ALTERATION IN SERUM PHOSPHORUS LEVELS AFTER MODERATE PHYSICAL EXERCISE IN HEALTHY VOLUNTEERS

Dr. Meenakshi Kaushik [MD Biochemistry Resident]
Dr. Manju Bala Pahwa [M.D., DNB Biochemistry] Professor*
Dr. Ramesh Verma [M.D. Community Medicine] Professor**

Department of Biochemistry* and Community Medicine**
Pt. B.D. Sharma PGIMS, Rohtak-124001.

ABSTRACT

Background: Exercise is widely accepted as having favorable effects on bone health and helps in prevention and treatment of low mineral density. **Aims and Objectives**: To estimate the serum phosphorus levels after moderate physical exercise in female volunteers and to compare the levels before exercise and after exercise. **Material and Methods:** Thirty female volunteers without any menstrual irregularities of the age group 20-50 years were included and further divided into three groups. Group I (15 minutes before exercise), Group II (One hour after exercise) and Group III (24 hours after exercise). **Results**: Mean age of female volunteers was 31.57±6.89 years. Nine (30%) females were working as bearer in hospital, 13 (43.3%) females were laboratory technician, 7 (23.3%) were staff nurse and 1 (3.3%) female was sweeper. Mean±SD of BMI in volunteers was 22.09±2.38 kg/m2. The mean value of serum phosphorus level fifteen minutes before exercise was 2.85±0.55 mg/dL, one hour after exercise was 3.14±0.61 mg/dL and twenty four hours after exercise was 3.33±0.57 mg/dL. The statistically significant increase in the serum phosphorus values was observed between the three groups with p=0.007. **Conclusion:** Young females responded with altered phosphorus levels secondary to a single bout of moderate exercise. Further detailed studies with higher sample size are recommended to support the use of exercise programs.

INTRODUCTION

Physical exercise has frequently been shown to induce bone mass gain, especially in weight bearing bone sites. Physical exercise improves bone formation and bone mineral density. The role of exercise is particularly important in children and adolescents as in them bone mineral density (BMD) reaches 90% of its peak by the end of second decade.[1] American College of Sports Medicine (ACMS) classified physical activity intensity on the basis of maximal heart rate. For moderate intensity physical activity, a person's target heart rate should be 55% to 69% of his or her maximum heart rate. This maximum rate is based on the person's age. An estimate of a person's maximum age related heart rate can be obtained by subtracting the person's age from 220.[2]

Phosphorus is the most abundant anion in the human body and contributes nearly 1% of total body weight. Maximum amount (85%) of phosphate is present in bone and teeth, while 14% is distributed between other tissues and 1% is present in extracellular fluid. In the extracellular fluid, approximately one-tenth of the phosphorus content is bound to proteins, one third is complexed with calcium, sodium and magnesium and the remaining is present as inorganic phosphate. In the skeleton, phosphate is present in the form of hydroxyapatite crystal, after it get complexed with calcium. Rest of the phosphate present as amorphous calcium phosphate.[3]

Phosphorus plays a vital role in number of physiological processes like maintenance of cell membrane integrity, cellular metabolism, generation of ATP, cell signaling through protein phosphorylation of key enzyme, maintenance of acid base homeostasis, bone mineralization and apoptosis of mature chondrocytes in the growth plate. Attributing to its crucial functions, deficiency of phosphorus can result into variety of clinical conditions like abnormal bone mineralization leading to osteomalacia or rickets, rhabdomyolysis, impaired leukocyte function and muscle weakness. Serum phosphate concentration is highest in infants (4.5–8.3 mg/dL (1.50– 2.65 mmol/L), due to their higher need of mineral for bone growth and soft tissue buildup. The concentrations declines in adulthood [normal range 2.5–4.5 mg/dL (0.8–1.5 mmol/L).[4] Phosphorus levels mainly depend on dietary phosphate intake and absorption; Calcitriol, which increases phosphate absorption from the bone and gut & PTH leads to phosphate resorption from bone and decreases its reabsorption in the renal proximal tubule. It also stimulates the production of calcitriol which also affects phosphorus concentration.[5] After exercise, the alterations in serum phosphate levels occur. This may occur because of various factors like serum PTH concentration, vitamin D levels, changes in pH of blood, health status of participants, type of exercise performed and age group of participants.

MATERIAL AND METHODS

The present study was conducted in the Department of Biochemistry in collaboration with the Department of Community medicine, Pt. B.D. Sharma PGIMS, Rohtak. Thirty female volunteers without any menstrual irregularities of the age group 20-50 years were enrolled in the study by simple random sampling from the hospital staff. They were further divided into three groups. Group I (15 minutes before exercise), Group II (One hour after exercise) and Group III (24 hours after exercise). Female volunteers with history of medication for any chronic disease like Hyper/Hypothyroidism, diabetes, hypertension, respiratory disease, etc. were excluded from the study.

METHODOLOGY

After getting written informed consent from volunteers, detailed history were obtained and recorded in their respective proforma. They were subjected to physical examination and anthropometric measurements as per protocol. Systemic examination of respiratory, cardiovascular, nervous systems and abdomen were done for any associated diseases.

SAMPLE COLLECTION AND STORAGE

After proper informed written consent, six ml of venous blood sample was withdrawn before exercise in red plain vacutainer under aseptic precautions. After 15 minutes of rest, they performed moderate physical exercise in the form of walking or jogging or cycling for 30 minutes or till heart rate reaches 55% to 69% of maximum heart rate. Second and third blood sample were collected after one hour and 24 hours of the exercise respectively.

Samples were processed within one hour of collection. Serum was separated by centrifugation (2000rpm X 10 minutes) after clotting and analysed on the same day for biochemical parameters. Serum phosphorus levels were performed on auto-analyzer (Randox Suzuka, United Kingdom, model no. 6L7WD5J) using the standard methods.

Principle of Method: Inorganic phosphorous reacts with ammonium molybdate in the presence of H2SO4 to form a phosphomolybdate complex measured at 340 nm.

Reference range-

2.5–4.5 mg/dL (0.8–1.5 mmol/L).

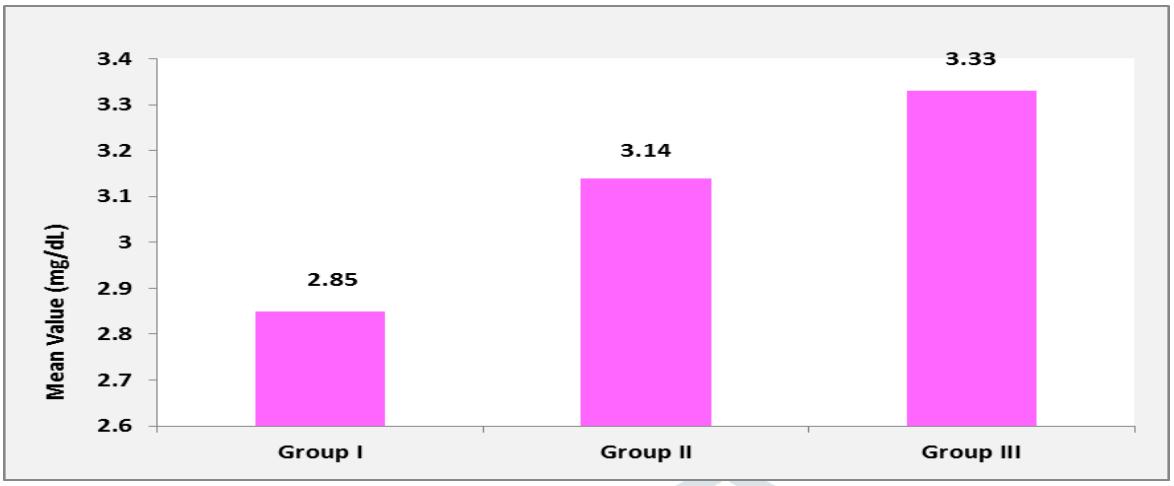
RESULTS

Serum phosphorus levels were compared fifteen minutes before exercise, one hour after exercise and twenty four hours after exercise. The mean value of serum phosphorus level fifteen minutes before exercise was 2.85±0.55 mg/dL, one hour after exercise was 3.14±0.61 mg/dL and twenty four hours after exercise was 3.33±0.57 mg/dL. The statistically significant increase in the serum phosphorus values was observed between the three groups (p=0.007) by using multi-group statistical analysis (ANOVA). Similarly, when we compared group I vs. II and group I vs. III, it was found to be statistically significant (<0.05 and <0.001), but group II vs. III, no significant difference was observed.

Table1 showing serum phosphorus levels fifteen minutes before exercise, after one hour of exercise and twenty four hours of exercise

Serum phosphorus levels (mmol/L)	**Number of volunteers**	**Mean±SD**	**Statistical analysis**			
			Multi-group comparison	**Gr. I vs. II**	**Gr. II vs. III**	**Gr. I vs. III**
Fifteen minutes before exercise (Group I)	30	2.85± 0.55	0.007	0.058	0.217	0.001
One hour after exercise (Group II)	30	3.14± 0.61				
Twenty four hours after exercise (Group III)	30	3.33± 0.57				

BAR GRAPH SHOWING SERUM PHOSPHORUS LEVELS FIFTEEN MINUTES BEFORE EXERCISE, AFTER ONE HOUR OF EXERCISE AND TWENTY FOUR HOURS OF EXERCISE



DISCUSSION

Physical exercise has frequently been shown to induce bone mass gain, especially in weight bearing bone sites. Physical exercise improves bone formation and bone mineral density. Physical exercise exerts external as well as internal forces on the skeleton system. This causes variable amount of deformation in bone tissue and produces mechanical strain, which is sensed by osteocytes, the mechanosensitive cells of bone. Osteocytes then starts an adaptive response with the help of action of osteoclasts, which causes resorption of bone tissue and via osteoblasts, which then produces new bone tissue. Physical exercise has proved to be advantageous for the maintenance of healthy strong bones, particularly in children and adolescents.[6]

The mean value of serum phosphorus level fifteen minutes before exercise was 2.85±0.55 mg/dL, one hour after exercise was 3.14±0.61 mg/dL and twenty four hours after exercise was 3.33±0.57 mg/dL. The statistically significant increase in the serum phosphorus values was observed between the three groups (p=0.007).

Our results are in consistent with studies by Karakukcu et al[7], Nishiyama et al[8] and Scott et al.[9] It was found that after acute exercise serum phosphorus levels were increased and body's element distribution was affected by physical activities. Bradle et al and Dale et al have also demonstrated increased serum phosphorus concentration after aerobic and anaerobic exercises.[10][11] It was stated that release of phosphate increases from the exercising muscles after adenine nucleotide degradation.[12] This causes efflux of phosphate from the intracellular stores in the muscle to the blood. It has been found that endurance athletes have elevated resting serum phosphate levels.[13]

CONCLUSION

Our study showed that the moderate physical exercise in healthy volunteers have positive effect on serum phosphorus levels after 1 hour and 24 hours of exercise. Further detailed studies with higher sample size are recommended to support the use of exercise programs.

REFERENCES

[1] Maimoun L, Simar D, Malatesta D, Caillaud C, Peruchon E, Couret I, et al. Response of bone metabolism related hormones to a single session of strenuous exercise in active elderly subjects. Br J Sports Med 2005;39:497-502.

[2] Pollock ML, Gaesser GA, Butcher JD. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. Med Sci Sports Exerc 1998;30:975-91.

[3] Alizadeh Naderi AS, Reilly RF. Hereditary disorders of renal phosphate wasting. Nat Rev Nephrol 2010;6:657-65.

[4] Amanzadeh J, Reilly RF Jr. Hypophosphatemia: an evidence-based approach to its clinical consequences and management. Nat Clin Pract Nephrol 2006;2:136-48

[5] Marks J, Edward S, Debnam ES, Unwi RJ. Phosphate homeostasis and the renal-gastrointestinal axis. Am J Physiol Renal Physiol 2010;299:285-96.

[6] Alan HG, McMurray JR, McLanchlan DM. In: Varley's Practical Clinical Biochemistry, 6th ed., 2002.p.601-8.

[7] Karakukcu CI, Polat Y, Torun YA, Pac AK. The effects of acute and regular exercise on calcium, phosphorus and trace elements in young amateur boxers. Clin Lab 2013;59:557-62.

[8] Nishiyama S, Tomoeda S, Ohta T, Higuchi A, Matsuda I. Differences in basal and postexercise osteocalcin levels in athletic and nonathletic humans. Calcif Tissue Int 1988;43:150-4.

[9] Scott JP, Sale C, Greeves JP, Casey A, Dutton J, Fraser WD. The role of exercise intensity in the bone metabolic response to an acute bout of weight-bearing exercise. J Appl Physiol 2011;110:423-32.

[10] Bredle DL, Stager JM, Brechue WF, Farber MO. Phosphate supplementation, cardiovascular function and exercise performance in humans. J Appl Physiol 1988;65:1821-6.

[11] Dale G, Fleetwood JA, Inkster JS, Sainsbury JR. Profound hypophosphataemia in patients collapsing after a “fun run”. Br Med J 1986;292:447-8.

[12] Kreider RB, Miller GW, Williams MH, Somma CT, Nasser TA. Effects of phosphate loading on oxygen uptake, ventilatory anaerobic threshold and run performance. Med Sci Sports Exerc 1990;22:250-6.

[13] Sorlie D, Myhre K, Saugstad OD, Giercksky KE. Release of hypoxanthine and phosphate from exercising human legs with and without arterial insufficiency. Acta Med Scand 1983;211:281-6.