Hippotherapy simulator would improve stability in patients with multiple sclerosis

Running title: Hippotherapy simulator in MS

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Abstract: Multiple sclerosis (MS) causes various problems due to progressive disease with different disabilities and complications. Rehabilitation is performed with the aim of increasing activity and improving independence in patients with MS. We aim to evaluate the effects of hippotherapy on stability in patients with MS. In this clinical trial, 28 MS patients (67.9% female with mean age of 41.28±9.79 years) received 30 minutes of treatment with hippotherapy simulator device 3 sessions a week for 12 weeks. Falling risk, postural stability, Berg Balance Scale (BBS) and Expanded Disability Status Scale (EDSS) before and each four weeks after the intervention were evaluated. Falling risk, postural stability, BBS and EDSS were significantly improved during treatment period ($p<0.001$). Sixteen patients (57.14%) had more than 10% improvement. Cox regression analysis showed no relation between time to BBS improvement and hippotherapy ($p=0.026$). Using hippotherapy simulator would improve postural stability and fall risk in MS patients. However, patients do not have same improvement. Further studies are needed to evaluate the exact efficacy of this device.

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Introduction

Multiple sclerosis (MS) is a common autoimmune disease that affects central nervous system. The disease is unpredictable, and when occurs, gradually debilitates the patient (Kesselring and Beer, 2005; Shinto et al, 2008). Disease progress includes progressive weakness with limitation in stability and movement and has negative effects on quality of life. All treatment efforts are in order to delay the disease progress and Rehabilitation is performed with the aim of increasing activity and participation level and improving independence in patients with MS (Langdon and Thompson, 1999).

Horse-related therapies including horse-back riding and hippotherapy are physical therapy strategies with well-known effects in some neurological disease with locomotor disability (Munoz Lasa and Franchignoni, 2008). The main effects of hippotherapy are to improve harmony between muscles, reduce muscle tone, keeping the postural stability, improving gait and weight bearing (Bass et al., 2009; Lechner et al., 2003; Lechner et al., 2007; McGibbon, Benda, Duncan and Silkwood-Sherer, 2009; Shurtleff et al., 2009). A systematic review by Bronson et al. (2010) showed that hippotherapy has positive effects on MS patients and improves their quality of life.

Hippotherapy simulator is a newly introduced device that simulates horse movement and in comparison to the real horse has more safety. The device is used in treatment of muscle weakness and balance disorder in few neurological diseases such as spastic cerebral palsy (Herrero et al, 2012; Silva e Borges et al, 2011). The simulator produces simple movements which lead the person to experiencing the feelings of real horse riding. The improvement of muscular power and muscular strengthening are attainable only by the action of sitting down and keeping the balance. As MS is a progressive neurologic disorder, in this report we evaluated the effect of hippotherapy simulator on improving stability indexes in patients with MS.

Methods

In this clinical trial, 28 patients with MS were studied. MS patients aged 18–60 years were randomly selected from a list of clinic patients and approached for recruitment into the study until 28 cases were enrolled. Definite diagnosis of MS in all patients were based on clinical manifestations and performing MRI according to McDonald's criteria. MS patients with the ability to stand upright for at least 1 minute and with no history of prior orthopedic or other non-MS-associated conditions or prior hippotherapy were included. MS patients who have undergone an amputation or with CVA or Diabetes were excluded. The Expanded Disability Status Scale (EDSS) has a possible range from 0, indicating no disability and normal neurological examination, to 10, referring to death due to MS. For this study we included people able to walk at least 100 meters with or without aid (EDSS score between 4.5 and 6). The informed, written consent had been obtained prior to the procedure from all patients. The study protocol was approved by the Ethic committee of Tabriz University of Medical Sciences.

The hippotherapy simulator used for this study is therapeutic apparatus called Joba® EU6441 (Panasonic Electric Works Co., Osaka, Japan) to reproduce the movement of the saddle during horseback riding. The time, tilt and speed adjustment allows for unequivocally defining the test parameters. One movement cycle of the simulator is a set of back and forth swing/slide of the saddle, swaying left and right and returning to the initial position. Movement speed of the simulator ranges from 0.62 Hz to 1.21 Hz. There are three predefined tilt levels; basic conditioning (flat), forward tilt, backward tilt. During the treatment sessions, patients maintain a sitting position on the simulator. The therapist helped the patients be safe by stabilization of patients' pelvis and holding the saddle.

All patients received 30 minutes of treatment with hippotherapy simulator device 3 sessions a week for 12 weeks. Patients were evaluated before starting the hippotherapy (Baseline) and each 4 weeks by measuring Berg Balance Scale (BBS), EDSS, falling risk and postural stability.

The Berg balance scale (BBS) is used to measure a subject's ability to maintain balance while doing functional tasks. The BBS assesses the static and dynamic balances by using usual tasks, such as reach, standing position, and transferences. The test includes fourteen items that are common in everyday life. Each item of the BBS is rated on a 5-point scale. In this study we evaluated overall BBS score before and after each treatment session.

The falling risk and postural stability were measured using Balance system SD BIODEX. At the end of the study, changes in outcome measures were evaluated. This equipment has the ability to measure many components of balance, such as percent weight bearing, amount of lateral weight shifting, limits of stability, and postural control. The Fall Risk test allows identification of potential fall candidates. Test results are compared to age dependent normative data1. Scores higher than normative values suggest the potential to fall. To compute Fall risk, the results of the five trials (5 trials x 20 seconds, 30 seconds rest) are collected and averaged by the software and displayed to the right of the age related Predictive Value. A high number is indicative of poor neuromuscular control, which may increase the potential for orthopedic injury or falling. The Postural Stability Test emphasizes a patient's ability to maintain center of balance. The patient's score on this test assesses deviations from center, thus a lower score is more desirable than a higher score.

Data analysis:

Statistical analyses were performed using the Statistical Package for Social Sciences, version 17.0 (SPSS, Chicago, Illinois). Quantitative data were presented as mean ± standard deviation (SD), while qualitative data were demonstrated as frequency and percent (%). Serial changes during sessions were compared using repeated measure of ANOVA. The Cox regression analysis was used to evaluate the optimal time to reach 10% improvement by hippotherapy. A p value <0.05 was considered significant.

Results

Twenty-eight MS patients including 9 male and 19 female with mean age of 41.28±9.79 years were included in this clinical trial.

Patients' stability status during the study period is demonstrated in Table 1. Overall stability index and fall risk were significantly improved during the treatment period ($p<0.001$). EDSS was also decreased during the therapy sessions ($p<0.001$); it was 5-5.5 score which reduced to 4.5-5, indicating functional improvement. BBS increased with therapy sessions and accompanied with improvement in balance and posture of patients.

Overall, 16 patients (57.14%) gained over 10% improvement. Cox regression analysis was used to define the time to gain 10% improvement of BBS (figure 1). The analysis showed no effect of hippotherapy simulator on BBS

improvement (p=0.26), as not all patients reach the improvement the same time and with the same amount. However, it could be noted that hippotherapy simulator improved all patients overall stability and postural state to some extents.

Discussion

In hippotherapy, horse movements stimulates the cooperation between pelvis and body which along with the horse's body temperature causes muscle tone improvement (Heine, 1997). However there are several obstacles that complicate clinical application of hippotherapy like difficulties to access riding centers, high expenses of horse riding and fear of some patients from the horse which make them reject the therapy. Similar advances are observed in hippotherapy simulator, with exception that there is no probability to observe hippotherapy complication in a simulator such as bone fractures and serious injuries due to falling from the horse or kicks (Ball et al., 2007; Kiuru et al., 2002; Siebenga et al., 2006; Thomas et al., 2006). The simulator could imitate movements in three positions similar to horse movements and though prepare similar efficacy with more safety and availability. The hippotherapy simulator is more precisely reproducible and standardized for therapeutic purposes (Shinomiya

In this study we evaluated the effects of hippotherapy simulator device on the stability of 28 MS patients and observed that this therapy improves the patients' stability and balance. BBS and EDSS were both improved during therapy demonstrating a better balance and less dependency to other people in these patients.

Previous studies have evaluated effects of hippotherapy (horseback riding) on MS patients (Branson et al., 2010; Hammer et al., 2005; Muñoz-Lasa et al., 2011; Silkwood-Sherer et al., 2007). In the literature, it is shown that all evaluated stability markers were improved by hippotherapy. Using BBS, significant improvement in balance is reported after therapy by Silkwood-Sherer et al. (2005) and Hammer et al. (2007). In this report, for first time we have evaluated the effects of hippotherapy simulator device on these patients and observed promising results in improving BBS, EDSS and fall risk.

All previous studies performed hippotherapy sessions between 7-12 weeks and there is no study evaluating the time to achieve optimal improvement. However, we found no correlation between hippotherapy simulator therapy sessions with improvement of BBS. However, we observed that the more sessions of hippotherapy are used, the more functional improvement in MS patients is achieved.

Considering the reported efficacy of hippotherapy simulator in improving patients with various neurological disabilities (Herrero et al, 2012; Silva e Borges et al, 2011) and the findings of the current study, using the simulator as an available tool with less expenses in comparison to using horses in treating these patients could be very helpful.

This study was a preliminary study evaluating the effects of hippotherapy simulator on postural stability of MS patients. However, it is confounded to some limitations; the major limitations include small sample size, lack of long-term follow-up and no control group. As we had no control group, we could not compare the results and define whether the hippotherapy simulator treatment caused the improvement or another factor.

Table 1. Patients' stability status during the study period

Postural Stability	Before therapy	4th week of therapy	8th week of therapy	12th week of therapy	P value
Overall stability index	0.82±0.36	0.71±0.31	0.56±0.26	0.45±0.26	<0.001*
Anterior/posterior index	0.69±0.27	0.58±0.24	0.45±0.21	0.33±0.23	<0.001*
Medial Lateral index	0.49±0.31	0.40±0.23	0.30±0.16	031±0.35	<0.001*
Fall risk test	3.25±1.28	2.62±1.04	1.57±0.81	1.42±1.37	<0.001*
EDSS	5.23±0.31	5.01±0.37	4.87±0.39	4.78±0.41	<0.001
BBS	45.75±5.10	45.96±3.93	16.67±4.13	49.10±4.40	<0.001*

* p is two-sided significant. EDSS: Expanded Disability Status Scale; BBS: Berg Balance Scale.

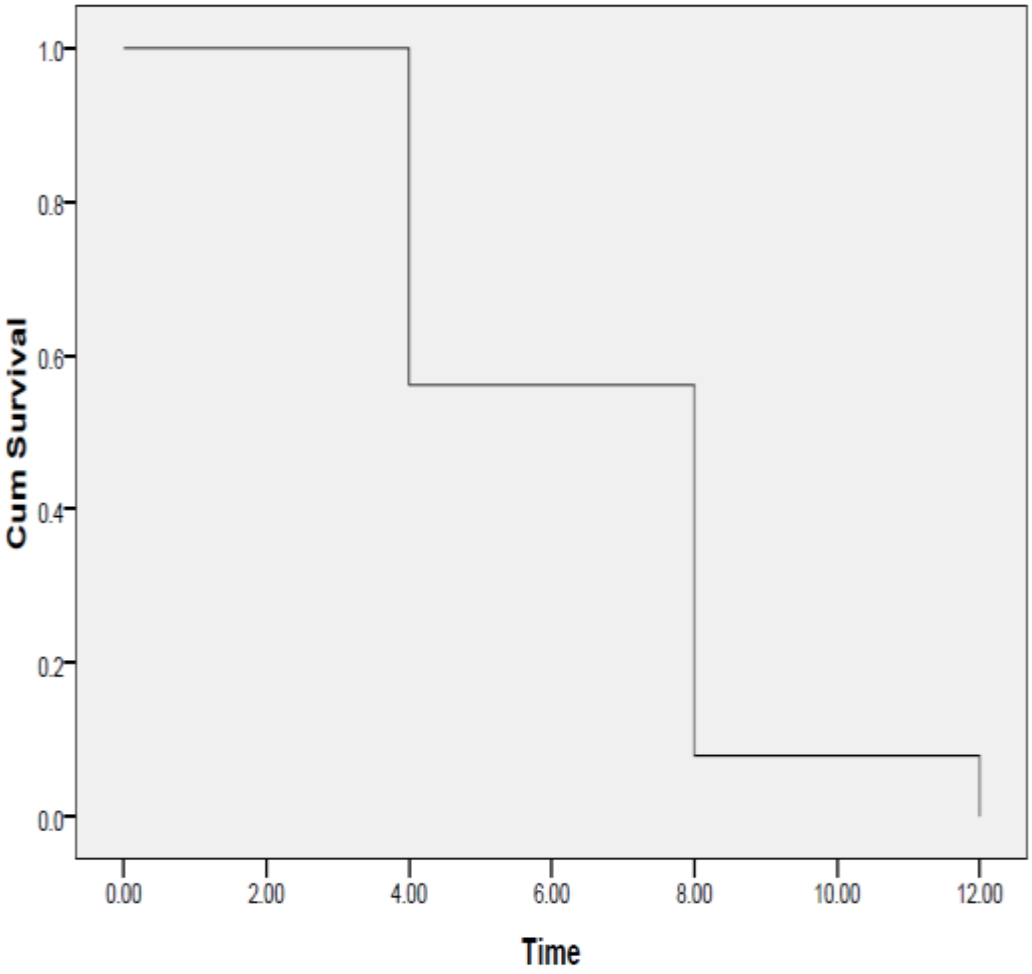

Figure 1. Cox regression analysis

Conclusion

Using hippotherapy simulator would improve postural stability and fall risk in MS patients. However, patients do not have same improvement. The treatment period is recommended for at least 12 weeks for all patients. Further randomized clinical trial studies are needed to evaluate the exact efficacy of this device.

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Disclosure section:

The authors report no conflicts of interest.

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