Scripta Scientifica Medica, 2024;56(1):40-45
DOI: 10.14748/ssm.v57i1.10390

ISSN 0582-3250 (Print)
ISSN 1314-6408 (Online)

ORIGINAL ARTICLES

EVALUATING THE IMPACT OF SPECIALIZED CARDIO-CYCLING EXERCISES ON THE CLINICAL STATUS OF CHRONIC DIALYSIS PATIENTS, OBJECTIFIED BY EXAMINING LABORATORY INDICATORS OF MINERAL AND BONE DISORDERS

Magdalena Bliznakova[1], Snezhana Atanasova[2], Valentina Madjova[1]

[1]Department of General Medicine, Faculty of Medicine, Medical University of Varna, Bulgaria
[2]Second Department of Internal Diseases, Faculty of Medicine, Medical University of Varna, Bulgaria

ABSTRACT

Chronic kidney disease leads to serious complications related to the disability of patients. This gives reason to discuss and work to improve their quality of life. In recent years, attention has been focused on physical activity and renal rehabilitation, in order to overcome movement disorders.

In the Nephrology Clinic at St. Marina University Hospital, Varna, the influence of cardio-cycling exercises on the clinical status of hemodialysis (HD) patients was assessed, objectified by examining laboratory indicators, such as serum phosphorus, serum calcium, iPTH, and CRP.

We studied a total of 69 patients-divided into two groups: control (n = 32) and experimental (n = 37), conducting cardio-cycling exercises. The values of serum phosphorus, calcium, and CRP were examined in both groups at the beginning, at the 3rd and at the 6th month, and the values of iPTH—at the beginning and at the 6th month.

The analyzed data showed that in HD patients performing intradialytic exercises, bone mineral indices improve in terms of Ca and P, but not those for PTH. The highest correlation was found for serum Ca.

In patients with CKD on HD treatment, in whom various techniques of renal rehabilitation were applied, good results were reported in the volume and cycling. The cooperation of patients is important. This requires convincing them of the positive effect of the test and its implementation in order to improve their tone and physical activity.

Keywords: *cardio-cycling exercises, MBD-CKD, patients on hemodialysis treatment, renal rehabilitation*

Address for correspondence:
Magdalena Bliznakova
Faculty of Medicine
Medical University of Varna
55 Marin Drinov St
9002 Varna, Bulgaria
e-mail: maggie.bliznakova@gmail.com

Received: February 7, 2024
Accepted: March 23, 2024

INTRODUCTION

Chronic kidney disease (CKD) is a global health problem associated with reduced life expectancy. In patients with end-stage CKD (ESKD) undergoing hemodialysis (HD) treatment, it is reduced by nearly 75%. Limited functional physical capacity is also observed, which is 70% of that of clinically healthy individuals, and with the onset of HD, its values decrease



© The Author(s) 2024. This is an open access article distributed under the Creative Commons Attribution License (CC BY), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

to 50%. In patients on HD treatment, a high level of disability is also reported as a result of the main complications of CKD and a sedentary lifestyle, which negatively affects the ability to perform their daily activities normally (1–4).

Chronic kidney disease presents with various clinical manifestations and complications. One of them is mineral and bone disorder (MBD) (5). It is characterized by bone pain and pathological bone fractures. Bone disease in CKD has a key role in terms of the quality of life and is a factor in the permanent disability of patients (6–10).

The KDIGO (Kidney Disease: Improving Global Outcomes) Foundation recognizes that CKD involves systemic disorders of mineral and bone metabolism (11–15).

In renal failure, due to disturbances in bone mineral homeostasis, the following occur: phosphorus (P) retention, hypocalcemia, increased plasma concentrations of fibroblast growth factor-23 (FGF-23) and PTH, bone fragility, and vascular calcification (16–18). These changes lead to pathological changes in bone metabolism, vascular and soft tissue calcifications (19–22). They form the MBD-CKD syndrome in patients with CKD. The latter develops secondarily as a result of progressive loss of nephrons and renal function. The ability of the kidneys to excrete phosphorus and form calcitriol is gradually limited (23–25).

Control of elevated serum P, Ca levels, restoration of vitamin D levels, and suppression of PTH production are indications for effective treatment of MBD-CKD (26–30).

Chronic kidney disease leads to serious complications associated with disability of patients. This gives reason to discuss and work to improve their quality of life (31–33). In recent years, attention has been focused on physical activity and renal rehabilitation in order to overcome movement disorders. The teamwork of nephrologists and physicians specializing in physical and rehabilitation medicine is aimed at searching for new innovative methods in this direction.

MATERIALS AND METHODS

In the Nephrology Clinic at St. Marina University Hospital, Varna, the influence of cardio-cycling exercises on the clinical status of HD patients was assessed, objectified by examining laboratory parameters, such as serum P, serum Ca, iPTH, and CRP.

We studied a total of 69 patients divided into two groups: control (n = 32), 18 men and 14 women, and experimental, performing intradialysis cardio-cycling exercises (n = 37), 21 men and 16 women (Table 1). Patients in both study groups received therapy with both calcimimetics and erythropoietin to optimize and maintain serum Ca, P, and parathyroid hormone levels, as well as a target hemoglobin level of 110–115 g/L.

The levels of serum P, Ca, and CRP were examined in both groups at the beginning of the study, at the 3rd and 6th months, and the values of iPTH—at the beginning and at the 6th month.

All patients have declared in writing their willingness to participate in the study, and we followed a previously developed detailed protocol, approved by the Ethics Committee at MU-Varna by decision 129/06.04.23.

Table 1. Distribution of patients by groups.

Group	0	Control
	1	Experimental

RESULTS

When comparing the serum P values at the beginning of the study at the 3rd and 6th month, we found a statistically significant difference in both groups in terms of P levels in all three studied periods (Table 2).

The comparative analysis regarding CRP values (Table 3) between the two groups did not report a sig-

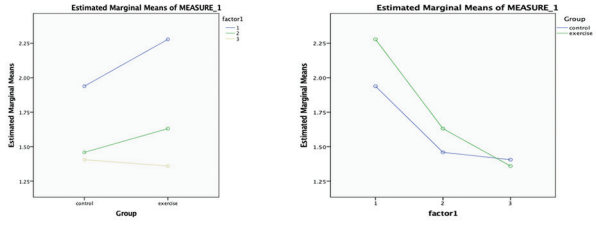


Fig. 1. Levels of P in both groups at the beginning and at the 6th month.

Table 2. Comparison of the P levels.

Serum Phosphorus Levels			
	Total	Experimental Group	Control Group
	n = 69	n = 37	n = 32
Initial measurement	1.78 (0.460)	1.85 (0.427)	1.71 (0.491)
Level at the 3rd month	1.61 (0.447)	1.54 (0.358)	1.69 (0.524)
Level at the 6th month	1.45 (0.343)	1.38 (0.225)	1.55 (0.425)

Table 3. Comparison of the CRP values.

CRP Values				
	Total	Experimental Group	Control Group	p Value
	n = 69	n = 37	n = 32	
Initial measurement average (SD)	17.4 (26.28)	17.1 (18.26)	17.7 (28.89)	0.056
Level at the 3rd month average (SD)	13.6 (26.25)	12.4 (27.27)	15.1 (26.28)	0.002
Level at the 6th month average (SD)	7.3 (9.10)	6.8 (8.59)	7.9 (9.77)	0.069

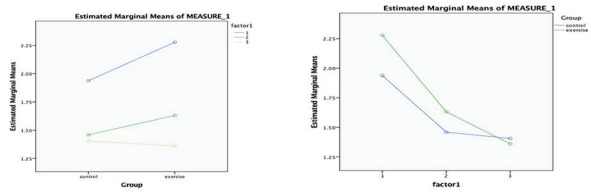


Fig. 2. CRP values in both groups at the beginning of the 6th month.

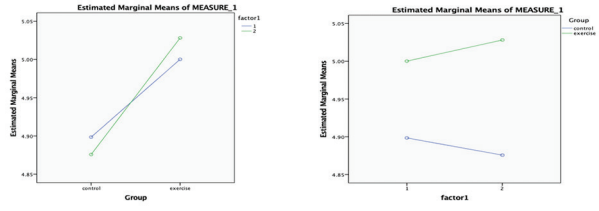


Fig. 3. iPTH levels in both groups at the beginning and at the 6th month.

nificant difference, but there was statistical significance when comparing the results at the 3rd month.

We performed a comparative analysis regarding iPTH levels, both between the two groups of patients and for a period of 6 months; statistical significance was not found in the subjects studied in both groups (Table 4).

Serum Ca levels were compared at the beginning, at the 3rd and 6th month in both groups of patients.

From the obtained results, we established significance in our experimental group of patients. No statistical significance was reported in the control group. The statistical reliability in the experimental

Table 4. Comparison of iPTH levels.

PTH Levels				
	Total	Experimental Group	Control Group	p Value
	n = 69	n = 37	n = 32	
Initial measurement average (SD)	347.9 (535.16)	423.4 (625.20)	260.5 (399.52)	0.21
Level at the 6th month average (SD)	340.7 (560.95)	407.1 (616.37)	263.9 (487.55)	0.294

Table 5. Comparison of the serum Ca levels.

Ca Levels				
	Total	Experimental Group	Control Group	p Value
	n = 69	n = 37	n = 32	
Initial measurement average (SD)	2.1 (0.104)	2.1 (0.100)	2.1 (0.109)	0.916
Level at the 3rd month average (SD)	2.2 (0.167)	2.3 (0.119)	2.1 (0.149)	0.680
Level at the 6th month average (SD)	2.2 (0.237)	2.4 (0.089)	2.0 (0.244)	0.633

group was proven already at the 3rd month of conducting cardio-cycling physical exercises.

The analyzed data showed that when performing intradialysis exercises in HD patients, bone mineral indices improve in terms of Ca and P, but not those for PTH. The highest correlation was found for serum Ca.

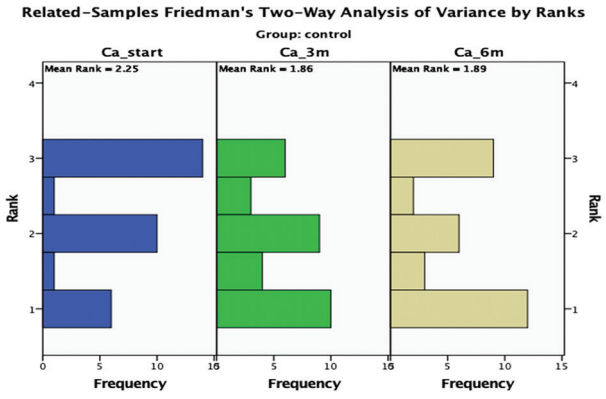


Fig. 4. Ca levels in the control group at the beginning, at the 3rd month, and at the 6th month.

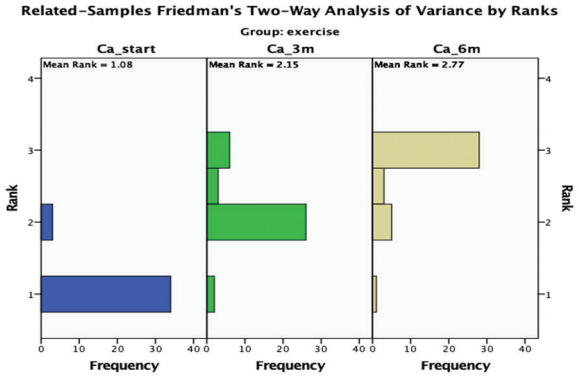


Fig. 5. Ca levels in the experimental group at the beginning, at the 3rd month, and at the 6th month.

CONCLUSION

Chronic kidney disease is a global problem. It is extremely important to prevent its development on the one hand, and on the other hand, to slow down its progression once it has already developed. This requires knowledge of its causes, as well as their timely prevention. A method of treating CKD is replacement therapy, including chronic dialysis. The latter allows for the cleansing of toxins and at the same time supports the function of individual organs and systems. In addition to the symptoms of CKD, patients who are on long-term dialysis also develop complications. One of the severe complications of CKD are disorders of bone and mineral metabolism.

It is extremely important to implement a team approach in chronic dialysis patients. It should include not only nephrologists, but also general practitioners and, last but not least, physical and rehabilitation medicine doctors. The survey conducted among patients with CKD, in whom various techniques of renal rehabilitation were applied, incl. cycling, demonstrated good results. Patient cooperation of the is important. This requires convincing them of the positivity of the test and its implementation in order to improve their tone and physical activity.

REFERENCES

1. Canaud B, Tong L, Tentori F, Akiba T, Karaboyas A, Gillespie B, et al. Clinical practices and outcomes in elderly hemodialysis patients: results from the Dialysis Outcomes and Practice Patterns Study (DOPPS). Clin J Am Soc Nephrol. 2011 Jul;6(7):1651-62. doi: 10.2215/CJN.03530410.

2. Josse M, Patrier L, Isnard M, Turc-Baron C, Grandperrin A, Nottin S, et al. Cardioprotective Effect of Acute Intradialytic Exercise: A Comprehensive Speckle-Tracking Echocardiography Analysis. J Am Soc Nephrol. 2023 Aug 1;34(8):1445-55. doi: 10.1681/ASN.0000000000000149.

3. Moinuddin I, Leehey DJ. A comparison of aerobic exercise and resistance training in patients with and without chronic kidney disease. Adv Chronic Kidney Dis. 2008 Jan;15(1):83-96. doi: 10.1053/j.ackd.2007.10.004.

4. Yamada S, Tsuruya K, Kitazono T, Nakano T. Emerging cross-talks between chronic kidney disease-mineral and bone disorder (CKD-MBD) and malnutrition-inflammation complex syndrome (MICS) in patients receiving dialysis. Clin Exp Nephrol. 2022 Jul;26(7):613-629. doi: 10.1007/s10157-022-02216-x.

5. Yonova D. Disorders of bone and mineral metabolism in chronic kidney disease, dialysis and kidney transplantation. In: Paskalev E, editor. Nephrology. Ed. Sofia, Bulgarresurs; 2015. pp. 725-46.

6. Afsar B, Siriopol D, Aslan G, Eren OC, Dagel T, Kilic U, et al. The impact of exercise on physical function, cardiovascular outcomes and quality of life in chronic kidney disease patients: a systematic review. Int Urol Nephrol. 2018;50(5):885. doi: 10.1007/s11255-018-1790-4.

7. Alem AM, Sherrard DJ, Gillen DL, Weiss NS, Beresford SA, Heckbert SR, et al. Increased risk of hip fracture among patients with end-stage renal disease. Kidney Int. 2000 Jul;58(1):396-9. doi: 10.1046/j.1523-1755.2000.00178.x.

8. Arbor. DOPPS Practice Monitor -- Content Navigator [Internet]. Dopps.org. 2023. Available from: https://www.dopps.org/DPM-HD/DPMSlideBrowser.aspx

9. Jung TD, Park SH. Intradialytic exercise programs for hemodialysis patients. Chonnam Med J. 2011 Aug;47(2):61-5. doi: 10.4068/cmj.2011.47.2.61.

10. K/DOQI Workgroup. K/DOQI clinical practice guidelines for cardiovascular disease in dialysis patients. Am J Kidney Dis. 2005 Apr;45(4 Suppl 3):S1-153.

11. Chen X, Mao G, Leng SX. Frailty syndrome: an overview. Clin Interv Aging. 2014 Mar 19;9:433-41. doi: 10.2147/CIA.S45300.

12. Chigira Y, Oda T, Izumi M, Yoshimura T. Effects of exercise therapy during dialysis for elderly patients undergoing maintenance dialysis. J Phys Ther Sci. 2017 Jan;29(1):20-3. doi: 10.1589/jpts.29.20.

13. Cosman F, de Beur SJ, LeBoff MS, Lewiecki EM, Tanner B, Randall S, et al. Clinician's Guide to Prevention and Treatment of Osteoporosis. Osteoporos Int. 2014 Oct;25(10):2359-81. doi: 10.1007/s00198-014-2794-2.

14. Greenland P, Blaha MJ, Budoff MJ, Erbel R, Watson KE. Coronary Calcium Score and Cardiovascular Risk. J Am Coll Cardiol. 2018 Jul 24;72(4):434-47. doi: 10.1016/j.jacc.2018.05.027.

15. Yamada S, Tsuruya K, Taniguchi M, Tokumoto M, Fujisaki K, Hirakata H, et al. Association Between Serum Phosphate Levels and Stroke Risk in Patients Undergoing Hemodialysis: The Q-Cohort Study. Stroke. 2016 Sep;47(9):2189-96. doi: 10.1161/STROKEAHA.116.013195.

16. Christodoulou M, Aspray TJ, Schoenmakers I. Vitamin D Supplementation for Patients with Chronic Kidney Disease: A Systematic Review and Meta-analyses of Trials Investigating the Response to Supplementation and an Overview of Guidelines. Calcif Tissue Int. 2021 Aug;109(2):157-178. doi: 10.1007/s00223-021-00844-1.

17. Cobo G, Lindholm B, Stenvinkel P. Chronic inflammation in end-stage renal disease and dialysis. Nephrol Dial Transplant. 2018 Oct 1;33(suppl_3):iii35-iii40. doi: 10.1093/ndt/gfy175.

18. Zamojska S, Szklarek M, Niewodniczy M, Nowicki M. Correlates of habitual physical activity in chronic haemodialysis patients. Nephrol Dial Transplant. 2006 May;21(5):1323-7. doi: 10.1093/ndt/gfi323.

19. Manfredini F, Mallamaci F, D'Arrigo G, Baggetta R, Bolignano D, Torino C, et al. Exercise in Patients on Dialysis: A Multicenter, Randomized Clinical Trial. J Am Soc Nephrol. 2017 Apr;28(4):1259-68. doi: 10.1681/ASN.2016030378.

20. Mohseni R, Emami Zeydi A, Ilali E, Adib-Hajbaghery M, Makhlough A. The effect of intradialytic aerobic exercise on dialysis efficacy in hemodialysis patients: a randomized controlled trial. Oman Med J. 2013 Sep;28(5):345-9. doi: 10.5001/omj.2013.99.

21. Rogers M, Goettsch C, Aikawa E. Medial and intimal calcification in chronic kidney disease: stressing the contributions. J Am Heart Assoc. 2013 Sep 23;2(5):e000481. doi: 10.1161/JAHA.113.000481.

22. Stewart P. Exercise and a cycle of life: help us help ourselves. Adv Ren Replace Ther. 1999 Apr;6(2):184-6. doi: 10.1016/s1073-4449(99)70049-x.

23. Nakanishi T, Nanami M, Kuragano T. The pathogenesis of CKD complications; Attack of dysregulated iron and phosphate metabolism. Free Radic Biol Med. 2020 Sep;157:55-62. doi: 10.1016/j.freeradbiomed.2020.01.024.

24. Rodelo-Haad C, Rodríguez-Ortiz ME, Martin-Malo A, Pendon-Ruiz de Mier MV, Agüera ML, Muñoz-Castañeda JR, et al. Phosphate control in reducing FGF23 levels in hemodialysis patients. PLoS One. 2018 Aug 7;13(8):e0201537. doi: 10.1371/journal.pone.0201537.

25. Roetker NS, Peng Y, Ashfaq A, Gilbertson DT, Wetmore JB. Adherence to Kidney Disease: Improving Global Outcomes Mineral and Bone Guidelines for Monitoring Biochemical Parameters. Am J Nephrol. 2019;49(3):225-232. doi: 10.1159/000497477.

26. Greenwood SA, Koufaki P, Macdonald JH, Bulley C, Bhandari S, Burton JO, et al. Exercise programme to improve quality of life for patients with end-stage kidney disease receiving haemodialysis: the PEDAL RCT. Health Technol Assess. 2021 Jun;25(40):1-52. doi: 10.3310/hta25400.

27. Greenwood SA, Koufaki P, Macdonald JH, Bhandari S, Burton JO, Dasgupta I, et al. Randomized Trial-PrEscription of intraDialytic exercise to improve quAlity of Life in Patients Receiving Hemodialysis. Kidney Int Rep. 2021 May 30;6(8):2159-70. doi: 10.1016/j.ekir.2021.05.034.

28. Groussard C, Rouchon-Isnard M, Coutard C, Romain F, Malardé L, Lemoine-Morel S, et al. Beneficial effects of an intradialytic cycling training program in patients with end-stage kidney disease. Appl Physiol Nutr Metab. 2015 Jun;40(6):550-6. doi: 10.1139/apnm-2014-0357.

29. Smart N, Steele M. Exercise training in haemodialysis patients: a systematic review and meta-analysis. Nephrology (Carlton). 2011 Sep;16(7):626-32. doi: 10.1111/j.1440-1797.2011.01471.x.

30. Storer TW, Casaburi R, Sawelson S, Kopple JD. Endurance exercise training during haemodialysis improves strength, power, fatigability and physical performance in maintenance haemodialysis patients. Nephrol Dial Transplant. 2005 Jul;20(7):1429-37. doi: 10.1093/ndt/gfh784.

31. Alfaadhel TA, Soroka SD, Kiberd BA, Landry D, Moorhouse P, Tennankore KK. Frailty and mortality in dialysis: evaluation of a clinical frailty scale. Clin J Am Soc Nephrol. 2015 May 7;10(5):832-40. doi: 10.2215/CJN.07760814.

32. Choi RB, Robling AG. The Wnt pathway: An important control mechanism in bone's response to mechanical loading. Bone. 2021 Dec;153:116087. doi: 10.1016/j.bone.2021.116087.

33. Mallamaci F, Pisano A, Tripepi G. Physical activity in chronic kidney disease and the EXerCise Introduction To Enhance trial. Nephrol Dial Transplant. 2020 Mar 1;35(Suppl 2):ii18-ii22. doi: 10.1093/ndt/gfaa012.