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Original Article

Effect of increasing maximal aerobic exercise on serum gonadal hormones and alpha-fetoprotein in the luteal phase of professional female soccer players

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Abstract. [Purpose] The performance of female athletes during their menstrual period has attracted the attention of researchers for many years. It is known that the menstrual period changes with exercise. Alpha-fetoprotein (AFP) is an oncofetal protein. In this study, the effect of maximal aerobic exercise in the luteal phase on some hormones and AFP in female athletes was researched. [Subjects and Methods] Twelve volunteers and healthy female footballers with normal menstrual cycles volunteered for this study as subjects. All the participants performed a shuttle run test. Blood samples were taken before, after, and one hour after exercise. Serum AFP, estrogen, progesterone, follicle-stimulating hormone (FSH), and luteinizing hormone (LH) values were measured using an auto analyzer and original kits. Heart rate measurements were performed before and after the exercise. [Results] AFP activity had significantly decreased after 1 h of recovery from the exercise in the female soccer players, and estrogen and LH activity had significantly increased immediately after the exercise. Progesterone activity had significantly decreased immediately after the exercise. FSH values had significantly increased immediately after the exercise. [Conclusion] The results of the present study show there were significant decreases in the values of AFP, which is a cancer parameter, 1 hour after the exercise. This result may be valuable in future physiotherapy studies on the relationship between exercise and cancer.

Key words: Aerobic exercise, Alpha-fetoprotein, Female athlete

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INTRODUCTION

During the menstrual period, women experience prominent hormonal changes. The menstrual period is composed of three phases. These phases are the early follicular, follicular, and luteal phases. The hormones dominating the phases are gonadotropin releasing hormone (GnRH), follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen and progesterone. These hormones can be changed by exercise estrogen and progesterone increase after acute exercise. In the menstrual period, many of hormonal changes occur during luteal phase. Especially in this phase, progesterone and estrogen secretion is suppressed by chronic exercise[1, 8, 13, 26)]. The performance of female athletes during their menstrual periods has attracted the attention of researchers for many years. There are many studies about this subject. In general, studies have not detected any decrease in the performance of female athletes during their menstrual periods[4, 6, 10, 24)]. In this study, the effect of maximal aerobic exercise the luteal phase on some gonadal hormones and alpha-fetoprotein (AFP) in female athletes was

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researched.

AFP is an oncofetal protein. It is found in fetal maternal blood at higher rates[21]. It has a molecular weight of 70 KD is and it synthesized by the yolk sac, fetal gastrointestinal tract, and liver[20]. It is observed in high rates in neoplastic and non-neoplastic disorders[7]. Its function is not known. It is an important parameter in pregnancy follow-up as the AFP level increases in intrauterine fetal deaths, hydrocephalus, hemolytic diseases, placental separations, and neural-tube defects in pregnant women[21]. The measurement of AFP level is important for tracing prognosis and diagnosis hepatoma and germ cell tumors[18, 21]. Serum AFP is also elevated in 5–24% of malignancies of the pancreas, stomach, and colon[20]. In a 12-week study performed in 2014, Ko et al. found no change in the AFP level of women aged around seventy after 1, 3 and 5 days of an exercise program. Our study will contribute to the literature in terms of the relationship between AFP and exercise.

Estrogen is an 18-carbon corticosteroid molecule released from the ovaries of women and from the testis of men. It is primarily important for sexual development and cell proliferation. Furthermore, it is also affects the cardiovascular system, muscle skeletal system, immune system, and central nervous system. It plays a role in the repair of the skin, nervous system, and hepatic tissues. It stimulates satellite cells in skeletal muscles and triggers proliferation[2]. While the estrogen level in women is not changed by acute exercise, it is suppressed by chronic exercise[16]. Kraemer et al. found an increase in estradiol with mild exercise. During the luteal phase, the progesterone level increases and exercise triggers this increase[1, 8, 13, 26]. Nakamura et al. detected an increase in both estrogen and progesterone after exercise in the mid-luteal phase.

The hormonal responses to exercise vary in women. The menstrual disorders observed in female athletes result from differences in the release of oligomenore and amonore gonadotropin releasing hormones, and the release of FSH and LH is decreased by exercise[11].

SUBJECTS AND METHODS

Twelve healthy female soccer players with normal menstrual cycles (regular for one year, 28±2 days) were included in the study as subjects. None of the subjects was using oral contraceptives. All of the subjects were conforming to the luteal phase period (22nd and 25th day) according to body temperatures (Table 1).

The experimental protocol of this study was approved by the local ethics committee. All the subjects were informed about the purpose and risks of the study before signing a written consent. Studies were performed in accordance with the Declaration of Helsinki.

The subjects performed a shuttle test as it is a commonly used test method. The test started with slow running (8 km/h), and the subjects ran 2 meters apart from each other between two lines. The run was started with a sound signal. Then, the same distance was run again and the second run was started. The running speed was adjusted by the signals and it was increased by 0.5 km/h per minute. The test was stopped when a subject failed to follow the set pace of the "beeps" for two successive shuttles or stopped voluntarily[14]. Heart rate was measured just before and after the exercise. All the subjects who completed the test were successful. The subjects were instructed not to eat anything three hours before the exercise and not to do any sports from two days before the exercise to control the test and these conditions.

Blood samples were taken from each participant before the exercise. Posttest blood samples were taken immediately after and one hour after the exercise. The authors of this manuscript have carried out the blood sampling and testing. The samples were kept at −80 °C until the analysis. AFP, estradiol, progesterone FSH, and LH values were measured using an Enzyme-Linked ImmunoSorbent Assay (ELISA) and original kits in a laboratory.

All the measured values were input into SPSS 20.0, a computer program. Repeated measure ANOVA was used to compare AFP, estradiol, progesterone FSH, and LH serum levels at baseline and immediately and 1hour after the test. Statistical significance was accepted for values of $p<0.05$.

RESULTS

The subjects' characteristics are shown in Table 1. AFP levels had significantly decreased after 1 h of recovery from exercise in the female soccer players ($p<0.05$). In the female soccer players, estradiol and LH levels had significantly increased immediately after the exercise but had returned to resting levels after 1 h of recovery ($p<0.05$). Progesterone levels had significantly decreased immediately after the exercise but had returned to resting levels after 1 h of recovery ($p<0.05$). FSH values had significantly increased immediately after the exercise. The value of FSH1 h after exercise was lower than its value before the exercise ($p<0.05$) (Table 2). Our findings of heart rate before and after maximal aerobic exercise are shown in Table 3.

DISCUSSION

In the present study, the effects of acute maximal exercise on AFP, estradiol, progesterone, FSH, and LH in female soccer players during the luteal phase of the menstrual cycle were researched.

AFP is an oncofetal glycoprotein with a molecular mass of approximately 70 KD[17, 21]. AFP is used as a biomarker diseases. Measurements of maternal serum and amniotic fluid AFP during pregnancy are important and widely applied in

Table 1. The subjects characteristics (n=12)

Age (years)	19.6±1.3 (18–22)
Sports age (years)	5.4±0.7 (4–7)
Height (cm)	166±4.7
Weight (kg)	55.4±5.7

Table 3. Before exercise (PE) and after exercise (PSE) heart rate values (n=12)

	PE	PSE
Heart rate (pulse/min)	63.1±5	159.1±10.3*

Table 2. Repeated measure of ANOVA comparison of pre and post (immediately and 1-hour after) shuttle run test effect on hormone level (n=12)

	PE	PSE	P1HSE
AFP (ng/ml)	1.5±0.5	1.5±0.38	1.4±0.5*
FSH (mıu/ml)	5.5±2.4	6.2±2.7	5.1±2.4*
LH (mıu/ml)	4.8±3.5	5.6±3	4.9±4*
Estradiol (pg/ml)	96.7±5.5	104.2±59.1	95±58.9*
Progesterone (ng/ml)	6.4±5.9	5.4±5	6.1±6.2*

PE: before exercise, PSE: after exercise, P1HSE: one hour after exercise

screening methods for the detection of congenital anomalies of the fetus[17, 21]. Measurement of serum AFP plays an important role as a diagnostic or in screening tests for in certain malignancies. Hepatocellular carcinoma is the most frequently occurring malignant disorder for which AFP is used as a biomarker[17, 21]. Other cancer types that increase serum AFP levels are pancreatic and gastrointestinal carcinomas, and germ cell tumors of the testis or children's brains[17, 21]. AFP increases in congenital hypothyroidism and neurodegenerative disorders such as ataxia telangiectasia[17]. It is our supposition that decreases in the AFP values, a cancer parameter, taking place with exercise, could be used to determine the importance of exercise in cancer treatments. Exercise prevents age-based diseases and increases of life[16]. We found only one publication in the literature concerning the change in AFP with exercise. In a study of women aged over seventy, it was found that the AFP level did not change with exercise[5]. In our study, AFP values had decreased significantly one hour after the exercise. This result shows that exercise has benefits for women's health.

Estradiol and progesterone are gonadal hormones which decrease with aging, and this may lead to problems such as metabolic syndrome and sarcopenia[16]. Furthermore, estrogen also affects other endocrine responses during exercise[9]. While the effect of exercise on anabolic hormones is maximal in the young women with normal menstruation, estrogen and progesterone levels decrease more in the women with the menarche disorder[11, 25]. Consequently, female athletes may show menstrual disorders such as amenore (no menstruation), delay in the age of menarche, oligomenore (frequency of menstruation of more than 35 days) and insufficiency of the luteal phase[3, 12, 15, 19, 22, 23, 25]. In our study, the estrogen values had increased immediately after the exercise. This shows that acute exercise increases hormone levels in female athletes. It has been mentioned in the literature that chronic exercise suppresses estrogen and progesterone[25]. In the present study, the progesterone level had decreased 1 hour after the exercise a result that is consistent with the literature.

In female athletes, the pulsatile release of gonadotropin-releasing hormones decreases. This suppresses the release of LH and FSH from the ovaries; therefore, the release of estrogen decreases. Low luteinizing hormone levels explain menarche disorders and secondary amenore in female athletes[3, 15]. In our study, LH increased immediately after the exercise and returned to its former level after 1 hour. This may show there is a positive effect of acute exercise on LH. On the other hand, the decrease of the FSH level to under its original value 1 hour after the exercise shows that intense exercise suppresses FSH. This result is also consistent with the literature[3, 15, 19, 22, 23, 25].

In the present study the effect of maximal aerobic exercise in the luteal phase during which athletes show the most menstrual problems on FSH, LH, estradiol and progesterone hormones, and AFP was studied. The observed of suppression progesterone and FSH values is the literature consistent with other reports while the increase of estradiol and LH levels immediately after exercise shows that acute exercise can be used as a method of training for female athletes. On the other hand, the significant decrease in the value of AFP, which is a cancer parameter, 1 hour after the exercise, may be of valuable in the future studies of the relationship between exercise and cancer.

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