

Review Article

Influence of Variations in Seat Surface Inclination on Trunk Muscle Recruitment and Reaching Ability in Children with Spastic Cerebral Palsy: Systematic Review

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Abstract

Functional sitting is defined as a position in which children with Cerebral Palsy gain head- trunk and foot control with maximum degree of independent function while performing arm and hand movements during tasks. Aim of systematic review was to evaluate current evidence on effect of seat surface inclination on trunk muscle recruitment and manual reaching ability in children with spastic Cerebral Palsy (CP). Literature search was conducted through electronic databases which included Google Scholar, Pub Med, Science Direct, ERIC and Web of Science for studies performed from year 2004 to 2017. Reaching activity, seat surface inclination and spastic CP were used as keywords. In total 217 articles were identified through database search, out of which 208 were removed due to duplication or exclusion. Out of 217 studies, 9 were selected for this review from search in electronic databases. Literature search was performed from year 2004 referring to subject of interest up to 2017. Majority of the studies included in systematic review demonstrated that children with spastic CP sitting with an anterior incline demonstrated reduced postural sway which resulted in improved postural control. Reaching activity also improved with anterior inclination in these children in comparison with posterior inclination. However, these literatures did not highlight influence of seat surface inclination on trunk muscle recruitment in children with CP.

Keywords: *Reaching activity, seat surface inclination and spastic cerebral palsy.*

Introduction

CP is described as group of developmental disorders of movement and posture, causing activity limitations that are attributed to disturbances occurring in fetal or infant brain. It is most common physical disability with a prevalence of 33,000 children and incidence of about 1 in 500 birth.¹ Atypical movement patterns, abnormal muscle tone and lack of postural control along with persistence of primitive reflex patterns interferes with movement quality. Postural dysfunction plays a key role

in motor impairments further leading to lack of mobility.² This causes them to spend majority of their time in either sitting or lying position which exposes them to risk of developing deformities and other related cardiovascular impairments.³ In children, trunk stability in sitting posture is primarily controlled by muscle recruitment, active muscle stiffness, and reflex responses resulting in highly coordinated muscle activation patterns.⁴ Inadequate control of trunk and proximal musculature may contribute to inefficient control of upper extremity of child with CP. Optimal sitting posture, especially one that promotes good postural alignment and stability, is a critical prerequisite to efficient motor control.⁵ Correct sitting posture reduces likelihood of tissue trauma and provides optimum position for feeding, respiratory and digestive function. It also aids head control which is essential for orientation, socialization and for child to develop cognitive and communication skills.⁶ One of

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the frequent activity limitations in children with CP include reaching and manipulation, which is essential for performing activities of daily living.⁷

Ability to sit independently is fundamental for function but delayed in children with CP, due to poor trunk muscle recruitment, causing asymmetry in sitting posture. It has been recognized that proper seating, especially stabilization of pelvis and postural control of trunk, is an important factor contributing to voluntary control of upper extremity; similarly, an unstable seating posture can negatively influence development and refinement of upper-extremity motor control.

Facilitation of correct sitting position can be achieved with help of seating devices which provides correct alignment along with stability. These devices have a positive effect on postural control and enhances function of upper extremity.⁸ Objective of this systematic review is to explore effect of seat surface inclination on trunk muscle recruitment and arm function in children with spastic CP in terms of manual reaching.

Material and Method

Identification and selection of studies-

Preferred Reporting items for Systematic reviews and Meta Analyses (PRISMA) was used for conducting this Systematic review. Literature search was performed using following databases: PubMed, Science Direct, Google scholar, ERIC & Web of Science. Keywords used for the search were "Reaching activity, seat surface inclination & Spastic CP". Full text articles were compiled and evaluated for inclusion

Inclusion criteria:

All types of articles evaluating effect of seat surface inclination in children with spastic CP on reaching activity and on trunk muscle recruitment in age group of 0-17 years were included. Articles in only English language were included.

Exclusion criteria:

Articles evaluating other parameters apart from reaching activity and their effect on trunk muscle recruitment were considered as exclusion.

Literatures on neurological disorders other than CP were excluded.

Inclusion criteria were applied to article's title, abstracts and full texts. In case article did not fit inclusion criteria, it was excluded from review.

Study Sources:

Literature search was performed referring to subject of interest from year 2004 to 2017, using following databases- Google scholar, Pub Med, ScienceDirect, ERIC and Web of Science using different key words. Keywords included reaching activity, seat surface inclination and spastic cerebral palsy.

Study Selection:

Records were identified through database search which included search engines like Google scholar (n=116), PUBMED (n = 45), Science Direct (n = 41), ERIC (n=8) & Web of Science (n=7). Out of 217 articles, 208 articles were removed due to duplication or exclusion criteria. 9 studies were included in present systematic review. Out of nine studies five were experimental studies, three were systematic review and one was meta-analysis.

Data Collection Process:

Full text were obtained for each article from above mentioned database. In total 217 articles were extracted but due to duplication 208 articles were removed. Finally 9 articles were included in our systematic review. Required details were systematically extracted from each study and findings are summarized based on their principal findings.

Results & Discussion

Objective of this systematic review was to evaluate studies investigating influence of seat surface inclination on manual reaching and trunk muscle recruitment in children with spastic CP. Nine articles were found that specifically evaluated reaching in children with CP upto 15 years of age.

Participants characterization and research design:

With regards to population of interest out of 9 studies, 8 studies compared performance of manual reaching in children with CP with that of typically developing children. However, only one study evaluated only children with CP.⁸ These studies demonstrated that children with CP have a different pattern of movement as

compared to typically developing children with context to changes in inclination of supporting surfaces.⁷ Sample size varied from 7 to 58 children. Age group studied ranged from 1-20 years. Most of studies consisted 7-13 children per group i.e. an experimental group and a control group with typically developing children. Classification of CP was heterogeneous across studies, with variations in, functional capacity reported by GMFCS level varying from I-V.⁹⁻¹⁰ The study included children with spastic, hypotonic, dyskinetic, and ataxic CP. Degrees of inclination varied from 0°-30° anterior, horizontal and posterior.

Measurements and procedure:

Reaching activity was divided into phases such as reaching, grasping, transporting, and releasing object. Reaching movements were recorded with SIMI Motion System, Pediatric reach test & Electromagnetic Force Plate (Kistler 9286AA). Kinematic analysis were carried out with PedEMG software. Kinematic analysis of upper limb tasks is gold standard for evaluation of motion¹¹ and provides accurate, reliable, quantitative, valid and sensitive data to quantify level of motor performance of individuals with movement disorders.¹²⁻¹³

Above mentioned studies evaluated spatiotemporal variables of reaching and trunk kinematics. Two studies used combination of kinematic and electromyographic analysis (EMG) of upper limbs and trunk. Electromyographic examination interprets normal and pathological conditions through study of muscles electrical activity.¹⁴ When arms are lifted muscles of neck and trunk are activated to keep trunk and head steady. Good postural response mechanism ensures that right muscles are activated at right time, in right sequence and with just right amount of force. Anterior inclined sitting position increases hand movement efficiency for children with spastic CP.

It is reported that children with CP have large activation of neck extensor's muscles, while it causes little activation of thoracic and lumbar extensor muscles during sitting.⁷ Trunk hypotonia in children with Cerebral palsy is a common finding. Difficulties in functional activities is attributed to insufficient trunk control in children with cerebral palsy. These children present with weak postural muscles, inefficient balance reactions causing a delay in development of movement control.¹⁵ When trunk is stable, upper and lower limbs

can be used optimally. To best of our knowledge there is no literature evaluating trunk muscle recruitment with changes in seat surface inclination. However, literature suggests that with improved trunk control there is better upper extremity function in terms of lifting objects from one place to other, moving of blocks, feeding activity etc, in children with CP.¹⁶

All studies showed that postural control improved in anterior inclined sitting. Anterior-inclined seat surface facilitates weight bearing through feet and thus improves postural stability and reaching efficiency of children with CP, while posterior inclined seat surfaces pose more postural challenges. Children with unilateral spastic CP benefit most in terms of less postural muscle activity, a better quality of reaching, and better postural stability during reaching from a forward tilted inclined position.

Conclusions

Present systematic review suggests strong evidence for use of anterior seat surface inclination for improving reaching activity in children with spastic CP. There is dearth of studies evaluating effect of seat surface inclination on muscle recruitment of trunk muscles.

Future Recommendations:

Further research needs to explore on specifications for anterior inclination in terms of degree of inclination required and its effect on trunk muscle recruitment along with its influence on arm function in children with spastic CP.

Ethical Clearance: Ethical approval was obtained from MGM Medical College Institutional Ethics Committee.

Conflict of Interest: Authors declared no conflicts of interest.

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