Depression, anxiety, and quality of life in patients undergoing hemodialysis and renal transplantation

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Background
End-stage renal disease (ESRD) is a severe and debilitating disease. Insignificant data exist on depression, anxiety, quality of life (QoL), and life satisfaction in patients on hemodialysis (HD) in comparison with patients with renal transplantation (RT).
Aim
The aim of this study was to compare the presence and severity of depression and accompanying anxiety symptoms between HD patients and RT recipients and to correlate both depression and anxiety with the QoL and life satisfaction affection in both groups of patients.
Patients and methods
A comparative cross-sectional study was conducted on 64 patients with ESRD who were recruited consecutively from the nephrology outpatient clinic of Kasr Al Ainy, Cairo University Hospitals, over a period of 1 year. Patients were applied the Physical, Cognitive, Affective, Social, Economic and Ego Questionnaire to assess QoL, Beck Depression Inventory to assess depression, Middlesex Hospital Questionnaire to assess anxiety, and Life Satisfaction Scale for life satisfaction.
Results
The study results showed that depression, anxiety, and somatization in the HD group showed significant higher scores than the RT group. Patients on HD were significantly less satisfied with their life and showed lower scores on the physical domain, whereas patients with RT had significant lower scores on the economic domain of QoL. Life satisfaction and most domains of QoL were negatively correlated with depression, anxiety, and somatization in the HD group.
Conclusion
Depression accompanied with a variety of anxiety symptoms constituted determinants of poor QoL in the setting of ESRD and consequently, less life satisfaction. HD patients showed higher levels of depression, anxiety, and somatization along with poorer QoL and less life satisfaction than patients with RT.

Keywords:
anxiety, depression, hemodialysis, quality of life, somatization

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Introduction

End-stage renal disease (ESRD) is defined as an irreversible decline in the individual's own kidney function, which is severe enough to be fatal without dialysis or transplantation (Abbasi *et al.*, 2010). The number of people with this condition is growing rapidly worldwide, especially in developing countries. This is partly linked to better identification of cases, improvement in the physical health care, and longer life expectancy of those owing to advancement in their care (Olagunju *et al.*, 2015).

A review of literature from developed countries suggests poor quality of life (QoL) and high emotional burden among individuals with ESRD (Lew and Patel, 2007). There are several reasons, suggesting that people with ESRD in developing countries experience poor QoL and psychiatric morbidities. Such reasons include poor health insurance coverage, lack of governmental funding, and unequal distribution of renal dialysis as well as transplantation services. Even when such services are available, they are predominantly urban based and may be inaccessible for some patients (Kimmel *et al.*, 2003).

Regarding psychiatric comorbidities, depression is the most important of them, owing to its high prevalence,

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adverse effect on QoL, and its potential to increase mortality. Yet, depressive disorders are commonly accompanied by anxiety symptoms in individuals with ESRD and those on hemodialysis (HD) (Kimmel *et al.*, 1998). Depression accompanied with anxiety in ESRD negatively affects the clinical course, morbidity, and outcome as well as constitutes independent associated factor of QoL reduction in ESRD (Vázquez *et al.*, 2003). Hence, monitoring the psychological aspects is just as important as monitoring the disease progress.

HD and kidney transplantation are types of renal replacement therapy (RRT). Although HD is the most widely used modality of RRT, patients on HD show severe depression, anxiety, and low QoL. Estimate rates of depression and anxiety are 15–60% and 27–45.7%, respectively, in patients with chronic renal failure (Mollahadi *et al.*, 2010). Their functional capacity was strongly correlated with severity of their psychiatric illness (Kimmel *et al.*, 2003).

On the contrary, renal transplantation (RT) offers a near-normal life to patients with ESRD for up to 20 years and more, with less physiological effects on recipients (El-Agroudy *et al.*, 2008). Although renal transplant recipients (RTRs) showed better functional and employability status than either HD or Continuous Ambulatory Peritoneal Dialysis patients (Panagopoulou *et al.*, 2009), yet RT and Continuous Ambulatory Peritoneal Dialysis are much less affordable or available (Soliman *et al.*, 2012). In developing countries, RT can be of greater benefit as it reduces the morbidity and the dialysis expenses (El-Agroudy *et al.*, 2004). There is little information about depression, anxiety and their correlation with QoL and life satisfaction in patients with ESRD in Egypt. The aim of this study was to compare the presence and severity of depression and accompanying anxiety symptoms between renal HD patients and RTRs and to correlate both depression and anxiety with the QoL affection in both groups of patients.Our hypothesis was that HD patients have a higher rate and severity of depression and anxiety symptoms with poorer QoL and life satisfaction than RTR.

Patients and methods

A comparative cross-sectional study was conducted on 64 patients (35 males and 29 females) with ESRD who were recruited consecutively from the nephrology outpatient clinic of Kasr Al Ainy, Cairo University Hospitals, during the period between August 2012 and September 2013. The inclusion criteria were individuals aged 18–60 years, who were clinically diagnosed with ESRD (defined by glomerular filtration rate <15 ml/min) and provided informed consent to participate in the study. Patients' anonymity was preserved. Patients who were severely ill, or those who were attending the clinic for the first time were excluded. The patients were divided into two groups: group A comprised patients on HD and group B comprised RTRs. At the time of the assessment, none of the patients had been treated for any psychiatric symptoms. The study was approved by our institution (university) research ethics committee, and the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Measures: the following tools were applied on all participants:

(1) Physical, Cognitive, Affective, Social, Economic and Ego Questionnaire for QoL (Bech, 1993).
It is a validated questionnaire that clarifies the subjective expression of the QoL of the patients. It consists of six domains to estimate the degree of impairment in the QoL. These domains are physical, cognitive, affective, social, economic, and ego (personality). This clinical instrument showed good interrater reliability, ranging from 0.85 to 0.97. The construct validity of the scale is fairly supported by factor analysis and convergent validation with the Lehman QoL interview (Beck *et al.*, 1993).

(2) Beck Depression Inventory (BDI) (Beck*et al.*, 1961).
It was applied to assess the presence and severity of depression in the study sample showing high reliability, capacity to discriminate between depressed and nondepressed patients, and structural validity (Wang and Gorenstein, 2013). It consists of 21 questions. BDI measures both somatic and cognitive aspects of depression. Scores range from 0 to 63 and are graded as follows: not depressed (0–9), mildly depressed (10–15), moderately depressed (16–23), and severely depressed (24–63).

(3) Middlesex Hospital Questionnaire (MHQ) (Crown and Crisp, 1966).
It was used to screen for psychiatric morbidity. It is a reliable and validated (Gada, 1981) self-assessment questionnaire that consists of 48 questions and is composed of six subscales (anxiety, phobia, obsession, somatization, depression, and hysteria); each of which has eight questions.

(4) Life Satisfaction Scale (Al-Desouki, 1998).
It was used to assess subjective experience of life satisfaction. It consists of five scales: happiness, social, secure, psychological satisfaction, and social appreciation. Each scale consists of 12 phrases, which has 5° from 0 to 4, and then the whole sum is calculated. High grades indicate high degree of life satisfaction and low grades indicate low degree of life satisfaction.

Statistical analysis

Data were coded and entered using the statistical package for the social sciences, version 25 [IBM SPSS Statistics for Windows (2017). Version 25.0. Armonk, NY: IBM Corp]. Data were summarized using mean ±SD in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the nonparametric Kruskal–Wallis and Mann–Whitney tests (Chan, 2003a). For comparing categorical data, χ^2 test was performed. Exact test was used instead when the expected frequency is less than 5 (Chan, 2003b). Correlations between quantitative variables were done using Spearman correlation coefficient (r) (Chan, 2003c). P values less than 0.05 were considered as statistically significant. Cramer's V was used to analyze the effect sizes.

Results

The mean age of patients was 33.41±12.38 years (group A mean age was 39.94±12.36 years and group B mean age was 25.52±6.45 years, $P<0.001$). Patients in both groups were matched regarding sex, education, occupation, and social status (Table 1). The mean scores of depression, as assessed by BDI and the depression subscale of MHQ, were statistically significantly higher in group A (Table 2). In addition, 34.3% ($n=12$) of patients in group A experienced severe depression, whereas nearly half (51.7%) of the patients of group B had normal scores on the BDI and none of them was severely depressed ($P<0.001$) (Fig. 1). Moreover, scores of anxiety and somatization subscales of MHQ were statistically significantly higher in group A compared with group B. Patients of group A were significantly less satisfied with their life and showed lower scores on the physical domain of QoL questionnaire compared with group B. On the contrary, patients of group B had statistically significant lower scores on the economic domain of QoL questionnaire compared with A group (Table 2).

Regarding correlative results, in patients of group A, the scores of depression, anxiety, somatization, and phobia subscales of MHQ were positively correlated. Furthermore, life satisfaction and all domains of QoL scales, except the economic one, were negatively correlated with depression, anxiety, and somatization. The physical domain of QoL questionnaire was significantly correlated with depression, anxiety, and somatization in the group B (Table 3).

In group B, the scores of depression of both BDI and depression subscale of MHQ were positively correlated with somatization and hysteria subscales. Scores of anxiety subscale were positively correlated with those of phobia and obsession subscales. Regarding QoL, depression was negatively correlated with the cognitive domain, and somatization was negatively correlated with the affective domain. Moreover, phobia was negatively correlated with the ego domain, and obsession was negatively correlated with the economic domain. Life Satisfaction Scale scores were negatively correlated with depression and positively correlated with social domain of QoL (Table 4).

Table 1 Sociodemographic data of dialysis and transplant groups

	Group A [*n* (%)]	Group B [*n* (%)]	*P* value
Sex			
Male	19 (54.3)	16 (55.2)	
Females	16 (45.7)	13 (44.8)	0.943
Total	35 (100)	29 (100)	
Education			
Illiterate	5 (14.3)	5 (17.3)	
Read and write	3 (8.6)	3 (10.3)	
Primary	7 (20.0)	9 (31.0)	0.731
Preparatory	14 (40.0)	8 (27.6)	
High	6 (17.1)	4 (13.8)	
Total	35 (100)	29 (100)	
Occupation			
Working	11 (31.4)	7 (24.1)	
Not working	24 (68.6)	22 (75.9)	0.904
Total	35 (100)	29 (100)	
Social status			
Without partner	18 (51.4)	17 (58.6)	
With partner	17 (48.6)	12 (41.4)	0.852
Total	35 (100)	29 (100)	

χ^2 test and exact test. *P* value more than or equal to 0.05 is nonsignificant.

Discussion

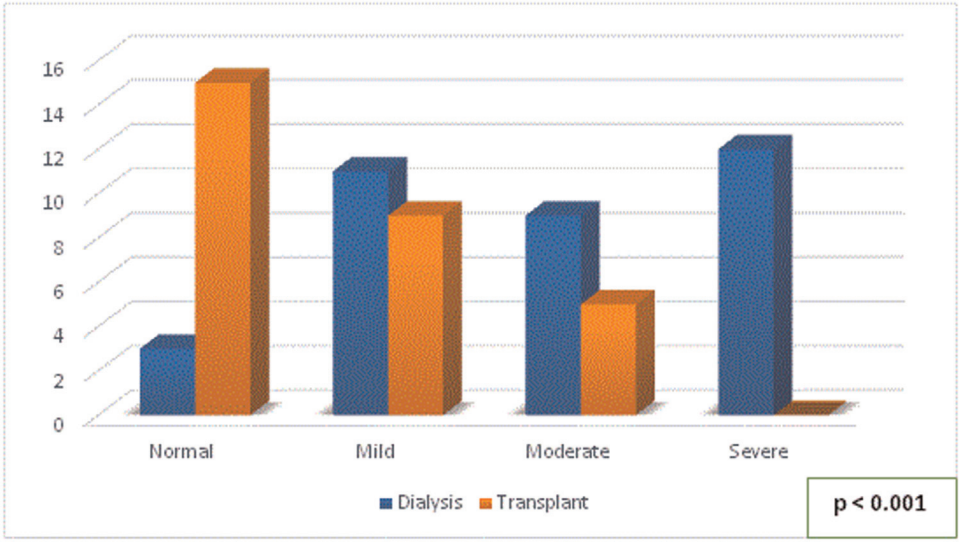
Group A showed significant higher rate and severity of depression, significant more anxiety and somatization symptoms, less life satisfaction, and poorer QoL regarding the physical domain, compared with group B. Life satisfaction and QoL except the economic domain were significantly negative correlated with

Table 2 Psychological and quality-of-life profile of group A and group B

	Group A		Group B		*P* value	Cramer' *V* effect size
	Mean	SD	Mean	SD		
BDI	21.4	11.9	8.97	6.82	<**0.001**	**0.566**
MHQ						
Depression	10.23	4.15	7.52	2.95	**0.006**	**0.341**
Anxiety	9.60	5.13	6.0	3.98	**0.003**	**0.366**
Phobia	7.51	3.44	6.9	3.44	0.405	0.104
Obsession	8.17	3.94	9.48	3.24	0.272	0.137
Somatization	9.69	4.21	6.83	3.14	**0.005**	**0.351**
Hysteria	5.57	2.6	6.79	3.51	0.142	0.184
PCASEE						
Physical	21.26	10.57	27.72	9.85	0.017	0.297
Cognitive	27.31	8.32	29.93	8.92	0.203	0.159
Affective	23.77	9.84	26.14	8.42	0.329	0.122
Social	22.97	10.81	23.31	10.48	0.713	0.046
Economic	25.89	11.03	18.62	13.41	0.018	0.295
Ego	23.66	7.02	23.10	8.34	0.973	0.004
LSS	74.2	21.95	94.31	15.76	<**0.001**	**0.467**

BDI, Beck Depression Inventory; LSS, Life Satisfaction Scale; MHQ, Middlesex Hospital Questionnaire; PCASEE, Physical, Cognitive, Affective, Social, Economic and Ego Questionnaire for QoL. χ^2 test; Mann–Whitney test. *P* value less than 0.05 is significant.

Figure 1



Severity of depression by BDI in group A and group B. P value less than 0.05 is significant. BDI, Beck Depression Inventory.

depression, anxiety, and somatization in group A. In group B, only the physical domain of QoL was significantly positive correlated with depression, anxiety, and somatization. Life satisfaction was negative correlated with depression and positive correlated with social domain of QoL.

The significant higher mean scores of depression in patients on HD compared with RTRs were consistent with Kimmel (2000) and Virzì *et al.* (2007). The experience of several losses, including kidney function, the serious influence on family roles, work competence, mobility, sexual function, and time significantly and negatively affect the lives of sufferers (Chilcot *et al.*, 2008). In addition, further stressors, including effect of medications, dietary restrictions, fear of death, and dependency upon treatment, may affect the QoL and exacerbate feelings of depression and loss of control (Armaly *et al.*, 2012). Furthermore, pain is a significant problem for nearly half of HD patients, where Davison and Jhangri (2005) revealed that there was a higher prevalence of depression in HD patients with moderate or severe chronic pain compared with patients with mild or no pain. Anxiety symptoms and somatization were significantly higher in patients on HD, which was in line with Novaković (2007), who

Table 3 Correlation between psychological profile and quality-of-life scores among group A patients

	BDI	Anxiety MHQ	Phobia MHQ	Obsession MHQ	Somatization MHQ	Depression MHQ	Hysteria MHQ	LSS score
BDI								
r	1.000	0.628	0.537	0.101	0.767	0.783	0.270	–0.788
P value		<0.001	0.001	0.565	<0.001	<0.001	0.116	<0.001
MHQ depression								
r	0.783	0.777	0.579	0.259	0.683	1.000	0.316	–0.708
P value	<0.001	<0.001	<0.001	0.133	<0.001	.	0.064	<0.001
MHQ anxiety								
r	0.628	1.000	0.614	0.236	0.734	0.777	0.316	–0.663
P value	<0.001	.	<0.001	0.173	<0.001	<0.001	0.064	<0.001
MHQ somatization								
r	0.767	0.734	0.471	0.174	1.000	0.683	0.176	–0.729
P value	<0.001	<0.001	0.004	0.318	.	<0.001	0.312	<0.001
PCASEE physical								
r	–0.572	–0.759	–0.520	–0.202	–0.594	–0.716	–0.213	0.605
P value	<0.001	<0.001	0.001	0.245	<0.001	<0.001	0.219	<0.001
PCASEE cognitive								
r	–0.454	–0.637	–0.308	–0.052	–0.443	–0.548	–0.319	0.525
P value	0.006	<0.001	0.072	0.765	0.008	0.001	0.061	0.001
PCASEE affective								
r	–0.729	–0.701	–0.445	–0.217	–0.630	–0.773	–0.394	0.721
P value	<0.001	<0.001	0.007	0.210	<0.001	<0.001	0.019	<0.001
PCASEE social								
r	–0.371	–0.625	–0.269	0.034	–0.410	–0.615	–0.209	0.406
P value	0.028	<0.001	0.118	0.848	0.014	<0.001	0.229	0.016
PCASEE economic								
r	–0.062	–0.161	0.237	–0.077	–0.255	–0.093	–0.045	0.171
P value	0.725	0.356	0.171	0.659	0.140	0.593	0.797	0.327
PCASEE ego								
r	–0.568	–0.621	–0.440	–0.098	–0.439	–0.617	–0.199	0.546
P value	<0.001	<0.001	0.008	0.575	0.008	<0.001	0.251	0.001

Spearman correlation coefficient. BDI, Beck Depression Inventory; LSS, Life Satisfaction Scale; MHQ, Middlesex Hospital Questionnaire; PCASEE, Physical, Cognitive, Affective, Social, Economic and Ego Questionnaire for Quality of Life. *P* value less than 0.05 is significant.

found that anxiety appeared in all tested dialysis patients. He concluded that anxiety may be independent, somatized as part of another mental disorder or reinforced by some sort of cognitive damage. He added that structured anxiety and depression result in presuicidal risk as when high levels of anxiety symptoms occur in the context of major depressive disorder, and they are associated with greater severity of the depressive illness, greater functional impairment, more chronicity, and an increased risk of suicidality.

The less satisfaction of life and poorer physical domain QoL in the HD group might be explained by the stressful circumstances of the dialysis, as many patients on dialysis acquire the sense of life-long dependence on the machine, procedure, and the group of medical professionals (Olagunju *et al.*, 2015). Moreover, the additive effect of comorbid disease in the group of patients who were awaiting transplantation could be another contributing factor of lower QoL. Pain, poor appetite, and disturbance of sleep structure were additional factors to the subjective dissatisfaction of sense of physical well-being in HD patients in this study. This was in concordance with Cinar *et al.* (2009), who reported that patients undergoing HD confront stressful issues like dependence on the machine and health care persons. Hence, the patients perceived that their overall lifestyle

Table 4 Correlation between duration of illness, psychological profile and quality-of-life scores among group B patients

	BDI	Anxiety MHQ	Phobia MHQ	Obsession MHQ	Somatization MHQ	Depression MHQ	Hysteria MHQ	LSS score
BDI								
r	1.000	0.229	0.114	0.252	0.480	0.110	0.487	–0.445
P value		0.232	0.555	0.188	0.008	0.571	0.007	0.016
MHQ depression								
r	0.110	0.346	0.759	0.516	0.529	1.000	0.212	–0.091
P value	0.571	0.066	<0.001	0.004	0.003	.	0.268	0.638
MHQ anxiety								
r	0.229	1.000	0.427	0.654	0.353	0.346	0.262	–0.057
P value	0.232	.	0.021	<0.001	0.061	0.066	0.170	0.771
MHQ somatization								
r	0.480	0.353	0.340	0.531	1.000	0.529	0.232	–0.092
P value	0.008	0.061	0.071	0.003	.	0.003	0.226	0.635
PCASEE physical								
r	–0.428	–0.509	–0.279	–0.457	–0.539	–0.403	–0.359	0.129
P value	0.021	0.005	0.142	0.013	0.003	0.030	0.056	0.505
PCASEE cognitive								
r	–0.497	0.050	0.030	–0.006	–0.213	–0.040	–0.354	0.286
P value	0.006	0.797	0.878	0.975	0.267	0.839	0.059	0.133
PCASEE affective								
r	–0.146	–0.127	–0.237	–0.110	–0.373	–0.304	–0.343	0.212
P value	0.448	0.510	0.216	0.569	0.046	0.109	0.068	0.270
PCASEE social								
r	–0.156	–0.088	–0.114	–0.119	–0.103	0.025	–0.135	0.411
P value	0.419	0.649	0.555	0.537	0.594	0.898	0.484	0.027
PCASEE economic								
r	0.076	0.273	0.137	–0.552	0.158	0.193	0.323	0.067
P value	0.694	0.152	0.478	0.002	0.412	0.316	0.087	0.729
PCASEE ego								
r	–0.192	–0.102	–0.428	–0.055	–0.287	–0.333	0.000	0.227
P value	0.319	0.599	0.021	0.779	0.131	0.078	0.999	0.236

Spearman correlation coefficient. BDI, Beck Depression Inventory; LSS, Life Satisfaction Scale; MHQ, Middlesex Hospital Questionnaire; PCASEE, Physical, Cognitive, Affective, Social, Economic and Ego Questionnaire for Quality of Life. *P* value less than 0.05 is significant.

was negatively affected by the long duration associated with the HD therapy. All domains of QoL, except the economic domain, in the HD group were inversely correlated with depression, anxiety, and somatization, and this was supported by the study of Li *et al.* (2016). They found that in relatively healthy maintenance HD patients, QoL scores are usually decreased in those with depression and/or anxiety but appears to be normal in those without depression or anxiety.

On the contrary, the better quality of physical health of the RTR group agreed with the study of Tayyebi *et al.* (2010) who found that RTR patients have higher QoL in the global physical health compared with patients on HD. In the same context, the study by Baguelin-Pinaud *et al.* (2009) showed that health perceived by the patients was greater after RT. In fact, it was observed during the current study that the RTR comprised healthier and younger individuals compared with those in the HD group. Such individuals were assumed to be more fit for the transplant procedure.

However, the significant lower scores of the economic domain in the RTR group compared with the HD group were consistent with Elsharif *et al.* (2010) who found that HD was less expensive than kidney transplantation. Similarly, Kapoor *et al.* (2015) found

that more than 65% of their patient population had poor socioeconomic rehabilitation even after a successful RT. Nevertheless, Tayyebi *et al.* (2010) stated that satisfaction from the economical situation was higher in RTR patients, which coincided with Perović and Janković (2009), who found that the costs of HD at ESRD is far greater than that of RT and maintenance, by almost three and a half times. The difference in the aforementioned studies could be explained by the serious global unfairness in access to transplantation that exists internationally. Transplantation programs face many challenges in low-income and middle-income countries owing to the lack of infrastructure, financial constraints, and inadequate cadaveric donor programs (Kapoor *et al.*, 2015). Another explanation could be the delay of transplantation owing to the long waiting list, as it is obvious that transplants performed preemptively reduce the costly complications such as acute rejection, delayed graft function, and allograft failure (Abecassis *et al.*, 2008). Furthermore, Gaston and Thomas (2005) found that only 24% of patients who were on HD for more than 1 year returned to work after RT compared with at least one half of those who received a RT preemptively.

In the RTR group, the physical health domain of QoL was inversely correlated with depression, the affective domain was inversely correlated with somatization, and the ego domain was inversely correlated with phobia, which were in line with Jana *et al.* (2014), who found that depression, anxiety, and alteration of body image were observed as comorbid conditions in patients with RT, where they might adversely affect the adherence and thereby cripple effective immunosuppression. In addition, high rates of fear and phobia may be related to concerns about rejection to the graft and returning to the HD state. Hence, psychological consult is mandatory before and after RT surgery at regular intervals.

Ganji *et al.* (2014) have reported that patients with RT had excessive worries about the costs of transplant and donor evaluations, posttransplantation costs (paying for expensive immunosuppressant medications and losing the coverage of their health insurance), and living donor expenses. This was further supported in the current study by the negative correlation between obsession and economic domain of QoL.

Regarding the positive correlation between depression and somatic symptoms, dysfunctional hypothalamic and sleep centers may be of paramount importance, all influenced by both serotonin and norepinephrine, and they are also mediated by different malfunctioning neuronal circuits regulated by multiple neurotransmitters (Demyttenaere *et al.*, 2005). Thus, the typical form of presenting depression is via somatization, and this is considered one of the main reasons for low rates of recognition of depression in such patients. Different causal illness interpretations, a tendency to exaggerate somatic distress, and difficulties in identifying and dealing with emotional distress, all have an effect on the extent and form of a somatic mode of presentation (Henningsen *et al.*, 2005).

Regarding the positive correlation of cognitive symptoms with depression in both groups, cognitive complaints are core symptoms of acute major depressive episodes as diminished ability to think or concentrate and/or indecisiveness are criterion items for the diagnosis of major depressive disorder (Lam *et al.*, 2014). Poor sleep quality of the depressed group which is known to negatively affect cognitive performance could be another contributing factor. It is worth mentioning that some studies demonstrated an association between the Cognitive Depression Index and lower survival rates in HD patients (Kimmel *et al.*, 2000; Peterson *et al.*, 1991).

The findings of our study support the hypothesis that HD has a higher rate and severity of depression and anxiety symptoms with poorer QoL and life satisfaction than RT.

Limitations

It was found that RT was preferred by younger patients owing to many advantages of the intervention, for example, physical and social independence on the HD unit. From the other side, old age was a relative contraindication of RT because of increased association with other medical diseases and the lower donor availability. Thus, the age difference between both groups may be considered a limiting factor in this study.

Although the study results showed that RT is the superior form of RRT regarding health-related QoL, the issue of donor organ availability and eligibility remains a key limiting factor in many developing countries. Duplication of the study in multicenters is a necessity to be able to generalize the results by increasing the sample size, as recruiting such type of study participants from one location may be a second limitation.

Recommendation

The strong correlation between depression, anxiety, and QoL, in HD or RTR patients emphasizes the need

of a multidisciplinary approach to facilitate early referral and intervention. In addition, a follow-up study to detect the long-term effect of RRT on patients is recommended. Improvement of the RT program in Egypt and preemptive transplantation decisions are needed.

Conclusions

Depression accompanied with a variety of anxiety symptoms constituted determinants of poor QoL in the setting of ESRD and consequently, less life satisfaction. HD patients showed higher levels of depression, anxiety, and somatization along with poorer QoL and less life satisfaction than patients with RT.

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Conflicts of interest

There are no conflicts of interest.

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