INTERNATIONAL CONFERENCE ON EDUCATION, TECHNOLOGY & HUMANITIES 2020

ITECH2020 PROCEEDINGS

18 JULY 2020, MALAYSIA

EDUCATIONAL DEVELOPMENT & INNOVATIVE TECHNOLOGICAL APPLICATIONS FOR IMPROVING SOCIETAL WELLBEING

MOHD MAHZAN AWANG, NURUL HIDAYATI HAMID &
ABDUL RAZAQ AHMAD

STANDING FRAME DEVELOPMENT FOR THE NEEDS OF CHILDREN WITH CEREBRAL PALSY

Fatimahwati Hamzah[1], Norshahanis Hashim[2], Mohd Fakhrul Azri Abdullah[3], Intan Suria Hamzah[4],

[1]Civil Engineering Department, Polytechnic Sultan Salahuddin Abdul Aziz Shah, Malaysia.
[2]Civil Engineering Department, Polytechnic Kota Kinabalu, Malaysia.
[3]Faculty of Engineering and Built Environment, National University of Malaysia.
[4]Faculty of Human Sciences, Sultan Idris Education University, Malaysia.
Corresponding Author: fatimahwati.hamzah@gmail.com

ISBN No. 978-967-16473-4-9 Vol 1. No.6. Page 43 of 52

ABSTRACT

Cerebral palsy (CP) is a group of permanent movement disorders that appear in early childhood. They may have problems with sensation, vision, hearing, swallowing, movement and speaking. Basically, there is no specific treatment or medicine for them to cure. However, supportive treatments, assistive devices, occupational therapy, medications, and surgery may help them. This study is carried out to focus on developing assistive devices for children with CP. In our survey, there is lack off special equipment in local market, the product sizes are unsuitable with Asian size and the price is costly because it need to be imported. Therefore, the objective of this study is to develop a Standing Frame and to test it with the sample. The chosen sample is in mild CP category. Anthropometric data is the most important in designing and developing the product because it has to be customized for the needs of children with CP and meet the ergonomic aspect. The main materials used are hollow steel, leather, and sponge foam. In term of mechanical aspect, sitting position will help the standing position system more effective when combined. Wide straps used to make it more safety and the table equipped will help the children more stable in standing position. Overall, this product has a potential to penetrate in local market because it has a demand, affordable by parent and it will help the CP children to do the standing exercise regularly. It is hopefully by develop more assistive devices through innovation; disabilities people will feel love, support and concern from community.

Keywords: *standing frame, cerebral palsy, assistive devices, anthropometric, ergonomics.*

INTRODUCTION

Cerebral palsy also known as CP is a condition caused by injury in the parts of the brain that control the ability to use of our muscles and bodies. CP in simple word is to describe a problem with movement and posture that makes certain activities become difficult. “Cerebral” means having to do with the brain and “Palsy” means weakness or problems with using the muscles. The brain damage that leads to cerebral palsy can also cause health issues including movement, vision, hearing, and speech problems, and learning disabilities. Often the injury happens before birth, sometimes during delivery, or soon after being born. Physical symptoms typically appear in the first few years of life. Infants with cerebral palsy are frequently slow to reach developmental milestones such as learning to roll over, sit, crawl, smile, or walk. CP can be mild, moderate, or severe in category. Mild CP may mean a child is clumsy. Moderate CP may mean the child walks with a limp. He or she may need a special leg brace or a cane. More severe CP can affect all parts of a child’s physical abilities. The types of CP are Spastic, Dyskinetic, Ataxic, Hypotonic and Mixed. There is no specific cure for CP, but treatment, therapy, special equipment, and in some cases, surgery can help a child with cerebral palsy. Therefore, this study is carried out to produce a special equipment to help the CP children to stand up by themselves and to test it with the sample. A standing frame is an assistive device that used by a person who is unable to stand up by themselves. Standing can help to stretch out tight muscles and maintain good range of motion. It is especially helpful for tight hamstrings, calves and the muscles at the front of the

hips. For children who are already have limited range of motion, certain standers can accommodate and work to improve their current range. Standing can help develop trunk and neck control and give children a stable base to develop their reaching and grasping skills. It has been shown to improve general motor skills such as rolling and sitting. Based on the interview with doctors and therapists at Occupational Therapy (OT) Clinic, National University of Malaysia (UKM), KL they need more equipment to support the CP children to do their routine activity. Parents also faced a problem to find suitable equipment for their child. The existing standing frame are costly and need to be imported from abroad. Many parents are unaffordable to get the aids for their child. Furthermore, the parents faced a problem to let the child stand in upright position while holding their child's weight. To overcome the problems, the innovation standing frame have been design whereby a sitting and standing position will be combined. The study aspect in this product including the materials used, ergonomics design, and anthropometric data. The objective of this research is to develop a Standing Frame and to test the product with the sample. The patient sample have been identified have a mild CP category. She is 10 years old and cannot stand up by herself. The body measurement of the sample has been taken as a guideline for standing frame dimensions. The size of the product was 600mm (length) x 650mm (width) x 1200mm (height)

SOME OF IMPORTANT ELEMENTS

a. Cerebral Palsy

Cerebral palsy is a group of severe disorders in the development of movement and posture occurred in developing fetal or infant brain, often accompanied with disturbances of movement, sensation, cognition, communication, perception, and/or behavior and/or by a seizure (Liming Wang et, al., 2013). Cerebral palsy is a group of problems that affects body movement and posture. It is related to a brain injury or problems with brain growth. It is one of the most common causes of lasting disability in children. Cerebral Palsy occurs in about 2 to 2.5 out of every 1,000 people (Pellegrino, 2007). Everyone with Cerebral Palsy has problems with body movement and posture. But the physical problems are worse for some people than for others. Some people with Cerebral Palsy have a slight limp or a hard time walking. Other people have little or no control over their arms and legs or other parts of the body, such as the mouth and tongue, which can cause problems with eating and speaking. People with severe forms of Cerebral Palsy are more likely to have other problems, such as seizures or intellectual disability. Cerebral Palsy can't be cured, so the child will probably need lifelong treatment. But treatments can help deal with symptoms, prevent problems, and improve most of child's abilities. Physical therapy is one of the most important treatments. Other than that, medicines, surgery, and special equipment such as walker, standing equipment, transfer aids, parallel bar can also help.

b. Seat Surface Design

According to Wright-Ott and Egilson, 2001 stated that the seating surfaces may be custom molded, planar or contoured. Custom molded seating is specifically designed to accommodate fixed deformities and provide comfort to the user. The seat base, backrest or both can be molded too. A planar surface is flat and more appropriate for those requiring only minimal support. So, the planar surface design is the most simplest. The third seat surface design is contoured seating. The design

must follow the spine shape, buttocks and thighs. Besides, the contoured seating design will allow the body to have more contact with the seating surface and providing increased control and support. There are several studies was discussed on the fabrication and contoured seating use. Washington, Deitz, White and Schwartz (2002) are the only one study on investigating its efficacy. They also evaluated the effects of a contoured foam seat on children with neurological impairment. The results showed a sustained improvement in postural alignment for all subjects whilst seated on the contoured foam seat. Effects on increasing bilateral play were not demonstrated but qualitative data obtained from parents described perceived benefits of increased independence in functional skills and improved their social interaction. However a major limitation of this study as acknowledged by the authors was the small sample size of only 4 infants. Nevertheless, a number of disadvantages of molded seating have been identified. Study by Mulcahy, Pountney, Nelham, Green and Billington (1988) discuss on how the trunk weight can cause the pelvis to slide around the contours of the base leading to sacral sitting and the risk of tissue trauma. While Cook and Hussey (2002) list the disadvantages of custom contouring as being its limited ability to allow for growth of the individual, difficulty with transfers and its lack of dynamic properties as the individual is held in a fixed posture. However Cogher, Savage and Smith, 1992 said that custom contouring will be useful for children with severe fixed deformities. Freney-Bailey (2005) suggested a system incorporating a dynamic adjustable contoured back would be appropriate for children with growth considerations or clients who have changes in their orthopedic status. Positive feedback was obtained after using the system with a variety of clients but further research is needed to gain more data.

c. Seat and Backrest Inclinations

Siti Rasyidah et.al 2019 defined human posture as, “the position of one or many body segments in relation to one another and their orientation in space”. Patients with cerebral palsy (CP) especially one affected with total body involvement has a very loose head control. The research found by Hadders-Algra, Van Der Fits, Stremmelaar and Touwen, 1999 shows that children with CP often are hampered by dysfunctional postural control. There are debatable whether postural control of sitting in children with CP can be enhanced by the seat surface inclination or not (Myhr and Von Wendt, 1991). Two studies indicated that an interiorly tilted sitting position induced a more upright sitting position, which was associated with reduced muscle activity in the lower extremities. McClenaghan, Thombs and Milner (1992) however, found that a forward-inclined sitting position resulted in worse postural stability and that a posterior inclination of the seat surface resulted in better stability. Study by Mattana et, al. (2015) found that an adaptive seating systems (AdSSs) are part of the postural management programmed recommended in multifaceted guidance for children with severe CP. The AdSSs that include trunk and hip support devices may improve postural control outcomes, and also may improve self care and play behavior at home. A number of studies examined the effects of seating position and function. Seegar, Caudrey and O’Mera (1984) investigated the effect of variations in seat angle (with a vertical backrest) on hand function of 9 children and young adults with CP. Their study found that increasing the seat angle above horizontal to increase hip-flexion failed to improve hand function. This was consistent with findings by McPherson et al (1991) who found that sitting positions did not consistently alter the quality of reaching movements in 12 adults with and without CP. This study evaluated function whilst the hip was tilted 15 angles posterior and interior with a vertical backrest.

d. Pelvic Stabilization and Straps

Pelvic stabilization is regarded as crucial for the individual to obtain optimal postural support, control and ultimately function. Often disabled children are unable to achieve pelvic and trunk stability independently and hence various external stabilization devices are used. The pelvic strap is designed

to provide additional pelvic stabilization, to support the pelvis in a neutral or anterior tilted position and prevent forward sliding in the seat. Additionally, it can prevent the child from standing or extending out of the seat and for safety purposes (Green and Nelham, 1991). However controversy remains regarding the ideal angle at which these devices should be attached to the seating system. According to Mulcahy, Pountney, Nelham, Green and Billington (1988), Green and Nelham (1991) & Healy, Ramsey and Sexsmith (1997) advocate the use of a pelvic strap which should pull down and back at 45 angles to apply an opposing force to the sacral pad. This was supported in research studies by Myhr and Von Wendt (1990, 1991) in their investigation to find a functional sitting position for children with CP. They found that, a hip belt positioned at 45 angles and anchored under the seat provided good symmetrical pelvic positioning helped to prevent the child from sliding but allowed forward movements of the upper body. It is important to note however that these studies did not investigate the efficacy of the hip belt as a single component but rather as part of the functional sitting position as a whole.

e. How useful the 90-90-90 position in seated position?

According studies by Engstrom (2002), the 90-90-90 position may be regarded as an ideal seated position from an ergonomic perspective. Whilst Lange, 2001 stated that from an anatomical aspect, the goal is to achieve orthopedic maximum symmetry between left and right sides of the body are via a neutral pelvis to avoid obliquity, rotation and posterior pelvic tilt. Studies by Ham, Aldersea and Porter (1998), the advantages of this position include minimization of orthopedics deformity and promotion of proximal stability in turn aimed to promote distal control. One of the goals of seating is to promoted relaxation and comfort (Jones and Gray 2005). According to Kangas (2002), the 90-90-90 position temporarily reduces tone when considered as a resting position. Study conducted by Nwaobi (1987), regarding the effects of body awareness in space on tonic muscle activity of patients with CP concluded that muscle activity was lower in the upright position (90-90-90) than the reclined position (30 degree from vertical plane). The 90-90-90 position is difficult to maintain overtime (Ham, Aldersea and Porter, 1998 & Howe and Oldham, 2001) and may impede function (Engström, 2002). One study however concluded that the upright position was more functional compare with the anterior and posterior sitting positions. Nwaobi (1987) investigated the seat orientation of thirteen upper extremity function in children with spastic CP and athetoid CP, concluded that's arm movements were significantly faster when positioned in 90-90-90 compared to anterior (15 angle) and posterior (15 angle and 30 angle) orientations. Several authors advocate the idea of bypassing the 90-90-90 position. Kangas (2002) argues that for functional performance, movement and tone are required, but the 90-90-90 position prevents functional performance as it is essentially a resting position and only limited movement is allowed. Minkel (2001) postulates that the goal of adapted seating should extend beyond achieving perfect symmetry, but should focus on providing external support, at the angles needed by an individual to achieve an upright, stable and functional position. The ideology derived by expert opinion and experience provides important valuable information to strengthen the findings but special attention should be given when using anecdotal evidence to justify the practice. The 90-90-90 position can be use as a baseline position to achieve symmetrical position with further seating adaptations or components being utilized to facilitate function (Shimazu et al., 1994).

f. Standing frame

Ming Wu et. al (2015), applying a controlled pelvis assistance force improved step height, and applying a controlled leg assistance force improved step length in children with CP, although leg assistance reduced muscle activation of leg flexors and pelvis assistance tended to increase muscle activation of hip abductors. For example treadmill training in which controlled forces were applied to the pelvis and

leg, suggesting a potential transfer of motor adaptation from the treadmill to over ground walking. According to Goktepe; Tugcu; Yilmaz; Alaca; Gunduz (2008), a standing frame also known a stand, stander, standing technology, standing aid, standing device, standing box, tilt table is assistive technology that can be used by a person who relies on a wheelchair for mobility. A standing frame provides alternative positioning to sitting in a wheelchair by supporting the person in the standing position. Many children who have problems with balance or control for standing may benefit from standing or playing in a 'standing aid'. Here is the main benefits of standing, especially for children who are unable to stand up on their own:

i. Bone mineral density: When they stand and walk, it helps to strengthen the bones in their pelvis, spine and legs.
ii. Posture: Standing can help to stretch out tight muscles and maintain good range of motion. It is especially helpful for tight hamstrings, calves and the muscles at the front of the hips.
iii. Bladder and Bowel: When in standing, gravity and the contraction of the stomach muscles help to keep things moving.
iv. Respiration: Standing is excellent for improving children's breathing and helps to reduce the incidence and severity of upper respiratory infections.
v. Circulation: Standing up improves circulation and blood pressure due to the change in orientation.
vi. Hip development: When children start standing it helps to develop the hip joint into a more stable position.
vii. Alternate positioning: It is important to use a variety of positions to keep skin and tissue healthy and to help children to engage socially.
viii. Wellbeing: Children who are involved in a standing program have been shown to have improved alert-ness and sleep patterns, decreased fatigue and improved feeling of wellbeing.

METHODOLOGY

These present study had been conducted at Occupational Therapy Clinic (OT), UKM, KL, Forest Research Institute of Malaysia (FRIM), Furniture Technology Center Industry (Fitec) and Malaysian Timber Industry Board (MTIB) to gather information about the patient sample's and product design.

a. Identifying the sample.

The CP motor disorders are often occurring with disturbances of movement, sensation, perception, cognition, communication and behavior. Figure 1 show the types of Cerebral Palsy. The patient sample's is a girl, 10 years old and have a quadriplegia which is mild CP category. Both of her hands and legs are affected.

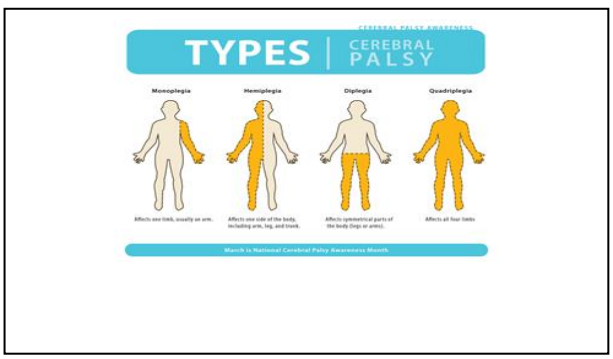

Figure 1: Types of Cerebral Palsy

b. Development of Standing Aid

An interviewed with Mr. Faris bin Masron and Mr. Muhammad Muhsin bin Suadi have been done.

According to both of them, which is the former group conducted the previous research on Standing Aid, there are a problem arises with the existing product and need to do an enhancement such as the safety aspect should be improved, barrier leg must be adjusted, strap must fully support the patients' body and barricades at the neck should be added.

Additional recommendations from Dr. Dzalani and Mr. Mohammad Shahrul Hafezz from UKM staff who are experts on the cerebral palsy problems, said that the existing Standing Aid need to add support at the knee so that the load of CP children does not depend entirely on the stopper, the support at the hip belt is also necessary to use a slightly larger to give comfort to the children as well as safety while in a standing position and neck support should also be placed because a CP child's neck is weak and flexible down. So, at least one support should be added.

c. Design process

i. Sketching is the first step in order to get the idea of product design.

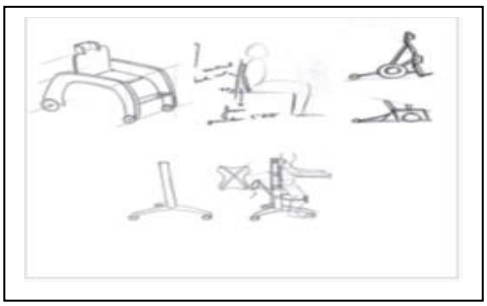

Figure 2: Sketch design of standing aid

ii. Autocad drawing

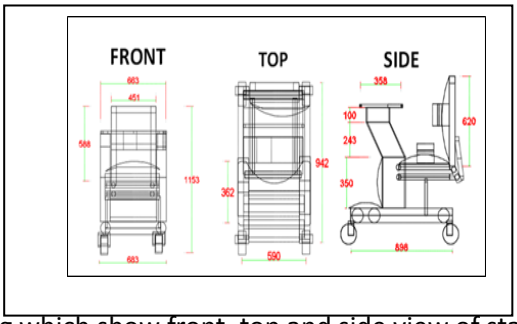

Figure 3: Autocad drawing which show front, top and side view of standing aid

d. Measurement process

The measurement of whole body of the sample has been used as a guidance to produce the standing aid. The data collected is shown in table 1.

Table 1: The measurement of sample physical body.

Bil.	Description	Measurement (mm)
1.	Height	1485
2	Chest	290
3	Height neck to head	260
4	Waist	590
5	Seat	480
6	Length leg	895

7	Waist to knee	475
8	Knee to ankle	390
9	Shoulder to waist	330
10	Knee to heels	420
11	Hand length	245
12	Foot length	220
13	Foot width	90

e. Production process

The main materials used in the production of standing aid are hollow steel, plywood, leather, foam, screw , lock , wheel, strap, c bracket , t pipe steel connector and finishing color. The table saw, arm saw, ripsaw, drill, grinder and welding machine has been used. The frames jointed by welding technique. The backrest rest and seat are using upholstery technique. The frames were attached by wheels for easy moving. Table is added to make the sample more stable when stand up and do an activity during treatment.

RESULT

A standing frame is an assistive device that can be used by a person who is unable to stand by themselves. It helps the CP children to train their leg muscle. The new standing aid designed can be used in sitting position before fixing up the children to be stand. Thus, parents can handle their child and the product itself. This product also will add up a number of assistive devices in local market because there are fewer manufacturers involved. Lastly, the feedback given by the parents and therapist stated that the standing aid is suitable to be use at home and medical center as one of the treatment devices. The advantages of this product are:

i. Provide 2 in 1 concept which is sitting and standing in one designed.
ii. Finishing's used were non-toxic and odourless type.
iii. Sponge foam used covered with leather for patient's comfortable and easy to clean.
iv. Straps locked used for safety.
v. Easily handled and mobile.
vi. Low of product cost compared with the imported.
vii. Hollow steel used as a frame for heavy duty purpose.

Finding from this study shown that, the backrest support is too high and does not match with patient's height, the table locks are difficult to be adjust, the curve side of the frame base preventing the wheels from working properly and sponge foam and leather applied are untidy. Thus, all the weaknesses of the product need to be improve.

CONCLUSION

The standing frame has been produced by incorporated with mechanical and safety aspect. Sitting position will help the standing position system become more effective when combined. Straps used are wider to make it more safety and the table equipped will help the children more stable during standing exercise. From this study, it can be concluded that there are certain aspect should be improve such as body measurement technique, transform mechanism from sitting to standing position and find a better wheels and locked system for the table. Having a child with disability will lead extra

challenges to parent. As a society we should show our love, support and concern by develop more assistive devices through innovation.

ACKNOWLEDGMENT

This research was supported by sub-warrant given by Department of Polytechnic and Community College. Special thanks to Commercialization, Research & Innovation Unit, Polytechnic Sultan Salahuddin Abdul Aziz Shah and Malaysian Advocates for Cerebral Palsy (Mycp) for their encouragement and providing valuable information during execution the project. Our deep gratitude also goes to our collaborator which is OT Clinic, FRIM, Fitec and MTIB.

REFERENCES

1. Cogher L, Savage E, Smith MF (1992). Seating In Management of Disability Series. Cerebral Palsy. The Child and Young Person. London: Chapman & Hall Medical.
2. Cook AM, Hussey SM (2002). Seating systems as extrinsic enablers for assistive technologies. In Assistive Technologies Principles and Practice. St Louis: Mosby.
3. Engström B (2002). Ergonomic Seating A True Challenge Wheelchair Seating and Mobility Principles. Sweden: Posturalis Books.
4. Freney-Bailey D (2005). Custom contoured seating: a pediatric lightweight system and an adjustable contoured back. Proceedings of the 21st International Seating Symposium.
5. Goktepe, A.S.; Tugcu, I.; Yilmaz, B.; Alaca, R.; Gunduz, S. (2008). "Does standing protect bone density in patients with chronic spinal cord injury?". J Spinal Cord Med 31 (2): 197–201.
6. Green EM, Nelham R (1991). Development of sitting ability, assessment of children with a neuromotor handicap and prescription of appropriate seating systems. Prosthetics and Orthotics International, 15, 203-216.
7. Hadders-Algra M, van der Fits, IBM, Stremmelaar EF, Touwen BCL (1999). Development of postural adjustments during reaching in infants with CP. Developmental Medicine and Child Neurology, 41, 766-776.
8. Ham R, Aldersea P & Porter D (1998) Wheelchair Us-ers and Postural Seating A Clinical Approach. London: Churchill Livingstone
9. Healy A, Ramsey C, Sexsmith E (1997). Postural support systems: their fabrication and functional use. Developmental Medicine and Children Neurology, 39, 706-710.
10. Hong C, (2002). Positioning for children with learning disabilities. British Journal of Therapy and Rehabilitation, 9, 443-446.
11. Howe T & Oldham J, (2001). Posture and balance. In M Trew & Everett T (Ed) Human Movement an Introductory Text. London: Churchill Livingstone.
12. Jones M & Gray S (2005). Assistive technology: positioning and mobility. In SK Effgen (Ed) Meeting the Physical Therapy Needs of Children. Philadelphia: FADavis Company.
13. Kangas KM (2002). Seating for task performance; creating seating systems that allow weight-bearing, pelvic stability and mobility. Rehab Management: The Interdisciplinary Journal of Rehabilitation, (15), 54-56, 74.
14. Lange ML (2001). Focus on positioning philosophies. Occupational Therapy Practice, 6, 15-16.
15. Liming Wang, Haijie Ji, Jianjun Zhou, Jiang Xie, Zhanqiang Zhong, Ming Li, Wen Bai, Na Li, Zijia Zhang, Xuejun Wang, Delin Zhu, Yongjun Liu, and Mingyuan Wu. (2013) Therapeutic Potential of Umbilical Cord Mesenchymal Stromal Cells Transplantation for Cerebral Palsy: A Case Report.
16. Mattana Angsupaisal, Carel G B Maathuis & MijnaHadders-Algra.(2015). Adaptive seating systems in children with severe cerebral palsy across International Classification of Functioning, Disability and Health for Children and Youth version domains: a systematic review. Developmental Medicine & Child Neurology, (57), 919–931.
17. Ming Wu, Janis Kim, Pooja Arora, Deborah J. Gaebler-Spira, and Yunhui Zhang. (2016). Kinematic and EMG Responses to Pelvis and Leg Assistance Force during Treadmill Walking in Children with Cerebral Palsy. Neural Plasticity,1-12.

18. McPherson JJ, Schild R, Spaulding SJ, Barsamian P, Transon C & White SC (1991). Analysis of upper extremity movement in four sitting positions: a comparison of persons with and without cerebral palsy. American Journal of Occupational Therapy, 45, 123-129.
19. McClenaghan BA, Thombs L, Milner M (1992). Effects of seat-surface inclination on postural stability and function of the upper extremities of children with cerebral palsy. Developmental Medicine and Child Neurology, 34, 40-48.
20. Minkel JL (2001). Long term rehab: sitting outside of the box: clinicians need to let go of the 90/90/90 seating rule to explore more effacious alternatives. Rehab Management – The Interdisciplinary Jour-nal of Rehabilitation, 14, 50-51, 82.
21. Mulcahy CM, Pountney TE, Nelham RL, Green EM, Billington GD (1988). Adaptive seating for motor handicap: problems, a solution, assessment and prescription. British Journal of Occupational Therapy, 51(10), 347-352.
22. Myhr U, von Wendt L (1990). Reducing spasticity and enhancing postural control for the creation of a functional sitting position in children with cerebral palsy: a pilot study. Physiotherapy Theory and Practice, 6, 65-76.
23. Myhr U, von Wendt L (1991). Improvement of functional sitting position for children with cerebral palsy. Developmental Medicine and Child Neurology, 33, 246-256.
24. Nwaobi OM (1987). Sitting orientations and upper extremity function in children with cerebral palsy. Physical Therapy, 67, 1209-1213.
25. Pellegrino L (2007). Cerebral palsy. In ML Batshaw et al., eds., Children with Disabilities, 6th ed., pp. 387–408. Baltimore: Paul H. Brooks Publishing.
26. Seeger BR, Caudrey DJ, O'Mara NA (1984). Hand function in cerebral palsy: the effect of hip-flexion angle. Developmental Medicine and Children Neurology, 26,601-606.
27. Siti Rasyidah Hamzah, Nor Aiman Nor Izmin, Giha Tardan, Abdul Halim Abdullah.(2019). Design and Analysis of Adjustable Headrest for Total Body Involvement Cerebral Palsy. International Journal of Recent Technology and Engineering (IJRTE), 8(1), 3208-3211.
28. Shimazu ME, Tanaka S, Takamagari H, Honda K, Shimizu H, and Nakamura S (1994). Optimal Positioning for an Adult Athetoid Cerebral Palsy pa-tient in a wheelchair. Hiroshima Journal of Medical Science, 43, 69-72.
29. Washington K, Deitz JC, White OR, Schwartz IS (2002). The effects of a contoured foam seat on postural alignment and upper-extremity function in infants with neuromotor impairments. Physical Therapy, 82(11), 1064-1076.
30. Wright-Ott C, Egilson S (2001). Mobility. In J Case-Smith (Ed) Occupational Therapy for Children. St Louis: Mosby.
31. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interfaces (Translation Journals style)," IEEE Transl. J. Magn. Jpn., vol. 2, Aug. 1987, pp. 740–741 [Dig. 9th Annu. Conf. Magnetics Japan, 1982, p. 301].