**RETROSPECTIVE ANALYSIS OF INFLUENCE OF ABHYANG AND SVEDAN ON NEUROPLASTICITY IN CEREBRAL PALSY PATIENTS**

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**ABSTRACT**

**Introduction:** Panchakarma are a group of very unique ayurvedic therapeutic approaches having the potential of releasing spasticity and contractures, providing positive neuroplasticity after neurologic insult, removing abnormal metabolites developed due to faulty life style or any pathological process in the body, etc. Some of these procedures involve drug delivery systems bypassing the hepatic first pass effect. Abhyang (therapeutic massage) is one such system, which employed with svedan (therapeutic sudation), relieves spasticity and is widely used in several neurological conditions including cerebral palsy (CP). Since both these procedures are used externally they are extremely helpful and effective therapeutic tools for the ayurvedic pediatricians and are also readily accepted by patients and parents. Several children with cerebral palsy opt for ayurvedic treatment in ------------.

**Material and methods:** In this article, retrospective analysis of both these procedures in 51 cases of CP during a finite period (of 22 months) is carried out with focus on their neuroplastic ability. Gross Motor Function Classification System Expanded and Revised (GMFCSE-R) levels of each patient before and after treatment, data related to impairment of speech, vision and cognitions as well as epilepsy along with available radiodiagnostic reports were noted. Detail analysis of the documented data in their files was done to evaluate the possible effect of abhyang and svedan.

**Observations and results:** Only three patients out of 51 failed to respond to this treatment i.e. 94.11% of the patients showed improvement. Some children achieved near normal motor function and became independent in their routine activities. The results in detail are discussed in this article.

**Discussion:** Currently proposed ten principles of neuroplasticity are discussed along with proposal for consideration of willingness (attitude) of the patient and cognition as another principles as they influence the neuroplasticity.

**Conclusion:** Considering the improvement in motor function in 94.11% cases it can be said that abhyang and svedan have positive neuroplastic effect on the motor function of the CP patients irrespective of site of pathology in the brain and time of initiation of panchakarma therapy.

**Key words** neuroplasticity; cerebral palsy; *abhyang*; *svedan*

**MAIN ARTICLE**

**Introduction**

Cerebral palsy (CP) is a group of disorders characterized by disability of movement, and maintaining posture and balance. CP is classified in many ways

based on topographical distribution, gross motor function classification system, etc. depending on the criteria considered during the classification and the medical interest. Classification based on pyramidal and extrapyramidal system considers the parts of the brain involved along with clinical features. When pyramidal tracts (cortical tracts descending to brain stem and responsible for voluntary movements) are damaged or not functioning properly they produce spastic types of CP, which are characterized by hypertone in muscles. About three-fourth of the cases of CP are spastic. It can be spastic hemiplegic, spastic diplegic and spastic quadriplegic. Injury to areas outside the pyramidal tract such as basal ganglia, thalamus and cerebellum cause extrapyramidal CP. The muscle tone in such type of CP are hypotonous or fluctuating. Extrapyramidal CP can be athetoid or ataxic. The athetoid CP is characterized by slow writhing, involuntary or uncontrolled movements of proximal parts of limbs, poor head control and head lag, swallowing difficulty, salivary drooling and speech deficit. Seizures are uncommon and intellect is preserved in many patients. Ataxic CP is characterized by incoordination, wide-based gait, imbalance and difficulty in depth perception, and can be associated with other developmental disabilities such as intellectual dysfunction, seizures, and visual, speech and hearing deficits. Cognition may be poor.

This most common childhood disorder of motor dysfunction imposes many challenges to not only the patients and the family members, but also to the consultants from different specialties, speech therapists, occupational therapists, etc. It also imposes financial burden on family, society and nation as a whole. Currently emphasis is laid on taking advantage of positive neuroplasticity for providing improvement in motor, sensory and cognitive functions of children with CP.

Neuroplasticity is the structural and/or functional adaptability of the brain imparting it the ability to alter its activity in response to extrinsic or intrinsic stimuli such as learning, new information, sensory stimulation, development, damage or dysfunction and also to treatment. Normal developmental neuroplasticity occurs in fetal, neonatal, infant and even older children’s brain through synaptogenesis, strengthening and weakening of synapsis, and pruning of unused synapsis finally resulting in an efficient neuronal network. Various teratogens including genetic disorders, perinatal and postnatal insult to the developing brain, etc have the potential to interfere in this normal development and cause CNS disorders. Cerebral palsy is one among such disorders.

Panchakarma are a group of very unique ayurvedic therapeutic approaches having potential of removing abnormal metabolites developed due to faulty life style or any pathological process in the body and thereby either restore the health or provide possible maximum relief in severely morbid conditions. Some of these procedures involve drug delivery systems bypassing the hepatic first pass effect. Abhyang (therapeutic massage) is one such system, which employed with svedan (therapeutic sudation), relieves spasticity1,2 and is widely used in several neurological conditions including cerebral palsy (CP). This approach solves not only the challenge of prescribing a number of oral drugs to tiny or small children with neurologic conditions, but also of making the drugs reach the targeted organs without getting altered by hepatic first pass effect. They consistently provide expected and reproducible positive results. For these reasons, both these procedures have become extremely helpful and effective therapeutic tools for the ayurvedic pediatricians.

**MATERIAL AND METHODS**

Many children, not only from India, but also from other countries, come for this treatment to pediatrics department of -------------------. Considering the beneficial effect ayurveda in pediatric patients, it was decided to analyze the neuroplastic effects of two procedures Abhyanga and Svedan in patients of CP. Data of children with CP admitted (under last author of this article) between January 2018 to October 2019 (period of 22 months) were collected from in-door files. The patients were classified into different age groups according to GMFCS E-R and analyzed. Wherever the radiodiagnostic investigation reports were available they were also taken into consideration. Analysis of the data were done as described in observations. The results are discussed later in this article.

**OBSERVATIONS & RESULTS**

**Common observations**

Many guardians could not provide proper natal history in relation to birth weight, maturity and crying of newborn after birth. Medical reports of children between 12-18 years of age were also not available with the parents or the guardians as they were lost during the long time lapsed after birth. Considering the non availability of such information about many children, these criteria are not discussed in this study.

Radiodiagnostic investigations are incorporated in the data as they may provide some insight into response to the treatment and even the extent of positive neuroplasticity. Many financially weak patients and parents/guardians of teenagers were unwilling to undergo any further investigation as they have spent a lot from their available financial resources.

Cognition was considered involved only when they were diagnosed by professional pediatric psychiatrist prior to admission in this hospital. It was not possible for the undiagnosed doubtful cases with poor cognition to evaluate here.

Total 51 children were admitted with diagnosis of CP. Amongst them 27 had extrapyramidal CP while 24 had pyramidal CP. All the children underwent the same treatment with abhyang and svedan during their period of hospitalization. Bala taila and ashvagandha taila were used for all the children for abhyang, and brahmighrit for shirobhyang; while shashtishali pinda svedan was used as a mode of sudation. Children with speech deficits, salivary drooling and/or vision deficits were also treated with abhyang on related areas on the face supplied by the concerned nerve with a view to activating positive neuroplasticity in the related brain areas. In addition to abhyang and svedan all the children were given brahmi churna and shankhapushpi churna with honey, and brahmarasayan in appropriate doses as per their age and body weight. All children were motivated (through fun-providing activities in groups) to acquire motor milestone according to their age. It was a consistent observation that after just three or four days of treatment the rigid or spastic muscle started relaxing. Muscles with hypotone took a longer time (more than a week) for improving or acquiring motor mile stone e.g. head control. Only three children did not get any significant relief. Slightly more than half of the children were of age below 4ys.

Repeated hospital admissions were mainly influenced by financial burden, distance of the residence from the hospital and availability of care provider. Other siblings who needed to be looked after at home and the type of CP were also among the main influencing factors. Eight children were admitted multiple times; five with extrapyramidal CP and three with pyramidal type. One child with extrapyramidal type was admitted four types and became near normal for his motor functions and is independent now. Since he was topper in his academic performance the school authorities frequently provided him additional leaves for multiple hospitalization. All the children continued abhyang at home, which was taught to the parent/care provider; however, all were unanimous in their opinion that professional-type of abhyang was not possible at home.

Out of total 51 cases only three children did not get any relief; 94.11%.

* One-year-old child with pyramidal CP had thinning of corpus callosum with cystic PVL and reduction in white matter volume of deep and subcortical white matter in fronto-parieto-occipital lobes with effacement of cerebral sulci and cistern in B/L cerebral hemisphere. This infant had poor cognition and did not have eye contact with any one.
* One child aged 8 ys with pyramidal CP stayed in the hospital for only a week.
* One teenager aged 13 ys with diplegic spastic CP was non-cooperative for his motor activities.

**Birth to 2 years (tables 1 and 6-12)**

* Total 13 children were in this age group. Amongst them the youngest was of 11 months of age with extrapyramidal CP.
* Two children had two admissions.
* Only one child was not benefited in terms of improvement in the motor function.
* Five children (four with extrapyramidal CP and one with pyramidal CP) had improvement of three levels within varying duration ranging between 25 days to slightly more than 100 days. Amongst these one had improvement of one more level during second admission of 19 days.

**Extrapyramidal CP**: Among 9 children with extrapyramidal CP (4 males and 5 females) three had HIE, one had kernicterus and one had metabolic insult at the time of birth.

* Eight children had GMFCS-ER level V at the time of hospital admission.
* One female (no. 8 table 1) and one male (no. 9 table 1) child were admitted twice during the period of study.
* Three children with level V improved to level II.
* Two children with level V required less than one month for this recovery
* One needed 80 days for this much recovery.
* One infant (no. 3 table 1) who had CP due to HIE and also had epilepsy reached level II within one and a half month-duration of treatment and reached level I at the end of second course of treatment of 19 day-duration. Surprisingly this was the youngest infant (11-month-old).
* Two children with level V improved to score IV within 20-25 days.
* The child (no. 7 table 1) with severe developmental defect of brain resulting in severe microcephaly surprisingly improved to level III from level V within 18 days and displayed an improved cognition.
* One child (no. 8 table 1) with level V had mild improvement in the form of complete relief in hypertone and flexion posture of right hand with improvement in some motor function within 9 days.
* One child with GMFCS-ER level of III improved to level I within two weeks.
* Four were normal for their speech. Amongst the five who were lagging for speech milestone, two did not get any improvement while the girl who was admitted twice got improvement during the second course of treatment.
* The 11 month-old boy (no. 3 table 1) who used to get occasional seizure despite receiving regular AED did not get any ictal episode during the hospital stay.

**Pyramidal CP**: Total 4 (2 male and 2 female) children had pyramidal CP in this age group. Amongst them one had HIE and another had perinatal insult (ICH). Both of these children had GMFCS-ER level V. Both had thinning of corpus callosum in addition to involvement of white matter in different parts of brain. One child reached level II in four weeks of treatment while another did not get any significant relief in motor function and motor-sensory function of speech. Two children never underwent any radiologic investigation. One male child was at GMFCS-ER level IV and had undeveloped speech before starting treatment. He reached level II in five weeks with development of few syllables (speech). The other child was at level II and reached level I within four weeks.

**2 to 4 years (tables 2 and 6-12)**

* Total 12 children.
* Two children had double admissions.
* All the children had improvement in their GMFCS-ER levels. Maximum improvement of three levels was observed in two children. Both had pyramidal CP.

**Extrapyramidal CP**

* Four children (all male) had extrapyramidal CP. Three of them had involvement of basal ganglia. Two had in addition to these, some other brain structures involved. All were at GMFCS-ER level V.
* One child achieved GMFCS-ER level III from level V in about 6 week-time. Improvement in the speech was from a few monosyllables to a few words.
* One child developed dyskinetic (dystonic) CP unfortunately due to late diagnosis of organic aciduria type I. This child had speech and cognition issues in addition to his motor dysfunction. He improved to level IV from level V in less than four week-time. Another child was believed to have developed dyskinetic (athetoid) CP due to some unspecified metabolic insult (confirmed through MRI) reached GMFCS-ER level IV in five weeks.
* The female child was born premature to an elderly mother after IVF in India. She was born premature and SGA, and suffered neonatal asphyxia with NICU stay of more than one month. She took nearly four month-time to improve by one level from V to IV in about four month-duration. She had GDD, severe rigidity with fixed posture, poor head control, salivary drooling and delayed speech. Cognition and social behavior (for her age and within her capacity) were normal. She improved from level V to IV within about four months.
* Three children had speech complaints. The female child (IVF baby) could speak only few words with broken speech got ability to speak sentences of three to four words, but the speech was slow in fluency and low in pitch with clear articulation. One child who could speak a few monosyllables BT was able to speak a few bisyllables AT. The child with organic aciduria type I had cooing before treatment and could not improve further in the aspect of his speech.

**Pyramidal CP**

* Eight children (6 males and 2 females) had pyramidal CP.
* Two children were at level V. One improved to level II in seven week-duration and another improved to IV in about four weeks and continued to improve further to less than level III in her motor function during her second stay in hospital for about 2 months.
* A male child was conceived after IVF in USA. He was born there with congenital heart disease (single ventricle requiring surgical intervention on the very first day of life) and congenital ichthyosis vulgaris. He also had history of GDD except for the speech and had received the same treatment about slightly more than two years ago in this hospital with result of acquiring milestones of standing and walking with support. At the time of second admission he was not able to free-walk, climb and jump (level IV). He achieved all the motor milestones for his age (level I – near normal) during this stay. Social, cognitional and intellectual levels were normal.
* Total five children had grade IV before treatment. Two children improved to level I. The IVF baby within six-week-time while another child in four-week-time. One male child (of age of 3ys) had germinal matrix hemorrhage (GMH grade IV) improved from level IV to level II in about six-week-time. Two more children improved to level III with treatment in about five and six week-time.
* One child was at level III and improved to level I in about three-week-duration of treatment.
* One child was cortically blind. He could not develop blindsight during his hospital stay.
* Seven children had speech issue. Only one could not get any relief.
* One child with poor cognition had improvement in it.

**4 to 6 years (tables 3 and 6-12)**

* Total 7 children (4 males and 3 females) were in this age group. Four children had extrapyramidal CP while three had pyramidal CP.
* All of them responded positively to treatment showing improvement.

**Extrapyramidal CP**

* Three children were admitted with level V; out of them two had double admissions. One child, who had finding of cerebral atrophy in his MRI brain scan reached level I and another child level III in total 65 days and 118 days, respectively.
* The female child with level V had finding of ICH in left posterior temporal lobe with focal area restricted diffusion in bilateral basal ganglia and thalamic regions in her first MRI brain scan. She needed about 75 days to improve from level V to IV.
* All the above-mentioned three children had severe speech difficulty. They all responded positively to the treatment with slow improvement in their speech.
* A male child with dystonic CP had findings of gliosis with volume loss in bilateral lentiform nuclei and right caudate nucleus in his second MRI brain scan surprisingly needed just about four weeks to recover from level II to near normal motor ability for his age.

**Pyramidal CP**

* Out of three children in this group two had spastic diplegic CP while the third had spastic hemiplegic CP.
* All the three children had speech deficit. Two of them improved. The male child with spastic diplegic CP did not get any significant improvement in his speech.
* One child improved from level V to II in about 12 weeks, second child improved from level III to I in five weeks and the third child improved from level I to near normal in her motor function for age in slightly more than 2 weeks.

**6 to 12 years (tables 4 and 6-12)**

* There were 12 children in this group. Amongst these 7 children (4 males and 3 females) had extrapyramidal CP while five children (one male and four females) had pyramidal CP. One child with extrapyramidal CP had double admissions.
* Except one child with pyramidal CP all the children improved in their motor function abilities.

**Extrapyramidal CP**

* Four children suffered from ataxic type of CP, two had athetoid CP and one had dystonic CP.
* Four children had level V. Out of them one child reached level I in about 20 weeks, two children reached level IV in about slightly more than three weeks. The fourth child (patient no. 4 in table 4 in extrapyramidal group) reached level III during two admissions of total 178 days.
* A female child with microcephaly and ataxic CP improved to level I from level IV within about 4-week-treatment.
* Two children with level II improved to level I. The patient no. 7 in extrapyramidal CP group was born to a mother who had septate uterus. This child had multiple admissions in this hospital before this study period and he attends a school for normal children as he excels in his studies and is topper in his class.
* Total five children in this group had speech deficits. Two children with slurred speech developed clear speech. The remaining three children also had some improvement in their speech in about 3-4 weeks with this treatment.

**Pyramidal CP**

* Spastic quadriplegia, spastic hemiplegia and spastic diplegic CP were observed in one, three and one child, respectively.
* Amongst total five children in this group, one child each had level V and level III improved to level III in 18 days and II in 15 days, respectively. Three children had level II before treatment. Out of these two children improved to level I within 3 to 4 weeks. The patient no. 7 did not get any improvement with this treatment during her one-week-stay in the hospital.
* One child had severely impaired vision. He failed to improve in his visual deficit.
* A female child with spastic diplegic CP had speech difficult with unclear articulation and expressing with gesture. She got improvement in her speech in articulating small sentences with slow fluency, but good clarity.
* One female child used to get occasional seizures despite receiving regular AED. She never had any ictal episode during her three-week-stay in the hospital. No child had cognitional problem.

**12 to 18 years (tables 5 and 6-12)**

* Among seven children in this age group, three had extrapyramidal CP while four had pyramidal CP. All were diagnosed on the basis of clinical features. All the children did not have previous medical reports as they were either misplaced or lost due to long time passed after the investigations.

**Extrapyramidal CP**

* Dystonic, ataxic and choreoathetoid CP were observed in one teenager each.
* Two teenagers had level V. Out of these two the one with dystonic CP had speech complaint. He improved to level III in about 16-week-treatment with speech becoming more clear. The ataxic teenager took about 5 weeks to improve by one level to reach level I.
* Teenager with choreoathetoid CP was independent for his mobility with certain limitations like pincer grasp, awkward running and jumping, and clumsy posture while sitting, walking and speaking. He developed pincer grasp, with better posture while performing all routine activities. He also was able to many complex yogasanas including halasan.

**Pyramidal CP**

* Out of four teenagers two had level V. These two improved to level II within about two and three weeks. The remaining two had level III before treatment.
* One improved to level I in about three weeks-duration of treatment. He also improved in his broken and slurred speech to speak clearly.
* The one with diplegic spasticity (patient no. 4 in table no. 5) did not get any relief in his motor function during the same duration of treatment. In fact, he had contractures of both knees and would not like to stand straight or walk despite improvement in passive ROM of both the knees.

**DISCUSSION**

Considering the improvement in motor function in 94.11% cases it can be said that abhyang and svedan have positive neuroplastic effect. The mechanism could be anatomical by developing new synapses or altogether new pathway, or functional. The responses to abhyang and svedan are highly variable among different age groups. How different principles of neuroplasticity could have influenced the outcome is shown hereunder. It should be noted that these children were encouraged to execute fun-providing activities (beyond their normal capacity), not the physiotherapy. They actively try to do those activities. Parents or care-providers were warned not to help their child and this way passive motor activities were discouraged. The activities suggested were in the normal order of the development of motor milestones.

1. **Use it or lose it:** There was a case (patient no. 8 in EP group, table no. 1) who after receiving treatment and improvement (earlier before this study period) lost the learned activities as the parents failed to motivate to reinforce the learned activities. This also became a reason for another admission (during the study period) with firm determination on the part of the guardian to help the child. Losing the motor skill is especially true for young children who are dependent or who had poor cognition and who are left unattended at home with modern entertaining gadgets such as video games, smart phone or TV for passing the time when the parent or guardian is busy in the domestic chores. All these gadgets are by and large known to exert negative plasticity on the brain.

2. **Use it and improve it, repetition, intensity and salience:** In quite contrast to earlier principle of ‘use it or lose it’ the principle of ‘use it and improve it’ was observed in children who had good cognition. Playing with peer group-children and exploring the outside world were the main motivators for younger children with normal cognition as their newly acquired motor abilities provided them the joy of what they can do and this resulted in further improvement. There were children who after learning to walk kept on walking for several hours daily till their physical strength allowed. Similar was the observation with children who have learnt climbing or jumping. The joy of getting success and subsequent attitude of the children repeating the newly learned motor skill resulted in remarkable improvement within two or three days in such milestones, which provided them the better independence. This attitude was more remarkable in teenagers who realized that the importance of doing activities in a normal way is more efficient in terms of energy expenditure and reducing pain due to spasticity, and better in terms of body posture and activities that would be required in a person’s future marital life (if the child grows into a normal or near normal adult). The mother of a teenager (patient no. 3 in EP group, table no. 5) was overwhelmed with joy while narrating the newly acquired ability of her son balancing on his four limbs in prone and maintaining this posture for sufficiently long time. The intensity of newly learned activities was mostly decided by the children themselves because they felt those activities salient to them. However, some children needed coaxing and encouragement during their first few attempts, when the failures were inevitable.

3. I**nterference:** Maladaptive way of walking with contracted knees and ankles by a 13-year-old male teenager (pt. no. 4 in pyramidal group table no. 5) resulted in failure to treatment (of duration of 24 days) as he felt this way of walking was easier than working hard to unlearn the faulty walking style and learn the normal way. Similarly, an eight-year-old female (patient no. 5 in pyramidal CP group, table no 4) child did not want to learn working with left arm and put in hard efforts to improve the strength of left side and discontinued the treatment on 7th day as she had developed compensatory preference for the right hand. Thus, the right time for starting the panchakarma intervention, willingness and cooperation on the part of the patient are also very important factors for developing positive neuroplasticity.

**4. Time of intervention:** It is always better to start therapeutic (abhyang and svedan) intervention earlier than the consequences of disuse such as contractures of joints and fixed posture in extrapyeramidal CP appear. The time taken for initiation of treatment is directly proportional to the time taken for improvement.

**5. Site of lesion responsible for CP in brain:** There were two children who had corpus callosum (CC) abnormalities in addition to some other abnormalities. Coincidentally, both were almost of the same age and received treatment for the same duration. The child (pt. no. 2 in pyramidal group table no. 1) had acquired secondary thinning of CC due to HIE. He had also developed PVL with cystic encephalomalacia; reduction of while matter volume in periventricular, deep and subcortical areas in fronto-parieto-occipital lobes with prominence of B/L ventricles, and effacement of cerebral sulci and cisterns in cerebral hemisphere. He did not find any response to the treatment. However, another child (pt. no. 2 in pyramidal group table no. 1) who had severe microcephaly, partial agenesis of CC, thinned out anterior body of CC with absence of rest of CC along with microcephaly, severely simplified gyral pattern, prominent sulci, dorsal interhemispheric cyst arising as diverticula and mega cisterna magna (this anomaly classified as type IC according to Barkowich Classification) improved from GMFCSE-R level V to III. He would eagerly look at the entrance after listening the voice of the consultant on the other side of the wall suggesting improvement in his cognition also. In addition to this he acquired holding food items in his hand when given to him and feeding to self, and standing holding the furniture. Hence, it would not be prudent to predict how much motor skill a child would achieve by simply radiodiagnostic findings.

The conventional ten principles of neuroplasticity include age also as one of the factors. However, the data of this retrospective study indicates that in different pediatric age groups used in assessing GMFCSE-R for CP there was no significant difference in acquiring positive neuroplasticity in response to abhyang and svedan. Instead, we propose that cognition and willingness should also be considered in the principles of neuroplasticity because when the children understand that their motor function deficits become hindrance in what they want to do they tend to work hard to improve their function. This attitude is not possible when the children have poor cognition or intellectual dysfunction. Similarly, willingness on the part of the patients to achieve the missing motor skill stimulates them to work hard. Finally, the family support is very crucial. Unsupportive parent/s or guardian miserably leave such children to their fate. All the 48 patients who were benefited during their hospital stay sustained their improvement in motor functions after discharge and continued improving further. This observation was made during the follow up during the study period.

Based on the improvement in motor function, the same treatment was adopted for the children who had only sensory deficits. During this study period two children with cortical blindness and a child with sensory-neuronal hearing loss (SNHL) (all the three with normal MRI brain and relevant other investigations) were treated. Surprisingly, the two children with cortical blindness developed blindsight. A child with SNLH also developed some sporadic hearing. Since all the reports were normal and they reported normal developmental history these children are not included in this study. However, this experience of the last author led to analyze the data whether the children with vision defect got any improvement in terms of developing blindsight.

Speech is a highly complex sensory-motor skill. Failure in speech development in younger age groups could be due to the fact of absence of realization of importance of the speech. Children above 6 years of age worked hard to learn coordination of different muscles needed for articulation.

**Patient or parents’ perspective:** Children of all age groups finding improvement in their motor or sensory deficits were very happy because they were able to do the activities that were not under their control before treatment. Parents or guardians were happy since they realized the importance of the independence.

**CONCLUSION**

This retrospective analytical study provides evidence of positive neuroplastic benefits to the pediatric patients of cerebral palsy who underwent abhyang and svedan therapies. These benefits have life-long implications on such children with independence in many or almost all motor activities. Although it was never advised post-treatment any neuroimaging scan in those children who became near normal with this panchakarma treatment, such scans would help understand how the structural and functional changes help achieve motor, sensory and cognitive improvement, and probable mechanism involved in these.

This study involves relatively small number of children. However, many ayurvedic hospitals in India are using these two therapeutic procedures as a treatment of CP. Hence, if all hospitals carry out such kind of study with concerted efforts it would lend better incredibility to the claim made by ayurvedic pediatricians and also better understanding of the neuroplastic effects of different PK therapies.

**ACKNOWEDGEMENT**

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**CONFLICT OF INTEREST**

The authors declare no academic or financial conflict interest.

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**TABLES**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 1. CP age group birth to 2 years** | | | | | | | |
| **Pt. No.** | **Sex** | **Age (m/ys)** | **MRI/CT brain?EEG** | **Likely cause & other significant medical information** | **Duration of treat.**  **(in days)** | **GMFCS E-R**  **BT 🡪 AT\*\*** | **Improvement in sensory function &/or seizures - BT 🡪 AT** |
| **Extrapyramidal CP** | | | | | | | |
| 1 | M | 20m | MRI (brain): Abnormal near symmetrical hyperintensity in B/L globus pallidi suggestive of B/L encephalopathy or kernicterus | Encephalopathy or kernicterus – athetoid CP | 25 | V 🡪 II | No sensory involvement |
| 2 | F | 2ys\* | MRI (brain): Gliosis in left frontoparietal lobe, B/L symmetrical posterior putamen, ventrolateral thalami & perirolandic cortex | HIE - athetoid CP | 30 | V 🡪 II | Speech only monosyllables 🡪 no improvement |
| 3 | M | 11m^ | MRI (brain): B/L symmetrical lesions involving thalami & lentiform nuclei with volume loss – likely due to prior HIE  EEG: Abnormal with intermittent slowing over both parietal regions. No e/o hypsarrhythmia | HIE - athetoid CP | 46 | V 🡪 II | No sensory involvement Seizures & on AED – no seizures |
| 19 | II 🡪 I |
| 4 | F | 2ys\* | MRI (brain): Deep grey nuclei swollen; diffusion restriction in B/L perirolandic region, putamina, posterior limbs of internal capsules, anterolateral thalami & hippocampi | HIE - athetoid CP | 80 | V 🡪 II | Speech – only cooing 🡪 no improvement  Poor cognition 🡪 improved |
| 24 | II 🡪 Continued progress in motor function & cognition | Speech – only cooing 🡪 few Poor  Cognition 🡪 further improvement |
| 5 | F | 21m | MRI (brain): atrophy of B/L globus pallidus | Not known - athetoid CP | 20 | V 🡪 IV | No sensory or cognition issues |
| 6 | M | 14m | NA | Not known - athetoid CP | 25 | V 🡪 IV | Speech only cooing 🡪 few monosyllables |
| 7 | M | 13m | MRI (brain): Microcephaly, severely simplified gyral pattern, anterior body of corpus callosum is thinned out and rest of corpus callosum is not visualized. P/O hypoplasia. Prominence of sulci. Dorsal interhemispheric cyst arising as diverticula. Megacisterna magna noted (Barkowich Classification type IC) | Congenital developmental defect of brain – Probably dystonic CP | 18 | (V 🡪 III) | Speech occasional cooing 🡪 occasional monosyllable |
| 8 | F | 2ys\* | MRI (brain): B/L symmetrical areas of cystic degeneration of B/L globus pallidus with volume loss | Possibly metabolic - dystonic CP | 9 | V 🡪 V (with complete relief in hypertone and posture of right arm) | Speech delayed 🡪 no improvement |
| 9 | F | 2ys\* | MRI (brain): Areas of encephalomalacia in left periventricular region extending to basal ganglia, left lobe showing CSF isointense signals.  Mild ex-vacuo prominence of adjacent left ventricle. | Not known – dystonic CP | 14 | III 🡪 I | No sensory issue |
| **Pyramidal CP** | | | | | | | |
| 1 | M | 1yr | MRI (brain): Focal gliosis in frontal and central semiovale, and hemosiderin deposition due to perinatal insult. Diffuse thinning of corpus callosum | Perinatal insult -  Spastic quadriplegic CP | 28 | V 🡪 II | No sensory issue |
| 2 | F | 1yr | MRI (brain): Thinning of corpus callosum, PVL with cystic encephalomalacia, T2 hyperintense areas in B/L periventricular, deep & subcortical white matter in fronto-parieto-occipital lobes, with reduction of while matter volume and prominence of B/L ventricles with effacement of cerebral sulci & cisterns in cerebral hemisphere | HIE -  Spastic quadriplegic CP | 19 | V 🡪 V (no relief) | Speech not developed 🡪 no improvement  Cognition poor 🡪 no improvement |
| 3 | F | 18m | NA | Cause not known - spastic quadriplegic CP | 38 | IV 🡪 II | Speech not developed 🡪 Few monosyllables |
| 4 | M | 1yr | NA | Cause not known - Spastic hemiplegic CP | 29 | II 🡪 I | No sensory issue |
| \* Before completion of two years  \*\* Does not indicate the exact time of milestone of individual motor function.  ^ The temperature was reduced to slightly above body temperature. This was judged by the panchakarma technician on the advice by the treating consultant and the child’s behavior was constantly monitored during the therapy.  NA Not available | | | | | | | |

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| **Table 2. CP age group 2-4 ys** | | | | | | | |
| **Pt. No.** | **Sex** | **Age (ys)** | **MRI/CT brain/EEG** | **Likely cause & other significant medical information** | **Duration of treat.**  **(in days)** | **GMFCS E-R**  **BT 🡪 AT\*** | **Improvement in sensory function &/or seizures - BT 🡪 AT** |
| **Extrapyramidal CP** | | | | | | | |
| 1 | M | 3 | MRI (brain): Gliosis with volume loss in fronto-parietal lobe, B/L thalami, basal ganglia, internal capsules – ex-vacuo dilation of B/L & 3rd ventricles | Cause not known -ataxic CP | 45 | V 🡪 III | Few monosyllable 🡪 few bisyllables |
| 2 | M | 4 | MRI (brain): Acute encephalopathy involving both basal ganglia and caudate nuclei | Hereditary organic aciduria type I – anti DR1/DR2 -  Dyskinetic (dystonic) CP | 27 | V 🡪 IV | Only cooing 🡪 no improvement |
| 3 | M | 4 | MRI (brain): Minimal hyperintense signal in anterior globus pallidus, probably due to metabolic insult | Probable metabolic insult  Dyskinetic (athetoid) CP | 37 | V 🡪 IV | No sensory issue |
| 4 | F | 4 | NA | IVF baby – maternal advanced age - Premature birth & SGA – neonatal asphyxia – NICU of > one month –  ataxic CP | 123 | V 🡪 IV | Few words with no fluency 🡪 Few sentences of two or three syntaxes |
| **Pyramidal CP** | | | | | | | |
| 1 | M | 4 | MRI (brain): Thinning of corpus callosum, mild dilation of both lateral ventricles, paucity of white matter in B/L fronto-parietal & occipital lobes – likely severe HIE | Severe HIE - Spastic diplegic CP | 54 | V 🡪 II | Few bisyllables 🡪 few more words |
| 2 | F | 3 | NECT brain: ex-vacuo mild ventricular dilation of all ventricles | PVL - Spastic quadriplegic CP | 30 | V 🡪 IV | Only vocalization 🡪 No improvement Cognition poor 🡪 improved |
| 59 | IV 🡪 improvement in motor functions, but short of III | Delayed speech 🡪 few monosyllables Cognition further improved |
| 3 | M | 3 | MRI (brain): Mild asymmetrical prominence of B/L high parasagittal frontal sulci – sequel to mild to moderate HIE | Mild to moderate HIE – predominantly spastic hemiplegic CP | 30 | IV 🡪 I | Speech slurred 🡪 clarity improved |
| 4 | M | 4 | NRI child (born in USA) - reports were in USA | IVF baby born with single heart ventricle & congenital ichthyosis - Spastic diplegic CP | 45 | IV 🡪 I (near normal – could jump, but not continuous two jumps) | No sensory issue |
| 5 | M | 3 | MRI (brain): Microcephaly with features of PVL & residue of previous germinal matrix hemorrhage (GMH Gr. IV) | Germinal matrix hemorrhage (GMH Gr. IV) - Spastic diplegic CP | 45 | IV 🡪 II | Speech not developed 🡪 some Loss of vision 🡪 No improvement in term of blindsight |
| 6 | F | 3½ | NA | Cause not known - Spastic diplegic CP | 37 days | IV 🡪 III | Speech monosyllables 🡪 few bisyllables |
| 7 days | III 🡪 improvement | Few more |
| 7 | M | 3 | NA | Cause not known - Spastic diplegic CP | 45 days | IV 🡪 III | Speech: no vocalization 🡪 only vocalization; no significant relief |
| 8 | M | 3½ | NA | Spastic diplegic CP | 24 days | III 🡪 I | No sensory issue |
| \* Does not indicate the exact time of achievement of milestone of individual motor function.  NA Not available. | | | | | | | |

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| **Table 3. CP age group 4 to 6** | | | | | | | |
| **Extrapyramidal CP** | | | | | | | |
| **Pt. No.** | **Sex** | **Age (ys)** | **MRI/CT brain** | **Likely cause & other significant medical information** | **Duration of treat.**  **(in days)** | **GMFCS E-R BT 🡪 AT\*** | **Improvement in sensory function &/or seizures - BT 🡪 AT** |
| 1 | M | 6 | MRI (brain): Cerebral atrophy | Not known  Dyskinetic CP | 50 | V 🡪 II | Speech only 🡪 few words |
| 15 | II 🡪 I | Few more words |
| 2 | F | 4½ | MRI (brain): ICH in left posterior temporal lobe with focal area of restricted diffusion in B/L basal ganglia & thalamic regions – suggestive of HIE | HIE – Athetoid CP | 75 | V 🡪 IV | Speech not achieved 🡪 only few |
| 3 | M | 5 | NA | Not known – dyskinetic CP | 30 | V 🡪 IV | Speech: no vocalization 🡪 No improvement |
| 88 | IV 🡪 III | Speech with vocalization & sometimes few monosyllables |
| 4 | M | 4½ | MRI (brain): Multiple abnormal signal intensity involving cortical & subcortical B/L fronto-temporo-parietal lobes & occipital lobes, B/L thalamocapsular region & brain stem  Repeat MRI after about 4 months and three weeks:  Gliosis with vlume loss in B/L lentiform nuclei & right caudate nucleus | Not known – dystonic CP | 28 | II 🡪 near normal for age | No sensory issue |
| **Pyramidal CP** | | | | | | | |
| 1 | F | 5½ | MRI (brain): Areas of periventricular white matter loss; B/L frontal, parietal and occipital white matter loss – ex-vacuo dilation of lateral ventricles | Spastic diplegic CP | 86 | V 🡪 II | Speech: only vocalization 🡪 few |
| 2 | M | 5½ | NA | Spastic diplegic CP | 35 | III 🡪 I | Impaired speech 🡪 No significant improvement |
| 3 | F | 5 | NA | Spastic hemiplegic CP | 18 | I 🡪 near normal except speech | Speech only a few 🡪 few words |
| \* Does not indicate the exact time of milestone of individual motor function.  NA Not available. | | | | | | | |

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| **Table 4. CP age group 6 to 12** | | | | | | | |
| **Extrapyramidal CP** | | | | | | | |
| **Pt. No.** | **Sex** | **Age (m/ys)** | **MRI/CT/EEG** | **Likely cause & other significant medical information** | **Duration of treat.**  **(in days)** | **GMFCS E-R**  **BT 🡪 AT\*** | **Improvement in sensory function &/or seizures - BT 🡪 AT** |
| 1 | M | 8 | MRI (brain): Subtle abnormal T2/FLAIR hypotense signals in B/L parieto-occipital deep/periventricular white matter. Mild paucity of the white matter in B/L cerebral hemisphere. These findings most likely represent perinatal hypoxic ischemic insult (HIE)– near complete agenesis of body of splenium of corpus callosum | Congenital developmental defect of brain & HIE -  Ataxic CP | 143 | V 🡪 I | Slurred speech 🡪 Clarity & fluency of speech achieved |
| 2 | F | 12 | NA | Extrapyramidal (diagnosed through clinical features) – athetoid CP | 24 | V 🡪 IV | Speech not developed 🡪 Few words |
| 3 | M | 11 | MRI (brain): Symmetrical signal abnormality in periventricular white matter in both cerebral hemispheres, predominantly in parietal lobes suggestive of sequel of hypoxemic insult (HIE) EEG: myoclonic epilepsy | Choreoathetoid CP with Epilepsy | 28 | V 🡪 IV | Speech only few 🡪 few more words |
| 4 | M | 10 | NA | Dystonic CP | 28 | V 🡪 IV | Speech slow & slurred 🡪 No significant change |
| 150 | IV 🡪 III | Speech slow & slurred 🡪 more clear |
| 5 | F | 7 | NA | Microcephaly  Ataxic CP | 30 | IV 🡪 I | Speech only few 🡪 few more |
| 6 | F | 9 | MRI (brain): Hyperintensity in B/L thalami & putamina with PVL – (HIE gr. III) | HIE (Gr. III)  Ataxic CP | 30 | II 🡪 I | Not involved |
| 7 | M | 7 | MRI (brain): HIE - Cerebral and cerebellar ischemia (mother had septate uterus) | HIE  Ataxic CP | 14 | II 🡪 I | Not involved |
| **Pyramidal CP** | | | | | | | |
| 1 | F | 7 | MRI (brain): Altered signal in B/L parieto-occipital & adjacent fronto-temporal parenchyma with significant volume loss representing gliosis with encephalomalacia | HIE -  Spastic quadriplegic CP | 18 | V 🡪 III | Not involved |
| 2 | M | 10 | NA | Spastic hemiplegic CP | 15 | III 🡪 II | Vision severely impaired 🡪 no improvement in vision |
| 3 | F | 9 | NA | Spastic diplegic CP | 30 | Ii 🡪 I | Speech difficulty –communicates by unclear words with gesture 🡪 small sentences with slow fluency |
| 4 | F | 10 | MRI (brain): Gliotic changes in left parietal lobe with localized atrophic changes & ex-vacuo dilated left ventricle | Right hemiplegic spastic CP with epilepsy | 21 | II 🡪 I | Seizures occasional 🡪 No seizures during hospital stay |
| 5 | F | 8 | MRI (brain): Gliotic scars in right T1, F & P areas, insular cortex and basal ganglia on right side | Left spastic hemiplegic CP | 7 | II 🡪 II (no relief) | Not involved |
| \* Does not indicate the exact time of milestone of individual motor function.  NA Not available | | | | | | | |

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| **Table 5. CP age group 12 to 18** | | | | | | | |
| **Pt. No.** | **Sex** | **Age (m/ys)** | **MRI** | **Likely cause & other significant medical information** | **Duration of treat.**  **(in days)** | **GMFCS E-R**  **BT 🡪 AT\*** | **Improvement in sensory function &/or seizures - BT 🡪 AT** |
| **Extrapyramidal CP** | | | | | | | |
| 1 | M | 15 | NA | Dystonic CP | 117 | V 🡪 III | Speech slow & slurred 🡪 more clear |
| 2 | F | 12 | NA | Ataxic CP dystonic (based on features) | 38 | V 🡪 IV | Not involved |
| 3 | M | 14 | NA | Choreoathetoid CP | 22 | (I 🡪 I with development in pincer grasp - better movement of all joints and coordination) | Not involved |
| **Pyramidal CP** | | | | | | | |
| 1 | M | 13 | NA | Spastic diplegic CP | 21 | V 🡪 II | Not involved |
| 2 | M | 14 | NA | Spastic diplegic CP | 18 | III 🡪 II | Not involved |
| 3 | M | 14 | NA | Spastic left hemiplegic CP | 24 | III 🡪 I | Speech broken & slurred 🡪 speech clear |
| 4 | M | 13 | NA | Diplegic spastic CP | 24 | V 🡪 V (no relief) | Not involved |
| \* Does not indicate the exact time of milestone of individual motor function.  NA Not available as after several years parents and/or guardians tend to lose previous medical files. | | | | | | | |

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| **Table 6. Incidence of extrapyramidal and pyramidal CP in various age groups (values in parentheses denote percentage of incidence)** | | | | | |
| **Age groups** | **Extrapyramidal** | | **Pyramidal** | | **Total no. of cases** |
| **Male** | **Female** | **Male** | **Female** |
| Birth to 2ys | 4 (7.84%) | 5 (9.80%) | 2 (3.92%) | 2 (3.92%) | 13 (25.49%) |
| 2ys to 4ys | 3 (5.88%) | 1 (1.96%) | 6 (11.76%) | 2 (3.92%) | 12 (23.52%) |
| 4ys to 6ys | 3 (5.88%) | 1 (1.96%) | 1 (1.96%) | 2 (3.92%) | 7 (13.72%) |
| 6ys to 12ys | 4 (7.84%) | 3 (5.88%) | 1 (1.96%) | 4 (7.84%) | 12 (23.52%) |
| 12ys to 18ys | 2 (3.92%) | 1 (1.96%) | 4 (7.84%) | 0 (00%) | 7 (13.72%) |
| Total | 16 (31.37%) | 11 (21.56%) | 14 (27.45%) | 10 (19.6%) | 51 (100%) |

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| **Table 7. Incidence of speech involvement in no. of cases (values in the parentheses denote improvement in no. of cases)** | | | | | |
| **Age groups** | **Extrapyramidal** | | **Pyramidal** | | **Total no. of cases** |
| **Male** | **Female** | **Male** | **Female** |
| Birth to 2ys | 2 (2) | 3 (1) | 0 | 2 (1) | 7 (4) |
| 2ys to 4ys | 2 (1) | 1 (1) | 4 (3) | 2 (2) | 9 (7) |
| 4ys to 6ys | 2 (1) | 1 (1) | 1 (0) | 2 (2) | 6 (4) |
| 6ys to 12ys | 3 (2) | 2 (2) | 0 (0) | 1 (1) | 6 (5) |
| 12ys to 18ys | 1 (1) | 0 (0) | 1 (1) | 0 (0) | 2 (2) |
| Total | 10 (7) | 7 (5) | 6 (4) | 7 (6) | 30 (22) |
| Percentage of incidence & improvement (in parentheses) | 19.60%  (70%) | 13.72% (71.42%) | 11.76% (66.66%) | 13.72% (85.71%) | 58.82% (73.33%) |
| Overall results: 22 patients (73.33%) out of 30 with speech difficulty had improvement in speech. | | | | | |

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| **Table 8. incidence of vision** **involvement in no. of cases {values in the parentheses denote improvement in no. of cases (in terms of development of blindsight)}** | | | | | |
| **Age groups** | **Extrapyramidal** | | **Pyramidal** | | **Total no. of cases** |
| **Male** | **Female** | **Male** | **Female** |
| Birth to 2ys | 0 | 0 | 0 | 0 | 0 |
| 2ys to 4ys | 1 (0) | 0 | 0 | 0 | 1 (0) |
| 4ys to 6ys | 0 | 0 | 0 | 0 | 0 |
| 6ys to 12ys | 0 | 0 | 1 (0) | 0 | 1 (0) |
| 12ys to 18ys | 0 | 0 | 0 | 0 | 0 |
| Total | 1 (0) | 0 | 1 (0) | 0 | 2(0) |
| Percentage of incidence & improvement | 1.96% (0%) | 0 | 1.96% (0%) | 0 | 3.92% (0%) |

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| **Table 9. incidence of cognition involvement in no. of cases (values in the parentheses denote improvement in no. of cases)** | | | | | |
| **Age groups** | **Extrapyramidal** | | **Pyramidal** | | **Total no. of cases** |
| **Male** | **Female** | **Male** | **Female** |
| Birth to 2ys | 0 | 1 (1) | 0 | 1 (0) | 2 (1) |
| 2ys to 4ys | 0 | 0 (0) | 0 | 1 (1) | 1 (1) |
| 4ys to 6ys | 0 | 0 | 0 | 0 | 0 |
| 6ys to 12ys | 0 | 0 | 0 | 0 | 0 |
| 12ys to 18ys | 0 | 0 | 0 | 0 | 0 |
| Total | 0 | 1 (1) | 0 | 2 (1) | 3 (2) |
| Percentage of incidence & improvement | 0 | 1.96% (100%) | 0 | 3.92% (50%) | 5.88% (66.66%) |
| Overall results: Out of total six patients, four patients (66.66%) had improvement in their cognition. | | | | | |

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| **Table 10. Seizures in no. of cases (values in the parentheses denote improvement in no. of cases)** | | | | | |
| **Age groups** | **Extrapyramidal** | | **Pyramidal** | | **Total no. of cases** |
| **Male** | **Female** | **Male** | **Female** |
| Birth to 2ys | 1 on AED (no ictal episode during hospital stay)\* | 0 | 0 | 0 | 1 (1)\* |
| 2ys to 4ys | 0 | 0 | 0 | 0 | 0 |
| 4ys to 6ys | 0 | 0 | 0 | 0 | 0 |
| 6ys to 12ys | 0 | 0 | 0 | 1 occasional seizure despite on AED before treatment (no ictal episode during hospital stay) | 0 |
| 12ys to 18ys | 0 | 0 | 0 | 0 | 0 |
| Total | 1 (1)\* | 0 | 0 | 1 (1) | 2 (2) |
| Overall results: Total two patients had complaint of seizures and both (100%) had ictal-free hospital stay. | | | | | |
| \* Ictal free duration was not due to treatment as the child had already responded to modern AED. | | | | | |

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| **Table 11. Relief in motor function involvement** | | | | | | | | | | | | |
| Relief in GMFCS-ER in levels | **Birth-2** | | **2-4 years** | | **4-6 years** | | **6-12 years** | | **12-18 years** | | **Total (% out of total CP cases)** | |
| **EP (%)** | **P (%)** | **EP (%)** | **P (%)** | **EP (%)** | **P (%)** | **EP (%)** | **P (%)** | **EP (%)** | **P (%)** | **EP** | **P** |
| 4 levels | 1 (11.11) | 0 (0) | 0 | 0 | 1 (25) | 0 | 1 (16.6) | 0 (0) | 0 (0) | 0 (0) | 3 (5.88) | 0 (0) |
| 3 levels | 3 (33.33) | 1 (25) | 0 | 3 (33.33) | 0 | 1 (33.33) | 1 (16.6) | 0 (0) | 0 (0) | 1 (33.33) | 4 (7.84) | 6 (11.76) |
| 2 levels | 2 (22.22) | 1 (25) | 1 (33.33) | 2 (22.22) | 1 (25) | 1 (33.33) | 0 | 1 (16.66) | 2 (50) | 1 (33.33) | 6 (11.76) | 6 (11.76) |
| 1 level | 2 (22.22) | 1 (25) | 2 (66.66) | 4 (44.44) | 2 (50) | 1 (33.33) | 4 (66.66) | 3 (50) | 2 (one NN) (50) | 1 (33.33) | 12 (23.52) | 10 (19.60) |
| MI | 1 (11.11) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (1.96) | 0 |
| NR | 0 (0) | 1 (25) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (33.33) | 0 (0) | 0 (0) | 0 (0) | 3 (5.88) |
| Total | 9 | 4 | 3 | 9 | 4 | 3 | 6 | 6 | 4 | 3 | 26 (50.980 | 25 (49.01) |
| Overall % of relief in no. of cases | 94.11% | | | | | | | | | | | |
| EP = extrapyramidal P = pyramidal NN = near normal | | | | | | | | | | | | |

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| **Table 12. Improvement in terms of GMFCS E-R level with duration of hospital stay (in days)** | | | | | | | | | | | |
| **Pt.s no. (as per earlier tables 1 to 5)** | | **Birth- 2 ys** | | **2-4 years** | | **4-6 years** | | **6-12 years** | | **12-18 years** | |
| **EP** | **P** | **EP** | **P** | **EP** | **P** | **EP** | **P** | **EP** | **P** |
| 1 | **GL (BT🡪AT)** | 5 🡪 2 | 5🡪2 | 5🡪 3 | 5 🡪 2 | 5 🡪2\*  2 🡪 1\* | 5 🡪 2 | 5 🡪 1 | 5🡪3 | 5🡪 3 | 5🡪2 |
| **IL** | 3 | 3 | 2 | 3 | 3\*  1\* | 3 | 4 | 2 | 2 | 3 |
| **D** | 25 | 28 | 45 | 54 | 50\*  15\* | 86 | 143 | 18 | 117 | 21 |
| 2 | **GL (BT🡪AT)** | 5🡪2 | 5🡪5 | 5🡪4 | 5🡪4\*  4🡪CI\* | 5🡪4 | 3🡪1 | 5🡪4 | 3🡪2 | 5🡪4 | 3🡪2 |
| **IL** | 3 | NR | 1 | 1\*  CI\* | 1 | 2 | 1 | 1 | 1 | 1 |
| **D** | 30 | 19 | 27 | 30  59\* | 75 | 35 | 24 | 15 | 38 | 18 |
| 3 | **GL (BT🡪AT)** | 5🡪2\*  2🡪1\* | 4🡪2 | 5🡪4 | 4🡪1 | 5🡪4\*  4🡪3\* | 1🡪NN | 5🡪4 | 2🡪1 | 1🡪1 | 3🡪1 |
| **IL** | 3  1\*  Total 4 | 2 | 1 | 3 | 1\*  1\*  Total 2 | 1 (NN) | 1 | 1 | NN | 2 |
| **D** | 46  19\* | 38 | 37 | 30 | 30  88\* | 18 | 28 | 30 | 22 | 24 |
| 4 | **GL (BT🡪AT)** | 5🡪2\*  2🡪CI\* | 2🡪1 | 5🡪4 | 4🡪1 (NN) | 1🡪NN | - | 5🡪4  4🡪 3\* | 2🡪1 | - | 5🡪5 |
| **IL** | 3  CI\* | 1 | 1 | 3 | 1 | - | 1  1\* | 1 | - | NR |
| **D** | 80  24\* | 29 | 123 | 45 | 28 | - | 28  150\* | 21 | - | 24 |
| 5 | **GL (BT🡪AT)** | 5🡪4 | - | - | 4🡪2 | - | - | 4🡪1 | 2🡪2 | - | - |
| **IL** | 1 | - | - | 2 | - | - | 3 | NR | - | - |
| **D** | 20 | - | - | 45 | - | - | 30 | 7 | - | - |
| 6 | **GL (BT🡪AT)** | 5🡪4 | - | - | 4🡪3\*  3🡪CI\* | - | - | 2🡪1 | - | - | - |
| **IL** | 1 | - | - | 1  CI\* | - | - | 1 | - | - | - |
| **D** | 25 | - | - | 37  7\* | - | - | 30 | - | - | - |
| 7 | **GL (BT🡪AT)** | 5🡪3 | - | - | 4🡪3 | - | - | 2🡪1 | - | - | - |
| **IL** | 2 | - | - | 1 | - | - | 1 | - | - | - |
| **D** | 18 | - | - | 45 | - | - | 14 | - | - | - |
| 8 | **GL (BT🡪AT)** | 5🡪5 | - | - | 3🡪1 | - | - | - | - | - | - |
| **IL** | <1 (NN) | - | - | 2 | - | - | - | - | - | - |
| **D** | 9 | - | - | 24 | - | - | - | - | - | - |
| 9 | **GL (BT🡪AT)** | 3🡪1 | - | - | - | - | - | - | - | - | - |
| **IL** | 2 | - | - | - | - | - | - | - | - | - |
| **D** | 14 | - | - | - | - | - | - | - | - | - |
| **Results (% of cases improved)** | | 9/9 100% | 3/4  75% | 4/4  100% | 8/8  100% | 4/4 100% | 3/3 100% | 7/7 100% | 5/6 83.33% | 3/3 100% | 3/4 75 % |
| \* Two admissions  EP = extrapyramidal; P = pyramidal; GL = GMFCSE-R level; BT = before treatment; AT = after treatment  IL = improvement in level; D = duration of hospital stay (in days); CI = continued improving; NR = no relief  NN = near normal | | | | | | | | | | | |