Effect of Correction of Erb's Engram on Spinal Geometrical Measurements for Brachial Plexus Injured Children

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ABSTRACT

Background and Purpose: *the purpose of this study was to investigate the effect of correction of erb's engram on changing the degree of deviation of the spinal geometrical measurements in children with upper type of brachial plexus injuries (Erb's type).* ***Subjects and procedures:*** *Thirty erb's palsied children from both sexes (eighteen girls and twelve boys) ranged in age between four to six years ($\bar{X}$ ± SD) was 5.68 ± 0.81 years participated in this study. All children had an erb's engram and a degree of spinal deviation including trunk imbalance, surface rotation, lateral deviation, and kyphotic angle according to formetric evaluation system. Patients were assigned randomly into two groups of equal numbers (fifteen patient in each group) represented control (GI) and study (GII) groups respectively. A formetric (rasterstography) system was used for selection of the sample and assessment of spinal geometry in both groups before and after treatment application. The control group received traditional line of treatment for erb's palsy cases while children in the study group received the same program given to GI in addition to a designed program for correction of erb's engram. Children in both groups were assessed at the beginning of the study and after three successive months of treatment application.* ***Results:*** *the data was collected and statistically analyzed before and after the suggested treatment period showed a statistically insignificant difference between both groups before treatment application while there was statistically significant difference after treatment application among both groups for all measured variables ($P< 0.05$). Conclusion: Brachial plexus palsied children should be reevaluated on a regular basis to ensure that spinal deviations don't develop from asymmetrical motor and muscular imbalance and exercises for correction of erb's engram should included in the physical therapy rehabilitation program.*
Key words: *Brachial plexus lesions, Erb's palsy, Erb's engram, spinal geometrical measurements and phormetric system.*

INTRODUCTION

Brachial plexus palsy (BPP) refers to injury to all or portion of the brachial plexus noted at time of delivery. Injuries associated with upper brachial plexus (C5,C6) termed as Erb's palsy. Obstetrical brachial plexus injuries often associated with birth over weight and shoulder dystocia[8,11].

The effects of brachial plexus injury may present themselves in a variety of ways as in addition to asymmetry issues at shoulder, scapula and trunk there is also a decreased function at elbow, forearm, wrist and hand[5]. In the early stages of development, the infant props him/herself on arms, in a position that permits the elevation of the chest from the surface. Spinal extension strengthens in any gravity prone position and proceeds in a cephalic-caudal direction from the cervical to the thoracic spine promoting stability in the upper quadrant[12].

Erb's engram develops when the child has weak biceps (elbow flexor and prime supinator) and weak triceps (elbow extensors), the child tends to position the arm in elbow flexion with pronation, as there is no full muscle potential to fully bend or straighten the arm. As the child continues to carry the arm flexed, without the ability to fully flex or extend, weight-bearing becomes less likely and the joint integrity is compromised[14].

In Erb's palsied children with erb's engram there is unequal loading on the spinal vertebra due to asymmetrical use of both upper limbs as the child has a tendency to use the sound side and ignore the affected side in addition to the unequal weight bearing on both upper limbs affects the symmetry of the spine causing spinal lateral deviation which indicates the development of scoliosis of those children[18].

Chen et al.,[3] reported that 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.

The stability of the vertebral column depends upon a number of factors one of these factors is the relationship between to the vertical line representing the center of gravity and muscle pull around the vertebrae so, when weight is properly balanced on the vertebral column, minimal muscular activity is necessary. A constantly maintained position in which the weight is not reasonably well balanced resulting in structural changes and permanent deformity in growing child[7].

So the problem in this study was to detect the effect of correction of the Erb’s engram on spinal geometrical measurements of children suffering from brachial plexus lesions (Erb’s type).

SUBJECTS AND PROCEDURES

Subjects

Thirty children with upper type brachial plexus lesion (Erb's palsy) participated in this study. They were selected based on the following criteria:

- Their ages ranged from 4-6 years.
- Their average height was not less than one meter.
- They had no significant tightness or fixed deformity of the affected upper limb.
- They ranged from grade 2 to grade 4 in Mallet classification.
- All children had an Erb's engram i.e they raise their affected upper limb with elbow maintained in flexion and pronation pattern and the desired movement was produced with shoulder abduction.
- They had a degree of spinal deviation according to formetric evaluation including trunk imbalance, surface rotation, lateral deviation, and kyphotic angles.

Patients were selected and treated at Pediatric Physical Therapy Outpatients Clinic and assessment was performed at the spinal geometrical lab of the Faculty of Physical Therapy, Cairo University.

Instrumentations

1- Formetric instrumentation system: (manufactured by AESCULAP-MEDITEC GMBH, Holland): this system serves for determination of the geometry of the spine based on non-contact three dimensional scan and spatial reconstruction of the spine. It is composed of Scan system: (optical column with base plate) contains a raster projector and a CCD video camera mounted into profile tube. Projector and camera are firmly aligned to each other and telescope drive provides vertical adjustment of the entire system Black background screen: that allows absorption of any light rays. Computer system: it consists of a standard PC for image processing, with printed circuit board for capturing images (frame grabber), a module for rotation of live images and image presentation on a monitor. Printer: laser printer that provides high quality image presentation. VRS visual spine software: it generates a three dimensional reconstruction of the form of the spine and allows individual image analysis of the carried out examinations.

2- Faradic stimulation: Medisana dual-channel muscle stimulator was used to enhance muscular contraction.

Evaluation procedures

Evaluation of the spinal geometrical measurements was done for each child in both groups before and after three months of treatment application. The following steps were followed during the evaluation procedure:

- Feminization and complete illustration to the child and his parents with each step in the procedure.
- Patient specific data were entered in the recording file including date of birth, name, sex, height, weight, any previous radiological findings and any comment for the case.
- Each child was asked to stand freely facing the black ground screen at a distance of 2 meters away from the measurement system.
- Then the scan system was operated with the horizontal lines laid and kept below the inferior angles of the scapulae. The back of the child was illuminated by a pattern of parallel lines recoded in a single frame.
- After the child was ready in the appropriate position, green horizontal lines appeared on the computer screen. Then child was asked to hold on breath for few milliseconds (40 milliseconds) during capture in order to eliminate movement artifact.
- Full back shape 3D analysis was done, recorded and printed out for each patient.

The collected data from both groups included the following parameters:

1- Trunk imbalance: it is the lateral deviation of the vertebral prominences from dimple midpoint (DM). +ve value means shift of VP (vertebral prominence) to the right & -ve value means shift to the left.

2- Surface rotation: it is the root mean square (rms) of the surface rotation on the symmetry line it should be zero in healthy persons.

3- Lateral deviation: it represents the root mean square (rms) of lateral spinal deviation of spinal midline from the line VP-DM it should be zero in healthy persons.

4- Kyphotic angle VP-T12: this is the kyphotic angle measured between VP and the estimated location of T12.

Treatment procedures

A) <u>Treatment for control group (GI):</u>

Traditional treatment program given to children with erb's palsy in a form of stretch to the tight muscles, activities to encourage passive stretching of the wrist include weight-bearing activities by positioning the child's palm flat on the floor, tactile stimulation to enhance muscle contraction, graduated active exercises to the weak muscles. Electrical stimulation: was used for stimulating muscle contraction one electrode was placed on the motor erb's point and the other electrode was placed on the motor point of the weak muscles.

B) Treatment for study group (GII):

Children in this group received the same exercises given to children in GI in addition to a specific treatment program for correction of Erb's engam including:

- Unilateral weight bearing exercises on the affected upper extremity.
- Bilateral weight bearing from the quadruped position.
- Eccentric contraction of the shoulder and elbow flexors by gliding movement on a smooth stick.
- Enhancement of arm elevation in forward direction instead of abduction by manual guidance.
- Using fingertips stairs and the child was asked to ascend and descend in forward (not sideway) direction.
- The elbow was maintained in extension and forearm in full supination by an air cast which is a long arm pillow tube that resembles an "arm swimmie" as a form of a night-time splint. It was wrapped around the arm, and inflated until the compressed air straightens the arm.
- Strength exercises to back muscles and scapular retractors.

All children received 3 sessions per week for thirty-six sessions and evaluation of the spinal geometrical measurements was done before (baseline) and after the suggested treatment duration.

RESULTS

In the present study effect of correction of Erb's engram on improving the degree of spinal deviation in children with upper type of brachial plexus lesions (Erb's palsy) was evaluated. The collected data was analyzed and statistically treated to show the mean values and standard deviation of the measured parameters before and after the suggested treatment period in both groups as follows:

Trunk imbalance and Lateral deviation for both groups before treatment:

Comparison between mean values of all measuring variables in both groups before starting treatment indicated statistically non significant difference (P> 0.05).

As shown in table (1) and illustrated in figure (1) statistical analysis of trunk imbalance and lateral deviation in both groups before treatment showed statistically insignificant difference as mean values of trunk imbalance in both groups were 13.93±7.76 and 14.2±7.18 while for lateral deviation it was 5.33 ±3.04 and 6.27±2.52 respectively (P>0.05).

Table (1): Mean values of trunk imbalance and lateral deviation (in mm) for both groups I & II before treatment.

	$\bar{X}$ ±SD (GI)	$\bar{X}$ ±SD (GII)	MD	t	P
Trunk imbalance (mm)	13.93±7.76	14.2±7.18	0.27	0.1	>0.05*
Lateral deviation (rms) (mm)	5.33±3.04	6.27±2.52	0.93	0.92	>0.05*

$\bar{X}$ ±SD : Mean ± Standard deviation   * Non-significant   MD : Mean difference
t: Tabulated value   P: Probability value

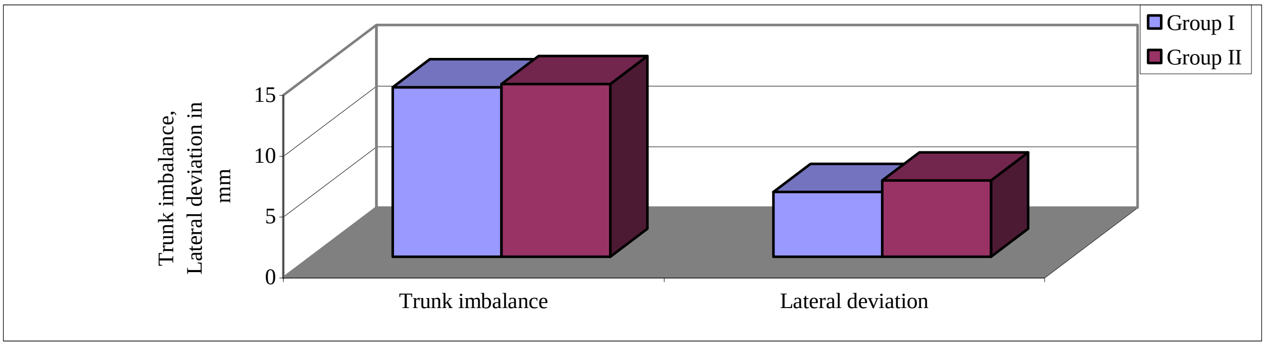

Fig. (1): Mean values of trunk imbalance and lateral deviation (in mm) for both groups I & II before treatment.

<u>Surface rotation and kyphotic angle for both groups before treatment:</u>

As shown in table (2) and illustrated in figure (2) there was a statistically insignificant difference of surface rotation and kyphotic angle as mean values of surface rotation for both groups I and II were 3.53±1.19 and 4.2±1.42 while for kyphotic angle they were 39.47±5.32 and 38.93±6.05 respectively ($P>0.05$).

Table (2): Mean values of the surface rotation and kyphotic angles for both GI & GII before treatment.

	$\bar{X}$ ±SD (GI)	$\bar{X}$ ±SD (GII)	MD	t	P
Surface rotation (rms) degree	3.53±1.19	4.2±1.42	0.667	1.39	>0.05*
Kyphotic angle VP-T12	39.47±5.32	38.93±6.05	0.53	0.26	>0.05*

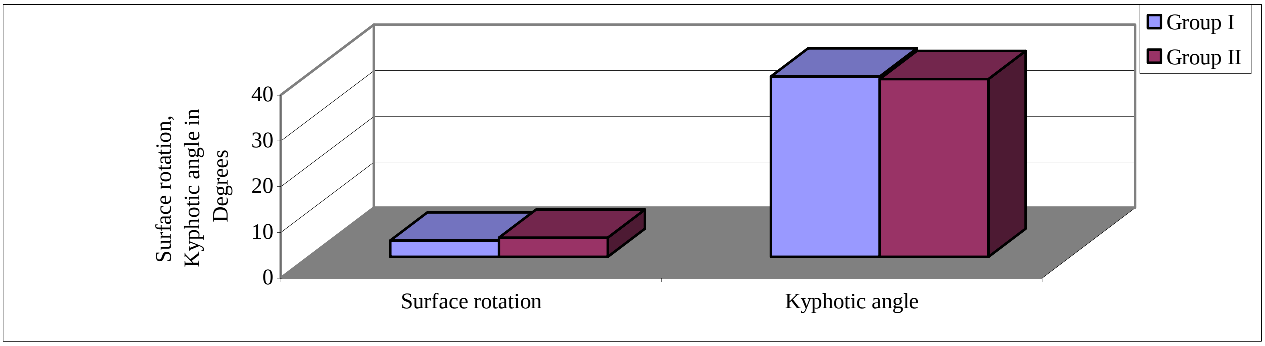

Fig. (2): mean values of surface rotation and kyphotic angle VPT12 in both groups before treatment.

<u>Trunk imbalance and Lateral deviation for both groups after treatment application:</u>

As shown in table (3) and illustrated in figure (3) trunk imbalance and lateral deviation among both groups after treatment application showed statistically significant difference as mean values for trunk imbalance for both groups I and II were 11.53±6.39 and 6.27±3.51 while for lateral deviation they were 5.67±2.29 and 3.53±1.73 respectively ($P<0.05$).

Table (3): Mean values of trunk imbalance and lateral deviation for both groups GI &GII after treatment.

	$\bar{X}$ ±SD (GI)	$\bar{X}$ ±SD (GII)	MD	t	P
Trunk imbalance	11.53±6.39	6.27±3.51	5.27	2.8	<0.05*
Lateral deviation (rms)	5.67±2.29	3.53±1.73	2.133	2.88	<0.05*

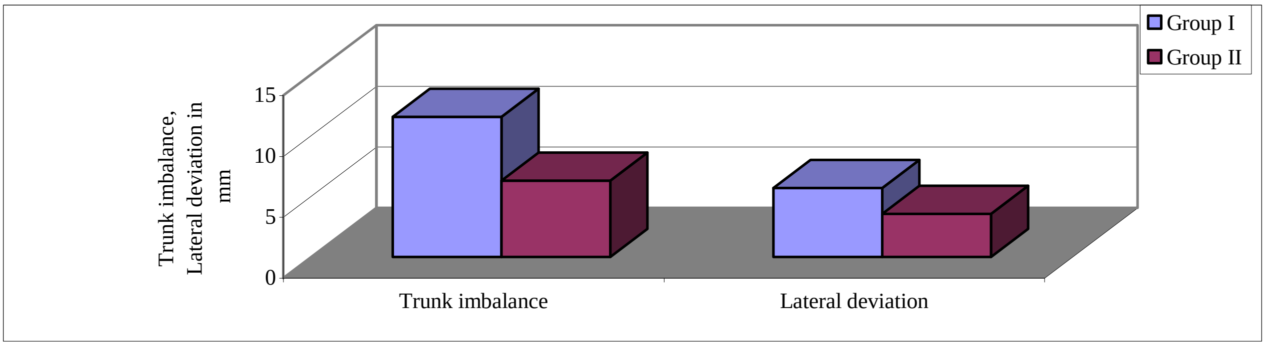

Fig. (3): Mean values of trunk imbalance and lateral deviation (in mm) for both groups I & II after treatment.

<u>Surface rotation and kyphotic angle after treatment application:</u>

As shown in table (4) and illustrated in figure (4) there was a statistically significant difference of surface rotation and kyphotic angle between both groups I and II after treatment application as mean values of surface rotation were 3.33±1.11 and 2.53±0.99 while for kyphotic angle they were 32.8±5.44 and 29.73±3.58 respectively (P<0.05).

Table (4): Mean values of surface rotation and kyphotic angles for both groups GI &GII after treatment.

	$\bar{X}$ ±SD (GI)	$\bar{X}$ ±SD (GII)	MD	t	P
Surface rotation (rms)	3.33±1.11	2.53±0.99	1.80	2.08	<0.05*
Kyphotic angle VP-T12	32.8±5.44	29.73±3.58	3.07	1.82	<0.05*

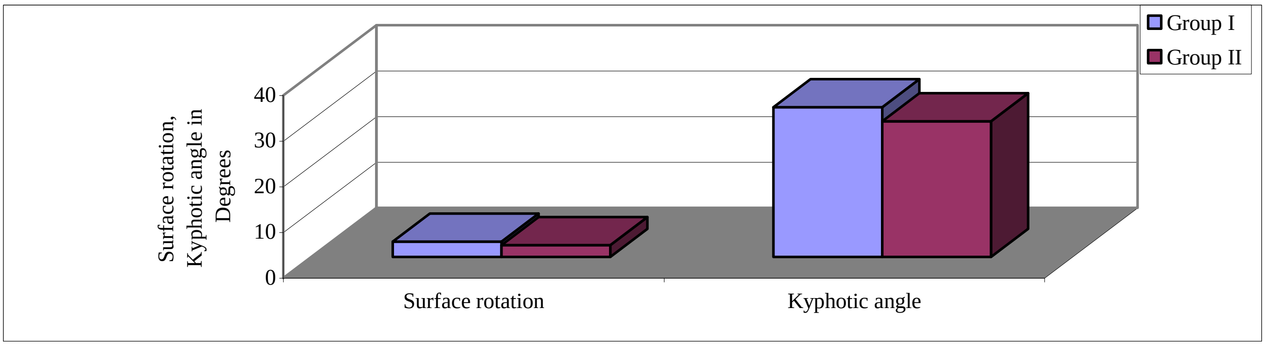

Fig. (4): Mean values of surface rotation and kyphotic angle (in mm) for both groups I & II after treatment.

DISCUSSION

The effect of correction of erb's engram on changing the degree of spinal deviation of children with erb's palsy was the issue of the current study.

Spinal deviation that occur in erb's palsied children with erb's engram can be attributed to the lack of the effect of weight bearing in the affected upper limb from sitting and quadruped positions which plays an important role on strengthening the upper quadrant of the body including the upper limbs and the spine[7].

Using formetric system in the current study to detect the spinal geometrical measurements comes in agreement with many authors[9,13,19] who reported that the formetric system is reliable, easy and the results of measurement are obtained very quickly and evaluation of data is not particularly time consuming.

Choosing the sample of the present study suffering from Erb's palsy as a common form of brachial plexus lesions comes in agreement with Geutjens et al.,[10] who recorded that most infantile injuries of the brachial plexus predominantly involve the upper trunk (C5-C6) the classic Erb's palsy. However, many of these infants also have impairment of the C7 nerve root and this portends poor prognosis. Far less frequently, the entire plexus (C5-T1) or the lower trunk or the lower trunk (C8-T1 Klumpk's paralysis).

Behraman et al.,[1] also reported that upper root injury (Erb's) is seen in about 60% of the time and isolated Klumke's is seen approximately 5% of time. Wilson and Kenyon[20] reported that Duchenne-Erb type constitutes a major form among brachial plexus palsied children as it accounts about 80-90% of all brachial plexus palsied cases as a result of unilateral upper trunk lesion.

The results of the present study revealed statistically insignificant difference of the pre treatment mean values between the two groups. However there was a significant improvement in study group when comparing its post treatment values with the control group. The post treatment improvement in the study group may be attributed to the effect of correction of erb's engram by strengthening exercises for arm, shoulder girdle and back muscles that resulted in redistribution of the weight around the vertebral column and equalization of loading on the spinal vertebra due to a symmetrical use of both upper limbs.

The results of the current study can be attributed to the effect of the program of erb's engram correction that emphasized on weight bearing exercises and strengthening exercises for arm and back muscles.

This comes in agreement with Roaf[16] who reported that weight-bearing is most crucial for integrity and alignment at all of the joints of the arm. It is also vitally important for the sequence of normal development, and it is a necessary part of the rehabilitation process for overall strengthening, and providing sensory feedback into the arm.

These results can also be explained by the work of Cutler et al.,[6] who reported that lesions of the peripheral nervous system result in poor postural tone cause a degree of functional scoliosis. Strengthening exercises to arm and back muscles may corrected the unequal stress on the spine which occur as a result of muscle imbalance which cause the stress on the spine not equal in all directions.

The results of the current study clarified the great relationship between the shoulder and the trunk indicating that any impairment of the shoulder girdle will directly affect the spinal geometry and causing deviation of the alignment from normal.

This comes in agreement with David[7], who reported that the shoulder region in human anatomy includes in a broad sense, not only the round contour between the arm and the body but also the pectoral region, the region of the back around the shoulder blade, and the axilla or armpit. The shoulder muscles cover the upper part of the chest and spread posteriorly so, they almost completely cover the true back muscles. Therefore, treatment of the shoulder must include both the trunk and the arm.

The post treatment results of the current study can be explained by the work of Nof and Rebecca[15], who stated that The upright human posture requires continuous and precise coordination between the central nervous system and a complex array of bone, muscle, cartilage and other soft tissue. Therefore any disease, injury or mutation that results in failure of assembly or deterioration of any component can result in development of scoliosis.

Also the results of the current study are supported by many authors[2,17] who recorded that muscle strengthening, are described as a control factor affecting developmental progression as postural alignment is difficult to achieve and maintain when imbalance exists between flexor and extensor muscles of the trunk.

The findings may also be supported by Cook and Woolacott[4] who reported that the back strengthening influences the achievement of optimal biomechanical alignment necessary for efficient and effective motor function in upper quadrant, trunk and cervical region.

Conclusion

Brachial plexus palsied children should be re-evaluated on a regular basis to ensure that spinal deviation does not develop from muscle imbalance and a symmetric motor patterns and exercises for correction of erb's engram should be emphasized in the physical therapy rehabilitation programs in cases of Erb's palsy.

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الملخص العربي

تأثير تعديل أنموذج الأرب علي التحليل الهندسي للعمود الفقري لدى الأطفال المصابين بشلل ملخ الولادة

تم إجراء البحث على ثلاثين طفلاً من المصابين بشلل ملخ الولادة تم اختيارهم من العيادة الخارجية لكلية العلاج الطبيعي . وتم تقسيم العينة عشوائيا إلى مجموعتين (15 طفل في كل مجموعة) وقد تم وضع برنامج علاجي خاص للمجموعة الأولى يشمل الأنواع المختلفة من العلاج التقليدي لمثل هذه الحالات متضمنا التنبيه الكهربي للعضلات الضعيفة تحميل الوزن على اليد المصابة لتنبيه مستقبلات الإحساس داخل المفاصل مع استخدام تمرينات تقوية العضلات للطرف المصاب . كما تم علاج المجموعة التجريبيةِ بنفس البرنامج السابق مع إضافة برنامج لتحسين أنموذج الأرب (وهو الرفع الجانبي لمفصل الكتف بدلا من الرفع الأمامي) مشتملا على استخدام الانقباض السلبي للعضلة ألأمامية لمفصل الكتف عن طريق الانزلاق التدريجى على العصا ذات السطح الأملس وسلم الأصابع وتثبيط الحركة في الاتجاه الجانبي وتشجيعها في الاتجاه الأمامي . وضع جبيرة هوائية لفرد مفصل الكوع أثناء النوم بالإضافة إلى تقوية عضلات الظهر ومفصل الكتف وقد تم التقييم عن طريق التحليل الهندسي لتشوهات العمود الفقري مشتملا على 1- عدم اتزان الجذع ، 2- الدوران السطحي للفقرات ، 3- الانحراف الجانبي للجذع ، 4- زاوية الانحناء الأمامي . وقد أظهرت النتائج وجود فروق ذات دلالات إحصائية بالنسبة للتحسن في القياسات السابقة للعمود الفقري في المجموعة التجريبية بالمقارنة مع نتائج ما بعد العلاج للمجموعة الضابطة عند الأطفال المصابين بشلل ملخ الولادة . وقد تم التوصية بضرورة تقييم العمود الفقري للأطفال المصابين بشلل الإرب وكذلك إضافة برنامج تصحيح النموذج الإرب للبرنامج التأهيلي .