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Research Article

Muscle Ultrasound as an Emergy Tool for Assessment of Quantity and Quality of Muscle in Chronic Kidney Disease (CKD) Patients

Guillermina Barril[1,2]*, Alicia Cabrera[2], Paloma Lopez Alvarado[2], Patricia Ochoa[2], Graciela Alvarez[2] and Angel Nogueira[3,2]

[1]*Fundación Investigaciones Biomédicas, Spain*

[2]*Department of Nephrology Hospital Universitario de la Princesa, Madrid, Spain*

[3]*Avericum Las Palmas de Gran Canaria, Spain*

***Corresponding Author:** Guillermina Barril, Fundación Investigaciones Biomédicas, Spain.

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Abstract

Objective: This study aimed to explore the usefulness muscle ultrasound as tool for evaluation muscle parameters in CKD patients.

Methods: Ultrasound muscle evaluation of the right rectus femoris , hand grip strenght, biochemical parameters, right calf circumference and vectorial bioelectrical impedance analysis measurement of the right lower limb were performed in CKD patients. The correlations between the changes in the corresponding ultrasound and bioelectrical impedance analysis variables were analyzed. Results: Have been evaluated a total of 78 patients, (68 in CKD stage G5, G4, G3b non in dialysis and 10 on peritoneal dialysis (PD)), with mean age of 71.54 ± 11.76 years, 59% were male and 48% Diabetes Mellitus. Compared to advanced CKD patients , the measurements of cross-sectional area and axes didn´t find significant difference between CKD and DP. In relation with muscle mass ultrasound parameters in CKD patients the possible factor can influence favorizing better values were: Exercice, lower age, and good hand grip strenght as phase angle and intracellular water adecuate can influence a good muscle mass parameters.

Conclusions

- CKD results in lower values in the eco-muscular assessment than healthy people in both CKD and DP.
- The transverse and longitudinal diameters and muscle area are smaller than those described in the healthy population.
- Having performed physical exercise conditions better parameters in the muscle ultrasound
- Muscle ultrasound appears as an emerging, economical, easy tool that does not provide ionizing radiation.
- It´s necessary more study in order stablish the normal values according age groups

Introduction

Chronic kidney disease (CKD) is estimated to be the 5th leading cause of death worlwide by 2040 [1]. It affects 8–16% of the global population of the world [2] and is considered a major health problem due to its potential to increase morbidity and mortality in these patients [3].

Chronic kidney disease favors the appearance and with a higher percentage in its progression of protein energy wasting, which leads to a decrease in muscle mass [4].

Describing by the International Society of Renal Nutrition and Metabolism (ISRNM) reduced total body fat and muscle mass are mainly indicators for the diagnosis of PEW [5].

This occurs due to a decrease in anabolism and an increase in catabolism that affects muscle mass and can produce muscle wasting and thus deterioration of functionality unless it is adequately prevented. As CKD progresses, it becomes more evident, especially in elderly patients, that the loss of muscle mass may already be favored by age [6].

These alterations in muscle mass are not only in the amount of muscle mass but also in the composition of fibers and their functional capacity, so there are a series of requirements that must be met when talking about sarcopenia.

The European sarcopenia group made 2 consensuses in 2010 [7] and later in 2019 with the intention of establishing how we could establish the diagnosis of sarcopenia by evaluating muscle strength, muscle mass and functionality (muscle strength or dynapenia, muscle mass and finally functionality) [8].

Sarcopenia can be seen in more than 10% of the general elderly population and leads to greater morbidity and mortality, with a greater risk of falls due to loss of functionality and worse quality of life [7,8]. The intrinsic repair capacity of skeletal muscle when it has received damage decreases with age because the capacity for muscle regeneration is reduced, and sarcopenia and fibrosis are favored. If we also have a disease such as kidney disease that favors catabolism and sedentary lifestyle adds enhancing effects [9].

An important problem is how we measure muscle mass and with what tool, in addition to finding the appropriate cut-off points to diagnose its deficit. The tools used are Bioimpedance, DXA, MRI and computed tomography. For a long time, DXA has been the gold standard, but for kidney patients, CT and MRI are currently more common [10].

These tools are not very accessible and in the case of CT they can promote excess radiation [11].

Bioimpedance is very useful but it is not a direct measurement, which is why a tool that is easy to perform and seems to have a promising future has emerged: muscle ultrasound [12-14].

There is evidence that measuring the muscle mass of the rectus femoris in the thigh can constitute an early diagnostic criterion to determine the presence of sarcopenia [15].

The measurement of the rectus femoris of the quadriceps is a referenced measurement for its correlation with muscle mass, strength and functional tests. The most used are muscle area and thickness (transverse and fascicle length) [15,16].

For kidney patients, we need a tool that is easy to perform, affordable, reproducible and that helps us evaluate changes in the size of muscle mass when CKD progresses and especially when we intervene with physical exercise to improve muscle mass and functionality. It is also necessary to establish the limitations that states of hyperhydration and inflammation exert on some tools that affect nutritional and body composition parameters such as BIA [17].

Independently the possible limitations of the toll that we have to can measure muscle parameters, due to accesibility, early to assess and no risk radiation, musclesqueletal ultrasound is being developed as an emerging alternative in recent last years to assess body composition within morphofunctional evaluation [18].

There are not many published articles on patients with CKD and only two talks about a control group for comparison. Few articles has been carried out comparing it with nuclear magnetic resonance to establish the possible usefulness of ultrasound to assess changes in the rectus femoris muscle of the quadriceps [19,20].

Material and Methods

Retrospective cross-sectional unicentric study with data collected from usual clinical practice that includes patients over 18 years of age, with the absence of myopathy, neurological or skeletal diseases that affect the muscles and who were in advanced CKD (ACKD) consultation with periodic assessments of nutrition and functionality in the CKD Unit.

The aim of this study was to assess the usefulness of ultrasound parameters of muscle mass in CKD patients and correlate it with age, gender, hand grip strenght, exercise, biochemistry and body composition by BIVA.

We evaluated 78 ACKD patients stages 3,4,5 not on dialysis (68 patients, 87.2%) and peritoneal dialysis assessed for nutritional status (10 patients, 12.8%) according to the usual practicum measuring by ultrasound the rectus femoris of the quadriceps since october 2022 to october 2023.

Exclusion criteria were limb amputation; hospitalization within the previous one month; bedridden or immobilization syndrome.

Inclusion criteria: Patients over 18 are included, with the absence of myopathy, neurological or orthopedic diseases that affect the muscles. Also presence of cardiac pacemaker, implantable cardioverter-defibrillator, or metallic non-removable pieces. Patients from Outpatient advanced CKD consult with monitorization nutritional parameter routinely.

Demographic, clinical and anthropometric data were collected, and routine biochemistry was measured at the time of US and BIVA measurement. Body mass index (BMI) was calculated as weight (kg)/height^2 (m^2).

We perform muscle ultrasound at the same time as BIVA AKHERn 101, calf circumference, hand grip strenght (Hydraulic dynamometer Baseline® model 12-0240. to evaluate body composition and muscle strength using dynamoter, as well as analytical parameters from the same review for comparison. Likewise, we asked if they had done and/or did physical exercise or not because of the impact on muscle mass. For hand grip strenght we considered 16 kg for female and 27 for male as cut of point.

Ultrasound muscle study

Ultrasound Technique for quadriceps rectus femoris muscle (QRFM) thickness was measured using ultrasound portable sonosyte portable device. Patients are evaluated in the supine position in knee extension and muscles relaxed, the measurement is made at the junction between the proximal 2/3 between the anterior superior iliac spine and the superior pole of the patella. The measurement is done with ultrasound with straight transducer.The transducer was placed perpendicular to the long axis of the thigh, with minimal pressure to avoid compression of the muscle.

The measurement was carried out coinciding with the advanced CKD outpatient consultation and after the bioimpedance and was repeated two times.

The muscleultrasound parameters evaluated were: Transverse axis(A),Longitudinal axis(B),Circumference and muscle area and ratio B/A.

Vectorial BIA body composition

The monofrequency (50 KHz) BIVA (AKERN 101, with hydrasite technology) was used to obtain Rz, resistance; Xc, reactance; and PA, phase angle) [23]. Body cell mass (BCM), extra-cellular mass (ECW), basal metabolic rate (BMR) were estimated from BIVA parameters [24]. The electrodes were placed on the arm and leg free of vascular access according to the usual technique, connecting the clamps to the electrodes to obtain the measurements. Today the normal values are: Aperdicular muscle mass (AMM) the 20 kg for males and 15 kg for females,or el valor de la AMM/Kg^2, stablising as cut-off point 7 Kg/m^2 for males and 6 Kg/m^2 for males.

Statistical analysis

It was performed with SPSS (version 23, IBM Corp. Armonk, NY, USA). Data were expressed as means and standard deviations or median and interquartile range (IQR) based on their distribution for continuous variables; and as frequencies (percentage) for categorical variables.

ANOVA was used to compare the laboratory differences among three or more subgroups.

The correlation between BIVA parameters and muscle thickness was assessed by Pearson's correlation coefficient for parametric data and Spearman correlation coefficient for non-parametric data. A multivariable approach was used to assess the association between both the BIVA parameters and QRFM thicknesses ultrasound, and nutritional parameters.

Linear regression analysis was performed between phase angle cut off point 4, and different ultrasound parameters in relation with muscle and other BIVA and demographic parameters. The variables with $p < 0.15$ at univariate analysis were selected and included in the multivariate regression model. Next, backward variable selection method with an elimination criterion of $p < 0.10$ was performed to fit the best multivariate linear regression model

Results

We evaluated muscle parameters by ultrasound 78 CKD patients, with stages 3,4,5 not on dialysis (68 patients, 87.2%) and (10 patients, 12.8%) in peritoneal dialysis as complement as assessed for nutritional status.

xAge 71.54 ± 11.76 years, 59% were male and 41% were female and 48% were diabetic although it was not the cause of CKD in all diabetic patients.

Global results from ultrasound parameters

The mean of muscle ultrasound parameters in all patients were: A 0.99 ± 0.43, B 2.63 ± 0.77, Circunference (C) 6.31 ± 1.83, muscle area 2.23 ± 1.23 and ratio B/A 2.97 ± 0.94.

The values describing in one article in healthy population A=1,31 ± 1,2 cm, B=3,21 ± 3,4 cms), higher than patients with CKD evaluated in this study.

The global data with the differences between men and women (46 men and 32 women) are shown in table. In the only parameters that we did not find a significant difference according to gender were: B/A ratio in ultrasounds and in BIA: phase angle, Body Cell mass, lean mass, fat mass, albumin, prealbumin, CRP, or Hb.

Didn´t find significant differences in lean mass, fat mass, albumin, prealbumin, CRP or Hemoglobin.

Comparing results of muscle ultrasound parameters between advanced CKD and peritoneal dialysis didn´t find significant difference between muscle ultrasound parameters, xage was lower but not significant 72.75 ± 10,71 years vs 63.30 ± 15.57 p 0.092 and dindn´t find some dinapenia patients perhaps by only 10 patients in this group.

Muscle Mass by BIVA and relation with muscle ultrasound and muscle strenght

We have calculate cut off point cut percentils in muscle mass by BIVA in the CKD patients: 25% =19,24 kgrs, 50% = 24,92 kgrs y 75%= 29,75 kgrs. Analysing divided in for groups, we have showed significant difference in ultrasound parameters according muscle mass by BIVA, hand grip strenght and calf circumference.

Muscle strength and its relationship with muscle ultrasound parameters

We consider normal or low dynamometry according to the cut-off points of the European sarcopenia group 17 kg for female and 26 kg for male. Overall, we found dynapenia in 16 patients (20.8%) in the analyzed sample. Didn´t find some Dialysis peritoneal patients with dynapenia. Normal or low hand grip strenght does not lead to significant differences in ultrasound-muscular parameters. Table.

	Gender	Number	Standard Mean deviation		p
A	M	46	1,0920	,43601	0,012
	F	32	,8453	,38888	
B	M	46	2,8318	,65879	0,007
	F	32	2,3569	,84708	
C	M	46	6,7611	1,63777	0,009
	F	32	5,6744	1,93955	
Muscle Area	M	46	2,5731	1,18578	0,003
	F	32	1,7491	1,14165	
ratioB/A	M	45	2,8380	,77408	0,131
	F	32	3,1727	1,13793	
Phase Angle (PhA)	M	46	5,0522	,80215	0,594
	F	32	4,9484	,88237	
BMI	M	46	29,3848	4,62928	0,013
	F	32	26,3355	5,43388	
Body Cell Mass (BCM)	M	46	28,4478	6,55939	0,001
	F	32	20,9290	4,36151	
Muscle Mass	M	46	28,9565	5,05484	0,001
	F	32	17,3110	3,52679	
Intracelular wáter (ICW)	M	46	22,3283	4,88656	0,001
	F	32	15,3226	3,10416	
Hand Grio Strenght	M	46	30,9333	7,41744	0,001
	F	32	22,0125	6,34633	

Table 1: Differences in ultrasound and BIA parameters in relation with gender in the global of the patients.

Anova mean muscle ultrasound parameters in muscle mass percentils		N	Media	Desviación estándar	p	95% del intervalo de confianza para la media		Mínimo	Máximo
						Límite inferior	Límite superior		
A	1,00	18	,7556	,31379	,01000	,5995	,9116	,23	1,35
	2,00	20	,9380	,41023		,7460	1,1300	,33	1,93
	3,00	19	1,0374	,28474		,9001	1,1746	,58	1,52
	4,00	21	1,2005	,54971		,9502	1,4507	,46	3,01
	Total	78	,9908	,43231		,8933	1,0882	,23	3,01
B	1,00	18	2,3422	,79918	,09700	1,9448	2,7396	1,03	3,76
	2,00	20	2,4900	,83797		2,0978	2,8822	,87	3,91
	3,00	19	2,8963	,65892		2,5787	3,2139	1,66	4,18
	4,00	20	2,7930	,71758		2,4572	3,1288	1,38	3,91
	Total	77	2,6344	,77424		2,4587	2,8101	,87	4,18
C	1,00	18	5,4617	2,01723	,11800	4,4585	6,4648	1,06	8,79
	2,00	20	6,2850	1,87339		5,4082	7,1618	3,27	9,73
	3,00	19	6,7826	1,42988		6,0935	7,4718	4,02	9,37
	4,00	21	6,6529	1,83399		5,8180	7,4877	1,88	9,07
	Total	78	6,3153	1,83617		5,9013	6,7292	1,06	9,73
muscle area	1,00	18	1,5885	1,06098	,00800	1,0609	2,1161	,22	3,79
	2,00	20	1,9670	1,13182		1,4373	2,4967	,48	5,04
	3,00	19	2,5011	1,05199		1,9940	3,0081	,86	4,54
	4,00	21	2,8038	1,34159		2,1931	3,4145	,75	6,86
	Total	78	2,2350	1,23000		1,9577	2,5124	,22	6,86
Hand grip strenght (Right)	1,00	18	18,3000	4,78441	,00100	15,9208	20,6792	10,00	26,00
	2,00	19	27,8421	4,93585		25,4631	30,2211	20,00	36,00
	3,00	19	31,2632	6,24359		28,2538	34,2725	20,00	45,00
	4,00	21	30,6667	9,02404		26,5590	34,7744	20,00	54,00
	Total	77	27,2260	8,23793		25,3562	29,0958	10,00	54,00
Hand grip strenght left	1,00	17	15,2941	5,30053	,00100	12,5688	18,0194	4,00	24,00
	2,00	19	28,2632	4,10747		26,2834	30,2429	20,00	34,00
	3,00	19	31,1053	6,24406		28,0957	34,1148	14,00	42,00
	4,00	21	31,0476	7,85797		27,4707	34,6245	18,00	50,00
	Total	76	26,8421	8,72705		24,8479	28,8363	4,00	50,00
Calf right circunference	1,00	18	32,9722	3,64398	,00100	31,1601	34,7843	27,00	43,00
	2,00	20	36,0500	3,90647		34,2217	37,8783	29,00	42,00
	3,00	19	35,8158	2,34645		34,6848	36,9467	31,00	39,50
	4,00	20	39,0250	3,57062		37,3539	40,6961	30,50	45,50
	Total	77	36,0455	3,98284		35,1415	36,9494	27,00	45,50
Calf left circunference	1,00	17	32,4412	4,35848	,00100	30,2003	34,6821	23,00	42,00
	2,00	19	35,5384	3,59285		33,8067	37,2701	30,00	42,00
	3,00	18	36,3889	2,07616		35,3564	37,4213	32,50	39,50
	4,00	19	40,0263	5,79145		37,2349	42,8177	30,50	59,00
	Total	73	36,1949	4,91685		35,0477	37,3421	23,00	59,00

Table 2: Anova muscle ultrasound parameters, hand grip strenght and calf circumference in relation with percentiles of muscle mass by BIVA.

Muscle parameters	Mean ± St Deviation	
A Normal	0.9949 ± 0.4388	0.928
Low	0.9837 ± 0.4331	
B Normal	2.6543 ± 0.7978	0.536
Low	2.5181 ± 0.6984	
C Normal	6.3787 ± 1.8742	0.459
Low	5.9925 ± 1.7369	
M. Area Normal	2.2870 ± 1.2510	0.453
Low	2.0271 ± 1.2028	
Ratio B/A Normal	2.9725 ± 0.8629	0.884
Low	2.9242 ± 1.2238	

Table 3: Differences in muscle parameters in relation with hand grip strenght normal or low.

We found significant direct correlations from muscle área with

- Hand grip strength right r0,324, p0,01 and calf circumference right r0,296, left r0,323 p0,01, Phase angle r= 0,353 p0,01,
- **BIVA parameters:** A-fase r0,353 , Masa celular (BCM) r0,389 , Masa muscular(MM)r0,404 y agua intracelular (AIC) r0,379 (p0,01)

Age inverse significant relation only in males not in females: r= -0,388, p0,05 .The correlations in the different parameters appeared mainly in males.

Physical exercise and its influence on muscle ultrasound parameters

Analyzing whether they did physical exercise we found significantly better parameters in some muscle ultrasound parameters: A1.10 ± 0.48 vs 0.82 ± 0.33 p 0.003, area 2.50 ± 1.36 vs 1.72 ± 1 .03 p0.004 (B and C not next) figure 1.

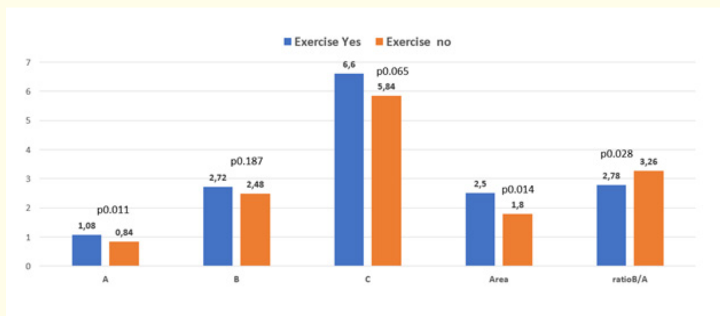

Figure 1: Differences between ultrasound parameters in relation to exercise performed.

Given the good correlation between muscle area and phase angle, which in men is r = 0.421 p0.004, and since the phase angle in patients with CKD below 4 with BIVA can influence mortality, we performed a regression using the phase angle as dependent variable with cut-off point 4.

The result of lineal regression study was

- **Muscle area:** OR B4.90, CI 95% 1.09-22.30, p0.038, Intracellular Water (L) OR 2.73 CI 95% 1,42-5.19, p 0.002, muscle mass percentiles OR 0.084, CI95% 0.13-0.53, p 0.009, Cte OR 0.000 CI 95% .

	OR	CI 95%	p	Wald
Muscle area	4.90	1.09-22.30	0.038	4.30
Intracellular water	2.73	1.42-5.19	0.002	9.17
Muscle mass percentils (higher percentil)	0.084	0.13-0.53	0.009	6.87

Table 4: Values of variables in multivariate regression analysis.

Discussion

The term PEW was proposed by the ISRNM in 2008 as a metabolic and nutritional alteration characterized by a decrease in body protein and energy stores (lean mass and fat mass) [4].

It was initially described for haemodialysis patients , but was later validated for CKD, observing how it can be established from stage 2 and that the percentage increases with the progression of CKD, being greater than 75% in stage 5, on dialysis or not [23,24].

CKD is a catabolic state, which can be associated with PEW and multiple metabolic disorders, uremic toxins retention and inflammation due to uremia. PEW is a strong predictor of adverse outcome and is associated with CVD [25].

Persistent inflammatory processes in CKD could act as links between inflammation, PEW, and CVD. Several studies have reported that there are strong interactions between inflammatory parameters, nutritional status and CVD in CKD patients.(26,27). It has been shown that nutritional status and body composition monitoring programs to prevent PEW in CKD units obtain a low prevalence of PEW [38].

With age, muscle mass can be lost progressively unless appropriate interventions are taken (practicing physical exercise and maintaining good nutritional status).Has been described that from the age of 75, this loss will amount to between 0.80 – 0.98% per year, being 0.64-0.70% in men, and 0.80-0.98% in women. It is vitally important to point out that not only will Muscle Mass be lost, but muscle quality and strength (Fat Mass) will also be lost since from the age of 75, Fat Mass decreases between 3-4% in male, and between 2.5-3% in female.

For this reason, it is important to prevent if possible, if not to make an early diagnosis with timely intervention to try to reverse the loss of muscle mass that leads to a decrease in quality of life, increased dependency and greater mortality [25,29].

Given that muscle mass decreases with age, muscle monitoring can often help to assess the decrease in age, which is added by associated pathology. It is proven that older people who exercise regularly can preserve muscle mass better [4,30,31].

In our study it can be seen that age influences in such a way that since there is a significant difference in the average age of females vs. males, with the men being older, it is reflected in the correlation with the muscle parameters by ultrasound.

In this regard, in our study we found that patients who exercised showed significantly better muscle assessment via ultrasound parameters independently of age.

Sarcopenia in CKD is an imbalance between skeletal muscle regeneration and catabolism, both being altered in the uremic environment.We considered probably sarcopenia through Sarc-F scale diagnosis [32], sarcopenia when there is a decrease in muscle strength by hand grip strenght , frank sarcopenia if it is accompanied by a decrease in muscle mass and severe sarcopenia if it coexists with a decrease in functionality such as a decrease in gait speed <0.8 m/sec according to the consensus criteria of the European Sarcopenia Group 2019 [6].

Thus, PEW and sarcopenia are interrelated and given the advanced age of the current population and that the older the population, the greater the probability of developing CKD, not only the monitoring of nutritional status but also the assessment of muscle in terms of muscle mass, strength and functionality appears as a diagnosis priority in CKD patients [33].

PEW and sarcopenia lead to muscle wasting and if not stopped in time can lead to irreversible cachexia [34].

Muscle ultrasound assessment has been considered as a tool to detect changes in muscle mass in one metaanalysis in older patients without CKD and another in CKD patients [35,36].

For all these reasons, measuring muscle mass correctly with a simple, accessible tool that allows us to monitor muscle mass parameters appears to be a requirement at the present time [37].

DXA was postulated as the gold standard of body composition, but it is expensive and not easily accessible in many cases. CT and Magnetic Resonance imaging are currently being used in the present, although they are not accessible at any time and can lead to more radiation to the patient [13,14,38].

For this reason, the assessment of muscle mass by bioimpedance, especially the BIA vector one, is being used as it is valid for the renal patient, being able to determine the skeletal muscle mass with software. It is easy, accessible and not expensive, but it is not a direct measure and it is influenced by the hydration and inflammation so frequent in the renal patient [39].

There is also evidence of good correlation with bioimpedance parameters such as phase angle, which is a predictor of mortality.

In our study we performed logistic regression with body composition parameter using phase angle cut of point 4 as criteria PEW. We found in the multivariate analysis the best model contained intracellular water by BIVA, muscle area by ultasound and percentils of muscle mass by BIVA [40].

In search of a useful, simple and easily learnable tool in the last decade, the measurement of muscle mass and fat through ultrasound has been developed within the study of muscle composition, which has given rise to the concept the Nutritional® ultrasound. This method asses the musculoskeletal area with linear, transducer, multi-frequency probes, with a depth of field of 20 to 100 mm, rectus area of the quadriceps has been considered good to be used in the context of malnutrition.

We can evaluate many parameters and exit association between ultrasound measurements of muscle thickness, pennation, angle and echogenicity and skeletal muscle strenght in the elderly [41].

Somme articles shows the ussefullness of muscle ultrasound evaluation in morfofunctional evaluation after hospital discharge by different pathologies [42,43].

There is evidence of the usefulness of ultrasound assessment of muscle mass and fat within the study of body composition both in healthy patients and in the different pathologies [43].

Morphofunctional evaluation appeared as global nutritional tool in daily clinical practice. There is evidence in cancer patients to asses loss of muscle mass in cancer, respiratory pathologies [43,47].

The pathophysiological mechanisms of muscle loss in patients with CKD are well known [48-52] and tools are sought to assess not only the amount of muscle mass but also to assess whether it is structurally correct in its fibers and with functionality [53].

Malnutrition, PEW and sarcopenia can be detected precociously to developpe an intervention measures to avoid irreversibility, Some authors such as Stevinkel el als have proposed some therapeutic strategies to avoid PEW [54,55].

Although there is not much evidence at present about the use of muscle ultrasound in patients with CKD are many groups that are including this emergent tool it in daily practice within the morphofunctional assessment. The study using ultrasound offers muscle evaluation not only in quantity but also in quality, differentiating between myoesteatosis and myofibrosis wich have different recoverability. Also phosphate depletion, iron supplementation uremic toxins and inflammation can modify muscle mass and must be taken into account [56-62].

Although muscle mass has an impact on functionality in patients with CKD, having adequate muscle mass does not always imply having good muscle strength, the first criterion to define sarcopenia. If the muscle is sufficient but not of adequate quality, dynapenia may occur.

In our study with a 20,8% of dynapenia didn´t found significant differences between normal and dynapenic patients, but hand grip strenght right offers correlation with muscle area by ultrasound r0,324, p0,01 . Its important remark that study was made with older patients.

In our study carried out for muscle assessment by ultrasound in CKD patients, we found decreased values in some muscle parameters with respect to the little evidence of cut off points in the healthy population, being significantly higher in males.

There are some articles in HD patients who usually have due to catabolism increased can favorize a decreased muscle mass as CKD [63] and therefore it is vital to monitor strength, muscle mass and functionality since sarcopenia is a factor that favors mortality in these patients, which is why they are proposed to improve it [43,44].

Some of the modifications in the quantity and quality of the muscle may be present already in the predialysis stage and in elderly patients it is difficult to demarcate which part is due to age and which is due to CKD or [38,65-67].

In relation with quality of muscle the fat infiltration of the muscle can also be assessed by ultrasound, which may be important to assess as the quality of the muscle [68].

There are some studies in which it is demonstrated that there is good agreement by means of the Bland-Altman test between the muscular area of the anterior rectus of the quadriceps measured by ultrasound placing a transverse transducer to measure it and the volume of the same by magnetic resonance imaging [69,70].

For this reason, it can be considered a valid marker to monitor with ultrasound the changes in muscle mass in the evolution of a patient with CKD over the years or if there is intervention to improve to improve muscle mass see if it is effective or not. Sabatino et als compare three groups of healthy young patients, admitted without CKD and patients on HD, finding worse ultrasound muscle parameters in HD patients, and their found decreased muscle parameters in HD patients comparing the other two groups. Franchi el als described the improving of cross sectional area when strenght training was performed [70,71].

Conclusions

- CKD results in lower values in the eco-muscular assessment than healthy people in both CKD and PD.
- The transverse and longitudinal diameters and muscle area are smaller than those described in the healthy population and larger in men with good correlation with Phase angle, BCM, MM, AIC by BIA
- Having performed physical exercise conditions better parameters in the muscle ultrasound
- Muscle ultrasound appears as an emerging, economical, easy tool that does not provide ionizing radiation.
- It´s necessary more study in order stablish the normal values according age groups.

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