SELENIUM DEFICIENCY IN CHRONIC HEART FAILURE: PREVALENCE AND IMPACT OF DIETARY CORRECTION

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Abstract

Aim. *To assess selenium status in patients with chronic heart failure (CHF) of different etiologies and to evaluate the effectiveness of dietary correction of selenium deficiency using a functional food enriched with organic selenium.* ***Material and Methods.*** *A total of 116 patients with CHF class II–IV according to the New York Heart Association (NYHA) classification and 13 apparently healthy controls were examined. Serum selenium concentration was measured using a fluorometric method. Fourteen patients with insufficient selenium status received a kelp-based dietary product enriched with organic selenium for 2 months. In 12 patients, serum selenium levels were reassessed after the intervention.* ***Results.*** *Patients with CHF demonstrated significantly lower serum selenium levels compared with healthy controls ($p<0.05$). Selenium deficiency (<90 μg/L) was detected in 51% of patients, while reduced selenium status was observed in 42%. After dietary correction, serum selenium concentration increased by an average of 35.9%, predominantly in patients with baseline selenium deficiency.* ***Conclusion.*** *Selenium deficiency is highly prevalent in patients with CHF regardless of etiology. Dietary correction using functional foods containing organic selenium is an effective and safe approach to improving selenium status and may contribute to optimization of comprehensive CHF management.*

Keywords: *chronic heart failure; selenium; micronutrients; oxidative stress; dietary correction; kelp.*

Абстрактный

Цель. *Оценить селеновый статус у пациентов с хронической сердечной недостаточностью (ХСН) различной этиологии и оценить эффективность диетической коррекции дефицита селена с использованием функциональных продуктов питания, обогащенных органическим селеном.* ***Материал и методы.*** *Всего было обследовано 116 пациентов с ХСН II–IV класса по классификации Нью-Йоркской ассоциации кардиологов (NYHA) и 13 практически здоровых лиц контрольной группы. Концентрацию селена в сыворотке крови измеряли с помощью флуорометрического метода. Четырнадцать пациентов с*

недостаточным содержанием селена получали диетический продукт на основе ламинарии, обогащенный органическим селеном, в течение 2 месяцев. У 12 пациентов после вмешательства был проведен повторный анализ уровня селена в сыворотке крови. ***Результаты.*** *У пациентов с ХСН уровень селена в сыворотке крови был значительно ниже, чем в контрольной группе (p<0,05). Дефицит селена (<90 мкг/л) был выявлен у 51% пациентов, в то время как снижение уровня селена наблюдалось у 42%. После коррекции рациона концентрация селена в сыворотке крови повысилась в среднем на 35,9%, преимущественно у пациентов с исходным дефицитом селена.* ***Вывод.*** *Дефицит селена широко распространен у пациентов с ХСН независимо от этиологии. Коррекция рациона с использованием функциональных продуктов, содержащих органический селен, является эффективным и безопасным подходом к улучшению селенового статуса и может способствовать оптимизации комплексного лечения ХСН.*

Ключевые слова: *хроническая сердечная недостаточность; селен; микроэлементы; окислительный стресс; диетическая коррекция; ламинария.*

Annotatsiya

Maqsad. *Turli etiologiyali surunkali yurak yetishmovchiligi (CHF) bo'lgan bemorlarda selen holatini baholash va organik selen bilan boyitilgan funktsional oziq-ovqat yordamida selen yetishmovchiligini parhez bilan tuzatish samaradorligini baholash.* ***Materiallar va usullar.*** *Nyu-York yurak assotsiatsiyasi (NYHA) tasnifiga ko'ra II-IV sinfdagi CHF bilan og'rigan jami 116 bemor va 13 nafar sog'lom nazorat guruhi tekshirildi. Zardobdagi selen konsentratsiyasi fluorometrik usul yordamida o'lchandi. Selen holati yetarli bo'lmagan o'n to'rt bemor 2 oy davomida organik selen bilan boyitilgan dengiz o'ti asosidagi parhez mahsulotini oldi. 12 bemorda aralashuvdan so'ng zardobdagi selen darajasi qayta baholandi.* ***Natijalar.*** *CHF bilan og'rigan bemorlarda sog'lom nazorat guruhiga nisbatan zardobdagi selen darajasi sezilarli darajada past edi (p<0.05). Bemorlarning 51 foizida selen yetishmovchiligi (<90 mkg/L) aniqlangan, 42 foizida esa selen holatining pasayishi kuzatilgan. Parhezni tuzatishdan so'ng, zardobdagi selen konsentratsiyasi o'rtacha 35,9 foizga oshdi, asosan boshlang'ich selen yetishmovchiligi bo'lgan bemorlarda.* ***Xulosa.*** *Selen yetishmovchiligi CHF bilan og'rigan bemorlarda etiologiyasidan qat'i nazar, juda keng tarqalgan. Organik selenni o'z ichiga olgan funktsional oziq-ovqatlardan foydalangan holda parhezni tuzatish selen holatini yaxshilashning samarali va xavfsiz yondashuvidir va CHFni kompleks davolashni optimallashtirishga hissa qo'shishi mumkin.*

Kalit so'zlar: *surunkali yurak yetishmovchiligi; selen; mikroelementlar; oksidlovchi stress; parhezni tuzatish; dengiz o'ti.*

Introduction

Chronic heart failure (CHF) remains one of the most significant global health problems and represents the final common pathway of the majority of cardiovascular diseases. Despite substantial advances in pharmacological therapy, interventional cardiology, and device-based treatments, CHF continues to be associated with high morbidity, frequent hospitalizations, and poor long-term prognosis [1,2]. According to epidemiological data, the prevalence of CHF is steadily increasing due to population aging and improved survival after acute cardiovascular events. In the Russian Federation, the prevalence of CHF exceeds that reported in many European countries, resulting in a pronounced socioeconomic burden and highlighting the need for optimization of both therapeutic and preventive strategies [3]. Traditional approaches to CHF management primarily focus on neurohumoral blockade and hemodynamic optimization. However, growing evidence suggests that metabolic disturbances and micronutrient deficiencies play an important role in disease progression and clinical deterioration. Contemporary concepts of CHF pathophysiology emphasize the contribution of systemic inflammation, endothelial dysfunction, mitochondrial impairment, and oxidative stress [4,5]. Oxidative stress, resulting from an imbalance between reactive oxygen species production and antioxidant defense mechanisms, promotes cardiomyocyte injury, extracellular matrix remodeling, and progressive ventricular dysfunction. Selenium is an essential trace element incorporated into more than 25 selenoproteins, including glutathione peroxidases, thioredoxin reductases, and selenoprotein P, which are crucial for redox regulation, immune modulation, and myocardial energy metabolism [6–8]. Selenium deficiency has been linked to impaired mitochondrial function, increased oxidative damage, and reduced myocardial contractility [9].

Several clinical studies have demonstrated that patients with CHF exhibit significantly lower serum selenium levels compared with healthy individuals, irrespective of the underlying etiology of heart failure [10–12]. Moreover, selenium availability varies considerably across geographic regions due to differences in soil selenium content and dietary patterns [13]. In regions with low environmental selenium, subclinical deficiency may remain undetected while contributing to chronic cardiovascular pathology. Therefore, assessment of selenium status and evaluation of targeted correction strategies are of particular relevance.

Material and Methods

Study Population

This observational study included 116 patients with CHF of different etiologies (ischemic heart disease, rheumatic heart disease, and dilated cardiomyopathy) residing in the Ryazan region. The study population consisted of 77 men (66.4%) and 39 women (33.6%), with a mean age of 55.4 ± 10.9 years. CHF severity was assessed according to the NYHA classification using the 6-minute walk test. All patients received guideline-directed medical therapy for CHF. The control group comprised 13 apparently healthy volunteers matched for age and sex, with no history of cardiovascular disease or chronic inflammatory conditions.

The study protocol was approved by the local ethics committee, and written informed consent was obtained from all participants.

Assessment of Selenium Status

Venous blood samples were collected in the fasting state. Serum selenium concentration was determined using a fluorometric method. Selenium status was categorized as follows:

- 115–120 μg/L — optimal selenium status
- 90–115 μg/L — suboptimal status
- <90 μg/L — insufficient selenium status
- <70 μg/L — severe selenium deficiency

Dietary Intervention

Fourteen patients with insufficient selenium status received a functional dietary product — kelp-based jam enriched with organic selenium (selenium-enriched yeast hydrolysate). The selenium content of the product was 3.22 μg/g, and the recommended daily intake was 20 g. The intervention lasted 2 months. Serum selenium concentration was reassessed in 12 patients after completion of the dietary intervention.

Statistical Analysis

Statistical analysis was performed using Microsoft Excel and Statistica 8.0 software. Quantitative variables with normal distribution were expressed as mean ± standard deviation. Comparisons between groups were performed using Student's t-test. A p-value <0.05 was considered statistically significant.

Results

Baseline assessment revealed that the majority of patients with CHF had reduced selenium status. Selenium deficiency (<90 μg/L) was detected in 51% of patients, while reduced selenium status was observed in 42%. Only 7% of patients demonstrated suboptimal selenium levels. In contrast, selenium deficiency was significantly less frequent among healthy controls. Patients with CHF of ischemic etiology showed a tendency toward more pronounced selenium deficiency compared with those with

rheumatic heart disease or dilated cardiomyopathy. However, interpretation of etiological differences was limited by heterogeneity in age and sex distribution across subgroups. Following 2 months of dietary correction, all 12 reassessed patients exhibited an increase in serum selenium concentration. In patients with severe baseline deficiency (<70 μg/L), selenium status improved to reduced or suboptimal levels. Overall, mean serum selenium concentration increased by 35.9%, confirming the effectiveness of the dietary intervention.

Discussion

The present study demonstrates a high prevalence of selenium deficiency among patients with chronic heart failure, consistent with findings from previous investigations conducted in different populations [10–12,15]. Reduced selenium availability may exacerbate oxidative stress, impair mitochondrial function, and accelerate myocardial remodeling, thereby contributing to disease progression. An important observation of this study is that dietary correction with organic selenium resulted in a significant increase in serum selenium levels primarily in patients with baseline deficiency. This finding supports the concept of targeted micronutrient correction rather than indiscriminate supplementation. Randomized trials have shown limited cardiovascular benefit of selenium supplementation in individuals without deficiency, emphasizing the importance of baseline assessment [16]. The use of kelp (Laminaria) as a carrier for organic selenium offers additional advantages. Kelp is a natural source of macro- and micronutrients, polysaccharides, and organic iodine, which may exert favorable metabolic, antihypertensive, and anti-atherogenic effects [17]. These properties are particularly relevant in CHF patients, who often present with multiple metabolic and vascular comorbidities. From a clinical perspective, assessment of selenium status may help identify a subgroup of CHF patients who could benefit from targeted dietary interventions. Although selenium correction alone cannot replace standard CHF therapy, it may serve as an adjunctive strategy aimed at improving metabolic resilience and antioxidant capacity.

Study Limitations

The study has several limitations, including a relatively small sample size for the dietary intervention subgroup and the absence of long-term clinical outcome assessment. In addition, selenium-dependent enzyme activity was not directly measured. Future large-scale randomized studies are required to determine whether correction of selenium deficiency translates into improved clinical outcomes in CHF.

Conclusion

Patients with chronic heart failure class II–IV exhibit a significantly lower serum selenium concentration compared with healthy individuals. Dietary correction using

functional foods enriched with organic selenium is an effective and safe method for improving selenium status, particularly in patients with baseline deficiency. These findings support the incorporation of targeted micronutrient assessment into comprehensive CHF management strategies.

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