ORIGINAL ARTICLE

Relationship of Serum Calcium, Magnesium and Inorganic Phosphorus levels during various Menstrual Phases in Adolescent Girls

Ritu Gupta*, Mumtaz Goni*, A. K. Sadhoo*, Ravinder K. Gupta**

Abstract

In fifty healthy adolescent girl volunteers serum calcium, magnesium and inorganic phosphorus were estimated serially during various menstrual phases. The result shows significant cyclic variations within physiological limits. Serum calcium was highest during ovulatory phase ($p<0.001$) and lowest during luteal phase ($p<0.001$) as compared to other phases. The levels of serum magnesium were observed in opposite direction. It was highest during menstrual phase and lowest during ovulatory phase ($p<0.001$). The highest levels of inorganic phosphrous were seen in menstrual phase as compared to other phases ($p<0.001$). The influence of cyclic variations of the ovarian hormones probably results in these changes.

Key Words : Adolescent girls, Calcium, Magnesium,Inorganic Phosphorus, Menstrual phases.

Introduction

Menstrual cycle is unique to human beings and a few non-human primates. It is the result of complex interacting processes within the hypothalamus, anterior pituitary gland, ovaries and uterus (1). The menstrual cycle is the most extensively studied rhythm and scientific research has shown that bodily activities fall and rise regularly like a clock during the cycle. Although the coordinated sequence of hormonal changes during the normal menstrual cycle is well characterised, whether similar or parallel changes occur in the distribution of selected minerals has not been clearly established. However, a definite relationship between ovarian hormone activity and the blood constituents especially calcium, magnesium and inorganic phosphorus during various phases of menstruation has been studied (2-4).

Effect of ovarian hormones on water and electrolyte balance is well documented (2). Estrogen leads to marked acceleration of calcium uptake and decrease of its elimination through pigeon's gut (5). It is well established that the calcium homeostasis is maintained by parathyroid glands. However, effect of mestrual cycle on serum calcium remains controversial (6). Magnesium probably does not play a specific role in regulation of menstrual function although magnesium is invloved in basal metabolism that changed over the course of menstrual cycle (7). Decrease in inorganic phosphorus levels during prolifetative phase has also been documented (4).

The purpose of this study was to estimate serum levels of calcium, magnesium and inorganic phosphrous in

From the Departments of *Physiology and **Pediatrics, Government Medical College, Jammu (J&K) India.
Correspondence to : Dr. Ritu Gupta, 136, Nai Basti, Jammu Cannt.-180 003 (J&K) India.

various phases of menstrual cycle in adolescent girls and to study relationship between these essential minerals in various phases.

Methods

Fifty healthy adolescent girl volunteers (12-19 years) with normal and regular menstrual cycles participated in this prospective serial study between March and September, 2000. The girls with neuropsychiatric disorders or any other illness affecting menstruation were excluded. Three ml venous blood was drawn between 8 A.M. and 10 A.M. during each phase of menstruation viz menstrual (day 1-5), follicular (day 6-10), ovulatory and luteal (day 16-28 or more). The ovulation was judged by daily basal oral temperature. Estimation of serum calcium, magnesium and inorganic phosphorus was done by O-cresolphthalein-complexone method, Neil and Neely and Fiske and Subarow method respectively (8,9).

Statistical analysis of the 4 sets of recording (menstrual, follicular, ovulatory and luteal) of each variable was carried out by paired 't' test.

Results

The mean age of menarche was 12.75 years (12-14 years). The duration of menstrual cycle varied from 28-35 days with a mean of 29.03 ± 0.98 days, while, menstrual phase varied from 2 to 6 days. The mean basal body temperature was 98.2° F. The average fall of basal body temperature at the time of ovulation was 0.6° F (0.4-0.7° F) as shown in fig. 1. The temperature was slightly raised to the tune of 0.5 to 1° F during luteal phase. The ovulation varied from 15th to 18th day with a mean of 15.25 ± 1.008 day.

Serum calcium, magnesium and inorganic levels during various phases of menstrual cycle are summarised in Table 1 and represented graphically in Fig 2.

Gradual increase in serum calcium level was seen from menstrual to ovulatory phase ($p<0.001$) followed by luteal decrease ($p<0.001$) as compared to menstrual phase. The serum magnesium levels graudally decreased from menstrual to ovulatory phase ($p<0.001$), thereafter it again raised. The serum inorganic phosphorus had a cyclic variation during menstrual cycle. The highest levels were seen during menstrual phase as compared to all the phases. During ovulation it increased significantly ($p<0.001$) as compared to follicular phase. During luteal phase, values were the lowest.

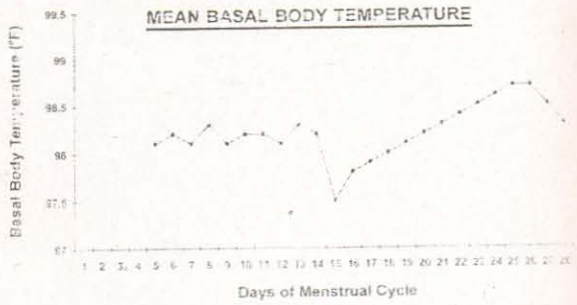

Fig. 1 : Showing Mean Basal Body Temperature during Menstrual Cycle

Table 1

The mean values of Serum Calcium, Magnesium and Inorganic Phosphorus during different phases of menstrual cycle

	Menstrual Phase	Follicular Phase	Ovulatory Phase	Luteal Phase
Serum Calcium (mg/dl)	9.4	9.85	10.32	9.26
S. Magnesium (mg/dl)	2.18	1.89	1.61	2.01
Inorganic Phosphurus (mg/dl)	4.29	3.67	3.82	3.44

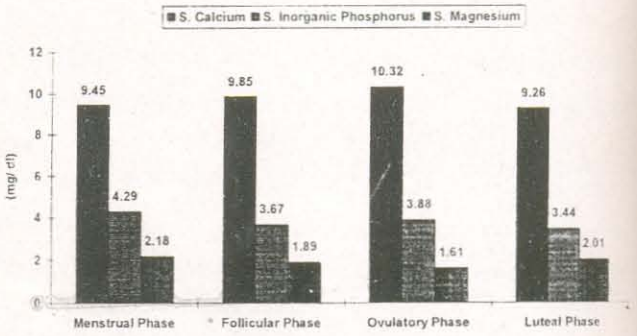

Fig. 2 Showing Relationship between Calcium, Magnesium and Inorganic Phosphorus during different Phases of Menstrual Cycle

Discussion

The relationship between essential minerals and ovarian hormone activity has been a topic of interest during past several years. The coordinated sequence of hormone changes during normal menstrual cycle is well characterised but whether similar or parallel changes occur in the distribution of selected minerals has not been clearly established, especially in the adolescent girls. Several studies have provided evidence for phase related changes in blood constituents during menstrual cycle (2,3,4,10).

The present study revealed that distinct changes occured in serum calcium, magnesium and inorganic phosphrous levels during menstrual cycle in adolescent girls. Gradual but significant increase in serum calcium level was seen during menstrual, follicular and ovulatory phases compared to luteal phase. The results are analogous to the studies that report serum calcium is in higher concentration during ovulatory phase and in lowest concentration during prémenstrual phase (4,6) while some have stated slight variation during mensus and intermensus though the observations were not significant (11). Earlier research work suggest that the increase in serum calcium levels during follicular and ovulatory phase could be the effect of estrogens on the parathyroid glands. The estrogen causes increase in parathyroid activity which leads to marked acceleration of calcium uptake (12, 13). These observations indicate that estrogen alone can possibly cause an increase in blood calcium levels during follicular and ovulatory phases through parthyroid harmone regulation. In addition low serum magnesium levels during ovulatory phase could be responsible for increased parathyroid activity (14).

Serum calcium in the present study was found to be low during luteal phase inspite of an increase in estrogen level. This relationship cannot be explained on the basis of estrogen levels and parathyroid activity alone. The higher levels of progesterone than estrogen during luteal phase could be responsible for low serum calcium levels. Alternatively, because estrogen is utilised to enhance the progesterone activity (priming effect) it may not be involved in calcium uptake during luteal phase (4). Also it could be due to the effect of increased serum magnesium levels, as there is inhibition or competition for common calcium reabsorptive sites in the loop of Henle (15). Thus decline in serum calcium could be a direct response to elevated serum magnesium and its action on nephrons.

The levels of serum magnesium were highest during the menstrual phase and lowest during ovulatory phase. The result of present study are in agreement with the observations in different studies (3,4,16). The decrease in serum magnesium levels during ovulatory phase could be due to pre-ovulatory estrogen peak which in turn is associated with concurrent leutinizing hormone and follicle stimulating hormone peaks (17,18). The raised estrogen levels possibly by acting through parathyroid hormone could be responsible for depleting the body stores of magnesium by decreasing the reabsorption of magnesium ions by the renal tubules thus resulting in midcycle decline (10).

Increased basal metabolic rate and oxygen consumption are associated with increased carbohydrate utilization and enhanced sympathetic activity during luteal phase thus resulting in increased serum magnesium levels. Serum magnesium concentration has been possibly correlated with basal body temperature during ovulation and the luteal phase metabolism (17,18). Although the hormone levels were not measured during the study, it seems likely that progesterone is responsible for rise in both basal body and serum magnesim, which increased in parallel in a single day (7).

In present study, the values of serum inorganic phosphorus were significantly low in follicular, ovulatory and luteal phases. The calcium-inorganic phosphorus ratio was 2.2:1, 2.7:1, 2.7:1 in menstrual, follicular,

ovulatory and luteal phases respectively.

There is scanty published literature regarding relationship of serum inorganic phosphrous and various phases of menstrual cycle. In one of the studies, it was revealed that the values of serum inorganic phosphorus were highest during menstrual phase as compared to other three phases (4). The decrease in inorganic phosprous levels during follicular, ovulatory and luteal phase as compared to menstrual phase could be on account of estrogen. High estrogen production can lead to decrease in serum inorganic phosphorus levels. Increased estrogen causes increase in parathyroid activity which further causes fall in phosphate concentration rapidly than the calcium rise. The decline in phosphate concentration could be caused by strong effect of parathyroid hormone on kidney resulting in excessive renal phosphate excretion, an effect that usually is great enough to override increased phosphate absorption from bone (19).

To conclude, a definite relationship was observed between calcium and magnesium levels during ovulatory phase and similar co-relationship was also observed between serum calcium and inorganic phosphorus levels in various menstrual phases in adolescent girls. These changes are probably brought about under the influence of cyclic variations of the ovarian hormones. Although the cyclic changes were noted in serum calcium, magnesium and inorganic phosphorus levels during the menstrual cycle among adolescent girls, they were all found to be within physiological limits.

References

1. Bayer, Steven R, De Cherney AH. Clinical manifestation and treatment of dysfunctional uterine bleeding. *JAMA India* 1993 ; 13 : 299-306.
2. Dadlani AG, Chandwani S, Desai CA, Pandya KD. Serum electrolyte during various phases of menstrual cycle. *Ind J Physiol Pharmacol* 1982 ; 26 : 302-06.
3. Deuster PA, Dolev E, Bernier LL, Trostmann UH. Magnesium and zinc status during menstrual cycle. *Am J Obst Gynecol* 1987 ; 157 : 964-68.
4. Pandya AK, Chandeani S, Das TK, Pandya KD. Serum calcium, magnesium and inorganic phosphorus levels during various phases of menstrual cycle. *Ind J Physiol Pharmacol* 1995 ; 39 (4) : 415-17.
5. Silberberg M, Silbeberg R. In Biochemistry and Physiology of Bone. Bourne GH (ed.). Academic Press, New York 1956. 632-44.
6. Southam AL, Gonzago FP. Systemic changes during menstrual cycle. *Am J Obst Gynecol* 1965 ; 91 : 141-65.
7. Solomon SF, Kurer MS, Calloway DM. Menstrual cycle and basal metabolic rate in women. *Am J Clin Nutr* 1982 ; 36 : 611-16.
8. Chawla Ranjana. Serum inorganic phosphorus. In : Chawla Ranjana (ed.) Practical Clinical Biochemistry : Methods and Interpretations. Jaypee Brothers, Medical Publishers (P) Ltd. New Delhi, Ist Edition 1995 ; 140-144.
9. Neil and Neilly. Estimation of Mg in serum using titan yellow. *J Clinical Pathology* 1956 : 162.
10. Zitterman A. *et. al.* Physiologic fluctuations of serum estradiol levels influence biochemical markers of bone resorption in young women. *J Clin Endo Metabol* 2000 ; 85 (1) : 95-101.
11. Frank HA, Carr MH. Normal serum electrolytes with a note on seasonal and menstrual variation. *J Lab Clin Med* 1957 ; 42 (2) : 246-52.
12. Conor EB, Chang JC, Edelstein SL. Coffee associated osteoporosis offset by daily milk consumption. *JAMA* 1994 ; 217 : 280-83.
13. Heaney RP. Thinking straight about calcium. *N. Eng J Med* 1993 ; 328 : 503-05.
14. Chaudhuri KS. Calcium, metabolism, parathyroid, vitamin D and calcitonin. In Chaudhuri KS (ed.). Concise Medical Physiology, 2nd Ed. New Central Book Agency (P) Ltd. Calcutta, 1993 : 300.
15. Corney SL, Wong NLM, Quamme GA. Effect of magnesium deficiency on renal magnesium and calcium transport in rat. *J Clin Invest* 1980 ; 65 : 180-86.
16. Muneyvirci-Delale O, Nacharaju VL, Altura BM, Altura BT. Sex steriod hormones modulate serum ionized magnesium and calcium levels throughout the menstrual cycle in women. *Fertil Steril* 1998 ; 69 (5) : 958-62.
17. Johnson AJ, James DO, Baumber JS, Schneider E. Effect of estrogen and progesterone on electrolyte balance in normal dog. *Am J Physiol* 1970 ; 219 (6) : 1691-97.
18. Mehta V, Chakarvarty AS. Autonomic functions during different phases of menstrual cycle. *Ind J Physiol Pharmacol* 1993 ; 37 : 56-58.
19. Guyton AC, Hall JE. Parathyroid hormone, calcitionin, calcium and phosphate metabolism, vitamin D, bone and teeth. In Guyton AC, Hall JE (eds.) Guyton and Hall Textbook of Medical Physiology, 9th Edition. WB Saunders Company 1996 ; 992-93.