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Facilitating new movement strategies: Equine assisted physiotherapy for children with cerebral palsy

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ABSTRACT

Background: Equine Assisted Physiotherapy (EAPT) offers children with cerebral palsy (CP) opportunities for new movement experiences, and may influence movement qualities. Descriptions of how, and to what extent EAPT affects trunk control is missing. The aim of this study was to explore if, and how changes in trunk control and changes in other movement aspects were observable in children with CP during EAPT, and if potential changes in trunk control could be measured.

Method: A multiple case study with a mixed methods design was completed. Two children with CP, GMFCS grade 1, were observed using video during a period of six months, and tested with Trunk Impairment Scale modified Norwegian Version. Skilled physiotherapists analyzed the videos qualitatively, and triangulated recurring changes in movement with the results from the test.

Results: Riding bareback, improvements in trunk control were observed and measured. However, riding in a saddle led to reduced trunk control. Other observable movement changes were: from asymmetry to symmetry, adaptation to rhythm, mastery of riding skills, and reduced loss of postural control. Increased instances of adapting own movements in spontaneous dialogue with the horse, were observed. Instructions and feedback from the therapist influenced the dialogue with the horse both positively and negatively.

Conclusion: This study describes in detail how balance and symmetry can be stimulated during EAPT in a body characterized by imbalance and asymmetry. During EAPT, the children gained the possibility to explore new movement qualities. Equipment and feedback influenced movement qualities.

1. Introduction

Cerebral palsy (CP) is one of the most common neurological disorders amongst children (Oskoui et al., 2013), including a wide variety of symptoms and always displaying disorders in movement and posture (Rosenbaum et al., 2007). They often receive a lifelong follow up from physiotherapy with the aim of improving function. Equine Assisted Physiotherapy (EAPT) is one of the many treatments offered to this group. Several studies have described improvements in functional outcomes for patients with CP receiving EAPT (Snider et al., 2007; Whalen and Case-Smith 2012; Zadnikar and Kastrin 2011; Kwon et al., 2015). It has been described as a treatment with multiple physiological and psychological effects and a unique opportunity for motor learning with carryover effect off the horse (Debuse et al., 2009). It can provide considerable variations in tasks while constantly moved by the horse (Hamill et al., 2007), and it takes place in an enriched living environment with possibilities for being outdoor as well as indoor (Sudmann 2020). According to International Association of Human-Animal Interaction Organizations (IAHAIO), Equine Assisted Therapy is a goal oriented, planned and structured intervention directed or delivered by a health professional undergone formally training in the human animal practice, in this case a physiotherapist, hence Equine Assisted Physiotherapy (EAPT) (Jegatheesan et al., 2018).

A major aspect of the motor symptoms for children with CP is

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affection of the postural control (Hadders-Algra and Carlberg, 2008; Sæther et al., 2014). To be able to adjust to postural changes, the coordination of the trunk is of major importance. Its task is on the one hand to keep the body stabile while using the extremities functionally, and on the other hand to be an active part of the execution of movements (Gjelsvik et al., 2012). Some studies have measured positive changes in trunk control in children with CP receiving EAPT (Benda et al., 2003; Moraes et al., 2018; Shurtleff et al., 2009) using devices as accelerometer, balance platforms and EMG-measures. Description of how to observe these changes in trunk control and other important movement aspects during treatment is missing. During EAPT there are multiple aspects to observe: the patient is almost constantly moving while adapting to the smooth and rhythmic movements of the horse (Garner and Rigby 2015; von Dietze 2005). In addition, the treatment involves interaction not only between the therapist and patient, but also between the patient and the horse (Carlsson 2016; Lindstrom et al., 2015; Pohl et al., 2018; Debuse et al., 2009). The relationship between the patient and the horse is described in several studies. It has even been described as "therapy for the soul" by people with CP receiving EAPT (Debuse et al., 2009). Adults surviving stroke expressed how a mutual understanding between the horse and the patient evolved (Pohl et al., 2018), and adult riders with disabilities have described how riding or equine assisted therapeutic riding gave them back or a new identity as a rider as opposed to being a patient (Wanneberg, 2014). Movement and motor learning contain a multitude of themes and models. One model for describing motor learning is dynamic system theory; where the development of movement is seen as depending on factors in each individual person, in which task they perform and in which environment the movement is performed (Shumway-Cook and Woollacott 2012). Treatment changing any of these factors will affect the movement. Another important aspect for movement is the cyclic rhythm of many movements, like walking and jogging. For people with a disability, this rhythm might be disturbed (Thelen 1995), and treatment introducing an even rhythm might be beneficial (Bunketorp-Käll et al., 2017).

The aim of this study was to obtain knowledge if and which changes can be observed during the treatment in children with CP receiving EAPT, with specially emphasis on trunk control. To operationalize these aims, several subquestions were posed:

- Are there observational changes in trunk movements and potentially other movement aspects during a treatment series of EAPT? If so, what characterize these changes?
- How does the movement interaction between the rider and horse evolve over time, and how does this interaction influence the truncal movement and truncal control?
- Which changes in trunk control can be measured from the start and during a treatment series?
- Are there other important movement related aspects during riding that can be connected to the observed changes?

2. Method

A longitudinal multicase study including two children with CP receiving EAPT was performed. A case study recognizes that the results of the study are individual, and particularly time and context dependent (Carter et al., 2011). The purpose is to give a rich and descriptive information, in our case of selected aspects in the treatment sessions of EAPT. This also included letting the therapist use his or her own professional judgement to let the therapy session evolve, thus no standardization of treatment, nor of the use of equipment. A mixed method design, with a triangulation of methods, gave the study a closeness to everyday practice where usually qualitative and quantitative methods are used alternately (Malterud 2001). The main method was a qualitative, open, video recorded observation (Patton 2002). This method made it possible to describe the richness in movement and interaction in its natural settings (Carter et al., 2011). The test used was Trunk Impairment Scale – modified Norwegian Version (TIS-modNV) (Gjelsvik et al., 2012) with an AB-design. The test is derived and translated into Norwegian from the Trunk Impairment Scale (TIS) (Verheyden et al., 2004), and validated in Norwegian patients with stroke (Gjelsvik et al., 2012). TIS is tested for construct validity, intra-tester and intertester reliability on Norwegian children with CP (Pham et al., 2016; Sæther et al., 2013; Sæther and Jørgensen 2011). The test assesses static and dynamic balance and trunk coordination in sitting position. The TIS and TIS-modNV consist of the same test items but TIS-modNV take less time to apply, and was better known to the first author, thus chosen. Both methods are applicable in everyday practice for an EAPT. To include and document reflection and flexibility to unforeseen incidents, an important part of a qualitative study, a project log was made during the process (Malterud 2011).

2.1. Equipment

An observation guide was compiled based on the research question and test films prior to the study. A handheld video camera, DJI-Osmo® was used for the observations. The films were edited in Windows Movie Maker. The TIS-modNV was filmed up front with a fixed camera, Canon ®Legria HFR 16 and edited in an "Image Browser EX". These latter films were used for scoring the test together with a physiotherapist trained in the test.

2.2. Participants

Two children with CP, novice to EAPT, was followed over a period of 5–6 months. The inclusion criteria were: CP GMFCS grade 1–4, age between 5 and 12 years, be able to sit alone, be able to understand simple instructions. The exclusion criteria were: epilepsy not controlled by medication, no large operations during the last 6 months and no braced back. Other additional diagnoses were considered individually. The participants were recruited by convenience sampling. They are presented in Table 1 together with the procedures. The first author was the therapist for one of the girls due to practical reasons. This caused a dual role as observer and therapist.

2.3. Data collection

The process of producing data is summarized in Fig. 1. The test was completed in a separate room adjoined to the stable. During the test, the children were sitting on a coffee table with a small step underneath their feet. All data were collected by the first author.

2.4. Data analysis

The films were evaluated continuously during the observation period, and changes in focus or outlines were noted in the project log. The therapist was informed about the intention of the study, but had few restrictions in the treatment with the intention of making the observation close to ordinary practice. The data from the study was analyzed using interpretative interpretation (Polit and Beck, 2012), where the quantitative data were analyzed statistically and the qualitative data analyzed according to qualitative principles described below. The video was analyzed using a stepwise method described by Heath et al. (2010). A raw analysis

Table 1
Characteristics of the two girls and procedures during the observations.

	"Kari"	"Anne"
Age	5 years	6 years
Diagnosis	CP, spastic diplegia, GMFCS grade 1	CP, spastic hemiplegia, GMFCS grade 1
Differential diagnosis	None	Epilepsy controlled by medication
Additional physiotherapy	Intensive training at habilitation center Followed by local physiotherapist	Followed by local physiotherapist
Procedures		
Help	Her father led the horse	Employee from the staff led the horse. Employee from the kindergarten walked beside her.
Equipment	Observation 1–3: bareback, girth with a stiff handle Observation 4 and 5: saddle	Bareback, girth with a stiff handle
Intervention outlines[a]	Group of 5–6 persons lasting 45 min	Group of 5–6 persons lasting 45 min Individually for 30 min when observed
Arenas	Inside and outdoor arena Gravel path outdoor	Inside and outdoor arena

[a] Both changed horses between 3rd and 4th observation.

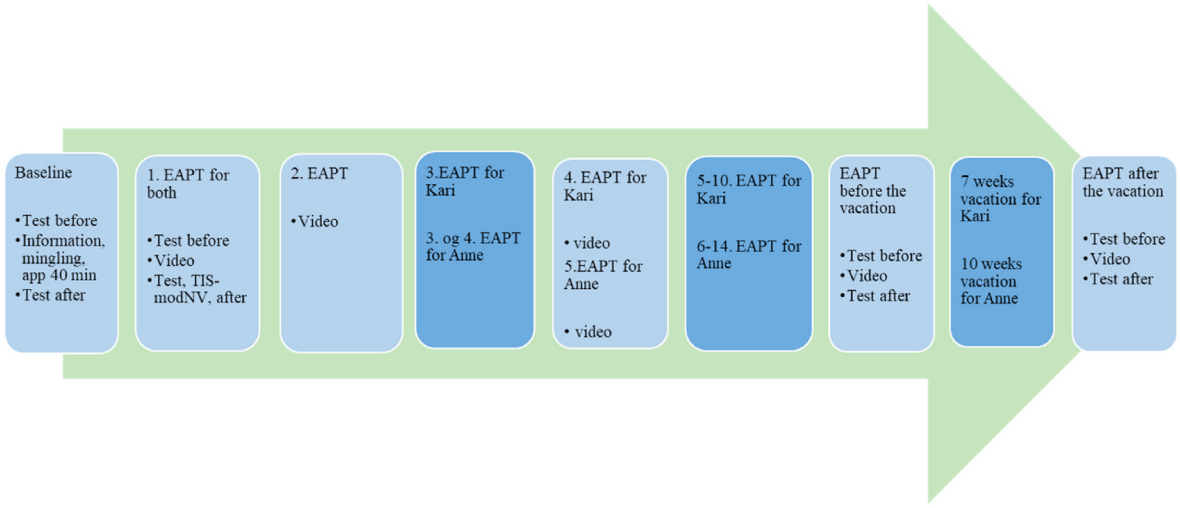

Fig. 1. Outline of the production of data. The test used was Trunk Impairment Scale modified Norwegian Version (TIS-modNV). For Kari, the observation period lasted 5 months, for Anne the observation period lasted 6 months. EAPT: Equine assisted physioterapysession.

providing a rough overview, of each film was done. Then the video was searched for important segments containing phenomenon, themes or episodes highlighting the research question. Finally, a detailed analysis of these segments was performed. These sequences or themes could last from a few seconds up to a few minutes. The process of finding themes and sequences were accomplished together with the second and fourth author.

The data from the TIS-modNV was analyzed statistically using the mean and two standard deviation band (SD) in the A-phase (before EAPT), which consisted of three baseline tests. Two consecutive measures in the B-phase, which consisted of five tests, outside ± 2SD indicated a change that was larger than the measure uncertainty (Carter et al., 2011).

The data from the observations and the tests were triangulated, compared and discussed looking for converging, nuanced or diverging results (Polit and Beck, 2012). The project log was used for reflections of both the separate analyzes and the triangulation.

2.5. Ethics

This study was approved by the Regional Committees for Medical and Health Research (REK) in Norway (no. 2016/1260). This also included an approval from Norwegian Center for Research data (NSD). The parents and children received an information leaflet with a written consent. Acknowledged procedures for secure filing of data was followed. The stables were approved by the Norwegian Food Safety Authority for using horses in business and of the Health authorities to do EAPT. To ensure the safety for the children, only authorized horse equipment was used, the children wore a riding helmet, and the horse was always held in a lead rope to control the horse's tempo and gait.

3. Results

The themes from the qualitative data are presented in Figs. 2 and 3. The themes are then more thoroughly described, first mutually observed themes, then themes specific for each child. The results from the TIS-modNV are presented last.

3.1. Trunk and pelvic movement - fast change and adaptation

Both Anne and Kari started riding in a similar "chairseat": The pelvis was tilted backwards; their hip was flexed approximately 70° and their knee flexion was about 90°. Their line of gravity fell behind the vertical line through the body. Both had difficulties integrating the horse's movements in their body, and the movements in their pelvis and trunk was a passive consequence of the horse's movements. In this example Kari is holding on to the handles of the girth. She is filmed from her right side:

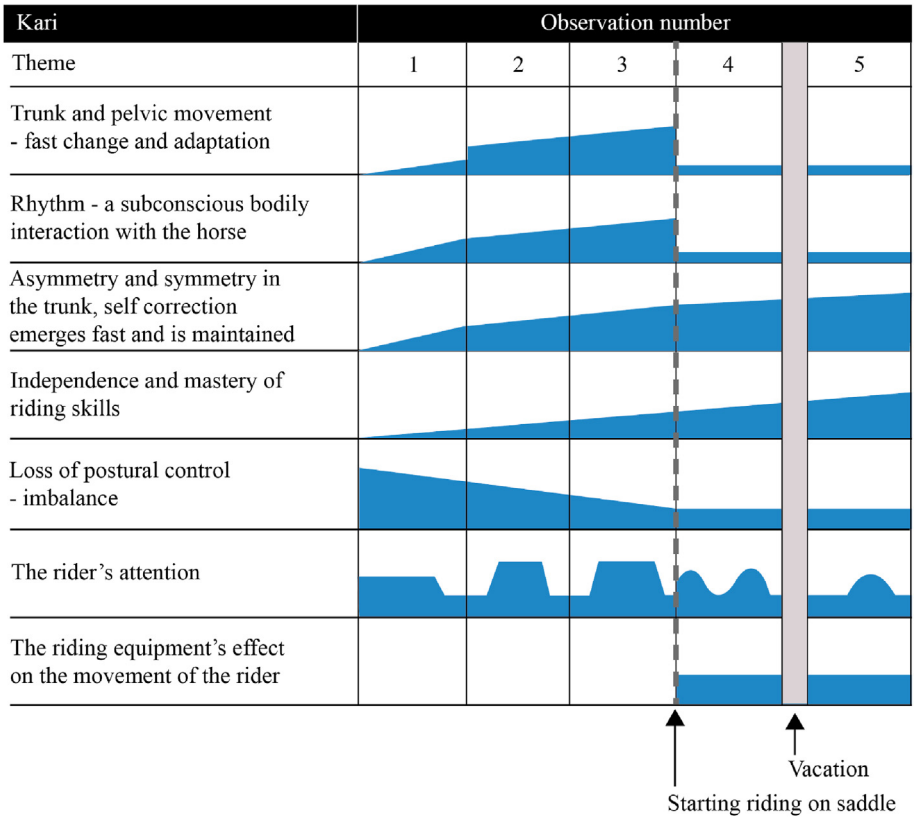

Fig. 2. Themes from the observations of Kari. The colored area indicates how the themes evolved and were present during the observations. They are not built on exact numbers, but represents the observed tendencies.

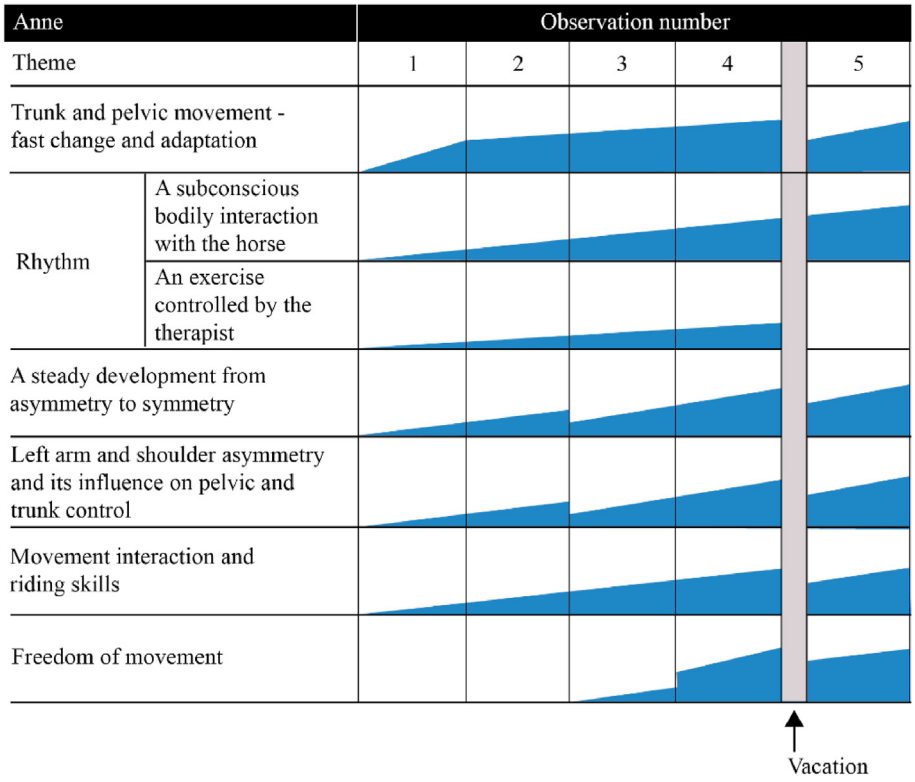

Fig. 3. Themes from the observations of Anne. The colored area indicates how the themes evolved and were present during the observations. They are not built on exact numbers, but represents the observed tendencies.

5.30–6.03: … for each step the horse is making, she has a small twitch laterally in her elbow, she is also flexing her hip in the rhythm of the horse's step, her trunk is stiff and is moving in one piece …. For each step the horse is making with his front feet, a small second passes and a twitch through her body from the seat and up is seen …. .from behind she is sitting symmetrically.

There was little variation in trunk and pelvis movement until the end of the first session. From the start of the second session both girls chose to sit with the pelvis in mid-position, and the gravity line and vertical line corresponded. The pelvic and trunk movement then developed into a fluent movement, with the lateral flexion of the trunk most visible in the lumbar section. They also experimented with the position; they would exaggerate the tilt of the pelvis backwards or forwards– but mainly ending in a position with the pelvis and trunk in midposition, relaxed lower extremities and an elongated spine. There was a small relapse after the vacation for Anne which she corrected during the session.

During the last two observations, Kari rode in a saddle. She once again sat in a chairseat with the pelvic tilted backwards, curved her trunk and the gravity line fell behind the vertical line. The movements in her trunk and pelvis became once more a reaction of the horse's movement, and they lacked fluency. Sometimes, Kari tried to tilt her pelvis to midposition and straighten the trunk in order to move the gravity line forwards. She succeeded when the horse stood still, but when it started to move, the pelvis tilted backwards and the trunk became flexed again.

3.2. Adaption to rhythm

As described in the previous transcript, in the beginning the girls did not follow the horse's movement, they were rigid and fell a bit behind the horse's rhythm. But already at the end of the first session they acquired what we call a "subconscious bodily interaction with the horse." A bodily based understanding that the pace of the pelvis changed when the horse walked faster or ran evolved, and they actively changed the rhythm of the pelvic movement to initiate a faster pace in the horse. During the observations they could sing by themselves in the rhythm of the horse's pace. Kari's therapist used the horse's rhythm giving instructions, and Kari copied this. One example was when the therapist asked Kari to look for any bushes, and Kari started to repeat, in the rhythm of the horse's pace "bush, bush, bush". From the fourth observation, now riding in a saddle, the rhythm was not as prominent in Kari, neither in movements nor in singing. Her rhythm was often behind the horse's movement, which was particularly visible during the trot, in which she was almost pushed out of the saddle for every step. It also seemed hard for her to use the rhythm of the pelvis to control the horse's movements.

Anne's therapist chose to let her work with rhythm through exercises involving moving to the beat of the horse's pace. This is what is meant by "the rhythm as an exercise controlled by the therapist". Anne had troubles finding the rhythm in these exercises. Sometimes she started other exercises instead or changed them slightly. Despite practicing several times and over several observations, her rhythm in these exercises did not improve noticeably.

3.3. Development from asymmetry to symmetry in the trunk

This theme had a slightly different development in the two girls. With Kari, "self-correction emerged fast and was maintained." Kari started by sitting symmetrical on the horse, but during the first observation her pelvis glided to the left and she lateral flexed in the lumbar section of her spine to maintain her balance. During the whole series of EAPT she slid into a similar asymmetric position, but it was decreasingly present. At first her father or the therapist corrected this asymmetric position, but from the second session she corrected this asymmetry by herself to a symmetric position. During the last two observations, while sitting in a saddle, she was consistently more symmetrical.

For Anne the development was "a steady development from asymmetry to symmetry." Anne sat asymmetrical from the start. Observed from behind, Anne's point of gravity was on her right side, her right shoulder was rotated forward and she had a small lateral flexion to the left in the lumbar region to compensate for the rotation. An asymmetry in the lower extremities was also present. The asymmetry in the upper extremity influenced the position and movement of the trunk and pelvis to such an extent that it developed into a separate theme described later. The asymmetry in her trunk and pelvis was also visible in exercises such as turning with the horse – where she would lateral flex her trunk to the left when the horse did a left turn, but sat symmetrical while doing right turns. The asymmetry in her trunk and pelvis gradually diminished through the observations, also during the exercises, but persisted to some extent. After the vacation, the asymmetry was more visible, but she regained the symmetry during the session.

3.4. Acquiring riding skills, movement interaction and independence

The themes "independence and mastery of riding skills" from Kari, and "movement interaction and mastery of riding skills" from Anne, contain similar movement aspects, but some differences occurred, thus different theme names. During all the observations, they both acquired skills connected to riding, like controlling the horse with long reins, the voice, the seat, and the legs. In the beginning they barely interacted with the horse. They did inappropriate movement interactions, for example when Anne wanted to ride faster; she grabbed the handles and shook them vigorously to and fro. They developed an understanding that interacting with the horse could be done through their bodies, for example by using their pelvic movement to make the horse move faster or slower. They also developed an understanding that changing the position of the pelvis facilitated the horse's movement while walking up- or downhill.

Simultaneously another kind of interaction developed: Anne might stroke the horse down the shoulder while looking at him, she might bend forward and rest on the horse's mane while the horse was moving, displaying how she enjoyed the horse's movements. Here, is a rare quiet moment, she is filmed from the right side inside the riding hall:

26.50–27.40: Anne is fidgeting. She flexes her trunk and seems to be stretching her right arm forward, pushes her seat towards the left side and extends the left side of the body. The left leg slides down on the horse's flank. …. nobody is talking. Anne looks forward to the right and thus avoiding eye contact. She sits with the pelvis in midposition and the spine is elongated from the pelvis. Her hands are resting on her thighs. Her left elbow is relaxed and dangles slightly in the rhythm of the horse's pace. She follows the horse's movement with the pelvis and trunk in a forward-backward direction and in rotation …. (after some time, riding with barely any instructions) … The sidewalker slows down and leave Anne to ride the last short side of the hall alone with the horse leader.

They addressed exercises differently; Anne spontaneously initiated exercises from the start while Kari waited for instructions; that is why the theme included "independence" in her case. Kari displayed more initiative and needed less help throughout the

sessions. In this transcript, Kari initiated movements to interact with the horse by herself. She was preparing to ride into the riding hall. There was a small downhill slope before entering the hall. She is filmed from the right side:

30.09–30.18: Kari is sitting with her pelvis tilted backwards and a kyphotic trunk. She is holding both of her hands on the handles … …The therapist is walking up from behind on the left side of the equipage and passes them. While passing, Kari asks attentively: "Like this or like this?" Simultaneously she is tilting her pelvis further back and extends her trunk. As the therapist passes the horse's head, she looks at Kari and says: "Kind of backwards". Kari relaxes her trunk slightly, but keeps the pelvis tilted backwards.

3.5. Kari: A Reduction of Imbalances, Loss of postural control

Sometimes Kari lost her balance without falling off the horse. The imbalance seemed to start in the trunk: by a sharp tilt of the pelvis backwards, forwards or by a rotation in the trunk. This imbalance spread out to the extremities and led to straightening of the knee, a quick flexion of the ankle or an abduction of the shoulders. She responded with a quick reaction; often by grabbing the handles. When feeling safe again, she would release her hands again. There were several episodes during the first and second observation, then they diminished in numbers, and changed into smaller imbalances. It still started in the trunk, but did not necessarily pass all the way out to the extremities, it could be a rotation of the shoulder, a quick tilting of the pelvis or a slight flexion of the hip. Here Kari is filmed from her right side:

34.22–34.32: Kari is sitting with the pelvis in the midposition, her trunk and hips are following the horse's movement. Her hands are resting on her thigh. She is looking around the hall. Her gravity line is suddenly driven backwards and the pelvis is tilted quickly backwards. Kari tilts the pelvis in midposition and her gravity line falls again together with the vertical line. There is another imbalance: the pelvis is pushed backwards, there is a quick flexion of the hips and the hands are moved slightly towards her knees. She tilts her pelvis to the midposition again, remains in this position for two steps of the horse before she lifts her hands from her thighs, puts them on the handles and looks straight forward.

3.6. Kari: shifts in the Rider's attention

Kari's attention varied during an EAPT session, she was usually very attentive during the first 30 min of the session, then her attention dropped. This could be expressed in different ways – her gaze became empty, she curled her trunk or started fidgeting. Her attention rose if she was to run with the horse, even though this occurred at the end of the therapy session, and she was more attentive while riding outdoor. Here is a description of her increased attention and interaction with the horse while riding outdoor. She is filmed from the left side:

17.30–17.53: Kari is sitting with the pelvis in midposition, she is holding on to the handles with both hands, her trunk is elongated and she is looking attentively away from the arena, to the right. She is looking on something (a pedestrian?) invisible to the observer behind a tiny shed. Kari turns and looks at the reins laying in front of her handles. She picks them up with both hands, holding long reins with relaxed shoulders, 90° angle in her elbow and pronated underarms. She moves the gravity line in front of the vertical line, and is simultaneously following the horse's rhythm with her body.…The horse increases its pace, resulting in an increased rhythm in her body; the pelvis is following the horse's movement in a forward -backwards direction. The movement transfers to the trunk, spreading upwards to the neck and head, and creates a flowing movement in which the arms are included by small swings. She looks attentively down at the horse's neck. "Hoopla" she whispers to the horse and herself. The only sounds are of the horse's hooves and the steps from the observer.

3.7. Kari: The Riding Equipment's influence on the Movement of the Rider

As described earlier, Kari's pelvic position changed when riding in a saddle. Other parts of the equipment disturbed her body position too; the stirrups and the reins. Kari seemed to fight with them, she partly worked against them and partly became troubled by them. In the fourth observation, the therapist and her father wanted her to have the feet into the stirrups. Kari seemed accidently to lose them, she would take her feet out, and it looked like a struggle between Kari and the adults; feet in or out of the stirrups. While resting the feet in the stirrups, her pelvis was more tilted backwards and the movement in her trunk was blocked. Taking the feet out of the stirrups seemed a relief: "Yes!" she would say. In the fifth observation, the focus was on holding the reins tight – Kari did as she was told, but while holding the reins tight, she stiffened her trunk, and her pelvis was lifted up from the saddle when the horse's head nodded slightly. She soon started to protest, saying it hurt to hold the reins. When letting go of the reins, she relaxed and regained some movement in the pelvis and trunk.

3.8. Anne: left arm and shoulder asymmetry and its influence on pelvic- and trunk control

Anne's asymmetry in her trunk was affected by the position of the left upper extremity. Sometimes she fixated the left arm into her body to compensate for the asymmetry that appeared in the trunk, as described when the horse trotted. She is filmed from behind.

20.48–20.59: Anne is holding the handles with both hands. She is sitting symmetrically. When the horse starts running, she lateral flexes her trunk towards the left. She squeezes her left elbow towards her body, her body is pushed slightly to the left for every step of the horse. There is a slight rotation in her trunk to the right. Her left leg is dangling along the horse's side. Anne is following the rhythm of the horse actively, and straightens herself in the pelvis and trunk. Her right arm is shaking in the rhythm of the horse, while the left elbow is glued to her trunk.

This improved, and while developing a more refined movement in her pelvis and trunk, the left extremity followed the movement of the pelvis and trunk similar to the right extremity. Another aspect of the upper extremity asymmetry was how the movement of the left arm would affect the movement of the trunk, for example: when reaching forward on the horse's mane with her left hand and rotating her trunk, she tilted the pelvis backwards simultaneously. When doing the same with her right hand, she would sit with her pelvis in midposition. Onwards in the observations she developed the ability to move her left upper extremity without simultaneously tilting the pelvis, and a new theme, "freedom of movement" emerged.

3.9. Anne: freedom of movement

Anne started to vary the position of the arms, head, trunk and pelvis more spontaneously. One example was when the therapist asked Anne to lay down backwards on the horse, she sensed the difficulty of this position and said "Hold me!" to the sidewalker, at the same time glancing at the therapist, laughing. While sitting up, she ended up sitting skewed – her seat was almost on the horse's side. Anne continued holding on to the handles, smiling and laughing. The sidewalker supported her, but after a while Anne managed to pull herself up on the horse's back and sat symmetrically. The gained arm symmetry seemed to increase her ability to move with more variability, explore and play with the movement.

3.10. Results of the test, TIS mod-NV

The results of the tests are shown in Figs. 4 and 5. Kari started with a quick improvement in the B-phase of the test larger than ±2SD from the mean at baseline. This change was larger than measurement error and indicated a change in trunk control. This did not endure though, and the test results dropped. Anne's score on the other hand, improved slowly. Her end score was ±2SD from mean at baseline, even after a pause in the treatment, which indicated a change in trunk control.

4. Discussion

The aim of this study was to explore if, and how changes in trunk control and changes in other movement aspects were observable in children with CP during EAPT, and if potential changes in trunk control could be measured. Some aspects will be discussed here.

4.1. Observation of changes in trunk control are also measurable

Observed changes were discovered and measured, improvements as well as reductions. These changes occurred quickly, already in the first session, was manifested during the second session and persisted as long as the girls rode bareback. The riding thus became a unique arena to develop and explore trunk control. The adaption of the pelvis position seemed to be initiated by, and an active response of the movement of the horse. So, what are the important aspects of this study? First, it answers the research question – yes, changes in trunk control are observable in clinical practice despite the fact that the client is constantly moving and thus difficult to observe. These changes are also possible to measure in the clinical setting. Measurements and observations are reliable and possible to compare. This means that clinical observation skills detect development of trunk control and rhythmical movements despite a challenging situation. A skilled physiotherapist can observe changes in trunk control without special knowledge of riding, but to use the horse and its' environment for treatment purposes, special knowledge on biomechanics of horse and rider has to be present (von Dietze 2005; Håkanson 2008; Sudmann 2020). There are also other important aspects that we will discuss.

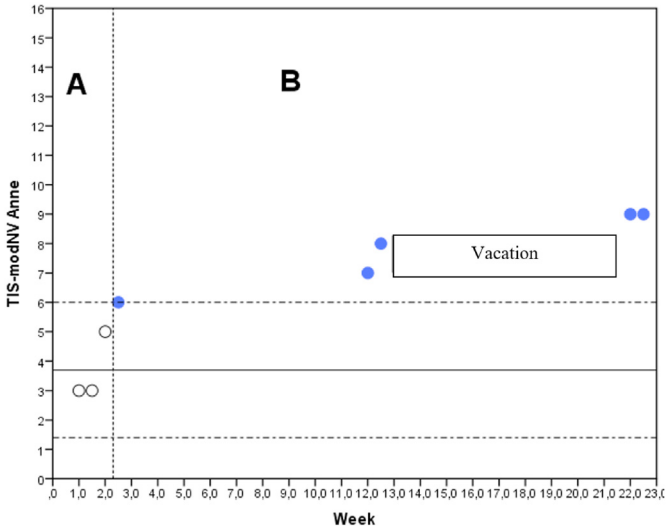

Fig. 5. The results of the TIS-modNV for Anne. The filled dots are the B-phase. The dotted lines represent ±2SD from the mean of the results at baseline (A-phase). According to Gjelsvik et al. (2012), a change of more than three scores indicates a clinically significant change.

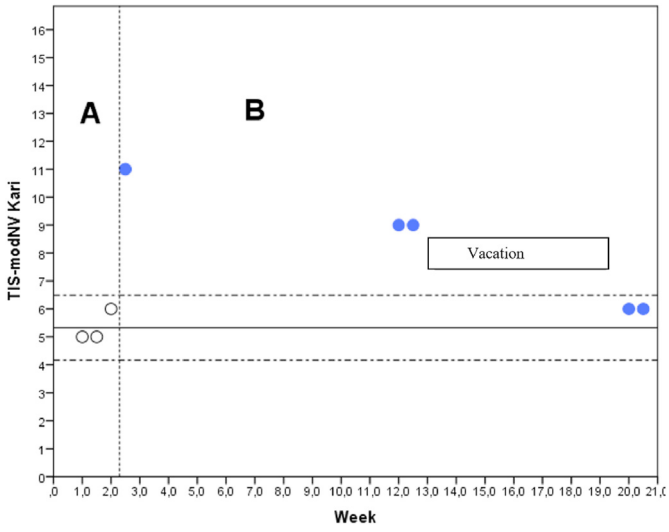

Fig. 4. The results of the TIS-modNV for Kari. The filled dots are the B-phase. The dotted lines represent ±2SD from the mean of the results at baseline (A-phase). According to Gjelsvik et al. (2012), a change of more than three scores indicates a clinically significant change.

4.2. Equipment and the feedback from the therapist – impact on expected outcome

The impact from equipment and the therapist's feedback are other important experiences from the study. As mentioned earlier, equipment, in this case a saddle, reduced trunk control for Kari. It also reduced the rhythm, fluency and harmony of the movements. Still, the saddle may have other benefits for the rider and for the treatment intended. For Kari the symmetry improved riding in a saddle. What we don't know is whether this obtained symmetry was carried over in daily life. According to the measured trunk stability, the ability to stabilize her trunk decreased for Kari which implies that the equipment was contraproductive in establishing longlasting trunk stability. Anne, on the other hand, continued riding bareback and improved trunk stability and posture as well as spontaneous movements in her shoulder and arm as she explored new movement possibilities. This is in accordance with what is described in former studies (Moraes et al., 2018; Benda et al., 2003).

In our ambition to enhance improvements, we, the therapists, give exercises and adjust equipment. We seldom have the possibilities to investigate the effects of these everyday parts of treatment. Anne did not improve when she was given exercises with emphasis on rhythm. The obvious contra productive impact from oral instructions for Anne, and equipment for Kari, is important. How do we optimize the treatment situation for children with CP?

How important are the equipment and how important are the therapists verbal feedback? Maybe the optimizing strategy is to offer an arena where movements may be executed without instructions and where the joy of harmonic movements are the golden goals? The aim for physiotherapy for children with CP is to reduce symptoms and enhance motor learning (Shumway-Cook and Woollacott 2012) through changes in tasks and environment. Current understanding of motor development and development of the neural circuits in the brain support the idea that the possibility to play with the movements support motor development fast and efficient (Sudmann 2020). This may rise new demands on therapist and the development of physiotherapy for children with CP. Focusing on the core issues, trunk stability and postural control in an enriched environment rise opportunities to develop motor skills beyond the therapist's imagination. For children in need of lifelong treatment sequences for motor disturbances, harmony and joy in the treatment situation is a rich source for development and helps holding on to everyday practice (Rosenbaum and Gorter 2012).

4.3. Importance of rhythmical movements

According to Bunketorp-Käll et al. (2017), the introduction of rhythm as a treatment modality was an important adjunct for improved movement skills in neurological rehabilitation. Horses, like humans, have their own personal rhythm while moving. Sitting on a moving horse gives a plentitude of movements and rhythms to respond to, depending on the individual horse, the setting and the speed (Garner and Rigby, 2015). Postural control and trunk stability may benefit from the diversity of rhythmical movement input from different horses, different speed and tempo and from being indoor or outdoor. The horses hoofbeat influenced the girls as they used the rhythm in speech and humming, showing how important the rhythm was on their wellbeing. This is described in the study. Movements were explored, played around with, and the movement dialogue became more fluent during the treatment period for Anne. Her shoulder and arm mobility increased as her trunk stability improved. This mirrors the complexity of the movement disorder in children with CP and how the movement of the extremities are connected with the movement of the trunk (Gjelsvik et al., 2012). Kari lost her postural control quite frequent in the beginning, this may be due to small changes in the horse's steady rhythm due to an unexpected stride by the horse's leg, thus the rider has to expect an unexpected movement. Ohtani et al. (2017) has described that children without disabilities improved their ability to respond to unexpected stimuli after riding. Whether this applies for children with CP is uncertain but may explain Kari's improvement in postural control.

The rhythmical movement influence from a horse is hard to imitate. The importance of the according sound and the smells as well as the whole environment we do not fully understand, but multimodal influence are highlighted when patients themselves describe their experience from riding (Wanneberg, 2014; Pohl et al., 2018). In our study, the rhythmic movement of the horse was observed in movements of the rider but also in the children's humming and singing to the rhythm once comfortable on horseback. This indicates that these signs of comfort may be used to support the observed development of trunk stability. This need to be explored in further studies.

4.4. The patient as a rider

The experience of a new identity as a rider as opposed to a patient has been mentioned as an important factor in the treatment with equine assisted therapy (Wanneberg, 2014). To become a skilled rider, movement interaction between the rider and the horse is an important aspect (von Dietze 2005). People receiving EAPT, have described the interaction as an important factor of the treatment (Debuse et al., 2009; Pohl et al., 2018), and how it made them perceive their body in new ways, especially when riding bareback. In our study this interaction became apparent by observing the rider's movement, especially in the trunk, together with the horse's movement. But it also had other expressions, like stroking the horse, retreating into oneself, smiles, and increased initiative towards the horse, also by using the reins to control the horse. Using reins is also an important feature for a skilled rider, which needs to be intertwined with the movement interaction. In this study we observed that these aspects may develop independently. For the therapist, the ability to use the reins might be more prominent and easier to observe, but improvement in these skills is not necessarily connected to improvement in interaction between the horse and rider, which seems to be more important for improved trunk control for these girls. For a therapist it is important to be aware of the connection, or lack of connection, between these two features when observing changes in the treatment.

4.5. Strengths and limitations

A mixed method design has a validating aspect, since data from one of the methods may support or contradict the other (Polit and Beck, 2012). Data from the test supported the data in the observations concerning trunk control, thus strengthening the results. The closeness to everyday practice this design had is also considered a strength and increases the study's relevance to therapists who consider using EAPT for their patients.

The main data collection, using video in a systematic manner resulted in a large amount of data. The data was enough to reflect the aim of the study. Still we cannot say that saturation of data was fully achieved, and further observation may lead to deeper knowledge. The analysis of the videos was done primarily by the first author. Reflection and discussion together with the second and fourth author were completed to validate the analysis. This was especially important for increasing the validity in Anne's case, where the first author was both observer and therapist. The whole process involved alternating between the aim, the analysis and the discussion, which is a way to validate the data in qualitative research (Malterud 2011).

The children received physiotherapy outside the EAPT. Can we be certain the improvement on the TIS-modNV was caused by EAPT? For Kari improvement on the test was measured right after receiving EAPT, which was a strong indication for EAPT causing the changes. Another validating aspect was how the observations supported the results of the test. The test was done slightly different from the protocol, sitting on a table with their feet on a stool, with more clothes on than described, and it was filmed. The first two factors might reduce the reliability but was chosen to make the study feasible. The filming meant that the tests could be watched several times together with another physiotherapist who was very experienced with the test. The films thus made the scoring of tests more reliable.

There were some differences in the production of data (Fig. 1). We want to mention the duration of the data production: Kari had fewer sessions, 11 versus 15 and the length of vacation differed; 7 weeks for Kari versus 10 weeks for Anne. They both changed horse during the treatment as well. This was taken into consideration but was found not to be relevant due to conformity in the data altogether (Wanneberg, 2014; Garner and RhettRigby, 2015).

Any study is a product of the interpretation of the researcher, and thus it is important to clarify the role of the researcher (Malterud 2011). In this study, the first author had experience from EAPT, which is considered a strength. Second author had no

experience with EAPT, whilst number three and four did. These different perspectives gave room for discussion, reflection and adjustments necessary to strengthen the study.

There are several questions not reflected in this study, for example, the role of the person leading the horse and how the horse did respond to the rider. One question which arose during the study was why the therapist chose to use a saddle instead of riding bareback. All these questions are highly relevant, remains unanswered and reveals the complexity in the factors during EAPT.

The girls had some similarities, which created both strengths and limitations to the study: They both loved riding when they started and eagerly went through with riding sessions, which was important when observing possible impact on movement aspects. For children with CP who do not like riding, the results may not be the same. Two girls took part, approximately the same age and with similar affection of CP. On the one hand, this meant data consistency. On the other hand, by including variation in gender, age, or type of CP, the data probably would be different. This study is not enough to draw any solid conclusions. It still gives a direction for the therapist to look for changes during treatment, and highlights the importance of looking closely to reveal changes in movement.

4.6. Clinical implications

- The measured change in trunk control implies that EAPT is a unique arena to improve trunk control. The initiation of movements from the horse to the child gives a three-dimensional movement experience in an enriched environment which is difficult to create in an ordinary physical therapy session.
- Sometimes exercises and instructions can be helpful, but leaving the child to explore and experience all by themselves within a well-planned framework may be more important.
- When changing equipment from for example bareback to saddle, the therapist needs to pay attention to unintended changes in the movements of the child.
- In order to create a framework facilitating development of new and improved movement strategies, an Equine assisted physiotherapist needs the education of a physiotherapist; movement science, pathology and movement analysis; and schooling as a rider; riding skills and handling the horse. Equally important is the ability to combine this knowledge, and a basic understanding of the movement interaction between the horse and rider.

5. Conclusion

Changes in trunk control, both progress and regress, were observed and measured with TIS- modNV in these children with CP receiving EAPT. The therapist's choice of equipment, like riding in a saddle or not, or exercises introduced by the therapist, affected the movement of the rider and could lead to no change or reduced function. Moments of interaction and connection with the horse arose spontaneously. The opportunity for the children to explore and play with new movements in a challenging environment seemed important in order to learn new movement skills, for example trunk control. The rhythmic movement from the horse was an important aspect for improving and challenging trunk control. Skills needed for riding, like movement interaction and controlling the reins developed separately, indicating that improvement in one aspect does not necessarily lead to improvement in the other. The use of systematic observation can provide information of changes in important movement aspects, and thus lay a foundation for evaluation of EAPT. Themes described in this study can be a basis for observation. Further studies, both qualitative and quantitative, are needed to better understand how EAPT may contribute in the treatment of children with CP.

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Brita Cecilie Norrud: Conceptualization, Resources, Data curation, Writing - original draft, Supervision, Project administration. **Målfrid Råheim:** Methodology, Validation, Resources, Writing - original draft. **Tobba Therkildsen Sudmann:** Resources, Writing - original draft. **Margareta Håkanson:** Validation, Resources, Writing - original draft.

Declaration of competing interest

The authors declares no conflict of interests.

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