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ORGINAL ARTICLE

Assessment of Upper Muscle Function in Elderly Patients with Chronic Kidney Disease

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Abstract

Background: Chronic kidney disease (CKD) is a major public health issue that is increasingly common in the senior population around the world. However, there are a few research on muscular function in CKD-affected older persons. This study aims to evaluate the function of upper limb muscles in elderly CKD patients.

Methods: A case-control study was conducted, including 73 patients with CKD and 73 healthy individuals as a control group. Patients were divided into two groups: 37 predialysis patients and 36 patients on regular hemodialysis. History was recorded, blood pressure, anthropometric measures, handgrip strength (HGS) were assessed, and a blood sample was withdrawn for measuring complete blood count, random blood sugar, lipid profile, renal and liver function tests. **Results:** In comparison to the control group, CKD patients were having a significantly lower HGS. Predialysis CKD patients have significantly higher HGS compared with patients on regular hemodialysis. Both hemoglobin and albumin were positively correlated with HGS. Fasting triglycerides were inversely correlated with HGS. **Conclusions:** There is a significant decline in upper limb muscle function in CKD patients. The decline in muscle function is more evident in hemodialysis than in predialysis CKD patients.

Key words: chronic kidney disease; Elderly; Muscle strength; Handgrip strength.

INTRODUCTION

Muscle weakness in older persons is a prevalent issue that is linked to physical impairment and functional limitations **[1]**. Low muscle strength has been linked to all-cause and cardiovascular mortality in numerous studies **[2]**. Patients with chronic renal disease rank maintaining functional independence as their top health priority **[3]**. Patients with chronic kidney disease (CKD) have a lower quality of life, especially physical quality of life, than the general population, even at an early stage of the disease **[4]**. CKD can lead to a reduction in exercise capacity and as a result muscular atrophy **[5]**.

Many studies have shown a cross-sectional relationship between hand grip strength (HGS) and the strength of other muscle activities in both healthy and ill adults indicating that HGS can be used as a biomarker of health status **[6]**. Based on this research applicability of hand-grip dynamometry, the measurement of HGS has been widely accepted as a singular indicator of overall muscle strength **[7]**. The question of which limb muscles are more affected in CKD patients and the discrepancy in the literature regarding the correlation between the anthropometric measures and HGS strongly motivated us to construct this work.

This study aimed at assessing upper limbs muscle function through using the HGS measurement by hand dynamometer.

METHODS

Written informed consent was obtained from all participants, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The study was done according to the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Criteria for inclusion into the study included elderly predialysis CKD patients and elderly end-stage renal disease (ESRD) patients on regular hemodialysis

with age ≥65 years. Criteria for exclusion included patients with acute kidney injury, diabetes mellitus, end-organ failure, malignancies, connective tissue disease, acquired immunodeficiency syndrome, dementia, limb amputation, metallic implant, or hand/ knee osteoarthritis. Also, we excluded those who are using walkers or wheelchairs and those who used drugs that cause muscle weakness.

We conducted a matched case-control study. Cases were selected from the Geriatric Unit in association with the Nephrology Unit of Internal Medicine Department in the period from June 2019 to June 2020.

Our study included 73 patients with CKD and 73 healthy individuals as a control group. Patients were subdivided into two groups: 37 predialysis patients and 36 patients on regular hemodialysis.

After full medical history was taken, all subjects underwent a thorough physical examination as well as anthropometric measurements such as the mid-upper arm circumference (MAC), mid-calf circumference (MCC), and body mass index (BMI). In addition, all individuals were subjected to an HGS evaluation. A handheld dynamometer (Jamar Hydraulic hand dynamometer; 5030J1, USA) was used to assess HGS. The dynamometer is held in the dominant hand with the arms by the sides of the body. For patients on hemodialysis, the non-fistula arm was used as there are concerns of bleeding if the patient overexerts. The participant was asked to squeeze the dynamometer using maximum isometric effort. No other body movement was allowed. The better performance of the three trials was recorded **[8]**.

LABORATORY INVESTIGATIONS: A liver function test, kidney function test, complete blood count, random blood sugar, Albumin and Lipid profile were done.

STATISTICAL ANALYSIS: All data were collected, tabulated, and statistically analyzed using SPSS 20.0 for Windows (SPSS Inc., Chicago, Illinois, USA) and MedCalc 13 for Windows (MedCalc Software BVBA, Ostend, Belgium). Continuous data were described as the mean ± standard deviation, mean, range and the categorical data were described as a percentage. An independent student t-test was used to compare two groups that have normally distributed data. Percent of categorical variables were compared with the Chi-square (χ^2) test. Correlations between variables were done by using the Pearson correlation coefficient. P< 0.05 was statistically significant, P< 0.01 was highly statistically significant.

RESULTS

Regarding age, sex, smoking status, and anthropometric measures, no significant difference was found between cases and controls (Tables 1 and 2).

Patients with CKD were having significantly higher systolic and diastolic blood pressure (BP), both systolic and diastolic BP as compared to healthy participants (144.13 ± 21.76 vs 131 ± 14.1, p= 0.016 respectively for systolic BP and 85.37 ± 10.7 vs 79.5 ± 9.01, p=0.022 respectively for diastolic BP) as shown in Table 3.

Hemoglobin concentration (Hb%), serum alanine transaminase (ALT), serum aspartate Aminotransferase (AST), total plasma proteins, serum albumin, high density lipoprotein (HDL), and estimated glomerular filtration rate (eGFR) were significantly lower in patients with CKD while serum creatinine, blood urea, low density lipoprotein (LDL), and triglycerides were significantly higher in patients with CKD as shown in Table 4.

HGS was lower in CKD patients as compared to the control group with a highly significant difference (30.1 ± 3.9 vs 34.8 ± 3.2, p=0.008, respectively) as shown in Table 5.

HGS was having a positive significant correlation with both Hb and Albumin levels and negatively correlated with and fasting TG3 with statistical significance.

Table (1): Age, sex and smoking status dispersion between the considered gatherings

		Cases (n = 73) No. (%)	Control (n = 73) No. (%)	Test	P value
Age (years)	Mean ± SD	67.1±3.5	66.9±2.8	T=0.233	0.407
	Range	65 – 79	65-79		
Sex	Male	40 (54.8%)	35 (47.9%)	χ^2=0.685	0.407
	Female	33 (45.2%)	38 (52.1%)		
Smoking status	Current	12 (16.4%)	9 (12.3%)	χ^2=1.14	0.563
	Former	14 (19.2%)	11 (15.1%)		
	Never	47 (64.4%)	53 (72.6%)		

Table (2): Comparison of anthropometric measures among cases and controls

	Cases (n = 73)	Control (n = 73)	T test	P value
	Mean ± SD Range	Mean ± SD Range		
Weight (kg)	74.3 ± 15.4 65-100	75.4 ± 16.1 64-98	0.421	0.673
Height (cm)	168.6 ± 12.6 155-187	167.2 ± 10.67 158 – 184	0.724	0.470
BMI (kg/m2)	25.1 ± 4.4 22 – 34	25.5 ± 4.36 22 – 33	0.551	0.582
MAC (cm)	24.5±3.2 20-30	25.2±3.6 22-30	1.24	0.216
MCC (cm)	25.3±1.2 22-27	25.8±1.8 22-29	1.97	0.0502

BMI: body mass index; MAC: mid-upper arm circumference; MCC: mid-calf circumference.

Table (3): Distribution of pulse estimations between the examined gatherings

	Cases (n = 73)	Control (n = 73)	T test	P value
	Mean ± SD Range	Mean ± SD Range		
Systolic BP (mm Hg)	144.13 ± 21.76 110 – 185	131 ± 14.1 105 – 150	2.408	0.016
Diastolic BP (mm Hg)	85.37 ± 10.7 85 (80 – 105)	79.5 ± 9.01 80 (65 – 90)	2.293	0.022

BP: blood pressure

Table (4): Laboratory examinations in the contemplated gatherings

	Cases (n = 73)	Control (n = 73)	T test	P value
	Mean ± SD Range	Mean ± SD Range		
Hb (g/L)	108 ± 11 80.0-117	129.0± 21.0 115.0 – 160.0	7.56	<0.001
Creatinine (mg/dl)	7.7 ± 3.8 6.1– 10.4	0.9 ± 0.2 0.6– 1.2	56.97	<0.001
Urea(mg/dl)	124.2 ± 51.9 72 – 238	20.0 ±2.1 10 – 25	27.84	<0.001
eGFR (ml/min)	11.8 ± 6.7 2.9 – 24.3	118.0 ± 18.9 95.0 – 154.0	51.09	<0.001
ALT (units/L)	17.8 ± 2.4 16.0 – 24.2	19.0 ± 0.5 16.1 – 26.0	13.005	<0.001
AST (units/L)	19.9 ± 1.4 13.0 – 26.0	21.2 ± 1.2 16.0 – 29.0	32.705	<0.001
Total plasma protein(g/L)	73.6 ± 2.6 65.0 – 80.0	74.8 ± 4.4 65.0– 80.0	4.603	0.005
Serum albumin (g/L)	38.2 ± 2.8 33.0 – 44.0	39.2 ± 2.9 35.0 – 45.0	4.49	0.036
HDL (mg/dl)	47.93 ± 5.93 36 – 57	57.90 ± 5.42 47 – 70	18.381	<0.001
LDL (mg/dl)	129.5 ± 4.9 113 – 145	119.9 ± 7.72 60 – 110	12.586	<0.001
Fasting triglycerides (mg/dl)	166.5 ± 20.1 140 – 200	97.5 ± 16.5 59 – 110	18.003	<0.001
Total cholesterol (mg/dl)	186.9 ± 21.7 155 – 220	186.8 ± 14.06 140 – 220	0.428	0.733

eGFR: estimated glomerular filtration rate; Hb: hemoglobin; HDL: high density lipoprotein; LDL: low density lipoprotein.

Table (5): Comparison of handgrip strength (HGS) in cases and controls

	Cases (n = 73)	Control (n = 73)	T test	P value
	Mean ± SD Range	Mean ± SD Range		
HGS (Kg)	30.1 ± 3.9 24 – 35	34.8 ± 3.2 32 – 38	2.67	0.008

HGS: handgrip strength

DISCUSSIONS

CKD has received increasing attention as a major public health problem around the world **[9]**. The need for life-long dialysis or renal replacement therapy when entering ESRD is not the only reflection of CKD burden. Our study included 73 CKD patients, as well as 73 healthy participants, as a control group. The muscle strength of the upper limb was assessed using the HGS test, and our results showed that the patients with CKD had a significantly lower HGS value in comparison to the healthy participants. In agreement with our results, **Taşoğlu et al. [10]** reported significantly low HGS values in 148 CKD patients as compared to 40 healthy participants. Also, in agreement with our results, a very recent study by **Turoń-Skrzypińska et al. [11]** found significantly low mean HGS values in 30 CKD patients as compared to healthy participants. In partial agreement with our results, **Tran et al. [12]** reported in their study on 330 adults aged ≥ 65 years (40% had CKD and 60% had not) that in patients with CKD, the HGS was non significantly low when compared to those with no CKD. Also, **Roshanravan et al. [13]** reported a non-significant change in HGS in CKD patients as compared to normative values, a finding that is recently reported also by **Toyama et al [14].** Hormonal imbalance, malnutrition, ATP and glycogen depletion, inadequate oxygen transport because of anemia, metabolic acidosis and electrolyte disorder, lifestyle changes, muscle wasting and weakness due to muscle fiber atrophy are all factors that contribute to decreased muscle strength and physical function in elderly CKD patients **[15]**.

On the other hand, **Abdulan et al. [16]** found in their study on 80 hospitalized CKD patients in the geriatric unit, that anthropometric measures strongly correlated with HGS. Also, **Birajdar et al. [17]** found that HGS was significantly correlated with MAC ($r = 0.294$, $p = 0.007$). Meanwhile, Differences in ethnicity, dialysis modalities, duration of dialysis, patient characteristics, sample size, using different cut-off values, and presence of comorbidities may explain these differences among the studies.

Regarding the correlations of HGS with other variables, our results showed that there was a strong direct correlation between muscle strength assessed by HGS and Hb%. **Cesari et al. [18]** who studied 909 elderly aged ≥ 65 years to detect whether Hb% is associated with differences in quantitative and qualitative measures of muscle and fat found that Hb% was associated with muscle mass (evaluated by peripheral quantitative computed tomography scan), a finding that is near to our result. The anemia and physical association were examined by **Penninx et al. [19]** in 1156 older persons aged ≥ 65 years and found that anemia was associated with poorer physical performance and lower muscle strength, a result that is consistent with our finding. Also, **Fukushima et al. [20]** detected a significant strong direct correlation between Hb% and muscle strength. Our result also showed a strong direct correlation between muscle strength assessed by HGS and Albumin level. In disagreement with our finding were **Birajdar et al. [17]** who reported in their prospective observational cross-sectional study on 83 hemodialysis patients that there was no significant correlation between HGS and Hb% or albumin levels.

Our study was designed on a selection of cross-matched participants for age and gender to avoid the effect of these factors on our findings so, our results showed that as regard age and gender no significant difference between case and control groups was found with p-value = 0.911 and 0.407 respectively. In our study, the case group was having significantly higher systolic and diastolic BP than the control group; these results agree with **Ridao et al. [21]** This can be attributed to several factors including sodium retention, volume excess, renin-angiotensin-aldosterone system (RAAS) activation, activation of the sympathetic nervous system, usage of erythropoietin, endothelium-derived vasoconstrictor substances, and pre-existent essential hypertension **[22]**. Regarding liver functions tests, our results showed that serum ALT and AST were lower in the case group than in the control group with statistically significant difference; **Sette and de Almeida Lopes [23]** agreed with our findings as they reported that the serum aminotransferase levels were lower in the patients with ESRD on hemodialysis than in the patients with normal renal function.

A recent study by **Latiwesh et al. [24]** concluded that serum AST and ALT levels tend to be reduced in CKD patients, particularly in those on maintenance hemodialysis. Regarding Hb%, our results showed that patients in the cases group had significantly lower Hb% in comparison with those in the control group. This agreed with **McClellan et al. [25]** who reported that anemia was present in 47.7% of 5222 predialysis patients with CKD. Another study by Khan and **Elderdery [26]** also reported lower Hb% in CKD patients than in the control group. This can be attributed to iron deficiency (either absolute and functional due to impaired iron utilization for erythropoiesis), vitamin B12 or folate deficiency, effects of dialysis, bleeding because of platelet function defect, decreased synthesis of erythropoietin, decreased sensitization of erythroblasts to erythropoietin, and the effect of drugs used for treatment **[27]**.

Regarding lipid profile, our results showed that in comparison to the healthy participants, patients in the case group had a significantly lower HDL level and significantly higher LDL and Triglycerides levels, while regarding total cholesterol level there was no statistically significant difference between the case group and the control group. These findings agreed with **Tsimihodimos et al. [28]** as they reported that one of the common complications of CKD is dyslipidemia as lipid profile depends on the level of kidney function.

Also, **de Boer et al. [29]** reported that patients with CKD tend to have alterations in both HDL quantity and HDL quality, even a mildly impaired kidney function is associated with low HDL, which becomes progressively worse through ESRD. The decreased level of HDL in CKD patients is caused by that there is decrease in the apolipoproteins AI and AII levels', the main components of HDL, and the activity of lecithin–cholesterol acyltransferase is impaired, this enzyme is important for free cholesterol esterification in HDL, also the activity of cholesterol ester transfer protein increased, this supports of cholesterol esters from HDL transfer to triglyceride-rich lipoproteins **[30]**. Usually, because of increased hepatic production of triglyceride-rich lipoproteins (very low-density lipoproteins "VLDL", chylomicrons, and their remnants) and it delayed catabolism, hypertriglyceridemia was found to be constant finding in CKD patients' **[30]**.

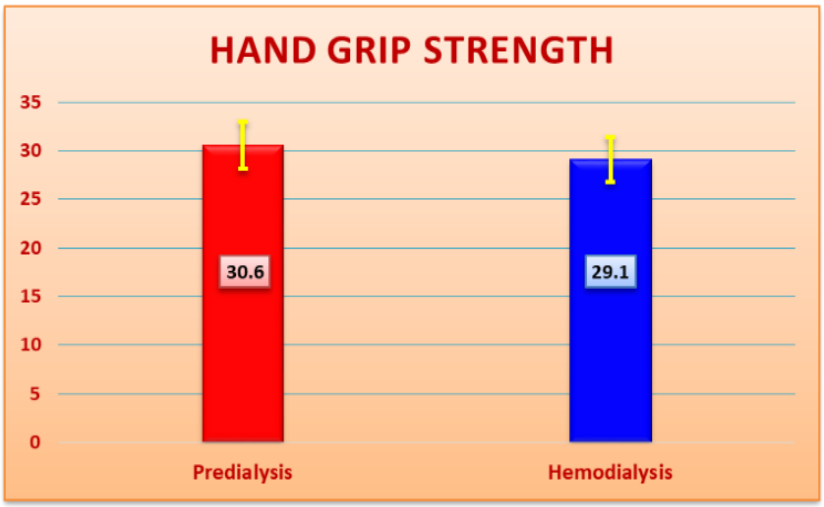

Figure (1) Mean Handgrip strength (HGS) in between predialysis and hemodialysis patients.

CONCLUSIONS

In conclusion, there is a significant decline in upper limb muscle function, as reflected by a significant decrease in HGS in CKD patients. We also concluded that the decline in upper limb muscle function is more evident in hemodialysis than in predialysis CKD patients.

This study recommended that muscle strength assessment should be considered an integral part of the evaluation of people with CKD and assessment of muscle function by HGS may be of value for the nephrologist to better manage CKD.

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