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Gut Microbiota Alterations In Patients With Chronic Heart Failure And Chronic Kidney Disease

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Abstract

Chronic heart failure (CHF) and chronic kidney disease (CKD) are closely interconnected pathological conditions associated with high morbidity and mortality worldwide. Recent studies suggest that intestinal microbiota plays an important role in the progression of both cardiovascular and renal dysfunction through inflammatory, metabolic, and immune-mediated mechanisms.

The aim of the present study was to investigate alterations of gut microbiota in patients with chronic heart failure and chronic kidney disease and to evaluate their association with clinical and metabolic disturbances.

The study included patients diagnosed with CHF and CKD who underwent комплекс clinical and laboratory assessment together with microbiological analysis of intestinal flora. Renal function parameters, inflammatory markers, and characteristics of gut microbiota composition were evaluated.

The results demonstrated significant dysbiotic alterations characterized by reduction of beneficial intestinal microorganisms and increased growth of opportunistic bacterial species. Patients with advanced CHF and CKD showed more pronounced microbial imbalance accompanied by elevated inflammatory activity and deterioration of renal function.

In conclusion, gut microbiota alterations play a significant role in the progression of chronic heart failure and chronic kidney disease. Intestinal dysbiosis may contribute to systemic inflammation, metabolic disorders, and worsening of cardiorenal dysfunction.

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Keywords: Gut microbiota, chronic heart failure, chronic kidney disease, dysbiosis, inflammation, cardiorenal syndrome, intestinal flora, metabolic disorders

Introduction

Chronic heart failure and chronic kidney disease are among the most common chronic disorders associated with significant morbidity, reduced quality of life, and increased mortality. The coexistence of these conditions leads to the development of complex pathophysiological interactions commonly referred to as cardiorenal syndrome. Progressive impairment of cardiac and renal function is accompanied by systemic metabolic disturbances, chronic inflammation, and endothelial dysfunction.

In recent years, increasing scientific attention has been directed toward the role of gut microbiota in the development and progression of cardiovascular and renal diseases. The intestinal microbiota represents a complex ecosystem of microorganisms involved in metabolic regulation, immune homeostasis, and maintenance of intestinal barrier integrity. Alterations in microbial composition may contribute to systemic pathological processes affecting multiple organs.

Patients with chronic heart failure and chronic kidney disease frequently develop intestinal dysbiosis characterized by reduced diversity of beneficial microorganisms and excessive growth of opportunistic bacterial species. Hemodynamic disturbances, intestinal wall edema, impaired perfusion, metabolic acidosis, and accumulation of uremic toxins create favorable conditions for disruption of normal microbial balance.

Disturbance of the intestinal barrier increases translocation of bacterial endotoxins and pro-inflammatory metabolites into the systemic circulation. These factors stimulate chronic inflammatory activity, oxidative stress, and endothelial dysfunction, further aggravating both cardiac and renal impairment.

Accumulation of microbiota-derived toxic metabolites, including indoxyl sulfate and p-cresyl sulfate, is considered an important mechanism contributing to progression of chronic kidney disease and cardiovascular complications. These compounds exert nephrotoxic and cardiotoxic effects, promoting fibrosis, vascular injury, and deterioration of organ function.

Despite growing evidence regarding the gut-heart-kidney axis, the relationship between intestinal microbiota alterations and progression of combined chronic heart failure and chronic kidney disease remains insufficiently investigated. Understanding the mechanisms linking intestinal dysbiosis with cardiorenal

dysfunction may provide new opportunities for early diagnosis and development of targeted therapeutic strategies.

Therefore, the aim of the present study was to investigate gut microbiota alterations in patients with chronic heart failure and chronic kidney disease and evaluate their association with clinical and metabolic disturbances.

Materials and Methods

The present investigation was carried out among patients diagnosed with chronic heart failure combined with chronic kidney disease. The study population consisted of 72 individuals aged from 42 to 76 years who received inpatient and outpatient treatment in a multidisciplinary therapeutic clinic.

Clinical evaluation was performed using a комплекс approach that included assessment of cardiovascular and renal status, laboratory testing, and examination of intestinal microbial composition. Chronic heart failure was confirmed according to clinical manifestations, echocardiographic findings, and functional classification criteria. Renal dysfunction was assessed through serum creatinine concentration and estimated glomerular filtration rate.

Venous blood samples were collected in the morning after overnight fasting. Biochemical analysis included determination of creatinine, urea, C-reactive protein, lipid profile parameters, and electrolyte balance. Particular attention was paid to markers reflecting inflammatory activity and severity of metabolic disturbances.

The condition of the intestinal microbiota was evaluated through microbiological analysis of large bowel flora. Stool samples were obtained under standard sterile conditions and examined to determine qualitative and quantitative characteristics of intestinal microorganisms. The analysis focused on the content of beneficial bacterial populations, including bifidobacteria and lactobacilli, as well as the presence of opportunistic microorganisms.

Cardiovascular assessment included blood pressure monitoring, electrocardiography, and echocardiographic examination with evaluation of left ventricular functional parameters. The severity of chronic heart failure was determined according to functional status and clinical symptoms.

For comparative analysis, patients were stratified according to the stage of chronic kidney disease and severity of heart failure manifestations. Associations between intestinal dysbiosis, inflammatory markers, and progression of cardiorenal dysfunction were subsequently evaluated.

Statistical processing of the obtained results was performed using standard methods of medical data analysis. Quantitative indicators were expressed as mean values with

standard deviation, while qualitative parameters were analyzed as percentage distributions.

Results

The conducted study demonstrated that patients with chronic heart failure combined with chronic kidney disease developed pronounced disturbances in the composition of intestinal microbiota. The severity of dysbiotic alterations increased with progression of both cardiac and renal dysfunction.

Microbiological analysis revealed a marked reduction in the population of beneficial intestinal bacteria, primarily bifidobacteria and lactobacilli. At the same time, excessive growth of opportunistic microorganisms was observed in a considerable proportion of patients. The most significant microbial imbalance was identified in patients with advanced stages of chronic kidney disease and severe manifestations of heart failure.

Clinical and laboratory findings showed that pronounced intestinal dysbiosis was associated with elevated inflammatory activity and worsening renal functional parameters. Patients with severe microbial imbalance demonstrated higher serum creatinine and urea concentrations together with increased levels of inflammatory markers.

In addition, patients with advanced chronic heart failure more frequently presented with intestinal discomfort, reduced appetite, abdominal bloating, and manifestations of metabolic intoxication. These symptoms were more pronounced in individuals with significant alterations of intestinal microbial composition.

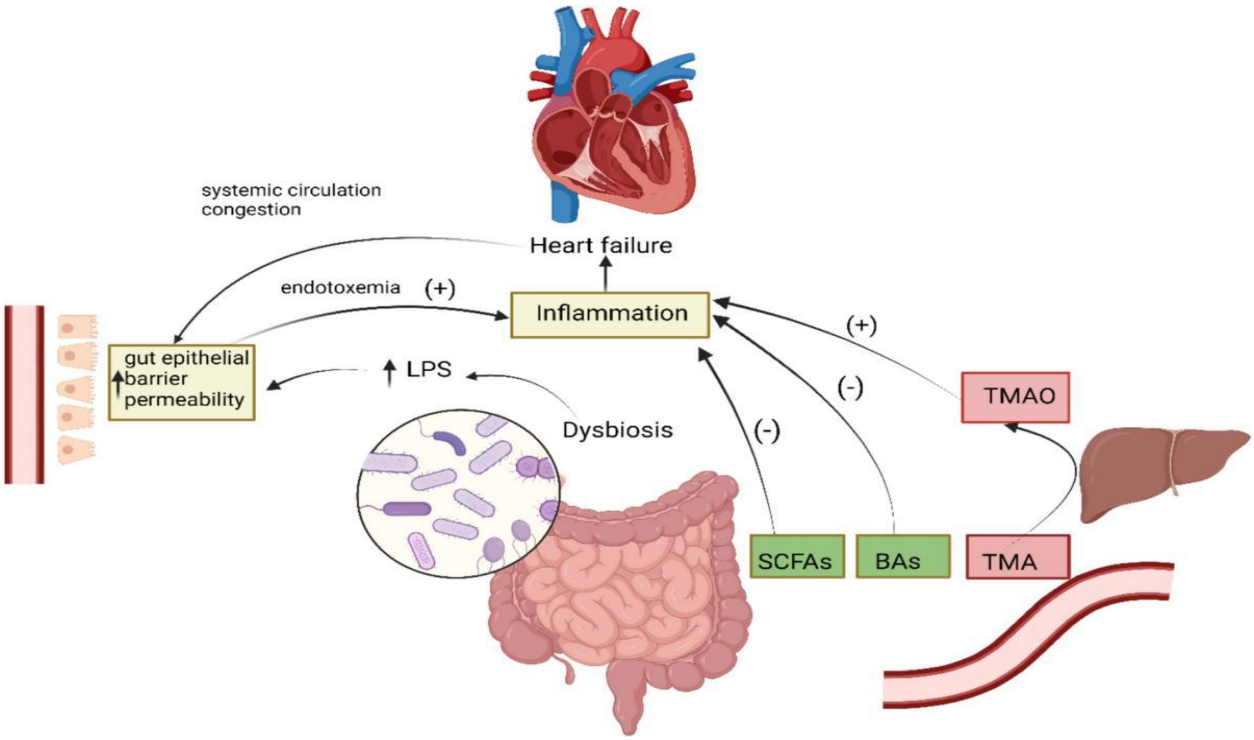
Parameter	Moderate Disease Course	Severe Disease Course
Reduction of bifidobacteria	54%	81%
Reduction of lactobacilli	48%	76%
Growth of opportunistic microorganisms	39%	73%
Elevated inflammatory markers	Moderate	Pronounced
Decline of renal filtration function	Mild	Significant

Note. *Data obtained from microbiological and clinical evaluation of patients with chronic heart failure and chronic kidney disease.*

Table 1. Gut Microbiota Alterations in Patients with CHF and CKD

The obtained results indicate a close relationship between intestinal microbiota disturbances and progression of cardiorenal pathology. Intestinal dysbiosis appears

to contribute to chronic systemic inflammation, metabolic imbalance, and deterioration of both cardiovascular and renal function.



Note. Representative illustrations demonstrating intestinal microbiota alterations associated with chronic heart failure and chronic kidney disease.

Figure 1. Gut Microbiota Alterations in Cardiorenal Syndrome

Discussion

The results of the present study demonstrate that disturbances of intestinal microbiota play a substantial role in the progression of chronic heart failure and chronic kidney disease. Patients with combined cardiorenal pathology exhibited significant alterations in microbial composition characterized by depletion of beneficial microorganisms and excessive growth of opportunistic bacterial species.

One of the principal findings of the study was the progressive reduction of bifidobacteria and lactobacilli in patients with severe manifestations of chronic heart failure and renal dysfunction. These microorganisms are essential for maintaining intestinal barrier integrity, regulating immune responses, and supporting normal metabolic processes. Their deficiency contributes to disruption of intestinal homeostasis and increased permeability of the intestinal wall.

The observed increase in opportunistic microorganisms may intensify production of toxic metabolites and bacterial endotoxins. Under conditions of impaired intestinal

barrier function, these compounds enter the systemic circulation and promote chronic inflammation, oxidative stress, and endothelial dysfunction. Such mechanisms are considered important contributors to progression of both cardiovascular and renal disease.

The association between intestinal dysbiosis and elevated inflammatory markers identified in this study confirms the role of chronic systemic inflammation in the pathogenesis of cardiorenal syndrome. Persistent inflammatory activity may aggravate myocardial remodeling, vascular injury, and progressive decline of renal filtration function.

Another important observation was the relationship between severity of dysbiotic alterations and deterioration of renal biochemical parameters. Patients with advanced microbial imbalance demonstrated more pronounced impairment of kidney function, suggesting that intestinal microbiota disturbances may contribute to accumulation of uremic toxins and progression of metabolic disorders.

The obtained findings support the concept of the gut-heart-kidney axis, according to which intestinal microbiota acts as an important mediator between metabolic, inflammatory, cardiovascular, and renal processes. Disturbances within this complex interaction may accelerate progression of chronic diseases and increase the risk of systemic complications.

Clinical manifestations such as abdominal discomfort, appetite reduction, and symptoms of endogenous intoxication observed in patients with severe dysbiosis additionally indicate the systemic impact of intestinal microbiota alterations. These symptoms may negatively influence nutritional status and overall quality of life in patients with chronic cardiorenal pathology.

Despite the informative results of the study, several limitations should be considered. The relatively limited sample size and absence of long-term dynamic observation do not allow complete evaluation of causal relationships between microbiota disturbances and progression of cardiorenal syndrome. Further investigations involving molecular microbiological analysis and larger patient populations are necessary to clarify the mechanisms underlying these interactions.

In conclusion, intestinal microbiota alterations are closely associated with progression of chronic heart failure and chronic kidney disease. Intestinal dysbiosis contributes to chronic inflammation, metabolic imbalance, and worsening of cardiorenal dysfunction, highlighting the potential importance of microbiota-targeted therapeutic strategies in patients with combined cardiovascular and renal pathology.

Conclusion

In conclusion, the present study demonstrated that patients with chronic heart failure and chronic kidney disease develop significant alterations of intestinal microbiota associated with progression of cardiorenal dysfunction. The observed dysbiotic changes were characterized by reduction of beneficial intestinal microorganisms and increased growth of opportunistic bacterial species.

The severity of microbial imbalance increased in parallel with deterioration of renal function and progression of chronic heart failure. Intestinal dysbiosis was accompanied by elevated inflammatory activity, metabolic disturbances, and signs of endogenous intoxication, indicating the important role of the gut-heart-kidney axis in the pathogenesis of combined cardiovascular and renal disorders.

The obtained findings suggest that alterations of intestinal microbiota may contribute to chronic systemic inflammation, endothelial dysfunction, and accumulation of toxic metabolites, thereby aggravating progression of cardiorenal syndrome.

Comprehensive evaluation of intestinal microbiota in patients with chronic heart failure and chronic kidney disease may have important diagnostic and prognostic value. Correction of dysbiotic alterations could represent a promising therapeutic approach aimed at reducing inflammatory activity, improving metabolic balance, and slowing progression of cardiorenal dysfunction.

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