Assessment of Serum Levels of Copper, Magnesium, and Zinc in Patients Infected with *Trichinella britovi*

*Trichinella britovi* ile Enfekte Hastalardında Serum Bakır, Magnezyum ve Çinko Seviyelerinin Değerlendirilmesi

**ABSTRACT**  **Objective:** *Trichinella britovi* is found in many species of carnivores and omnivores. *T. britovi* occurs in Eurasia and there are also studies on trichinellosis in Turkey showing the outbreak of trichinellosis, which occurred in İzmir, between January and March 2004. It was aimed to investigate the changes of level of the essential elements of copper, magnesium and zinc status in cases of trichinellosis. **Material and Methods:** This research has focused mainly on the relationship of copper, magnesium and zinc contents in human serum with *Trichinella* infection. Subjects were selected from anti-*Trichinella* IgG ELISA positive patients (48 patients, 24 controls). The parasite species was diagnosed from the deltoid muscle biopsy specimen using PCR and it was confirmed as *T. britovi*. The copper, magnesium and zinc concentrations of serum samples were determined using Zeeman atomic absorption spectrometry. **Results:** There was significantly higher serum magnesium concentration in both female and male patients than in controls. However, there was no significant difference in female and male patients’ serum copper and zinc concentrations as compared with the controls. **Conclusion:** The increased magnesium levels clearly suggest that pathophysiology of trichinellosis may effect on element status and accordingly in human health.

**Key Words:** *Trichinella; copper; magnesium; zinc*

**ÖZET** **Amaç:** *Trichinella britovi* carnivor ve omnivor canlıların bir çok türünde bulunur. *T. britovi*, özellikle avrasya bölgesinde görülür. Bu çalışmada amaç temel olarak trichinellosisli hastalarda meydana gelen eser element seviyelerindeki değişiklikler bakır, magnezyum ve çinko elementleri üzerinden değerlendirilmektedir. **Gereç ve Yöntemler:** Çalışmaya alınan anti-*Trichinella* IgG ELISA pozitif hastalardan seçilmiştir (48 hasta, 24 kontrol). Hasta deltoid kas biyopsi numuneleri PCR ile analizi sonucu *T. britovi* olarak belirlenmiştir. Serum örneklerindeki bakır, magnezyum ve çinko seviyeleri Zeeman atomik absorbsiyon spektrofotometre kullanarak tespit edilmiştir. **Bulgular:** Serum zinc ve magnezyum konsantrasyonları kontrol grubunda daha yüksek bulunmuştur (p<0.05). Bu çalışmada hasta kadın ve erkeklerin serum bakır ve çinko konsantrasyonları kontrol grubu ile karşılaştırıldığında istatistiksel olarak anlamlı fark gözlenmemiştir (p>0.05). **Sonuç:** *Trichinella* hastalığında magnezyum ve bakır seviyelerinin femme ve erkek hastalar arasında anlamlı bir fark gözlemlenmemiştir. **Anahtar Kelimeler:** *Trichinella britovi; bakır; magnezyum; çinko*


Trace elements have been extensively studied in recent years to assess whether they have any modifying effects in the aetiology of diseases. Although it has been previously reported that some other diseases change the concentration of trace elements in humans, there are no...
reports on the effects of trichinellosis on the serum levels of any elements.

Trichinella britovi is a parasitic nematode. The life cycle of the parasite begins when the infectious capsules are eaten with the flesh of any meat-eating animal. The capsules are digested and the liberated larvae invade the small intestine. The female hatches larvae are carried by the blood and lymph to the muscles.7,8

Trichinellosis is probably best known as a parasitic infection that humans contract from eating raw or undercooked meat. Trichinellosis is caused by the colonisation of Trichinella larvae in muscles where they grow in encapsulated. Severe symptoms are likely if the levels exceed 100 larvae per gram of muscle.9 Many cases are never diagnosed, but, nausea, dysentery, colic can be observed. In addition, migrating larvae causes pain as they invade muscle tissue, there may also be oedema, delirium, cardiac and pulmonary difficulty, pneumonia, nervous disorders, deafness and delayed or lost reflexes due to invasion.10

Copper is needed by a variety of key systems in the body. It is required for numerous enzymes necessary for reproduction, immunity and growth. In addition, copper is necessary for proper metabolism of iron, maintenance of connective tissue, pigmentation of skin and hair, maturation of hoof tissue, and many other functions.11 Magnesium is needed for more than 300 biochemical reactions in the body. It helps to maintain normal muscle and nerve function, bone strength and to keep heart rhythm steady. It is also involved in energy metabolism and protein synthesis.1 Zinc is an essential element found in almost every cell. It stimulates the activity of several enzymes, which promote biochemical reactions in the body. Zinc supports a healthy immune system, is needed for wound healing, helps to maintain sense of taste and smell, and is needed for DNA synthesis. Zinc also supports normal growth and development during pregnancy, childhood, and adolescence.12

There are limited number of studies available on element level changes relating to the parasite infections. This will be the first study evaluating the levels of elements’ changes during the T.brito-vi infection.13-15 The aim of this study was to determine a possible relationship between trichinellosis and copper, magnesium and zinc level changes, i.e., whether trichinellosis might have a modifying effect on these trace elements level. For this we investigated serum concentrations of copper, magnesium and zinc levels in 48 patients with trichinellosis and compared the results with those of 24 healthy controls.

**MATERIALS AND METHODS**

**PATIENTS**

It was assayed copper, magnesium and zinc levels of 72 subjects in human serum aged between 3 and 62 years (39 males and 33 females). Patients were included the history of raw pork eaten subjects (via eating raw meatball, a special Turkish food which was normally made of raw beef, but the patients were had these raw meatballs without knowing that they have made of pork) and with the symptoms of trichinellosis during the outbreak of trichinellosis in Izmir between January and March 2004. Diagnosis of patients were confirmed with myalgia, weakness, malaise, arthralgia, jaw pain, fever, peri-orbital and/or facial oedema, oedema at the trunk and limb, abdominal pain, nausea and vomiting and diarrhoea complaints as indicated previous study.16

Serum copper, magnesium and zinc levels were studied in patients with T. britovi between the twentieth-thirtieth days after they had eaten raw meatballs deceptively made of pork.

These patients had tested positive for serologic and laboratory results for trichinellosis. All patients were positive for anti-Trichinella IgG ELISA (Ridascreen-Biopharm). The parasite species detection were performed from the deltoid muscle biopsy specimen PCR by Dr. Edoardo Pozio (International Trichinella reference center, Rome, Italy) and confirmed as T.britovi.

Serum samples for control group were obtained from healthy people who had come to the different departments of Ataturk Training Hospital for regular check-up and students or employees of the hospital. All subjects fasted after midnight be-
fore blood collection in the next morning. Forty-eight patients and 24 controls were examined in this study. The mean age of the patient group was 25 men (aged 27±13 years) and 23 women (aged 33±14 years). The mean age of the control group was also 14 men (aged 31±10 years) and 10 women (aged 29±16 years).

**ASSAY**

All venous blood samples were taken between 8 am and 9 am after 8 h of fasting and collected in polystyrene tubes. The tubes were centrifuged at 400 × g for 15 min. Sera were then removed and stored at -20ºC until analysis.

The copper, magnesium and zinc concentrations of serum samples were determined using Zeeman atomic absorption spectrometry (Hitachi Z-8000 model). Standard solutions were freshly made from standard stock solutions containing 1 g Cu/L, 1 g Mg/L and 1 g Zn/L. Serum samples were prepared by dilution with deionized distilled water (serum in a dilution of 1:5). We matched the viscosity of the standard solutions to viscosity of diluted serum by adding an appropriate amount of glycerol. The total levels of copper, magnesium and zinc in the samples were determined by the regression analysis of the sample absorption data on the standard curve.

**STATISTICAL ANALYSIS**

Statistical analysis was performed with SPSS software package (Version 10.0 for Windows). Data were expressed as mean ± standard deviation (SD). For comparison of 2 groups of continuous variables, independent samples t-test was used. A probability value of p < 0.05 indicated a statistically significant difference.

**RESULTS**

Magnesium levels were comparable in both male and female patients and controls. Magnesium was above the normal range in female patients (5,8±1,2) and male patients (6,1±1,4) compared to female controls (4,4±0,9) and male controls (4,5±0,6), respectively (p < 0.05). Copper, magnesium and zinc scores are given in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Patients</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Male (25)</td>
<td>Male (14)</td>
</tr>
<tr>
<td></td>
<td>27 ± 13</td>
<td>31 ± 10</td>
</tr>
<tr>
<td>Copper (µg/L)</td>
<td>155 ± 32</td>
<td>128 ± 33</td>
</tr>
<tr>
<td>Magnesium (mg/L)</td>
<td>5,1 ± 1,4</td>
<td>4,5 ± 0,6</td>
</tr>
<tr>
<td>Zinc (µg/L)</td>
<td>111 ± 25</td>
<td>101 ± 26</td>
</tr>
<tr>
<td></td>
<td>Female (23)</td>
<td>Female (10)</td>
</tr>
<tr>
<td></td>
<td>33 ± 14</td>
<td>29 ± 16</td>
</tr>
<tr>
<td>Copper (µg/L)</td>
<td>150 ± 21</td>
<td>139 ± 37</td>
</tr>
<tr>
<td>Magnesium (mg/L)</td>
<td>5,8 ± 1,2</td>
<td>4,4 ± 0,9</td>
</tr>
<tr>
<td>Zinc (µg/L)</td>
<td>91 ± 15</td>
<td>98 ± 16</td>
</tr>
</tbody>
</table>

There was no significant difference in serum copper and zinc concentrations between patients and control groups both in females and males (p> 0.05).

**DISCUSSION**

Human growth and development is strictly dependent on copper, magnesium and zinc. The nervous, reproductive and immune systems are particularly influenced by copper, magnesium and zinc deficiency, as well as by increased levels of copper, magnesium and zinc.1,2,11 In the present study, serum levels of copper, magnesium and zinc were estimated in 48 patients with trichinellosis and 24 age-and sex-matched controls.

*T. britovi* occurs in Eurasia. There are also studies on trichinellosis in Turkey such as showing the outbreak of trichinellosis, which occurred in Izmir, between January and March 2004.16 It is common in sylvatic carnivores, and occasionally infects domestic animals. Trichinellosis can occur at 2 stages of infection: in the muscle and in the intestines. Trichinellosis is caused by the colonization of *Trichinella* larvae in muscles where they grow in encapsulated. Severe symptoms are likely when the number of parasites increases. Capsules may be difficult to see with the naked eye; however, active muscles such as the tongue, diaphragm and muscles of the jaw usually contain the highest concentrations of infective larvae. Muscle tissue containing larval capsules was used for diagnosis.9
The most effective way to prevent trichinello-
sis is cooking meat thoroughly. Freezing could be
effective if carried out properly. Several safe and
effective prescription drugs are available to treat
trichinellosis. Treatment should begin as soon as
possible and the decision to treat is based on symp-
toms, exposure to raw or undercooked meat, and
laboratory test results.10

Magnesium is an important electrolyte needed
for proper muscle, nerve, and enzyme function. It
also helps regulate energy production in cells and is
needed to move other electrolytes (potassium and
sodium) into and out of cells.4 Copper and zinc are
required for the normal functioning of humans.
They are incorporated into a variety of organics,
which perform specific metabolic functions. Beca-
use they are essential elements, daily dietary re-
quirements have been recommended by a number of
agencies.5,17,18

In compare to our results with the results from
the other parasite infections show that elements
status changes show difference from one parasite
infection to other; such as; in patients with cystic
echino-coccosis the mean serum levels of zinc and
magnesium were lower and the mean serum level
of copper was higher in the preoperatory period
when compared with the control. It has been fo-
und that as duration of symptoms increased, serum
zinc and magnesium levels decreased but copper
levels increased.13

However, the mean concentration of copper,
magnesium, and zinc in blood has also showed no
statistically difference in Taenia saginata-positive
patients and in their controls.14 In addition, inves-
tigation of zinc, iron, copper, cobalt, magnesium,
and selenium levels in patients infected with intes-
tinal parasites, Giardia intestinalis and Enterobius
vermicularis have demonstrated that element sta-
tus were either increasing or decreasing and also
some of element status were correlated each others
but some of them uncorrelated.15

The present study shows that both copper and
zinc but not magnesium, have seems as biomarkers
of disease progression. However, although the
exact mechanism responsible for the alteration of
magnesium levels is not clear, it is clear that there
is an obvious increase in magnesium levels in pa-
ients compared to controls and a detailed study on
a large sample size is therefore needed. As a result,
in the present study, the rise of magnesium in the
blood is probably due to insufficient uses of magn-
sium in body. Signs of excess magnesium can be si-
milar to magnesium deficiency and include psy-
chological changes, nausea, diarrhoea, appetite
loss, muscle weakness, breathing difficul-
ties, extremely low blood pressure, and irregular
heartbeat. Inhibition of consumption of magnesi-
un by T. britovi may also play a role in serum mag-
nesium increase. These findings clearly suggest that
trichinellosis may affect element metabolism.

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