Impact of Walking Training on Bone Mineral Density and Bone Metabolism in Asthmatic Patients Treated with Corticosteroids

Hala M. Hamed and Shehab M. Abd Elkader
Physical Therapy Department for Cardiopulmonary Disorders & Geriatrics, Faculty of Physical Therapy, Cairo University.

ABSTRACT

Background: There is evidence that prolonged treatment with high doses of corticosteroids have a determined effect on bone mass. The aim of this 6 months study was to detect the changes in bone mineral density and bone metabolism after 6 months of walking training and corticosteroids therapy in asthmatic patients. Method: Twenty four asthmatic patients of both sexes were chosen from the Out Clinic of the Medical Center of Egyptian Television. Their ages ranged between 20-40 years old. Then they divided into two equal groups: G(1) the training group received walking exercise (treadmill) in addition to the medical treatment, and G(2) the control group received only the medical treatment. The measurements of bone mineral density and metabolism were taken before and after 6 months at the end of the study. Results: There was a significant increase in bone mineral density and markers of bone metabolism in the training group. While the results off the control group showed no significant changes.
Key words: *Walking, bone mineral density, bone metabolism, asthma & corticosteroids.*

INTRODUCTION

Asthma has been well defined in the last decade as a broad physiological and clinical findings including air way obstruction, reversible with or without treatment , air way inflammation and hyper responsiveness to many types of stimuli[1].

Asthma and chronic obstructive pulmonary disease responsible for about 3 million deaths worldwide each year, also they are among the three main causes of lost work days and are the fourth most common cause of disability[2]. Systemic corticosteroids by oral administration are suggested for any patient whose bronchospasm dose not respond completely to initial B2 – agonist therapy and is usually preferred because it is less invasive. Inhaled corticosteroids therapy has become standard only for persistent asthma[3]. Corticosteroids are clearly beneficial in patients with asthma since they are tolerated, reduce symptoms and improve the quality of life. The systemic effects are considerably less with inhale than oral corticosteroids. So the longer term risk-benefit ratio need to be considered, however corticosteroids are often taken for several decades. The development of osteoporosis is a major concern with oral corticosteroids[4]. Several studies reported changes in bone mineral density in asthmatic patients received high doses of inhaled corticosteroids due to the depressed bone formation or increased bone resorption, potentially leads to osteoporosis[5]. The physiological effects aerobic training in adults with bronchial asthma remains to be clearly delineated Regular physical activity of adequate intensity and duration involving large muscle groups has been proved to have a number of potential beneficial effects on

general health. This including improvement in aerobic capacity, body composition, flexibility, muscular strength and psychosocial aspects[6]. Several authors have recommended the usage of exercises to prevent bone loss. The mechanism for the maintenance of skeletal integrity relies on a cellular response to hormonal and mechanical load stimuli[7]. Also, mechanical demands on bone tend to cause the physiochemical processes of bone formation to increase bone mass[8].

The aim of this study is to investigate the differences in both bone mineral density, BMD and biochemical markers of bone metabolism after a training program in form of walking in asthmatics treated with corticosteroids.

SUBJECTS, MATERIALS AND METHODS

Subjects

Twenty four asthmatic patients of both sexes (13 males & 11 females), were chosen from the Out Clinic of the Medical Center of Egyptian Television. Their ages ranged between 20-40 years. The chronicity of the bronchial asthma not less than 10 years. For the six months preceding the start of the study, the patients had been receiving regular treatment with corticosteroids, as described by the physician, in doses ranged from 1000 to 1600 μg / day.

Exclusion criteria include endocrinal, renal, liver, cardiac disorders, obesity, diabetes and chest diseases rather than bronchial asthma, fractures occurring within the six months preceding the start of the study, disorders of bone metabolism such as osteoporosis and pregnancy, lactation, inadequate contraceptive precautions, amenorrhea or a history of irregular menstrual cycles during the 12 months preceding the start of the study and treatment with any medication likely to influence bone metabolism. All the patients who participated in the study were non smokers and were continued in their ordinary diet throughout the study.

Equipment

1) Peripheral quantitative computed tomography (PQCT) and Dual energy x-ray absorptiometry (Densiscan-1000, Scanco Medica, Switzerland) was used to measure the BMD (mg/cm^2) of the lumber spine and the radius.
2) Weight & Height scale in order to measure the weight and height to calculate the body mass index BMI (weight/ height 2). BMI was calculated for each subject involved in this study to exclude the obese subjects. Obesity was defined as BMI > 28 Kg/m^2).

Measurements:

1) Bone mineral density (g/cm^2) measurement: these measures were taken at the second to fourth lumber vertebra (posterior/anterior view) and the radius.
2) Markers of bone metabolism: samples of venous blood were taken from fasted patients between 8-10 hours to be analyzed for markers of bone metabolism include: serum calcium and parathyroid hormone.

Measurement of the bone mineral density and markers of bone metabolism were taken before the starting of the study (pre-test) and after six months at the end of the study (post-test).

Procedures

Following the previous evaluation steppes all patients were divided randomly into two equal groups:

1. The training group: included twelve asthmatic patients of both sexes (6 males & 6 females), who received an aerobic

exercise training program in addition to the medical treatment. The training program consisted of treadmill exercise of progressive increasing intensity and frequency. The starting walking of the treadmill speed was 5 kilometer/hour and at 2 degrees angle of inclination. Then gradually increased at 2 minute intervals until reaching the initial intensity of 60% of the maximal heart rate. Then increased gradually until reaching 85% of the maximal heart rate by the end of the 6 months. The duration of each session was 30 minutes, included warming up for 5 minutes, 20 minutes for the active stage of training and finally 5 minutes for the cooling down. This training was repeated 3 times per week for 6 months.

2. The control group: included the remaining 12 patients (6 males & 6 females). They were asked to maintain their ordinary current life style with the usual medical therapy.

Statistical Analysis

The mean values of bone mineral density, serum calcium and parathyroid hormone were measured and calculated before and after 6 months for both the trained and the controlled groups. Then the data were compared using paired "t" test to determine the level of significance. Comparison between both groups was done by using the independent "t" test. The significance level was fixed at $P< 0.005$.

RESULTS

Table (1): Show the difference between the pre and post values of bone density (BMD), serum calcium (SC) and parathyroid hormone (PTH) of the training group.

	Mean ± SD		t. value	Significance
	Pre-training	Post-training		
BMD of lumber spine (mg/cm)	119.167± 11.41	150.75± 16.103	3.787	Sig.*
BMD of radius (mg/cm)	277.917± 24.26	315.083± 26.89	2.731	Sig*.
Serum Calcium (ng/dl)	8.667 ±1.23	10.417± 1.24	2.815	Sig*.
Parathyroid Hormone (ng/dl)	14.833 ±2.517	12.167± 2.208	-2.49	Sig*.

* Sig.: significant. SD: standard deviation.

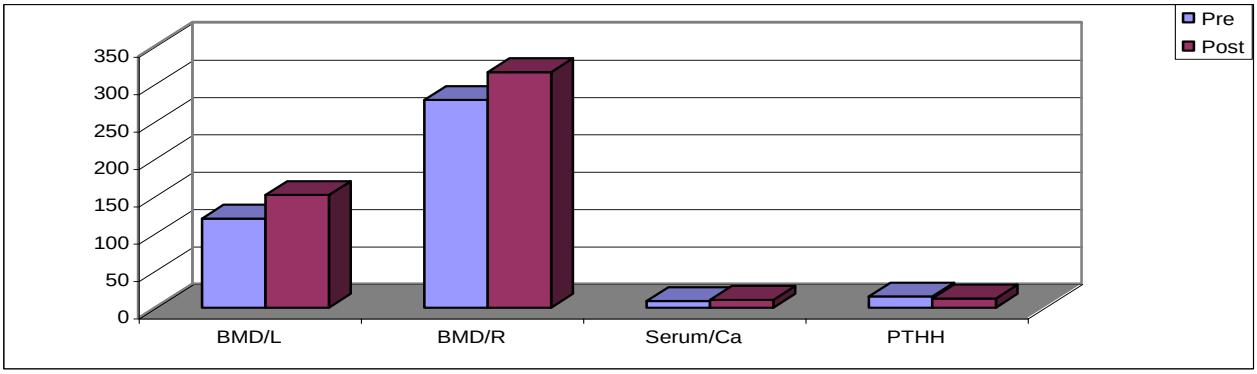

Fig. (1): Show the difference between the pre and post values of bone density (BMD), serum calcium (SC) and parathyroid hormone (PTH) of the training group.

Table (2): Show the difference between the pre and post values of bone density (BMD), serum calcium (SC) and parathyroid hormone (PTH) of the control group.

	Mean± SD		t. value	Significance
	Pre-training	Post-training		
BMD of lumber spine (mg/cm)	122.167± 12.04	118.917± 11.44	-1.388	Non-sig**.
BMD of radius (mg/cm)	280.917± 25.69	276.583± 26.09	-1.581	Non-sig**.
Serum Calcium (ng/dl)	8.833± 1.267	8.583 ±1.378	-0.332	Non-sig**.
Parathyroid Hormone (ng/dl)	14.167 ±2.657	14.917 ±2.088	0.711	Non-sig**.

** Non sig.: non significant. SD: standard deviation.

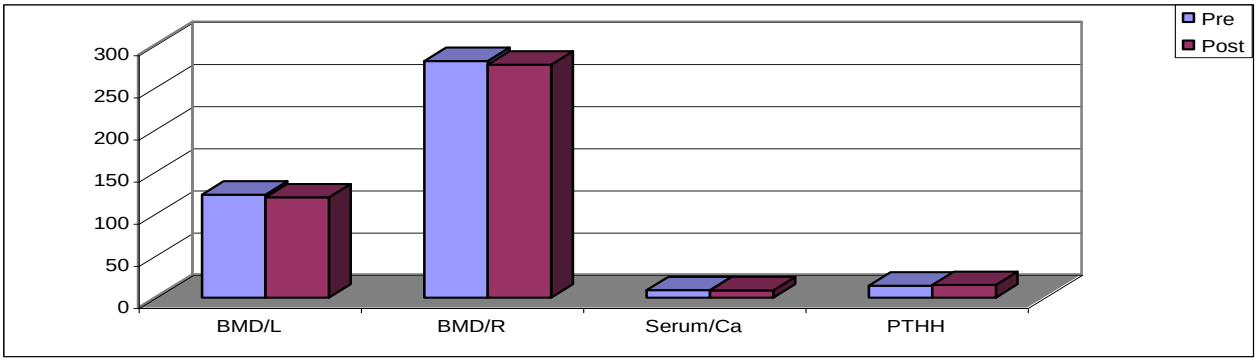

Fig. (2): Show the difference between the pre and post values of bone density (BMD), serum calcium (SC) and parathyroid hormone (PTH) of the control group.

Table (3): Show the difference between the training and the control groups values of bone density (BMD), serum calcium (SC) and parathyroid hormone (PTH) after 6 months.

	Mean ± SD		t. value	Significance
	Training	Post-training		
BMD of lumber spine (mg/cm)	150.75± 16.10	118.91± 11.44	3.882	Sig*.
BMD of radius (mg/cm)	315.08± 26.89	276.58 ±26.1	2.517	Sig*.
Serum Calcium (ng/dl)	10.167 ±1.24	8.583 ±1.38	2.426	Sig*.
Parathyroid Hormone (ng/dl)	12.167± 2.21	14.92 ±2.02	2.356	Sig*.

* Sig.: significant. SD: standard deviation.

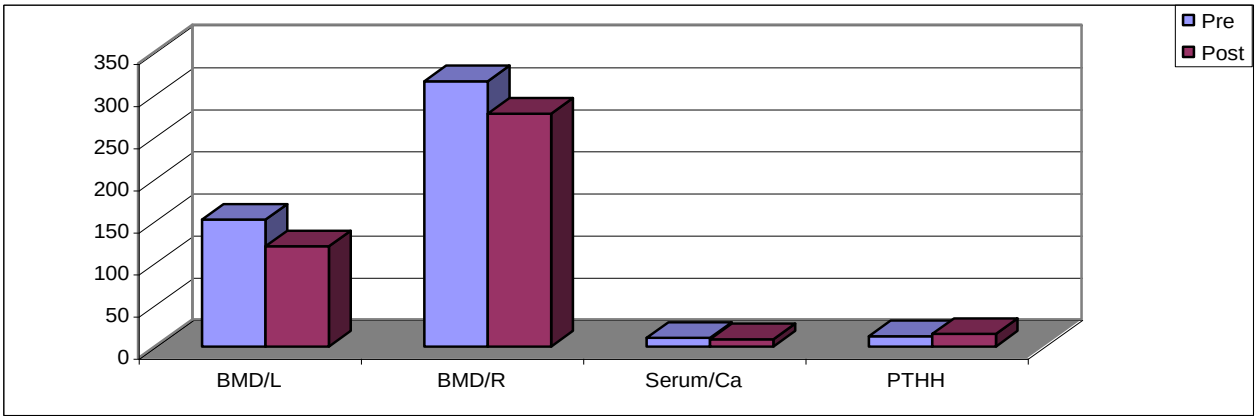

Fig. (3): Show the difference between the training and the control groups values of bone density (BMD), serum calcium (SC) and parathyroid hormone (PTH) after 6 months.

DISCUSSION

This study aimed to determine the effect of weight bearing exercise training (treadmill walking) for 6 months on bone mineral density and markers of bone density, which include serum calcium and parathyroid hormone, in asthmatic patients who treated with corticosteroids. The results of this study indicated a great significant increase in bone mineral density of the lumber spine and the radius. Also the results showed a great significant reduction in parathyroid hormone in the training group. While these changes were not significant in the control group. The results of this study agreed with the previous studies in similar cases.

The possible mechanism by which exercise maintains the skeletal integrity are: changes in the biochemical structure of the blood by altering the level of its component which has a role in the integrity of normal skeletal and mechanical load of the exercise which can modify and increase bone mass. The rise in serum calcium is mainly die to the effects of exercise induced acidosis. So, when the PH falls the excess hydrogen ions reversibly displace calcium ions from imidazole groups of the albumin molecule, this causing the serum calcium to rise[9]. The increase in bone mineral density after exercise may be due to increase in serum calcium associated with decreased parathyroid hormone following exercise training[10]. The deposition of bone at the points of compressional stress has been suggested to be caused by piezoelectric effect as continual physical stress stimulates osteoblastic deposition of bone causes a negative potential at the compressed site and a positive potential elsewhere in the bone. So minute quantities of current flowing in bone cause osteoblastic activity at the negative end of the leads to increase in bone deposition and as a result increase in bone mineral density[11,12].

Conclusion

This study clearly indicated that walking exercise improves bone integrity and prevents development of osteoporosis in asthmatic patients treated with long term intake of high dose of corticosteroids.

REFERENCES

1- Tinkelman, D. and Brenda Conner, L.: Diagnosis and management of asthma in the young child. Journal of Asthma, 31(6): 419-425, 2001.

2- Strassels Scott, Smith David, Sullivan Sear and Mahajan Puneet: The costs of treating chronic obstructive pulmonary diseases in the United States. Chest, 119: 344-352, 2001.

3- Emond, S.D., Camasrge Cardos and Nowek, R.M.: Advances, Opportunities and the New Asthma Guidelines, Ann Emerg Med., (31): 590-594, 1998.

4- Tattersfield, A., Town, G., Johnell, O. and Picado, C.: Bone mineral density in subjects with mild asthma randomised to treatment with inhaled Corticosteroids or non Corticosteroids treatment for two years. Thorax, 56: 272-278, 2001.

5- Medici, T., Grebski, G., Hacki, M. and Ruogessger, P.: Effect of one year treatment with inhaled Fluticasone Propionate or Bedomethasone Dipropionate: a randomized parallel group study in adult asthmatic subjects. Thorax, 55: 375-382, 2000.

6- Hallstrand Teal, Bates Peter and Schoene Robert: Aerobic conditioning in mild asthma decreases the hyperpnea of exercise and improves exercise and ventilatory capacity. Chest, 118: 1460-1469, 2000.

7- Harvison, J.: Neutron activation studies & the effect of exercises on osteoporosis. J. Med., 15: 285-294, 1993.

8- Hatori, M., Hasegawa, A., Adochi, H. and Shingozoki, A.: The effect of walking at

anerobic threshold level on vertebral bone loss in post menopausal women. Calcific Tissue Int., 52: 411-414, 1998.

9- Ligunghall, S., Joborn, H. and Benson, L.: Effects of physical exercise on serum calcium and parathyroid hormone. Eur Clin Invest., 14: 469-473, 1999.

10- Grimston, S., Tanguay, K., Gundberg, C. and Hunely, D.: The caliotropic hormone response to changes in serum calcium during exercise in female. J. Clin. Endocrinol. Metab., 76: 867-872, 1998.

11- Guyton, A.: Human Physiology and Mechanisms of disease, 7th ed., W. B. Saunders Company, Tokyo, 610-612, 1993.

12- Menkes, A., Mazei, S. and Redmond, R.: Strength training increases regional bone mineral density and bone remodling in middle aged and older women. J. Appl. Physiol., 74: 2478-2484, 2002.

الملخص العربي

تأثير رياضة المشي على كثافة العظام والتمثيل الغذائي للعظام في مرضى الربو الذين يعالجون بالكورتيزون

يلعب الكورتيزون دور كبير في علاج مرضى الربو و يؤدى إلى تقليل حدة نوبات الربو. إلا أن للكورتيزون العديد من الآثار السيئة على المدى البعيد خاصة إذا أستعمل بجرعات عالية ، ومنها على سبيل المثال هشاشة العظام . وتهدف هذه الدراسة إلى محاولة التغلب على نقص كثافة العظام الناتجة عن العلاج بالكورتيزون وذلك عن طريق برنامج رياضة المشي . أجريت الدراسة على 24 حالة من الجنسين الذين يعانون من الربو الشعبي . وقد قسمت العينة إلى مجموعتين متساويتين : المجموعة التجريبية التي تلقت العلاج بالأدوية بالإضافة إلى برنامج رياضة المشي لمدة 6 أشهر متتالية . أما المجموعة الضابطة فقد تلقت فقط العلاج بالأدوية لنفس مدة العلاج وتم قياس كثافة العظام ونسبة الكالسيوم في الدم وكذلك هرمون الغدة الجاردرقية قبل بدء التجربة وبعد 6 أشهر في نهاية الدراسة لكل من المجموعتين وقد أظهرت النتائج تحسن ملحوظ في كثافة العظام ونسبة الكالسيوم في الدم ونقص في هرمون الغدة الجاردرقية في المجموعة التجريبية في حين لم تسجل المجموعة الضابطة تحسن ذو مغزى أخصائي . لذلك توصي الدراسة بتطبيق مثل هذا البرنامج لمرضى الربو خاصة المعالجين بالكورتيزون للتغلب على آثاره السيئة على العظام .