

Responses of Urea, Creatinine and Uric Acid to Soft Tissue and Passive Mobilization in Patients with Renal Diseases Undergoing Haemodialysis

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Abstract

Background: The deterioration of nephrons at an advanced stage of renal disease results to chronic dysfunction of the kidneys, which requires either dialysis treatment or renal transplant. The need to enhance the clearance of by-products of metabolism from the body during haemodialysis spurred the study.

Purpose: To determine Responses of Urea, Creatinine and Uric Acid to Soft Tissue and Passive Mobilization in Patients with Renal Diseases Undergoing Haemodialysis.

Method: This study is a randomized controlled clinical trial. The total of 33 participants (23 males and 10 females) was involved in the study. The participants were randomly and consecutively assigned into two groups as they register for haemodialysis. The treatment group (n=16) received the soft tissue and passive mobilisation prior to haemodialysis. The control group (n=17) had only haemodialysis. In each group, the pre and post-dialysis blood samples for determination of plasma concentration of urea, creatinine and uric acid were taken. Data collected were subjected to descriptive statistics, and analyzed using independent t-test. Probability value less than 0.05 was considered statistically significant. SPSS version 17 was used.

Result: The results showed that soft tissue and passive mobilisation clinically enhances the reduction (p<0.05) of the plasma concentration of creatinine and uric acid after haemodialysis in patients with renal disease. However, there was no significant reduction (p>0.05) in the plasma concentration of urea compare to the control, probably due to low molecular weight of urea.

Conclusion: Soft tissue and passive mobilization enhances fluid kinetics, dislodges metabolites, especially those of high molecular weight such as uric acid, in the interstitial spaces and mobilizes them into the blood stream for clearance.

Implication: Soft tissue and passive mobilization could be utilized as an adjunct to haemodialysis in the clearance of by-products of metabolism in relevant patients.

Keywords: Haemodialysis; Soft Tissue and Passive Mobilisation; Renal Disease

Introduction

Renal disease is a major global health concern. The deterioration of nephrons at an advanced stage results to chronic dysfunction of the kidneys, which requires either dialysis treatment or renal transplant [1]. Breaking tissue adhesions and enhancing fluid kinetics will ensure better clearance of accumulated waste products of metabolism during dialysis [2]. Thus, soft tissue mobilisation of the entire body will likely dislodge pools of metabolites that otherwise might be trapped in interstitial and extracellular spaces. In addition, soft tissue mobilisation breaks tissue adhesions [3], enhances fluid kinetics in tissues, facilitates excretion of metabolites, and invariably enhances cellular vitality [4]. It is plausible that dislodging metabolites from extracellular and interstitial spaces using soft tissue mobilisation, will enhance fluid kinetics and invariably clearance of accumulated products of metabolism during dialysis. This will positively impact the quality of life of patients with renal diseases.

Renal diseases are diverse, but affected individuals frequently present characteristic clinical features. Aetiologically, the pathological process is often slow and insidious. Most of the time, people with early kidney disease have no symptoms, and are unaware that their kidneys are starting to fail. With chronic kidney disease, the kidneys do not usually fail all at once; instead, they deteriorate slowly and progressively over a period of years. The National Kidney Foundation (NKF) in the United States of America, created a guideline to help identify each level of kidney disease [5]. The NKF divided kidney disease into five stages, which are defined by changes in Glomerular Filtration Rate (GFR), which measures how well the kidneys are excreting metabolites from the blood. Stage 1 renal disease presents with normal or high GFR (GFR>90 mL/min). Stage 2 is termed mild chronic kidney disease with GFR ranging from 60-89 mL/min. Stage 3 is moderate chronic kidney disease with GFR ranging from 30-59 mL/min. Stage 4 represents severe chronic kidney disease, which has GFR of 15-29 mL/min, while stage 5 is termed End Stage Renal Disease (ESRD), which presents GFR of less than 15 mL/min [6].

Patients with end stage kidney (Renal) disease, ESRD, are treated with renal replacement therapy including dialysis or kidney transplantation [1]. Dialysis treatment can be haemodialysis or peritoneal dialysis [7]. Haemodialysis is the process of filtering the accumulated waste products of metabolism from the blood of a patient, using a haemodialysis machine. It is one of the most successful alternative treatments for the disease. Around the world, hundreds of thousands of patients have undergone such treatment [8]. In fact, more than one million people with kidney failure in the United States of America, survive on dialysis [2]. Dialysis regulates patients' general condition, fluid-electrolytes balance, and assures the disposal of accumulated toxic substances in the body [1]. Invariably, the aim of haemodialysis is to allow body fluid to pass through the dialyzer so that accumulated wastes in the body can be excreted. Thus, there is a need for adequate tissue and fluid mobilisation for effective clearance of metabolites in the body systems.

According to the National Center for Complementary and Alternative Medicine (NCCAM), soft tissue mobilisation is an act of manipulating soft tissues of the body to achieve many purposes and goals. Target tissues may include skin, muscles, tendons, ligaments, joints, or other connective tissues, as well as lymphatic vessels, and/or organs of the gastrointestinal system [9]. Soft tissue mobilisation also increases alertness and mental clarity, and provides pleasant touch experience [10]. The application of soft tissue mobilisation is known to impact positively on the quality of life of patients on haemodialysis. Such patients are known to experience improved sleep patterns, less fatigue, fewer aches and pains, and feel better in general [11]. Other benefits include the improved blood circulation, better blood pressure control, and reduction in edema and muscle atrophy [12]. In fact, the patients become more active and productive while their outlook on life becomes more positive, which lead to a better quality of life [11].

Based on available scientific evidences, it is plausible to suggest that there can be improved clearance of metabolites at dialysis when the blood flow through the peripheral circulatory system is increased. Thus, as metabolites lodged in the tissue adhesions are released by soft tissue mobilisation, which can be synergised with the therapeutic benefits of therapeutic exercise to improve the excretion of metabolites [4]. These have significant therapeutic value in urea reduction ratio and kt/v during dialysis.

Utilization of Physiotherapy modalities such as soft tissue and passive mobilization, in the care of patients with renal disease is a rapidly evolving area, but there is paucity of data on the utilization any health facility in Nigeria. Most patients do not achieve the target clearance rate during dialysis, which contributes to burden of the disease. This situation demands new innovation that will address these challenges, and possibly ensure that the desired target clearance rate is achieved. There is paucity of data on the effect of soft tissue and passive mobilization on the clearance of by-products of metabolism among patients with renal diseases undergoing haemodialysis in Nigeria.

Methodology

This study adopted an experimental design and was conducted at the Renal Unit of University of Nigeria Teaching Hospital, Ituku/Ozalla and Dialysis Unit of Neo Hospital, Enugu, Enugu State, Nigeria. Ethical approval was obtained from the Human Research and Ethics Committee of University of Nigeria Teaching Hospital Ituku/Ozalla and informed consent was obtained from each patient prior to the study. The total number of participants in the study was 40 (28 males and 12 females). However, seven had incomplete result from the laboratory, and thus were dropped. Therefore data for 33 participants were presented in the study.

The primary participant was randomly assigned into either of the two groups (A, treatment and B, control). Others were consecutively assigned to alternate groups as they register for haemodialysis. Group A were 16 participants (11 males and 5 females). Group B (control group) were 17 participants (12 males and 5 females). Group A had haemodialysis sessions, which were preceded by a 30 min session of soft tissue and passive mobilisation. Soft tissue mobilisation was done on the subject using the following techniques: kneading, gentle stroking, cupping, effleurage and joint passive mobilisation. Areas of the body tissue that were mobilised include: lower limbs, upper limbs, back and abdomen. Group B had haemodialysis only. Blood samples of 3 mL were collected pre and post dialysis for the determination of plasma concentration of urea, uric acid and creatinine at the Chemical Pathology Department of University of Nigeria Teaching Hospital Itukku/Ozalla. Data collected were subjected to descriptive statistics, and analyzed using independent t-test. Probability value less than 0.05 was considered statistically significant (Table 1).

	Test group (N=16)	Control (N=17)	Percentage (%)	p-value		
Age (years)	47.88 ± 16.81	47.41 ± 18.00		0.94		
Gender						
Male	11	12	69.7			
Female	5	5	30.3	0.813		
Occupation						
Civil servants	7	8	45.5			

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Traders	3	4	21.2	0.795		
Farmers	1	0	3			
Retired	3	3	18.2			
Students	2	2	12.1			
Religion						
Christianity	16	17	100			

Table 1: Demographic Distribution of participants (N=33).

Results

The pre-dialysis and post-dialysis values for plasma urea for group A were: 22.63 ± 6.55 and 14.88 ± 6.53 ; for group B were: 20.41 ± 3.38 and 12.71 ± 4.15 . There was a significant difference (p<0.05) in the pre

and post dialysis plasma urea values in both groups. There was no significant difference (p>0.05) in plasma urea values between groups A and B after dialysis (Table 2).

Urea	Pre dialysis	Post dialysis	t-value	p-value	Eff size
Test group (N=16)	22.63 ± 6.55	14.88 ± 6.53	8.15	>0.001	1.19
Control group (N=17)	20.41 ± 3.38	12.71 ± 4.15	11.95	>0.001	2.05
t-value	1.24	1.15			
p-value	0.225	0.281			

Table 2: Plasma concentration of urea in the subjects (N=33).

The pre and post dialysis values for plasma uric acid for group A were: 484.13 ± 133.97 and 176.31 ± 90.37 ; for group B were: 557.84 ± 180.95 and 268.64 ± 89.48 . There was a significant difference (p<0.05) in the pre and post dialysis plasma uric acid values in both groups.

There was significant difference (p<0.05) in plasma uric acid between groups A and B such that group A recorded lower plasma values after dialysis (Table 3).

Uric acid	Pre dialysis	Post dialysis	t-value	p-value	Eff size
Test group (N=16)	484.13 ± 133.97	176.31 ± 90.37	10.14	<0.001	2.74
Control group (N=17)	557.84 ± 180.95	268.64 ± 89.48	7.62	<0.001	2.14
t-value	-1.33	-2.948			
p-value	0.195	0.006			

Table 3: Plasma concentration of uric acid in the subjects (N=33).

The pre and post dialysis values for plasma creatinine for group A were: 870.13 ± 364.37 and 334.94 ± 144.01 ; for group B were: 1198.71 ± 467.99 and 593.00 ± 265.37 . There was a significant difference (p<0.05) in the pre and post dialysis plasma creatinine values in both groups.

There was a significant difference (p<0.05) in plasma creatinine between groups A and B such that group A recorded lower plasma values after dialysis (Table 4).

Creatinine	Pre dialysis	Post dialysis	t-value	p-value	Eff size
Test group (N=16)	870.13 ± 364.37	334.94 ± 144.01	7.57	>0.001	2.11
Control group (N=17)	1198.71 ± 467.99	593.00 ± 265.37	8.443	>0.001	1.65
t-value	-2.24	-3.44			

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p-value	0.032	0.002		

 Table 4: Plasma concentration of creatinine in the subjects (N=33).

Discussion

The results of the study show that there was no significant difference in the plasma concentration of urea between the two groups prior and after haemodialysis. Low molecular weight of urea, 60.06 g/mol, may have put urea clearance at advantage over creatinine (113.12 g/mol) and uric acid (168.11 g/mol). This low value makes urea to move across membranes more easily, making soft tissue and passive mobilisation irrelevant for the clearance of urea. Though significant mean reductions in plasma urea concentration were evident after haemodialysis, when within-group comparisons were made, the difference in mean recorded for the control was not superior to that recorded for the test group.

There was a significant reduction in plasma concentration of uric acid after haemodialysis in patients with renal disease treated with soft tissue mobilisation and passive mobilisation compared to patients that do not receive the treatment. Uric acid is one the most important purine metabolites that are retained in uremia. These metabolites constitute a major class of uremic toxins, which can negatively affect the metabolism of vitamin D and calcitriol [13]. Disturbances in the vitamin D and calcitriol deficiency, is implicated in renal osteodystrophy and soft tissue calcifications in renal disease [14]. This may have implications for bone metabolism considering the role of vitamin D in bone formation and bone turnover [15], which will have significant implications for women at post-menopause. From the demographic data, only a few of the participants fall into this group. Similarly, the significant reduction in the uric acid among the test group shows that soft tissue mobilisation and passive mobilisation of the patients translated to tangible clinical benefits for the patients since both the within-group and between group data comparison supports this possibility. Moreover, the fact that there was a large effect size of reducing uric acid in the patients within the test group, and such that it was even larger than that recorded for control, suggest that treatment of the patients using soft tissue mobilisation and passive mobilisation, before dialysis, is of clinical importance, and benefitted a larger group of patients than when the treatment was not given.

Clinically, the results imply that reduction in the plasma concentration of uric acid observed in the test group may hold a high hope that soft tissue and passive mobilisation can reduce the incidence of uremic syndrome seen in renal diseases. However, a longitudinal study involving patients on regular haemodialysis sessions is required to substantially verify and validate these possibilities.

There was a significant reduction in the plasma concentration of creatinine after haemodialysis in patients with renal diseases treated with soft tissue mobilisation and passive mobilisation compared to patients that do not receive the intervention. This holds significant clinical implications, because creatinine is a by-product of tissue catabolism, and produced at a constant rate in the body depending on the muscle mass of the individual [16]. In fact, plasma concentration of creatinine is an important indicator of renal function, because it is a by-product of muscle metabolism that is excreted unchanged [17]. Therefore, increased muscle work during physical activities and exercise will imply increase in the plasma concentration of creatinine, and explains why patients with kidney diseases are required to

minimise their level of physical activity. It also implies that patients with greater muscle mass will have higher plasma concentration of creatinine, and thus, there is a possibility that body composition will have an influence on the plasma concentration creatinine in renal conditions. In this regards, the reduction in the plasma concentration of creatinine in the test group holds a great promise for relevant individuals. The fact that the test group had a larger effect size in bringing about the creatinine level reduction implies that a larger proportion of the patients benefitted from the pre-dialysis treatment using soft tissue and passive mobilisation. It further indicates the possibility that soft tissue mobilisation is very effective in enhancing fluid dynamics and clearance of waste products of metabolism during haemodialysis. In fact, Kong et al. [18] stated that exercises during dialysis enhance the removal of waste metabolites in patients with diseases. However, a longitudinal study involving patients on regular haemodialysis sessions is required to verify and validate the effect.

Conclusion

Haemodialysis is an efficient renal replacement option. This is confirmed in the very high significant difference (p<0.001) between pre-dialysis and post-dialysis values of the plasma concentration of the metabolic by-products studied.

Three metabolites were considered in the study: urea, creatinine and uric acid. Two of the three metabolites (creatinine and uric acid) studied showed a significant (p<0.05) reduction in the post dialysis plasma concentration in the group that received the soft tissue and passive joint mobilization compared to those who did not receive the intervention. However, there was no significant difference (p>0.05) in the post dialysis plasma concentration of one of the metabolites (urea). This is probably because of lower molecular weight of urea which makes it easier to be cleared from the body without the aid of any adjunct such as soft tissue and passive joint mobilization.

Soft tissue mobilization enhances fluid kinetics, dislodges metabolites in the interstitial spaces and mobilizes them into the blood stream where they are cleared through the dialyzers. Soft tissue and passive joint mobilisation are important adjuncts which improve metabolic waste clearance during haemodialysis especially metabolites of high molecular weight such as uric acid (168.11 g/mol), compared to urea (60.06 g/mol) and creatinine (113.12 g/mol). This can be utilized to enhance the effectiveness of maintenance haemodialysis in relevant patients

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