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Hippotherapy on Gross Motor Function in a Child with Hypotonic Quadriplegic Cerebral Palsy: A 1-year Follow-up

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Hippotherapy is used to improve gross motor function in children with cerebral palsy (CP). However, the therapeutic effects of hippotherapy using specific position and its longitudinal improvements in children of hypotonic CP have not been thoroughly examined. A 6-year-old girl with hypotonic quadriplegic CP was noted to have generalized hypotonia and global delay in development before intervention. There was sustained improvement in gross motor function after 12-month hippotherapy. She received a 15-minute intervention twice a week for one year with two treatment positions being used, sitting backwards for the first 3 months and prone propped position for the next 9 months. Gross motor function was measured using Gross Motor Function Measure (GMFM-88), Gross Motor Function Classification System (GMFCS), and selected GMFM-88 items assessed on horseback (GMFM-h). The improvement was limited after initial 3-month hippotherapy with sitting backward; however, marked improvement was noted after replacing the sitting backwards program by prone propped position in the following courses. GMFM scores increased from 31.37% to 82.35% and from 0 to 25% in dimension A and B, respectively. GMFCS improved from Level V to Level IV and GMFM-h total scores also increased from 29.17% to 81.25% after the prone propped treatment. We suggested that hippotherapy might enhance gross motor performance and functional ability in hypotonic CP with appropriate treatment position. (Tw J Phys Med Rehabil 2008; 36(3): 177 - 185)

Key Words: cerebral palsy, hypotonia, hippotherapy, prone propped, gross motor function

INTRODUCTION

Cerebral palsy (CP) is a heterogeneous group of disorders affecting the brain and leading to impaired motor abilities and other aspects of development. CP is characterized by abnormal muscle tone (e.g. hypertonia or hypotonia), posture, gross motor function, reflexes, motor development and coordination. However, CP characterized by severe hypotonia involved in the upper and lower
extremities is uncommon. In addition to physical and occupational therapy, hippotherapy is now becoming an alternative approach for CP children with impaired motor function. However, studies of hippotherapy in hypotonic CP have been limited thus far.

Hippotherapy utilizes the nature movement of a walking horse to improve client’s posture, balance, and overall function. Its inclusion as part of an integrated treatment plan to enhance therapy outcome is by the added benefit of engaging and motivating the child. However, hippotherapy is not recommended for children of age under 2 years, seizure disorder, scoliosis, and dislocated hip because of the potential hazards. Hippotherapy has been used for decades in the treatment of CP. Sterba et al. reported hippotherapy may improve gross motor function in children with CP, which may reduce the degree of motor disability. Haehl et al. demonstrated in two subjects that hippotherapy improved postural stability using a kinematic analysis of the rider’s trunk and the horse’s back in relationship with each other. McGibbon et al. also demonstrated that hippotherapy may improve energy expenditure during walking and gross motor function in children with CP. Cherng et al. reported that hippotherapy may be beneficial for gross motor function in some children with spastic cerebral palsy and this effect appears to be sustained for at least 16 weeks. Current evidence suggests that hippotherapy is individually effective, and is medically indicated as therapy for gross motor rehabilitation in children with spastic CP. These reports suggest that therapeutic riding contributes to spasticity reduction, weight shifting ability, and balance and postural control of the trunk.

In hippotherapy, the horse is used as a treatment modality similar to the therapeutic balls and bolsters typically used in pediatric physical therapy clinics. A therapist places the child rider in various positions on the horseback, such as supine, prone, prone backwards, sitting backwards, or sitting sideways to facilitate desired postural reactions and motor responses. The prone position is defined as being when the rider is prone over the horse’s barrel; and the prone propped position is defined as being when the rider is prone over the horse’s barrel, propped on both elbows, with weight bearing equally on shoulder joints and across the shoulder girdle (Figure 1). The prone propped position is a functional skill and there are very few published studies measuring its effects on improving gross motor function in children with hypotonic CP. Clearly, both of the positions (prone and sitting) on horseback can activate axial extension of the back and facilitate head control to improve gross motor function in children with spastic CP. Yet the effects of the two positions utilized in hypotonic CP are still unclear due to limited evidence of its effectiveness.

The Gross Motor Function Measure (GMFM) and Gross Motor Function Classification System (GMFCS) may provide information for planning of service provision and documenting therapeutic outcome in children with CP. GMFM has been developed for children aged under 20 months or up to a motor age of 5 years old as a means of measuring the degree of change in gross motor function for clinical and research purposes. The GMFCS has recently been developed for clinical practice in children with CP under 12 years of age. The reliability and validity of GMFM and GMFCS has been previously established. In many studies of hippotherapy, GMFM and GMFCS were constructed specifically to determine whether treatment approaches were effective for children with CP and have been used by researchers as an outcome measure for therapy.

Hippotherapy appears to be a viable means of improving functional outcome in children with CP. However, the therapeutic effects for the specific position and its longitudinal improvement of hippotherapy on children with hypotonic CP have not been investigated. This case report describes a 12-month hippotherapy intervention in 2 positions, i.e., sitting backwards and prone propped approached to increase gross motor function and to facilitate the motor control of head/neck and upper back extensors in a child with hypotonic CP.

### CASE REPORT

**Patient history and pretreatment assessment**

This 6-year-old girl had hypotonic quadriplegic CP secondary to bacterial meningitis when she was 10 months old. At 1 year of age, a ventriculo-peritoneal shunt (VP shunt) was placed to manage hydrocephalus. The subject received physical therapy in a local clinic since she was 3.5 years of age but with limited improve-
ments. Her parents, therefore, brought her to our center to receive hippotherapy treatment according to a pediatric physician’s suggestion. At 5 years of age, the girl received her initial hippotherapy treatment. At that point, she was not receiving regular therapy during the period of time covered by the report. This case report was approved by the Institutional Review Board of Hungkuang University, Taiwan. Informed consent was obtained from her parents.

The subject was selected for this case report because she was the only hypotonic CP in our therapeutic riding center and hippotherapy has seldom been applied for a patient with hypotonia in previous studies. She met the established selection criteria for hippotherapy in our center: absence of allergies, cancer, recent major surgery, diabetes, peripheral vascular disease, varicose veins, hemophilia, hypertension, serious heart condition, seizure disorders, and cerebrovascular accident. Prior to intervention, she was assessed for developmental status and the findings suggested severe global delay with developmental age at 2-3 months old. She was noted to have marked generalized hypotonia in her extremities, trunk and neck, and had no contractures in the knees, hips, elbows and ankles. In supine, she could turn her head slowly and orient to auditory stimuli and exhibited severe head lag with minimal contraction of neck flexors when pulled to sit. In prone, she could lift her head up briefly to 45 degree asymmetrically and could not assume prone on elbow. When placed in supported sitting, she presented substantial shoulder protraction and round back. Fine motor ability was also severely impaired with no functional use of hand. She could grasp when object was placed in hand and had difficulty in engaging both hand in the midline. Examination of visual function revealed subtle responses to light and no visual tracking. Cortical blindness was impressed by physician. She could orient to sound, however. Assessment of communication showed impaired expressive and receptive language. She could only make vocal sounds that were understood only by her parents. Despite profound delay in development, her parents cooperated well and involved actively and showed positive attitude to intervention. During the course of hippotherapy, she did not take any medication.

Hippotherapy intervention

Hippotherapy was conducted at the Therapeutic Riding Center of Taiwan, Chungli. It was administrated by a therapeutic riding team consisting of a physical therapist experienced in hippotherapy, a certified riding instructor of North American Riding for the Handicapped Association (NARHA) and a horse leader. The horse chosen was a 20-year-old pony gelding of a Chinese breed. The trained hippotherapy horse had the following characteristics: exemplary temperament, good health, constant length of stride, and free rhythm with a symmetrical walking movement. The subject wore a fitted helmet and used the same pony for every treatment session. The pony was equipped with a vaulting surcingle that was selected to help the subject to stretch the tight adductors. In addition, for added comfort of the horse and patient rider a thick pad under the surcingle was used. The 12-month hippotherapy course was performed in two 15-minute sessions a week. For the first 3 months she was sitting backwards on horseback with sufficient support if the pelvis and trunk for maintaining an upright midline position. For the subsequent 9 months, we changed the treatment program by using the prone propped position.

In the first 3 months, the treatment sessions were divided into three parts of equal length (Table 1). The first 5 minutes after mounting were used as a warm-up phase, during which the horse walked around the arena (45 meters in length × 20 meters in width) with the subject facing forwards on the horse and becoming accustomed to the horse’s width and movement. For the next 5 minutes, the subject sat backwards with the horse walking on the left rein stopping at the midst of the long sides with a 20-second rest. The last 5 minutes, the subject sat backwards with the horse changing to the right rein.

Due to limited improvement in head and neck control (Table 2), after 3 weeks, the prone propped position was used (Figure 2). This technique was proposed by Barbara Heine, former President of American Hippotherapy Association, at the annual meeting and symposium of the Deutsches Kuratorium für Therapeutisches Reiten in 2006. The therapy in our case was two 15-minute sessions a week for 9 months. One treatment session was divided into three parts of equal length. The first 5 minutes served as a warm-up phase during which the horse walked around the arena with the subject prone over the
horse’s barrel and becoming accustomed to the horse’s movement. For the next 5 minutes, the subject was prone propped on both elbows, weight bearing equally on shoulder joints and across the shoulder girdle with the horse walking on the left rein. To avoid retching and vomiting induced by an increase in prone-induced abdominal pressure, the treatment duration for prone propped position was less than 15 minutes. Therefore, for the last 5 minutes, the subject was placed in an upright position and sat sideways to provide a large base of support on the horse and avoid overstretching the child’s VP shunt thereby allowing the child’s body to calm. The focus of this treatment was threefold: 1) work on trunk strength secondary to increasing upper extremity activity, 2) facilitate an upright trunk and increase the use of back extensors and 3) promote good control of the head.

**Instrumentation and testing procedures**

The motor function abilities were measured using the Gross Motor Function Measure (GMFM), Gross Motor Function Classification System (GMFCS), and GMFM assessed on horseback (GMFM-h). The GMFM-88 consists of 88 items grouped into five subscale dimensions, including lying and rolling, sitting, crawling and kneeling, standing and walking, running and jumping. Each item is scored on a 4-point Likert scale. A percentage score was calculated for each dimension. The intraclass correlation coefficients for inter-observer reliability ranged from 0.87 to 0.99 and intra-observer reliability ranged from 0.92 to 0.99 for the 5 dimensions had been reported. The validity of GMFM was also considered acceptable. The GMFCS for children with CP is based on a 5-level grading, with an inter-rater reliability of 0.84 and content validity has been established. For the hypotonic quadriplegic CP in this case report, selected items of GMFM-88 were used for assessing gross motor function on horseback when the case was in prone, prone propped and sitting positions. The reasons for GMFM-88 item selection for assessment using on horseback were due to the case’s current level of motor ability and feasibility of item administered on the horse back. The modified motor assessment chart referred to as GMFM-h which had not been validated and systematically investigated its psychometric properties was tentatively modified by our team for this study. There were 16 items in GMFM-h, including the items 10-15 (Dimension A) and 18, 21-24 (Dimension B) of GMFM-88, respectively. Items 10-13, 18 and 21-24 of GMFM-88 in GMFM-h assessed the patient’s gross motor function on a walking horse and items 14 and 15 were performed on a resting horse. Each item was scored on a 4-point Likert scale the same as the GMGM. Subject was videotaped on each GMFM-h test date. Item agreement was reported to be 90% between the two scorers using videotapes of three children who did not participate in this case report performing the GMFM-h test items. One scorer was a pediatric neurologist with 10 years of pediatric experience. The other scorer was a physical therapist who received formal training in the use of the GMFM and achieved criterion with GMFM in 2000.

GMFM-88 Dimensions A and B were measured before treatment, at the 3rd, 6th, 9th and 12th months following hippotherapy interventions. GMFCS was measured at the beginning (prior to hippotherapy), 3rd (end of hippotherapy in sitting backwards position) and 12th month (end of hippotherapy in prone propped position) of hippotherapy treatment. The patient’s head/neck motor function and gross motor function were also assessed for GMFM-h once a month. These data were determined by a physical therapist and a pediatric neurologist who were blind to the position of hippotherapy the child received.

**Treatment outcomes**

The case report indicates that the patient’s gross motor function was greatly improved by 12 months of hippotherapy when compared with the scores before therapy. Nevertheless, after intervention with the sitting backwards position, she still sat totally supported for only short periods of time with head hyper-extended, trunk rounded and in an asymmetrical position. After therapy with the prone propped position, her gross motor control improved markedly. She could sit alone for longer periods of time with the head in midline, trunk extended and in a more symmetrical position. After therapy with the prone propped position, her gross motor function was also assessed for GMFM-h once a month. These data were determined by a physical therapist and a pediatric neurologist who were blind to the position of hippotherapy the child received.
position (Table 2). The GMFM improvement lasted until the end of our report (Table 2). GMFCS also improved from Level V (before and after 3-month sitting backwards) to Level IV (after 9-month prone propped) (Table 2). In addition, GMFM-h scores continued to increase monthly after prone propped position therapy (Figure 3). GMFM-h scores increased from 3% to 13% in items 18 and 21-24 (Dimension B) after 3 months sitting backwards and from 17% to 100% in items 10-15 (Dimension A) and from 37% to 70% in items 18 and 21-24 (Dimension B) after therapy in the prone propped position. According to the trend and slope analysis, GMFM-h increased to a greater degree after therapy in the prone propped position compared with scores from the first 3 months spent sitting backward (Figure 3).

Table 1. Summary of a fifteen-minute treatment session in the 12-month hippotherapy

<table>
<thead>
<tr>
<th>Program</th>
<th>Duration (min)</th>
<th>Program</th>
<th>Duration (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-up phase: Sitting forwards with horse walking around the arena</td>
<td>5</td>
<td>Warm-up phase: Prone with horse walking around the arena</td>
<td>5</td>
</tr>
<tr>
<td>Sitting backwards with horse walking on the left rein</td>
<td>5</td>
<td>Prone propped on elbows with horse walking on the left rein</td>
<td>5</td>
</tr>
<tr>
<td>Sitting backwards with horse walking on the right rein</td>
<td>5</td>
<td>Sitting sideways with horse walking on the left rein</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2. Serial changes of GMFM-88 and GMFCS before treatment, after hippotherapy in the sitting backwards and in the prone propped positions

<table>
<thead>
<tr>
<th>before hippotherapy</th>
<th>sitting backwards</th>
<th>after hippotherapy</th>
<th>prone propped</th>
</tr>
</thead>
<tbody>
<tr>
<td>0th month</td>
<td>3rd month</td>
<td>6th month</td>
<td>9th month</td>
</tr>
<tr>
<td>GMFM-88 Dimension A (%) score</td>
<td>21.56</td>
<td>31.37</td>
<td>64.7</td>
</tr>
<tr>
<td>GMFM-88 Dimension B (%) score</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>GMFCS Level (I-V)</td>
<td>V</td>
<td>V</td>
<td>N/A</td>
</tr>
</tbody>
</table>

GMFM = Gross Motor Function Measure; GMFCS = Gross Motor Function Classification System
N/A: Non-assessment
DISCUSSION

This case report is an objective description of the effects of hippotherapy in sitting backwards and prone propped positions on gross motor function in a child of hypotonic CP. The data showed that the child of hypotonic CP treated in sitting backwards position during the first 3 months improved little in gross motor function; however, more improvements were consistently observed with treatment in the prone propped position during the same 3-month treatment period and continued to show improvement for the following 9 months. She did not show obvious changes in gross motor function and head control in the sitting position probably due to the following reasons. In children with profound hypotonia, therapy generally begins with activities that primarily challenge their neck and upper back stability. When a horse is walking, a rider requires greater head and neck stability in the sitting position than in prone propped position. The
reciprocal movement of the walking horse can produce excessive stimulation in the head/neck similar to a whip-lash motion when a child with hypotonic neck muscles sits backwards. Hippotherapy in sitting backwards position may place the child under an over challenging task and override the child’s ability to respond appropriately due to her profound motor disability. Therefore, the beneficial effect was limited. It was likely that the child could adjust and respond properly to the less challenging task when she was placed in prone propped position on the horse back. Therefore, an optimal level of task difficulty met the child’s ability might enhance more motor learning and improvement.

The acquisition of postural control in the prone position has been studied for normal infants in the context of the development of gross motor abilities. Prone lying ability in which head and trunk are extended and body weight is supported only on the abdomen and forearm is a fundamental stage in motor development and predicts the later acquisition of more complex motor abilities.[11] In developing tonic postural extension against gravity, the prone position demands more extension than other positions.[12] In the second part of this report, to have the child inhibit primitive reflexes and follow the normal sequence of motor development, we placed her in the prone position and encouraged propping on extended arms. This approach was emphasized on neurodevelopment treatment based from Bobath concepts.[13] This prone propping management can also serve as an entry point for children with hypotonia whose functional ability is not yet well enough developed for therapeutic riding in the sitting position. In addition, management of the prone propped position contained 10-minutes in the prone/prone propped and 5-minutes in the side sitting position in this case report. It can not exclude the effects of 5-minutes in the side sitting position which facilitates trunk flexors and extensors and provides further functional training for this CP child with general weakness.

The rider can obtain the benefits from the three-dimensional reciprocal movement of a walking horse including: (1) normalized pelvic movement in the rider, closely resembling pelvic movement during ambulation in individuals without disability; (2) the sensation of smooth, rhythmical movements made by the horse improves co-contraction, joint stability, and weight shift, as well as postural and equilibrium responses; (3) dynamic postural stabilization, recovery from perturbations, as well as anticipatory and feedback postural control; and (4) continuous vestibular, somatosensory and visual feedback to the rider.[4,9] The prone propped position on horseback can also produce increased proprioceptive input via elbow propping, forearm support and weight bearing, facilitation of upper back extension, reaching and improvement of head control. Motor skills or active postural control also achieved while elbow propped in the prone position on the horse have the potential to influence the functional task of the horse. It is hypothesized that the stretching, facilitation, mobilization, spatial orientation, and tactile reactions that are required of the child during hippotherapy will improve posture, balance, mobility and function in daily living. It can be expected that in a CP child with general weakness, hippotherapy in the prone propped position would enhance prone extension, increase muscle strength of the vertical neck and back and the ability of the upper extremities, to a greater extent than when using the sitting backwards position. In addition, in the analysis of GMFM-h, the scores of Dimension B (sitting) increased more than that of the Dimension A (lying) after therapy whilst sitting backwards, and the scores of Dimension A increased more than that of the Dimension B after therapy in the prone propped position. The results of the case report was in accordance with the principles of task specificity.

In the present study, our case did not receive another therapy during the study period. However, hippotherapy should be regarded as an adjutant therapy and the importance of regular rehabilitative treatment cannot be overemphasized for the benefit of each child with cerebral palsy. Also, interpretation of our findings should be with caution. We still can not rule out the developmental effects due to the flaws of our study design.

**CONCLUSION**

The present case report represents a hippotherapy approach in the sitting backwards and prone propped positions and documents their effects on gross motor function in a hypotonic CP child with general weakness. The findings of this case report suggest that hippotherapy in the prone propped position may improve gross motor
function in this particular child with hypotonia. We suggest that hippotherapy may be used to facilitate the functional motor performance in children with hypotonic CP and the selection of specific therapeutic position on horse back should meet the developmental level of each patient. This pilot report needs further investigation to confirm long-term effects of hippotherapy in a larger sample of children with the similar diagnosis and functional abilities.

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REFERENCES

馬術治療對一位四肢低張型腦性麻痺兒童粗動作功能的療效：一年追蹤報告

謝悅齡 詹淑雅¹ 吳錫昆 楊鎮嘉² 李友淳² 羅鴻基

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馬術治療雖已廣泛用於改善腦性麻痺兒童的粗動作功能，但尚未有文獻長期追蹤並探討其在低張型腦性麻痺兒童的成效以及了解不同馬背上治療姿勢的影響。本病例為一位6歲四肢低張型腦性麻痺女童，治療前其四肢及軀幹呈現嚴重低張與整體發展遲緩。在12個月的馬術治療後，個案持續呈現粗動作功能的改善。我們採行兩種馬背上的治療姿勢，前3個月採行馬背上「倒坐」的姿勢，接下來的9個月療程則更改為「橫臥肘撐」的姿勢，每次治療時間為15分鐘，每星期2次，為期一年。患童的粗動作功能使用「粗動作功能評估量表」、「粗動作功能分類系統」及「馬背上粗動作功能評估量表」來量化評估。在起初3個月的馬背上「倒坐」姿勢治療，患童的粗動作功能進步有限；然而，在改採「橫臥肘撐」姿勢治療後，粗動作功能呈現持續、明顯的改善。患童之「粗動作功能評估量表」向度A的百分比由31.37%進步至82.35%，向度B由0%進步至25%；而「粗動作功能分類系統」由第五級進步至第四級；「馬背上粗動作功能評估量表」之百分比總分亦由29.17%進步至81.25%。顯示對該名低張腦性麻痺患童而言，馬背上「橫臥肘撐」姿勢的治療成效顯著。「馬術治療可以用於改善低張型腦性麻痺患童的粗動作功能及功能性表現，唯有選擇馬背上的治療姿勢時，需仔細評估患童能力，選擇切合患童能力的姿勢進行治療。（台灣復健醫誌2008；36(3)：177-185）

關鍵字：腦性麻痺(cerebral palsy)，低肌張力(hypotonia)，馬術治療(hippotherapy)，橫臥肘撐(prone propped)，粗動作功能(gross motor function)

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