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Original Article

The short-term effect of hippotherapy on spasticity in patients with spinal cord injury

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Study design: Assessment of spasticity before and after hippotherapy treatment.
Objective: To evaluate the short-term effect of hippotherapy on spasticity of spinal cord injured patients (SCIs).
Setting: Swiss Paraplegic Centre, Nottwil.
Methods: 32 patients with spinal cord injury with various degrees of spasticity had repeated sessions (mean 11) of Hippotherapy-K®. Spasticity of the lower extremities was scored according to the Ashworth Scale.
Results: In primary rehabilitation patients Ashworth values after hippotherapy were significantly lower than before (Wilcoxon's signed-rank test: $P<0.001$). Highest improvements were observed in SCIs with very high spasticity. No significant difference between short-term effect in paraplegic and short-term effect in tetraplegic subjects was found.
Conclusions: Hippotherapy significantly reduces spasticity of lower extremities in SCIs.
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Keywords: hippotherapy; muscle spasticity; spinal cord injuries; rehabilitation; treatment outcome

Introduction

Spasticity is known as an accompanying phenomenon of spinal cord injuries and was defined by Lance[1] as an increased reflex activity, as well as a velocity-dependent increase in muscle tone elicited by passive stretching. Not every patient suffering from spasticity necessarily requires treatment. However, depending on the severity of spasticity it may interfere with activities of daily life. In the Stockholm spinal cord injury study,[2] for example, more than 41% of subjects with spastic paralysis reported excessive spasticity associated with additional functional impairment and/or pain, and 2/3 of the subjects with spastic paralysis took medication to treat their spasticity.[3] What other possibilities besides medication are there to reduce high muscle tone?

For several years hippotherapy has been used in rehabilitation of spinal cord injured patients (SCIs) and positive effects on spasticity have been reported.[4,5] Unfortunately, only few studies assessing the effect of hippotherapy on spasticity have been conducted, and most of the existing literature is not in the English language. Studies that aim at explaining the mechanisms underlying the positive effect of hippotherapy on spasticity are even more scarce. Unlike therapeutic horseback riding, which teaches riding skills to individuals with disabilities, hippotherapy is a neurophysiological treatment that uses the movement of the horse. The hypothesis is that the rhythmical side flexion and extension of the patient's trunk combined with trunk torsion have a beneficial effect on spasticity. The working mechanism of hippotherapy on spasticity may be complex. According to neurophysiological standards, an inhibition of the spasticity is achieved through the saddle position in hip flexion – abduction – external rotation as well as through rhythmical and three-dimensional equine movements communicated to the patients' pelvis and trunk.[6,7] A further impact on spasticity is also attributed to the psychosomatical effects.[5] According to Strauss[8] hippotherapy gains its unique effect through a neural facilitation, sensorimotor stimulation and psychosomatic influence.

We felt that there is a need for a study assessing the effect of hippotherapy on spasticity of SCIs and to report the result in the English language. We have tested the short-term effect of hippotherapy onto the increased muscle tone of the lower extremities in 32 SCIs as follows: the physiotherapist in charge rated the spasticity of the patients directly prior to and after the

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hippotherapy treatment according to the Ashworth Scale.[9]

Methods

Study subjects

From June 1996 to November 1997 and from June 1999 to May 2001 all patients with various degrees of spasticity were tested by the physiotherapists prior to and after hippotherapy treatment. Measurements were taken from 32 SCIs. The age ranged between 16 and 72 years (mean 37), four of the patients were female, 30 subjects were inpatients in primary rehabilitation (time after injury between 1 and 18 months, mean 5), and two were outpatients (4 and 6 years after injury). Levels of the spinal cord injury were between C4 and T12 and between A and D according to the 'ASIA Impairment Scale'[10] (Table 1). Informed consent of all patients was obtained according to the Helsinki protocol.

Intervention

On average each patient was tested prior and after 11 (range: 5–24) hippotherapy sessions. The treatments were performed according the concept of Hippotherapy-K® (HTK).[11] The subject sat on a sheepskin (without saddle), while the horse (Icelander) was led at walking pace by a skilled equestrian. The physiotherapist walked beside the horse facilitating postural responses and repositioning the patient if necessary. Some patients with high lesions needed a second physiotherapist sitting on the horseback behind them for stabilisation. One session lasted for 25–30 min.

Measurement of spasticity

Rating of spasticity was done directly before and after the hippotherapy session in the riding hall. The patient was lying on an examining table in supine position while eight movement directions were rated: hip flexion and extension, abduction and adduction, knee flexion and

Table 1 Study subject demography

ASIA level	*Age (years)*	*Gender*	*Injury duration (months)*	*HTK sessions (n)*	*ASV: means ± SD*		
					Before HTK	*After HTK*	*Difference means ± SD*
C4 C	23	F	4	12	23.2±1.4	19.0±1.4	−4.2±1.1
C4 D	64	M	48	5	17.6±0.9	16.6±0.5	−1.0±1.2
C4 D	31	M	3	7	24.3±2.1	20.6±1.1	−3.7±2.1
C4 D	64	M	18	10	18.0±1.9	17.7±1.3	−0.3±0.8
C5 D	16	M	2	12	41.4±3.5	36.2±4.1	−5.3±3.0
C5 D	38	M	2	23	24.8±4.5	20.8±3.2	−4.0±2.4
C6 A	26	M	60	7	38.9±5.5	33.0±1.0	−5.9±4.6
C6 C	27	M	4	7	44.3±6.8	36.9±4.9	−7.4±4.6
C6 C	53	M	7	7	38.7±3.7	33.1±2.7	−5.6±1.6
C7 B	43	M	4	19	32.3±5.5	25.2±4.6	−7.1±3.2
C7 C	22	M	3	24	27.9±3.1	22.4±2.4	−5.5±2.3
C7 C	24	M	5	12	35.1±4.3	26.9±3.3	−8.2±2.8
C7 D	55	F	2	8	37.1±2.9	27.9±4.2	−9.3±5.3
C8 A	29	M	3	5	44.2±1.9	34.2±4.4	−10.0±3.3
TH2 D	31	M	3	6	38.5±8.8	27.5±8.4	−11.0±6.1
TH2 D	35	M	2	5	23.0±1.7	21.8±1.9	−1.2±2.2
TH3 A	27	M	5	5	22.2±2.5	18.6±2.3	−3.6±0.5
TH3 C	58	M	3	8	21.1±2.4	18.0±1.8	−3.1±1.1
TH4 D	47	M	5	24	24.2±2.9	20.0±1.7	−4.2±3.0
TH6 A	34	M	12	8	31.0±3.8	22.5±2.8	−8.5±3.0
TH6 A	33	F	9	12	30.9±6.0	22.3±3.3	−8.7±3.6
TH6 B	30	M	3	14	42.7±4.0	30.0±1.8	−12.7±3.9
TH6 C	30	M	6	16	47.1±2.3	35.6±3.5	−11.6±3.7
TH7 A	28	M	4	9	19.7±3.1	18.3±3.4	−1.3±4.5
TH7 C	36	M	5	10	41.7±4.3	33.3±2.9	−8.4±3.2
TH8 C	61	F	4	8	52.1±8.7	36.6±7.5	−15.5±7.7
TH9 A	24	M	7	6	35.5±3.1	29.0±3.5	−6.5±2.7
TH9 C	72	M	2	12	20.2±1.7	17.8±1.1	−2.3±1.4
TH9 D	52	M	1	24	26.6±5.4	23.8±4.9	−2.8±2.4
TH10 A	23	M	4	5	20.0±2.1	17.4±0.9	−2.6±1.5
TH11 D	22	M	13	10	53.3±8.1	42.0±4.8	−11.3±6.3
TH12 C	20	M	5	11	32.8±3.2	26.0±3.8	−6.8±3.5
Range	16–72		1–60	5–24	17.6–53.3	16.6–42	−15.5– −0.3

extension, as well as ankle dorsi- and plantarflexion. The physiotherapist moved the limb in the directions as quickly as possible. The knees and the ankles were measured with extended hips, while the lower legs dangling off the end of the testing bed. Each direction was repeated three to five times. She rated the elicited spasticity according to the Ashworth Scale between 1 and 5 (Ashworth-value, ASV) (Table 2). The ASV of the eight movement directions of both sides were recorded as a sum of 16 scores ranging from a minimum of 16 to a maximum of 80.

Testing was performed prior to and after the HTK treatment by the same physiotherapist. Seven different physiotherapists performed the overall testing of the 32 patients. All seven physiotherapists were instructed on the testing by the same person and met on a regular basis to exchange testing experiences and to check inter- and intrarater reliability.

Statistical methods

For each patient and examination sums of the ASV from all directions on both sides were calculated (2×8 movement directions, minimum score $= 16$, maximum score $= 80$). Means and standard deviations were calculated of the repeated HTK treatments for each patient. The existence of a statistical difference between the ASV before and after HTK treatment was assessed by performing Wilcoxon's signed-rank test. Statistical significance[12] was set at the 5% level.

Results

A total of 351 hippotherapy treatments were performed and 327 of these sessions (93%) lead to a lower ASV immediately after as compared than before the sessions. In all, 20 sessions (6%) did not lead to a change in the ASV score; these sessions were completed by 10 patients with low ASV ($\leqslant 24$) prior to treatment. In only two patients with very low ASV ($\leqslant 18$) an increase of the value was measured twice in each patient (1%).

Hippotherapy led to a substantial decrease of muscle tone in the lower extremities of the 32 SCI patients. The calculated means of all individual patients ranged from 17.6 to 53.3 prior to treatment and from 16.6 to 42 after treatment (Table 1). Group scores after the treatment were significantly lower than group scores before treatment (Wilcoxon's signed-rank test: $P < 0.001$)

Table 2 Ashworth Scale[9]

Grade	
1	No increase in tone
2	Slight increase in tone giving a 'catch' when the limb is moved in flexion or extension
3	More marked increase in tone but limb easily flexed
4	Considerable increase in tone – passive movement difficult
5	Limb rigid in flexion or extension

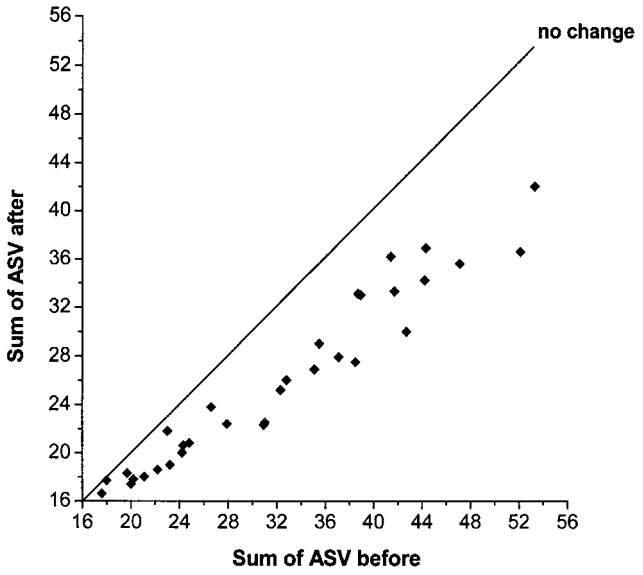

Figure 1 Scatterplot of the 32 subjects: means of sums of ASV before versus sums of ASV after HTK treatment. The 45° line indicates values of no change. All measured values show smaller sums of ASV after than before HTK treatment. Note: score of 16 signifies a patient with no spasticity

(Figure 1). The highest short-term improvement ($\geqslant 10.0$) was observed in six patients with severe before-session spasticity (ASV over 38).

There was no significant difference between short-term effect in paraplegic subjects and the short-term effect in tetraplegic subjects (Wilcoxon's signed rank test: $P = 0.4$). The mean of all differences between before- and after-session values for paraplegic subjects ($n = 18$) was -3.4 (SD $\pm$ 2.2) and for all tetraplegic subjects ($n = 14$) it was -2.8 (SD $\pm$ 1.0). There was no longitudinal effect (downward trend overall sessions in each patient) and the variance within the before-session values in each single patient ranged from 0.81 to 77.4 (SD $\pm$ 0.9–$\pm$ 8.8). Also, there was no detectable trend of the before- and after-session differences (data not shown).

Discussion

Our results show that hippotherapy causes an immediate reduction of spasticity of the lower extremities of SCI patients. The ASV was significantly lower after the treatment than before. The greatest before- and after-session differences were measured in patients with very high spasticity.

Hippotherapy and its reducing effect on the muscle tone was described earlier in connection with other clinical entities associated with spasticity such as multiple sclerosis (MS) and cerebral palsy (CP): in the 'Swiss Study' by Kuenzle and Wuethrich[13] including 255 patients with MS, relaxation and decrease in muscle tone was the most frequent effect of hippotherapy, according to subjective records of patients, therapists and treating doctors. However, these results were not backed up by Ashworth Scale. In another study with

MS patients, a reduction in the muscle tone of the lower extremities after hippotherapy was measured by electromyography.[14]

Tarnow[15] ascertained that children and teenagers with a spastic quadriplegia had shown a clear improvement in their trunk flexibility and their functional ability after treatment with hippotherapy. She attributed the results to a decrease in muscle tone as a result of this treatment. McGibbon *et al*[16] described a standardised protocol of hippotherapy treatment and documented its effect on gait, energy expenditure, and gross motor function in children with spastic CP. Bertoti[6] examined the effect of hippotherapy on the posture of children with CP and described improved posture because of the hippotherapy's reducing effect on spasticity. Exner *et al*[4] described a 'clear suppression of the spasticity' with a 'remarkable duration of effect'; however, the degree of the decrease in spasticity was not stated quantitatively.

In our study, the spasticity was rated according to the ASV directly prior and after treatment in primary rehabilitation patients. Our results represent a short-term effect of hippotherapy. However, it would be interesting to quantitatively evaluate the duration of the effect as well as a possibly persisting effect in the context of a further prospective study, since in the 'Swiss Study'[13] in over 70% of MS patients a benefit of 2 days or longer was observed.

Naturally, medication would have to be kept constant if changes in the severity of spasticity over a series of hippotherapy sessions were to be investigated. This would have to be conducted with chronic SCIs, as during first rehabilitation there are many more confounding factors like psychological stress, bladder infections or bowel complications, changes of therapies and various medications. Many of these factors may have an effect on muscle tone. To evidence a longitudinal effect of hippotherapy on spasticity, we just started a blinded long-time prospective study on chronic SCIs with stable antispastic medication, who are at least 18 months postinjury.

Regarding the rating of muscle tone with the Ashworth Scale, it needs to be mentioned that it is clearly a subjective method. Additionally, the physiotherapist conducting the measurement was not blinded to the treatment and ratings may have been influenced by personal expectations.

Conclusions

We show that hippotherapy has an alleviating short-term effect on spasticity of the lower extremities in SCI patients. In 32 patients such an effect could be shown with the help of the Ashworth Scale. There was a significant difference between the spasticity before and after treatment ($P<0.001$).

Further studies regarding the duration of the effect are necessary and will be performed with blinded assessment of spasticity reduction, comparing it with other interventions. In summary, hippotherapy is a valuable supplement to the conventional physiotherapy approach in holistic rehabilitation of SCIs.

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References

1 Lance JW. Symposium synopsis. In: Feldman RG, Young RR, Koulla WP (eds). *Spasticity: Disordered Motor Control*. Yearbook Medical Publishers: Chicago 1980, pp 485–494.
2 Levi R, Hultling C, Nash MS, Seiger A. The Stockholm Spinal Cord Injury Study: 1. Medical problems in a regional SCI population. *Paraplegia* 1995; **33:** 308–315.
3 Skold C, Levi R, Ake S. Spasticity after traumatic spinal cord injury: nature, severity and location. *Arch Phys Med Rehabil* 1999; **80:** 1548–1557.
4 Exner G, Engelmann A, Lange K, Wenck B. Grundlagen und Wirkung der Hippotherapie im Konzept der umfassenden Behandlung querschnittgelähmter Patienten (German). *Rehabilitation* 1994; **33:** 39–43.
5 Hegemann D, Zäch G. Hippotherapie zur Behandlung der Spastizität bei Para- und Tetraplegikern (German). In: Grueninger W (ed). *Spinale Spastik*. Ueberreuter Verlag: Stuttgart 1989, pp 147–149.
6 Bertoti DB. Effect of therapeutic horseback riding on posture in children with cerebral palsy. *Phys Ther* 1988; **68:** 1505–1512.
7 Wuethrich R, Kuenzle U. Hippothérapie chez des patients atteints de sclérose en plaques. *J Beige Med Phys Rehabil* 1978; **1:** 265–268.
8 Strauss I. *Hippotherapy: Neurophysiological Therapy on the Horse*. Ontario Therapeutic Riding Association: Thornhill, Ontario 1995.
9 Ashworth B. Preliminary trial of carisoprodol in multiple sclerosis. *Practitioner* 1964; **192:** 540–542.
10 Maynard FMJ *et al*. International standards for neurological and functional classification of spinal cord injury. American Spinal Injury Association. *Spinal Cord* 1997; **35:** 266–274.
11 Kuenzle U. *Hippotherapie auf den Grundlagen der Funktionellen Bewegungslehre Klein-Vogelbach. Hippotherapie-K: Theorie, Praktische Anwendung Wirksamkeitsnachweis*. Springer-Verlag: Berlin Heidelberg, 2000.
12 Sheskin DJ. *Handbook of Parametric and Nonparametric Statistical Procedures*. 2nd edn. Chapman & Hall/CRC press: Boca Raton, 7L 2000.
13 Kuenzle U, Wuethrich R. Schweizerische Studie über die Wirksamkeit der Hippotherapie K bei Multiple-Sklerose-Patienten. In: Kuenzle U (ed). *Hippotherapie auf den Grundlagen der Funktionellen Bewegungslehre Klein-Vogelbach*. Springer-Verlag: Berlin, Heidelberg 2000, pp 359–381.
14 Weber A. Hippotherapie bei Multiple-Sklerose-Kranken. *Ther Reiten* 1994; **21:** 16–19.
15 Tarnow A. Hippotherapeutische Behandlungsergebnisse – Versuch einer Dokumentation der Therapieerfolge (German). *Oeff Gesundh Wesen* 1979; **41:** 201–205.
16 McGibbon NH, Andrade CK, Widener G, Cintas HL. Effect of an equine-movement therapy program on gait, energy expenditure, and motor function in children with spastic cerebral palsy: a pilot study. *Dev Med Child Neurol* 1998; **40:** 754–762.