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The effect of physical activity on the levels of the hormones, serotonin and melatonin in premenstrual syndrome

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Summary

Objective: To determine the effects of physical activity on blood serum levels of the hormones serotonin and melatonin, which play a role in the appearance of the premenstrual syndrome (PMS) symptoms. *Materials and Methods:* The study was performed in a total number of 20 professional sports female patients who applied to the present clinic with the present diagnosis of PMS. Serum samples for serotonin and melatonin levels were taken in two terms, before and after the sport - season, and also before and after sport time in each of these terms. *Results:* Melatonin levels did not display significant change before and after the sport - season, but after physical activity, both in the period before the season and after it, it was found to be significantly increased. *Conclusion:* Effects of physical activity on blood serum levels of the hormones, serotonin, and melatonin play an important role in PMS symptoms. In the present study, which focused on 20 female professional athletes, it was found that regular exercise is effective in treating PMS symptoms.

Key words: Serotonin; Melatonin; Premenstrual syndrome; Physical activity; Sports; Depression.

Introduction

Premenstrual syndrome (PMS) is a clinical state characterized with recurrent psychological and somatic complaints that appear particularly in the luteal phase of the ovulatory cycle and disappear with the onset of menstruation [1]. Behavioral differences in emotional and cognitive processing have been reported in women with PMS, and it is of particular interest whether PMS affects the parallel execution of emotional and cognitive processing. In PMS, which is common, strong evidence exists in literature about the dysregulation of the serotonergic system [2, 3]. For diagnosis, the symptoms must be present for one or two weeks premenstrually and should subside with relief by the fourth day of menstruation, and should be documented prospectively for at least two cycles [4]. PMS symptoms like depression, mood swings, irritability, lack of self-control, anxiety, sleep disorder, aggression, decreased pain threshold, and concentration difficulties are linked to low serotonin levels, whereas serotonergic dysfunction is linked to melatonin. The effect of physical activity on the neurotransmitters is extensively studied and is well-known [5]. In the serotonin studies which were carried out in the control group with the individuals with PMS, it was shown that there was a decrease in serotonin recognising regions of the thrombocytes or in the serotonin levels premenstrually [3]. In addition, it was discovered that estrogen increases serotonergic activity, serotonergic receptor transport, and uptake activity [6-8]. Also, changed melatonin levels cause negative affective mood and sleep rhythm disorders which are among PMS symptoms [9].

In this study the authors aimed to determine the effects of physical activity on blood serum levels of the hormones serotonin and melatonin, which play a role in PMS symptoms; moreover they aimed to show that regular exercising affect these hormones even in professional athletes, considering the fact that they are already exercising on a regular basis compared to other patients.

Materials and Methods

All authors listed state that the protocol for the research project was approved by a suitably constituted Ethics Committee of the institution within which the work was undertaken. All patients were required to fill and sign a specific informed consent form detailing the study.

For PMS diagnosis, the symptoms had to be present for one or two weeks premenstrually and should have subsided with relief by the fourth day of menstruation and was documented prospectively for at least two cycles [4].

Statistical Package for the Social Sciences (SPSS) 15.0 was used for recording and archiving all data and Mann-Whitney U test was used to evaluate the data obtained in the study. Results were evaluated in a 95 % safety zone and a probability (p) value lower than 0.05 was considered to be statistically significant.

All of the patients were professional athletes with a mean body mass index score of 20.09 ± 2.48. Demographic data is distributed in Table 1.Sports-season was described as a six-month period of regular exercising, while active exercise was described as an additional 30 minutes of tap dance separate from regular exercise.

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Table 1. — *Patient demographics and general characteristics data.*

(n=20)	Mean (SD)
Age (years)	24.15±5.2
BMI (kg/m²)	20.09±2.48
Parity	1±1
Waist circumference (cm)	57.7 (7.6)

From 20 professional athletes who applied to the present clinic with the present diagnosis of PMS, serum samples for serotonin, and melatonin levels were taken in two terms, before and after the sports-season, and also before and after active exercise time in the season. For PMS-scoring, Menstrual Distress Questionnaire test (MDQ) was applied before, during, and after the menstrual period. These subjects were assigned to partake in sports activities regularly for six months. Scoring was repeated after six months. Subjects were required to perform tap dance for 30 minutes, three days a week. Blood samples were taken from the subjects to determine serotonin and melatonin levels at the beginning and at the end of the sports-season, and before beginning the exercise and after finishing it. From these samples serotonin and melatonin levels were estimated by the enzyme-linked immunosorbent assay (ELISA) technique and the measurements were given in pg/ml. The concentrations of serotonin in the serum was measured using commercially available kits. The enzymatic reactions were quantified in an automatic microplate photometer. The concentrations of melatonin in the serum were also measured using commercially available kits. The enzymatic reactions were quantified in an automatic microplate photometer. The existence of significant difference before and after the exercise were investigated with statistical repeated measure test, and the results were displayed in graphics. The data were analysed with SPSS 16.0 software package (Statistical Package for Social Sciences), Version 16.0.

Results

Melatonin levels did not display significant difference before and after the sports-season, ($p = 0.1$), but after active separate exercising, both in the period before the season and after it, it was found significantly increased ($p = 0.005$), Figure 1.

Serotonin levels, though unlike melatonin, were found to be significantly increased in both periods, before and after the sports-season, and before and after active separate exercising ($p = 0.017$, $p = 0.001$) (Figure 2).

Between the values of before the menstruation (bc), during menstruation (dc), and after menstruation (ac) MDQ scoring performed at the beginning of the season and at the end of the season showed a statistically significant difference (before the season: 154.35, 106.55, 38.15 and after the season: 111.65, 70.40, and 24.20 with $p = 0,01$, respectively). Scores were found out to be decreased at the end of the season (Figure 3).

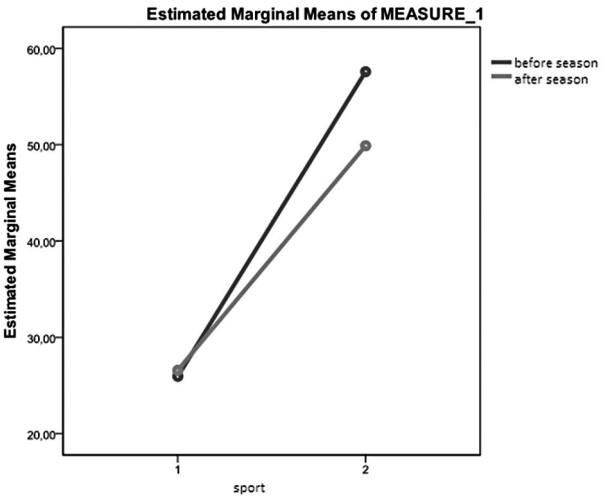

Figure 1. — Melatonin, before and after sports season.

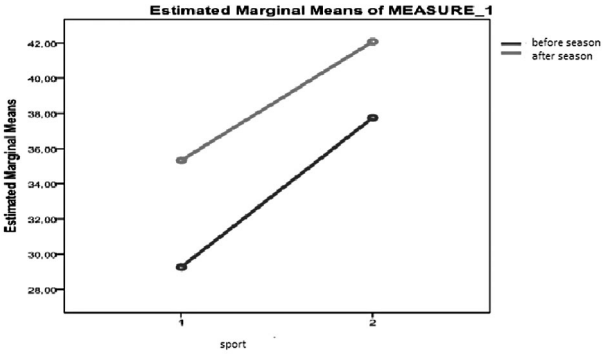

Figure 2. — Serotonin, before and after sports season.

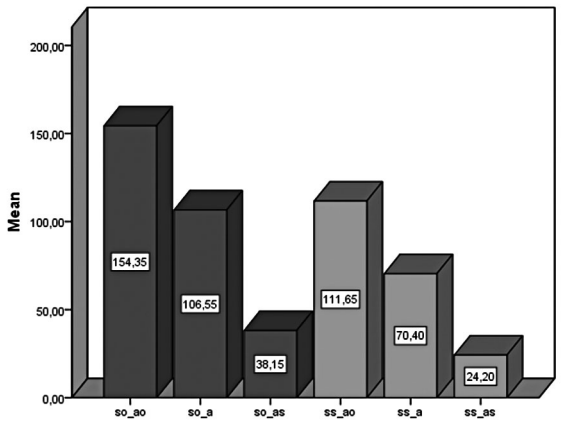

Figure 3. —MDQ scores, before cycle, during cycle, and after cycle, and before and after sports season, respectively.

Discussion

In PMS, strong evidence exists in literature about the dysregulation of the serotonergic system, and American Board of Obstetrics and Gynecology reported that regular physical exercise could help treat the symptoms of PMS. PMS symptoms like depression, mood swings, irritability, lack of self-control, anxiety, sleep disorder, aggression, decreased pain threshold, and concentration difficulties were observed to be associated with low serotonin levels [4]. The most striking behavioural effect of serotonin depletion in animal tests is an increase in irritability and aggression. Conversely it has been shown that the drugs which promote the serotonergic neurotransmission in the brain reduce aggressive behaviour in rats and mice. The positive effects of selective serotonin reuptake inhibitors (SSRI) in treating the psychological and physical symptoms of PMS have been verified by recent studies, and it has been found to be seven times more potent than placebo [10], as such there is strong evidence pointing SSRI usage in effective treatment of PMS symptoms with acceptable side-effects, but the present authors discovered that regular exercise, as nonpharmacological treatment without chemical side-effects, may actually contribute to reduction of PMS symptoms.

In order to support the serotonergic dysfunction theory that were asserted in PMS etiology, melatonin has also been associated to PMS. Melatonin is produced by the conversion of serotonin, and its levels are found to be low in women with PMS, and because of it, melatonin levels are changed during physical activity. On the other hand, it was found that after exercise, plasma lactate levels decreased in rats which were treated with melatonin, but the muscle and liver glycogen levels were increased [11]. Changes in melatonin levels induce negative mood and disturbances in sleep rhythm, which are also known PMS symptoms. In a recent study by Shechter *et al.*, the main finding was that compared to healthy controls, premenstrual dysphoric disorder (PMDD) diagnosed patients had significantly decreased melatonin secretion levels during the night-time hours. PMDD women also had a further reduction of melatonin levels during their symptomatic luteal phase compared to the asymptomatic follicular phase.

Concerning clinical implications of reduced melatonin in PMDD, the prevalence of insomnia and depression are both about twice as high in women than in men, yet the reasons for this are still not fully understood. The current results highlight the importance of considering melatonin and circadian rhythms as factors leading to PMDD, with many clinical implications. [9, 12]. The present authors have discovered in this study group that melatonin levels were increased after active exercising.

As shown in this study, physical exercise and sports, by affecting the central nervous system, increase the brain monoamines that affect mood, like dopamine, serotonin, and noradrenaline. The hypothalamo-hypophyseal axis which acts as a responding mechanism in stress conditions, is inhibited by regular long-term physical exercise [5].

Conclusion

The present authors are aware of the small size of this study group which is the main limitation of the study, but considering the fact that all the subjects were professional athletes, they believe that the results of this study to be important concerning PMS; hence it can be stated that physical activity increases low serotonin and melatonin levels, thereby treating the symptoms and it was also shown that regular exercising will increase these hormones even in professional athletes, considering the fact that they are already exercising on a regular basis compared to other patients. Therefore it is safe to conclude that regular physical exercise can be used as an effective nonpharmacological treatment method to treat PMS symptoms.

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