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# DENSITOMETRY IN THE ASSESSMENT OF BONE METABOLISM IN CHILDREN WITH CELIAC DISEASE

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**Abstract.** The active growth and development of a child may be accompanied by disorders of bone metabolism, and if the child has a chronic pathology of the gastrointestinal tract, then the risk of a decrease in bone mineral density increases manifold. Gluten intolerance is often accompanied by disturbances in nutritional status, in particular changes in bone tissue. An important aspect of dynamic monitoring of patients with celiac disease is monitoring the state of bone mineral density in order to timely detect and correct changes that have occurred. Densitometry today is not a routine diagnostic method and is not included in research protocols for gluten intolerance; however, literature data confirm the relevance of using this technique both among adults and in the pediatric population. The article presents studies that show the presence of a decrease in bone mineral density both at diagnosis of celiac disease and during subsequent follow-up. Arguments in favor of densitometry are presented and risk factors for decreased bone turnover are identified. An integrated approach to assessing the effectiveness of diet therapy and the nutritional status of patients, if followed, will significantly improve the quality of life of children.

**Keywords***: bone metabolism, bone mineral density, celiac disease*

# ДЕНСИТОМЕТРИЯ В ОЦЕНКЕ КОСТНОГО МЕТАБОЛИЗМА У ДЕТЕЙ С ЦЕЛИАКИЕЙ

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**Резюме.** Активный рост и развитие ребенка может сопровождаться нарушениями костного метаболизма, а если ребенок имеет хроническую патологию желудочно-кишечного тракта, то риск снижения минеральной плотности костной ткани кратно возрастает. Непереносимость глютена зачастую сопровождается нарушениями нутритивного статуса, в частности, изменениями со стороны костной ткани. Важным аспектом динамического наблюдения за пациентами с целиакией является контроль за состоянием минеральной плотности костной ткани с целью своевременного выявления и коррекции возникших изменений. Проведение денситометрии в настоящее время не является рутинным методом диагностики и не включено в протоколы исследования при непереносимости глютена. Однако литературные данные подтверждают актуальность использования данной методики среди взрослых и в детской популяции. В статье приведены исследования, которые показывают наличие снижения минеральной плотности костной ткани как при постановке диагноза «целиакия», так и при последующем наблюдении. Приводятся аргументы в пользу проведения денситометрии и указываются факторы риска снижения костного метаболизма. Комплексный подход к оценке эффективности диетотерапии и нутритивного статуса пациентов при ее соблюдении позволит в значительной степени улучшить качество жизни детей.

**Ключевые слова:** *костный метаболизм, минеральная плотность костной ткани, целиакия*

In recent years, the concept of gluten intolerance has changed dramatically, and the pathology has evolved from a gastroenterological nosology into a multiorgan disorder that requires a comprehensive approach in the assessment of clinical manifestations, diagnosis, and careful evaluation of the dynamics of the clinical picture in further therapeutic support after the prescription of a gluten-free diet (GFD) [1–3]. The widespread and multifaceted clinical picture of gluten intolerance suggests that a physician of any speciality may encounter this pathology or its complications [4–6].

Changes in bone metabolism can be both a complication due to malabsorption syndrome in gluten intolerance and the only manifestation of the disease [7, 8]. Assessment of nutritional status parameters and, in particular, bone metabolism, is an integral part of the therapeutic management of paediatric patients with chronic diseases, especially of the gastrointestinal tract [9–13]. Several studies confirm that changes in bone mineral density (BMD) are observed in patients of all ages at the time of diagnosis of gluten intolerance [14, 15]. For adult patients, ACG and ESsCD guidelines have been developed, which include performing densitometry in patients over 40 years of age or in the presence of symptoms of malabsorption at the time of diagnosis of celiac disease [16, 17]. The study by F. Tovoli et al. (2023), in which they evaluated the dynamics of bone metabolism in patients with low densitometry values at diagnosis and after the use of nutritional therapy for 10 years, shows that BMD values stabilise with long-term dietary restriction of gluten [15]. We obtained similar results earlier in paediatric practice. During the examination of 32 children who had been following the GFD for more than 6 months since the diagnosis of celiac disease, a decrease in BMD at densitometry of the lumbar spine was found in 18.75% of children, half of whom had low values. A significant dependence of bone mineralisation reduction on the quality of dietary adherence was revealed: the more often the child violated the diet, the lower the BMD. There was no history of fractures in the patients [7].

During analysis of literature data published between 1996 and 2017, BMD levels were found to be lower in children with celiac disease compared to healthy peers [18]. In this regard, it is worth noting the important aspect of dynamic monitoring of BMD status during adherence to dietary therapy, especially when patient adherence is low. In this case, the frequency of densitometry should be approached individually, depending not only on adherence to diet therapy, but also on the patient's age, nutritional status, in particular, physical development and quality of symptom control.

However, contrary data exist. When densitometry was performed in 24 children with celiac disease (12 boys aged 8.7±3.3 years) at diagnosis and after the use of GFD in therapy and subsequent comparison at two stages of the study in each patient, it was found that BMD within reference values was noted in all patients studied at the time of diagnosis and after treatment, with no difference between the two points of analysis [19]. A retrospective study including 86 patients with celiac disease aged 2–18 years evaluated the relationship between the z-scores of lumbar BMD calculated according to their chronological age and height and their clinical, laboratory and histopathological parameters. The authors found that BMD according to densitometry data when assessed according to chronological age ≤-2 standard deviation (SD) in 26.7% of patients, and when assessed according to height, the number of patients with ≤–2 SD decreased to 12.8% of patients and correlated with their age at the time of celiac disease diagnosis (r value=0.269). At the same time, no statistically significant differences between subgroups, between BMD values with respect to their clinical, laboratory and histopathological parameters were found in any group [20].

However, differences in BMD in patients with celiac disease are more frequently noted. In a cohort retrospective study, we analysed demographic, clinical and laboratory data from the medical records of: 673 children with celiac disease (63% female, mean age at diagnosis 10.6 years, interquartile range 7.8–13.9) who underwent densitometry at diagnosis. Logistic regression analysis showed that the mean aBMD-Z score at the initial scan of the children at the time of diagnosis was –0.4±1.2. Forty-six children had aBMD-Z scores less than -2 (6.8%; 95% 5.2–9.0). Those who underwent BMD reanalysis (n=108; 16.0%) had a significant increase in aBMD-Z score (mean change 0.29; p=0.0005). A higher body mass index (BMI) was associated with a more insignificant likelihood of a low aBMD-Z score at initial densitometry (0.46; 95% 0.35–0.50). BMI-Z scores greater than –0.4 identified children with low aBMD-Z at their initial BMD analysis (p=0.05). According to the authors, BMI-Z scores can be used to identify children with

celiac disease at risk of low BMD who should undergo densitometric screening [21].

A cross-sectional study conducted in Iran (2023) included 48 children (mean age 9.96±3.17 years) diagnosed with celiac disease (Marsh II and Marsh III stages). The authors proved that 35.4% of the patients had BMD within the normal range, 41.7% had values at the lower limit, and 22.9% had low bone mineralisation in femoral bone examination by densitometry. When lumbar densitometry results were evaluated, it was found that 39.6% had BMD within reference values, 25% had BMD at the lower limit of normal, and 35.4% were diagnosed with low BMD. No statistically significant correlation was between age, sex, place of residence, Marsh stage, adherence to GFD and bone densitometry in both areas. A statistically significant correlation was found between BMD in the lumbar region and two HLA types, namely HLA DQ8 and HLA DQ2/8 (p=0.016). Thus, the authors confirm the frequent occurrence of low BMD in children with first diagnosed celiac disease [22].

In a study involving children with celiac disease detected by screening and patients without celiac disease, BMD was assessed by densitometry, serum 25 (OH) vitamin D3, parathyroid hormone (PTH), interleukin (IL)-1β, IL-2, IL-4, IL-5, IL-6, IL-8, IL-10, IL-12p70, IL-13, IL-15, gamma interferon and tumour necrosis factor alpha. It was found that at the time of diagnosis, children with celiac disease detected at screening had an average –0.03 g/cm lower BMD of both whole body and spine compared to controls (p=0.009 and p=0.005 respectively), also an average –11.4 nmol/l lower 25(OH) vitamin D3 level (p <0.001) and an average +1.0 pmol/l higher PTH level (p<0.001). Systemic levels of cytokines IL-1β, IL-6, IL-8, IL-10, IL-12p70, IL-13 and tumour necrosis factor alpha were elevated in celiac disease detected at screening compared to controls (p<0.001). No differences in IPC, 25(OH) vitamin D3, PTH and cytokine levels were found in children receiving GFD compared to controls [23]. This study confirms the diagnostic significance of BMD control in patients with celiac disease. Due to the fact that patients with celiac disease are often diagnosed with reduced blood vitamin D levels, it is considered appropriate to perform dynamic BMD monitoring using densitometry [24].

BMD assessment is an important component of a comprehensive assessment of children's health; timely diagnosis of decreased bone metabolism will reduce the number of patient hospitalisations and the number of visits to specialists, preserving the quality of life of children and their families [25–27].

## ADDITIONAL INFORMATION

**Author contribution.** Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

**Competing interests.** The authors declare that they have no competing interests.

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