Marathon running may induce a temporary bone loss

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We do exercise, however, the intense exercise, such as marathon running affects the bone health, but it is believed to be temporary. The hypothesis is that, after the marathon running, bone crystals or hydroxyapatite is dissolved, which makes bone weaker.

The bone quality of participants after marathon running was examined by using the ultrasound technique. ¹ Tibia and patella were used for the measurement and it is found that the speed of sound (SOS) of ultrasound wave increases 1.6% in tibia and 3.5% in patella. People may say that it is caused by the microdamage formed by long lasting marathon running. However it is not clear the marathon running would generates microdamages.

Interestingly, men and women (total 12 subjects) ran on a treadmill until they were completely exhausted. This intense exercise increases the calcium and inorganic phosphorous in blood. ² They explain a severe metabolic acidosis with partial respiratory compensation follows the intense exercise. The acidosis lasts at least 30 min after the intense exercise. Similar to human, the calcium concentration of various types of vertebrates were examined after the intense activity. The intense activity lowers the pH and accumulates lactic acid. It is believed that the immediate source of the excess calcium in blood is bone. ³ The induced acidosis disturbs the skeletal homeostasis. ⁴ The accumulation of lactic acid induces a severe metabolic acidosis. ⁵

There are two types of acidosis. One is metabolic acidosis, which shows pH decrease by declining the bicarbonate concentration (HCO_3^-). The other is respiratory acidosis, which is the pH decrease due to the increase of partial pressure of carbon dioxide (P_{CO_2}). The acidosis due to the intense exercise has been explained by the increased

production of lactic acid or metabolic acidosis. If the lactate production is high enough, the cellular buffering capacity results in a decrease in cellular pH. These biochemical events have been termed lactic acidosis. The lactic acid production causes acidosis and the lactate production is increased by the intense exercise.

Intense exercise induces the metabolic acidosis as well as dissolving bone mineral, hydroxyapatite. Marathon running also reduces urinary excretion of calcium, but it returns to normal after 1 day. ⁶ We also know that marathon runners form the urinary stone in kidney easier than normal people ⁷ because the kidney tubules of marathon runners reabsorb calcium from urine more than those of normal people.

The urinary acid is dependent on pH level. As pH decreases, less is the solubility of uric acid. The uric acid stones may form by the less solubility of uric acid. The urine acid stones are known to be a type of kidney stones, but those are formed by that the urine becomes more acid.

Exercise acidosis occurs when the body fluid becomes acid when people are doing exercise. As pH level decreases, the lactate acid accumulates and hydroxyapatites in bone matrix dissolve. Then more calcium is in the body fluid and the blood. Also the kidney reabsorbs the calcium, which results in more calcium in blood.

As a conclusion, the intense exercise such as marathon running induces the temporary calcium dissolution from the hydroxyapatite in bone matrix (Fig. 1). The exercise acidosis decreases pH in the body fluid and blood, and it induces the temporary dissolution of hydroxyapatite in bone matrix. However it lasts only for a day or less and returns to normal.

Fig. 1. Schematic diagram of marathon running inducing metabolic acidosis.

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References

1. Rubin CT, Pratt GW, Porter AL, Lanyon LE, Poss R. The use of ultrasound in vivo to determine acute change in the mechanical properties of bone following intense physical activity. *J Biomech.* 1987;20:723–727.
2. Cunningham J, Segre GV, Slatopolsky E, Avioli LV. Effect of heavy exercise on mineral metabolism and calcium regulating hormone in humans. *Calcif Tissue Int.* 1985;27:598–601.
3. Ruben JA, Bennett AF. Intense exercise, bone structure and blood calcium levels in vertebrates. *Nature.* 1981;291:411–413.
4. Cunningham J, Fraher LJ, Clemens TL, Revell PA, Papapoulos SE. Chronic acidosis with metabolic bone disease: effect of alkali on bone morphology and vitamin D metabolism. *Am J Med.* 1982;73:199–204.
5. Nielsen SP, Christiansen TF, Harling O, Trap-Jensen J. Increase in serum ionized calcium during exercise. *Clin Sci Mol Med.* 1977;53:579–586.
6. Malm HT, Ronni-Sivula HM, Viinikka LU, Ylikorkala OR. Marathon running accompanied by transient decreases in urinary calcium and serum osteocalcin levels. *Calcif Tissue Int.* 1993;52:209–211.
7. Irving RA, Noakes TD, Rodgers AL, Swartz L. Crystalluria in marathon runners. 1. Standard marathon–males. *Urol Res.* 1986;14:289–294.

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