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Original Article / Özgün Araştırma

Investigation of Serum Levels of Selenium, Zinc, and Copper in Adolescents with Idiopathic Scoliosis

Zahide Yalaki[1], H. Mustafa Ozdemir[2], Tugba Zengin[3], Metin Işik[4]

1 Ankara Training and Research Hospital, Pediatric Clinic Ankara, Turkey
2 Acıbadem Hospital, Orthopedics and Traumatology, Ankara, Turkey
3 Ulus State Hospital, Pediatric Clinic, Ankara, Turkey
4 Ankara Vocational and Environmental Diseases Hospital, Orthopedics and Traumatology, Ankara, Turkey

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Abstract

Objective: The purpose of this study was to investigate the serum levels of selenium, zinc and copper on the etiology of idiopathic scoliosis in adolescents.

Methods: Forty four idiopathic scoliosis patients between 10 and 17 years of age were considered in this study. The vertebra curvature degrees of the patients were between 28° and 82°. The idiopathic scoliosis patients were assigned to two groups based on their vertebra curvature degrees. Curvature degree of 45° and lower was labeled as group 1 and curvature of upper 45° was labeled as group 2. Total blood count, serum levels of selenium, zinc and copper were studied.

Results: Thirty three of the idiopathic scoliosis patients (75%) were female. There was no statistically significant difference in serum zinc and copper levels between idiopathic scoliosis patients and the control group ($p > 0.05$). Serum selenium levels in idiopathic scoliosis patients were lower than that of the control group and the difference was statistically significant ($p < 0.05$). In terms of vertebra curvature degree and demographic characteristics of the patients, group 2 age average was significantly higher than that of the group 1 ($p < 0.05$). When serum selenium, zinc, and copper levels were compared based on the vertebra curvature degrees of the IS patients, no statistically significant difference was observed between group 1 and 2 in laboratory measurements ($p > 0.05$).

Conclusion: Among the measured trace elements, selenium was lower in the serum of the IS patients. This is the first study in Turkey that we know of about this subject and we think that further studies are needed.

Keywords: idiopathic scoliosis, selenium, zinc, copper

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Yazışma Adresi / Correspondence: *Correspondig Autor: Zahide Yalaki, Ankara Training and Research Hospital, Pediatric Clinic Ulucanlar, Ankara, Turkey E-mail: dr_zahide@yahoo.com*

Adolesan İdiyopatik Skolyozda Serum Selenyum, Çinko ve Bakır Düzeylerinin Araştırılması

Özet

Amaç: Bu çalışmada adolesanlardaki idiyopatik skolyozun etiyolojisinde serum selenium, çinko ve bakır düzeylerinin araştırılması amaçlanmıştır.

Yöntemler: Çalışmaya 10-17 yaş arası idiyopatik skolyozu olan 44 hasta alınmıştır. Hastaların vertebra eğrilik dereceleri 280 ile 820 arasında değişiklik göstermiştir. İdiopatik skolyozlu hastalar vertebra eğrilik derecelerine göre 450 altı (grup 1) ve 450 üstü (grup 2) eğrilikler olarak 2 gruba ayrılmıştır. Çocuklarda tam kan sayımı, serum selenyum, çinko, bakır düzeyleri çalışılmıştır.

Bulgular: İdiyopatik skolyozlu hastaların 33'ü (%75) kızdır. İdiopatik skolyozlu hastalar ve kontrol grupları arasında serum çinko ve bakır düzeylerinde istatistiksel olarak anlamlı farklılık görülmemiştir (p>0,05). İdiyopatik skolyozlu hastalarda kontrol grubuna göre serum selenyum düzeyi düşüktür ve istatistiksel olarak anlamlı bulunmuştur (p<0,05). Hastaların eğrilik dereceleri ve demografik özelliklerine bakıldığında, grup 2'nin yaş ortalaması, grup 1'e göre istatistiksel anlamlı olarak daha yüksektir (p<0,05). İdiopatik skolyozlu hastaların eğrilik derecelerine göre serum selenyum, çinko ve bakır düzeyleri karşılaştırıldığında grup 1 ile grup 2 arasında laboratuvar ölçümlerinde istatistiksel olarak anlamlı bir fark görülmemiştir (p> 0,05).

Sonuç: Eser elementlerden olan selenyum idiopatik skolyozlu hastaların serumunda daha düşük bulunmuştur. Çalışmamız bu konuda Türkiye'de yapılan ilk çalışmalardan biridir ve daha geniş çaplı çalışmalara ihtiyaç olduğu düşünülmüştür.

Anahtar kelimeler: idiyopatik skolyoz, selenyum, çinko, bakır.

INTRODUCTION

Spinal distortions, especially scoliosis, are among the most frequent orthopedic deformations observed in children and adolescents [1]. Scoliosis is generally defined as lateral curvature of vertebra on the frontal plane [2,3]. It can cause physical bends of the body as well as cardiopulmonary complications in advanced stages. At the same time, it can cause emotional anxiety and cosmetic abnormalities [4–6].

It is reported that scoliosis is observed in a wide interval, between 0.2–6%, and more frequently in adolescent girls around the world [1–4,7]. In Turkey, frequency of scoliosis was determined to be around 0.48% [5] and 0.47% [8], also more often among girls [4,5,8]. Treatment options of scoliosis differ based on the curvature degree of the vertebra. If the curvature degree is below 45°, medical and conservative treatment is preferred; if the curvature degree is over 45°, surgical treatment is considered [9].

Possibly congenital, however 75 – 80% of the scoliosis cases have no known reason (idiopathic). It may appear in a healthy child without being noticed and progress with skeleton development [4]. With early diagnosis, future complications of idiopathic scoliosis (IS) may be prevented, but its etiology is still not well known. It is thought that some biochemical, hematologic, hormonal factors may play a role in the beginning and progression of scoliosis [4,10–12].

In some studies, it was shown that essential trace elements necessary for the body (selenium, zinc, copper) have roles in synthesis of collagen and elastin and maturation of the body and therefore in the progression of IS [10,11,13]. Selenium, zinc, and copper show their functions through metalloenzymes. The absorption of these trace elements in the body, their transport in blood, and their metabolism in liver and target tissues are well known. Various studies have shown that deficiency of some trace elements, such as copper and

selenium, may cause disruptions in collagen synthesis and maturation [14–16]. Some studies suggested that selenium deficiency is a risk factor for IS [10,11,13]; recent studies have also suggested that excess selenium is also a risk factor for IS [17,18]. Consequently whether deficiency or excess of selenium is a bigger risk factor is not yet known.

Our study contributes to the literature of studies about IS conducted in various countries by reporting cases from Turkey. In our study, we evaluated scoliosis patients' serum levels of selenium, zinc, and copper that take part in IS etiology. Also, because of the different correlations found between scoliosis patients and selenium levels in recent studies, we wanted to determine the relationship between selenium levels and IS patients in our hospital.

METHODS

44 IS patients between 10–17 years of age were considered in this study. Another group of 44 patients, in the same age group, who were admitted to our pediatric clinic for different reasons were taken as the control group. Physical examination of these patients did not reveal any evidence of scoliosis. Malnutrition, malabsorption, chronic systemic illnesses were not determined in the patient group with IS.

The vertebra curvature degrees of the patients were between 28° and 82°. The IS patients were assigned to two groups based on Lenke classification [19]. According to this classification, Group 1 included patients that had 45° and lower curvature, while group 2 patients had 45° and upper curvature. Medical and surgical treatments were planned based on this grouping.

Calcium, phosphorus, alkaline phosphatase, total blood count, serum selenium, zinc and copper data obtained from the patients were studied. Atomic adsorption spectrophotometry (SPECTRAA) method was used to study selenium, zinc and copper in the plasma. The data of the study was analyzed with the SPSS 11.5 software program. The significance of the difference between means among groups was evaluated with Student's t-test and the significance of the difference between medians among groups was evaluated with Mann Whitney U test. Nominal variables were evaluated with Fisher's Chi-Square test and $p < 0.05$ was accepted as statistically significant for all results. For this study, we obtained permission from the ethics committee of our hospital on 26 October 2011 with reference number 0438.

RESULTS

33 (75%) of the IS patients were female and 11 (25%) were male. Their average age was 14.8 ± 1.7 (Table 1). There was no statistically significant difference in age and sex ratios between the IS patients and the control group.

Laboratory analysis results showed that calcium, phosphorus, and alkaline phosphatase levels in both groups were normal. Serum selenium levels in IS patients were lower than that of the control group and the difference was statistically significant ($p < 0.05$) (Figure 1). However, there was no statistically significant difference in serum zinc and copper levels between the IS patients and the control group ($p > 0.05$). There was no difference in serum selenium/albumin, serum zinc/albumin ratios between the IS patients and the control group ($p > 0.05$) (Table 1).

In terms of vertebra curvature degree and demographic characteristics of the patients, group 2 age average was significantly higher than that of the group 1 ($p < 0.05$) (Table 2). There was no statistically significant difference in terms of sex distribution among these groups ($p > 0.05$); however, 78.9% of the group 2 patients were female. Conservative treatments were applied to group 1 patients, while surgical treatments were applied to group 2 patients.

Table 1: Demographic Characteristics and Laboratory Measurement Values of Patient and Control Groups

	Patient Group (n=44)	Control Group (n=44)	p-value
Age	14.8±1.6	14.8±1.7	0.898
Sex			
Girls	33 (%75.0)	33 (%75.0)	
Boys	11 (%25.0)	11 (%25.0)	
Zinc (umol/L)	14.6	15.2	0.276
Copper (umol/L)	15.7	16.2	0.233
Selenium (umol/L)	78.0	93.0	0.012
Selenium/Albumin	18.2	19.7	0.054
Zinc/Albumin	3.2	3.3	0.238

Table 2: Demographic Characteristics and Laboratory Measurement Values within Patient Group Based on Curvature Degree

	Group 1 (n=6)	Group 2 (n=38)	p-value
Age	13.2±2.0	15.0±1.4	0.008
Sex			0.154
Girls	3 (%50)	30 (%78.9)	
Boys	3 (%50)	8 (%21.1)	
Zinc (umol/L)	12.7	14.9	0.131
Copper (umol/L)	13.9	15.8	0.907
Selenium (umol/L)	89.9	77.9	0.356
Selenium/Albumin	19.1	18.0	0.605
Zinc/Albumin	3.1	3.2	0.472

When serum selenium, zinc, and copper levels were compared based on the vertebra curvature degrees of the IS patients, no statistically significant difference was observed between group 1 and group 2 in laboratory measurements ($p > 0.05$) (Table 2).

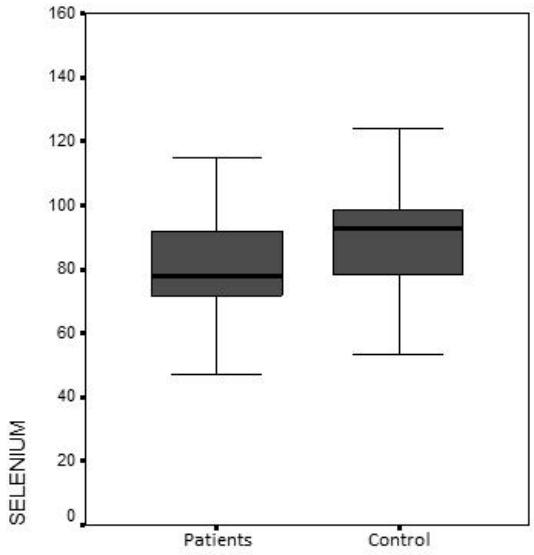

Figure 1. Selenium Level Distribution based on Patient and Control Groups

DISCUSSION

Etiology of IS is still under discussion while genetic tendency is being considered. In various studies, melatonin, thrombocyte anomalies; body asymmetry; intervertebral disc anomalies and connective tissue anomalies were suggested to have an important place in IS etiology [4,11,12,14].

Collagen and elastin are the structural components of fibril connective tissue. These are gene controlled enzymatic system products. Lysyl oxidase is the key copper dependent enzyme in the synthesis and maturation of collagen and collagen fibrils. A proper function of this enzyme system depends on the existence of all of the substrates, cofactors and sufficient quantities of multifunctional trace elements [12,13]. Se, Zn and Cu are important trace elements that take part in collagen synthesis and maturation. Se and Zn are transported by binding to albumin in the body. Their absorption decreases in cases of malabsorption and malnutrition [20,21]. Similarly, Zn/Cu ratio is an indication of malabsorption and it decreases in cases of protein energy malnutrition, malabsorption, and chronic systemic illnesses [22,23]. In our

study, evaluation of patients did not reveal indications of malnutrition and malabsorption; Zn/Cu, Se/Albumin, and Cu/Albumin levels were normal.

Data analysis revealed that, of the trace elements, selenium was lower in the serum of the IS patients compared to the control group, while serum zinc and copper levels and zinc/copper ratios were found to be normal. When similar studies in the literature were reviewed, these findings were supported. However, interpretation of the risks associated with various serum selenium levels is far from certain. The cause of selenium deficiency is not well known, however, some authors suggest low levels of selenium in the soil and environment may be a factor [15,24]. Variations in selenium levels in the environment may be the cause of selenium deficiency in our patients as well.

In some studies, serum selenium levels were found to be low in the scoliosis patients [10,13,14]. In a study for example, selenium levels both in the serum and in hair samples were found to be low in IS patients [14]. Dastych et al. compared vertebra curvature levels with serum selenium, zinc, and copper levels in their study and found that patients with more than 45° curvature who required surgical treatment had significantly lower levels of serum selenium and serum/albumin ratio compared to patients with less than 45° curvature [10]. In our study, we did not find statistically significant difference between curvature levels and serum levels of selenium, zinc, and copper; however, we found that serum selenium levels in IS patients were significantly lower compared to the control group.

Contrary to other studies, in an experimental study, Yang et al. suggested that high level of selenium is also a risk factor for IS [17]. In some studies, it is reported that high selenium levels in the environment could be a risk factor for scoliosis. In a study about fish, Lemly et al. reported that pollution caused by a thermoelectric power plant produced high levels of selenium in a lake in the USA. This pollution was linked to observed scoliosis in the fish found in the lake [25]. In another study, Ji et al. reported that two towns in China have the highest levels of environmental selenium in the world. In these towns, IS is observed more often in adolescents [18]. These results show that changes in selenium levels is an important risk factor in IS development. However, it is not clear whether the deficiency of selenium, based on Datch et al. study and our study, or, the excess of selenium is a more important risk factor. This situation merits wider studies.

In the study, conducted by Dastych et al., copper levels and zinc/copper ratios in IS patients' serums were found to be low; however, difference was not statistically significant [10]. In another study, serum copper and zinc levels were found to be normal in IS patients [13]. In a different study conducted by Dastych et al., copper levels in the back muscles of IS patients were found to be low, but no significant difference was found in hair, leucocyte, and serum compared to the control group [26]. In our study, IS patients' serum zinc and copper levels and zinc/copper ratios were found to be normal.

As a result, we determined that, of the trace elements, selenium was lower in the serum of the IS patients. This is the first study in Turkey that we know of about this subject and we think that further studies are needed. At this point, because of contradictory results in the literature, we cannot suggest that selenium support should be given in the early childhood period to prevent selenium deficiency. However variations in selenium levels may be considered a risk factor of adolescent scoliosis. More studies are needed in this subject.

LIMITATION OF THE STUDY

The main limitation of this study is the time-limited monitoring of the trace element levels of the patients. The trace elements were measured during the time of application to our hospital, but since the histories of the patients are not known until they apply to a hospital, long-term monitoring of their trace element levels is difficult. We also did not measure vitamin D levels in patients, which are considered to be another factor that may influence IS development.

The study was presented at 49. Turkish Pediatric Congress (İstanbul 2013)

Declaration of Conflicting Interests: The authors declare that they have no conflict of interest.

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