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RESEARCH ARTICLE

EFFECT OF HIGH TONE THERAPY ON SELECTIVE KIDNEY FUNCTIONS IN HEMODIALYSIS PATIENTS

[1,*]Prof. Dr. Hany Ezz at Obay, [2]Prof. Dr. Khalid Taha Yassin Turky and [3]Prof. Dr. Sahier Omar El-khashab

[1]Professor of Physical Therapy for Cardiovascular /Respiratory Disorder & Geriatrics, Faculty of Physical Therapy, Cairo University; [2]Assistant Professor of Physical Therapy for Internal Medicine and Geriatrics, Faculty of Physical Therapy October 6th University; [3]Professor of Medicine and Nephrology, Faculty of Medicine, Cairo University; (Master Thesis, 2021)

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ABSTRACT

Background: Chronic kidney disease (CKD) is the progressive deficiency of renal function that reach life threatening stage. ***Aim of Study:*** This study was be conducted to investigate the therapeutic effectiveness of High Tone Therapy (HTT) on selective kidney functions in hemodialysis patients. ***Subjects and Methods:*** Forty CKD patient received hemodialysis three times per week participated in this study and were recruited from the Nephrology and hemodialysis Unit at Cairo University hospital (kasr Al-ainy). Their ages ranged from 45 to 60 years old. All patients were divided randomly into two groups: study group (A) 30 patients received high tone therapy on quadriceps for one hour three times per week during hemodialysis for four weeks and control group (B) 10 patients.Measurements including Urea and creatininemeasured two times, before the treatment and after 4 weeks at the end of the study. ***Results:*** The current study showed significant decrease ofUrea and Creatinine in HTT group compared with control group. ***Conclusion:*** External muscle stimulation in form of High-Tone Therapy was able to improve ureal and creatininelevel in hemodialysis patients.

INTRODUCTION

Chronic kidney disease (CKD) is a clinical syndrome characterized by an irreversible change of kidney function and/or structure when approximately 90% of renal function has been lost, rendering the body incapable of maintaining proper fluid and electrolyte balance, adequate waste removal, and normal hormonal function (Parsons, Toffelmire and King-VanVlack, 2006). At this progressive stage the kidneys have missing almost all their capability to do their function effectively, and finally dialysis or a kidney transplant is required. Furthermore, In CKD, there is a greater prevalence of malnutrition, long-lasting inflammation, oxidative stress, anemia, vitamin D deficiency, insulin resistance, functional capacity decline, muscle wasting, and cachexia (Iorember, 2018). Hemodialysis (HD) is a renal replacement therapy where urea, creatinine, electrolytes, and free water from the blood are removed. (Batubo *et al.*, 2020). Hemodialysis (HD) therapy is time-consuming that takes at least 4 to 5 hours a day, 3 times a week. Moreover, HD is an expensive and needs fluid and dietary restrictions. Loss of freedom physical, psychological, socioeconomic,are negatively affected, leading to compromised quality of life (QOL) (Ravindran *et al.*, 2020).

Corresponding author:** ***Prof. Dr. Hany Ezz at Obay,
Professor of Physical Therapy for Cardiovascular /Respiratory Disorder & Geriatrics, Faculty of Physical Therapy, Cairo University.

Patients undergoing HD have a significant decrease in functional ability that reaches 50% of peak oxygen uptake (VO_{2peak}) when compared to normal. The decline in functional ability in HD patients is a consequence of uremic myopathy, anemia, cardiovascular abnormalities, comorbidities, and HD-related factors (Garcia *et al*., 2017). Sedentary life, low QOL and reduced VO_{2max} are related to high mortality rate between HD patients (Salhab *et al.*, 2019). The National Kidney Foundation's, Kidney Disease Outcomes Quality Initiative (KDOQI), has set the minimally adequate dose of HD should be greater than 65% of urea reduction ratio (URR). Although aerobic and/or resisted exercises training are effective in improving QOL, they are seldom used in a regular way in HD patients. Despite the guidelines on good clinical practice, recommended exercise training as a part of routine activities is implemented in a very small number of dialysis centers (Stolić *et al.*, 2018).Furthermore, many HDpatients cannot perform self-administered exercise training for their muscle wasting, weakness, and sarcopenia (Sun *et al.*, 2002). Electrical muscle stimulation (EMS) has anadvantage of easy application andhas a minimal risks for HD patients (Suzuki *et al.*, 2018) (Ruiz-Ortega *et al.*, 2020). High tone power therapy is a novel method of EMSfor treatment of painful conditions such as peripheral neuropathy and musculoskeletal system. High Tone therapy is a new quantum leap in the field of electrotherapy built on the idea that not only active exercise improves the

metabolism, but also "passive" in the form of external electrical muscle stimulation (Heidland *et al.*, 2012). This study aimed to investigate the effect on blood urea and creatinineon HD patients.

MATERIAL AND METHODS

The study approved by the Ethics Committee of the Faculty of Physical Therapy, Cairo University. A written informed consent was obtained from all the patients . All patients have ESRD on HD were recruited from the Nephrology and hemodialysis Unit at Cairo University hospital (Qasr El Eyni Hospital) to ensure that all patient received the same protocol. The inclusion criteria were patient with CKD received HD three times weekly, their ages ranged from 45 to 60 years., both genders were included. The exclusion criteria were uncontrolled diabetes mellitus (DM), uncontrolled hypertension. patients with a pacemaker, a recent myocardial infarction (MI). Patient also excluded if they hadgastrointestinal bleeding,recent trauma, severe infection, starvation, corticosteroid use.

Study design: A pre and post study design in which the selected patient was divided randomly into either high tone therapy group or control group. Both groups evaluated by the same manner.

Procedure

Assessment

Laboratory investigation: The use of creatinine or urea measurement to assess renal function is that plasma/serum levels of both reflect glomerular filtration rate (GFR), the parameter that defines kidney function for the clinician. Blood samples were drawn for selected kidney function which was blood urea and creatinine level.

Intervention: Patients in high tone therapy group received HTT during the HD process three times per week for one hour. High tone therapy was performed using a HiToP191 device; (gbo Medizintechnik, Rimbach, Germany). The device provides external muscle electrical therapy inform of middle frequency waves . The placement of four electrodes placed at both femoral muscles. The intensity of HTT was adjusted appropriately to produce contraction of both quadriceps without producing discomfort or pain lasting for one hour every session. While patients in control group advised to do their usual daily level activity without intervention.

Statistical analysis: Unpaired t-test were conducted for comparison of subject characteristics between groups. Chi-squared test was used for comparison of sex distribution between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to ensure the homogeneity between groups. Mixed design MANOVA was performed to compare within and between groups effects on urea before dialysis, urea after dialysis, creatinine before dialysis and creatinine after dialysis. Post-hoc tests using the Bonferroni correction were carried out for subsequent multiple comparison. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

RESULTS

Forty CKD patient received HD participated in this study. All patients divided into either high tone therapy group or control group. All patients in high tone therapy group received HTT on quadriceps lasting one hour three times per week during dialysis for one month. While The outcome measures where selective kidney function tests include blood urea and creatinine level.

Subject characteristics: Table 1 showed the subject characteristics of high tone therapy group and control groups. There was no significant difference between groups in the mean age, weight, height, BMI and duration of illness ($p > 0.05$). Also, there was no significant difference in the distribution of sex between groups ($p > 0.05$).

Effect of treatment on urea before dialysis, urea after dialysis, creatinine before dialysis and creatinine after dialysis

Mixed MANOVA revealed that there was a significant interaction of treatment and time ($F = 27.69$, $p = 0.001$). There was a significant main effect of time ($F = 39.48$, $p = 0.001$). There was a significant main effect of treatment ($F = 4.42$, $p = 0.006$).

Within group comparison: There was a significant decrease in urea before and after dialysis and creatinine before and after dialysis post treatment in high tone therapy group post treatment compared with that pretreatment ($p < 0.001$). There was no significant change in urea before and after dialysis and creatinine before and after dialysis in the control group post treatment compared with that pretreatment ($p > 0.05$) (table 2).

Between groups comparison: There was no significant difference in all parameters between groups pre-treatment ($p > 0.05$). There was a significant decrease in urea before dialysis, urea after dialysis, creatinine before dialysis and creatinine after dialysis of high tone therapy group compared with that of control group post treatment ($p < 0.05$) (table 2).

DISCUSSION

The primary purpose of the study was to evaluate the potential modulation of blood urea and creatinine level. The current study showed an improvement of blood urea and creatinine level in high tone therapy group compared with control group in high tone therapy group. Our hypothesis deals with the concept that HTT might improve blood urea due to improved removal of uremic toxins into vascular compartments during dialysis. Measurement of urea concentration has established role in monitoring the HD adequacy, the life-preserving renal replacement therapy for patients with ESRD(Mathew *et al*., 2016). Di Micco *et al*., 2015 reported beneficial effects of HTT on renal function with increment of urine output and of urinary creatinine excretion in subjects with severe muscle atrophy following absence of physical activity. This result supported by the observation of other authors who reportedthat transcutaneous electrical nerve stimulation (TENS) increased the microcirculation of the intact skin in healthy volunteers (Wikstr□m *et al.*, 1999).Also, HTT of the thighs increase the blood flow of the lowerlimbs. (Humpert *et al.*, 2006).

Table 1. Basic characteristics of participants

	High tone therapy group	Control group	
	Mean ± SD	Mean ± SD	p-value
Age (years)	51.46 ± 9	54.5 ± 5.1	0.32*
Weight (kg)	73.23 ± 13.8	70.7 ± 11.72	0.61*
Height (cm)	164.96 ± 7.74	162.4 ± 7.48	0.37*
BMI (kg/m²)	26.71 ± 4.08	26.63 ± 5	0.96*
Duration of illness (years)	1.92 ± 1.06	1.58 ± 0.81	0.36*
Sex			
Females	14 (54%)	6 (60%)	0.73*
Males	12 (46%)	4 (40%)	

SD, Standard deviation; p value, Probability value: * insignificant

Table 2. Mean urea before dialysis, urea after dialysis, creatinine before dialysis and creatinine after dialysis pre and post treatment of the study and control groups

	Pre	Post			
	Mean ± SD	Mean ± SD	MD	% of change	p value
Urea before dialysis (mg/dl)					
High tone therapy group	128.03 ± 37.32	96.88 ± 29.48	31.15	24.33	0.001**
Control group	118.5 ± 33.76	122.1 ± 30.89	-3.6	3.04	0.75*
	p = 0.48	*p = 0.03*			
Urea after dialysis (mg/dl)					
High tone therapy group	54.9 ± 15.35	26.5 ± 10.25	28.4	51.73	0.001**
Control group	55.7 ± 14.77	59.1 ± 14.91	-3.4	6.1	0.4*
	p = 0.88	*p = 0.001*			
Creatinine before dialysis (mg/dl)					
High tone therapy group	7.13 ± 1.67	3.5 ± 0.97	3.64	51.05	0.001**
Control group	6.76 ± 2.2	6.27 ± 2.01	0.5	8.17	0.13*
	p = 0.58	*p = 0.001*			
Creatinine after dialysis (mg/dl)					
High tone therapy group	6.21 ± 1.83	2.57 ± 1.07	3.64	58.62	0.001**
Control group	6.12 ± 1.56	5.68 ± 1.15	0.44	7.19	0.16*
	p = 0.89	*p = 0.001*			

SD, Standard deviation; MD, Mean difference; p-value, Level of significance. ** ; significant .* ; insignificant

In another study of healthy volunteers, HTTresulted in a significant transient increase of creatinine clearance and fractional sodium excretion. (Peckova *et al.*, 2013). Iorio *et al.* concluded that HTT showed a significant shorter duration of oliguria, a faster decline of serum creatinine and urea levels, less need of dialysis treatment and a shorter period of hospitalization for patient with acute kidney injury. This finding suggests a reduced catabolism of muscle proteins which – via a lower release of amino acids into the circulation – results in a decline of hepatic ureagenesis. Dobsak *et al*., proved that electrical stimulation of lower limb extensors is an adequate alternative of aerobic exercise training in HD patients which leads to a significant improvement of fitness, muscle power, and certain parameters of quality of life.

The metabolic effects of electrical stimulation showed an increase in muscle oxidative capacity of the lower extremities of healthy humans was shown to enhance energy consumption, carbohydrate oxidation, and whole-body glucose uptake (Martin *et al.*, 1992). (Hamada *et al.*, 2003). Compared with voluntary cycling exercise at an identical intensity, electrical stimulation resulted in a higher respiratory gas exchange ratio, indicating higher carbohydrate oxidation. Further explanation of patients who receive HTT are there HTT increase of ATP production, improve mitochondrial function, activation of anti-oxidative stress and decrease insulin resistance which is an important risk factor of muscle wasting (Reichstein, 2005). In line with these observations of enhanced glucose metabolism, HTT (one hour/day) induced a significant improvement in HbA1c (–0.6%) over a treatment period of 6 weeks, associated with a decline in body weight (–1.4 kg) (Rose *et al.*, 2007).

Conclusion

External muscle stimulation in form of HTT was able to improve blood urea and creatinine level in HD patients may lead to positive effects on low physical capacity, making HTT a viable, intermediate treatment strategy.

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REFERENCES

Alshimy, A. M. *et al.* 2020. 'Effect of high tone power ;kml;mk on neurophysiological measures and function outcome in patients with diabetic neuropathy', *European Journal of Molecular and Clinical Medicine*, 79., pp. 269–275. doi: 10.31525/ct1-nct03888872.

Bogataj, Š. *et al.* 2019. 'Exercise-Based Interventions in Hemodialysis Patients: A Systematic Review with a Meta-Analysis of Randomized Controlled Trials', *Journal of Clinical Medicine*, 91., p. 43. doi: 10.3390/jcm9010043.

Brown, P. D. S. *et al.* 2018. 'Impact of intradialytic exercise intensity on urea clearance in hemodialysis patients', *Applied Physiology, Nutrition and Metabolism*, 431., pp. 101–104. doi: 10.1139/apnm-2017-0460.

Chilibeck, P. D. *et al.* 1999. 'Functional electrical stimulation exercise increases GLUT-1 and GLUT-4 in paralyzed skeletal muscle', *Metabolism*, 4811., pp. 1409–1413.

Dobsak, P. *et al.* 2012. 'Intra-dialytic electrostimulation of leg extensors may improve exercise tolerance and quality of life in hemodialyzed patients', *Artificial Organs*, 361., pp. 71–78. doi: 10.1111/j.1525-1594.2011.01302.x.

Fleischli, J. G. and Laughlin, T. J. 1997. 'Electrical stimulation in wound healing', *The Journal of Foot and Ankle Surgery*, 366., pp. 457–461.

García Testal, A. *et al.* 2019. 'Influence of Physical Exercise on the Dialytic Adequacy Parameters of Patients on Hemodialysis', *Therapeutic Apheresis and Dialysis*, 232., pp. 160–166. doi: 10.1111/1744-9987.12762.

Hamada, T. *et al.* 2003. 'Enhancement of whole-body glucose uptake during and after human skeletal muscle low-frequency electrical stimulation', *Journal of Applied Physiology*, 946., pp. 2107–2112.

Hamada, T. *et al.* 2004. 'Electrical stimulation of human lower extremities enhances energy consumption, carbohydrate oxidation, and whole-body glucose uptake', *Journal of Applied Physiology*, 963., pp. 911–916.

Humpert, P. M. *et al.* 2006. 'Hochfrequente Muskelstimulation zur Behandlung schmerzhafter Neuropathie bei Typ 2 Diabetikern verbessert die mikrovaskuläre Endothelzellfunktion', *Diabetologie und Stoffwechsel*, 1S 1., p. A128.

Iorio, B. Di *et al.* 2012. 'High-frequency external muscle stimulation in acute kidney injury AKI. : potential shortening of its clinical course', *Clinical Nephrology*, 79SUPPL. 13., pp. 37–45. doi: 10.5414/CNX77S101.

Jacobs, M. J. *et al.* 1988. 'Epidural spinal cord electrical stimulation improves microvascular blood flow in severe limb ischemia.', *Annals of surgery*, 2072., p. 179.

Kirkman, D. L. *et al.* 2019. 'The effects of intradialytic exercise on hemodialysis adequacy: A systematic review', *Seminars in Dialysis*, 324., pp. 368–378. doi: 10.1111/sdi.12785.

Kono, K. *et al.* 2014. 'Investigation of factors affecting the six-minute walk test results in hemodialysis patients', *Therapeutic Apheresis and Dialysis*, 186., pp. 623–627.

Lu, Y., Wang, Y. and Lu, Q. 2019. 'Effects of exercise on muscle fitness in dialysis patients: A systematic review and meta-analysis', *American journal of nephrology*, 504., pp. 291–302.

Martin, T. P. et al. 1992. 'Influence of electrical stimulation on the morphological and metabolic properties of paralyzed muscle', Journal of Applied Physiology, 724., pp. 1401–1406.

Mathew, A. T. *et al.* 2016. "Preservation of residual kidney function in hemodialysis patients: reviving an old concept," *Kidney international*, 902., pp. 262–271.

Di Micco, L. *et al.* 2015. 'Muscle stimulation in elderly patients with CKD and sarcopenia', *Giornale italiano di nefrologia : organo ufficiale della Societa italiana di nefrologia*, 325., pp. 1–7.

Natoli, J. L. *et al.* 2013. 'Is there an association between elevated or low serum levels of phosphorus, parathyroid hormone, and calcium and mortality in patients with end stage renal disease? A meta-analysis', *BMC Nephrology*, 141.. doi: 10.1186/1471-2369-14-88.

Paluchamy, T. and Vaidyanathan, R. 2018. 'Effectiveness of intradialytic exercise on dialysis adequacy, physiological parameters, biochemical markers and quality of life – A pilot study', *Saudi Journal of Kidney Diseases and Transplantation*, 294., pp. 902–910. doi: 10.4103/1319-2442.239661.

Peckova, M. *et al.* 2013. 'Effects of high-tone external muscle stimulation on renal function in healthy volunteers', *Clinical Nephrology*, 79SUPPL. 13., pp. 34–36. doi: 10.5414/CNX77S105.

Rose, B. *et al.* 2007. 'Externe Muskelstimulation beeinflusst die Diabeteseinstellung: eine neuartige Therapieoption für Typ 2 Diabetes', *Diabetologie und Stoffwechsel*, 2S 1., p. P308.

Scapini, K. B. *et al.* 2019. 'Combined training is the most effective training modality to improve aerobic capacity and blood pressure control in people requiring haemodialysis for end-stage renal disease: systematic review and network meta-analysis', *Journal of physiotherapy*, 651., pp. 4–15.

Somji, S. S., Ruggajo, P. and Moledina, S. 2020. 'Adequacy of Hemodialysis and Its Associated Factors among Patients Undergoing Chronic Hemodialysis in Dar es Salaam, Tanzania', *International Journal of Nephrology*, 2020. doi: 10.1155 /2020/9863065.

Suzuki, T. *et al.* no date. 'Beneficial Effect of Intradialytic Electrical Muscle Stimulation in Hemodialysis Patients: A Randomized Controlled Trial'. doi: 10.1111/aor.13161.

Valenzuela, P. L. *et al.* 2020. 'Intradialytic neuromuscular electrical stimulation improves functional capacity and muscle strength in people receiving haemodialysis: a systematic review', *Journal of Physiotherapy*, 662., pp. 89–96. doi: 10.1016/j .jphys.2020.03.006.

Al Wakeel, J. S. *et al.* 2002. 'Morbidity and mortality in ESRD patients on dialysis', *Saudi Journal of Kidney Diseases and Transplantation*, 134., p. 473.

Wikström, S. O. *et al.* 1999. 'Effect of transcutaneous nerve stimulation on microcirculation in intact skin and blister wounds in healthy volunteers', *Scandinavian journal of plastic and reconstructive surgery and hand surgery*, 332., pp. 195–201.

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