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Prevalence of erectile dysfunction in patients with chronic kidney disease on renal replacement therapy

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ABSTRACT: **The current study aimed to investigate the prevalence of erectile dysfunction (ED) in patients with chronic kidney disease (CKD) on renal replacement therapy (RRT) in the form of hemodialysis (HD). The study included the data of prospective observation of 201 patients on hemodialysis program. The erectile function (EF) was assessed using the International Index of Erectile Function (IIEF-5) score, doppler sonography of the penile arteries was used to diagnose hemodynamics in the vessels of the penis, the hormonal profile of patients was determined using testosterone, luteinizing hormone, and follicle-stimulating hormone levels, and reproductive function was determined using a spermogram at three stages of the study: initially, high azotemia and 12 months after start of RRT. The results showed that in patients on hemodialysis, ED progression was noted with a decrease in IIEF-5 score from 21.9 to 9.7 points (P<0.001). The average peak systolic velocity in the right cavernous arteries decreased from 6.5±0.1 to 4.8±0.1 cm/s (P<0.001), and also testosterone level, luteinizing hormone, follicle-stimulating hormone, and the frequency of normospermia were significantly decreased (P<0.001), while there was an increase in cases of pathological disorders of spermatogenesis in total up to 14.0% (P<0.001). It is concluded that there is persistence of multifactorial erectile dysfunction caused by vascular, hormonal and structural changes in patients with CKD on RRT in the form of HD.**

KEYWORDS: Chronic kidney disease, erectile dysfunction, renal replacement therapy

INTRODUCTION

Erectile dysfunction (ED) is a significant and common complication in patients with chronic kidney disease (CKD), with reported prevalence rates ranging from 70% to 86%. This includes patients on hemodialysis (77–84%) and those on peritoneal dialysis (up to 84%) [1–5]. In recent decades, increasing attention has been directed towards understanding the underlying mechanisms of ED and reproductive dysfunction (RD) in CKD. These conditions are multifactorial, resulting from a complex interplay of hormonal imbalances, uremic toxins, vascular damage, and metabolic disturbances. The clinical importance of this issue extends beyond the physical impact of ED, as it also severely affects patients' psychological well-being, leading to social isolation and a marked decline in quality of life [2,4,5].

Of particular interest is the impact of renal replacement therapy (RRT) and kidney transplantation (KT) on erectile function (EF). While the effect of RRT duration on EF remains debated, multiple studies report a high prevalence of ED in patients undergoing RRT, with rates ranging from 41% to 98%. Notably, around half of CKD patients already experience ED in the pre-dialysis stage, with prevalence rising to approximately 80% during dialysis [3–5].

The International Index of Erectile Function (IIEF-5) questionnaire is the most widely used tool for ED assessment, regarded as the gold standard for evaluating key aspects of sexual function. However, its scores can be influenced by the patient's psychological state. In CKD, key risk factors for ED include hormonal abnormalities (notably low testosterone and hyperprolactinemia) and metabolic disturbances such as dyslipidemia and impaired glucose metabolism. To assess vascular contributions to ED, instrumental techniques like pharmacodopplerography and shear wave elastography are employed, enabling the identification of fibrotic changes and differentiation between vasculogenic and non-vasculogenic ED forms [6–9].

Despite the high prevalence of ED among CKD patients, diagnostic approaches, pathophysiological understanding, and treatment strategies for ED in this population remain underdeveloped in clinical practice. This underscores the need for further research focusing on vascular, hormonal, and structural changes at different CKD stages and during RRT, to develop effective management strategies.

This study aimed to evaluate the prevalence of erectile dysfunction in patients with chronic kidney disease undergoing renal replacement therapy.

MATERIALS AND METHODS

The study was based on a prospective analysis of treatment outcomes in 201 men with CKD, who were receiving RRT and treatment for ED at the Republican Specialized Scientific Practical Medical Center of Urology (Tashkent, Uzbekistan). All methods were performed in accordance with the relevant guidelines and the principles of Helsinki Declaration. The mean age of the patients was 35.1±2.0 years. The majority of patients were young adults (aged 18–44 years), accounting for 82.4%. Middle-aged patients (45–59 years) comprised 15.1%, and elderly patients (60–74 years) accounted for only 2.5%.

The primary cause of stage 5 CKD in most cases (88.3%) was chronic glomerulonephritis. Less frequent causes included polycystic kidney disease (2.9%), CKD of unknown etiology (2.7%), urolithiasis (2.3%), chronic pyelonephritis (1.7%), type 2 diabetes mellitus, and congenital anomalies of the urinary system (1.0% each).

The study was conducted in accordance with the Declaration of Helsinki. All patients provided informed consent, and the protocol was approved by the local ethics committee of the Republican Specialized Scientific Practical Medical Center of Urology (Tashkent, Uzbekistan).

Inclusion criteria for the study were: male patients with CKD, preserved EF, a regular sexual partner, treatment in the form of RRT (n=201), and absence of other comorbidities in the acute or decompensated stage.

In general, the study included the following stages of patient follow-up with EF assessment:

- Initial stage – evaluation of EF before the development of advanced renal failure;
- Stage of severe azotemia – during stage 5 CKD, characterized by accumulation of uremic toxins and deterioration of systemic functions, including EF;
- 12 months after initiation of RRT – long-term evaluation reflecting the final outcome of therapy on EF, including complete or partial restoration of EF.

EF was assessed using the International Index of Erectile Function (IIEF-5) with classification as follows: severe ED (≤7 points), moderate (8–11 points), mild to moderate (12–16 points), mild (17–21 points), and no ED (22–25 points). Hemodynamic assessment of penile vasculature was performed using ultrasound with Doppler imaging of penile arteries, measuring peak systolic velocity (PeakSV) in the cavernosal and dorsal arteries. Hormonal profile (testosterone, luteinizing hormone (LH), and follicle-stimulating hormone (FSH)) was analyzed using enzyme-linked immunosorbent assay (ELISA). Reproductive function was evaluated by semen analysis, assessing the prevalence of normozoospermia, asthenozoospermia, oligozoospermia, OAT syndrome (oligoasthenoteratozoospermia), and azoospermia in the overall patient sample.

For ED treatment, first-line phosphodiesterase type 5 (PDE-5) inhibitors were used at a dose of 5 mg orally once daily for 3 months, followed by 20 mg taken 30 minutes before intercourse. A special set of pelvic floor muscle exercises aimed at improving penile blood flow was also implemented, in addition to vacuum therapy: the

first 10 sessions were conducted daily, and the remaining 12 sessions with 2-day intervals. Physiotherapy using a specialized device was applied for 15 minutes over 10 consecutive days.

Statistical analysis

Descriptive and comparative statistical methods were used to analyze the obtained data. Data collection, adjustment, systematization, and result visualization were performed using Microsoft Office Excel 2016. Statistical analysis was conducted using IBM SPSS Statistics v.26 (developed by IBM Corporation, USA). Descriptive statistics were used to characterize clinical and demographic indicators, including calculations of means (M), standard errors of the mean (m), and percentage distributions. One-way analysis of variance (ANOVA) was used to assess statistically significant differences across various follow-up stages. The chi-square (χ^2) test was used for categorical variables.

RESULTS

At the initial stage of the study, 75 patients (37.3%) had mild ED, while 126 patients (62.7%) showed no signs of ED. However, as the underlying disease progressed to end-stage renal disease (stage 5 CKD) and during severe azotemia, all patients developed ED of varying severity — from mild to moderate — according to the IIEF-5 scale. After 12 months of RRT, no improvement in erectile function was observed. On the contrary, in a significant proportion of patients, dysfunction worsened, and 13.9% of patients developed severe ED.

Erectile dysfunction risk factors in CKD patients (Table 2) were diabetes (OR 1.58, 95% CI 1.10–2.26), hyperprolactinemia (OR 1.72, 95% CI 1.15–2.60), hyperparathyroidism (OR 1.99, 95% CI 1.42–2.80), psychosocial factors (OR 1.73, 95% CI 1.23–2.45), smoking (OR 1.48, 95% CI 1.04–2.11), alcohol abuse (OR 1.49, 95% CI 1.05–2.11), sarcopenia (OR 1.79, 95% CI 1.18–2.43), and cardiovascular diseases (OR 1.74, 95% CI 1.11–2.75).

Table 1. Dynamics of ED severity according to the IIEF-5 scale at different stages of the study

ED severity according to the IIEF-5		Initial	High azotemia stage	12 months after start of RRT
Severe ED	n	0	0	28
	%	0%	0%	13.9%
Moderate	n	0	8	132
	%	0%	4,0%	65.7%
Moderate-mild	n	0	186	41
	%	0%	92.50%	20.4%
Mild	n	75	7	0
	%	37.3%	3,50%	0%
No ED	n	126	0	0
	%	62.7%	0%	0%
Total	n	201	201	201
	%	100%	100%	100%

n: number of cases; IIEF-5: international index of erectile function; ED: erectile dysfunction; RRT: renal replacement therapy

Table 2. Factor analysis of ED in patients with CKD

Risk Factor	OR	95% CI
Diabetes	1.58	1.104; 2.262
Hyperprolactinemia	1.724	1.145; 2.597
Hyperparathyroidism	1.994	1.42; 2.801
Psychosocial factors	1.735	1.228; 2.451
Smoking	1.482	1.041; 2.11
Alcohol abuse	1.486	1.046; 2.112
Sarcopenia	1.791	1.176; 2.432
Cardiovascular diseases	1.744	1.107; 2.748

At the initial stage (before azotemia progression), the mean IIEF-5 index was 21.9±0.1, reflecting a pronounced reduction in EF, yet with preserved sexual activity. During the stage of severe azotemia, further deterioration was noted — the IIEF-5 dropped to 13.7±0.1, indicating a significant decline in EF. One year after the initiation of RRT, an even more pronounced decrease was observed, with the IIEF-5 dropping to 9.7±0.1 ($F(2,600)=2418.29$; $P<0.001$), signifying a critical impairment of EF despite ongoing therapy.

Analysis of PeakSV dynamics during the observation period in CKD patients on RRT (Table 3) showed that in the right cavernosal artery, baseline PeakSV was 6.5±0.1 cm/s, decreasing to 5.6±0.1 cm/s during severe azotemia (a 13.8% reduction), and further declining to 4.8±0.1 cm/s after one year on HD ($P<0.001$). Similar trends were observed in the left cavernosal artery: the initial value was 6.3±0.1 cm/s, 5.4±0.1 cm/s during azotemia, and 4.7±0.1 cm/s after one year on HD ($P<0.001$). The dorsal artery, initially showing higher values (12.2±0.2 cm/s), also demonstrated progressive deterioration: 10.5±0.2 cm/s during azotemia and 9.0±0.2 cm/s one year after HD initiation ($P<0.001$).

The analysis of hormonal status (Table 4) revealed a progressive decrease in testosterone, LH, and FSH levels as the patients' condition worsened and RRT continued. At the baseline stage, the testosterone level was 5.1±0.2 ng/mL, which decreased to 4.5±0.2 ng/mL during the stage of high azotemia, and further declined to 4.0±0.1 ng/mL after one year of RRT ($F(2,600)=23.49$; $P<0.001$). A progressive decrease in LH levels ($F(2,600)=127.81$; $P<0.001$) and FSH levels ($F(2,600)=47.88$; $P<0.001$) was also observed against the background of deteriorating kidney function and ongoing RRT. This may be associated with suppression of the hypothalamic-pituitary-gonadal axis, metabolic disorders, and possible dysregulation of gonadotropin secretion, leading to the development of hypogonadotropic hypogonadism.

Semen analysis with assessment of the degree of spermatogenesis disorders also made it possible to determine whether RRT had a positive or negative impact on the reproductive health of CKD patients (Figure 1). According to the results, there was a progressive deterioration in sperm quality, with an increase in the incidence of pathological spermatogenesis disorders (asthenozoospermia, oligozoospermia, and oligoasthenoteratozoospermia) reaching a combined total of 14.0% ($\chi^2=30.87$, $P<0.001$).

Thus, the most significant changes in erectile function (EF) and reproductive health occurred during the progression of CKD to the stage of high azotemia, which is associated with increasing uremic intoxication, as well as endocrine and vascular disorders. Further treatment with RRT and specific ED therapy did not lead to substantial improvement.

Table 3. Mean PeakSV in cavernosal arteries according to doppler ultrasound

Research stage	PeakSV on the right cavernous artery	PeakSV on the left cavernous artery	PeakSV on the dorsal artery
	M±m	M±m	M±m
Initially	6.5±0.1	6.3±0.1	12.2±0.2
High azotemia stage	5.6±0.1	5.4±0.1	10.5±0.2
12 months after the start of RRT	4.8±0.1	4.7±0.1	9±0.2
ANOVA	F(2.600)=287.65; P<0.001	F(2.600)=77.81; P<0.001	F(2.600)=81.40; P<0.001

n= number of cases, M= mean value, m= standard error of the arithmetic mean, RRT= renal replacement therapy, PeakSV= peak systolic velocity

Table 4. Dynamics of mean levels of key hormones regulating reproductive function

Research stage	Testosterone (ng/mL)	LH (mIU/mL)	FSH (mIU/mL)
	M±m	M±m	M±m
Initially	5.1±0.2	8.9±0.1	6.3±0.1
High azotemia stage	4.5±0.2	7.8±0.1	5.6±0.1
12 months after the start of RRT	4±0.1	6.9±0.1	5±0.1
ANOVA	F(2.600)=23.49; P<0.001	F(2.600)=127,81; P<0,001	F(2.600)=47.88; P<0.001

n= number of cases, M= mean value, m= standard error of the arithmetic mean, RRT= renal replacement therapy, LH= luteinizing hormone, FSH= follicle-stimulating hormone.

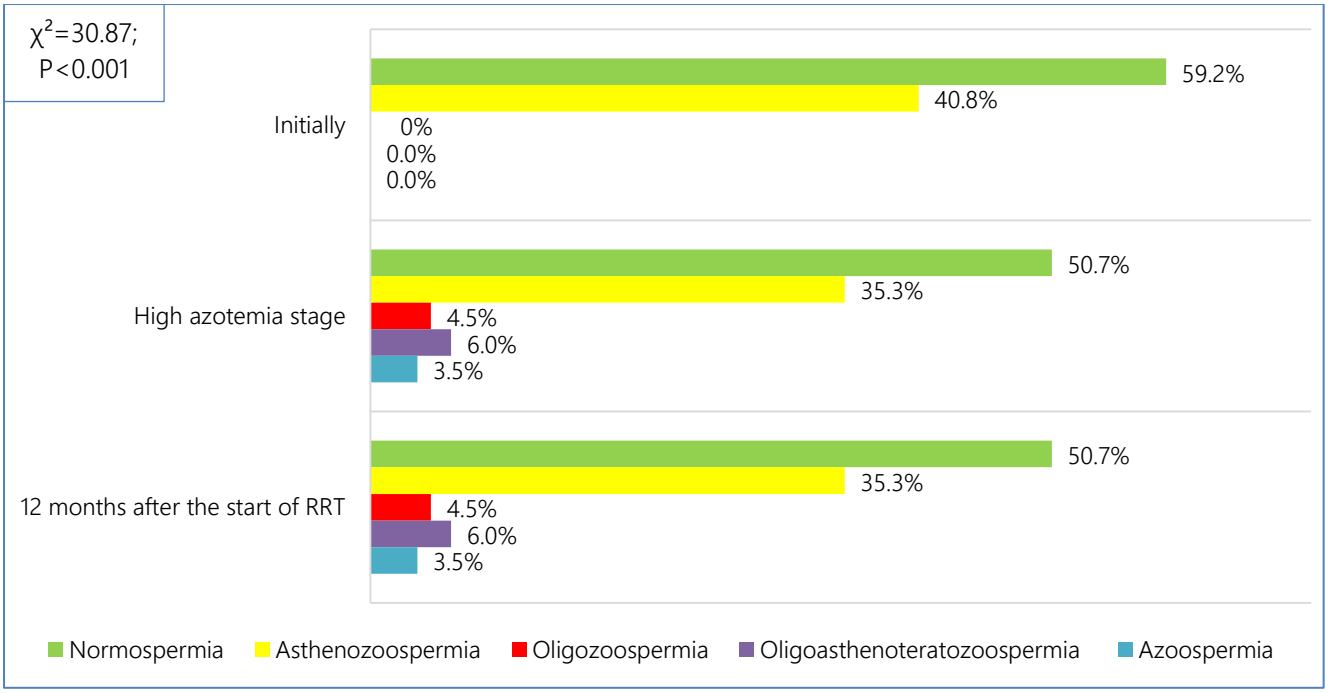

Figure 1. Distribution of patients with CKD and ED receiving RRT based on the dynamics of changes in spermogram.

DISCUSSION

ED and RD remain critical areas of research in CKD, given their profound impact on patient quality of life and overall health. Recent studies have focused on identifying diagnostic tools and key pathophysiological mechanisms underlying ED in CKD patients. Hormonal and vascular abnormalities—including hypogonadism, hyperprolactinemia, and cavernous body ischemia—are recognized as pivotal contributors to persistent ED.

Salonia et al. [6] reported that IIEF-5 is widely accepted as the gold standard for ED assessment, covering key domains such as erectile capacity, orgasmic function, sexual desire, and overall satisfaction. However, Neijenhuijs et al. [7] highlighted that IIEF-5 scores may fluctuate depending on psychological factors, with higher scores often observed in psychogenic ED compared to organic causes.

Beyond questionnaires, several laboratory markers are under investigation in CKD-related ED. Wang Q. et al. identified low testosterone and hyperprolactinemia as significant risk factors [8], while Zhang et al. [9] emphasized the role of dyslipidemia and impaired glucose metabolism in vascular dysfunction contributing to ED. Antonucci et al. [10] found that 65% of patients with hypogonadism and hyperprolactinemia had persistent moderate ED despite stable graft function.

Ye et al. [3] evaluated 176 patients on RRT, reporting an ED prevalence of 80.6%. Independent predictors included younger age (P=0.014), low daily urine output (P=0.032), and elevated C-reactive protein (CRP) levels (P=0.043). Daily urine volume correlated positively with IIEF-5 scores (P=0.011), while older age (P=0.001) and CRP (P=0.017) were negatively correlated.

In a study of 164 men on maintenance hemodialysis (HD), Lau et al. [4] found ED in 93.3% of participants, with 63% experiencing severe ED; age and diabetes were significant risk factors. Similarly, Tekkarismaz et al. [5] reported a higher prevalence of ED in patients on peritoneal dialysis compared to HD, with associated risk factors including age, hypertension, iron therapy, hyperlipidemia, and depression.

Savadi et al. [12] observed significant improvements in EF after six months of HD, with notable gains across sexual satisfaction, desire, orgasmic function, and EF scores (P=0.001). Selvi et al. [13] found dialysis adequacy to be a protective factor against ED in men (P=0.019) and women (P=0.041), while depression strongly correlated with ED, particularly in women (P=0.002).

Ahmed et al. [14] reported an ED prevalence of 78.8% in men with end-stage CKD, with no significant association between RRT duration and ED severity or gonadal hormone levels. Notably, hyperprolactinemia was observed in 90% of cases, while testosterone deficiency affected 18.6%. The study suggests that endothelial dysfunction and vascular damage may outweigh hormonal factors in ED pathogenesis.

Chou et al. [15] estimated the ED prevalence in RRT patients at up to 83%, significantly exceeding rates in the general population. Antonucci et al. [10] confirmed higher ED rates in long-term RRT patients compared to transplant recipients. However, El Hennawy et al. [11] found that pre-transplant dialysis duration had no significant effect on post-transplant EF.

Our study revealed that CKD progression and the initiation of RRT were associated with worsening erectile and reproductive function. While 62.7% of 201 CKD patients had no ED at baseline, this proportion dropped to 0% with disease progression and RRT initiation. After 12 months of RRT, 13.9% of patients developed severe ED, highlighting the need for comprehensive management strategies addressing vascular, hormonal, and anatomical dysfunctions in this population.

CONCLUSIONS AND RECOMMENDATIONS

The progression of CKD and the implementation of RRT are accompanied by deterioration in erectile and reproductive function due to vascular, hormonal, and structural changes. Future studies should focus on longitudinal, multicenter trials incorporating detailed hormonal profiling, penile hemodynamic assessments, and quality-of-life metrics, with particular attention to the impact of different RRT modalities and timing of initiation on sexual and reproductive outcomes.

DECLARATIONS

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Authors' contributions

All authors contributed equally to this work.

Ethical approval

The review board and ethics committee of the State Institution "Republican Specialized Scientific and Practical Medical Center of Urology" approved the study protocol and informed consents were taken from all the participants. All methods were performed in accordance with the relevant guidelines and the principles of Helsinki Declaration.

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Competing interests

All authors declare that they have no conflict of interest.

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