stroke patient.

Subjects: A total number of 30 hemiplegic subjects fulfilling the inclusion criteria were conveniently selected from SVNIRTAR, Department of Occupational Therapy for the study over a period of 8 weeks.

Methods: A randomized controlled trial. All subjects were assessed on MMSE, MMAS & 6MWT.

Result: There was significant improvement on the MMAS (p=0.001) and 6MWT (p=0.001).

Conclusion: It can be concluded that application of repeated muscle vibration will have positive effect on gait in stroke survivors.

INTRODUCTION

Stroke is the sudden loss of neurological function caused by an interruption of the blood flow to the brain. To be classified as stroke neurological deficits must persist for at least 24 hours. Ischemic stroke is the most common type, affecting about 80% of individual with stroke, and results when a clot blocks or impairs blood flow, depriving the brain of essential oxygen and nutrients. Hemorrhagic stroke occurs when blood vessels rupture, causing leakage of blood in or around the brain. Itoccurs in 20% of stroke incidence. Clinically, a variety of focal deficits are possible, including changes in the level of consciousness and impairments of sensory, motor, cognitive, perceptual and language functions. Stroke is the most common cause of chronic disability. Of survivors, an estimated one third will be functionally dependent after 1 year experiencing difficulty with activity of daily living (ADL), ambulation, speech, and so forth. Stroke survivors represent the largest group admitted to inpatient rehabilitation hospitals. Patients with stroke may present a variety of motor problems such as impairment of postural control, balance, ambulation and functional mobility.[1]

The mobility is a major problem in stroke patients due to gait asymmetry and reduced gait velocity. Gait velocity and asymmetry of patients with mild to moderate stroke are affected by different physical impairments. Gait velocity is mainly affected by weakness of the affected hip flexors and knee extensors, gait asymmetry is influenced primarily by the degree of the spasticity of the affected ankle plantar-flexors.[2,3,4]

Various conventional treatment techniques are used to treat the stroke patients using the principle of Roods, Neurodevelopment therapy and proprioceptive neuromuscular facilitation. Muscle vibration is a strong proprioceptive stimulus, which, at low amplitude, preferentially produces Ia afferent input . Such a powerful input reaches both the S1(somatosensory) and M1(motor cortices) directly

.Data derived from non-human primates have shown that Group Ia afferent stimulation, induced by trains of low-amplitude vibration, affects the discharge of M1 cells, which indicates that motorcortical neuron activity is modulated by proprioceptive input arising from Ia afferents. Interestingly, many previous transcranial magnetic stimulation(TMS) studies have shown that low amplitude vibration of a muscle is able to induce different changes in corticomotor excitability of the vibrated versus non-vibrated muscle. These somatotopically-organized effects, observed in M1 after peripheral stimulation, may be ascribable to the afore-mentioned pattern of S1-M1 connections, which modify muscle representations that are "homotopic" relative to the stimulation site.[5,6] Van Nes IJW et al. in 2004, found in their study Whole body vibration may be a promising candidate to improve proprioceptive control of posture in stroke patients. These changes consisted of an improvement in postural stability, in resistance to fatigue, as well as in the rise time of the maximal isometric force, which lasted for up to 2 weeks. One conceivable explanation for these results is that this intervention induces long-lasting neuroplastic changes in the network underlying motor control.[7] F.Camerota at al. in 2011, found in their study rMV protocol may be a safe,low cost and useful approach to reduce TS spasticity in children with diplegic spastic CP.[8] Byoung-Kwon Lee at al. in 2013, found in their study Whole body vibration may improve mobility in children with cerebral palsy.[9] Furthermore, since several studies have highlighted the role played by the combination of somatosensory afferents and motor cortical circuit activity in driving plasticity in M1. Vibration was administered in through: directly to a specific muscle belly by a vibration unit that can be hand-held or fixed to an exterior support or indirectly through whole-body vibration where the user stands on a plate or other device in a static position or while simultaneously performing dynamic stretches or movements. The majority of the studies about application of muscle vibration to a target muscle showed increased motor evoked potentials and decreased short-interval intracortical inhibition (SICI) in vibrated muscle, and had the opposite effect on the antagonist non-vibrated muscle in children with cerebral palsy.[6,8,10] Several studies have done to improve postural control using whole body vibration but no study has found to detect the effect of vibration to improve gait in stroke patients using repeated muscle vibration.[6]Therefore, this study attempts to find out the effect of repeated muscle vibration on gait in stroke patient.

AIM

To find out repeated muscle vibration on tricep surae muscle is effective in gait in stroke patient.

HYPOTHESIS:

There will be significant effect of repeated muscle vibration on tricep surae musle in gait.

NULL HYPOTHESIS:

There will be no significant effect of repeated muscle vibration on tricep surae musle in gait.

METHODS

STUDY DESIGN:

The research design for this study was a Pre and Post-test experimental group design.

SUBJECTS AND SETTINGS:

A total number of 30 hemiplegic subjects fulfilling the inclusion criteria were conveniently selected from SVNIRTAR, Department of Occupational Therapy for the study over a period of 8 weeks. Their eligibility was confirmed by discussing the information in the ―purpose and aim of study‖ section in the consent form.

SELECTION CRITERIA:

Inclusion criteria:-

- Subjects diagnosed as Stroke by the Physician.
- Age: 40 to 60 years.
- First stroke incidence at least 6 months old.
- Lower extremity Brunnstrom motor recovery stage: 3 or 4.
- MMSE score: 24 to 30
- MMAS score: 2 or 3
- Patients have ability to walk at least 6 minutes.

Exclusion criteria:-

- Hemiplegia due to other cause like TBI.
- Orthopedic and other gait-influencing disease.
- Severs cardio-pulmonary or respiratory insufficiency.
- Difficulty in comprehension of verbal command and simple instructions.

SCREENING TOOL

- MMSE: Mini mental state examination[36]
- MMAS : Modified modified ashworth scale[37]

MMSE

The Mini Mental State Examination (MMSE) is a tool that can be used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment. The MMSE takes only 5-10 minutes to administer and is therefore practical to use repeatedly and routinely.[36]

MMAS

Ansari et al. modified the Bohannon-Smith modified Ashworth scale, titling the new scale the Modified Modified Ashworth Scale (MMAS). It is an ordinal level measure of spasticity, which grades the intensity of spasticity from 0 to 4. In this modified version of the Ashworth scale, the grade ―1+‖ is omitted and the grade ―2‖ is redefined. The results of several studies have demonstrated that the MMAS is a reliable measure for assessing spasticity in either upper or lower limbs of patients with spasticity. The MMAS has overall very good intra-rater reliability in patients with lower-limb muscle spasticity. A statistically higher reliability for distal ankle plantar flexors than for proximal hip adductors. (Weighted kappa = 0.85).[37]

OUTCOME MEASURE

- 6 MINUTE WALK TEST[38]

6MWT

The 6MWT is a functional walking which measures the distance that a patient can walk on a flat, hard surface in a period of 6 minutes. It requires the patient to walk at the fastest speed over a period of 6 minutes. Walking is performed along a 30 meters walking course. It show acceptable inter-rater and intra-rater reliability and highest correlations when used for the assessment of walking following stroke.[38]

TOOL

- Muscle vibratior of frequency- 60 hz

PROCEDURE:

Thirty subjects of diagnosed case of hemiplegia who fulfilled the inclusion criteria were selected for the study. Written consent was taken from patient or caregiver prior to enrolment for the study. Selection of subjects was done by convenient sampling. The sample was divided into two groups GROUP A i.e. experimental and GROUP B i.e. control group. Subjects of both the group were assessed by using the common occupational therapy evaluation format. In addition to this all the subjects were also assessed by Mini Mental State Examination, Modified Modified Asworth Scale & 6 Minute Walk Test to obtain the baseline data. Both the groups received conventional therapy. Experimental group received repeated muscle vibration on triceps surae along with conventional Occupational therapy intervention. Repeated muscle vibration was given through vibrator of 60 Hz frequency over the triceps surae muscle (TS) in the prone position.

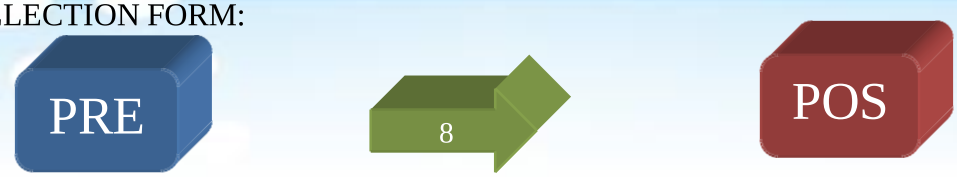
Vibration intervention was applied over 3 consecutive days, one session a day consisting of 3×10min applications, with 1-minute interval. During the repeated muscle vibration (rMV) the subject was required to make a voluntary isometric contraction of vibrated muscle, against the hand of the assessor. The therapy was given for eight weeks. 3 sessions per week. Each session was for half an hour. At the end of Eight weeks, all the subjects of control & experimental group were again administer Modified Modified Asworth Scale & 6 Minute Walk Test to obtained post treatment data. Pre and post data were taken for statistical analysis.[3]

DATA COLLECTION

MMSE, MMAS, & 6MWT Were taken prior to the beginning of treatment (0 weeks) & MMAS, 6MWT were repeated finally after the completion of treatment protocol (8 weeks).

The data collected were taken for analysis.

DATA COLLECTION FORM:



DATA ANALYSIS

The Test parameters were compared before and after therapy. Data analysis was performed with an application software SPSS version 23. Statistical test were carried with the level of confidence set at $\alpha \leq 0.05$.The value of statistics of particular test has a corresponding level of significance. The results are interpreted comparing with set confidence level ($\alpha \leq 0.05$). MMAS scores analyze using nonparametric Wilcoxan sign Rank test to know the difference within the groups. Mann Whitney U test was used to find the difference between the groups. 6MWT scores were analyzed using parametric tests. The Paired T test is administered to know the difference within the groups. The Independent T Test was performed to know the difference between the groups. Statistic values obtained were used to know corresponding level of significance. The significance level obtain were compare with the confidence level ($\alpha \leq 0.05$).

RESULTS

The analysis of data gives the following tables showing the descriptive characteristics and test results.

Table-1: shows demographic characteristics

Characteristics		**Experimental Group (A)**	**Control Group (B)**
Mean age (years)		44.93	46
Standard deviation		4.79	4.78
Sex	Male	13	12
	Female	2	3

This table shows mean age of all the participants in the study. Mean age of 15 subjects in experimental group is 44.93 and mean age of 15 subjects in control group is 46 with minimum age of 40 years and maximum 55 years in experimental group and minimum age of 40 and maximum age of 55 years in control group.

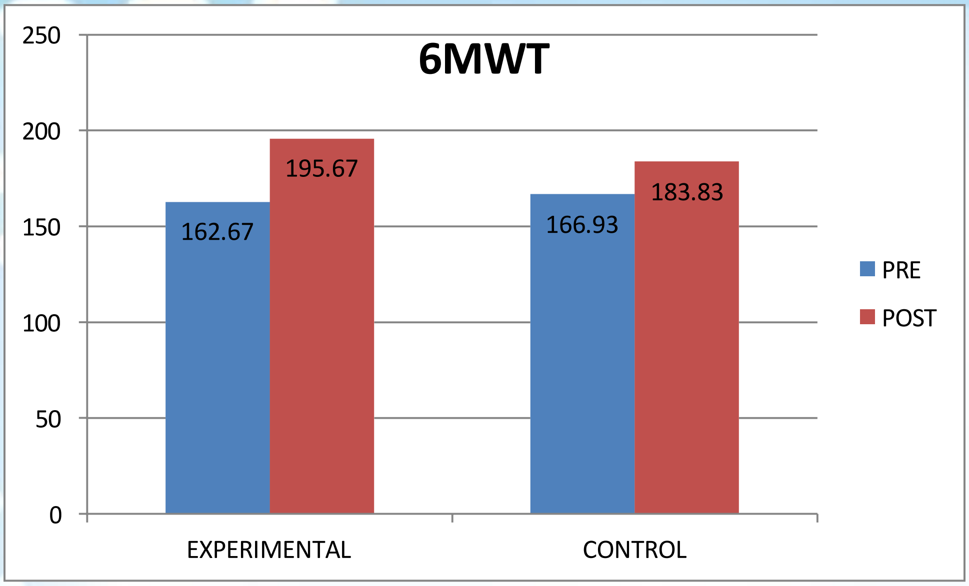
Table-2: Showing results of Paired t test for 6MWT within the groups.

GROUP	**MEAN DIFF**	**t (2 tailed)**	**p (2 tailed)**
EXPERIMENTAL	-33	-5.789	0.000*
CONTROL	-16	-9.163	0.000*

*Shows significant result.

This table shows significance of results of 6MWT in Experimental Group and Control Group. The p value for Experimental group is 0.000 and for Control group is 0.000 (≤ 0.05).

GRAPH-1: Bar graph showing mean score changes in 6MWT within the group.



This graph shows that there is significant improvement in Experimental & Control group.

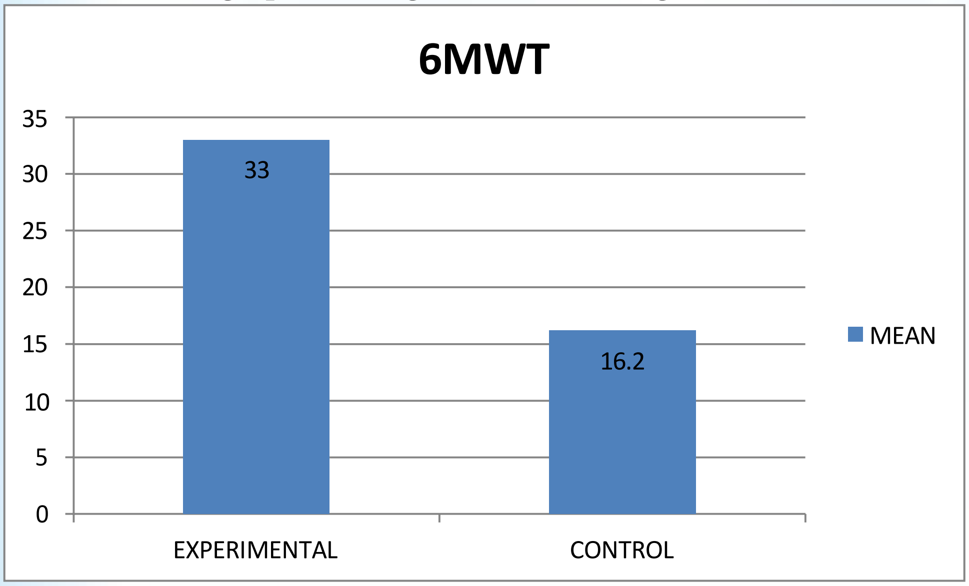
Table – 3: Independent t test results between the groups.

OUTCOME MEASURE	MEAN DIFF.	T	P
6MWT	16.8	2.815	0.001*

*Shows significant result.

This table shows significance of results of 6MWT in Experimental group and Control group. The p value for this is 0.001 (≤0.05).

GRAPH-2: Bar graph showing mean score changes in 6MWT between the groups



This graph shows that there is more improvement in Experimental group as compared to Control task group.

Table-4: Showing results of Wilcoxon Sign Rank Test for MMAS within the group.

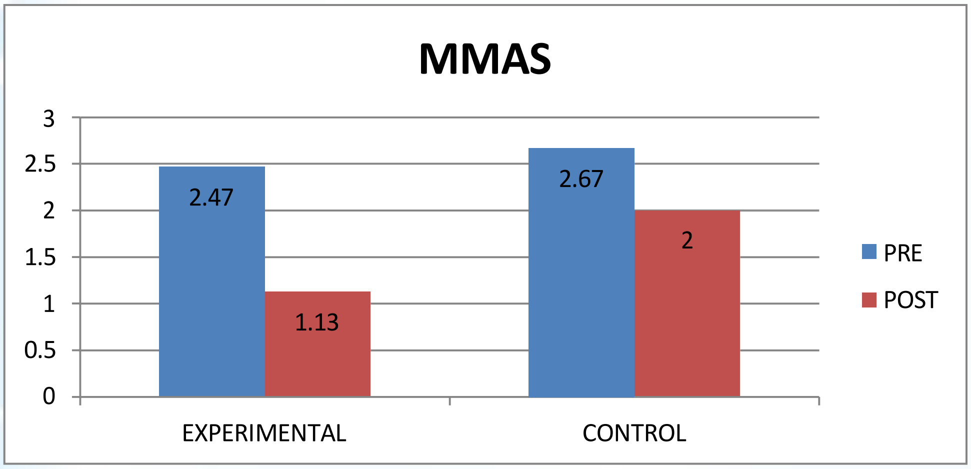
Group	Mean Diff.	Z (2 tailed)	P (2 tailed)

Experimental	1.4	-3.542	0.000*
Control	0.6	-3.162	0.002*

*Shows significant result.

The results of MMAS in this table shows, there is significant improvement in experimental group & control group with p values of 0.000 and 0.002 (≤0.05) respectively.

GRAPH 3: Bar graph showing mean score changes in MMAS of both groups



This graph shows that there is significant improvement in Experimental & Control group.

Table-5: Showing results of Mann-Whitney U Teast for MMAS between the groups.

Ranks

	Group	N	Mean Rank	Sum of Ranks
difmmas	1	15	20.00	300.00
	2	15	11.00	165.00
	Total	30		

Test Statistics[a]

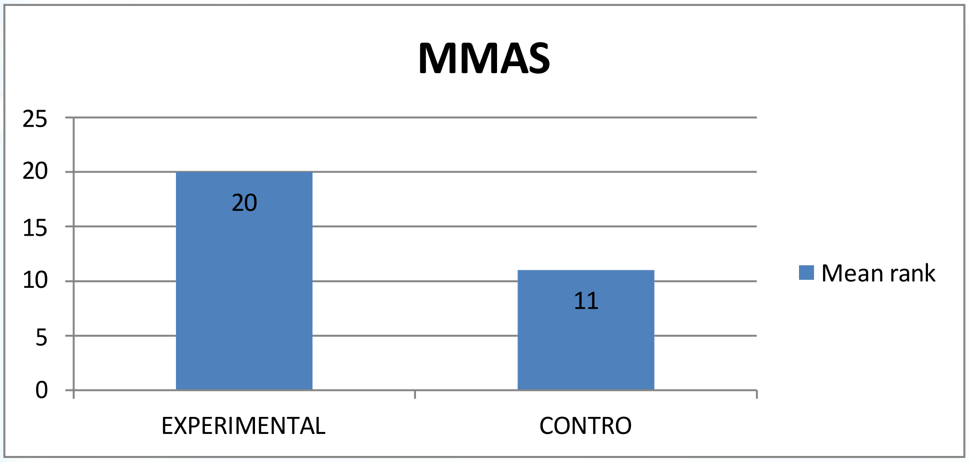
	Difmmas
Mann-Whitney U	45.000
Wilcoxon W	165.000
Z	-3.268
Asymp. Sig. (2-tailed)	.001
Exact Sig. [2*(1-tailed Sig.)]	.004[b]

a. Grouping Variable: group

b. Not corrected for ties.

The result shows U = 45 which corresponds to p = 0.001. As the $\alpha \leq 0.005$ hence, there is a significance difference between the two sets of data. The data taken for analysis is the individual improvements of subjects. The mean rank of improvements in the experimental groups is more than the control group. So the result is favourable towards the experimental group. This shows there is significantly more improvement in the experimental group as compared to control group.

GRAPH-4: Bar graph showing mean score changes in MMAS between the groups.



GRAPH 4 shows the significantly more improvement in experimental group as compared to control group with mean rank of Experimental group is 20 & mean rank of Control group is 11.

DISCUSSION

As Gait is the common area of deficits in Stroke survivors & Gait was important for ambulation to do most of functional task. Therapeutic interventions can improve gait velocity & decreases spasticity which is the important part of Stroke rehabilitation.. The present study was designed to examine the effect of repeated muscle vibration on Gait among Stroke survivors. Overall results of the study showed that after 8 weeks of therapeutic intervention of Stroke patients there was significant improvement in gait velocity in both the group, experimental (vibration+ conventional therapy) and control group(conventional therapy). However Experimental group showed significantly better improvement than the control group in Gait velocity measured by 6MWT.The result of MMAS showed higher mean rank in Experimental group (20) as compared to Control group (11) in Table-5 & mean rank of 6MWT shows more improvement in experimental group (33) as compared to control group (16.2) in Table-3. The reason for decrease in spasticity in experimental group may be due to-

1- Decrease in the excitability of α motor neurons through the activation of pre-synaptic inhibition.
2- Modification of primary motor cortex plasticity (M_1) inducing an increase in short intra-cortical inhibition (SICI) of the vibrated muscle which will decrease the muscle tone and increase motor function.

The result of present study was similar to the studies of Tomokazu Noma in 2012, Anti -spastic effects of the direct application of vibratory stimuli to the spastic muscles of hemiplegic upper limb in post stroke patients, which showed that when vibratory stimuli applied directly to the spastic muscle of hemiplegic patient produced an initial intense contraction, followed by a suppression of spasticity after continuous stimulation for several minutes. Direct application of vibratory stimulus (DAVS) treatment was intended to apply multiple vibratory stimuli simultaneously to the fully stretched spastic muscles. The vibratory stimuli initially produce intense contraction known as tonic vibration reflex (TVR) of the spastic muscles. After continuous stimulation for several minutes, the contraction derived from TVR disappears and the spasticity is suppressed for more than 30 min without stimuli. Tomokazu Noma et al. in 2012 suggested that decrease in spasticity was due to decrease in the excitability of the α motor neurons through the activation of pre synaptic inhibition when vibratory stimuli was applied.[40] Marconi et al. In 2008 showed, by Transcranial Magnetic Stimulation (TMS), that rMV, combined with therapeutic intervention, reduced the resting motor threshold of M1 areas and increased SICI. These changes showed significant correlations with parallel reduction in muscle tonus and increase in motor function. rMV effects persisted, in all the tested patients, without any decrease throughout all the follow up (2 weeks) after the end of rMV.[5] Marconi et al in 2011 also reported that long term application of vibratory stimulation to stroke patients with upper extremity spasticity resulted in decrease in spasticity & motor map area increases & emphasised the importance of long term stimulation.[6] The reason for improvement in Gait velocity in experimental group may be due to-

1- ibratory stimuli may have caused the muscle to become more supple by relaxation of the triceps surae i.e. decrease in spasticity allowing the ankle to go through a greater ROM which will increase the contact of foot with the floor there by increasing the base of support and standing balance & hence increase gait velocity.

2- ibratory stimuli may improve ankle control which will improve hip pattern and pelvic tilt thereby improving gait velocity.

The above statement is supported by Kathryn a. Faust in 2011 who did a study on the acute effect of whole-body vibration on gait parameters in adults with cerebral palsy in this study the WBV exposure resulted in an increased ROM at the ankle which could have been the results of changes in overall muscle length which can be an indicator of a decrease in spasticity thereby improving gait.[41]

Another study which supported the present study was done by Filippo camerota et al in 2011 he used a low amplitude (0.3–0.5mmpeak to peak),100 Hz vibration over the triceps surae muscles (TS) in the prone position. Vibration intervention was applied over 3 consecutive days, one session a day consisting of 3 × 10 min applications, separated by 1-minute interval. One month after the rMV therapy performed on the calf muscles there was significant improvement in terms of spatiotemporal parameters and kinematics. The duration of stance phase and step length improved, displaying a more symmetric gait pattern. At the proximal joints, the pelvic tilt and the hip pattern also improved, reasonably because of an increased ankle control.[18]

C. celletti et al in 2011, reported the effect of repeated muscle vibration on lower limb spasticity of cerebral palsy child. RMV was applied for 3 consecutive days, 30 minutes per day on triceps surae. Outcome was measured using the MAS scale & ankle range of movement & spasticity was evaluated at T0, T1 (24 hours afterwards), T2 (30 days afterwards), & T3 (12 weeks afterwards). They found in his result Spasticity ameliorated with a 40% reduction of the MAS value and a 7.7% improvement of the ankle ROM at T1. Similar results were observed in T2 and T3, thus suggesting long-lasting effects of the treatment.[8] Byoung-Kwon Lee et al. 2013 discovered that three minutes of vibration followed by three minutes of rest and then repeated three times for a total of nine minutes of WBV exposure thereby increased their average walking speed in 28 school-aged children diagnosed with CP.[9] Hence in the above study results shows more significant improvement in post score of 6MWT and MMAS in experimental group after receiving 8 weeks of RMV intervention in addition to regular conventional therapy.

CONCLUSION

From this study it can be concluded that application of repeated muscle vibration will have positive effect on gait in stroke survivors. It also have been observed that the effect of repeated muscle vibration not only focused on the specific joint where it was applied but also it enhanced the control of other joints. Therefore, repeated muscle vibration can be used as an adjunct to the conventional therapy to achieve a better quality of life of stroke survivors.

LIMITATIONS

Several limitations of the present study should be acknowledged.

1. Firstly, It included a small number of participants.
2. Secondly, follow up of the study could not be done.

RECOMMENDATIONS

1 Large sample size can be used to find more generalized effects with proper protocol and for long durations.

2. Long term follow-up study can be conducted to understand the sustained effects of REPEATED MUSCLE VIBRATION.

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RATCHET BASED ADJUSTABLE RANGE OF MOTION ELBOW ORTHOSIS FOR NON UNITED DISTAL FRACTURE OF HUMERUS

Type of manuscript: Case Report

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Abstract

Background: Non-operatively treated fracture of distal humeral fractures has a high rate of union with good functional results. Various designs of elbow orthoses are available for its immobilization and improving rehabilitation outcomes. However, clinical efficacy of the elbow orthosis with adjustable range of motion (ROM) in improving functional outcomes has not been emphasised.
Aim: The aim of the study is to design, develop and have a clinical trial of a ratchet lock based adjustable ROM elbow orthosis for the treatment of non- union distal humeral fracture.

Method: A clinical trial of 72 years old female patient with non-union distal humeral fracture was performed with an adjustable ROM elbow orthosis. Clinical efficacy of orthosis was evaluated by radiographic findings; joint range of motion assessment, bone alignment and Upper Extremity Functional Index (UEFI) scores. Baseline and post intervention data comparison was made after 16 weeks.

Results: The elbow joint alignment and congruency were achieved with the use of orthosis. The range of motion of upper limb joints was increased significantly. Satisfactory result in UEFI scoring was found with an increase in percentage from 33.33 to 62.5 for pre and post orthotic conditions respectively. The patient's view about the orthosis was satisfactory. The orthosis was comfortable to wear with easy don and doff features and it resulted in reduction in oedema and relief of pain.

Conclusion: The orthosis provided good support to the fracture site with enhancement of hydrostatic pressure principle. It resulted in improved comfort, improving joint alignment, increasing range of motion of joints and enhanced activity scores. These clinical outcomes suggest that, a subject specific customised elbow orthosis can be useful for non-operative management of distal humeral fracture.

Key words: Elbow, Fracture, Humerus, Orthosis, Ratchet

Introduction

Humeral shaft fractures represent approximately 1-5 % of all fractures with a larger peak occurring in older females from 60–80 years of age [1]. Management of humeral shaft fractures has historically been largely conservative. However, treatment of transverse, displaced fractures of the middle and distal thirds of the humeral shaft are at increased risk of non-union. Earlier studies have observed that conservative treatment of fracture of distal humerus has a high rate of union with good functional results [2-3]. The functional bracing may achieve greater than 80 % union rates and acceptable functional outcomes [4]. In spite of few positive evidences, there is also significant controversy regarding what specific type of humeral shaft fractures are best treated with a fracture brace [5]. Despite the agreement concerning fractures of the middle and proximal thirds of the humeral shaft, there has been controversy about the distal third fractures [6].

Various designs of elbow orthoses are available for immobilization of fracture sites and improving rehabilitation outcomes. The clinical efficacy of the elbow orthosis with adjustable range of motion (ROM) features in improving functional outcomes has not been emphasised. This study is aimed to design, develop and have a clinical trial of a ratchet lock based adjustable ROM elbow orthosis for the treatment distal humeral fracture. We report the results of treating a geriatric patient with transverse and displaced fracture of distal humerus who was fitted with a custom fabricated elbow orthosis.

Method

Case Description

A 72-year-old, right-hand dominant, old geriatric female subject who sustained an injury to her left arm due to a fall in 2010 was presented with a non-union distal humeral fracture of left side. Management was done by the plaster cast method but the fracture did not heal and remained as a non-union. She suffered another fracture around the previous non-union site in 2021. The radiogram findings revealed a protruding distal femur away from its normal position causing gross mal-alignment. She reported to Swami Vivekanand National Institute of Rehabilitation Training and Research (SVNIRTAR) for the management and rehabilitation in July 2021. She has complained of pain at the elbow and forearm, swelling of the forearm and hand, mal-aligned left upper limb and inability to perform daily activities. Surgery was not considered for the patient as she is overage. The patient did not have any other chronic medical history. She reported with supporting the affected elbow by the sound side hand. On observation, it was noticed that the elbow joint was mal-aligned; hand was in hanging position with considerable swelling of entire left upper limb. The arm was flailed having barely any range of motion. There was loose skin hanging on the posterior side of the elbow with scars. Antero-posterior and lateral roentgenograms revealed a displaced non united fracture of the left distal humerus (Fig. 1). Roentgenograms of the arm and physical examination have revealed fracture mal-alignment which includes 20 degrees of anterior bowing, 30 degrees of varus angulation, 25 degrees of mal-rotation, and 3 cm of shortening (Fig. 2).

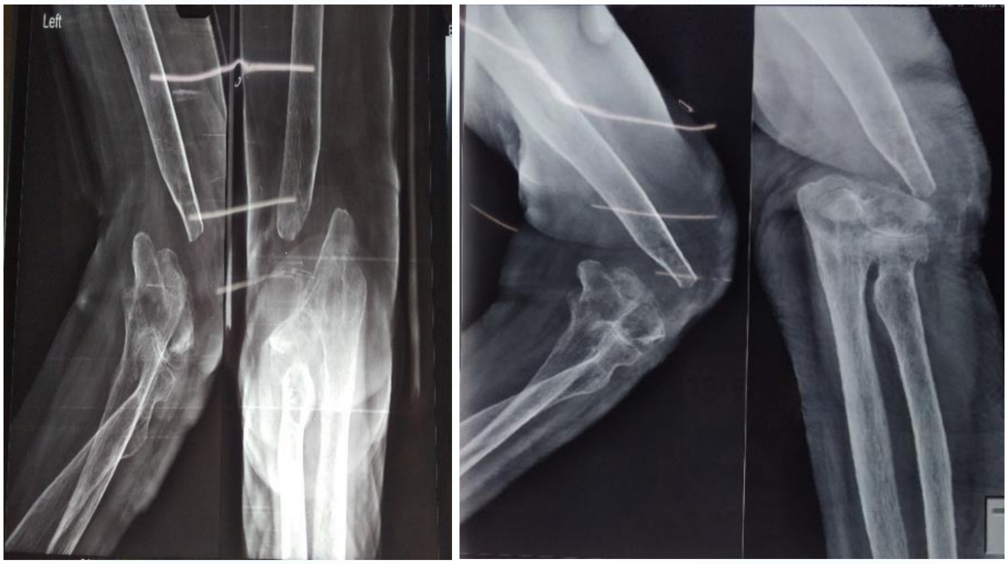

Fig. 1. Radiographs showing distal humeral fracture non union

Orthotic Management

The goal of management was to support the hand and elbow, maintain the joint alignment and enhance the activities of daily living. To achieve the aforesaid management goals, an elbow orthosis with variable ROM elbow was planned. For the hand support, the orthosis was extended up to the metacarpal joint with an additional attachment.

Orthotic Design Principles

The elbow orthosis is meant to provide total contact surface which creates a hydrostatic environment within the soft tissue to enhance the joint alignment and function (Fig. 3). It is presumed to provide the following functions.

a) Enhancing stability to fracture site
b) Provision of adjustable range of motion
c) Improving the bony alignment
d) Reduction of pain and discomfort
e) Ease of ADL
f) Reducing swelling

Fig. 2. The subject with distal humeral fracture and mal-alignment of upper limb

Features of Orthotic components

a) *Proximal trim line:* The orthosis covers whole arm from the acromion to the metacarpo-phalangeal joints; thus providing a cylindrical cage for the fracture site around elbow. The extended distal trim lines are meant to reduce the swelling.
b) *Arm cuff:* This provides total contact surface, hence providing maximum support and function. A liner along with a chest strap is attached to the arm cuff to place the arm close to the body by providing fit and comfort.

c) *Elbow joint:* An adjustable ratchet based locking elbow joint is provided to lock the elbow in various degrees of flexion according to the patient‘s requirement. This provides attachment to proximal and distal shells for immobilization to the fracture site. This elbow joint is secured by upper arm cuff and lower forearm cuff to provide support and stability for the non-union fracture site.

d) *Forearm cuff:* The forearm cuff is provided with 2 straps. One strap is used for the proper fit of the forearm shell and another thoracic strap is used for the placement of the orthosis close to the body in horizontal orientation.

e) *Cross shoulder strap:* This is attached with the forearm shell via liner. The basic function of the cross-shoulder strap is to keep the forearm in flexion by supporting its weight through the contralateral shoulder.

f) *Hand extension*: In order to keep the hand in functional hand position, the orthosis can be extended as modified hand splint on its place. It also minimizes swelling of the dorsal side of the palm.

Fig. 3. Patient with Elbow orthosis during flexion and extension

Procedure

The orthosis was designed by keeping the patient‘s requirements for enhancing basic ADLs and comfort as priority. Complete fabrication of the elbow orthosis was done as per the standard procedures (Fig. 4). The use of adjustable ROM elbow joint is instructed to the patient for the ease of ADL with locking facilities at the desired angles. The patient was advised to use the orthosis for minimum of 7-8 hours per day for 16 weeks. Baseline and post intervention data comparison was made. Joint ROM of all upper limb joints was checked with and without the orthosis separately.

The activity percentage score was calculated with the use of orthosis through questionnaire and five points based Upper Extremity Functional Index (UEFI) calculator [7]. The efficacy of the elbow orthosis was evaluated through following methods.

a) UEFI scores
b) Range of motion
c) Functional outcomes
d) Correction of mal-alignment

Fig. 4. Fabrication steps for Elbow orthosis

Results and Discussion

After the suggested period of 16 weeks, the radiographic data of the patient was observed carefully and was found that the elbow joint alignment and congruency was achieved. The result of UEFI scoring was found satisfactory with the increased percentage from 33.33 to 62.5 for pre and post orthotic conditions respectively which is presented in Table 1. The range of motion of joints both proximal and distal to the elbow was increased significantly as presented in Table 2.

Table 1 UEFI Calculator (Upper Extremity Functional Index)

Task No.	Activities	Scores	
		Without orthosis	With orthosis
1	Any usual work/ house work	01	02
2	Grooming hair	01	03
3	Pushing off hands	01	01
4	Dressing	01	03
5	Doing up buttons	02	04
6	Using tools or appliances	01	03
7	Opening doors	02	04
8	Cleaning	01	02
9	Lacing shoes	02	03
10	Sleeping	03	01
11	Opening a jar	02	02
12	Throwing a ball	0	02
	Total score	**16**	**30**
	UEFI SCORE	**33.33%**	**62.5%**

It is clear that the UEFI percentage has been increased significantly with the use of orthosis. This indicates that the patient‘s ADL activities have been enhanced.

Fig. 5. Improved bone alignment post orthosis use

Table 2 Range of motions of upper limb joints

Joints	Right	Left	Post Orthosis
Shoulder	180 degrees of flexion	95 degrees of flexion	150
Elbow	150 degrees of flexion	55 degrees of flexion	120
Wrist	130 degrees of flexion-extension	30 degrees of flexion-extension	95 degrees flexion-extension
Hand	Normal range	Flail hand	Improved but not significant

Roentgenograms of the arm and physical examination with elbow orthosis have revealed an improved joint alignment which includes 7 degrees of anterior bowing, 10 degrees of varus angulation, 10 degrees of mal-rotation, and 1 cm of shortening (Fig. 5). Result obtained through application of elbow orthosis satisfied the functional as well as the psychological needs of the patient to a large extent. As reported by the patient, the orthosis was very comfortable to use and easy to don and doff. The orthosis helped in reducing pain from the fracture site and controlled oedema up to a certain amount. The orthosis can be further modified on the basis of materials to be used and functional components to improve the quality of life of individuals with distal humeral fracture.

Conclusion

Non-surgical fracture management with the use of orthosis for the distal humeral fracture has resulted in improved comfort, improving joint alignment, increasing the ROM and enhancing ADL activities. The elbow orthosis provided good support to the fracture site by the total contact principle and was comfortable to wear throughout the day. The clinical outcomes suggest that the orthosis can be useful for non- operative fracture management of distal humeral fracture. Further researches and clinical trials are encouraged including incorporation of newer materials, better design concepts and optimising its biomechanical effectiveness.

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EFFECT OF TONE BALANCING SUPRA MALLEOLAR ORTHOSIS IN SPASTIC CEREBRAL PALSY: A CASE

Type of manuscript: Case Report

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Abstract

Background: Gait instability is a common problem associated with disorders of movement and posture in case of cerebral palsy (CP). Patients with ankle spasticity present a combination of biomechanic and neurophysiologic (tone control) problems in the lower limbs. Supramalleolar orthoses (SMO) can be modified to include tone-reducing features which supposedly enhance orthotic control when used with concerned subjects. Several studies revealed the effects of SMO on improvement in certain gait parameters but there is a little research conducted regarding the efficacy of tone balancing SMO on gait characteristics, postural balance, active ROM and stability.

Purpose: - The purpose of the research study is to evaluate the efficacy of tone balancing SMO in a patient with cerebral palsy having spastic equinus ankle and flat foot deformity.

Method: - A 10yr old female patient with ataxic cerebral palsy continuing therapeutical treatment since 5 years reported to us with the clinical features of spastic equinus and severe foot deformity, walking with instability and postural imbalances. After detailed evaluation the patient was fitted with custom made bilateral tone balancing supra malleolar orthosis. The variables such as stability score, active ankle ROM, weight distribution and center of pressure were taken using Humac Balance and Tilt System with and without TB-SMO. The patient was given an acclimation period of 6 weeks to get accustomed with TB-SMO for taking the post data results. Comparison was made between pre and post use of orthosis with foot wear to measure the significant effect of TB-SMO.

Results: - The overall postural balance performance of the subject was improved with the use of TB-SMO along with stability score. The displacement of center of gravity is reduced to maintain postural stability while walking and standing. The orthosis also allows stimulated dorsiflexion and decreases the muscle tone by the application of different neurophysiological pressure system. Dynamic bracing principles incorporated in the TB-SMO helps in reflex activation of the foot and ankle musculature.

Conclusion: - The TB-SMO was found to be effective in correcting foot and ankle deformity by reducing muscle tone which resulted in improving postural balance and stability. By incorporating tone reducing concept in SMO, the muscle tone of the subject is balanced which enhances the stability in normal weight bearing attitude by controlling the subtalar deformity.

Keywords: Balance, Cerebral Palsy, Supra-malleolar Orthosis, Gait.

1. Introduction

Walking is considered to be a complex motor function that can be severely compromised when an individual suffers from cerebral palsy (CP).[1] Ambulant children with CP often present with flatfoot and other musculoskeletal malformations mainly due to muscle spasm, muscle strength imbalance, bone anomaly, and joint capsule relaxation. The pathological changes include the collapse of the medial longitudinal arch of the foot, forefoot supination, and hindfoot valgus.[3]These subjects are normally prescribed by custom molded solid ankle foot orthoses (AFO) to biomechanically control the foot deformity. The major issue behind prescribing custom molded solid AFO is that they restrict the normal range of motion at ankle which ultimately affects the gait pattern and balance during stance phase of gait cycle. The neurophysiological AFO incorporates biomechanical tone reducing concept in order to control abnormal muscle tone. [2]

Erect body posture is the most crucial parameter to determine balance and it can be measured by different ways in various body posture mechanisms. In that case we need to restore balance and increase our functional activity so that spasticity will be reduced maintaining appropriate ROM. The relevant literature supports the theory that Tone Reducing AFOs can effectively decrease spasticity in the foot and ankle neurophysiologically.[2,4] Furthermore it is possible to incorporate the features of Tone Reducing AFO in Supramalleolar Orthoses(SMO) with higher trim line focuses towards the management of deformity. Till date the efficacy of the tone balancing concept in SMO had not been established in such conditions. To our knowledge, the impact of using Tone Balancing SMO in a case of CP on its gait and balance has not investigated so far. The primary purpose of this investigation was to determine efficacy of the Tone balancing (TB- SMO) on reducing spasticity and their effect to achieve the balance in a particular case of CP. We hypothesized that there could be improvement in gait and balance with Tone Balancing SMO in the concerned case approach.

2. Methods

2.1 Case description:-

A 10yr old female patient with ataxic cerebral palsy continuing therapeutical treatment since 5 years reported to us with the clinical features of spastic equinus and severe flat foot deformity, walking with instability and postural imbalances. The complete assessment findings were taken into consideration such as patient history, physical examination, Gross Motor Functional Classification System (GMFCS), bony deformities and foot pain on weight bearing. The ongoing conservative treatment includes stretching, strengthening exercises and some activity training modifications. The patient was able to walk without assistance but in an uncoordinated and unsynchronized manner. On detailed radiographic foot evaluation it was noticed that the talus subluxates medially, the calcaneus is in valgus, and the forefoot is in supination and external rotation related to the midfoot.

The patient was also using a SMO since 4 months while reported to us. The problems encountered in previously fitted SMO was severe pain at the junction of mid and hind foot while standing and walking with SMO, improper contact, contoured and fit with the surface anatomical structures and lack of support and assistance by the orthosis to the joints and bones of the foot.

Fig-1 Previously fitted SMO during assessment

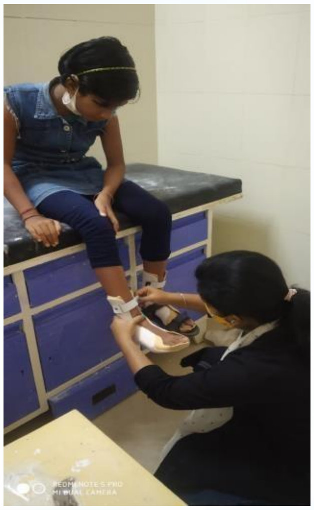

Fig-2 Trial of Tone Balancing SMO

2.2 Description of Orthosis:-

The patient was reported to us with a chief complaint of pain at the medial and posterior aspect of the foot with the use of old SMO for some time. After extensive assessment and evaluation, the subject was prescribed for custom made Bilateral Tone Balancing SMO. Tone balancing SMO is a custom polypropylene device, vacuum-formed over a plaster model of the patient's affected lower extremity. Impression was taken in the same manner like SMO in a position of maximal dorsiflexion preferably 20 degrees extending from mid shank to toes. The cast was achieved in the patient supine position (non-weight bearing). All the inhibitive and facilitative forces of tone reducing concept were incorporated during the rectification of thee positive mold. Pressure points were maintained for toe grasp reflex and rockers of the foot were stimulated while modifying the structure. The foot arches were restored and the normal alignment of joints of the foot was maintained. The orthosis is fabricated from thermoplastic material of 3mm polypropylene which gives better flexibility for ankle motion. The molding process was done by vacuum formed with soft liners inherent with the orthotic design. The overall height of the orthosis extends from the palntar surface of the calcaneum to the distal 1/3rd of the leg. The lateral trimlines come as far anterior as possible and still allow passage of the leg into the orthosis. Length of the plantar extension is terminated 6mm proximal to the metatarsal heads for comfort. Posteriorly the achilles tendon was left exposed by trimming the tendoachillies portion. Medial and lateral margin was trimmed just anterior to the medial and lateral malleolus. The instep strap at the ankle was provided to minimize the tibial advancement during swing and to maintain the heel cup properly.

The total contact design of TB-SMO can be incorporated by the following forces[5]: -

1. A three-point pressure system to biomechanically control calcaneal varus.
2. A biomechanical force medial to the achilles tendon to counterbalance and prevent excessive pronation and rotation of the orthosis in the footwear.
3. A neurophysiological force on the medial aspect of the calcaneus, extending to the plantar surface of the longitudinal arch without creating pressure under the navicular itself .This facilitates straight plane dorsiflexion.
4. A neurophysiological force on the lateral aspect of the plantar surface of the foot to facilitate the eversion reflex (peroneals) and recruit more proximal controls (vastus lateralis and gluteus medius) for knee and hip stability. The amount of dorsiflexion assist may be graded by adjusting the width of the segment joining the heel cup and the metatarsal arch.
5. A neurophysiological force to inhibit the toe grasp reflex (toe flexors and gastrocnemius-soleus) by unweighting of the metatarsal heads through use of a metatarsal arch.

2.3 Tools & Instrumentation:-

HUMAC® Balance & Tilt System (CSMi, Stoughton, MA) was used to measure balance parameters. Observational gait analysis by video was performed to detect any gait deviations. Gait parameters by 10m walk test and energy expenditure using physiological cost index (PCI) were recorded. Goniometer was also used to measure active ROM of joints of the lower limb. All the tests were performed with prior written informed consent form our subject.

2.4 Procedure

After fitment of custom made bilateral TB-SMO, the subject was instructed to use along with appropriate foot wear. The outcome measures were taken along with the therapeutical treatment regimen before the use of current intervention. Then the patient was given an acclimation period of 6 weeks to get accustomed with TB-SMO for taking the post data results. Comparison was made between pre and post use of orthosis with foot wear to measure the significant effect of TB-SMO.

Temporal-spatial gait parameters such as step length, stride length, velocity and cadence were measured on a 10 m paper walkway test. PCI is a simple method used to estimate energy expenditure during walking. It is based on a ratio between heart rate and self-selected walking speed (PCI = working heart rate – resting heart rate / walking speed). The subject was instructed to walk in his self-selected walking velocity. The balance variables, active ankle ROM, optimal weight distribution and center of pressure were measured with and without TB-SMO.

Fig-3 Subject standing on Humac Balance and Tilt

Fig 4 Static and

Fig 5 Anterior view of TB-SMO

3. Results

The compliance of patient was good; she wore the orthosis whenever she is on weight bearing condition (standing and walking). After a period of use we found that due to inherent neurophysiological pressure on the plantar aspect of the foot the muscle tone approaching towards normal fashion. The movement allowed at ankle by the TB-SMO encourages dynamic control of the entire lower extremity. It also corrected the spastic equinus deformity in order to enhance the efficiency of patient gait. The range of motion at ankle joint also showed positive result for forward propulsion. Patient started walking without any support and gained walking and standing balance. As a whole, this orthotic design was able to balance tone and to achieve stability in normal weight bearing attitude by controlling the subtalar deformity in this particular case study approach.

Table-1 shows Results of Temporal-spatial Parameters

Walking Conditions	**Cadence (steps/min)**		**Velocity (m/s)**		**Step length (m)**		**Single limb Support(s)**		**Double Limb Support(s)**	
	Left	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**
Without TB-SMO	**27.09**	**29.7**	**0.09**	**0.09**	**0.19**	**0.24**	**0.37**	**0.75**	**3.32**	**2.98**
With TB-SMO	**44.28**	**43.32**	**0.20**	**0.18**	**0.26**	**0.25**	**0.41**	**0.82**	**1.63**	**1.64**

Observational Gait Analysis showed the overall measure showed improvement in gait patterns justifying the effectiveness of orthosis in particular scenario. The orthotic gait was energy efficient than the normal gait without orthosis.

Table-2 shows Results of Balance Parameters

Parameters	Without TB-SMO	With TB-SMO
Stability Score (%)	*67*	*72*
Path Length (Centimeters)	*51.2*	*26.4*
Average Velocity (cm/s)	*2.12*	*1.4*

The subject demonstrated improved stability score, reduced path length and average velocity of COP with the use of TB-SMO as compared to no use of orthosis during balance test evaluation. There was minimal excursion of COP path indicating higher balance and maintenance of posture while standing on new orthotic design.

4. Discussion

The concerned case study aimed to investigate the effectiveness of TB-SMO in correction of spastic equinus and flat foot deformity. A detailed comparison of all variables was made and taken into account with and without use of orthosis. The result of this study shows that there is a significant contribution of TB-SMO in controlling the tone and achieving balance in the subjects with CP. This Orthoses described as tone inhibiting or tone balancing orthosis have been successfully used to control movement in spastic conditions associated with cerebral palsy. The goal should be at least the possibility to reduce the tonic spasm which will increase balance by reducing fixed reflex inducing foot deformity.

Spastic cerebral palsy of lower limb typically present with various problems including an impaired range of motion that affects the positioning of the lower extremity. This impaired range of motion often develops into contractures that further limit functioning of the ankle, knee and hip motion.[6,7]By providing the introduced version of SMO for a specific time period the restoration of range of motion of joints of the foot helps in gait. Dod et al 2013 has demonstrated that minimum of 6 weeks program will improve the ability to generate muscle force in children with cerebral palsy.[8] Children with some voluntary control and mild equinus are benefit more from an orthosis of less restriction in activities.[9]

In balanaced condition our body's weight distribution is on left (50.07%) and right (50.12%)on the foot . From that 38% load bears the hind foot(heel),32% of weight is distributed over the forefoot ball area, 11% of weight is transmitted by the lateral half of the mid foot, 7% through the medial part of mid foot (arches)and rest of the weight is distributed on the toes of the foot. The system of weight distribution on the plantar aspect of the foot in weight bearing is disturbed under deformed conditions which alters the body symmtery and gait pattern.[10,11] The results showed proper cordination and orientation of weight distribution in both the limbs with the use of orthosis that was also clear speculated in the improvement of gait pattern. If dorsi-flexors with knee extensors are actively contracting, TB SMO of less restrictive style is best to use.[12] It was seen that use of orthotic device improves gait and foot abnormalities in spastic cerebral palsy child after 6 weeks period of intervention.

5. Conclusion

The TB-SMO was found to be effective in correcting foot and ankle deformity by reducing muscle tone which resulted in improving postural balance and stability. By incorporating tone reducing concepts in SMO, the muscle tone of the subject is balanced which enhances the stability in normal weight bearing attitude by controlling the subtalar deformity.

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Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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