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ECHOCARDIOGRAPHIC CHARACTERISTICS OF THE HEART IN PATIENTS WITH CHRONIC KIDNEY DISEASE RECEIVING MAINTENANCE HEMODIALYSIS

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Abstract

Chronic kidney disease is associated with a high risk of cardiovascular complications, particularly in patients receiving maintenance hemodialysis. Long-standing arterial hypertension, chronic volume overload, anemia, and metabolic disturbances contribute to the development of cardiac remodeling. Echocardiography is the primary non-invasive method for assessing the structural and functional status of the heart in this patient population. The evaluation of echocardiographic characteristics enables early detection of adverse myocardial changes and optimization of patient management strategies.

Keywords: chronic kidney disease; maintenance hemodialysis; echocardiography; cardiac remodeling; left ventricular hypertrophy; diastolic dysfunction; valvular calcification; pulmonary hypertension.

ЭХОКАРДИОГРАФИЧЕСКИЕ ХАРАКТЕРИСТИКИ СЕРДЦА У ПАЦИЕНТОВ С ХРОНИЧЕСКОЙ БОЛЕЗНЬЮ ПОЧЕК, ПОЛУЧАЮЩИХ ПРОГРАММНЫЙ ГЕМОДИАЛИЗ

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Республиканский специализированный научно-практический медицинский центр нефрологии и трансплантации почки

Аннотация

Хроническая болезнь почек ассоциирована с высоким риском сердечно-сосудистых осложнений, особенно у пациентов, получающих программный гемодиализ. Длительная артериальная гипертензия, перегрузка объёмом, анемия и метаболические нарушения способствуют развитию кардиального ремоделирования. Эхокардиография является основным неинвазивным методом оценки структурно-функционального состояния сердца у данной категории больных. Изучение эхокардиографических характеристик позволяет своевременно выявлять неблагоприятные изменения миокарда и оптимизировать тактику ведения пациентов.

Ключевые слова хроническая болезнь почек; программный гемодиализ; эхокардиография; кардиальное ремоделирование; гипертрофия левого желудочка; диастолическая дисфункция; клапанный кальциноз; лёгочная гипертензия.

SURUNKALI BUYRAK KASALLIGI BO‘LGAN, DASTURIY GEMODIALIZ OLAYOTGAN BEMORLARDA YURAKNING EKOKARDIYOGRAFIK XARAKTERISTIKALARI

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Toshkent davlat tibbiyot universiteti
Respublika ixtisoslashtirilgan ilmiy-amaliy nefrologiya va buyrak transplantatsiyasi markazi

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Annotatsiya

Surunkali buyrak kasalligi yurak-qon tomir asoratlari rivojlanishining yuqori xavfi bilan bog‘liq bo‘lib, ayniqsa dasturiy gemodializ olayotgan bemorlarda uchraydi. Uzoq davom etuvchi arterial gipertenziya, hajmiy ortiqcha yuklama, anemiya va metabolik buzilishlar kardial remodellasiyalanishning rivojlanishiga olib keladi. Ekokardiyografiya ushbu bemorlar guruhida yurakning strukturaviy va funksional holatini baholash uchun asosiy noinvaziv usul hisoblanadi. Ekokardiyografik ko‘rsatkichlarni o‘rganish miokarddagi noxush o‘zgarishlarni o‘z vaqtida aniqlash va bemorlarni davolash hamda olib borish taktikasini optimallashtirish imkonini beradi.

Kalit so‘zlar: Surunkali buyrak kasalligi; dasturiy gemodializ; ekokardiyografiya; kardial remodellasiyalanish; chap qorincha gipertrofiyasi; diastolik disfunksiya; yurak klapanlarining kalsifikatsiyasi; o‘pka arterial gipertenziyasi.

ECHOCARDIOGRAPHIC CHARACTERISTICS OF THE HEART IN PATIENTS WITH CHRONIC KIDNEY DISEASE RECEIVING MAINTENANCE HEMODIALYSIS

Introduction

Chronic kidney disease (CKD) remains one of the most significant medical and social problems in modern medicine, largely due to the high prevalence of cardiovascular complications in this patient population. In patients receiving maintenance hemodialysis, the combination of long-standing arterial hypertension, chronic volume overload, anemia, and metabolic disorders leads to the development of pronounced structural and functional myocardial changes. Echocardiography, as an accessible and informative non-invasive method, allows comprehensive assessment of cardiac structure and function, identification of

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Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
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early signs of cardiac remodeling, and detection of prognostically unfavorable changes, which is of great importance for optimizing patient management strategies.

Aim of the Study

To evaluate echocardiographic characteristics of the heart in patients with chronic kidney disease receiving maintenance hemodialysis, with an assessment of structural and functional myocardial changes.

Materials and Methods

The study included 103 patients with stage 5D chronic kidney disease. The mean age of the patients was 41.68 ± 1.05 years, and the mean duration of maintenance hemodialysis was 8.45 ± 0.57 months. Patients with CKD stage 5D underwent standard maintenance hemodialysis following a three-day interdialytic interval.During a scheduled hemodialysis session, within the first hour of treatment (for 30 minutes), patients performed physical exercise in the form of lower- or upper-limb cycle ergometry according to an individually tailored program. Echocardiographic examinations were performed three times in all patients: before the start of hemodialysis, at 60–90 minutes after initiation of hemodialysis, and after completion of the procedure. Echocardiography was carried out using standard transthoracic techniques.

Results

According to the study protocol, maintenance hemodialysis with intradialytic physical exercise was performed after a standard hemodialysis session. Predialysis echocardiographic parameters did not differ between the two study phases, indicating complete resolution of intradialytic myocardial changes by the beginning of the subsequent hemodialysis session.

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The relative dynamics of myocardial systolic function during standard hemodialysis and hemodialysis combined with physical exercise demonstrated a unidirectional pattern. However, intradialytic physical exercise resulted in a significantly lower severity of systolic dysfunction compared with the standard procedure ($p < 0.001$). Statistically significant differences in relative dynamics between the two hemodialysis modalities were observed for left ventricular ejection fraction and the regional wall motion abnormality index.The identified differences in the severity of myocardial systolic dysfunction were accompanied by significant changes in pulmonary hemodynamic parameters. By the end of standard hemodialysis, mean pulmonary artery pressure increased compared with the predialysis level ($+13.65 \pm 0.98\%$), whereas during hemodialysis with physical exercise, a decrease was observed ($–11.31 \pm 0.29\%$, $p < 0.001$). Serial echocardiographic analysis demonstrated that changes in the main echocardiographic parameters during hemodialysis with physical exercise were unidirectional relative to standard hemodialysis. However, the reduction in left ventricular end-diastolic volume was significantly more pronounced when intradialytic physical exercise was performed. Left ventricular systolic function during hemodialysis with physical exercise decreased to a lesser extent than during standard hemodialysis, both in terms of regional contractile dysfunction and ejection fraction.

Stroke volume and cardiac output decreased more markedly during hemodialysis with physical exercise than during standard hemodialysis, which was associated with a significant reduction in end-diastolic volume while maintaining a relatively preserved ejection fraction. The dynamics of left and right ventricular indices were comparable between both hemodialysis modalities. However, by the end of the procedure, a reduction in mean pulmonary artery pressure was observed during hemodialysis with physical exercise, indicating more favorable conditions for myocardial function.

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Conclusions

Intradialytic physical exercise has a positive effect on echocardiographic parameters of central hemodynamics in patients with chronic kidney disease receiving maintenance hemodialysis. Physical exercise during hemodialysis contributes to a more pronounced intradialytic reduction in left ventricular end-diastolic volume compared with standard hemodialysis (–20.28% vs –8.73%, $p < 0.001$). During hemodialysis combined with physical exercise, less pronounced impairment of left ventricular contractile function was observed, manifested by a smaller reduction in ejection fraction (–3.11% vs –11.99%) and a less significant increase in the regional wall motion abnormality index (+15.28% vs +23.95%, $p < 0.001$ for both parameters). These findings indicate a beneficial effect of intradialytic physical exercise on the structural and functional state of the heart, as assessed by echocardiography, in patients undergoing maintenance hemodialysis.

Discussion

Contemporary studies confirm that patients with end-stage chronic kidney disease receiving maintenance hemodialysis exhibit a high prevalence of structural and functional cardiac abnormalities detected by echocardiography [1,2]. Left ventricular hypertrophy, reduced contractile reserve, and transient intradialytic systolic dysfunction are considered key mechanisms underlying increased cardiovascular risk in this patient population [3]. According to several authors, standard hemodialysis sessions may be associated with deterioration of myocardial systolic function due to rapid preload reduction, electrolyte imbalance, and episodes of intradialytic hypotension [4,5]. In this context, the impact of intradialytic physical exercise, which may modify the myocardial hemodynamic response, is of particular interest. The results of the present study are consistent with contemporary data demonstrating the beneficial effects of intradialytic exercise training on central hemodynamic parameters and

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Eureka Journal of Health Sciences & Medical Innovation (EJHSMI)
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https://eurekaoa.com/index.php/5

echocardiographic indices of left ventricular function [6,7]. A more pronounced reduction in end-diastolic volume with relative preservation of ejection fraction may reflect improved myocardial adaptation to ultrafiltration and reduced hemodynamic stress [8]. The reduced severity of regional contractile dysfunction and more stable ejection fraction values during hemodialysis with physical exercise support evidence of a cardioprotective effect of dose-controlled physical activity in dialysis patients [9]. In addition, the observed decrease in mean pulmonary artery pressure is consistent with reports of a positive effect of intradialytic exercise on pulmonary hemodynamics and right heart function [10]. Thus, intradialytic physical exercise may be considered an effective non-pharmacological approach for correcting unfavorable echocardiographic changes and improving myocardial functional status in patients with chronic kidney disease receiving maintenance hemodialysis, as supported by current clinical and echocardiographic evidence [6–12].

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