

**CONCENTRATIONAL CHANGES OF SODIUM POTASSIUM CALCIUM MAGNESIUM IONS BLOOD PRESSURE AND HEART RATE DURING MENSTRUAL CYCLE**

<sup>1</sup>Nahid Darvishzadeh ; <sup>1</sup>Shahr banoo Oryan ; <sup>2</sup>Mahnaz Kesmati

1. Department of biology , North Tehran branch , Islamic azad university , Tehran , Iran
2. Department of biology , Faculty of sciences , Shahid Chamran university , Ahvaz , Iran

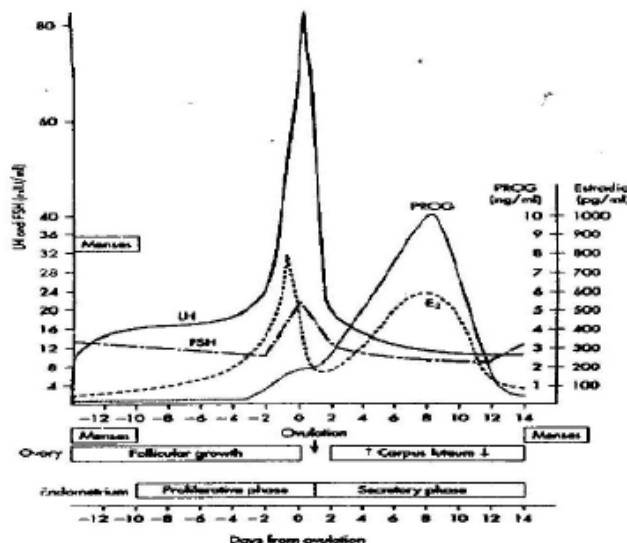
**ABSTRACT**

Menstrual cycle is formed by complex processes that include the interference of nervous and hormonal systems. This makes vast physiological changes in body. One of these changes is the imbalance between water and electrolytes. In this research, we study the role of ovarian hormones on the balance of Sodium, Potassium, Calcium, and Magnesium ions and its effect on the blood pressure and the heart rate in Luteal and menstrual phases. For this purpose, the 33 healthy students from Andimeshk city participated in this research and their age was 18-25. In first, the blood pressure and heart rate of each student was determined and then the mentioned ions concentration was measured in menstrual phase (two day after ovulation) and Luteal phase (eight day after ovulation). According to obtained results, the difference between the amount of Sodium, Potassium, Calcium, and Magnesium ions in menstrual phase and Luteal phase isn't noticeable. Also, the average Arterial pressure, pulse pressure, and heart rate decrease in menstrual phase. Generally, according to present results, it seems that ovarian hormones don't have a significant effect on the ions regulator systems.

**KEYWORDS:** menstrual phase, the balance between Sodium and potassium ions, Luteal ions, and ovarian hormones.

**INTRODUCTION**

In psychology view, the Menstruation is the most important event in puberty during ( Maleki, 1993). This phenomenon which is actually a part of visible signs of puberty is a result of complicated processes that include the interference of nervous and hormonal systems. This leads to physiological changes in body ( GreenSpam, 1991). Basically, this is a result of changes in ovarian hormones. One of these changes is the imbalance between water and electrolytes that is result of ovarian hormones effects (Dadlani, 1982). Some of reports confirm that ovarian hormones affect the Calcium, phosphor, and Magnesium concentration (Conor, 1994; Pandya, 1995), whereas other reports are in doubt about the effect of menstrual cycle on the change of concentration of some ions such as calcium (Al Southam, 1965).



**Figure 1-** the concentrations of blood's Hormones and the Endometrial and ovarian events during the menstrual cycle (S. Porter Field).

In this research, based on the evidences, we study the role of ovarian hormones on the balance of electrolytes such as Sodium, Potassium, Calcium, and Magnesium and its effect on the blood pressure and heart rate in menstrual cycle. Also we study the concentration of mentioned ions in two phases: first, in the start of natural menstruation (first and second day) that the amount of Estrogen and progesterone hormones is the least; and second, 7-9 days after the evaluation that amount of mentioned hormones is the most (Luteal phase). For both phases, we study the blood pressure and heart rate.

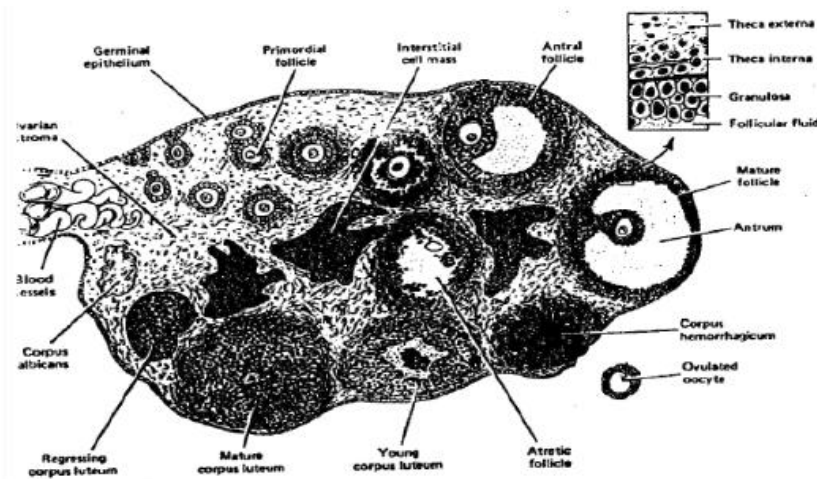


Figure 2- formation steps of follicle graph in ovary.

The natural properties of Menstruation and bloodshed are result of the reaction and interference of hypothalamus axis of pituitary gland, ovaries, and uterus and simultaneous changes in tissues of reproductive system. Although each parts are essential for normal reproductive process, but the ovary plays a central role in this process.

From birth, there are a number of primary follicles that everyone includes an immature ovum. Beginning the Menstrual cycle, some of these follicles grow and formed a cavity around the ovum that called antrum. The follicle of a mature ovary that called "follicle graph" has two parts, single internal and single external. Figure 2 shows a follicle graph (W. Ganong).

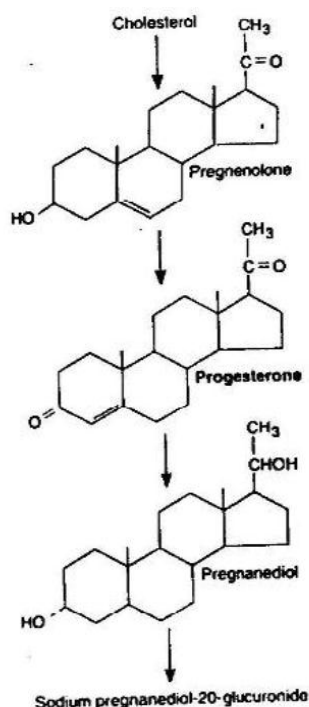
Follicular liquid contents plenty of estrogen and its major part is derived of granulose cells. About the 14-16 days, the follicle menstrual cycle is torn and the ovum is released into abdominal cavity. This process is named "ovulation". This ovum will be excreted through the vagina. After the tearing of follicle graph and releasing of ovum, the cavity in the follicle is filled by blood and forms the hemorrhagic part.

### Chemical structure, biosynthesis, and metabolism of progesterone

Progesterone is a 21 Carbon steroid (figure 3) that is secreted by the CL (Corpus luteum) and placenta and a little by follicles. 18 percent of the Progesterone in the blood sticks to globulin receiver of Corticosteroids and 80 percent of it sticks to Albumin and the rest of it is free. In men, the concentration of plasma progesterone is about 0.3 nano-grams per milliliter. In women, this concentration is about 0.9 nano-grams per mililiter during the ovarian follicles step.

In beginning of each monthly menstrual cycle, a large part of Endometrial is removed by Menstruation. After the Menstruation, it reminds a thin layer of Endometrial Struma. It reminds only the epithelial cells which are placed in the remaining deep parts of Endometrial. The surface of Endometrial is epithelialized again during the 4-7 days after the menstruation. Then because of rising the number of Strumal cells and progressive growth of Endometrial glands and the growth of new blood vessels, after the one and the half weeks, namely before the evaluation, the thickness of Endometrial is increased strongly. During the evaluation process, Endometrial has the 3-5 milimeters thickness. This step is called "proliferative phase".

In the final half of the menstrual cycle, the CL (Corpus luteum) secretes progesterone and estrogen, after the Ovulation, and in this step of endometrial cycle; estrogens cause the cell proliferation while the progesterone causes the inflation and appearing the secretory characteristics. In normal menstrual cycle, body excretes 40 milliliters blood and 35 milliliters serous fluid. During the 4-7 days after the beginning of menstruation, bleeding is stopped because in this time, the Endometrial is epithelialized completely. This step is called "menstrual phase" (A. Guyton)



**Figure 4- progesterone biosynthesis and its metabolism major rout.**

### The role and importance of electrolytes

Electrolytes are in all of the body liquids such as blood, extracellular fluid (ECF), digestive fluid, and the urine. The necessity of electrolytes is an obvious matter in cellular life. The most important electrolytes are Sodium, Potassium, Calcium, and Magnesium ions (A. Guyton). Adjusting the amount and concentration of electrolytes is a major duty of body. Then the insignificant change in amount and rate of electrolytes makes the physiological disturbance in the organs activities and the significant change causes death (Arefi Anbarani, 1952).

Calcium is a most important bivalency extracellular Cation. It has an important role even in doing the normal physiological actions and in Patho-physiological disorders in a cell. Calcium is necessary for many of processes such as nervous stimulation, Neurotransmitters, Blood coagulation, and many of necessary ingredients (Sayeed, 1996). Calcium enters to body by two mechanisms and only through the intestine. The calcium excretion is adjusted with body needs. By eating more calcium, it also increases renal excretion. One of the major control mechanisms is the calcium re-absorption by the renal tubules of Parathormone hormone. Increasing the Parathormone hormone concentration increases the Calcium re-absorption in thick part of ascending branch of loop of Henle and final tube and then reduces the Urinary excretion of Calcium. Decreasing of Parathormone causes Calcium excretion by reducing the re- absorption in Henle loop and final tube. Other factor that affected the Calcium re- absorption is the Plasma concentration of phosphate. Increasing the Plasma Phosphate motivates the secretion of Parathormone hormone and increases the Calcium re- absorption by renal tubules and therefore the Calcium excretion is reduced. Calcium re- absorption also is motivated by metabolic acidosis and is controlled by metabolic alkalosis.

Sodium ion with chlorine and Bicarbonate ions are involved in maintaining of body equilibrium (acid and Base). They are necessary for maintaining of Osmotic pressure of body liquids, avoiding of dehydration, and maintaining the Irritability property of muscles and nervous. Because Sodium is the most abundant ion in extracellular liquid, adjusting the osmolarity and the concentration of extracellular liquid Sodium are related together. However, there are two main systems that are involved in adjusting of Sodium concentration and osmolarity of Extracellular liquid: Osmotic receiver feedback system (ADH), thirst mechanism. Thirst mechanism adjusts the drinking process and controls the osmolarity and Sodium concentration of Extracellular liquid accurately.

The effect of Sodium ion on Acid- Base balance, PH adjust, Osmotic pressure, and water maintain and its effect on control and motivation of muscles and nervous is considerable. Because a lot of cellular actions are sensitive to changes in potassium concentration of Extracellular liquid, Sodium Adjustment is necessary. Since the excreted Potassium is just the 5-10 percent of eaten Potassium, then maintaining of potassium balance is dependent on its excretion by the kidneys. Therefore the Maintain the natural balance of potassium needs to kidneys adapt their potassium excretion with change in amount of eaten potassium very fast and carefully. Mainly, natural adjusting of potassium is a result of the change in potassium secretion by the main cells in final tube and urine collection tubes. The most important factors that control the potassium secretion are:

- 1- Increasing the potassium concentration of Extracellular liquid motivated the potassium secretion. This effect acts as a most important mechanism which increases the potassium secretion and adjusts the potassium ion of Extracellular liquid.
- 2- Aldosterone motivates the potassium secretion. Aldosterone stimulated the active re- absorption of Sodium ions by the main cells of final tubes and urine collection tubes. Second effect of Aldosterone is to increase the Luminal membrane permeability for potassium that increases the Aldosterone efficiency for potassium secretion again. Then Aldosterone has a strongly effect on the increasing of potassium secretion.
- 3- Increasing of liquid current motivates the potassium secretion in final tube.
- 4- Acute acidosis reduces the potassium. Sharp rise in the concentration of hydrogen of extracellular liquid (acidosis) reduces the potassium secretion whereas the reduction of concentration of hydrogen (Alkalosis) increases the potassium secretion (Arefi Anbarani, 1952).

Magnesium ion is necessary as a catalyst for a large number of intercellular enzymatic reactions, and especially for reactions that related to carbohydrates metabolism. Also, it plays the role in muscles and heart activities (A. Guyton) More than half of the Magnesium of body is stored in bones and the most part of rest is in cells. Just less than one percent is in extracellular liquid. For maintaining the Magnesium equilibrium, kidneys have to excrete the 150-125 milligrams of absorbed Magnesium. Following disturbances increase Magnesium: Increasing the Magnesium concentration of Extracellular liquid, increasing the extracellular liquid, increasing the calcium concentration of Extracellular liquid (Arefi Anbarani, 1952). One of the most important adjusting factors is the balance between water and electrolytes. A strong factor for adjusting the Sodium ion re- absorption is Aldosterone Steroid hormone. Aldosterone increases the Parameh test Enzyme in the tubular membrane and then the intercellular concentration is increased

### **A review of previous studies**

In women with menstrual cycle, the frequency of E2 values endogenous doesn't have effect on the Calcium homeostasis and the concentration of Hormones that regulate the bone regeneration (Baran, 1980). Also, despite of significant changes in Calcium regulator hormones, any significant changes in Calcium, Phosphate, and Magnesium excretion through urine or the bone markers is not reported (Demerre, 1968; Tjellesen, 1983). However, at least 50 percent of women have a spontaneous fracture result of Osteoporosis in postmenopausal. In the present, the only treatment is the estrogen- trophy (Christiansen, 1987). On the other hand, increasing of Calcium causes the increasing of bone mass (Rocker, 1992). Estrogen adjusts the effect of Parathormone which increased in the middle of the cycle. Also, estrogen increases the parathormone activities (Pitkin, 1978).

The amount of Calcium, during the ovulation is in the most amounts and in Luteal phase is in the least amounts [AK. Pandya, 1995). There is disagreement about Magnesium amount during the ovulation (Pitkin,1978; Patricia, 1987). Amount of Magnesium in Luteal phase is maximum and reduced from menstrual phase to follicular phase and it is in minimum amount during the ovulation (Pandya, 1995).



Any fluctuation cannot be found in electrolytes during the menstrual phase (Williamson, 1996). However, in some studies, the amount of Sodium and Calcium of plasma is increased in middle of Menstrual cycle and until the next Menstruation decreased gradually (Hill, 1974). Also, the maximum amount of electrolytes is in the ovulation phase. A little reduction from Luteal phase to Menstrual phase and increasing from Menstrual phase to follicular phase. This increasing has been seen from follicular phase to ovulation phase (Dadlani, 1982).

Renal retention of sodium during the Luteal phase of Menstrual cycle is not normal (Bisson, 1992). On the other hand, in comparison with rest of phase, any important change in Sodium amount wasn't observed in menstrual phase. Black women have the more Systolic blood pressure in during of follicular phase than white women (Mills, 1996). In other study, it is not seen any difference about blood pressure and heart rate between follicular and Luteal phases (Mills, 1996), and the Menstrual cycle has not significant impact on the blood pressure and heart rate (Stoney, 1990).

## METHODS

For doing this research, we choose 33 students of Fatemeh-Alzahra high school in Andimeshk city. The criterion of this selection is the being healthy and having the normal menstrual cycle. Their Menstrual period is  $28 \pm 2$ , and their age is 18-25.

Blood sampling was done in two steps, before and after menstruation, according to their menstrual cycle. The time of sampling was in 8-10 a.m. and all of them didn't eat breakfast. Before sampling, we measured the amount of systolic and diastolic blood pressure and heart rate of them. The amount of blood sample is 5 cc and the sample tube put in Ben Murrey Bath in 37 centigrade temperature.

To determine the pulse pressure and mean arterial pressure we use following formula:

Pulse pressure= Systolic pressure – diastolic pressure

Mean arterial pressure= diastolic pressure+ (Systolic pressure- diastolic pressure)

To determine the potassium and sodium ions we use the SEAC FP photometer film system. This system has two parts:

1- Dilution part 2- examiner part

To determine the potassium and sodium ions by the SEAC FP system, we need to 3 solutions:

1- Blank solution or internal standard: this solution is an internal standard which includes Lithium standard with 15 l/meq density.

2- Standard solution: this solution is in 5 cc Ampoule and its container is the Lit=1, K=5, Na=140 l/meq.

3- Control solution: this solution contains the various elements with the specified values.

To determine the Calcium ion in laboratory, we use the 30PC model of Pars test kid and Spectrophotometer device. Using the above formula we can calculate the Calcium concentration. The resulting number is accorded to the Calcium concentration of sample.

The Calcium concentration of sample=  $\frac{\text{sample Optical absorption}}{\text{standard Optical absorption}} \times \text{standard concentration}$

The standard concentration of this test is 8 milligram per deciliter in normal case and the Calcium concentration for all ages and both sexes 8.6-10.3 milligram per deciliter.

Such as Calcium ion, the test of determining of Magnesium ion is a Colorimetric test. In this test we use the Biochemistry kit spectrophotometer devise. In Alkalosis environment, Magnesium ion creates a reddish substance which its color intensity has a direct relation with amount of Magnesium in sample. Turn on the Spectrophotometer devise and then adjust it by the adjustment screw 500 nm wavelength. Then read the test and standard solution in front of the blank solution in wavelength 500 nm and by spectrophotometer devise. The Calcium concentration calculation is given by:

The Magnesium concentration of

sample=  $\frac{\text{sample Optical absorption}}{\text{standard Optical absorption}} \times \text{standard concentration}$

The standard concentration of this test is 2.5 milligram per deciliter in normal case and the Magnesium concentration for all ages and both sexes 1.6-2.9 milligram per deciliter.

## Results Of Statistical Data

The obtained data are sorted in two steps, Luteal and Menstrual step. The table 1 is related to Luteal phase and the table 2 is related to Menstrual phase. In each group of tables, the different parameters such as Sodium, Calcium, Magnesium, mean arterial pressure, heart rate, and pulse pressure is shown separately. Also, tables 3 and 4 specify the statistical

results. Obtained results are compared base on test 1. In all of the tests we consider the meaningful level  $P < 5\%$ . The averages is shown as "Mean  $\pm$  SEM" in plots.

**Table 1: the results of measuring the different parameters in Luteal phase.**

| Sample | Sodium | Potassium | Calcium  | Magnesium | arterial Pressure | Heart rate | Pulse Pressure |
|--------|--------|-----------|----------|-----------|-------------------|------------|----------------|
| Code   | meq/l  | meq/l     | mg/100ml | mg/100ml  | mmHg              |            | mmHg           |
| 1      | 138    | 4/4       | 9/5      | 2/2       | 70                | 86         | 42             |
| 2      | 139    | 4/5       | 9/2      | 1/9       | 78/66             | 88         | 35             |
| 3      | 141    | 5/1       | 8/9      | 2/2       | 87/33             | 87         | 46             |
| 4      | 135    | 5         | 8/9      | 1/6       | 81/66             | 68         | 47             |
| 5      | 140    | 4/1       | 9/3      | 2         | 72/66             | 55         | 56             |
| 6      | 140    | 5/1       | 8/9      | 2/5       | 79/66             | 67         | 53             |
| 7      | 137    | 4/8       | 9/2      | 2/5       | 79/33             | 91         | 46             |
| 8      | 142    | 4/5       | 9/2      | 1/9       | 75/33             | 83         | 46             |
| 9      | 147    | 5         | 9/3      | 1/7       | 88                | 93         | 54             |
| 10     | 138    | 4         | 9/2      | 2         | 86/33             | 94         | 43             |
| 11     | 148    | 4         | 9        | 2/9       | 72/66             | 81         | 56             |
| 12     | 140    | 4         | 8/8      | 2/1       | 87/66             | 97         | 35             |
| 13     | 142    | 4/5       | 8/8      | 2/9       | 78/66             | 94         | 32             |
| 14     | 138    | 4/8       | 29       | 1/6       | 94/66             | 86         | 35             |
| 15     | 145    | 4/1       | 9        | 1/8       | 82                | 94         | 36             |
| 16     | 140    | 4/5       | 9/2      | 2/2       | 82/66             | 99         | 47             |
| 17     | 143    | 4/8       | 8/6      | 2/9       | 73                | 76         | 42             |
| Sample | Sodium | Potassium | Calcium  | Magnesium | arterial Pressure | Heart rate | Pulse Pressure |
| Code   | meq/l  | meq/l     | mg/100ml | mg/100ml  | mmHg              |            | mmHg           |
| 18     | 140    | 4.9       | 9.3      | 1.6       | 94                | 99         | 36             |
| 19     | 135    | 4.6       | 8.9      | 2.3       | 93.66             | 82         | 35             |
| 20     | 142    | 4.6       | 8.9      | 2.9       | 76.33             | 93         | 43             |
| 21     | 138    | 4.5       | 9.3      | 2.3       | 71.66             | 76         | 41             |
| 22     | 133    | 4.5       | 8.9      | 2.3       | 71.66             | 98         | 50             |
| 23     | 130    | 4.6       | 8.9      | 1.6       | 77                | 76         | 42             |
| 24     | 130    | 4.7       | 8.2      | 1.9       | 80.33             | 73         | 52             |
| 25     | 133    | 4.7       | 8.8      | 1.9       | 95.66             | 84         | 50             |
| 26     | 132    | 4.8       | 8.8      | 1.8       | 97.33             | 88         | 34             |
| 27     | 143    | 4.9       | 8.6      | 2.3       | 80.33             | 91         | 34             |
| 28     | 136    | 4         | 8.9      | 1.7       | 85                | 92         | 42             |
| 29     | 136    | 4.5       | 8.8      | 2.3       | 79.66             | 84         | 38             |
| 30     | 135    | 4.7       | 9.3      | 2         | 82.66             | 70         | 44             |
| 31     | 142    | 4.8       | 9.4      | 2         | 81.33             | 75         | 31             |
| 32     | 133    | 4.6       | 8.8      | 1.7       | 77                | 84         | 54             |
| 33     | 131    | 4.6       | 8.1      | 2.4       | 76                | 76         | 60             |

**Table 2: the results of measuring the different parameters in Menstrual phase.**

| Sample | Sodium | Potassium | Calcium  | magnesium | arterial Pressure | Heart rate | Pulse Pressure |
|--------|--------|-----------|----------|-----------|-------------------|------------|----------------|
| Code   | meq/l  | meq/l     | mg/100ml | mg/100ml  | mmHg              |            | mmHg           |
| 1      | 140    | 5         | 8/9      | 2/5       | 77/33             | 86         | <b>58</b>      |
| 2      | 130    | 4/8       | 9/5      | 2/5       | 78/33             | 88         | <b>31</b>      |
| 3      | 135    | 4/5       | 9        | 2/2       | 88/66             | 87         | <b>41</b>      |
| 4      | 145    | 3/8       | 9        | 2/5       | 78/33             | 68         | <b>55</b>      |
| 5      | 134    | 4/1       | 8/6      | 1/7       | 74                | 55         | <b>30</b>      |
| 6      | 143    | 3/9       | 9/2      | 1/6       | 76/33             | 67         | <b>61</b>      |
| 7      | 141    | 4/6       | 10/2     | 2         | 88/33             | 91         | <b>46</b>      |
| 8      | 140    | 5         | 8/8      | 1/6       | 74/66             | 83         | <b>44</b>      |
| 9      | 135    | 5/1       | 9/5      | 2/2       | 89                | 93         | <b>45</b>      |
| 10     | 142    | 4/1       | 9/2      | 2/5       | 92                | 94         | <b>39</b>      |
| 11     | 139    | 4/3       | 8/8      | 2/8       | 73/66             | 81         | <b>47</b>      |
| 12     | 130    | 4/4       | 8/9      | 1/8       | 88/66             | 97         | <b>26</b>      |
| 13     | 133    | 4/7       | 8/7      | 1/6       | 66/33             | 94         | <b>37</b>      |
| 14     | 140    | 4/9       | 8/8      | 2/2       | 82/66             | 86         | <b>32</b>      |
| 15     | 142    | 4/6       | 8/8      | 1/9       | 77/33             | 94         | <b>37</b>      |
| 16     | 134    | 4/8       | 9/1      | 1/6       | 84/66             | 99         | <b>44</b>      |
| 17     | 140    | 4/8       | 8/9      | 2/1       | 77                | 76         | <b>33</b>      |
| Sample | Sodium | Potassium | Calcium  | magnesium | arterial Pressure | Heart rate | Pulse Pressure |
| Code   | meq/l  | meq/l     | mg/100ml | mg/100ml  | mmHg              |            | mmHg           |
| 18     | 142    | 4/2       | 9        | 1/7       | 92                | 99         | <b>39</b>      |
| 19     | 134    | 5         | 9.2      | 2.6       | 82                | 82         | <b>42</b>      |
| 20     | 140    | 4.8       | 8.2      | 2         | 81.66             | 93         | <b>26</b>      |
| 21     | 139    | 4.7       | 8.8      | 2.2       | 84                | 76         | <b>39</b>      |
| 22     | 135    | 3/7       | 8/8      | 1/6       | 69                | 98         | <b>54</b>      |
| 23     | 142    | 4/8       | 8/9      | 2         | 82                | 76         | <b>42</b>      |
| 24     | 139    | 4/3       | 8/8      | 2/2       | 74                | 73         | <b>48</b>      |
| 25     | 141    | 4/3       | 8/3      | 2/2       | 90/66             | 84         | <b>62</b>      |
| 26     | 140    | 4         | 8/5      | 1/6       | 90/66             | 88         | <b>44</b>      |
| 27     | 137    | 4         | 8/8      | 1/7       | 72                | 91         | <b>30</b>      |
| 28     | 134    | 4/5       | 8/7      | 2/6       | 93/33             | 92         | <b>40</b>      |
| 29     | 139    | 4/6       | 8/7      | 1/6       | 82                | 84         | <b>45</b>      |
| 30     | 141    | 3/8       | 9        | 1/9       | 82                | 70         | <b>51</b>      |
| 31     | 142    | 4/3       | 8/3      | 1/8       | 71                | 75         | <b>36</b>      |
| 32     | 130    | 3/5       | 8/8      | 1/6       | 77                | 84         | <b>51</b>      |
| 33     | 130    | 3/7       | 8/5      | 1/6       | 72/33             | 76         | <b>76</b>      |

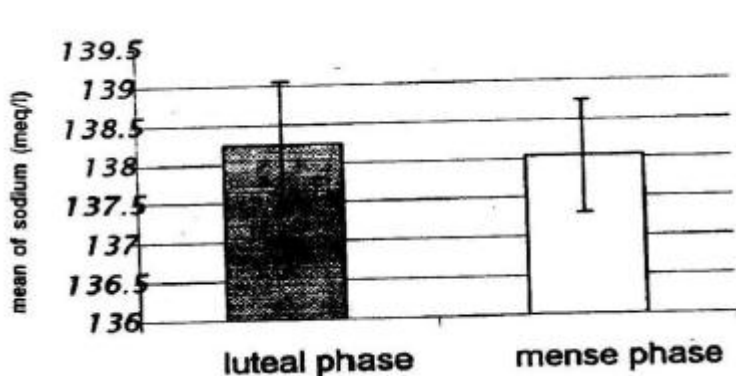
**Table 3: the statistical results of measuring the different parameters in Luteal phase.**

| Sample | Sodium | Potassium | Calcium | magnesium | arterial Pressure | Heart rate | Pulse Pressure |
|--------|--------|-----------|---------|-----------|-------------------|------------|----------------|
| n      | 33     | 33        | 33      | 33        | 33                | 33         | <b>33</b>      |
| Mean   | 138/24 | 4/58      | 8/97    | 2/11      | 81/51             | 84/24      | <b>43/54</b>   |
| SEM    | 0/81   | 0/05      | 0/05    | 0/06      | 1/30              | 1/83       | <b>1/38</b>    |

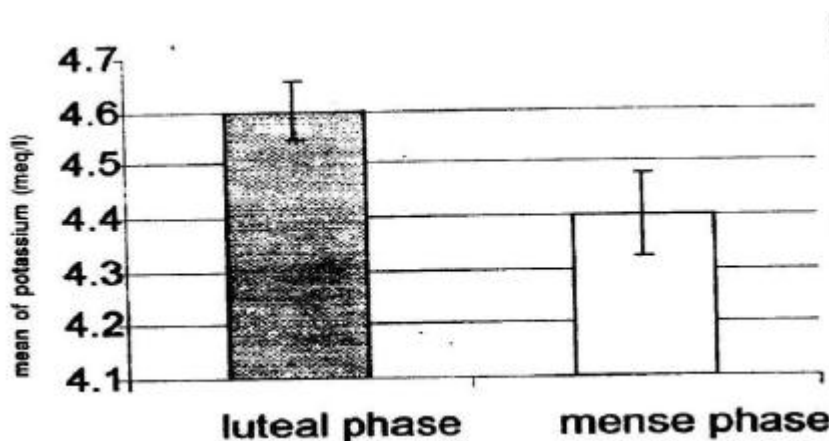
**Table 4: the statistical results of measuring the different parameters in Menstrual phase.**

| Sample | Sodium | Potassium | Calcium | magnesium | arterial Pressure | Heart rate | Pulse Pressure |
|--------|--------|-----------|---------|-----------|-------------------|------------|----------------|
| n      | 33     | 33        | 33      | 33        | 33                | 33         | <b>33</b>      |
| Mean   | 138/03 | 4/41      | 8/88    | 2/00      | 80/69             | 83/03      | <b>42/45</b>   |
| SEM    | 0/72   | 0/07      | 0/06    | 0/06      | 1/28              | 1/70       | <b>1/63</b>    |

With comparison the average Sodium amount in menstrual phase (n=33,  $138.03 \pm 0.72$ ) and Luteal phase (n=33,  $138.24 \pm 0.81$ ) in plot 1, we see the difference between two phase with  $P < 5\%$  is not meaningful. Although, the amount of Sodium is reduced in menstrual phase, but it is not significant.



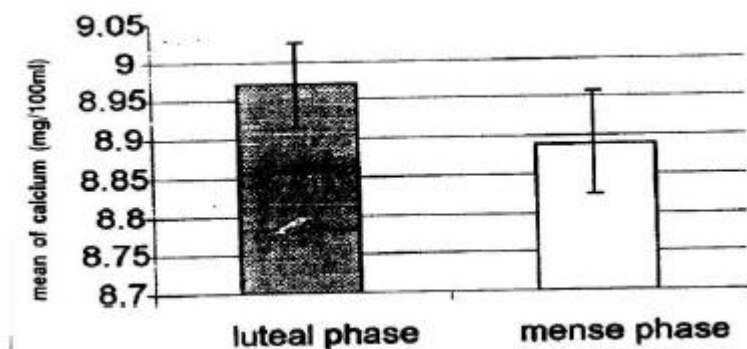
**Plot 1- the average of sodium concentration in blood in Luteal and Menstrual phases.**



**Plot 2- the average of Potassium concentration in blood in Luteal and Menstrual phases.**

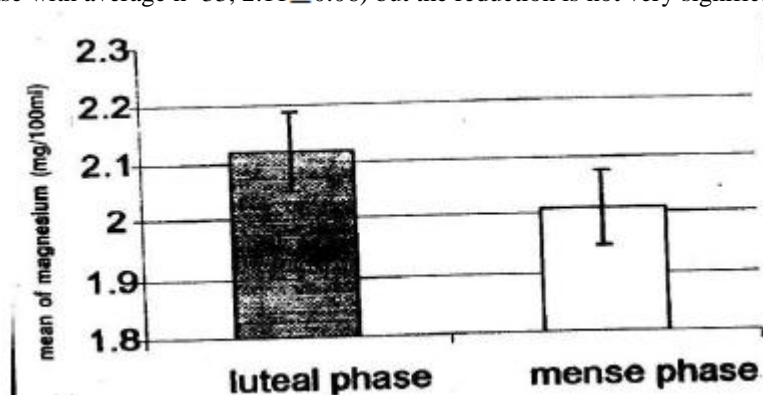


As seen in plot 3, in test of averages comparison, the average of Calcium ion in menstrual phase ( n=33,  $8.88 \pm 0.06$ ) and in Luteal phase (n=33,  $8.97 \pm 0.05$ ) doesn't show the meaningful difference in  $P < 5\%$ .



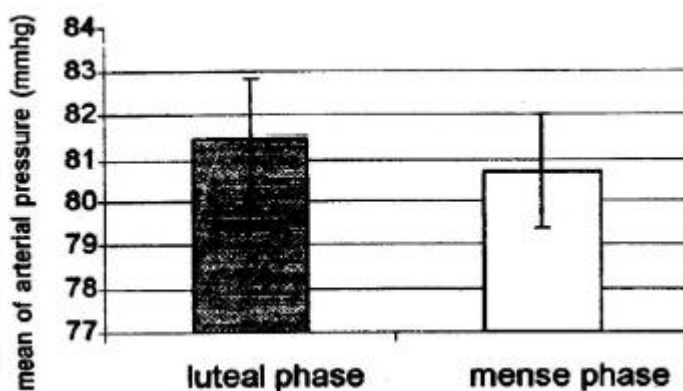
Plot3 - The average of Calcium concentration in blood in Luteal and Menstrual phases.

Although, the amount of magnesium ion in Menstrual phases, with average n=33,  $2.0 \pm 0.06$ , is decreased compared with Luteal phase with average n=33,  $2.11 \pm 0.06$ ) but the reduction is not very significant.



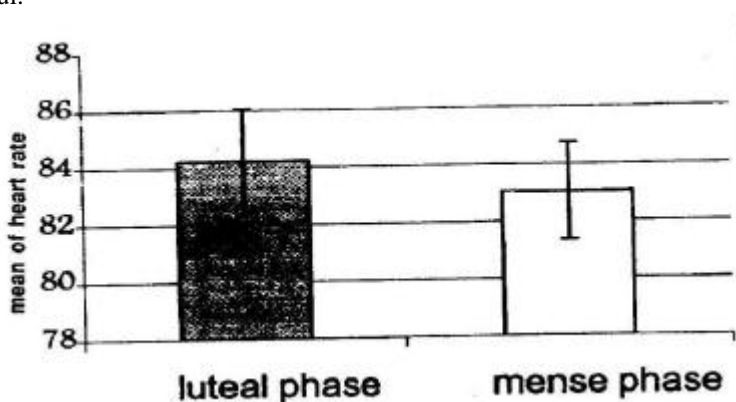
Plot 4- the average of Magnesium concentration in blood in Luteal and Menstrual phases.

As shown in plot 5, the Mean arterial pressure in Menstrual phases (n=33,  $80.69 \pm 1.28$ ) doesn't have an important difference compared with Luteal phase (n=33,  $81.51 \pm 1.30$ ) in  $P < 5\%$ .



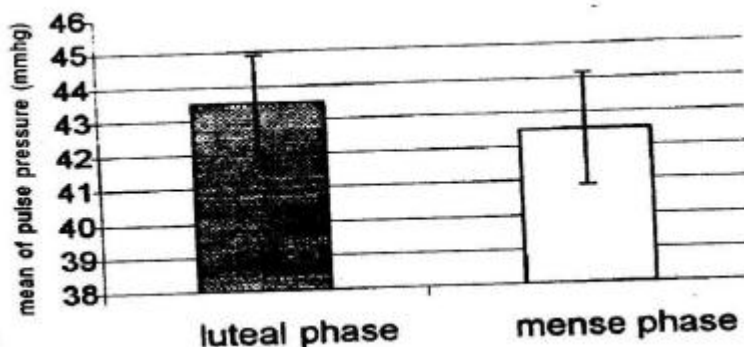
**Plot 5- Mean arterial pressure in Luteal and Menstrual phases.**

By doing the statistical tests, it is seen that the heart rate isn't so different in Luteal phase (n=33,  $83.03 \pm 01.70$ ) and Menstrual phase (n=33,  $84.24 \pm 1.83$ ) in  $P < 5\%$ . Although, a reduction is seen in Menstrual phase but it is not so meaningful.



**Plot 6- the average heart rate in Luteal and Menstrual phases.**

As you see in plot 7, the average of pulse pressure is not so statistical different in two phases, Menstrual phase (n=33,  $42.45 \pm 1.63$ ) and Luteal phase (n=33,  $43.54 \pm 1.38$ ). the pulse pressure reduced slightly in Menstrual phase.



**Plot 7- the average pulse pressure in Luteal and Menstrual phases.**

**RESULTS AND DISCUSSION**

Menstrual cycle is a result of complicated Evolutionary process in Hypothalamus, Pituitary, ovaries, and uterus. Physiological cycle changes, mainly, created by ovarian hormones. It means the estrogen and progesterone are fluctuated in Menstrual cycle (Pandya, 1995). In this research, we study the Sodium, potassium, calcium, and Magnesium ions and blood pressure and heart rate in Luteal and Menstrual phases. Obtained results show that although the amount of Sodium and potassium is reduced in menstrual phases than Luteal phase, but it is not meaningful statistically.

Dadlani shows the changes of these ions perform in ovarian phase and are greatly reduced in Luteal phase and slightly in Menstrual phase (Dadlani, 1982). In Luteal phase the amount of estrogen hormone is high. Then the estrogen can motivate the production of the hepatic Angiotensin and kidney rennin and increase the II Angiotensin synthesis and Aldosterone [A. Rostami]. Mechanisms by those the etrogens cause reducing of urine secretion are not determined. Therefore, the appropriate Sodium retention and water in Luteal phase is reported [GW. Thorne, 1938] that is result of estrogen hormone not progesterone hormone (Barlow, 1966; Brown, 1955; Smith, 1959; Zukerman, 1983). But we know the estrogen hormone is much more than estrogen in luteal phase and progesterone possesses an Antagonist role in Sodium retention than Aldosterone. It is because that progesterone has a comparison with Aldosterone receptor

protein. Probably, progesterone is combined with these receptors instead of Aldosterone and causes the sodium excretion in Luteal phase (Dadlani, 1982). Therefore, after the changes of sodium ion in Luteal phase, these effects are minimized. Considering to strong reduction of estrogen and progesterone in menstrual phase, the effect of these hormones on the sodium and potassium ions is reduced or destroyed. In this research, the concentration of ions has not changed meaningfully. These results are according to some studies that have not seen any fluctuation in electrolytes during the menstrual cycle (Klein, 1957; Newman, 1955; Roger, 1958; Vokes, 1988).

There is not significant statistical difference (in  $P=5\%$ ) about the amount of calcium between the menstrual phases and Luteal phase. Parathormone is a most important hormone to regular calcium. This hormone helps calcium re-absorption in blood by affecting on bones, kidneys, and intestine. Some studies show the effect of estrogen and progesterone on the calcium regulation (Pitkin, 1978). In others studies, it seen that amount of calcium increases when Menstruation stopped. On the other hand, despite of considerable changes in calcium regulator hormones, any considerable calcium excretion has not reported (Maleki and Demerre, 1968). In this research, important and meaningful fluctuations have not been seen and it accorded to those researches that have not shown considerable fluctuations during the Menstruation and Menstrual cycle.

The average amount of Magnesium ion in blood has not shown a noticeable change in menstrual phase than Luteal phase. Magnesium doesn't have an important role menstrual cycle regulation. However, it involves in metabolism that is changed in menstrual cycle (Patricia, 1987). In one research, it is found that Magnesium ion has the maximum amount in Luteal phase and then reduced in follicular and Menstrual phases (Pandya, 1995). The Probable changes of Magnesium can related to changes of metabolic BMR (Solomon, 1982). The increasing of Oxygen consumption and BMR in Luteal phase has been associated with increasing of carbohydrates. The carbohydrate consumption need to Magnesium ion.

In this research, related to mean arterial blood pressure, pulse pressure and heart rate don't have a significant difference in menstrual phase and Luteal phase. It found that in white women any important change has not been seen in follicular phase compared with Luteal. Whereas in black women, the Systolic pressure increases during the follicular phase compared with Luteal phase (Mills, 1996). Also, the menstrual cycle doesn't have important effect on the blood pressure and heart rate (Nozomi, 1995; C. Stoney, 1990). All of the Sodium, potassium, calcium, and Magnesium are in relation of blood pressure and heart rate. Studies show the increasing of blood pressure has the direct relation with sodium consumption. Epidemiological studies found that in societies that salt is added to food very much, there is a positive relation between total amounts of calcium and blood pressure (Resnick, 1987), while in others studies it found that increasing calcium in food causes a strong reduction in blood pressure (McCarron, 1984).

In present research, the concentration of Sodium, potassium, calcium, and Magnesium don't have meaningful change statistically. This observed for blood pressure and heart rate too. It seems ovarian hormones don't have significant impact on the ions regulator systems and the mechanisms control ions. Summary results are as follows:

- 1- The amount of sodium in Menstrual phase with average  $138.03 \pm 0.72$  is decreased compared with Luteal phase with average  $138.24 \pm 0.81$ . But this reduction is not important statistically.
- 2- The amount of potassium in Menstrual phase with average  $4.41 \pm 0.07$  is decreased compared with Luteal phase with average  $4.58 \pm 0.05$ . But this reduction is not important statistically.
- 3- The amount of Magnesium in Menstrual phase with average  $2 \pm 0.06$  is decreased compared with Luteal phase with average  $2.11 \pm 0.06$ . But this reduction is not important statistically.
- 4- The amount of calcium in Menstrual phase with average  $8.88 \pm 0.06$  is decreased compared with Luteal phase with average  $8.97 \pm 0.05$ . But this reduction is not important statistically.
- 5- Mean arterial blood pressure in Menstrual phase ( $80.69 \pm 1.28$ ) doesn't have noticeable difference compared with Luteal phase ( $81.51 \pm 1.30$ ).
- 6- The heart rate in Menstrual phase with average  $83.03 \pm 1.7$  doesn't show important difference compared with Luteal phase ( $84.24 \pm 1.83$ ).

7- Mean pulse pressure in Menstrual phase ( $42.45 \pm 1.63$ ) doesn't have noticeable difference compared with Luteal phase ( $43.54 \pm 1.38$ ).

Since in this research we study the changes of Sodium, potassium, calcium, and Magnesium ions and changes of blood pressure and heart rate in Luteal and Menstrual phases, and considering the probable effect of diets on the ion changes, which is result of harmonic changes in both phases, it suggested that more studies be performed in this field. Also, we suggest the change in mentioned ions and blood pressure and heart rate is studied in follicular and ovarian phases. Another suggestion is to investigate of relation between ions and depression level in women during the menstrual cycle, because of the effect of ions on the nervous system.

## REFERENCES

**Porter Field**, Endocrine Physiology

**Rostami A.** (1979). Physiology of identify the actions and duties of the body.

**Arefi Anbarani M.** (1952). Thesis entitled "study of NaCl and Potassium changes of blood after consuming the progestin Synthetic drugs, Tehran University, faculty of pharmacy.

**Ganong W.** Review of medical physiology

**Guyton A.** (2011). *Medical Physiology*.

**Hashemi A.** (1972). Thesis entitled "foor traphy and study of effect of Dietary factors on cuasing blood pressure diseases, Tehran University, faculty of Pharmacy.

**Barlow. J.J. and C.M. Roger. Estrogen Secretion.** (1966). Biosynthesis and metabolism. Their relationship to menstrual Cycle. *Steroid*. 1: 308- 320

**Bisson D.L., Dunster G.D., O'Hare-J.P., Hampton- D. and Penney M.D.** (1992). Renal Sodium Retention does not occur during the Luteal Phase of the menstrual cycle in normal Women. *Br. J. Obstet. Gynaecol.* 99(3): 247-52.

**Brown. J. B.** (1955). Urinary secretion of estrogen during menstrual cycle. *Lancet*. 1955 : 320-323.

**Conor E.B. Chang J.C. and Edelstein S.L.** (1994). Coffee associated osteoporosis offset by daily milk consumption. *JAMA*. 217: 280- 283.

**Christiansen C., Riss B.J., Rodro P.** (1987). Prediction of rapid bone Loss in Post menopausal women. *Lancet* 1987; 1: 1105-1107.

**Dadlani A.G., Chandwani S., Desai C.A., Pandya K.D.** (1982). Serum electrolytes during Various Phases of menstrual Cycle. *Indian J Physiol Pharmacol* 1982; 26: 302- 306.

**Daniel T. Baran, Michael P., Whyte, Mark R. Hausster, Leonard J. Deftes, Eduardo Slato Polsky and Lousi V.** (1980). Avioli Effect of the Menstrual Cycle on Calcium- Regluting Hormones in Normal young woman. 50(2): 377-379.

**Demerre L.J, Lotosky Fs** (1968). Alkaline- Phosphatase activity during menstruation. *Fertil Steril* 19: 593- 7.

**Green Spam F.S.** (1991). Basic and clinical Endocrinology. Third Editio, a loange medical book , 442-490.

**Klein and J. Carey** (1957). Total exchangeable Sodium in menstrual Cycle. *Am. J. obs. Gynec.* 74: 956.

**Michelakis A. M. , Stant E.G. and Brill A.B.** (1971). Sodium space and electrolyte excretion during the menstrual cycle. *Am. J. Obstet. Gynecol.* 109: 150- 154.

**Mccarron. D. A. and Henry. H. J.** (1984). Blood Pressure and Nutrieut In take in the united States. *Sci.* 224.



- Newman R.L.** (1995). Serum electrolytes in nonpregnant women. *obs. and Gynec.* 6: 615.
- Nozomi Sato, MA, shinji migake, PHD, Jun'Ichi akatsu MD, and Masaha Ru Kumashiro,** (1995). Power Spectral analysis of heart rate Variability in Healthy young women during the normal menstrual cycle. *Psychosomatic Medicine* 57: 331-335.
- Overman. R.P. T.S.Hill and H. Jost.** (1974). Ionic balance and Correlated Psycho – Physiological measurement in premenstrual tension states. *Federation Proceedings.* 6: 174.
- Pitkin RM. Renolds WA, Williams GA, Nargis G.K.** (1978). Calcium. Regulating hormones during the menstrual cycle. *J. Clin. Endocrin and Metabol.* 47: 626- 632.
- Patricia A.D, et al.** (1957). Magnesium and Zinc Status during menstrual cycle. *Am. J. Obs. Gynecol* 157: 964- 968.
- Pandya A.K., Chandwani S., Das T.K. and Pandya K.D.** (1995). Serum Calcium, Magnesium and inorganic Phosphorous levels during Various Phases of menstrual cycle. *Indian J Physiol. Pharmacol.* 39(4): 411- 4.
- Paul J. Mills, Richard A. Nelesen, Micheal G Ziegler, Barbaral. Parry, Charles C. Berry, Elaine Dillon. Joel E. Dimsdale** (1996). Menstrual Cycle effects on catecholamine and cardiovascular responses to acute stress in black but not while normotensive women. *Hypertension,* 27(41): 962- 967.
- Rocker R., Davies K.M., Hinders S.M. Heaney R.P., Stegman M.R. and Kimmel D.B.** (1992). Bone gain in young adult women. *JAMA.* 268: 2403- 2408.
- Roger.** Menstruation and systemic Disease. *New Eng. J. Med.* 259: 670.
- Resnick L.M.** (1987). Dietary Calcium and hypertension. *J. Nutrition.* 1987; 117: 1806- 1808.
- Solomon S.F., Kurer M.S. and Calloway D.M.** (1982). Menstrual Cycle and basal Metabolic rate in women. *Am. J. Clin. Nutr.* 36: 611- 616.
- Smith. O.W. G. V smith and N.G.** (1959). Gavian Urinary extrogen in women *Am. J. obs. Gynec.* 1959; 78: 1028- 1047.
- Sayed, M.M. and Papadakos P.J.** (1996). calcium homeostasis. *New horizons* 1996; 4(1), 2-18.
- Southam. AL. Gonzaga F.** (1965). Systemic Changes during menstrual. *Am. J. obs. Gynec.* 91: 141- 165.
- Stoney C., Owens J., Matthews K., Davis M. and Caggiula A.** (1990). Influences of the menstrual cycle on physiologic functioning during behavioral stress. *Psychophysiol.* 27: 125- 135.
- Tjellesen L, Christiansen C, Hummer L., Larsen N.E.** (1983). unchanged biochemical indices of bone turnover despite fluctuations in 1, 25 dihydroxy vitamin D during The menstrual cycle. *Acta Endocrinol (Copenh).* 102: 476- 80.
- Thorne. GW. K. R. Nelson and D. W.** (1938). Thorne Study of mechanism of oedema associated with menstruation. *Endocrinology.* 22: 155- 163.
- Vokes T. J. Weiss N. M, Schreiber, J, Gaskill M.B and Robertson G.L** (1988). osmoregulation of thirst and Vasopresin during normal menstrual cycle. *Am. J. Physiol.* 254 (4pt2) r641-7.
- Williamson P.M., Buddle M.L. and Brown M.A.** (1996). Monitoring (AMPM) in the normal menstrual cycle and in women using pressure Contraceptives. comparison with conventional blood pressure measurement. *Am. J. Hypertens.* 9(10pt 1): 953- 8.
- Zukerman S.** (1938). Water retention in the reproductive organs femal monkeys. *J. Physiol.* 94: 3.