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Improving gross motor function and postural control with hippotherapy in Down syndrome children: Case studies

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Hippotherapy research

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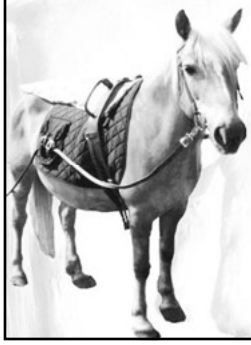
Hippotherapy Presentation plan



1. Hippotherapy and postural challenges;
2. Current state of knowledge;
3. Down syndrome;
4. Development of balance control in the child;
5. Coordination of head and trunk;
6. Research hypothesis;
7. Methodology;
8. Procedures;
9. Measures: motor function/kinematics;
10. Results;
11. Conclusion;
12. References.

Hippotherapy and postural challenges

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- The forward motion of the horse offers a postural challenge for the children;
- The aim of this therapy is to make the children's trunk receptive and responsive to the movements transferred by the horse;
- The three-dimensional movements of the horse is favourable to induce compensatory or anticipatory postural reactions;
- The horse is a sensory-motor mediator because it affects many sensory systems simultaneously.

Current state of knowledge

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- Hippotherapy was mainly studied in connection with spasticity in children with cerebal palsy;
- The results of these studies indicated improvements in functional motor performance(McGibbon et al., 1998; Casady & Nichols-Larsen, 2004) and a reduction or modification of muscle tone after an hippotherapy intervention(Benda et al.,2003);
- Hippotherapy has never been studied in connection with children with Down syndrome and postural control.

Down syndrome

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- Genetic abnormality caused by the addition of a chromosome on the 21st pair of genes;
- **Incidence:**
  - North America: around 1.25 to 1.3 per 1000 live births (Palisano et al., 2001);
  - Canada :1 out of 800 birth (Santé Canada; 2002).

Five key features of motor dysfunction in DS :

- **Hypotonia and laxity of ligaments ("rag doll" effect);**
- **Slower reaction times;**
- **Weaker voluntary muscular contraction;**
- **Delayed motor development.**

One of the major characteristics of infants with DS is their delay in achieving motor milestones (Piek, 2006)

Development of balance control in the child

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- Assaïante (1998) suggested two main functional principles to describe the types of strategies adopted in maintaining appropriate postural control:

  1. **Development of stability of the head in the cephalocaudal and caudo-cephalic directions;**
  2. **The importance of minimizing head movements to reduce the degrees of freedom (Assaïante & Amblard 1995).**

Ontogenesis of postural control

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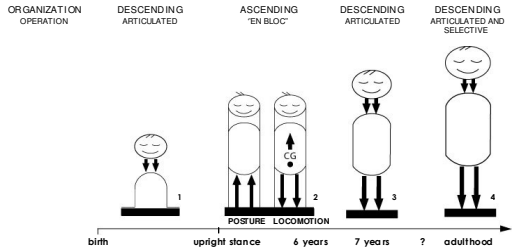

Fig. 1 Ontogenetic scheme of the organization of posturo-kinetic activities during the lifespan.

From Assaïante & Amblard,1995

Adaptation to a new postural challenge

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Experimental restraint

→ *Standing on a beam*

Coordination of head-trunk

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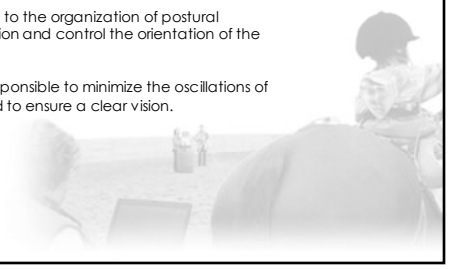
THE TRUNK

- is the key to the organization of postural stabilization and control the orientation of the body;
- is also responsible to minimize the oscillations of the head to ensure a clear vision.



Postural correction: anticipatory mechanism

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- Electromyographic study of adult walking.
- Anticipatory mechanism expressed in ms that comes from a top to bottom muscle activation (C_7 to L_4).

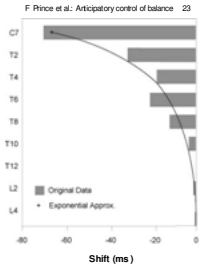

Figure 5. Shift of the activation profiles from the various paraspinal levels during normal walking. A minus shift indicates that the activation was in advance of the profile at the L_4 level. Curve fit was exponential from L_4 to C_7.

From Prince et al, 1994

Ontogenesis of postural control

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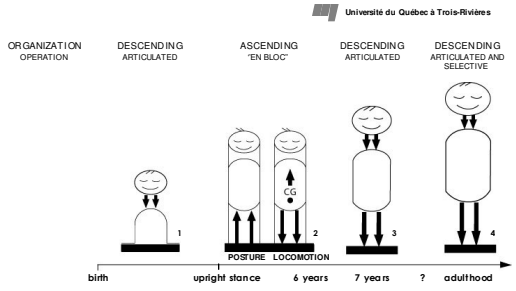

Fig. 1 Ontogenetic scheme of the organization of posturo-kinetic activities during the lifespan.

From Assaïante & Amblard,1995

Research hypothesis

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- The stimulation induced by the movement of the horse creates a new postural challenge which limits the appearance of the «en bloc» strategy;
- Hippotherapy intervention offers an effective stimulation to improve trunk and head control in two preschool aged children with Down syndrome;
- Hippotherapy intervention will improve gross motor function in two preschool aged children with Down Syndrome.

Methodology: Subjects

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- n=2 ;Two children with Down syndrome (2.5 and 3 years old);
- Criteria of exclusion for this study are atlantoaxial instability and\or other relevant medical conditions diagnosed by the family doctor;
- The two children had limited communication and used mostly sign language to communicate with their peers.

Flowchart research protocol

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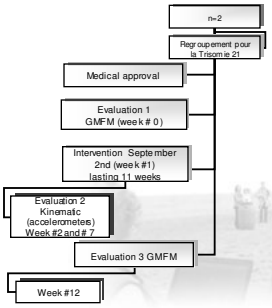

Procedures

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- 13 visits of 1hr approximately;
- 1 visit (pre-post) at the University location for evaluation using the Gross Motor Function Measure (GMFM) done by an independent physiotherapist;
- 11 weeks of treatment with 20-30 minutes on horseback including 2 evaluation sessions (pre and mid test) with accelerometry;
- The therapy included diverse graded positions that the child will adopted on the horse.

Graded postures adopted on the horse

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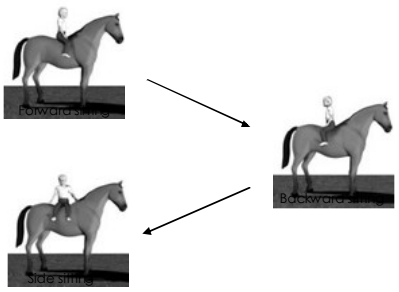

Progression

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- **For the horse**
  - a variation in horse speed (stop and go, half-halt);
  - in direction (graded riding figures);
  - in the use of different walking surface (flat indoor arena and irregular ground outside with more or less slope).

Graded riding figures used

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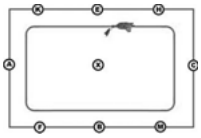
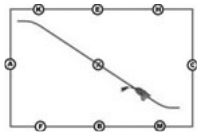
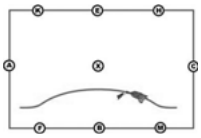
1. Full-school



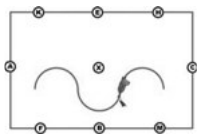
2. Across the long diagonal



3. Shalow loop on the long side



4. Adapted serpentine (flat cones weaving)



Progression

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- **For the child**
  - Activities that challenge balance, strengthen upper body, oral sounds and verbal communication.

Hippotherapy intervention summary		
Main goal	**Objectives**	**Description of activities on the horse**
Stimulation of balance	Crossing the midline with 1 hand	Reaching toys in different places on the horse
Stimulation of visual-motor coordination	Improving movement precision and strength	Grooming and throwing activities
Stimulation of visual-motor coordination	Stimulation of anticipation reactions to keep the visual platform stable	Catching activities
Stimulation of verbal communication and cognitive skills	Stimulation of memory	Teaching vocabulary related to horses

Hippotherapy intervention time

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	Subject 1	Subject 2
Position 1 Facing forward	93 min	95 min
Position 2 Facing backward	60 min	61 min
Position 3 Side-sitting	62 min	55 min
Total 330 min (11sessionsX30min)	215 min (65%)	211 min (64%)

Measures: Motor function

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- **GMFM** (Gross Motor Function Measure)

5 subsections :

A. Lying and rolling,
B. Sitting,
C. Crawling and kneeling,
D. Standing,
E. Running, walking and jumping.

GMFM Results

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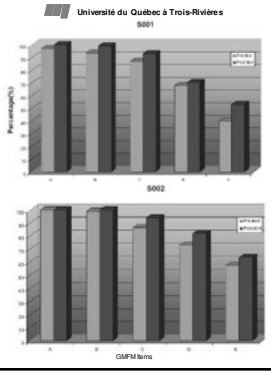
- The interrater reliability between therapists ranged from 0.96 to 0.97 for the pre and post test respectively.
- Statistical analysis ($p<0.05$) revealed that both subjects improved on dimensions C, D and E. Interestingly, the last item (E. Running, walking and jumping) of the GMFM-88 demonstrated the largest improvements in both subjects.
- The results of the t test on independent means, for the GMFM-88 scores of both examiners, revealed a significant treatment effect for subject 1 between the pre- and post-test ($t = 3.058$, $df = 4$, $p<0.05$) with a similar pattern for subject 2 ($t = 2.662$, $df = 4$, $p=0.056$).



Measures: Kinematics

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- **Kinematics-Accelerometry** (Week 2nd and 7th)
  - Measure of the accelerations of the trunk and the head in reaction to the movement of the horse;
  - Three multiaxial accelerometers: one on the horse (croup) and two on the child (head and trunk);
  - The magnitude of the acceleration signals and their frequency content will be analyzed.

Measures: Kinematics-accelerometers

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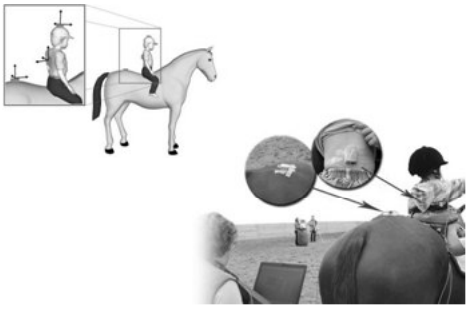

Accelerometry Results

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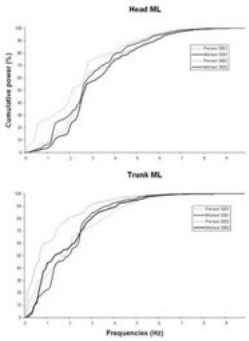

- Frequency profiles of head and trunk accelerations were similar for the VT and AP directions but only the ML axis showed interesting differences.
- These results demonstrated a decrease in lower frequency content (from .5 to 4 Hz), which reflected more stability of the head over time in the ML plane.
- The overall accelerometry data demonstrated interesting adaptive responses to the postural challenges induced by the horse.

Hippotherapy video

Conclusion

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- Two distinct adaptative strategies were observed. They both permitted improvements in dimension walking, running and jumping has evaluated with the GMFM;
- Motor variability is recognized has reflecting possible adaptive mechanisms in the CNS suggested by Latash (1996);
- Based on theses results, we believe that accelerometers could serve to objectively quantify modifications in the postural control system during hippotherapy;
- This type of case study thus not allows us to generalize because of the small sample size, we are confident that this study will constitute a beginning for future research in order to use hippotherapy with DS children.

References

Université du Québec à Trois-Rivières

- Assaiante, C. (1998). Development of locomotor balance control in healthy children. *Neuroscience & Biobehavioral Reviews, 22*(4), 527-532.
- Assaiante, C., & Amblard, B. (1995). An ontogenetic model for the sensorimotor organization of balance control in humans. *Human Movement Science, 14*(1), 13-43.
- Benda, W., McGibbon, N. H., & Grant, K. L. (2003). Improvements in muscle symmetry in children with cerebral palsy after equine-assisted therapy (hippotherapy). *Journal of Alternative and Complementary Medicine, 9*(6), 817-825.
- Casady, R. L., & Nichols-Larsen, D. S. (2004). The effect of hippotherapy on ten children with cerebral palsy. *Pediatric Physical Therapy, 16*(3), 165-172.
- Latash, M. (1996). How does our brain make its choices. In M. L. Latash, & Turvey, M.T. (Ed.), Dexterity and Its Development (pp. 277–304). Mahwah, NJ.

References

Université du Québec à Trois-Rivières

- McGibbon, N. H., Andrade, C. K., Widener, G., & Cintas, H. L. (1998). Effect of an equine-movement therapy program on gait, energy expenditure, and motor function in children with spastic cerebral palsy: a pilot study. *Developmental Medicine & Child Neurology, 40*(11), 754-762.
- Palisano, R. J., Walter, S. D., Russell, D. J., Rosenbaum, P. L., Gémus, M., Galuppi, B. E., et al. (2001). Gross motor function of children with down syndrome: creation of motor growth curves. *Archives of Physical Medicine and Rehabilitation, 82*(4), 494-500.
- Piek, J. (2006). *Infant motor development*: Human Kinetics.

Santé Canada (2002). *Les anomalies congénitales au Canada— Rapport sur la santé périnatale*.

- Prince, F., Winter, D. A., Stergiou, P., & Walt, S. E. (1994). Anticipatory control of upper body balance during human locomotion. Gait Posture, 2, 19-25.
- Shumway-Cook, A., & Woollacott, M. H. (1985). Dynamics of postural control in the child with Down syndrome. *Physical Therapy, 65*(9), 1315-1322.

References

Université du Québec à Trois-Rivières

- Ulrich, D., Ulrich, B., Angulo-Kinzler, R., & Yun, J. (2001). Treadmill training of infants with Down syndrome: evidence-based developmental outcomes. Pediatrics, 108(5), E84-E84.
- Winchester, P., Kendall, K., Peters, H., Sears, N., & Winkley, T. (2002). The effect of therapeutic horseback riding on gross motor function and gait speed in children who are developmentally delayed. *Physical and Occupational Therapy in Pediatrics, 22*(3-4), 37-50.