ORIGINAL ARTICLE

The Effect of Hippotherapy on Spasticity and on Mental Well-Being of Persons With Spinal Cord Injury

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ABSTRACT. Lechner HE, Kakebeeke TH, Hegemann D, Baumberger M. The effect of hippotherapy on spasticity and on mental well-being of persons with spinal cord injury. Arch Phys Med Rehabil 2007;88:1241-8.

Objectives: To determine the effect of hippotherapy on spasticity and on mental well-being of persons with spinal cord injury (SCI), and to compare it with the effects of other interventions.

Design: Crossover trial with 4 conditions.

Setting: Swiss paraplegic center.

Participants: A volunteer sample of 12 people with spastic SCI (American Spinal Injury Association grade A or B).

Interventions: Hippotherapy, sitting astride a Bobath roll, and sitting on a stool with rocking seat. Each session lasted 25 minutes and was conducted twice weekly for 4 weeks; the control condition was spasticity measurement without intervention.

Main Outcome Measures: Clinical rating by a blinded examiner of movement-provoked muscle resistance, using the Ashworth Scale; self-rating of spasticity by subjects on a visual analog scale (VAS); and mental well-being evaluated with the self-rated well-being scale Befindlichkeits-Skala of von Zerssen. Assessments were performed immediately after intervention sessions (short-term effect); data from the assessments were analyzed 3 to 4 days after the sessions to calculate the long-term effect.

Results: By analyzing the clinically rated spasticity, only the effect of hippotherapy reached significance compared with the control condition (without intervention); median differences in the Ashworth scores' sum before and after hippotherapy sessions ranged between −8.0 and +0.5. There was a significant difference between the spasticity-reducing effect of hippotherapy and the other 2 interventions in self-rated spasticity by VAS; median differences of the VAS before and after hippotherapy sessions ranged between −4.6 and +0.05cm. There were no long-term effects on spasticity. Immediate improvements in the subjects' mental well-being were detected only after hippotherapy (P=.048).

Conclusions: Hippotherapy is more efficient than sitting astride a Bobath roll or on a rocking seat in reducing spasticity temporarily. Hippotherapy had a positive short-term effect on subjects' mental well-being.

Key Words: Muscle spasticity; Physical therapy modalities; Physiotherapy; Rehabilitation; Spinal cord injuries.

SPASTICITY IS A COMMON sequela of spinal cord injury (SCI). Spasticity is a complex phenomenon that is associated with an upper motoneuron lesion and can be defined as a sensorimotor disorder resulting in an intermittent or continuous involuntary activation of muscles.[1] Decq[2] suggested subdivisions of the various components into (1) intrinsic tonic spasticity (eg, increased tone), (2) intrinsic phasic spasticity (eg, clonus), and (3) extrinsic spasticity (eg, flexor reflex). All 3 components can be beneficial or detrimental. On one side, symptoms of spasticity may be helpful with sitting balance or stability during transfers; on the other side, exaggerated spasticity can restrict the functional independence of persons with SCI.[3-5]

Especially during the early stages of rehabilitation, when spasticity develops and patients are not familiar with it, high muscle tone and suddenly occurring spasms may interfere with the rehabilitation program (eg, training of transfers and dressing or practicing wheelchair skills). In this phase, however, spasticity is only developing and is highly fluctuating.[6] Antispastic medication has potentially serious side effects and patients frequently complain of sleepiness,[7] which might interfere with motivation during early rehabilitation. For this reason, many patients and clinicians are on the lookout for conservative measures such as muscle stretching,[7,8] passive movements,[9,10] or hydrotherapy[11] to reduce symptoms of spasticity.

Debuse et al[12] reported that many physiotherapists performing hippotherapy shared the opinion that no intervention was as effective in regulating muscle tone as hippotherapy. This therapy has been used for many years in several rehabilitation centers as part of the physiotherapy (PT) program for SCI subjects.[13,14] Hippotherapy is a PT treatment strategy that uses the rhythmic equine movement to treat mainly persons with neurologic impairments. The horse, at a walking pace, is used as a facilitator, led by a horse master; a specially trained physiotherapist walks beside the horse and is in close contact with the patient. The patient does not actively influence the horse, but is passively influenced by the horse's movement. Several studies[12,15-17] have reported the positive impact of hippotherapy on muscle tone, posture, balance and pain, as well as its psychosomatic influence on patients. Other studies have documented the effect of hippotherapy on spasticity in children with cerebral palsy[18-20] and in adults with multiple sclerosis.[21,22] The literature about its effect on spasticity in persons with SCI is scarce, however.

To our knowledge, there has been only 1 study published in which the immediate spasticity reduction in patients with SCI was measured after hippotherapy.[23] According to neurophysiologic standards, this spasticity reduction may be attributed to an inhibiting astride position in hip flexion, abduction, and external rota-

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tion, as well as to rhythmic equine movements imposed on a patient's pelvis and trunk.[24,25] In the present study, we investigated whether either of these 2 most important elements of hippotherapy (an astride position and rhythmic movements) is as effective in reducing spasticity as hippotherapy. For this purpose, we compared the effects of the 2 following interventions with the effect of hippotherapy: (1) sitting astride a Bobath roll to gain a similar inhibiting position as on a horse's back and (2) sitting on a stool with rocking seat, which implies a rhythmic lateral tilting of the pelvis that provokes a lateral flexion of the trunk similar to when sitting on a walking horse.

A recent study[9] in our laboratory found that passive cycling movements did not change the objectively measured spasticity, but did have a positive effect on the patients' perceptions about whether their spasticity had changed. It therefore seemed important to assess the extent of a patient's spasticity and any changes resulting from an intervention through a rating by a clinician (with the Ashworth Scale score), as well as a self-rating by the patient (by visual analog scale [VAS]). Numerous qualitative and quantitative methods have been proposed for measuring spasticity. Resistance to passive movements is 1 symptom of spasticity and can be rated by a clinician with the Ashworth Scale.[26] This scale may provide a valid measure for increased tone but it is not the only available measure of spasticity.[27] VASs have been used for self-assessments of the spasticity,[10,28] and the importance of including self-reports in spasticity assessments has been emphasized.[29] We aimed to detect short-term and long-term spasticity reduction. The effect on spasticity of the interventions was evaluated clinically by physiotherapists and by the subjects through self-reported VAS.

In addition to its effect on spasticity, hippotherapy may also influence a person's mental well-being. Contact with a large animal has a profound effect on humans: for instance, a horse may help increase a patient's confidence and self-esteem through its acceptance of him/her as a rider.[15] To our knowledge, the psychologic effect has not been measured before. It was for this reason that our subjects completed the self-rated well-being scale, the Befindlichkeits-Skala (Bf-S) of von Zerssen. This is a well-known measure in German- and French-speaking countries; its reliability and validity has been evaluated in these 2 languages.[30-32] It is specific (adjectives on mood states, essentially), current and therefore sensitive (lack of adjectives on the habitual state, on personality traits), and easy to administer and analyze.[32] The Bf-S evaluates the extent of impairment of the subjective mental well-being. Because of its 2 parallel forms it is applicable for repeated measures to detect changes in mental well-being caused by interventions.[31] It was used in several studies to determine mental well-being of psychiatric patients[33-35] as well as mentally healthy persons.[36-39]

Spasticity in persons with SCI has the potential to negatively influence quality of life, to disturb sleep, to impede the rehabilitation efforts of the patient, and may even contribute to a negative self-image.[3] There is evidence that there is a greater prevalence of anxiety and depression in people with SCI than in people in the general population.[40] Moreover, depressive symptoms and impaired subjective mental well-being have been associated both with fewer functional improvements in SCI rehabilitation and with limitations in participation and motivation.[40,41]

We hypothesized that hippotherapy is a potential intervention with which to improve the mental well-being of persons with SCI.

METHODS

Participants

A volunteer sample of 12 people with motor-complete traumatic SCI (American Spinal Injury Association [ASIA] grade A or B) was recruited to participate in the study. They all met the following inclusion criteria: (1) more than 1 year after onset of SCI, (2) spasticity in the lower extremities (the minimal score defined for the inclusion criteria was that at least 1 of 10 muscle groups had to be scored with 2 on the Ashworth Scale and the Ashworth scores' sum had to be equal to or greater than 6 in 4 consecutive weekly measurements), (3) sufficient range of motion (ROM) to sit astride a horse and on a Bobath roll, (4) no skin problems or wounds, and (5) no horseback riding (therapeutic or recreational) during the 6 months before the study. All subjects gave their informed consent to participate.

Interventions

Each intervention session was 25 minutes in duration and was performed twice weekly for 4 weeks. In clinical practice, a hippotherapy session lasts 30 minutes.[24,25] We set the treatment time for all interventions at 25 minutes to provide time for transfers and to ensure that all 3 interventions would be of the same duration.

Intervention H. Intervention H was a hippotherapy treatment, performed according to the concept of Hippotherapy-K (HTK).[24] The therapy horse (Icelandic breed) was led by a trained horse master at walking pace while the subject sat astride the horse on a sheepskin without saddle or stirrups. The subject did not actively influence the horse, but was moved passively by its movement. A physiotherapist with special training in HTK walked beside the horse, controlling and repositioning the subject if necessary. Intervention H was conducted outdoors on a 270m rectangular dirt track or indoors in a riding hall (22×12m), depending on weather conditions.

Intervention R. Intervention R consisted of sitting astride a Bobath roll, a canvassed cylinder made of rubber foam with a diameter of 65cm and a length of 150cm.[a] The subject sat upright with flexed hips and knees, feet on the ground, and hands resting on the thighs (fig 1). The same physiotherapist involved in the hippotherapy intervention helped with transfers and remained with the subject throughout the session. Intervention R was performed in a therapy room beside the horse stables.

Intervention S. Intervention S involved sitting on a rocker board that was integrated into a wood stool with a cushioned seat.[b] The rocking seat was driven by an electrically powered motor; the rotation axis was in the middle of the seat in the sagittal plane. The rhythm of the rocking movement and its amplitude were adjusted to a horse's walking pace, with a frequency of about 1Hz and amplitude at the subject's sciatic tuber of about 2 to 3cm (depending on pelvic width). The subject was sitting with 90° hip and knee flexion, ankles in neutral position, feet on the ground or on a block (depending on shank length), and hands resting on a mounting bracket to prevent a fall (fig 2). The same physiotherapist involved in the other 2 interventions helped the subjects with transfers and stayed with them during the session. Intervention S was performed in the same therapy room as intervention R.

Measurements

Spasticity. Spasticity was assessed by a clinical rating using the Ashworth score and by a subject's self-rating using a VAS, as described in an earlier work.[29]

For the clinical rating the subjects were in a supine position, with knees flexed and lower legs dangling over the edge of a

Fig 1. Intervention R: subject sitting astride a Bobath roll.

table. On 1 limb after the other, the physiotherapist passively performed knee extension and flexion (with extended hip), hip extension and flexion (with knee in flexion), and hip abduction (with extended hip and knee) within the full individual ROM. Each movement from full flexion to full extension or vice-versa, or from full adduction to full abduction, lasted approximately 1 second and was performed 3 consecutive times, with 2 to 3 seconds of rest in the end positions. Thereafter, the examiner rated the perceived resistance against each single passive movement according to Ashworth, from 0 to 4[26] and added the scores of the 10 different muscle groups (5 each side) to a sum (Ashworth scores' sum).

For the self-report, subjects were asked to perform a motion sequence (transfer from chair to bed, lying down supine, sitting up on bed) and then to rate the spasticity experienced through the sequence on a 10-cm VAS, ranging from no spasticity to most imaginable spasticity. No further explanations for spasticity were given to the subjects.

Well-being. To assess subjects' present mental well-being and its change through the interventions, we used the Bf-S of von Zerssen and Koeller.[31] This measure consists of 2 parallel lists of 28 opposing adjective pairs with which to evaluate mood, motivation, self-esteem, and feeling of vitality. Subjects had to tick on the list given them by the examiner if they felt, for example, "rather happy," "rather unhappy," or "neither nor." The 28 answers were rated on a 3-step scale from 0 to 2 and test scores were subsequently calculated by summing the ratings. This test score consisted of a number between 0 and 56; a higher score represents a more depressed mood and impaired mental well-being. Normative data evaluated by von Zerssen and Koeller[31] indicate that 95% of mentally healthy men at ages between 20 and 64 years have a score of 28 or lower.

All measurements were taken in the rehabilitation center's PT department. The physiotherapist involved in the measurements was blinded as to the current intervention. This was possible because of the topology of the study setup and the cooperating subjects, who were instructed not to discuss therapy. There was a post-experimental check by the author (HEL) to ensure that examiners were blinded to the experimental condition.

Study Protocol

The 12 subjects were randomly divided into 3 groups (I, II, III) (fig 3).

The protocol began with 4 weeks of weekly measurement sessions, which included the clinical ratings, the subjects' self-reports of spasticity, and the Bf-S. Each spasticity measurement lasted about 15 minutes and was performed twice, with a 45-minute interval between measurements. The Bf-S was only completed once. These measurement sessions were performed as a control condition to detect any effects on spasticity from the Ashworth Scale and the transfers themselves.

After 4 weeks, each group performed the 3 interventions in a different order. Each intervention period comprised 8 treatments twice weekly for 4 weeks. Before the first session of each week, the subject went to the PT department for a mea-

Fig 2. Intervention S: subject sitting on a rocker board integrated in a wood stool.

Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Group I	**Control period**				**Intervention H**				**Break**		**Intervention R**				**Break**		**Intervention S**				
Mon or Tue	mpm	mpm	mpm	mpm	mHm	mHm	mHm	mHm	m		mRm	mRm	mRm	mRm	m		mSm	mSm	mSm	mSm	m
Thu or Fri					H	H	H	H			R	R	R	R			S	S	S	S	
Group II	**Control period**				**Intervention S**				**Break**		**Intervention H**				**Break**		**Intervention R**				
Mon or Tue	mpm	mpm	mpm	mpm	mSm	mSm	mSm	mSm	m		mHm	mHm	mHm	mHm	m		mRm	mRm	mRm	mRm	m
Thu or Fri					S	S	S	S			H	H	H	H			R	R	R	R	
Group III	**Control period**				**Intervention R**				**Break**		**Intervention S**				**Break**		**Intervention H**				
Mon or Tue	mpm	mpm	mpm	mpm	mRm	mRm	mRm	mRm	m		mSm	mSm	mSm	mSm	m		mHm	mHm	mHm	mHm	m
Thu or Fri					R	R	R	R			S	S	S	S			H	H	H	H	

Fig 3. Study protocol. Abbreviations: H, hippotherapy; m, measurement session; p, pause of 45 minutes in between measurement sessions; R, sitting astride a Bobath roll; S, sitting on a stool with rocking seat.

surement session (spasticity, well-being), then went in the wheelchair to the hippotherapy terrain (≈500m) for the intervention, and afterward was again measured in the PT department. In the week's second intervention, the subject went only to the hippotherapy terrain for the intervention and no measurements were taken. According to previous studies,[14,42] positive effects of hippotherapy can last as long as 1 week. Therefore, there was a break of at least 2 weeks with no interventions, but there was a measurement session in the first week after each 4-week intervention period. The subjects planned for their vacations or other absences to be taken during the breaks. Thus, there were no interruptions within the 4-week intervention period.

Subjects were asked not to change their medication during the study period, but if any such alterations were made, the subjects were asked to record them. During the study, subjects were not involved in any other PT interventions; they were asked to maintain their weekly routine of work, leisure, sports, etc. Additionally, they recorded the occurrence of any condition that might influence spasticity (eg, urinary tract infections).

All measurements and interventions were performed at the same time of day and on consistent days of the week (Monday and Thursday or Tuesday and Friday) to exclude any influence of differences in daily or weekly activities. With this protocol we aimed to assess short-term effects of the interventions, as well as any effects lasting longer than 4 days (time from second weekly intervention to the next first weekly visit). Our local ethics committee approved the study protocol.

Data Analysis

We calculated the differences in Ashworth scores' sums and VAS before and after the pause (during the control period), as well as before and after the intervention session (during intervention periods). For each subject and for each period we calculated a median of the differences. All the medians were grouped and significant differences between intervention periods and the control period were tested with the Friedman test and a post hoc multiple comparison test as described by Sheldon et al.[43] Pre and post within-group analyses were tested with the Wilcoxon signed-rank test to detect a significant immediate effect on Ashworth scores' sums and VAS medians.

We tested carryover effects lasting longer than 4 days with data from each first spasticity measurement by rank methods for longitudinal data.[44]

We analyzed data from the Bf-S by comparing the means of the before-session test scores with the means of the after-session test scores of each intervention separately with the Wilcoxon signed-rank test to detect an immediate effect. We tested a long-term effect on well-being by calculating a baseline mental well-being (mean of the first 4 test scores of the control period) and comparing it with the scores assessed after each 4-week period of intervention with the Friedman test. Statistical significance was set at the 5% level. We used SPSS[c] for Windows for the statistical analyses.

RESULTS

One subject withdrew because of health problems unrelated to the study's interventions. The remaining 11 subjects had 100% compliance with the interventions; none recorded any changes in their weekly routine or any health conditions that might have influenced the study results. The mean age of the 11 subjects was 44 years (range, 27−68y), mean time postinjury was 13.1 years (range, 1.5−39.9y). The sample included 3 men with tetraplegia and 8 men with paraplegia (table 1). The subjects' baseline spasticity (median of the 4 Ashworth scores' sum before-values during the control period) ranged from 7 to 24 (see table 1). Effects on mental well-being could be analyzed by the Bf-S values of 9 subjects—we did not assess the Bf-S of subjects 1 and 2. The baseline mental well-being of the 9 subjects ranged from 0 to 32.8 (see table 1).

Short-Term Effects

Spasticity: clinically rated. Analyzing the change in the clinically rated resistance against passive movements, using the Ashworth scores' sum data, there was a significant difference in the changes caused by the 4 conditions (control and 3 interventions; $P=.003$). Post hoc multiple comparisons detected a significant difference ($P<.05$) between the reduction of Ashworth scores' sum caused by intervention H in comparison to the change of Ashworth scores' sum in the control condition, whereas the reductions caused by the other 2 interventions did not reach significant differences as compared with the changes in the control condition (table 2).

Pre and post within-group analyses showed significant differences between Ashworth scores' sum medians before and after each session in all 3 interventions ($P=.004$, $P=.003$, $P=.005$, respectively); there was no significant difference between the first and the second Ashworth scores' sum median in the control condition ($P=.083$).

Table 1: Subject Characteristics

Subject No.	Age (y)	TPI (y)	LL and ASIA Grade	Baseline Spasticity ASS	Baseline Well-Being Bf-S Score
1	49	5.8	T1, B	12.0	NE
2	34	16.2	C7, B	7.5	NE
3	39	12.2	T5, A	9.5	4.3
4	59	1.8	T10, A	24.0	17.8
5	42	1.5	T8, A	17.0	4.5
6	44	21.0	T4, A	10.5	7.3
7	31	10.7	C7, A	7.0	32.8
8	45	3.0	T5, A	15.5	0.0
9	47	26.7	T4, A	7.0	3.0
10	68	39.9	T9, A	10.5	12.3
11	27	4.8	C7, B	7.0	12.5

NOTE. Baseline spasticity is defined as the median of the 4 Ashworth scores' sum before-values during the control period. Baseline well-being is calculated by the mean of the 4 Bf-S scores measured during the control period.
Abbreviations: ASS, Ashworth scores' sum; LL, lesion level; NE, not evaluated; TPI, time postinjury.

Spasticity: self-reported. Analyzing the effect on the self-reported spasticity, using the VAS data, there was again a significant difference between the 4 conditions (P=.043). Post hoc multiple comparisons detected significant differences (P <.05) between the effects on VAS between interventions H and R and between interventions H and S (table 3).

Pre- and post- within-group analyses showed significant differences between VAS medians before and after each session in the interventions H and R as well as in the control condition (P=.004, P=.014, P=.021, respectively); there was no significant difference between VAS medians before and after each session through intervention S (P=.181).

Well-being. Analyzing the immediate effects of the 3 interventions on subjects' mental well-being, we found significantly lower scores after intervention H than before (P=.048), which represents an improved mental well-being. There were no significant changes in the Bf-S scores caused by interventions R and S (P=.933, P=.497, respectively).

Long-Term Effects

Spasticity. There was no spasticity-reducing carryover effect that lasted as long as 4 days (from second weekly intervention to the next first weekly visit) and no long-term effect over the 4 weeks of treatment for any of the 3 interventions. This was true for all data, clinically assessed as well as self-reported with VAS.

Well-being. There was no significant difference between baseline mental well-being and the Bf-S scores assessed after each 4-week period of intervention.

DISCUSSION

In this study, we assessed the extent of spasticity reduction for 3 different interventions by both clinical and self-report measures in spastic SCI subjects. There was an immediate reduction of spasticity by hippotherapy, as demonstrated by both the clinical and the self-rating scores. Only the subjects discerned differences between the effects of the 3 interven-

Table 2: Effects of the Different Conditions (C, H, R, S) on Clinically Rated Resistance Against Passive Movement

Subject No.	Medians of ΔASS			
	C (C vs H: *)	H	R	S
1	−1.5	−5.0	−1.0	−1.5
2	1.5	−2.5	−1.0	−1.0
3	−0.5	−3.5	−1.0	−1.0
4	−2.0	−2.5	−1.0	−2.5
5	0.5	−4.5	0.0	−1.5
6	0.0	0.5	−2.0	−1.0
7	−1.0	−1.0	−1.5	−1.0
8	−1.5	−3.0	−2.5	0.0
9	0.0	−2.0	−1.0	−0.5
10	−0.5	−8.0	−1.5	−2.5
11	−1.0	−4.0	−3.0	−1.0

NOTE. Median differences between ASS before and after the interventions (H, R, S) or between first and second measurements during the control period (C); a negative value stands for a reduction in clinically rated spasticity.
Abbreviations: C, control period; H, hippotherapy; R, sitting astride a Bobath roll; S, sitting on a stool with rocking seat.
*Significant difference at P<.05.

Table 3: Effects of the Different Conditions (C, H, R, S) on Self-Rated Spasticity

Subject No.	Medians of ΔVAS (cm)			
	C	H (H vs R: *; H vs S: *)	R	S
1	−1.05	−1.10	−0.05	−0.45
2	−2.95	−4.60	0.05	−0.25
3	−0.40	−0.30	−0.05	−0.70
4	−0.55	0.05	−0.25	−0.15
5	0.30	−1.40	−0.85	−0.45
6	1.10	−1.25	0.20	−0.80
7	−0.65	−0.95	−0.05	−0.30
8	−1.75	−1.10	−1.10	1.55
9	−0.80	−1.70	−0.10	0.30
10	−0.20	−0.70	−0.30	−0.35
11	0.10	−0.70	−0.40	0.00

NOTE. Median differences between VAS before and after the interventions (H, R, S) or between first and second measurements during the control period (C); a negative value stands for a reduction in self-reported spasticity.
Abbreviations: see table 2.
*Significant difference at P<.05.

tions. Neither subjects nor physiotherapists detected long-term effects of the interventions on spasticity. Additionally, we evaluated the effect of the interventions H, R, and S on mental well-being. Temporary improvements in mental well-being were detected only after hippotherapy.

Short-Term Effects

Spasticity: clinically rated. The clinically rated data showed a significant difference between the reductions in spasticity by H compared with no intervention. Effects of the 2 other interventions (R, S) did not reach significant levels compared with the control condition. Meregillano[15] stressed the importance of sensory input through precise and repetitive movements provided by the horse's walking motion that are imposed on a subject's pelvis, lumbar region of the spine, and hip joints. The resultant movement responses in the patient are similar to human movement patterns of the pelvis while walking, including the physiologic rotation movement in the trunk. The concept of Bobath[45] emphasizes the importance of the rotation between pelvis and shoulder girdle or vice versa, as well as equilibrium reactions and postural reactions in the dissociation of spastic patterns. Strauss[25] attributed the unique spasticity-reducing effect of hippotherapy to this concept. Our data support the finding that neither the inhibiting saddle position nor the rhythmic lateral flexion of the trunk alone is sufficient to compete with hippotherapy in the treatment of patients with SCI. It is the combination of an inhibiting sitting position and rhythmic movements that produces these benefits. Additionally, the horseback movement not only applies a sagittal movement on the patient's pelvis, as our rocking board did, but also a complex 3-dimensional displacement. Moreover, the warmth of the horseback, the dangling of the lower legs following the movement of the pelvis, and the physiotherapist's controlling of subject's sitting position, may have an effect on muscle tone.[15,24,25] Spasticity is a malfunctioning of spinal circuits caused by an abnormal descending control of spinal pathways and local changes at the spinal level.[46] The walking movement of an able-bodied person causes reciprocal inhibition (by spinal circuitries). The alternating rhythmic movement of subjects' legs and pelvis while sitting on the walking horse may also act as proprioceptive afferent impulses, causing reciprocal inhibition on a spinal level. For this reason, we presume that intervention H has a superior effect on spasticity compared with the other 2 interventions.

It is remarkable that we found significant differences between the Ashworth scores' sum medians before and after each session for all 3 interventions. There was no significant difference, however, between the first and the second Ashworth scores' sum in the control period. Thus, the testing procedure alone did not significantly reduce resistance against passive movement. We found an immediate spasticity reduction after all 3 interventions, but comparing the magnitude of the effects of the 3 interventions with the effect of the testing procedure alone provides evidence that the benefits of hippotherapy on spasticity cannot be achieved by the other 2 interventions.

Spasticity: self-reported. It is noteworthy that subjects rated the effect on spasticity differently than did the physiotherapists. Subjects indicated a significant difference of spasticity reduction between H and R and between H and S, but they did not detect any difference between the effect of the testing procedure alone and the effect of any of the 3 interventions.

Looking at the immediate effects of the interventions H, R, and S on the subjective rating, we found a significant reduction between before and after values in the interventions H and R. There was no detected spasticity reduction through intervention S, however. Interestingly, subjects indicated a significant immediate subjective spasticity reduction through the testing procedure alone.

There may be different reasons for the discrepancy between the rating of the physiotherapist and subjects' self-ratings. The control period was the beginning of the study for each subject, and using VAS to indicate their spasticity was a new experience for all 11 subjects. They still felt less spasticity during the second motion sequence (transfer from chair to bed, lying down supine, sitting up on bed) that took place 45 minutes after the previous testing procedure. In a previous study,[29] only poor-to-moderate correlations between clinically rated and self-rated spasticity were shown, indicating that persons with SCI attributed different sensations (eg, pain) to their self-reported spasticity. This may have also occurred in this study. The clinical rating used incorporates only resistance against passive movements of the lower extremities, whereas the subjects may include high muscle tone or spasms in other body segments (eg, trunk muscles) in the VAS. Additionally, the fact that subjects could not be blinded to the intervention, but the examiners who did the clinical spasticity ratings were blinded, could be another reason for discrepancies.

Well-being. Concerning the short-term effect, our hypothesis that hippotherapy improves mental well-being of SCI subjects was corroborated. Although the subjects were given the same attention by a physiotherapist during all 3 interventions, we detected a slight improvement of subjects' mental well-being immediately only after the hippotherapy. According to Westgren and Levi and the Stockholm Spinal Cord Injury Study,[47] problematic spasticity affects—in addition to other components of quality of life—vitality, social function, role function (emotional), and mental health. Consequently, the temporary spasticity reduction and the concurrent improvement in mental well-being through hippotherapy may be related to each other. Additionally, the Bf-S scores may have been influenced by the psychologic effect of the contact with a large animal, as described by Meregillano,[15] as well as the fact that subjects were not blinded to the interventions and knew that they were participating in a study to test the effect of hippotherapy (Hawthorne effect). It is therefore not surprising that after hippotherapy there was a temporary improvement in the sense of well-being.

Long-Term Effects

Spasticity. In contrast to the short-term effect, we could not detect significant long-term effects by any of the interventions. With our study protocol we were only able to investigate spasticity-reducing effects covering more than 4 days, because the next measurement session was not earlier than 4 days after the last intervention.

Exner et al[14] studied the duration of hippotherapy's effect on spasticity of persons with SCI and found that in more than 20% of subjects spasticity could be reduced by hippotherapy for more than 36 hours, and for more than 24 hours in 33% of the subjects. ROM could be improved in two thirds of subjects with reduced joint movement for as long as 1 week. Hippotherapy sessions were held once a week and the authors stated that holding them more frequently could be beneficial. In the Swiss Paraplegic Centre, where our study was performed, patients usually receive hippotherapy twice a week. Because we wanted to keep our study protocol closely similar to our clinical practice, we did our interventions twice weekly. With this schedule, participants had to drive from home to the rehabilitation center twice weekly. We did not want to burden them with a third visit, therefore the measurements had to be taken on 1 of the 2 visits. Choosing a shorter time interval between intervention session and spasticity measurement might have provided information about effect duration. Moreover, the small sample size and the high fluctuation of spasticity made it impossible to study carryover effects. Previous work[23] showed that the highest short-term improvement was observed in patients with severe spasticity. Further research with a larger sample size and with subjects with higher muscle tone is needed to validate long-term effects.

Well-being. We did not detect any long-term effects with the Bf-S because of the large fluctuation over time in a person's mental well-being. According to Lienert,[30] a test to evaluate a person's present mental well-being must not be very time-invariant, because the construct *mental well-being* itself implies large variations. The coefficient of stability of the Bf-S drops when the interval between measurements is more than 1 or 2 days.[31] A longitudinal analysis of the Bf-S scores showed a high variability; any interactions with interventions could therefore not be detected.

Study Limitations

One limitation of the study was our inability to double blind it, which is impossible in therapeutic interventions when movement is involved. Another limitation was the fact that not all possible orderings of conditions could be included in the design. The lack of carryover effects from 1 intervention to another showed that this limitation might not have influenced the outcome however.

CONCLUSIONS

In this study it was shown that hippotherapy reduces spasticity for a short time and temporarily improves mental well-being in persons with SCI. Sitting astride a Bobath roll (stretching) or on a rocking seat (rhythmic passive movements) did not achieve the same effect. Subjectively, the subjects felt better and less spastic after hippotherapy. With the chosen measures, we could not detect any carryover effects on spasticity or mental well-being. After hippotherapy sessions, our subjects experienced a period of time of less spasticity and an improved sense of well-being. Such time periods could be of help during rehabilitation to motivate a recently injured patient and engage him/her in more functional activities. Therefore, hippotherapy may be a meaningful supplement to SCI rehabilitation programs.

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Suppliers

a. OBA AG, Auf dem Wolf 20, CH-4002 Basel, Switzerland.
b. Novotec Medical GmbH, Durlacher Str 35, D-75172 Pforzheim, Germany.
c. Version 13; SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.