Effect of Seat Inclination on Segmental Trunk Control and Shoulder Joint Angle in Hemiplegic Cerebral Palsied Children

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ABSTRACT

Purpose: *The aim of the present study was to evaluate the effect of three tilted seat positions on segmental trunk control and shoulder angle in hemiplegic cerebral palsied children.* ***Subjects:*** *Forty five children with hemiplegic cerebral palsy participated in this study. They were divided randomly into three groups of equal numbers.* ***Procedure:*** *Children in group one received physical therapy program while seated in right angled chair. Children in group two received the same program given to children in group one but while seated on backward tilted chair for 20 degrees. Children in group three received the same program given to group one and two but while seated on forward tilted chair for 20 degrees. The three groups are assessed by SATCo test and motion analysis pre and post-treatment period. Statistical analysis was performed using with the McNemar test and ANOVA.* ***Results:*** *SATCo results revealed statistically significant difference in all the test parameters for group two and for static component for group three. ANOVA test revealed statistically significant difference between pre and post treatment values for the three groups. As well as in comparing post treatment results in favor of group two.* ***Conclusion:*** *Significant improvement was recorded in favor of group two (children received physical therapy program in backward tilted seats) in segmental trunk control subtests and in shoulder angle measurement.*

Key words: *hemiplegic cerebral palsy, seat inclination, segmental trunk control.*

INTRODUCTION

Tilt-in-space wheelchairs and seats are increasingly used by people with neurological or neuromuscular impairments who cannot walk. Tilt-in space systems may be considered for a variety of reasons, including low sitting tolerance or discomfort, a requirement to rest in the seat, and to assist with manual handling[16].

Background:

Cerebral palsy (CP) is a group of disorders of the development of movement and posture causing activity limitation that are attributed to non-progressive disturbance that occurred in the developing foetal or infant brain. The motor disorders of CP are often accompanied by disturbance of sensation, cognition, communication, perception, and/or behavior, and seizure disorder[2]. Therefore, children with CP are faced with a variety of motor and sensory impairments that have an impact on their arm function[2,28]. It is the most common cause of physical disability in childhood, occurring between 2 and 3 per 1000 live births.

Children with CP have several fundamental limitations in postural control of static and dynamic tasks, such as sitting, standing and walking[33]. In particular, a delay in achieving the first milestone of postural control, which is independent sitting, is an early sign that a child’s development is not following a normal course[6]. Disruptions in sitting postural control significantly affect the development of a child, and can limit the ability to develop eventual independent movement[10,30].

The ability to control sitting balance gradually emerges in children with typical development (TD) during the period from about 2 to 9 months of age, with head control developing first, followed by progressive development of trunk control[12,13]. In children with neuromotor disability, development of sitting balance is delayed, and depending on the level of disability, children may continue to show constraints on sitting balance throughout their lives, with some never gaining independent control of the trunk and head[4,7].

Laboratory tests of sitting and standing balance control in both children with TD and children with neuromotor disability have examined 3 aspects of balance control, all of which are important to mastering functional balance and reaching skills involved in activities of daily living. These include tests of (1) static or steady-state balance, examining the child's ability to maintain a steady posture without support; (2) active or anticipatory balance adjustments, examining the child's ability to balance while reaching; and (3) reactive balance, examining the child's ability to maintain or regain balance following a brief perturbation, such as a translation of the base of support[7,26].

Proper positioning of children with neuromotor handicaps is important to achieve maximum function and to minimize abnormal movements. Positioning devices are also necessary, in some instances, to prevent undesirable postures that may lead to secondary deformities[32].

A backwards-tilted sitting position has been suggested to improve head and trunk posture[1,8] and to reduce the loading under the buttocks[14,29] or through the spine[11]. There are concerns that seating that is excessively tilted back limits communication, upper limb function and the ability to stand up from the chair[23].

A forward-tilted sitting position has also been proposed to maintain lumbar lordosis, decrease posterior pelvic tilt, reduce the effect of tight hamstrings on the position of the pelvis and to position a person within reach of the desk or table[3,18]. Forward-tilted positions have been incorporated into some pediatric seating[22].

Aim of the study:

To identify the effects of seat orientation on trunk segmental control and shoulder angle in hemiplegic cerebral palsied children.

SIGNIFICANCE OF THE STUDY

Previous research on the development of sitting balance models the entire trunk as a single unit, ignoring the fact that the trunk is made up of many muscular and skeletal subunits[9,12,13]. This approach does not take account of the neuromuscular coordination that must be achieved to sit independently, including coordinating the many sacral, lumbar, abdominal, thoracic, and cervical muscles used in maintaining equilibrium[24,25].

Results from studies on populations with spinal cord injury and neural tube defect suggest that a posterior seat tilt of 20°or more reduces pressures under the pelvis. Overall there is a lack of quality evidence to support and guide the use of the tilted position in seating for populations with neurological and neuromuscular impairment[20].

1- Subjects:

Forty five hemiplegic cerebral palsied children of both sexes from the Outpatient Clinic of the Faculty of Physical Therapy, Cairo University and the National Institute of Neuromotor disorders were recruited to participate in this study. They were randomly assigned into three groups of equal numbers. Children in the 1st group (group one) received physical therapy program while seated in right angled chair. Children in group two received the same program given to children in group one but while seated on backward tilted chair by 20 degrees. Children in group three received the same program given to group one and two but while seated on forward tilted chair by 20 degrees.

Inclusion criteria:

The participants were children with hemiplegic cerebral palsy, their ages ranged from 3-5 years who are able to sit with support either manual or mechanical. The degree of spasticity ranged between grade1, 1+ and 2 according to the Modified Ashworth Scale.

Exclusion criteria

- The presence of visual or hearing defects.
- Upper extremity surgical interventions.
- Injection of Botulinum toxins of upper extremity.
- Muscular contractures.

2- Instrumentation:

A-For evaluation:

- Motion analysis system (Qualisys Medical AB system) manufactured by Swedish company.
- Segmental Assessment of Trunk Control (SATCo).

B-For treatment:

1- Physical therapy tools of different shapes in the form of:

Mat, wedges, rolls, medical balls, and tilting board were used in conducting the exercise program.
2- Adjustable chairs, bench and straps.
3- Different tools of occupational therapy such as cubes, and blocks, with different geometrical shapes.

3- Procedure:

1- For evaluation

A- Upper limb Motion analysis:

Analysis of upper limb motion was carried out in the following steps:

1 : The work place was calibrated for capturing the motion of the children using a wand kit.
2 : Small, light weight reflective markers were placed on the child’s joints’ centers after determining them.
3 : Each child was asked to perform the reaching task. The positional changes of the marker were captured by the cameras.
4 : The gathered data was saved in files to be analyzed afterwards.

B- Segmental Assessment of Trunk Control (SATCo):

Children in the three groups were evaluated before and after treatment period by SATCo:

Each child was seated on a bench with feet supported on the ground or on a stable surface and pelvis/thigh position controlled by the strapping system. The pelvis was orientated to neutral relative to vertical. The child was supported in an upright posture "sitting up tall" with the presence of normal cervical, thoracic and lumbar curves. The head was upright.

The child's hands and arms should be free of all external contact including with own trunk, thighs, bench or the tester's arms/hands throughout the test except as indicated. The child's hands should not be joined together. The examiner applied firm manual support horizontally around the trunk at each of the designated levels in turn. The support given should be sufficient to ensure that the trunk was in a neutral vertical posture and that any collapse of the trunk was eliminated. The child's hands/arms should be lifted so that they there was no contact with the subject's body or legs, the bench or the examiner's hands. Toys could be used to motivate a child ensuring that the child stretches/turns towards the toy but does not grasp it. At each support level the examiner encouraged the subject to sit up tall and lift the hands/arms during testing of a) static control, b) active control, by turning the head slowly to each side (>45◦ or to limitation of range) and c) reactive control by remaining stable during nudges. This required an assistant to apply a single brisk nudge from front (sternum), from behind (~C7), and from each side (acromion) using the fingertips, sufficient to briefly disturb balance. If a child had minimal balance impairments, he swayed excessively but can return to vertical. If, however, he had moderate to severe balance impairments they lost balance and go to the limits of their range of motion. The test continues with lowering of support level until the subject clearly cannot maintain or quickly return to the starting posture.

The examiner should be behind the child, usually in kneeling depending on the size of the child and height of the bench and the assistant ideally out of line of the subject’s vision[5].

2- For treatment:

Treatment protocol:

The three groups attended one hour, three times/week for 12-week training program which included supervised exercise sessions.

A- The three groups received the following physical therapy program for thirty minutes:

- Neurodevelopment treatment activities.
- Facilitation of righting, equilibrium and protective reactions.
- Stretching exercises.
- Weight bearing activities.
- Training of trunk control and sitting balance by using upper extremity exercises (reaching, grasping and release).

B- Physical therapy program during sitting in different tilted chairs for other thirty minutes:

Intensive upper extremity exercises from sitting position on right angled chair (group one) and on tilted chairs (groups two and three) in the form of:

- Facilitation of unilateral reaching in forward, sideway and backward directions.
- Eye –hand co-ordination exercises and visual regard of objects while contacting it with the hand.

- Training of bilateral hand use.

RESULTS

1- There was no significant difference when comparing general characteristics between the three groups regarding age ,sex ,weight and height.

2- Pre and post treatment data of Segmental Assessment of Trunk Control (SATCo) are analyzed by Chi –square statistic test (McNemar test).

Table (1): Comparison of pre and post treatment values of the SATCo test result for the three groups.

Test Parameters	Group 1		Group 2		Group 3	
	X^2	Significance	X^2	Significance	X^2	Significance
Static	X^2:P=0.33	NS	X^2:P=0.016	S	X^2:P=0.023	S
Active	X^2:P=0.53	NS	X^2:P=0.028	S	X^2:P=0.64	NS
Reactive	X^2:P=0.65	NS	X^2:P=0.031	S	X^2:P=0.60	NS

X^2: Chi square S: Significant NS: Non significant

The comparison revealed statistically significant improvement in the test parameters for group two in all the subtests (static, active and reactive) with their subdivisions (head control, upper trunk control, middle trunk control, upper lumbar, lower lumbar and full trunk control).

Comparison also revealed statistically insignificant difference in the test values for both group one and three except for the static component in group three.

3-Motion analyses of shoulder joint angles were compared using one way ANOVA for the three groups.

Table (2): Comparison of pre and post treatment values of the shoulder joint angles for the three groups(between groups and within groups).

	Group 1	Group 2	Group 3	F value	P
	Mean ±SD	Mean ±SD	Mean ±SD		
Pre	84.53±2.39	86.32±2.95	85.32±2.54	1.157	0.330
Post	88.14±1.89	96.26±2.92	89.64±1.87	35.795*	0.0001*

*Significant at P<0.05 F: F- test value P: Probability Value SD: Standard deviation

The comparison of pre treatment mean values of shoulder joint angles for the three groups revealed no significant difference.

Statistically significant difference was recorded when comparing pre-treatment and post- treatment values for the three groups. As shown in table (2) and figure (1).

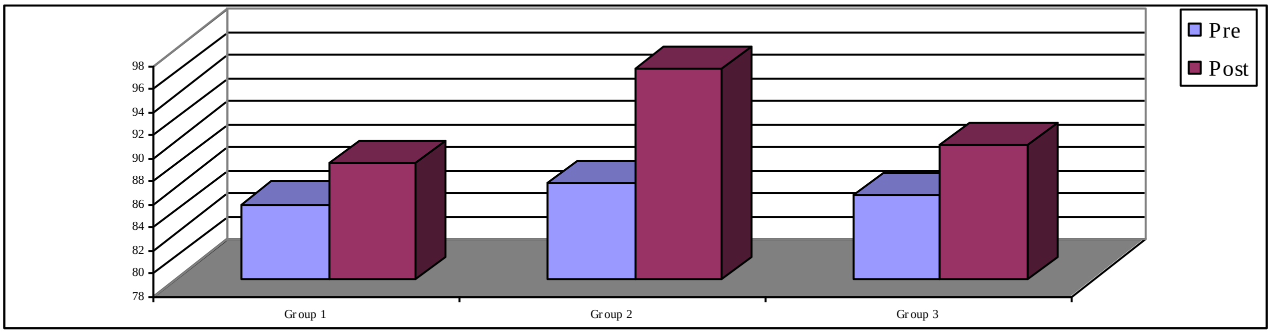

Fig. (1): Comparison between pre and post mean values of shoulder joint angles for the three groups.

Post treatment values of shoulder joint angles for the three groups were compared by Hoc test. Significant difference was recorded in favor of group two when comparing post treatment results of group one and two, as well as when comparing group two and three while insignificant difference was recorded when comparing post treatment results of group one and three, as shown in table (3).

Table (3): Multiple comparisons of pre and post treatment values of the shoulder joint angles between the three groups.

	Group I & Group II Comparison	Group II & Group III Comparison	Group I & Group III Comparison
	P- value	P- value	P- value
Pre	0.353	0.074	0.074
Post	0.0001	0.0001	0.056

DISCUSSION

The present study was conducted to evaluate the segmental trunk control and shoulder joint angle in hemiplegic cerebral palsied children after three months of occupational therapy treatment program in the form of upper extremity exercises while sitting on three different inclined seats.

Children with cerebral palsy (CP) often are hampered by dysfunctional postural control[10,31]. It is debatable whether postural control of sitting in children with CP can be enhanced by inclination of the seat surface[19,21].

Improvement of the segmental trunk control reported in the group of children that received exercise program with backward tilted seats than those with forward tilted seats is supported by the work done Clenaghan et al.,[19]. However, the authors found that a forward-inclined sitting position resulted in worse postural stability and that a posterior inclination of the seat surface resulted in better stability.

The designing of chair controls the angle of seat-to-back (the angle of hip flexion) and the backward tilting of seat itself; these two variables affect the hip angle. Most of authors recommend the most effective angle to be at 90°, tilted seats at angle of 100° was approved to reduce extensor pattern in the lower extremities[32].

Forward tilted chairs are studied by Kramer[15] who reported that increasing hip flexion angle or decreasing the angle of seat-to-back may reduce severe extension hypertonicity. So once tone is decreased, however, only minimal postural tone may still be found in the trunk musculature.

Improvement reported in children received exercises program in backward seats can be attributed to the fact that angles of hip flexion was found to be effective in cases of tight hamstrings which is commonly found in spastic hemiplegic cerebral palsied children, as extending the hips slightly from 5 to 10° degrees may reduce the backward tilting of pelvis caused by the pull of hamstrings[17].

Regarding the significant differences between group one and two as well as between group two and three which indicate improvement in the segmental trunk control and shoulder joint angle while reaching, these findings are in agreement with the work of Trefler et al.,[27] who found that when increased pelvic support level, the infants modified their reaching and grasping patterns to resemble those of older infants. These modified patterns were characterized by coordination between reaching of the hand and forward leaning of the trunk and a transition from reaching by both upper limbs at the same time to unilateral reaching.

Evidence has been provided, showing that the SATCo is a clinical evaluation tool that tests a child's trunk postural control as the evaluator progressively reduces the level of trunk support from full support to free sitting. The SATCo is a reliable and valid clinical measure that can be used with infants with TD or children with neuromotor disabilities. This level of reliability confirms that the administration and scoring instructions are clear and consistent. The SATCo has the advantage that it allows documentation of trunk control in children who have not yet achieved independent sitting as well as those who are able to sit[5].

Although segmental trunk control assessment results revealed statistically insignificant differences in the three domains; static, active and reactive and their subtests related to segmental levels of control in group 1 and in the active and reactive domains in group 3, clinical improvement was recorded in these test parameters which was reflected in improved sitting balance and upper extremity use in ADLs and children mothers' feedback.

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Ethical clearance

All subjects were informed about the study procedure and signed consent forms approved by the Local Research Ethical Committee for the Protection of Human Subjects, at Faculty of Physical Therapy, Cairo University.

Interest of conflict

There is no conflict of interest of with any organization, and this research is not funded.

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الملخص العربي

تأثير ميل المقعد على القدرة على سيطرة أجزاء الجذع و زاوية مفصل الكتف في أطفال الشلل الدماغي المصابين بالفالج الشقي

تهدف هذه الدراسة إلى مقارنة ثلاث أوضاع مختلفة لميل المقعد على القدرة على السيطرة على أجزاء الجذع و زاوية مفصل الكتف في الأطفال المصابين بالشلل الدماغي الفالج الشقي.تم اختيار 45 من الأطفال المصابين بالفالج الشقي و تم تقسيمهم عشوائيا إلى ثلاث مجموعات متساوية.تلقى الأطفال بالمجموعة الأولى برنامج علاج طبيعي أثناء جلوسهم على مقعد ذو زاوية قائمة بينما تلقى الأطفال بالمجموعة الثانية لنفس البرنامج أثناء جلوسهم على مقعد ذو زاوية ميل 20 درجه للخلف في حين تلقى الأطفال بالمجموعة الثالثة نفس البرنامج الذي تلقته المجموعة الأولى و الثانية و لكن أثناء جلوسهم على مقعد ذو زاوية ميل 20 درجه للأمام. تم تقييم الأطفال بواسطة اختبار ساتكو و جهاز تقييم الحركة قبل و بعد 3 شهور من العلاج لكلا الثلاث مجموعات. و تم معالجة النتائج إحصائيا بواسطة اختبار ماك نيمار و تحليل التباين بين المجموعات.وقد أظهرت النتائج وجود فروق ذات دلالة إحصائية واضحة في نتائج اختبار ساتكو للمجموعة الثانية لجميع البنود الفرعية للاختبار و لبند التحكم الثابت فقط للمجموعة الثالثة ، كما أوضحت نتائج تحليل التباين وجود فروق ذات دلالة إحصائية عند مقارنة زوايا الكتف قبل و بعد فترة العلاج للثلاث مجموعات مع وجود فرق لصالح المجموعة الثانية عند مقارنة النتائج بعد العلاج للثلاث مجموعات.

الكلمات الدالة: الشلل الدماغي- الفالج الشقي – ميل المقعد- السيطرة على أجزاء الجذع .