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"Effect of a Dynamic Seating Surface on Postural Control and Function in Children with Cerebral Palsy" – Experiences Gained and Lessons Learned; Using SPCM, Pressure Mapping and Videography

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We, Lisa Trew & Erna Rosenlund Meyer, do not have an affiliation (financial or otherwise) with an equipment, medical device or communications organization.

Introduction: Persons with even mild to moderate cerebral palsy (CP) can display many variations in levels of physical impairment, often accompanied by associated musculoskeletal handicaps and deficits in postural control⁽¹⁾. These can result in decreased function levels and increased reliance on assistive technology in daily life. Whether a person only uses an activity chair during school hours or is fully dependent on a seating system, many demands are placed on the device. It must be adaptable, with allowances for adjustments according to the individual's changing needs.

In clinical practice, assistive seating devices can be used as a therapeutic tool. They can be used, for example, to either decrease spasticity or increase levels of postural control and function, thus having an impact on the person's daily activities (ADL) and participation. To achieve this it is relevant for the therapist to analyze how a seating system effects the user's postural alignment and performance of ADL. Many therapists have expressed a need for a standardised measure for identifying changes in seated postural control⁽²⁾. In this study, one such measure has been adapted and used with videography and computer-based measurement methods. Pressure mapping has been used to identify if actual change has taken place and a movement quality assessment is used as a supplement.

Purpose: Physiotherapy (PT) and Occupational Therapy (OT) undergraduates from University College of Northern Denmark, Aalborg, were asked to use profession-relevant tests on persons with cerebral palsy sitting in a new prototype seating device. While OT has *Assessment of Motor and Process Skills* (AMPS), a search for a *valid, reliable* PT test was unsuccessful. However, a clinical outcome measure under development in Canada was found: *Seated Postural Control Measure*, for use in assessment of adaptive seating, specifically for children with neuromotor dysfunction^(3,5).

The primary purpose of the PT study was to investigate if a dynamic seating surface effects postural control in children with CP and if the prototype chair improved pressure distribution. The consequences of adapting the *Seated Postural Control Measure* (SPCM) was considered the secondary purpose.

Materials & Method: This study proposes a means for accurate alignment measurement and another visual dimension for movement analysis.

There were three hypotheses:

1. The dynamic seat surface in the prototype chair effects the child's postural alignment and function. That there will be positive change.
2. There will be an observed difference in pressure distribution. The prototype will contribute to a broader distribution of pressure, lower values in peak pressure

and less movement of *centre of pressure* (COP).

3. That movement quality will change with prototype use.

To answer the first hypothesis, a modified SPCM (MSPCM) was used to score observation of body segment alignment in sitting and degree of functional task completion. To answer the second, FSA4 pressure mapping software was used to analyse the relationship between seated posture and the support surface. To answer the third, an observation of movement during functional tasks was made.

Inclusion criteria were: 1) children and youth between the ages of 6-18 years with diagnosed CP; 2) a *Gross Motor Classification Scale* level of II, III or IV; 3) clear vision of minimum 1meter; and, 4) the ability to communicate and understand basic instructions relating to test protocol. Candidates that did not meet these criteria were excluded from the study. Recruitment through educational institutions took place over a one-month period.

Eleven students (4 females; 7 males) aged between 10-16 years participated, including one female as a pilot-test person. All have various subtypes of CP. Test facilities were located at the same educational institution as the subjects. A familiarisation period of min. 45 minutes for each subject took place one week prior to the start of the test. Testing occurred over two sessions (*T1*, *T2*) of max.45minutes per subject with a mean of 19.8 days between *T1* & *T2*.

T1 tested subjects in their existing seating system and was used as the control session, providing the baseline for which *T2* could be compared against. Existing seating systems included activity chairs (n5), saddle seat (n1) and powered wheelchairs (n4).

T2 tested subjects in the prototype chair.

Subjects had a familiarisation period of approx. 8minutes while body markers were placed. Testers positioned the subject in the *neutral seated position*¹, followed by 1minute of the subject in quiet sitting before testing began. Subjects were then video recorded 1minute via webcams during quiet sitting while watching a DVD. Recording of *function* tasks took place with the subject seated in front of a desk²

Test set-up: Three *Live! Cam Socialize HD* web-cameras were placed under a TV facing toward the front of the test chair (anterior view), facing the right side of the chair (lateral view) and directly above the chair (superior view). An electric height-adjustable desk placed in front of the subject during *function* testing was marked with three lines: one line in the center and two at 60° angles from each side of the center line. Three sand sacks were placed on the lines at arm's length³.

Prototype chair: The prototype chair is a modification of the type *Aeron* produced by *Herman Miller*. *Aeron* is said to give support in static and dynamic sitting situations, the dynamic material conforming to the body, cradling it. Pressure mapping and thermal testing indicate that the chair contributes to an even, broad pressure distribution across the body and away from the ischial tuberosities. The material is said to have heat- and moisture-dissipating qualities, keeping the user cool⁴. For test purposes, the two seat surfaces were attached to a frame equipped with brakes, foot- and arm-rests, ankle and hip belts and wheels from a standard

¹ 90°-90°-90° flex. in hips, knees, ankles with trunk & head in a midline position.

² With 15cm distance between navel and desk edge.

³ Distance from mid acromion to ulnar styloid process with arm passively outstretched & 90° shoulder flex.

manual wheelchair. The prototype is of two sizes: medium and medium with reduced seat depth.

SPCM modification: Although SPCM met the overall protocol requirements, a modified version (MSPCM) was used to accommodate the study's participants and protocol restrictions. SPCM takes into account the two constructs of postural control, static and dynamic, and is said to "...evaluate sitting behaviours which are thought to change as a result of adaptive seating intervention"⁽⁵⁾. MSPCM is based on the SPCM research manual⁽⁵⁾. The *alignment* section includes 14 of the original 22 items, the *function* section 8 of 12 items.

Body markers: Used as a visual aid in *alignment* measurement, yellow stickers are placed on 27 body landmarks of the head, neck, trunk and upper and lower limbs for easy viewing in three planes⁴.

Computer-based goniometry: MSPCM scoring is performed using *Kinovea-0.8.7* software. For *alignment* items, video recordings are first viewed in full and a still shot is taken of what is considered by the rater to be representative of the subject's general sitting posture. A grid is then superimposed over the still picture and used as a guide for angle measurement.

FSA: Data is generated from a thin mat with pressure sensors, placed on the seat of the chair and connected to a laptop with *Force Sensitive Application 4.0* (FSA) software that scans, records and compiles information collected from the sensors. FSA was used during all MSPCM activities. The sensing mat was calibrated before *T1 start*.

Movement quality: The rater observes if one or more of 4 pre-defined movement strategies occurs. These include head and trunk control, compensatory strategies and observance of shoulder instability. *Kinovea* is used to assess video recordings during playback of *function* task items. Slow motion function can also be used.

Results: Data from only six of the subjects were included in MSPCM results. Video data for the remaining four subjects was lost during data-backup. Data for all 10 subjects was included in results for FSA and movement quality analysis. No statistically significant results were obtained from the quantitative methods used for MSPCM and FSA. However, there was a slight increase in mean pressure distribution with use of the prototype chair. The subjective evaluation shows no clear trend.

Evaluation & Discussion: This study uses a method of computer-based measurement and a three-camera video set-up which may be useful in clinical practice, SPCM development and in further studies using videography.

SPCM: The first hypothesis cannot be upheld. It cannot be determined whether the modifications to SPCM, having subjects with different GMFCS levels or CP subtypes, influenced results. There is indication for more studies to investigate the chair's pressure distribution, thermal qualities and use as an activity chair.

The *alignment* section of SPCM requires measurement of small increments of angular deviation from "*normal*". This can be difficult and may be a deterrent for some therapists, especially for the inexperienced. The rater's had no previous experience with SPCM assessment methods and minimising this limitation was the prime impetus for test set-up design and analysis method. Item changes in MSPCMs

⁴ Body markers can be seen in: Frontal plane (n11), Sagittal plane (n9), Transverse plane (n7)

function section is a possible limitation and needs consideration; By changing the objects being manipulated in a task, have we changed what is meant to be tested? Furthermore, the prototype chair was itself a limitation; it was too large for subjects and could only be minimally adjusted.

Use of Video: Cameras capturing the anterior, lateral and superior views may be useful in eliminating limiting factors such as measurement inaccuracy. Three cameras ensure usable images for measurement and analysis in all three planes of movement. The superior view images clearly capture the rotation element of body segments, hip adduction/abduction and scapular position during upper limb movement. Studies involving reach and velocity may also benefit from superior-view video. Not all is captured such as the left side of the body and the seating system may block views of the pelvis and lumbar region. The pelvis' position is important for a correct sitting posture and using a combination of palpation, video and computer-based measurement is therefore recommended. Body markers are a useful visual aid with video-recording and computer-based measurement.

FSA results indicate that the first and second hypotheses are not statistically upheld. Calibration required considerable technical support and may not have been adequate which can affect the data. Numeric data extraction and interpretation also required assistance. These technical difficulties give rise to a questioning of FSAs viability for every-day use in clinical practice.

Movement-quality analysis was based on the knowledge of motor development in childhood, neuromotor dysfunction, postural control and the works of P Davies⁽⁶⁾. There are many limitations and the used analysis must be considered a preliminary attempt at identifying the parameters associated with decreased postural stability. This gives rise to discussion of the need for studies addressing movement quality. The author considers that quality of movement can indicate a decrease in stability, and is an important aspect in performance of tasks; Is completion of a task a satisfactory element in an analysis, *independent* of consideration for quality of performance?

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