Bone Mineral Density in Response to Upper Limb Weight Bearing in Erb's Palsied Children

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ABSTRACT

The purpose of this study was to investigate the role of upper limb weight bearing exercise program on bone mineral density in Erb's palsied children. Subjects: Thirty children with Erb's palsy due to obstetrical lesion of C_{5-6} nerve roots, ranging in age from four to six years, represented the sample of this study. They were selected from both sexes from the out-patient clinic of the Faculty of Physical Therapy, Cairo University. Procedures: They were divided randomly into two groups of equal number (A and B). Group A (control) received a traditional exercise program for treatment of Erb's palsy, While group B (study) received a program of weight bearing exercises for the affected upper limb, in addition to the program given to group A. Treatment session was repeated six times per week for six months. Evaluation was conducted before and after the suggested period of treatment including; measuring bone mineral density of the distal and proximal ends of the humerus of the affected upper limb via using dual energy x-ray absorptiometry technique. Results: The post-treatment results of this study after the suggested period of treatment revealed significant increase in the bone mineral density of the humerus of the affected upper limb of group B as compared with its pre-treatment results and the post-treatment results of group A. However, no significant difference was observed when comparing the pre and post-treatment results of group A and also the pre-treatment results of groups A and B. Conclusion: Such improvement may be attributed to the enhancing effect of the weight bearing exercise program on stimulating osteogenic response which refers to bone building.

Key words: Bone mineral density, Weight bearing, Erb's palsy.

INTRODUCTION

bstetrical brachial plexus palsy refers to lesion of the brachial plexus noted at the time of delivery. The incidence of injury is rare at birth. It ranges from 0.1 to 0.4% of live births with higher numbers in under developed countries¹. Most infants have involvement of the upper trunk (C_5 - C_6) which is termed Erb's palsy. Although there can be additional involvement of C_7 , the entire plexus C_5 to T_1 is less often affected. Rarely, the lower trunk (C_7 to T_1) is affected².

Although a vertex delivery with a shoulder dystocia is the most common cause,

obstetrical brachial plexus paralysis can also occur following cesarean section delivery, probably due to intrauterine forces. Breech presentations account for 1-2 % of cases. Mothers with diabetes and mothers who are multipara are considered to be at risk for delivering neonates with brachial plexus palsy³.

The traditional mechanism of injury in Erb's palsy is due to separation between the neck and shoulder. Complete rupture of the upper roots is far likely to occur in 88% of cases because of the anatomy of the transverse processes and the degree of flexibility at that level⁴.

Many affected brachial plexus palsied

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children recover with no deficits or only minor residual ones, however, others never achieve sufficient limb function and go on to sustain functional limitations, bony deformities and joint contractures⁵.

Normal bone growth and development is affected by factors including genetic coding, nutrients and hormones and mechanical loading through weight bearing and muscle tension. Also, muscle contraction places normal stress on the bones and affects its shape and density. It has been shown that decreased activity and weight bearing cause a loss of bone mineral content of 0.4% and 0.6% per month⁶.

As absence of normal stresses occurring in peripheral nerve injury may lead to degeneration, deformity, retarded growth and in turn impairment of function. So, different physical therapy programs have been used in treatment of such cases⁷.

The treatment of peripheral nerve injuries has always constituted an important medical problem because it is a very slow process and frequently incomplete, although clinical recovery eventually occurs⁸.

A great deal of proprioceptive input is provided by weight bearing. This sensory input is important for body awareness and the perception of body in space⁹. Joint compression has strong effect on motor system. It has been reported that the joint receptors lend themselves well to treatment techniques, they exert strong influences on the motor system and ultimately on musculature. Joint receptors are sensitive to movement, position, traction and compression¹⁰.

A new dual absorptiometry technique has been developed for measurement of bone mineral density in the skeleton, dual energy xray absorptiometry (DEXA). DEXA scanning has become the most widely used method for measuring bone density for several reasons.

When compared with radiographic absorptiometry or single energy x-ray absorptiometry, DEXA scanning documents small changes in bone mass and is also more flexible, since it can be sued to examine both the spine and extremities. It measures the transmission of two separate photon energies through a medium of bone and soft tissue, the advantage of this technique is that it requires short measurement time (5 to 15 minutes), better image detail, provide improve measurement precision (less than 1 percent) and reduces radiation exposure (1 to 3 $\mathrm{mrem})^{11}$.

The present study was conducted to determine the effect of upper limb weight bearing exercise program on bone mineral density in Erb's palsied children.

SUBJECTS, INSTRUMENTATION AND PROCEDURES

Subjects

Thirty children suffering from Erb's palsy since birth (12 right and 18 left sided) from both sexes, represented the sample of the study. They were selected from the out-patient clinic of the Faculty of Physical Therapy, Cairo University, according to the following criteria:

* They had unilateral Erb's palsy at $C_{(5\&6)}$ nerve roots with free scapular muscles and no other medical problems.

* Their ages ranged from 4 to 6 years.

* They were able to place their hands behind the neck, behind the back and over the mouth, according to the criteria of Mallet system.

* The children didn't suffer from any fixed deformities or contractures in the affected upper limb; however, mild tightness was manifested in shoulder internal rotators, forearm pronators, wrist and fingers flexors, and ulnar deviators.

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* They were at the same nutritional and socioeconomic level and didn't receive calcium supplementary medications.

* They were divided randomly into two groups of equal number (A and B).

* Evaluation was conducted for each child of the two groups individually, before and after six months of treatment. It included measuring bone mineral density of the humerus of the affected upper limb via using DEXA technique.

* Group A (control) received a traditional exercise program for treatment of Erb's palsy, while group B (study) received a program of weight bearing exercises for the affected upper limb in addition to the program given to group A.

Instrumentation

- For evaluation

Dual energy x-ray absorptiometry (DEXA): It is the standard of measuring bone mineral content using very low dose of radiation while producing bone mineral density of acceptable precision using bone mineral content in gram (Gm) by area of bone measured (cm. 2).

- For treatment

Mat, ball and roller.

Procedures

- For evaluation

Each child of the two groups was allowed to sit on a chair beside the machine and his affected arm was placed into a holding device. While the measurement was performed, a beam of low dose x-ray passes through the child's arm.

The machine converted the information received by the detector into an image of the skeleton and analyzed the quantity of bone the skeleton contained. The results were reported as bone mineral density of the distal and proximal ends of the humerus of the affected upper limb, which is the amount of bone per unit of skeletal area.

- For treatment

The thirty Erb's palsied children representing the sample of this study received the following traditional exercise program preceded by light type of massage in the form of longitudinal and transverse effleurage:

- Graduated active exercises
- Righting, equilibrium and protective reactions were encouraged from different positions as sitting and standing, in all directions (right, left, forward, backward).
- Stretching exercises for the tightened muscles of the affected upper limb including subscapularies, forearm pronators, wrist and fingers flexors and ulnar deviators.

In addition to the traditional exercise program given to group A, group B (study) received upper limb weight bearing exercises as follows:

- From sitting position on mat, each child was allowed to side sit resting on the affected upper limb with shoulder externally rotated, elbow fully extended, wrist extended, fingers and thumb abducted and extended.
- From four foot kneeling position, each child was allowed to bear weight on the affected upper limb with the elbow extended, wrist extended, fingers and thumb maintained abducted and extended.
- Approximation was conducted for the affected upper extremity through vigorous rapid irregular movements with the elbow flexed and extended. It was applied from supine lying, sitting on roll and quadriped position with the shoulder moved in different angles.

The time of the treatment session continued for one hour / six times / week for six months.

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RESULTS

The results collected from the present study were statistically analyzed to obtain the standard deviation of mean and each measuring variable for the two groups before and after six months of treatment. The student t-test was utilized to examine the significance of treatment procedures conducted in each group.

No significant difference was observed when comparing the pre-treatment mean values of the bone mineral density of the humerus of the affected upper limb of the two groups and also the pre and post-treatment results of group A. However, the posttreatment results of this study after the suggested period of treatment revealed evidence of significant improvement in the bone mineral density of group B, as compared with its pre-treatment results and the posttreatment results of group A.

As shown in table (1) and figure (1), the mean values of the bone mineral density (BMD) of the distal end of humerus of the affected upper limb for group A were gram/cm.² pre-treatment and 0.333±0.129 gram/cm.² 0.419 ± 0.013 post-treatment, (P>0.05) which was non-significant with percentage of improvement of 20.5%. While, the mean value of the bone mineral density (BMD) of the distal end of humerus of the affected upper limb for group B before treatment was 0.331 ± 0.012 gram/cm.², which increased after the suggested period of treatment to 0.899 ± 0.014 gram/ cm.², which revealed a highly significant difference (P< 0.0001). The percentage of improvement was 63.18 %.

Table (1): Pre and post-treatment mean values of BMD (gram / cm.²) of the distal end of humerus of the affected upper limb for groups A and B.

	Group A		Group B	
	Pre	Post	Pre	Post
Mean	0.333	0.419	0.331	0.899
SD	± 0.129	±0.013	± 0.012	± 0.014
%	20.5		63.18	
t-test	1.741		8.505	
P-value	>0.05		< 0.0001	
Significance	Non-significant		Highly Significant	
SD: Standard deviation	% : Percentage of improvement. P-		-value: Level of significance.	

SD: Standard deviation % : Percentage of improvement.



Fig. (1): Illustrating the pre and post-treatment mean values of BMD (gram/cm.²) of distal end of humerus of the affected upper limb for groups A and B.

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Concerning the proximal end of the humerus of the affected upper limb, the BMD for group A, pre and post treatment were 0.287 ± 0.012 gram/cm.² and 0.32 ± 0.021 gram/cm.² respectively (P>0.05), which denote non-significant improvement. The percentage of improvement was 10.3%. While, the mean values of BMD for group B

increased from 0.282 ± 0.013 gram/cm.² before starting the treatment program, to 0.716 ± 0.063 gram / cm.² after the application of the weight bearing exercise program(P<0.0001), which revealed significant improvement, with percentage of improvement of 60.61 %, table(2) and figure(2),

Table (2): Pre and post-treatment mean values of BMD (gram / cm.²) of the proximal end of humerus of the affected upper limb for groups A and B.

	Group A		Group B	
	Pre	Post	Pre	Post
Mean	0.287	0.32	0.282	0.716
SD	± 0.012	±0.021	± 0.013	± 0.063
%	10.3		60.61	
t-test	1.909		6.292	
P-value	>0.05		< 0.0001	
Significance	Non-significant		Highly Significant	
	0/ D			

SD: Standard deviation.

%: Percentage of improvement. P-value: Level of significance.



Fig. (2): Showing the pre and post-treatment mean values of BMD (gram/cm.²) of proximal end of humerus of the affected upper limb for groups A and B.

Significant improvement was also observed when comparing the post-treatment mean values of the bone mineral density of the humerus (distal and proximal ends) of the affected upper limb of the two groups in favor of group B, (P < 0.05) as shown in figure(3).

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Fig. (3): Demonstrating the post-treatment mean values of BMD $(\text{gram}/\text{cm.}^2)$ of distal and proximal ends of humerus of the affected upper limb for the two groups.

DISCUSSION

Normally, during childhood and adolescence, much more bone is deposited than withdrawn as the skeleton grows in both size and density. The amount of bone tissue in the skeleton (known as bone mass) can continue to increase until the child reaches his/her mid 20-s. At this point, bones reach their maximum strength and density or peak bone mass¹³.

Typically, when parents think about their children's health, they don't think about their bones. But building healthy bones by adopting healthy nutritional and lifestyle habits in childhood is very important to help in prevention of osteoporosis and fractures later in life¹⁴.

Osteoporosis, the disease that causes bones to become fragile, less dense and prone to fractures, has been called a pediatric disease or injury with geriatric consequences, because the bone mass attained in childhood and adolescence is a very important determinant of lifelong skeletal health¹⁵

Erb's palsy is one of the obstetrical peripheral nerve injuries which render the upper limb muscles paralyzed, weak and inactive. This in turn affects the whole musculoskeletal system of the affected upper limb including physiological and chemical constitutes of the muscles, bone shape, growth and density and also joints structures.

This study was conducted to evaluate the effect of upper limb weight bearing exercises on bone mineral density in Erb's palsied children.

The post-treatment results of this study after the suggested period of treatment revealed significant improvement in the bone mineral density of the humerus (distal and proximal ends) of the affected upper limb of group B as compared with its pre-treatment results and the post-treatment results of group A. However, no significant difference was observed when comparing the pre and posttreatment results of group A.

The DEXA technique was used in evaluation of the bone mineral density. This agrees with Wren et al.,¹¹ who reported that, several methods are available to measure bone density, but currently the most widely used technique in DEXA (Dual Energy X-ray Absorptiometry). They added that, this is the method used to determine efficacy in the recent large clinical trials, and to characterize fracture risk.

Using DEXA in evaluation support the findings of Lin and Henderson¹⁶ who stated that, using DEXA to determine bone mineral

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density can help health care providers to confirm a diagnosis.

The results of the present study after the suggested period of treatment come in agreement with Jones and Dwyen¹⁷ who established that physical activity is important for building healthy bones. They added that, the benefits of activity are most pronounced in those areas of the skeleton that bear most weight, such as the hips during walking and running and the arms during gymnastics and upper-body weight shifting.

The post-treatment results confirm the findings of Luiza et al., ¹⁸ who recommended vigorous physical activities to stimulate an osteogenic bone building response.

The results also agree with Seeman¹⁹ who concluded that physical activity appears to have a positive effect on bone mass during growth. Bone mass is increased by dynamic activity involving high strains and unusual strain distributions.

Significant improvement observed in the post-treatment mean values of the measuring variables support the findings of Rowland ²⁰ who reported that, children should participate in approximately 25 to 40 minutes a day of vigorous activity and dietary calcium intake for a positive impact on bone.

The results of group B obtained at the end of treatment denoted high significant improvement in the distal end of the humerus more than the proximal end which may be due to the effect of distribution of force which is more concentrated on the distal end of the humerus during weight bearing.

Improvement observed in the measuring variables of group B may be attributed to the effect of compression of the joints of the upper limb from different positions via approximation and weight bearing which stimulates static joints receptors, modulates muscle tone and enhances joint awareness. This improves muscle pull which is responsible for stimulation of bone growth and improving bone mineral density.

Conclusion

The results of this study objectively demonstrates the potential use of upper limb weight bearing exercise program on increasing bone mineral density in Erb's palsied children.

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الملخص العربي

كثافة العظام واستجابتها لتحميل الوزن على الذراع في الأطفال المصابين بشلل ارب

تهدف هذه الدراسة إلى تحديد تأثير دور تمرينات التحميل بالوزن على الذراع على كثافة العظام عند الأطفال المصابين بشلل ارب. اشتملت الدراسة على ثلاثين طفلاً من الجنسين ممن تراوحت أعمار هم بين أربعة إلى ستة أعوام، وقد تم اختيار هم من العيادة الخارجية بكلية العلاج الطبيعي - جامعة القاهرة تلي ذلك تقسيمهم عشوائيا إلى مجموعتين متساويتين (مجموعة ضابطة ومجموعة إجراء موضوع البحث). وقد تم قياس كثافة العظام في النهاية القريبة والنهاية البعيدة لعظمة العضد بالذراع المصاب عند جميع الأطفال موضوع الدراسة قبل وبعد ستة أشهر من العلاج ، وقد تلقت المجموعة الضابطة برنامج التمرينات العلاجية التقليدي للأطفال المصابين بشلل الرب بينما تلقت مجموعة إجراء موضوع البحث برنامج من التمرينات العلاجية العظمة العضد بالذراع المصاب عند جميع الأطفال موضوع الدراسة قبل وبعد ستة أشهر موضوع البحث برنامج من التمرينات العلاجية الخاصة بتحميل الوزن على الذراع المصاب بالإضافة إلى تطبيق نفس البرنامج المستخدم في المجموعة الضابطة. وقد أظهرت النتائج وجود فروق ذات دلالة إحصائية في جميع القياسات عند مقارنة نتائج ما قبل العلاج بنتائج ما بعد العلاج لمجموعة إجراء موضوع البحث وأيضا عند مقارنة نتائج ما بعد العلاج للمجموعتين لمصلحة مجموعة البحث كما أوضحت التنائج ما بعد عدم وجود فروق ذات دلالة إحصائية عند مقارنة نتائج ما بعد العلاج المجموعتين لمصلحة مجموعة البحث العلاج بنتائج ما بعد يعدم وجود فروق ذات دلالة إحصائية عند مقارنة نتائج ما بعد العلاج للمجموعتين لمصلحة مجموعة البحث المحموعة الضابطة. عنه أوضحا المتائية قبل العلاج المجموعتين وأيضا نتائج قبل والد النتائج ما بعد العلاج لمجموعة إجراء موضوع البحث وأيضا عند مقارنة نتائج ما بعد العلاج للمجموعتين لمصلحة مجموعة البحث عما أوضحت النتائج عدم وجود فروق ذات دلالة إحصائية في مالد وأيضا نتائج ما على وأيضا نتائج ما بعد العلام والدة محموعة البحث الحموعة البحث الموموعة الضابطة وقد ألفان المحموعة المون على أوضحت النتائج والعد وروق ذات دلالة إحصائية وي وأيضا نتائج ما عمو في عرام في عالمون المحموعة البحث عدم أوض والقال وال محموعة الصابطة. طبقا للعدم وجود فروق ذات دلالة إحصائية ومو عنين وأيضا نتائج ما محمو في عرائ والمعموعة البحموعة الضابطة والمحمو والفال المحموعة المحمو وال وال على الملور على الذراع في علاج الأطفال المصابيان

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