Motor function outcome in postnatal insult-related cerebral palsy

Aishah Ahmad Fauzi\textsuperscript{a,b,*}, Nadia Mohd Mustafah\textsuperscript{a,b} and Wan Najwa Wan Mohd Zohdi\textsuperscript{a,b}

\textsuperscript{a}Department of Rehabilitation Medicine, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia
\textsuperscript{b}Rehabilitation Medicine, Faculty of Medicine, Universiti Teknologi Mara, Shah Alam, Malaysia

Accepted 7 July 2013

Abstract.
INTRODUCTION: The Gross Motor Function Classification System (GMFCS) was developed to establish uniform communication between healthcare providers, patients, and the patients’ families. It is also used to prognosticate the outcome of motor function. Based on previous reports, prognostication of ambulation status in cerebral palsy is based on the motor development curve, which shows a plateau at a certain known age.

CASE REPORT: This report illustrates the case of a boy with spastic triplegic cerebral palsy secondary to postnatal insult at early childhood. The patient was noted to have tremendous progressive improvement in his GMFCS level beyond 7 years old: from level IV at 4 years old to level II at 9 years old.

CONCLUSION: Prognostication of ambulation in cerebral palsy based on the motor development curve provides a basis for physicians to predict motor function outcome and plan appropriate intervention. This case report shows that other important factors need to be considered in the clinical evaluation before rendering the prognostication of motor function outcome, including environmental factors as well as the etiology of cerebral palsy, for which special consideration should be given in cases of postnatal insult-related cerebral palsy.

Keywords: Cerebral palsy, GMFCS, prognosis, postnatal insult, environmental factors

1. Introduction

Cerebral palsy is described as a group of permanent disorders in movement and posture development that limits activities; this disorder is attributed to non-progressive disturbances that occur in developing fetal or infant brain [1]. Traditionally, the description of disability associated with cerebral palsy has been classified as mild, moderate, or severe, the reliability of which is doubtful. Thus, the current widely used tool to classify the severity of cerebral palsy, namely, the Gross Motor Function Classification System (GMFCS), was developed to set uniform communication between health care providers, patients, and the patients’ families [2].

Palisano et al. [3] and Rosenbaum et al. [4] proposed motor development curves based on age and stratum in the GMFCS level. In general, the motor curve as measured by the Gross Motor Function Measure (GMFM-66) slowly levels off at around 4 to 7 years old in each GMFCS stratum, with many reaching their 90% of maximum motor function (GMFM-66) by 5 years old or younger. This motor development curve helps physicians plan and decide on interventions as well as prognosticate the progress of motor function over time [4].

2. Case report

A four-year-old boy who was noted to have delayed growth in every aspect of developmental milestone was
brought to the Paediatric Rehabilitation Clinic in University of Malaya Medical Center for further assessment and management. He was born at term with uneventful prepartum and intrapartum periods. At 2 years old, he experienced a traumatic brain injury and left femoral shaft fracture after being thrown against the wall by his father, who was a drug addict. Sustained intracranial blood clots were evacuated, and a femur plate was used for internal repair. Since being discharged from the hospital, he has been cared for by his maternal aunt, who is unmarried and has financial constraints. He was only nursed at home where, throughout his stay with his aunt, he received neither formal therapy nor review or follow-up from a rehabilitation medical team. Generally, he had uttered no meaningful word and was being ambulated around in a child stroller. Prior to the traumatic event, he had been able to walk independently and speak two-word sentences. Further information on his pre-morbid developmental milestones was unknown, as neither his parents nor his next of kin accompanied him during the clinical consultation.

At the age of 4, he was finally ordered to be put under the custody of a legal guardian, who happened to be the unmarried, middle-aged woman who had brought him to the hospital for medical attention. His developmental milestones from the first clinical assessment until his ninth birthday are summarized in Table 1. Initial physical examination showed that he had a contracture of the left elbow at 60 degrees flexion and both feet were in equinus. Spasticity was present over the left finger flexors and left hamstrings with Modified Ashworth Scale (MAS) of 3, and over the right hamstring with MAS of 1+. Muscle power of the left upper limb and bilateral lower limbs was generally 2 to 3 based on MRC grading. Subsequently, he underwent botulinum toxin injection to the left finger flexors and left hamstrings. Throughout his pediatric rehabilitation follow-up, he was referred to a pediatric orthopedic team where multi-level surgeries were performed, namely, bilateral Achilles tendon lengthening, bilateral adductor release, bilateral hamstring release, and left femoral shaft plate removal at 6 years old.

The patient was under a pediatric rehabilitation program that involved sessions with a physiotherapist and an occupational therapist for neurodevelopmental therapy, as well as with a speech therapist for language assessment and development. He started gait training at 6 years old after the multi-level surgery of his lower limbs.

At age 8, he was put under the custody of a children’s welfare home and started defaulting therapy appointments at the hospital. Nevertheless, he was attended by a physiotherapist working with the home, who continued to provide him with gait training. At the children’s home, he was surrounded by many other children who were mostly normal and actively moving around during various sessions planned for them. He was also involved in all activities and outdoor programs for all of the children there. The guardians who looked after the children staying in the house were very supportive and always brought him out to the public with them.

During the series of clinical follow-up sessions, it was noted that his gross motor function continued to improve from the level of GMFCS IV to III beginning at age 7. He walked with a crouch gait, and spasticity of the left finger flexors and lower limb muscles, which generally were MAS 1, did not worsen. Muscle power of the left upper limb and bilateral lower limbs showed a marked improvement with MRC grade of 3 to 4. No rotational bony deformities were identified. He was prescribed bilateral solid ankle foot orthotics to improve his gait and was advised to continue with gait training.

Three months prior to his ninth birthday, his GMFCS improved from level III to II (with a crouch gait pattern), enabling him to walk unaided on even ground safely, both indoor and outdoor. He is now also able to self-propel a manual wheelchair for long-distance ambulation.

3. Discussion

This case report describes the case of a child with spastic triplegic cerebral palsy secondary to postnatal insult (traumatic brain injury) who experienced a tremendous improvement in gross motor function beyond the age of 7 years old. His progress is inconsistent with the prediction of motor function progress based on motor development curves. Thus, it motivated us to look into other factors that might influence the motor function outcome in a child with cerebral palsy, who had apparently been significantly neglected from rehabilitation for several years post injury.

Cerebral palsy that occurs as a result of an insult during the perinatal period, compared to brain insult from postnatal causes (in which some normal developments had taken place prior to the insult), may have a different outcome, particularly in motor function. The etiology of the majority of cases of cerebral palsy is due to perinatal causes, estimated to be 75% of all cerebral
### Table 1

<table>
<thead>
<tr>
<th>Age (Year)</th>
<th>Gross motor</th>
<th>Fine motor</th>
<th>Language</th>
<th>Personal-Social</th>
<th>GMFCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 (initial assessment)</td>
<td>Sit with support</td>
<td>Able to reach for object</td>
<td>Understand instruction</td>
<td>Able to self-feed using hand</td>
<td>IV</td>
</tr>
<tr>
<td></td>
<td>Bottom shuffle or rolling to move around</td>
<td>Unable to scribble</td>
<td>Communicate with gesture</td>
<td>Imitative play</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No spoken word except cooing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Sit without support</td>
<td>Improved left hand grip but still tend to drop things</td>
<td>Single word</td>
<td>Drink from cup</td>
<td>IV</td>
</tr>
<tr>
<td></td>
<td>Pull to stand</td>
<td>Right hand able to scribble</td>
<td>Recognize animals and imitate sound</td>
<td>Able to use spoon for feeding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bottom shuffle</td>
<td></td>
<td>Occasionally speak in phrases</td>
<td>Attempt to clean himself</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Able to walk with roller during therapy session only</td>
<td>Copy line and circle</td>
<td>Recognize color</td>
<td>Anxiety upon being examined</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Occasionally speak in phrases</td>
<td>Need help to dress and undress due to weakness</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Crawling indoor</td>
<td>Able to propel wheelchair with right hand</td>
<td>More vocabulary</td>
<td>Self-feed better than before using hand or spoon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Able to cruise outdoor using wheelchair</td>
<td></td>
<td>Speak in phrases</td>
<td>Able to indicate toileting</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Walking unaided indoor and self-propel wheelchair outdoor</td>
<td>Able to write name and words</td>
<td>Communicate full sentences</td>
<td>Help with house chores</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can read A-Z</td>
<td>Attending special class</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Can count 1–20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In postnatal insult-related cerebral palsy, the child might have developed certain functions and normal developmental milestones before the brain injury. Indeed, the recovery process for a child with brain injury is complex, as it interrupts the ongoing development while the brain is still developing. As brain synaptic plasticity allows the central nervous system to learn skills as well as retain information, the strength of synaptic plasticity refers to changes in the strength of neurotransmission induced by activity experienced by the synapse in the past [6]. Therefore, brain insult that occurs during antenatal, perinatal, and early neonatal periods may compromise subsequent brain development, possibly to a greater degree compared with brain insult at older ages (e.g., early childhood), when some developmental achievement already exists [7].

Scholars and practitioners should also acknowledge that environmental factors influence the variability of outcomes in post-traumatic brain injury in childhood. Characteristics of environmental factors can be 1) pre-morbid characteristics of the child and their family, 2) post brain injury environment, and 3) various management interventions [8]. These environmental factors were definitely involved in the motor function development of the child in this case report. The patient's pre-morbid function may have been negatively affected by a troubled family background. His lack of healthcare after the traumatic brain injury (between ages 2 and 4) is suggestive of negligence that might have hindered his developmental progress at an earlier age; the physical complication of left elbow joint contracture worsened his situation. Therefore, further improvement of his motor function trajectory at a later age, whereby he showed a tremendous improvement beyond the age of 7, was possibly related to various health care interventions. Limited access to coordinated healthcare service and rehabilitation interventions post injury likely explained his regression in motor function with musculoskeletal complication between ages 2 and 4. These factors need to be examined cautiously in order to explain the motor function improvement that occurred later, which, in his case, is beyond the expected age based on the prognostication value from the motor development curve.
Prognosticating ambulation in children with cerebral palsy is important for physicians in planning appropriate interventions. General rehabilitation management aims to minimize development of secondary problems, strengthen and improve both mobility and functional motor skills, as well as promote functional independence [9]. Evidence on rehabilitation management that achieves the aforementioned aims is still modest, especially in terms of improving motor function in children with cerebral palsy. However, available data do not refute the importance and benefits of rehabilitation; children with cerebral palsy may improve in their motor function through improvement in endurance, balance, and motor control, especially in ambulatory cerebral palsy (GMFCS I–III).

4. Conclusion

Prognostication of ambulation in cerebral palsy based on the motor development curve provides a basis for physicians to predict motor function outcome and plan appropriate intervention. This case report shows that other important factors need to be considered in the clinical evaluation before the prognostication of motor function outcome. Such factors include environmental factors, as well as the etiology of cerebral palsy; special consideration should be given in cases of postnatal insult-related cerebral palsy.

Conflict of interest

The authors report no conflict of interest.

References