Spinal Deviations in relation to Arm Functions in Obstetrical Brachial Plexus Injuries

Marwa Mostafa Ibrahim Ismaeel* [1, 2]; Tamer Mohamed El-Saeed [1] and Ehab Anwar Hafez [1]

[1.] Department of Physical Therapy for Growth and Developmental Disorders in Children and its Surgery, Faculty of Physical Therapy, Cairo University, Cairo, Egypt.
[2.] Department of Physical Therapy and Health Rehabilitation, College of Applied Medical Sciences, Al Jouf University, Sakaka, Kingdom of Saudi Arabia.
mmismaeel@pt.cu.edu.eg

Abstract: This study was conducted at the lab of geometrical analysis of spine, Faculty of Physical Therapy, Cairo University, Egypt to determine correlation between back geometrical parameters and arm function of children suffering from brachial plexus injury resulting from obstetrical trauma specially those of upper trunk lesion (Erb's type) affecting C_5, C_6 and C_7. Thirty Erb's palsied children participated in this study. All children ranged in age from three to six years. Formetric (rastersterography) instrument was used for assessing the back geometry. Data of Erb's palsied children was correlated to arm function according to modified Mallet system with p-value at 0.05. The results of this study showed negative correlation between the measured parameters including trunk imbalance, lateral deviation (rms), lateral deviation (max), surface rotation (rms) and surface rotation (max). From the obtained results, it can be concluded that, there is negative correlation between back geometrical parameters and arm function according to modified Mallet system in obstetrical brachial plexus palsied children.
[Marwa Mostafa Ibrahim Ismaeel; Tamer Mohamed El-Saeed and Ehab Anwar Hafez. **Spinal Deviations in relation to Arm Functions in Obstetrical Brachial Plexus Injuries.** *Life Sci J* 2014;11(12):1077-1081] (ISSN:1097-8135). http://www.lifesciencesite.com. 184

Keywords: Brachial Plexus Palsy, Back Geometry, Arm Function.

1. Introduction

Neonatal brachial plexus palsy (NBPP) is an injury to the brachial plexus, nerves in the upper part of the neck and shoulder, which occurs in 1-2 cases per 1000 live births before or during the birth process **(Foad *et al.,* 2008)**. The injuries to the nerves range from mild with spontaneous recovery to more severe resulting in permanent impairment of the child's upper extremity. Physicians often prescribe occupational therapy (OT) and physical therapy (PT) for patients with NBPP as a form of conservative management to achieve optimal recovery. However, the literature reveals limited and inconsistent findings on therapy interventions for NBPP **(Bialocerkowski *et al.,* 2005)**.

Brachial plexus birth palsy (BPBP) occurs in approximately 0.4 to 4.6 of every 1000 live births **(Hogendoorn *et al.,* 2010)**. The most common type of BPBP affects the upper trunk of the brachial plexus (C5 and C6) and is referred to as Erb's palsy. Damage to C5, C6 and C7, or extended Erb's palsy, is the next most frequent classification of BPBP **(Hale *et al.,* 2010)**.

While some infants fully recover, approximately one-third of these patients experience lifelong complications **(Hogendoorn *et al.,* 2010 and Hale *et al.,* 2010)**. Residual BPBP is known to cause a number of anatomical changes and functional deficits of the affected upper extremity including reduced limb length and girth **(Bae *et al.,* 2008, Abzug & Kozin, 2010 and Terzis & Kokkalis, 2010)**, abnormal scapular morphology **(Kozin *et al.,* 2010)**, glenohumeral (GH) dysplasia and subluxation **(Van Heest *et al.,* 2010 and Bahardwaj *et al.,* 2013)**, muscle weakness and range of motion limitations **(Nikolaou *et al.,* 2013)**.

Effects of BPBP have a dramatic impact on self-reports of function and quality of life in these children. Mean reported upper-extremity subscores on the Pediatric Outcomes Data Collection Instrument for children with BPBP range from 70.8 - 76.7 and are substantially lower than typically developing control children whose reported subscores range from 92.0 – 95.8 **(Huffman *et al.,* 2005 and Bae *et al.,* 2008)**.

Clinical measures, such as the modified Mallet classification, are used to assess development and progression over time, as well as functional outcomes of surgery **(Abzug & Kozin, 2010 and Abzug *et al.,* 2010)**; however, these measures provide no information regarding the scapulothoracic (ST) or GH contributions utilized to achieve these tasks **(Fitoussi *et al.,* 2009 and Blaauw & Muhlig, 2012)**.

Observation of children performing the modified Mallet classification indicated that children with BPBP often have difficulty executing the hand to spine task in the presence of seemingly adequate shoulder internal rotation. This suggests that additional factors – aside from sufficient internal rotation – are necessary for successful performance of this task **(Russo, 2014)**.

Ideal posture is variously described as the posture that requires the least amount of muscular support, the posture that minimizes the stresses on the joints, or the posture that minimizes the loads in the supporting ligaments and muscles. In the absence of clear understanding of meaning of the "ideal "posture, careful measurements of the positions assumed by individuals without known musculoskeletal impairments or complaints provide a perspective on the typical, if not ideal , alignment of limb segments **(Carol, 2008)**.

Brachial plexus palsy is considered as one of the predisposing factors that may lead to different geometrical changes of the spine such as scoliosis and kyphosis **(Ismaeel *et al.,* 2011)**.

2. Material and Methods

Subject:

Thirty Erb's palsied children were selected in this study and the study was conducted in the geometrical lab of the Faculty of Physical Therapy, Cairo University. They followed the following criteria: Children of both sexes participated in this study as they were receiving the traditional physical therapy program. Their age ranged from three to six years. C_5, C_6 and C_7were affected. They had between grade 2 and grade 4 according to modified Mallet classification (Figure 1). They were able to understand orders and follow verbal commands and instructions given to them. They had neither visual nor auditory defects. They had no significant perceptual disorders. They had no significant tightness or fixed deformity of the affected upper limb.

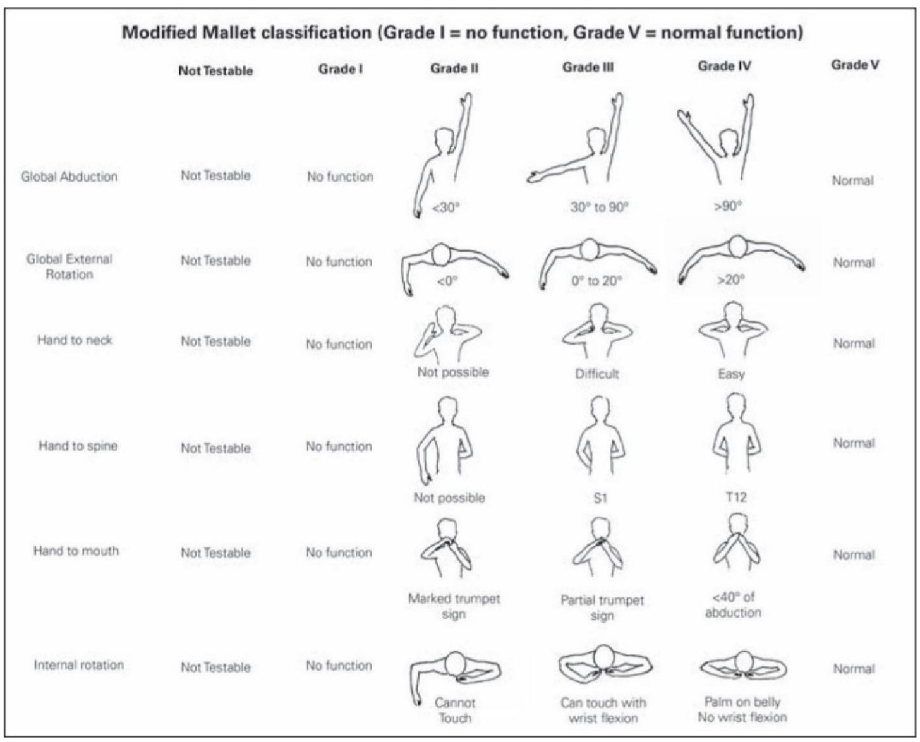

Figure (1): Modified Mallet system (Adopted from Abzug and Kozin, 2010).

Formetric instrumentation system (AESCULAP-MEDITEC GMBH, Holland) system was used to measure back geometry of all children.

It serves for determination of the geometry of the exposed back surface of human beings based on non-contact 3-Dimensions scan and, derived from it, a spatial reconstruction of the spine by means of a specific mathematical model. The device is a reliable, valid and non-invasive method in assessing any spinal or pelvic deviation.

The preparatory procedure:

The procedure was explained to the patient and his/her attending relatives. Child was taught to take and hold deep breathing. Care was taken not to interrupt the recording procedure to maintain the child in relaxed position. Child had to be bare feet before standing to avoid any spinal deviation.

The evaluative procedure:

The software program was started before positioning the child. Data was entered in his/her file on the computer including date of birth, name, sex, height, weight, any previous radiological findings and any comments on the case. Child was asked to stand facing the black ground screen at a distance of 2 meters away from the measurement system (scan system). A freestanding posture was preferable. Each child was asked to take normal breathing. The subject was asked to stop breathing for few seconds while image capture was released. Forced breathing in and out should be avoided, as it will affect his/her balance causing trunk imbalance. The scanner was elevated for different subjects' heights as there is a green horizontal line appears on the computer screen when the camera is ready for recording. Full back shape three-dimensional analysis was done, recorded, and printed out.

Statistical Analysis

The collected data of demographic and other baseline characteristics was statistically treated to show mean, range and standard deviation of mean for back geometrical parameters. The collected data were statistically analyzed using Graph pad instate software version 3.05. Spearman rank correlation was conducted between back geometrical parameters and arm function according to Mallet system. *P*-value (<0.05) was considered significant.

3. Results

General characteristics:

Table (1) presents a summary of children general characteristics at entry as age, frequency distribution of gender and frequency distribution of modified Mallet system grading, height of children and trunk length.

Table (1): General characteristics of all children:

Item		Study group
Age (year)	Mean ± SD	4.68 ± 0.78
	Range	3.58 – 6
Frequency distribution of gender	Male	18
	Female	12
Frequency distribution of modified Mallet system grading	Grade 2	6
	Grade 3	14
	Grade 4	10
Height (meter)	Mean ± SD	0.99 ± 0.08
	Range	0.9 – 1.17
Trunk Length (millimeter)	Mean ± SD	270.3 ± 30.43
	Range	216 – 327

It was observed negative correlation between back geometrical parameters including trunk imbalance, lateral deviation (rms), lateral deviation (max), surface rotation (rms) and surface rotation (max). All these negative correlations were weak except for trunk imbalance. Correlations between arm function and trunk imbalance was statistically significant as well as between arm function and surface rotation (max) (p<0.05) as shown in table (2).

Table (2): Correlation between back geometrical parameters and arm function according to modified Mallet system.

Variable	Mean ± SD	*r*-Value	*p*-value
Trunk Imbalance	13.37±8.18	- 0.9274	0.0001
Lateral deviation (rms)	5.33±2.98	- 0.2519	0.1794
Lateral deviation (max)	9.27±4.96	- 0.1982	0.2939
Surface Rotation (rms)	3.13±1.33	- 0.00197	0.9918
Surface Rotation (max)	6.43±2.82	- 0.4439	0.014

4. Discussion

Bae *et al.* (2003) assessed the reliability of the Toronto Test Score, the Active Movement Scale, and the modified Mallet system and determined that all 3 tests demonstrated positive intra- and interobserver reliability with aggregate scores. In addition, internal consistency (test-retest reliability) was excellent for the aggregate Toronto Test and the modified Mallet for all age groups tested.

There are excellent controls over the growth and development of the spine in most persons, except when there is muscular weakness. The apparently spontaneous development of scoliosis and abnormal kyphosis is difficult to explain **(Bettany-Saltikov *et al.,* 2012)**.

Scoliosis is rarely painful. Curves of less than 20 degrees are considered mild. Those of more than 40 degrees may result in permanent deformity, and those of 65 to 80 degrees may result in reduced cardiopulmonary function **(Weiss *et al.,* 2009)**.
Whatever the initial trigger that induces a spinal curvature, asymmetric loading of the spinal axis produces biomechanical forces that can account for most if not all progression of the spinal deformity **(Hawes and O'Brien, 2006)**.

Brachial plexus palsied child should be re-evaluated on a regular basis to ensure that scoliosis does not develop from muscle imbalance and asymmetric motor patterns. Scoliosis is the most common and serious of spinal curvature disorders. Lateral curvature of the spine is often accompanied by rotation of the vertebral bodies. Functional scoliosis is flexible and can be caused by poor posture, leg length discrepancy, poor postural tone, or pain. Diseases of the nervous system or spine also may create scoliosis **(Ismaeel *et al.,* 2011)**.

Results of this study comes in agreement with **Waston (2014),** who stated that asymmetrical development of the muscles of shoulders and back cause deviations of the spine.

Once a spinal curvature is triggered and continuous asymmetric loading is established, mechanical forces imposed by asymmetric loading directly because structures of the spinal column to become deformed.

The obtained results may be attributed to the weight differences between both upper limbs as the affected one suffer from atrophy which represent differences in force or load bearded by the spinal column.

Also, the findings of the present study may be attributed to the limitation in functional level as there is relation between stability and mobility. Any limitation in mobility around the spine will in turn affect the stability of the spine, which will lead to un-expected deformities through altering the loads around the spine. Also, defects in the work of one factor or more of the infra structures in which spinal alignment depends on such as bones, joints, ligaments and muscles may play a role.

From the biomechanical point of view, the applied stresses on a structure should be equal in all direction in which to maintain the alignment of this structure. This idea may not be achieved in brachial plexus palsied children in which the stresses the spine are not equal due to muscle imbalance which can be explained by effect of proximal affection through involving the muscles around either scapula or glenohumeral joint (shoulder complex).

5. Conclusion:

From the previous discussion of the results of this study and according to the reports of the investigators in the fields related to the present study, it can be concluded that, there is negative correlation between back geometrical parameters and arm function according modified Mallet system in obstetrical brachial plexus palsied children.

References

1. Abzug JM, Chafetz RS, Gaughan JP, *et al.* Shoulder function after medial approach and derotational humeral osteotomy in patients with brachial plexus birth palsy. J Pediatr Orthop. 2010 Jul-Aug; 30(5):469-74.
2. Abzug JM, Kozin SH. Current concepts: neonatal brachial plexus palsy. Orthopedics. [Review]. 2010 Jun; 33(6):430-5.
3. Bae DS, Ferretti M, Waters PM. Upper extremity size differences in brachial plexus birth palsy. Hand (N Y). 2008 Dec; 3(4):297-303.
4. Bae DS, Waters PM, Zurakowski D. Correlation of pediatric outcomes data collection instrument with measures of active movement in children with brachial plexus birth palsy. J Pediatr Orthop. [Research Support, Non-U.S. Gov't]. 2008 Jul-Aug; 28(5):584-92.
5. Bae DS, Waters PM, Zurakowski D. Reliability of three classification systems measuring active motion in brachial plexus birth palsy. J Bone Joint Surg Am. 2003; 85(9):1733–1738.
6. Bhardwaj P, Burgess T, Sabapathy SR, *et al.* Correlation Between Clinical Findings and CT Scan Parameters for Shoulder Deformities in Birth Brachial Plexus Palsy. J Hand Surg Am. 2013 Jun 28, 42
7. Bialocerkowski, A., Kurlowicz, K., Vladusic, S., & Grimmer, K. (2005). Effectiveness of primary conservative management for infants with obstetric brachial plexus palsy. International Journal of Evidence-Based Healthcare, 3 (2), 27-44.
8. Blaauw G, Muhlig RS. Measurement of external rotation of the shoulder in patients with obstetric brachial plexus palsy. J Brachial Plex Peripher Nerve Inj. 2012; 7(1):8.
9. Carol A. Kinesiology: The Mechanics and Patho-mechanics of Human Movement, 2nd Ed., Lippincott William and Wilkins, London, 2008, pp: 838.
10. Fitoussi F, Maurel N, Diop A, *et al.* Upper extremity kinematics analysis in obstetrical brachial plexus palsy. Orthop Traumatol Surg Res. 2009 Sep; 95(5):336-42.

11. Foad, S. L., Mehlman, C. T., & Ying, J. The epidemiology of neonatal brachial plexus palsy in the united states. Journal of Bone & Joint Surgery, American Volume, 2008, 90A (6), 1258-1264.
12. Hale HB, Bae DS, Waters PM. Current concepts in the management of brachial plexus birth palsy. J Hand Surg Am. 2010 Feb;35(2):322-31.
13. Hawes M.C. and O'Brien J.P. The transformation of spinal curvature into spinal deformity: pathological processes and implications for treatment, Scoliosis, 2006, 1:3 doi:10.1186/1748-7161-1-3.
14. Hogendoorn S, van Overvest KL, Watt I, *et al.* Structural changes in muscle and glenohumeral joint deformity in neonatal brachial plexus palsy. J Bone Joint Surg Am. 2010 Apr; 92(4):935-42. http://search.ebscohost.com/login.aspx?direct=true&db=rzh&AN=2009046386&site=ehost-live.
15. Huffman GR, Bagley AM, James MA, *et al.* Assessment of children with brachial plexus birth palsy using the Pediatric Outcomes Data Collection Instrument. J Pediatr Orthop. [Research Support, Non-U.S. Gov't]. 2005 May-Jun; 25(3): 400-4.
16. Ismaeel M.M., Al-Tohamy A.M. and Abdelwahab M.S. Posture Outcomes for Children Suffering from Obstetrical Injuries. Bioscience Research, 2011, 8(1): 51-55.
17. Bettany-Saltikov J, Cook T, Rigo M, De Mauroy JC, Romano M, Negrini S, Durmala J, Del Campo A, Colliard C, M'hango A and Bialek M. Physical Therapy for Adolescents with Idiopathic Scoliosis. In: Physical Therapy perspectives in the 21st century – Challenges and Possibilities. Edited by: Bettany-Saltikov J and Paz-Lourido B, InTech, Croatia, 2012, pp: 4 – 40.
18. Kozin SH, Chafetz RS, Shaffer A, *et al.* Magnetic resonance imaging and clinical findings before and after tendon transfers about the shoulder in children with residual brachial plexus birth palsy: a 3-year follow-up study. J Pediatr Orthop. 2010 Mar; 30(2): 154-60.
19. Nikolaou S, Hu L, Tuttle LJ, *et al.* The contribution of denervated muscle to contractures following neonatal brachial plexus injury: Not just muscle fibrosis. Muscle Nerve. 2013 Jul 8.
20. Russo, S.A. Assessment Of Scapulothoracic And Glenohumeral Function And Conservative Treatment Approaches For Children With Brachial Plexus Birth Palsy, Ph.D. dissertation, University of Delaware, ProQuest, UMI Dissertations Publishing, 2014, 3631208.
21. Terzis JK, Kokkalis ZT. Bone discrepancy as a powerful indicator for early surgery in obstetric brachial plexus palsy. Hand (N Y). 2010 Dec; 5(4): 386-96.
22. Van Heest A, Glisson C, Ma H. Glenohumeral dysplasia changes after tendon transfer surgery in children with birth brachial plexus injuries. J Pediatr Orthop. 2010 Jun; 30(4): 371-8.
23. Waston A.W. Physical Fitness and Athletic Performance, Routledge Publishing, New York, USA, 2014, pp: 63.
24. Weiss H.R., Turnbull D. and Bohr S. Brace treatment for patients with Scheuermann's disease - a review of the literature and first experiences with a new brace design. Scoliosis, 2009, pp: 4-22.

12/22/2014