

Effectiveness of Mat Exercises and Swiss Ball Training on Trunk Control in Spastic Diplegia: A Case Study

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ABSTRACT

Background

Children with Cerebral Palsy frequently show impaired trunk control, which can affect the performances of activities of daily life such as sitting, reaching and walking. Muscle Activation Technique (MAT) exercises and Swiss ball training address the need to improve functional abilities and quality of life. Studying their impact involves assessing how these exercises enhance trunk control through muscle strengthening and improved stability, potentially improving daily activities and quality of life for paediatric patients with spastic diplegic cerebral palsy.

Objective

This case study aimed to analyse the impact of Muscle Activation Technique (MAT) exercises and Swiss ball training on trunk control in spastic diplegic patient.

Methodology

A case study of a six-year-old child with a history of developmental delay, seizures and hypoxic ischemic encephalopathy was conducted. A four-week rehabilitation program was designed based on subjective and objective evaluation. The Trunk Impairment Scale (TIS) was used to assess static and dynamic sitting balance and trunk coordination and the Berg Balance Scale (BBS) was used for the evaluation of functional balance abilities.

Result

Static Balance improvements were evident in the areas that were preferentially exercised. The Trunk Impairment Scale (TIS) and the Berg Balance Scale (BBS) showed significant improvement. Hence, the results suggest that Muscle Activation Technique (MAT) exercises and Swiss ball training is effective in improving balance and coordination.

Conclusion

The four-week rehabilitation program effectively enhanced the paediatric patient's static balance and in trunk control.

Keywords: Spastic diplegia, Trunk Impairment Scale, trunk control.

INTRODUCTION

Children with Cerebral Palsy experience developmental delays in typical motor development, leading to abnormal movement patterns that misalign the natural architecture of the spine, causing restricted spinal mobility. Over time, these misalignments become more pronounced as spinal deformities. This occurs because spastic muscle groups create abnormal postures, and their antagonistic muscles are too weak to counteract the pull of the spastic muscles, making it impossible to correct the abnormal postures³

The Indian Paediatric Society estimates the prevalence of CP to be between 2.5 and 3 per 1,000 live births, although precise figures for India are not available.³

Effective trunk balance is crucial for upper limb function and overall balance in children, promoting independence in daily activities. The trunk's central role involves coordinating proximal muscles for limb movement control, balance maintenance, and precise adjustments of the body's centre of mass during static and dynamic postures. Research on impaired trunk control in children with cerebral palsy (CP) is limited, underscoring the importance of tools like the Trunk Impairment Scale (TIS). This scale assesses static and dynamic sitting balance and trunk coordination, aligning with the International Classification of Functioning. It has demonstrated reliability for evaluating children with CP across different observers.

Therapeutic exercises for children with CP often involve the use of adaptive equipment. This includes mats, benches, bolsters, tilt boards, and Swiss balls. Among these, the Swiss ball is particularly effective for developing trunk balance and postural stability⁵.

There is no standardized clinical scale to measure trunk performance in children with CP. The Trunk Impairment Scale (TIS), developed by Verheyden et al. to measure motor impairment in adults after a stroke, can also be used for children with CP due to their postural abnormalities⁴.

Evidence suggests that physiotherapy intervention can significantly benefit CP patients, making daily living activities easier and improving their quality of life. The primary goals in managing CP patients should be to prevent further complications and enhance functional capabilities. Evidence-based research indicates that physiotherapy approaches aim to improve muscle strength, endurance, joint flexibility, postural correction, reduce spasticity, and increase the range of motion¹⁰.

MAT (Muscle Activation Technique) activities such as curl-ups, bridging, prone on elbows, prone on palms, quadruped position, kneeling, half kneeling, wall supported standing and reaching activities are effective. Some of the ball exercises included, bouncing, prone rolling, prone side rolling, prone on hands, supine to sitting was designed to address different aspects of balance and trunk control curl ups.

MAT (Muscle Activation Technique) and Swiss ball training help teach patients to move an aligned trunk forward and backward in space, detect abdominal muscle weakness, stretch the trunk muscles, train balance and equilibrium reactions, engage lateral flexors, strengthen the abdominal muscles, stabilize the trunk extension, evaluate trunk balance, and facilitate trunk rotation. Most Swiss ball exercises designed for adults can be modified for children. The Swiss ball can also influence trunk muscle activity in the abdominals and external oblique muscles during prone bridge exercises.⁵

CASE STUDY

A six-year-old child was brought to the paediatric OPD with a history of developmental delay, seizures and hypoxic ischemic encephalopathy. According to the primary care giver the patient was unable to roll over even after 9 months. At 11 months of age, the baby had seizures and was diagnosed with

hypoxic ischemic encephalopathy and was advised to undergo physiotherapy treatment by the doctor. At the time of the examination, the patient was unable to stand independently and walk and also had difficulty maintaining balance for a long time while sitting. She had severe limitations in sitting and standing balance. On further evaluation of the developmental milestones of the patient it was observed that the patient had a delay in achieving gross motor milestones with the highest milestone at the time being sitting without support. There was also delay in fine motor milestone with the highest milestone being scribbles/ feeds self with spoon, and a delay in auditory milestones.

On examination of the patient's posture, bilateral knees were slightly flexed and the ankle pronated. While assessing the gait of the patient it was observed that there was no heel strike, the subject couldn't maintain foot flat for longer duration and weight shift was more on the right during midstance. The bilateral upper and lower limbs were categorized as Grade 1 with the impression: Hypertonia of bilateral upper limb and lower limb.

The patient underwent a pre-intervention measurement for the study outcome measures. The Trunk Impairment Scale (TIS) was used to assess static and dynamic sitting balance and trunk coordination and Paediatric Berg Balance Scale (BBS) was used for the evaluation of functional balance abilities of children with CP. Based on the assessment, a Muscle Activation Technique (MAT) and Swiss ball training program was developed to promote functional balance ability and improve trunk coordination.

PROCEDURAL INTERVENTIONS

The physiotherapy intervention involved a holistic approach including assessing the child's current level of trunk impairment, static and dynamic balance. Based on the assessment, Muscle Activation Technique (MAT) exercises and Swiss ball training were developed to promote functional balance ability and improve trunk coordination.

A four-weeks, six days-per-week physical therapy rehabilitation program was designed based on the subjective and objective evaluation. The main goal of the program was to optimise motor learning and promote meaningful improvement in functional performance including balance and trunk coordination. Each stage, included with activities such as sit to stand, retrieving object from the floor, Muscle Activation Technique (MAT) exercises such as prone on elbows, prone on hands, quadruped position, half kneeling, kneeling, walking supported, wall standing and, some Swiss ball exercises such as bouncing, prone rolling, prone side rolling, prone on hands, supine to sitting was designed to address different aspects of balance and trunk control. both with 10 repetitions and a 10-second hold. Each 45-minute session was conducted six times a week for four weeks, including sustained stretching for lower extremities.

By advancing step by step through these stages, the patient steadily enhanced their capability to participate in MAT and Swiss ball exercises. These exercises are beneficial for increasing trunk muscle activity, strengthening core muscles, improving stability when upright, and facilitating greater upper limb mobility.

RESULT

The trunk impairment scale (TIS) was used to assess static and dynamic sitting balance and trunk coordination. The static sitting balance subscale was used to assess whether a child can sit independently and remain seated when the legs are either passively or actively crossed. The dynamic sitting balance subscale assessed the ability to actively shorten each side of the trunk, starting initially from the shoulder and later initiated from the pelvic girdle. The trunk coordination test was used to assess the ability to

independently rotate the shoulder girdle and pelvic girdle. The total TIS scores range between 0 and 23 points, where a higher score indicates better truncal function.

The Berg Balance Scale (BBS)- was used for the evaluation of functional balance abilities of children with CP. It has 14 items of increasing difficulty for testing functional skills relevant to daily life activities from sitting to one leg stance. Each item is scored on a five-point ordinal scale ranging from 0 to 4 points, with a maximal score level of 56. A higher score indicates better postural balance. The items are performed within a designated time frame, with the test typically lasting 20-30 minutes depending on the child's abilities. According to the authors, the BBS proves valid for assessing balance in children with cerebral palsy.

Outcome measures - The Trunk Impairment Scale (TIS) and Paediatric Balance Scale (PBS) were recorded for the patient at the first baseline assessment and upon completion of the treatment intervention i.e., after four weeks.

Hence, the results suggest that MAT exercises and Swiss ball training are effective in improving trunk control and static and dynamic balance.

Scales	Pre-intervention	Post-intervention
Trunk Impairment Scale	1/23	5/23
Paediatric Balance Scale	3/56	10/56

DISCUSSION

The study examined the therapeutic impact of Muscle Activation Technique (MAT) exercises and Swiss ball training on improving trunk control in children with cerebral palsy. It conducted a comprehensive assessment of a child, evaluating pre- and post-intervention outcomes, which revealed a significant enhancement in both balance and trunk control. While there is some evidence supporting the benefits of physical therapy interventions for children with cerebral palsy, including exercises targeting trunk control, there is still a need for more comprehensive research specifically focusing on the effectiveness of floor exercises and Swiss ball exercises in this population.

The study focuses on the improvement of static and dynamic balance and trunk control through a structured four-week, six-day-per-week physical therapy rehabilitation program. This program incorporated structured stages to ensure a thorough approach to the Muscle Activation Technique (MAT) and Swiss ball exercise intervention.

Each stage, including sit to stand, retrieving objects from the floor, Muscle Activation Technique (MAT) exercises such as prone on elbows, prone on hands, quadruped position, half kneeling, kneeling, walking supported, wall standing and some of the Swiss ball exercises such as bouncing, prone rolling, prone side rolling, prone on hands, supine to sitting was designed to address different aspects of static and dynamic balance and trunk control. By advancing step by step through these stages, the patient steadily enhanced their capability to participate in MAT and Swiss ball exercises. These exercises are beneficial for increasing trunk muscle activity, strengthening core muscles, improving stability when upright, and facilitating greater upper limb mobility.

Sumitra Sakhawalkar¹ et.al conducted study to compare the effects of Swiss ball training versus stable surface training on functional performance in ambulatory children with cerebral palsy (CP). They reported that both Swiss ball and stable surface exercises had similar positive effects on functional

performance. Significant improvements were observed in both groups from baseline to post-intervention.

CONCLUSION

This study concludes that Muscle Activation Technique (MAT) exercises and Swiss ball training play significant roles in enhancing trunk muscle activity, strengthening core muscles of the trunk, improving stability in upright positions, and promoting freedom of movement in the upper limbs.

LIMITATION

Muscle Activation Technique (MAT) exercises and Swiss ball training can vary widely among individuals with spastic diplegia due to differences in severity of spasticity, muscle tone, and overall health status. And the evidence supporting their efficacy in this specific population remains limited. While case studies offer valuable insights, their findings may not be universally applicable to all individuals affected by the condition. This variability can affect the overall effectiveness of these interventions.

FUTURE SCOPE

Longitudinal studies could offer valuable insights into the sustained benefits of Muscle Activation Technique (MAT) exercises and Swiss ball training on trunk control over extended periods, helping to better understand their long-term effectiveness. Developing standardized and evidence-based protocols for Muscle Activation Technique (MAT) exercises and Swiss ball training that can be tailored to the specific needs and abilities of individual patients with spastic diplegic cerebral palsy, would enhance therapeutic outcomes.

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