Circulating mineral element concentrations in Sakiz crossbred lambs with pica disorder

I. AYTEKİN1, A. C. ONMAZ2*, A. KALINBACAK3, S. U. AYPAK4, H. ALP5

1Department of Internal Medicine, Faculty of Veterinary Medicine, Mustafa Kemal University, 31040 Hatay, TURKEY.
2Department of Internal Medicine, Faculty of Veterinary Medicine, Erciyes University, 38090 Kayseri, TURKEY.
3Department of Internal Medicine, Faculty of Veterinary Medicine, Ankara University, 06110 Ankara, TURKEY.
4Department of Biyokimya, Faculty of Veterinary Medicine, Adnan Menderes University, 09016 Aydın, TURKEY.
5Department of Pharmacology, Faculty of Veterinary Medicine, Erciyes University, 38090 Kayseri, TURKEY.

*Corresponding author: aconmaz@erciyes.edu.tr

SUMMARY

The aims of this study were to determine the serum calcium, phosphorus, magnesium, copper, iron and zinc concentrations in lambs with pica disorder, and to evaluate the efficiency of mineral preparation as treatment. The study was performed on 25 Sakiz crossbred lambs, 1-2 months old, whose 15 lambs exhibiting clinical signs for pica (soil eating, surface licking, wool-eating, weight loss, development retardation and a strong desire to eat non-food objects) and 10 were apparently healthy. Blood samples were taken for measuring serum concentrations of minerals and trace elements 5 days before and after treatment with a vitamin-mineral combination (Kalmina® VILSAN, 0.3 ml/kg, IV). Whereas serum Ca, Mg, P, Cu and Zn concentrations did not significantly differ between affected and healthy lambs, it was observed a marked decrease of iron concentration ($P < 0.05$) in all animals with pica. After Kalmina® injection, clinical signs of pica totally disappeared in 67% of diseased lambs (10/15) and a significant increase of P concentrations compared to initial values ($P < 0.05$) was observed associated with a slight and not significant increases of serum Cu and Zn concentrations. The sideremia was also significantly enhanced ($P < 0.05$) but remained below control values, particularly in the 5 lambs which still presented an abnormal behaviour. Consequently, it was concluded that iron deficiency may play an important role for the aetiology of pica and the mineral element supplementation could be beneficial for the treatment of lambs with pica.

Keywords: Pica, lambs, minerals, trace elements, iron deficiency, treatment.

RÉSUMÉ

Les objectifs de cette étude étaient de déterminer les concentrations sériques de calcium, phosphore, magnésium, cuivre, zinc et de fer chez des agneaux atteints de pica et d’évaluer l’efficacité thérapeutique d’une préparation minérale. L’étude a été conduite sur 25 agneaux croisés Sakiz âgés de 1 à 2 mois, dont 15 présentaient des signes cliniques de pica (léchage des surfaces, grignotage du sol et de la laine, perte de poids, retard de développement, et une forte envie de manger des objets non alimentaires) et 10 étaient apparemment en bonne santé. Des échantillons de sang ont été prélevés en vue de mesurer les concentrations sériques en minéraux et oligo-éléments 5 jours avant et après traitement par injection intraveineuse d’une combinaison de vitamines et de minéraux (Kalmina® VILSAN, 0.3 ml/kg). Alors que les concentrations sériques en Ca, Mg, P, Cu et Zn n’ont pas varié de façon significative entre les agneaux atteints et les agneaux sains, une diminution marquée de la sidérémie ($P < 0.05$) a été observée chez tous les animaux présentant du pica. Après injection de Kalmina®, les signes cliniques ont totalement disparu sur 67 % des agneaux malades (10/15) et une augmentation significative de la concentration en P par rapport aux valeurs initiales ($P < 0.05$) a été observée, couplée à des élévations faibles et non significatives de la cuprémie et de la zinçémie. La sidérémie a également significativement augmenté ($P < 0.05$) mais elle est restée inférieure aux valeurs observées chez les contrôle, particulièrement chez les 5 agneaux qui ont encore présenté un comportement anormal. On peut donc conclure de cette étude qu’une carence en fer semblable jouer un rôle important dans l’étiologie du pica et qu’une supplémentation alimentaire en minéraux pourrait être bénéfique dans le traitement du pica chez les agneaux.

Mots clés : Pica, agneaux, minéraux, oligo-éléments, carence en fer, traitement.

Introduction

Living organisms need minerals as well as essential nutrional elements to continue their normal development. Deficiency of mineral elements was reported to cause soil eating, surface licking, a desire to eat non-food objects, weight loss and decrease in body resistance to infections because of the affected immunity system [3]. Signs of mineral element deficiency are known to appear over a long period of time, and generally disappear shortly after supplementation with the necessary mineral elements, then, animal condition and performance improve, as well [3, 16, 18].

Pica is a metabolism disorder characterized with the symptoms such as surface licking, soil and non-food object eating (wool, hear, bone, wall, etc). It has been reported for calf, sheep, cattle, camel and pig [1, 3, 18]. There are many reasons effective in the aetiology of pica, which are mainly the deficiency in some proteins, α-amino-acids, vitamins and trace elements as well as reduction in alkali reserve of body, unbalanced dietary calcium-phosphorus ratio and phosphorus deficiency [3, 5, 18]. Soil eating behaviour is regarded as a different form of pica in mammals and thought to be caused by the deficiency of certain elements like phosphorus, iron, sodium, magnesium, sulphur, cupper, cobalt and manganese [3, 16, 18]. In fact, offspring of cattle and sheep that were not
given sufficient mineral elements during gestation period were observed to have soil eating habit [13].

The causes of pica are often difficult to identify. The objective of this study was to determine blood calcium, phosphorus, magnesium, cupper, zinc and iron concentrations found in lambs with pica and in healthy controls of the same age. Another objective of this study was to investigate the effects of mineral preparations on the treatment of pica in lambs.

Materials and Methods

ANIMALS AND TREATMENTS

A total of 25 Sakız crossbred lambs (15 lambs with pica disorder and 10 healthy lambs), 1-2 months old, were included in the study. The healthy lambs were apparently healthy and had no clinical sign of any disease.

Blood samples were taken from vena jugularis puncture 2 times (in pre- and post-treatment periods, respectively) in lambs with pica and only one time in healthy lambs. After blood collection in sterile tubes without anticoagulant, clotting for one hour at 4°C and centrifugation (3 000 g, 4°C, for 10 minutes), sera were carefully harvested and stored at -20°C until analysis.

A vitamin-mineral combination (Kalmina® VİLSAN, 0.3 ml/kg) was given intravenously (IV) to lambs with pica. One ml of Kalmina® contains 300 mg calcium gluconate, 65 mg calcium hypophosphite, 50 mg potassium iodide, 19.64 mg magnesium chloride 6H2O, 4.282 mg potassium chloride, 12.96 mg iron (II) chloride 4H2O, 0.164 mg cobalt (II) chloride 6H2O, and 0.1355 mg zinc chloride. Clinical examination and biochemical assessment of the lambs were carried out 5 days before and after the treatment.

COMPLEMENTARY ANALYSES

Serum calcium, phosphorus, magnesium, cupper, zinc and iron concentrations were measured using commercial equipments in Shimadzu UV-1601 UV Visible Spectrophotometer of the Biochemistry Department of Veterinary Faculty, Adnan Menderes University, Turkey.

Statistical Analysis

Data were analysed with the SPSS 15.0 statistical package programme (SPSS Inc, Chicago, Illinois USA). Tukey test was performed for the statistical analysis of biochemical results. Statistical significance was considered when $P < 0.05$. The results are expressed as means ± standard deviations.

Results

CLINICAL FINDINGS

The following symptoms were observed before treatment in the 15 lambs with pica disorder: soil eating, wool eating, weight loss, development retardation, surface licking and a desire to eat non-food objects.

Pica disorder indications such as soil eating, surface licking and wool eating known to be caused by mineral element deficiency totally disappeared in 10 lambs after treatment; however, 5 lambs showed occasional surface licking behaviour.

BIOCHEMICAL FINDINGS

As shown in Tables I and II, the serum iron concentration was dramatically depressed in lambs with pica before treatment compared to control values ($P < 0.05$); all diseased animals exhibited values below 21.53 $\mu$mol/L (corresponding to the mean - 1.96 x standard deviation calculated in healthy lambs). By contrast, the other biochemical parameters investigated in the study (serum Ca, Mg, Cu and Zn concentrations) were not significantly altered in the group of animals with pica. Nevertheless, the serum phosphorus concentrations appeared slightly increased in 73.3% lambs with pica (11/15) when mean + standard deviation was chosen as cut-off value (Table II) but the difference with the control group was not significant.

<table>
<thead>
<tr>
<th>Biochemical parameters</th>
<th>Healthy lambs (control, n = 10)</th>
<th>Lambs with pica (n = 15)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before treatment</td>
<td>After treatment</td>
<td></td>
</tr>
<tr>
<td>Ca (mmol/L)</td>
<td>2.89 ± 0.06</td>
<td>2.92 ± 0.05</td>
<td>3.01 ± 0.05</td>
</tr>
<tr>
<td>P (mmol/L)</td>
<td>2.36 ± 0.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.51 ± 0.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.97 ± 0.04&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mg (mmol/L)</td>
<td>0.83 ± 0.05</td>
<td>0.86 ± 0.04</td>
<td>0.89 ± 0.04</td>
</tr>
<tr>
<td>Fe (μmol/L)</td>
<td>25.41 ± 1.98&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.35 ± 1.30&lt;sup&gt;c&lt;/sup&gt;</td>
<td>18.30 ± 1.05&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cu (μmol/L)</td>
<td>16.54 ± 1.77</td>
<td>17.96 ± 1.52</td>
<td>20.04 ± 1.74</td>
</tr>
<tr>
<td>Zn (μmol/L)</td>
<td>17.67 ± 1.68</td>
<td>17.09 ± 0.98</td>
<td>20.15 ± 1.25</td>
</tr>
</tbody>
</table>

NS: not significant.

Different superscripts <sup>a, b, c</sup> in the same line indicate significant difference ($P < 0.05$).

Table I: Serum concentrations of mineral and rare elements in lambs with pica (n = 15) before and after treatment with a vitamin-mineral combination (Kalmina® VİLSAN, 0.3 ml/kg, IV) and in healthy lambs (n = 10). Results are expressed as mean ± standard deviations.
Biochemical parameters | Before treatment | After treatment
---|---|---
Ca | > C.O.1: 2.95 mmol/L | 7/15 | 8/15
| > C.O.2: 3.01 mmol/L | 5/15 | 8/15
P | > C.O.1: 2.46 mmol/L | 11/15 | 15/15
| > C.O.2: 2.56 mmol/L | 7/15 | 14/15
Mg | > C.O.1: 0.88 mmol/L | 5/15 | 8/15
| > C.O.2: 0.93 mmol/L | 4/15 | 6/15
Fe | < C.O.1: 23.43 μmol/L | 15/15 | 13/15
| < C.O.2: 21.53 μmol/L | 15/15 | 13/15
Cu | > C.O.1: 18.31 μmol/L | 8/15 | 8/15
| > C.O.2: 20.01 μmol/L | 6/15 | 6/15
Zn | > C.O.1: 19.35 μmol/L | 4/15 | 9/15
| > C.O.2: 21.03 μmol/L | 3/15 | 4/15

C.O.1: Cut-off value 1 (mean ± standard deviation); C.O.2: Cut-off value 2 (mean ± 1.96 x standard deviation)

TABLE II: Proportions of lambs with pica exhibiting abnormal values of serum concentrations of mineral and rare elements [values inferior or superior to the cut-off values calculated from healthy lambs as mean ± standard deviation (cut-off value 1) or as mean ± 1.96 x standard deviation (cut-off value 2)] before and after treatment with a vitamin-mineral combination (Kalmina® VILSAN, 0.3 ml/kg, IV).

Five days after treatment with a vitamin-mineral combination (Kalmina®, 0.3 ml/kg, IV), whereas serum concentrations of divalent cations (Ca and Mg) remained stable, those of some rare elements (Cu and Zn) weakly increased in treated lambs but not significantly compared to values before treatment and to control values (Table I); however, these concentrations exceeded 20.01 μmol/L for Cu and 20.96 μmol/L for Zn in 40.0% and 26.7% of lambs treated for pica, respectively (Table II). The sideremia has significantly increased after treatment compared to basal values (P < 0.05) but it remained markedly depressed compared to control values (P < 0.05), 86.7% (13/15) of treated lambs still exhibiting very low values (<21.53 μmol/L). Finally, a significant increase of serum P concentrations compared to basal values and to control values (P < 0.05) was observed after treatment, 93.3% of lambs presenting values above 2.56 mmol/L (mean + 1.96 x standard deviation) (Tables I and II). Furthermore, serum Fe concentrations were markedly depressed (< 21.53 μmol/L) in the all lambs (n = 5) still exhibiting some clinical signs despite treatment, whereas P concentrations exceeded 2.56 mmol/L except in one case.

Discussion

Pica is mainly caused by mineral element deficiency, and known as non-food eating and licking behaviour. Such other factors as deficiencies of some vitamins (vitamin B and C), trace elements, proteins, α-amino-acids and alkali reserve as well as unbalanced calcium-phosphorus ratio in diet are effective in the disorder [3]. Pica is seen in different clinic forms, depending on the animal species. Soil and wool eating behaviours are most evident signs for sheep and lambs [3, 10, 18, 20]. In this study, soil eating, weight loss, development retardation, surface licking and a desire to eat non-food objects were observed in all affected lambs and these clinical signs were compatible with clinical symptoms reported for the lambs with pica [3, 5] and wool eating lambs [10, 14, 18, 20]. After treatment, pica was not been determined in 10 lambs but 5 lambs have still shown occasional surface licking behaviour. The results for the treatment success were in agreement with previous reports [3, 10, 14].

AYTEKIN and KALINBACAK [3] reported significant decrease of phosphorus and cupper mineral concentrations in the sera of calves having soil eating behaviour. FAYE and BENGOUN [7] and GHERGARIU et al. [8] determined that circulating inorganic phosphorus concentrations were significantly lower in the animals with pica than in healthy controls in camels and in cattle and buffalos respectively. In addition, JAIN and CHOPRA [11] observed pica symptoms in calves fed on diet with insufficient phosphorus supply. Similarly, SAHIN et al. [18] found that mean values of serum phosphorus and cupper were significantly lower in the lambs with pica than in healthy ones. Moreover, some researchers such as HYSLIP [9] also evoked the involvement of a cupper deficiency in the pica aetiology. In this way, FAHMY et al. [6] have already demonstrated a significant reduction of cupper concentrations in serum and in fleece of lambs with pica and MA et al. [15] observed that the cupper contents of the soil and nutritional elements were markedly depressed in regions in which camels with pica disorder were sheltered compared to regions in which pica was not reported. On the other hand, zinc deficiency seems also to be implicated in pica: OTT et al. [17] and SULIMAN et al. [21] found that wool eating behaviour of sheep and lambs was caused by zinc deficiency, evidenced by low serum zinc concentrations. YOUDE et al. [22, 23] observed marked reductions of serum sulphur and cupper concentrations in wool eating sheep and goats in China while Ca, P, Fe, Mn, Zn, Co, Mo and Se concentrations remained in normal limits. Similarly, AKGUL et al. [2] determined that serum calcium, phosphorus, iron, manganese, sodium and chloride concentrations did not significantly differ among sheep groups but that serum zinc and cupper concentrations were lower in sheep with pica than in controls. Finally, an iron deficiency was
also suspected in pica in various animal species, firstly by LAWLOR et al. [14]. Thereafter, SINGH et al. [19] confirmed this probable aetiology by evidencing low sideremia in camels with pica compared to healthy controls and ICEN et al. [10] determined significant reductions in serum Zn, Cu and Fe concentrations in lambs with pica whereas the P, Ca and Mg concentrations were not significantly altered. Acute iron deficiency characterized by symptoms such as anorexia, depressed growth and emaciation could be induced in lambs fed with diets containing less than 10 ppm iron [14]. Growth was also delayed when rations with 25 ppm iron were used in lambs [14]. Therefore, these data suggest that the apparent minimum dietary iron requirement of the growing-finishing lamb is greater than 25 ppm and not more than 40 ppm [14]. In the present study, pica disorder was associated only with decreased serum iron concentrations and all affected lambs exhibited iron concentrations below 21.53 μmol/L. The other concentrations of minerals (Ca, Mg and P) and rare elements (Cu and Zn) have remained stable or did not significantly differ from control values. Many researchers [2, 10, 22, 23] reported that iron deficiency is very important in the aetiology of pica and the mineral element supplementation could be beneficial for the treatment in affected lambs.

Several researchers have orally administered capsules containing zinc sulphate or zinc carbonate each day weekly to severely affected rams and ewes respectively and clinical improvement was observed. The present study, the intravenous treatment with the vitamin-mineral combination Kalmia® VIΛSAN (0.3 ml/kg) has induced weak increases of serum cupper and zinc concentrations, a significant elevation of P concentrations and has corrected only partially the iron deficiency as previously reported in other studies [4, 10, 12, 14]. Furthermore, even if the iron concentrations were not completely restored, the global supplementation in minerals and rare elements successfully cured the majority of lambs (67%) and notably alleviated pica disorder in the others. Consequently, serum iron concentration was found significantly lower in the lambs with pica, whereas the concentrations of calcium, phosphorus, magnesium, zinc and cupper remained within the normal limits. By supplementation with mineral elements, phosphorus and iron concentrations were significantly increased, leading to the pica cure. It was concluded that iron deficiency is very important in the aetiology of pica and the mineral element supplementation could be beneficial for the treatment in affected lambs.

**References**


