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A COMPARATIVE STUDY OF NUTRITIONAL PARAMETERS IN HEMODIALYSIS PATIENTS

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ABSTRACT

The high prevalence of protein-energy malnutrition (PEM) is a critical issue for patients with end stage renal disease (ESRD) on hemodialysis (HD)**.** The aim of this study was to compare the nutritional indices of hemodialysis patients (HP) with healthy male subjects (control group) of the same age. Mean body mass index (BMI) was significantly low ($p<0.001$) in patients as compared with the control group (23 ± 3.8 vs $30.2 \pm 3.5 kg/m^2$, respectively). Similarly, the patients had body weight lower than the control group . The analysis of food intake showed that the mean energy and protein intakes were significantly lower in HP than the healthy subjects. Notably all patients had energy below the recommended intake for HP (30 kcal/kg/d), meanwhile, only 25 % of the patients had the protein intake above 1.2 g/kg/d. The total proteins and mean serum albumin levels were significantly low ($p<0.001$) in patients as compared with healthy subjects (6.6 ± 0.42 Vs 7.5 ± 0.3 g/dL and 3.05 ± 0.39 Vs 4.5 ± 0.35 g/dL, respectively**).** Moreover, 81.3 % of the patients had serum albumin level less than 3.5 g/dl, and 59.4% of these patients had moderate deficit (serum albumin; 2.98-3.5 g/dL) while 21.9% of them had a severe deficit (serum albumin level of lower than 2.98 g/dL)**.** Notably, none of the patients had serum albumin higher than 4.0 g/dL in contrast, all healthy subjects (control) had serum albumin levels higher than 4.0 g/dL. In conclusion, the present results of this study suggest that malnutrition is common in HP in Saudi Arabia and HP is at high risk mortality and morbidity. It is important to take some responsible and effective steps to correct the malnutrition of HP. To improve health and nutrition status for HP, energy and protein, in addition to other nutrients supplementation are recommended.

***Key words**: end-stage renal diseases, hemodialysis, nutrition status, protein-energy malnutrition, serum albumin, serum creatinine.*

1. INTRODUCTION

Malnutrition is present to some extent in approximately 40% of HP (Bergström and Lindholm 1993; Cuppari *et al.,* 1994; Rezende *et al*., 2000). Moreover, the prevalence of PEM in patients with ESRD is reported to vary between 30% and 76% and PEM is associated with increased morbidity and mortality. Many markers of malnutrition, including low BMI and low serum albumin have been associated with high morbidity and mortality rates in this group of patients (Lowrie and Lew 1990; Rezende *et al.,* 2000; Akner and Cederholm 2001; Shinaberger *et al.,* 2006). There were several causes which may promote malnutrition, and few studies of multiple factors analysis about the nutrition of HP were discussed. The nutritional status of HP in Saudi Arabia has not been well established. Therefore, the objective of this study was to analyze some possible factors contributing to malnutrition, including protein and energy intakes, BMI, total protein, serum albumin, and serum creatinine, and to compare the nutritional indices of HP with healthy male subjects of the same age. This study may help to improve meals of the nutritional status of HP as a part of an ongoing prospective work.

2. MATERIALS AND METHODS

The study was carried out on 32 male patients with ESRD who had been undergoing maintenance hemodialysis and were considered to be clinically stable. Also total of 39 age-matched healthy male subjects (control group) were subjected to provide blood samples for serum albumin, total protein and other parameters for comparison with HD patients who were randomly chosen from Riyadh central Hospital in Riyadh City. Blood samples were drawn from the patients under fasting conditions immediately before the dialysis session for the determination of biochemical assays. Albumin, urea, and serum creatinine were determined with a standard autoanalyzer. The intakes of energy and protein were determined by 3-day food record. The energy and protein intakes were compared with American Dietetic Association (ADA) (2000) The energy and protein intake were calculated for ideal body weight (Kopple 1994; Lorenzo *et al.*, 1995; Chertow and Lazarus 1997; Schmicker 1995; Toigo *et al.*, 2000). The recommended energy intake is 35 kcal per kg body weight for those who are younger than 60 years and 30-35 kcal per kg body weight per day for those who are 60 years or older. The recommended protein intake is 1.2-1.4 g/kg/day (ADA 2000). Post-dialysis creatinine concentration prediction is well correlated with the urea reduction ratio (URR=1– R where R = $Urea_{post}/Urea_{pre.}$ Post-dialysis). Creatinine was calculated according to the following formulas; $Cr_{post} = Cr_{pre}$ X (1 – 0.857 X URR) - 28 (Desmeules *et al.,* 2004). The cutoff low albumin was set at <3.5 g/dL (Health Care Financing Administration. 1998; Pichard *et al.,* 2004). Serum albumin levels ranged 2.98 – 3.5 g/dL have been considered moderate deficit and serum albumin levels < 2.98 g/dL have been considered severe deficit (Rogen, *et al.,* 1988). The statistical analysis included means; standard deviations, were analyzed by SSPS version 10.

3. RESULTS

Characteristics of the subjects are presented in **(**Table 1) and showed that the mean BMI was significantly low (p<0.001) in HD patients as compared with the control group (23 ± 3.8 vs 30.2 ± 3.5kg/m^2, respectively). Similarly, the patients had body weight significantly lower than the control group (p<0.001). The analysis of food intake showed that the mean energy and protein intakes were significantly higher in the healthy subjects than HP (p<0.001 and p<0.05, respectively) (Table 2). The mean energy and protein of patients were 20.9 ± 6.2 kcal /kg/d and 0.85 ±0.3 g/ kg /d, respectively, whereas, the mean energy and protein were 28.9 ± 4.4 kcal /kg/d and 1.1 ± 0.3 g/ kg /d. for healthy subjects, respectively **(**Table 2). Notably all patients had energy below the recommended intake for HP (30 kcal/kg/d) meanwhile only 25 % of patients had protein intake above 1.2 g/kg/d. The total proteins and mean serum albumin concentrations were significantly low (p<0.001) in patients as compared with healthy subjects (6.6 ± 0.42 vs 7.5 ± 0.3 g/dL and 3.05 ± 0.39 vs 4.5 ± 0.35 g/dL, respectively) (Table 3). The mean serum albumin level in patients was 3.05 ± 0.39 g/dL which was substantially lower than the normal range. Moreover, 81.3 % of the patients had serum albumin level less than 3.5 g/dL, and 59.4 % of these patients had moderate deficit (serum albumin; 2.98-3.5 g/dL) while 21.9 % of them had severe deficit (serum albumin level lower than 2.98 g/dL) (Table 4). In contrast, only 18.7% had serum albumin higher than 3.5 g/dL. Notably, no one of the patients had serum albumin higher than 4.0 g/dL, while the mean serum albumin level for healthy subjects was 4.5 ± 0.35 g/dL. Moreover, all the healthy subjects (control) had a serum albumin levels higher than 4.0 g/dL. In the control samples, the average urea concentration was 38.3 ± 8.3 mg/dL, which was markedly less than that of pre-HD (75.6 ± 16.6 mg/dL), and higher than post-HD (25.5 ± 8.1) (Fig. 1). The average creatinine concentration was 0.79 ± 0.19 mg/dL which was markedly less than that of pre-HD (7.5 ± 1.9 mg/dL), and post-HD (3 ± 1.1 mg/dL) (Fig.2). Both urea and creatinine levels were significantly higher in the patients on dialysis compared with the control samples (p < 0.001).

Table (1): Characteristics of the study population (mean ± S.D.).

Parameter	patients	control	p
Number	32	39	
Age (year)	51.5± 32.	53 ± 10.2	0.08
Height(cm)	166± 10.4	168.4 ± 6.5	0.09
Wight (kg)	63.5.1±15.3	85.76± 12.5	<0.001
IBW (kg)	66 ± 8.4	68 ± 8.4	0.1
BMI (kg/m^2)	23 ± 3.8	30.2 ± 3.5.	<0.001

BMI; body mass index IBW: ideal body weight

Table (2): Intakes of energy and protein.

	Patients (n=32)	Control (n=39)	P
Energy (kcal /kg/d)	20.9 ± 6.2	28.9 ± 4.4.	<0.001
Protein (g/ kg /d)	0.85 ±0.3	1.1 ± 0.3	<0.05

Values are mean ± standard deviation.

Table (3): Total protein and serum albumin in study groups (mean ± S.D.).

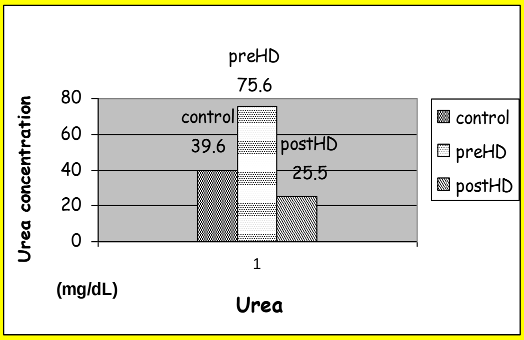
Parameter	Patients (n=32)	Control (n=39)	P
Total protein (g/dL)	6.6 ± 0.42	7.5 ± 0.3	<0.001
Albumin (g/dL)	3.05 ± 0. 39	4.5 ± 0.35	<0.001
URR (%)	68 ± 13.2		
Urea: Cr	12:1		

URR: urea reduction ratio.

T able (4): Percentage of patients with moderate and severe deficient.

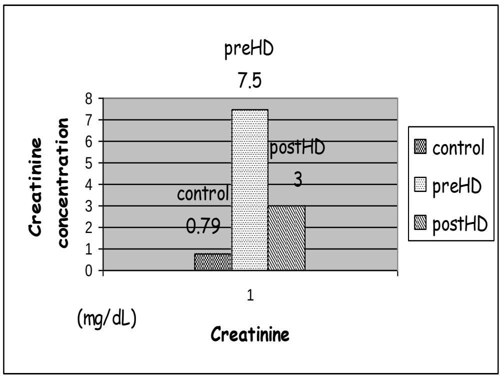
	Patients (32)			Control (39)		
	Mean ±SD range	**Moderate Deficit**	**Severe Deficit**	**Mean ±SD range**	**Moderate Deficit**	**Severe Deficit**
Albumin	**3.05 ±0.39**	**59.4 %**	**21.9 %**	**4.5± 0.35**	**0 %**	**0 %**
(g/dL)	**2.34-3.87**			**4.01-5.69**		

2.98 – 3.5 g/dL ; moderate deficit and < 2.98 g/dL severe deficit (Rogen *et al.,* 1988).



***Significant mean differences between pre-HD and normal control, between post-HD and normal control (p < 0.001).**

Fig. (1): Urea in normal control, pre-HD and post-HD Patients



***Significant mean differences between pre-HD and normal control, between post-HD and normal control (p < 0.001)**

Fig. (2): Creatinine in normal control, pre-HD and post- HD Patients.

4. DISCUSSION

Malnutrition is an important predictor of mortality in ESRD population. Serum creatinine and albumin can be measured easily and have been observed to be independent predictors of death (Lowrie *et al.,* 1995; Faintuch *et al.,* 2006). Daily protein intake is primary devoted to the preservation of muscle mass and body nitrogen reserves. For this reason, creatinine-based indices should be strongly used among the parameters to evaluate PEM. The serum creatinine concentration is related to nutritional status in that it reflects somatic protein stores, muscle mass, and intake of dietary protein. Mortality risk is associated with low serum creatinine levels in HP. In any case, low serum creatinine concentrations have been observed to be highly predictive of future mortality in HP (Lowrie and Lew 1990; Owen and Lowrie 1998; Pifer *et al.,* 2002). This was confirmed by Pifer`s study who also found that mortality risk was inversely associated with baseline serum creatinine level and decreased in the serum creatinine concentration. Mortality risk was 60 to 70 % higher in the lowest quartile group as compared with the highest quartile group (Pifer *et al.,* 2002). In this study, the mean serum creatinine concentration for the patients, 7.6 mg/dL, was lower than Pifer`s result. In the present study, serum creatinine levels were also low when compared with other studies (Allman, Iqbal *et al.,* 2005). In contrast, the mean serum creatinine concentration for healthy subjects was within the normal range (0.7-1.2 mg/dL). Although there is no reference value for serum creatinine for HP, the serum creatinine in the present study was low. Therefore, the HP are more likely represent to be at risk of death.

A low serum albumin level is a strong predictive risk factor. Since it is a marker of visceral protein stores (Kaysen *et al.,* 1997, Dutton *et al.,* 1999; Leon *et al.,* (2006). In this study the total proteins and mean serum albumin concentrations were significant low in patients group compared with healthy subjects (p<0.001). The mean serum albumin level for patients was 3.05 ± 0.39 g/dL which was substantially lesser than normal range. (Table 3). In England and USA, Huidobro *et al.,* (2001) and Kimmel *et al.,* (2003), observed that the mean serum albumin was lower than 4.0 g/dL. Recently Morsch *et al.,* 2005 found that the mean serum albumin was 3.6 g/dL. Owen *et al.,* 1994 found that the serum albumin level was a more powerful (21 times greater) predictor of death than the URR, and 60 % of the patients had serum albumin concentrations predictive of an increased risk of death (serum albumin level below 4.0 g/dL). Importantly, 81.3 % of the patients had a serum albumin level less than3.5

g/dL, and 59.4 % of these patients had moderate deficit (serum albumin; 2.98-3.5 g/dL) while 21.9% of them had a severe deficit (serum albumin level of lower than 2.98 g/dL) (Table 4). Notably, none of the patients had serum albumin higher than 4.0 g/dL. In contrast, the mean serum albumin level for healthy subjects was 4.5 ± 0.35 g/dL. Moreover, all healthy subjects (control) had serum albumin levels higher than 4.0 g/dl. Low total protein and low serum albumin levels observed in this study may largely be attributed to the low intake of protein (75 % of the patients had protein intake below 1.2 g/kg/d.). Although, protein needs for HP (1.2-1.4 g//kg/day) are high compared with recommended requirements for the general population (0.8 g//kg/day), the mean intake of dietary protein for HP was 0.85 ± 0.4 g//kg/day (Table 2) . This was significantly (p<05) lower than the control group (1.1 g//kg/day) and substantially less then the recommended intake for HP (1.2 g/kg/d.). In addition, energy deficiency might be an important factor to poor utilization of dietary protein. Energy intake should be sufficient to prevent catabolism and achieve and maintain optimal nutrition status. Adequate energy from carbohydrates and fats may prevent muscle and visceral protein from being used as energy sources (Beto 1995; Heathcock *et al.,* 1996; Turner *et al.,* 1997; ADA 2000). However, all patients in this study had energy below the recommended intake for HP (30 kcal/kg/d) with an overall sample mean of mean energy 20 kcal/kg/day. Moreover, the mean energy intake was significant lower (p<0.001) than the control group (28.9 kcal/kg/day) and was far below the recommended requirements for HP (30-35 kcal/kg/day (Table 2). Valenzuela *et al.,* 2003 found that 74% of HP in France had energy intake less than the recommended requirements, whereas 86% and 70% of HP in Spain and Italy, respectively, had energy intake less than the recommended requirements (Lorenzo *et al.*, 1995; Bossola *et al.,* 2005). The latter observed that 70.2 % of HP had a protein intakes less than 1.0 g/kg/day whereas 37.8 % and 47 % of HP in China and Brazil, respectively, had a protein intakes less than the recommended requirements (Ge *et al.,* 1998; Valenzuela *et al.,* 2003). HP have critically low levels of protein, energy (Table 2) and other nutrients including calcium, phosphorus, iron, vitamin B_{12}, vitamin B_6 and folate (data not shown). Reduced dietary protein intake may be associated with elevated mortality risk in individuals with ESRD undergoing maintenance hemodialysis (MHD) (Shinaberger *et al.,* 2006). Furthermore, the hemodialysis procedure may cause low total and serum albumin either by inducing losses of amino acids and other nutrients or by promoting inflammatory responses through blood-membrane interactions (Gutierrez, *et al.,* 1990). HP have significant alterations in their intracellular and plasma amino acid profile, which has been attributed to a low protein diet or insufficient intake, impaired protein or amino acid catabolism, and long-term dialysis. Loss of amino acid during dialysis has evidently been shown (Bergstrom *et al.,* 1990; Ikizler *et al.,* 1995; Navarro *et al.,* 2000). There are many possible reasons for PEM in HP. The most important cause of inadequate energy, protein and other nutrients intake is almost certainly anorexia. Anorexia may be caused by several factors including uremic toxins, gastrointestinal disorder and psychosocial disorder (Bergstrom, 1995; Laville and Fouque 2000). It has been demonstrated that uremia alters appetite (Ikizler *et al.,* 1995; Johansen *et al.,* 1998). Zinc deficiency contributes to taste disturbances (Laville and Fouque 2000).

Urea is the major metabolic end product of amino groups derived from amino acids. The plasma concentrations of most amino acids in HP with ESRD were increased due to increased protein catabolism. The accumulation of amino acids resulted in more waste products, including urea and ammonia, potentially contributing to greater morbidity in these patients. HD are effective in reducing some of the accumulated amino acids, hence restoring the plasma amino acid levels toward normal (Chuang *et al.,* 2006). Urea reduction ratio is defined as the percent reduction in blood urea nitrogen concentration during a single dialysis treatment. The risk of death was determined as a function of the urea reduction ratio and serum albumin concentration. Owen *et al.,* (1994) found that patient with URR below 60 percent had a higher risk of death during follow-up (odds ratio, 1.28 for urea reduction ratios of 55 to 59 percent and 1.39 for ratios below 55 percent). Fifty-five percent of the patients had urea reduction ratios below 60 percent. Low urea reduction ratios during dialysis are associated with increased odd ratios for death.

These risks are worsened by inadequate nutrition (Owen *et al.,* 1994). In this study, 19

% of the patients had urea reduction ratios below 60 percent. Therefore, HP are at risk of death and the risks are worsened by malnutrition or inadequate nutrition observed in this study.

In conclusion, the data in this study suggest that malnutrition is common in HP in Saudi Arabia and HP are at high risk mortality and morbidity. It seems important to take some responsible and effective steps to correct the malnutrition of HP. To improve health and nutrition status for HP,energy and protein supplementation are recommended.

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دراسة تغذوية مقارنة لمرضي الغسيل الكلوي الدموي

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ملخص

ان نقص الطاقة والبروتين من ابرز المشاكل لدى مرضى الغسيل الكلوي. لذا يهدف هذا البحث الى مقارنة بعض المؤشرات التغذوية لمرضى الغسيل الكلوي الدموي مع مجموعة من الأصحـاء في نفس العمر. تبين النتائج انخفاض متوسط مؤشر كتلة الجسم لدى المرضى مقارنة بالاصحاء (23 مقابل 30.2كجم/م^2 على التوالي). كما ان وزن الجسم منخفض لدى المرضى مقارنة بالاصحاء. كما اظهرت النتائج ان المتناول من الطاقة والبروتين لدى المرضى اقل بدرجة معنوية مقارنة بالاصحاء. كان المتناول من الطاقة لجميع المرضى اقل من الموصى به (30 كيلوكالوري/كجم/اليوم). في حين وجد ان 25% فقط من المرضى تناول بروتين أعلى من الموصى به (1.2 جرام/كجم/اليوم)

كما اتضح ان مستوى البروتين الكلي والألبيومن في السيرم منخفض بدرجة معنوية لدى المرضي مقارنة بالأصحاء، وجد علاوة علي ذلك أن81.3 % من المرضي كان مستوي الألبيومين لديهم أقل من 3.5 جرام / ديسلتر. 59.45 % من اولئك المرضي تراوح مستوي الألبيومين في السيرم ما بين 2.98 الى3.5 جرام / ديسلتر. في حين ان 21.9 % كان لديهم نقص شديد في مستوي الألبيومين في السيرم (أقل من 2.98 جرام/ ديسلتر) ، كما لوحظ ان أي أحد من المرضي وصل مستوي الألبيومين لديه الى 4 جرام/ ديسلتر ، وعلي العكس من ذلك كان جميع الأفراد الأصحاء مستوي الألبيومين في السيرم أعلي من 4 جرام/ ديسلتر .

وخلاصة القول أن هذه النتائج تظهر انتشار سوء التغذية لدي أفراد الغسيل الكلوي الدموي في المملكة العربية السعودية مما يعرضهم لخطر الموت. لذا من المهم وضع خطوات فعالة للتغلب علي سوء التغذية لدى مرضي الغسيل الكلوي الدموي. يوصي لتحسين الحالة الصحية والتغذوية لمرضى الغسيل الكلوي بالتدعيم بالبروتين والطاقة والعناصر الغذائية الأخرى.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (58) العدد الثاني (أبريل 2007):105-111.