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Comparison of the efficacy of tadalafil in three different groups; patients on hemodialysis, first kidney transplant recipients, and second kidney transplant recipients

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ABSTRACT

Introduction: The efficacy of phosphodiesterase-5 inhibitors (PDE5Is) on the improvement of erectile dysfunction (ED) in second kidney transplant (KT) recipients has not been studied before.

Objectives: We aimed to compare the efficacy of tadalafil in three groups: hemodialysis (HD) patients, first KT recipients (KT1) and second KT recipients (KT2) with bilaterally ligated internal iliac arteries (IIAs).

Patients and Methods: Age-matched men with ED were included in the study. Patients divided into three groups; HD, KT1 and KT2. The international index of erectile function 15 (IIEF-15) questionnaire was used to assess the baseline erectile function. Tadalafil was administered in a dose-escalation method for three months. Patients were reevaluated by the questionnaire at three months. The mean score evolution was compared between the study groups by Kruskal-Wallis H test.

Results: Total number of 106 patients in three groups was included in the final analysis. There was no significant difference between the study groups in terms of age, body mass index (BMI), blood pressure and frequency of smoking, opium, or alcohol use. Tadalafil was safe and effective in all three groups. The mean IIEF score evolution in HD, KT1 and KT2 groups was 16.4 (58.7% increase from baseline), 19.3 (45.0% increase) and 20.4 (52.7% increase), respectively.

Conclusion: Tadalafil is effective and safe in the management of ED even after the second kidney transplantation when the IIAs are cut bilaterally. The response rate is similar to first KT recipients and HD patients.

Trial Registration: The trial protocol was approved by the Thai Clinical Trials Registry (https://www.thaiclinicaltrials.org/show/TCTR20220310008, ethical code# IR.SBMU.UNRC.1396.43).

Implication for health policy/practice/research/medical education:
Second kidney transplant (KT) recipients with bilaterally ligated internal iliac arteries (IIAs) have lower erectile function scores than first KT recipients. In this age-matched non-randomized clinical trial, we compared the efficacy of tadalafil in three groups of hemodialysis (HD) patients, first KT recipients (KT1) and second KT recipients (KT2). The international index of erectile function 15 (IIEF-15) was conducted for assessment of efficacy. The results showed that tadalafil is effective in all three groups (around 45.0-58.7% increases from baseline scores). Thus, we recommend tadalafil for the treatment of erectile dysfunction even in second KT recipients.

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Original

Introduction

Erectile dysfunction (ED) is defined as the inability to attain or maintain penile erection for a satisfactory sexual intercourse (1). ED is one of the most bothering consequences of end-stage renal disease (ESRD) and is directly related to the duration of hemodialysis (HD) (2). The prevalence of ED in patients undergoing HD is reported to be as high as 70%-80% (3). Kidney transplantation is the lifesaving treatment of ESRD that can also improve the endocrine disturbances of the patients (4). However, the efficacy of kidney transplantation on the improvement of ED depends on multiple parameters and is still unclear. Some studies report that 30%-50% of patients still suffer from ED after kidney transplantation (5). Arterial damage is considered to be one of the main causes of the high prevalence of ED after kidney transplantation. This reason is more prominent when the internal iliac artery (IIA) is conducted for end to end anastomosis to the transplanted renal artery, especially when IIAs are cut bilaterally during second KT (6).

Phosphodiesterase-5 inhibitors (PDE5Is), including sildenafil citrate and tadalafil have been reported to be effective and safe in the treatment of ED in patients with chronic kidney disease or kidney transplant recipients (7). PDE5Is require sexual arousal and the production of nitric oxide to be effective (8). The internal pudendal artery, which is a branch of the IIA, is the main blood supply to the corpus cavernosa. It is unclear whether PDE5Is are effective in patients after cutting IIA for kidney transplantation, particularly when performed bilaterally. To the best of our knowledge, no study has examined the efficacy of PDE5Is in patients with second kidney transplantation where the IIAs are ligated bilaterally.

Objectives

The current study was aimed to compare the efficacy of PDE5Is in ESRD patients on HD, first KT and second KT recipients.

Patients and Methods

Study population

The current clinical trial was conducted in the urology department from January 2017 to February 2021. Men on HD and those with a history of first or second KT suffering from ED and referred to the kidney transplantation clinic were assessed for eligibility. Informed consent was obtained and patients aged 18 years or older who were in a stable relationship included in the study. ED was defined as a score of less than 25 in the "erectile function" domain of the international index of erectile function-15 (IIEF-15). All patients in the transplanted groups underwent end-to-end anastomosis to the IIA/IIAs. Patients were excluded from the study in the following situations; having cognitive or communication problems; no tendency to recover from ED; presence of genital anatomic deformities that could significantly impair erection; less than six months interval from last kidney transplantation; history of kidney transplantation with subsequent HD; taking medications that may lead to ED (such as beta-blockers, tricyclic antidepressants); taking nitrite derivatives or nitric oxide-releasing agents; not willing to withdraw any other ED treatments during the study period; and any contraindication for taking PDE5Is.

Study design

This study is a non-randomized, three-arm, dose-escalation, single-center, phase IV clinical trial conducted at a tertiary medical institute. The study population consisted of three groups; the first group included patients with ESRD undergoing HD; the second group consisted of patients with a history of renal transplantation once (KT1) and the third group included patients with a history of renal transplantation twice (KT2). Tadalafil was administered as follows and patients were evaluated for safety and efficacy at 2, 6, and 12 weeks after treatment. Figure 1 shows the CONSORT diagram of enrollment for this study. Clinical evaluations at baseline were blood tests including a lipid profile, fasting blood sugar, creatinine level, thyroid-stimulating hormone (TSH) and free testosterone levels.

Dosing

Tadalafil (Tiafil®, Samisaz, Iran) is available as 5, 10 and 20 mg film-coated tablets for oral administration. Tadalafil was purchased from the pharmacy and given to the patients for free. The long half-life allows for low dose daily administration of the drug. At the first visit, all transplanted patients (group II and III) were treated with 2.5 mg of tadalafil per day, whereas HD patients (group I) received tadalafil at a dose of 2.5 mg every 72 hours. In the second visit, patients with well-tolerated doses of 2.5 mg, however not having improved erectile function were able to increase their doses to the maximum dose of 5 mg. Failure to improve was defined as at least two unsuccessful attempts at sexual activity following sexual arousal. Patients who had a good response to the initial drug dose did not receive a higher dose. If an appropriate response to the higher dose was observed, the patients were not allowed to take higher doses. In patients receiving the higher dose, the dose of the drug was reduced only in the case of intolerable side effects. If the complication continued using the lower dose, the drug was discontinued and the patient was excluded.

Efficacy parameters

Erectile function and quality of life reported by the patient were scored by IIEF-15 questionnaire, whose validity has already been proven (9). The questionnaire consists of 15 questions in five domains; erectile function, orgasmic function, sexual desire, intercourse satisfaction and overall satisfaction. This tool is specifically designed to evaluate sexual function in patients with ED. The primary outcome

in this study was the evolution of overall IIEF score at three months compared to the baseline. Secondary outcomes included the other domains of sexual function which was obtained from the questionnaire. Clinical efficacy was defined as a 25% improvement in the overall IIEF score.

Safety parameters

Patients underwent a thorough physical examination at the start of the study and at the end of the treatment. We measured blood pressure and heart rate at each visit. At each visit, the evaluator obtained information about comorbidities or any interfering therapies. All adverse events were documented irrespective of the causal association with tadalafil. We defined serious adverse events as; any adverse events that occur at any dose that leads to death, are life-threatening, lead to a hospital stay or prolonged hospital stay, or cause permanent or significant disability.

Statistical analysis

The population per-protocol included all patients who received regular treatment according to the study protocol and completed the IIEF questionnaire at the beginning and also the end of the study. Data were analyzed using IBM SPSS version 23 statistical software. For the main efficacy parameter, we fixed the significance level at 2.5%. For secondary outcomes, a *P* value of less than 0.05 was considered significant. Wilcoxon signed rank test was conducted to compare the results of the IIEF at baseline and post-treatment in each group. Meanwhile, the Kruskal-Wallis H test was employed to compare the IIEF scores between the three study groups. One-way ANOVA and chi-square tests were used to assess the difference between groups. We also conducted Dunn's test for post-hoc analysis.

Results

Out of 135 patients assessed for eligibility, 29 patients (21.4%) withdrew the study; 21 patients did not meet the inclusion criteria, two patients were excluded due to drug side effects, four patients did not return for follow-up and two patients did not fill out the questionnaire. The study population consisted of 106 male patients with a mean age of 57.5 ± 11.8 years and a mean body mass index (BMI) of 26.1 ± 4.6 kg/m^2. On average, systolic blood pressure was 124.3 ± 13.6 mm Hg and diastolic blood pressure was 77.7 ± 7.9 mm Hg.

The number of patients in HD, KT1 and KT2 groups were 31, 48 and 27, respectively. The basic characteristics of the patients are given in Table 1. One-way ANOVA test showed that there was no statistically significant difference between the three study groups in terms of age, BMI and systolic and also diastolic blood pressures. There was no significant difference between the study groups in terms of the frequency of smoking, opium, and alcohol consumption.

The average duration of kidney transplantation in the KT1 group was 50.6 ± 52.8 months and in the KT2 group was 76.6 ± 78.6 months. Initial nephropathy was due to diabetes mellitus or hypertension in 54 patients (50.9%). The mean length of dialysis in the HD group was 83.7 ± 83.5 months, in KT1 was 27.5 ± 20.2 months and in KT2 was 21.7 ± 18.8 months. The final drug dose was 2.5 mg/d in 26 patients (24.5%) and 5 mg/d in 80 patients (75.5%).

Table 2 shows the median scores of the domains of the IIEF before and after the treatment. Kruskal-Wallis

Table 1. Characteristics of the study population

	HD	KT1	KT2	*P* value
N	31	48	27	NA
Age (y), mean ± SD	58.2 ± 13.1	57.6 ± 11.7	54.7±10.5	0.324[a]
BMI (kg/m^2), mean ± SD	26.4 ± 6.1	26.1 ± 4.1	26.0 3.0	0.950[a]
Systolic blood pressure (mm Hg)	122.4 ± 20.0	123.5 ± 11.9	130.8 ± 11.6	0.208[a]
Diastolic blood pressure (mm Hg)	77.1 ± 9.4	77.1 ± 70.8	78.3 ± 7.0	0.910[a]
Smoking (yes/no)	8/23	4/44	5/22	0.091[b]
Opium (yes/no)	5/26	2/46	4/23	0.332[b]
Alcohol (yes/no)	4/27	1/47	2/25	0.072[b]
Married/single	30/1	47/1	25/2	0.714[b]
Testis exam (normal/unilateral atrophy/unknown)	25/2/4	41/4/3	19/4/4	0.473[b]
Fasting blood sugar (mg/dL)	94.7 ± 12.3	129 ± 94.5	103.8 ± 14.2	0.147[a]
Hemoglobin A1c (%)	6.1 ± 1.9	6.3 ± 1.6	6.8 ± 2.7	0.768[a]
Triglyceride (mg/dL)	133.1 ± 52.1	193.8 ± 109.5	164.6 ± 84.5	0.050[a]
Total cholesterol (mg/dL)	126.6 ± 37.3	203.8 ± 163.7	170.2 ± 44.0	0.074[a]
TSH (mIU/L)	2.3 ± 1.7	1.6 ± 1.6	1.7 ± 1.4	0.292[a]
Total testosterone (ng/mL)	3.3 ± 1.8	4.7 ± 2.4	4.6 ± 2.3	0.082[a]
Free testosterone (ng/mL)	6.4 ± 4.2	8.7 ± 6.2	7.7 ± 4.2	0.281[a]

SD, standard deviation; BMI, body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TSH, thyroid-stimulating hormone.
[a] One-way ANOVA test, [b] Chi-square test.

Table 2. Median IIEF scores at baseline and after treatment in the study groups in addition to *P* values representing inter-group and intra-group analysis

	HD (n = 31)	KT1 (n = 48)	KT2 (n = 27)	Total	*P* value[a]
Erectile function score					
Before treatment	10	16	14	14	0.031
After treatment	18	26	24	24	<0.001
P value[b]	<0.001	<0.001	0.001	<0.001	
Orgasmic function score					
Before treatment	4	7	6	6	0.016
After treatment	6	8	8	8	<0.001
P value[b]	0.004	<0.001	0.009	<0.001	
Sexual desire score					
Before treatment	6	6	6	6	0.495
After treatment	7	8	8	8	0.041
P value[b]	<0.001	<0.001	0.046	<0.001	
Intercourse satisfaction score					
Before treatment	3	7	7	6	0.004
After treatment	6	11	11	10	<0.001
P value[b]	0.001	<0.001	0.003	<0.001	
Overall satisfaction score					
Before treatment	5	6	5	6	0.048
After treatment	7	8	8	8	0.061
P value[b]	<0.001	<0.001	0.019	<0.001	
Overall IIEF score					
Before treatment	28	43	39	38	0.009
After treatment	44	62	59	57	<0.001
P value[b]	<0.001	<0.001	<0.001	<0.001	

[a] Kruskal-Wallis H test, [b] Wilcoxon signed rank test.

H test showed that at baseline, there was a significant difference between the mean scores of the three study groups in the overall score and all the domains except for the sexual desire. Meanwhile, Dunn's test showed that before starting the treatment, the overall IIEF score in KT1 was significantly different from the HD group (P = 0.007); however, the overall IIEF score in the KT2 group was not significantly different from HD and KT1 groups (P = 0.777 and P = 0.259, respectively).

In the total study population, the mean IIEF score evolution was 48.8%. The mean IIEF score evolution in HD, KT1, and KT2 groups was 16.4 (58.7% increase from baseline), 19.3 (45.0% increase), and 20.4 (52.7% increase), respectively. The amount of increase in different domains of the questionnaire and the overall score after receiving tadalafil was clinically and statistically significant, except for the sexual desire in which the difference was not clinically but statistically significant. The rate of score evolution after taking tadalafil in all domains of the questionnaire was calculated and compared between the three study groups. The rate of change in all domains of the questionnaire and the overall score after treatment with tadalafil were not different between the three groups, indicating similar response rates.

Discussion

The most striking result to emerge from the data is that tadalafil has favorable and similar efficacy in the improvement of ED in patients on HD or KT recipients. Although patients with second KT had lower IIEF scores before treatment, the response rate to the drug was comparable with the other groups. To the best of our knowledge, this is the first study to evaluate the efficacy of PDE5Is in second KT recipients.

There is a growing body of literature that reports the safety and efficacy of PDE5Is in patients with ESRD, in whom the administration of these drugs was cautioned previously (10). Similarly, we found that patients on HD had a mean IIEF score evolution of 58.7% and we did not note a significant adverse effect.

The efficacy of PDE5Is has also been shown in kidney transplant recipients by some authors. These studies were focused on patients who have had a KT once. Barrou et al (11) studied 46 first KT recipients and seven second KT recipients and showed the efficacy and safety of sildenafil for the treatment of erectile function in these patients. The mean IIEF score was increased by 16.4 which shows a score evolution of 51.5%. In the study by Sharma et al (12), sildenafil citrate was effective in the improvement of all domains of IIEF, except for sexual desire. The mean IIEF score was increased by 19.4 which shows a score evolution of 56.0%. In the current study, patients in the first KT group improved by 19.4 in IIEF score after tadalafil consumption which is comparable with the

results of previous studies.

We found that in patients with second KT recipients in whom IIAs were cut bilaterally, tadalafil is as effective as patients with first KT recipients or HD patients. The mean IIEF score was increased by 18.7 which shows a score evolution of 48.8%. There was not a significant difference between the study groups regarding the mean IIEF score evolution. To the best of our knowledge, this is the first study to assess the efficacy of PDE5Is in second KT recipients.

It is assumed that IIAs are responsible for the blood supply of genital organs including the cavernosal bodies and when this artery is ligated in kidney transplantation, ED would be inevitable. However, this theory has been rejected in several investigations. There are contradictory data about the impact of kidney transplantation on erectile function. Cummings et al are skeptical about any positive effect and Fanbin et al have reported destructive impact of kidney transplantation on erectile function (13, 14). Several reasons may be considered for the absence of positive response in erectile function after kidney transplantation including preexisted risk factors such as DM, HTN, and smoking; side effects of medications, and violating the blood supply of genital organs during surgery. On the other hand, some studies have reported an improvement in erectile function after kidney transplantation (15-18). In our study, the data gathered before treatment showed that first KT recipients had better IIEF scores than HD patients, however second KT recipients had worse IIEF scores than first KT recipients.

Atherosclerosis is one of the main consequences of ESRD and KT that gradually increases and leads to hypoxemia in these patients. It can be presumed that patients with second KT have had this condition for a longer period. On the other hand, organ transplantation is associated with inflammation and immune system responses. The role of monocytes and growth factors, such as the granulocyte colony-stimulating factor can increase endothelial shear stress and stimulate the emergence of collateral arteries (19).

It seems that the collateral circulation for genital organs in ESRD and KT patients is the reason for a favorable response to PDE5Is. Probably, a longer period of ESRD and consequently atherosclerosis and immune system reaction to KT in patients of second kidney transplantation group has expanded the collateral circulation (20). Therefore, we can conclude that the destructive effect of penile devascularization due to bilateral ligation of IIAs on drug effectiveness is reversed by the development of arterial collaterals.

Conclusion

We conclude that, ED is a common problem in ESRD and, in many cases, persists after kidney transplantation. It can be treated effectively by tadalafil even after the second kidney transplantation where the IIAs are cut bilaterally.

Limitations of the study

A number of limitations need to be noted regarding the present study. First, there was no placebo-controlled group to compare the efficacy of the drug with patients with well-functioning native kidneys. Second, randomization between groups was not feasible. To neutralize the effect of age on drug efficacy on erectile quality, we matched samples on age. However, comprehensive group matching was not possible.

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Authors' contribution

Conceptualization: MD, AHA and MAA.
Methodology: MD, AHA and MAA.
Validation: AHA, MAA and FG.
Formal analysis: FG and NB.
Investigation: MD and MAA.
Resources: MD, AHA, and MAA,
Data curation: MD and MAA.
Visualization: AJ, FG, and NB.
Supervision: AHA and MAA.
Project administration: AHA.
Funding acquisition: MAA.
Writing–original draft preparation: MD and AHA.
Writing–review and editing: AJ, FG and NB.

Conflicts of interest

The authors declare that they have no competing interests. Tadalafil was purchased from the pharmacy and given to the patients in the form of unlabeled packages. No fees were received from the drug manufacturing company.

Ethical issues

The research conducted in accordance with the tenets of the Declaration of Helsinki. The Ethics Committee of Shahid Beheshti University of Medical Sciences approved this study (ethical code#IR.SBMU.UNRC.1396.43). Accordingly, written informed consent was taken from all participants before any intervention. Besides, ethical issues (including plagiarism, data fabrication and double publication) have been completely observed by the authors. The trial protocol was approved by the Thai Clinical Trials Registry (https://www.thaiclinicaltrials.org/show/TCTR20220310008).

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References

1. National Institutes of Health. National Institutes of Health consensus development panel on impotence. JAMA. 1993;270:83-90.

2. Costa M, Ponciano V, Costa T, de Oliveira A, Gomes C, de Oliveira E. Prevalence and factors associated with erectile dysfunction in patients with chronic kidney disease on conservative treatment. Int J Impot Res. 2017;29:219-224. doi: 10.1038/ijir.2017.20.
3. Navaneethan SD, Vecchio M, Johnson DW, Saglimbene V, Graziano G, Pellegrini F, et al. Prevalence and correlates of self-reported sexual dysfunction in CKD: a meta-analysis of observational studies. Am J Kidney Dis. 2010;56:670-85. doi: 10.1053/j.ajkd.2010.06.016.
4. Robinson BM, Akizawa T, Jager KJ, Kerr PG, Saran R, Pisoni RL. Factors affecting outcomes in patients reaching end-stage kidney disease worldwide: differences in access to renal replacement therapy, modality use, and haemodialysis practices. Lancet. 2016;388:294-306. doi: 10.1016/S0140-6736(16)30448-2.
5. Edey MM. Male sexual dysfunction and chronic kidney disease. Front Med. 2017;4:32. doi: 10.3389/fmed.2017.00032.
6. Steiner T, Wunderlich H, Ott U. Sexuality after kidney transplantation. Der Urologe Ausg A. 2009;48:1438-42. doi: 10.1007/s00120-009-2156-4.
7. Liu L-Y, Sun T, Liu Y, Sun Y-Y, Ma F-Z. The clinical effects of sildenafil for erection in patients after kidney transplantation: a meta-analysis. Nephron. 2019;141:1-9. doi: 10.1159/000492237.
8. Chen L, Staubli SE, Schneider MP, Kessels AG, Ivic S, Bachmann LM, Kessler TM. Phosphodiesterase 5 inhibitors for the treatment of erectile dysfunction: a trade-off network meta-analysis. Eur Urol. 2015;68:674-80. doi: 10.1016/j.eururo.2015.03.031.
9. Rosen RC, Riley A, Wagner G, Osterloh IH, Kirkpatrick J, Mishra A. The international index of erectile function (IIEF): a multidimensional scale for assessment of erectile dysfunction. Urology. 1997;49:822-30.
10. YenicerioGlu Y, Kefi A, Aslan G, Cavdar C, Esen A, Camsari T, et al. Efficacy and safety of sildenafil for treating erectile dysfunction in patients on dialysis. BJU Int. 2002;90:442-5. doi: 10.1046/j.1464-410x.2002.02914.x.
11. Barrou B, Cuzin B, Malavaud B, Petit J, Pariente JL, Buchler M, et al. Early experience with sildenafil for the treatment of erectile dysfunction in renal transplant recipients. Nephrol Dial Transplant. 2003;18:411-7. doi: 10.1093/ndt/18.2.411.
12. Sharma RK, Prasad N, Gupta A, Kapoor R. Treatment of erectile dysfunction with sildenafil citrate in renal allograft recipients: a randomized, double-blind, placebo-controlled, crossover trial. Am J Kidney Dis. 2006;48:128-33. doi: 10.1053/j.ajkd.2006.04.061.
13. Cummings J, Boullier J, Browne B, Bose K, Emovon O, editors. Male sexual dysfunction in renal transplant recipients: comparison to men awaiting transplant. Transplant Proc. 2003;35:864-5. doi: 10.1016/s0041-1345(02)04032-0.
14. Fanbin L, Mei Y, Yan Z, Yirong Y, Shaoling Z, Yong C, et al. Efficacy and safety of phosphodiesterase-5 inhibitors for treating erectile dysfunction in kidney transplant recipients: a meta-analysis. Exp Clin Transplant. 2014;12:184-9.
15. Antonucci M, Palermo G, Recupero SM, Bientinesi R, Presicce F, Foschi N, et al. Male sexual dysfunction in patients with chronic end-stage renal insufficiency and in renal transplant recipients. Arch Ital Urol Androl. 2016;87:299-305. doi: 10.4081/aiua.2015.4.299.
16. Yavuz D, Acar FO, Yavuz R, Canoz M, Altunoglu A, Sezer S, et al., editors. Male sexual function in patients receiving different types of renal replacement therapy. Transplant Proc. 2013;45:3494-7. doi: 10.1016/j.transproceed.2013.09.025.
17. Kang J, Tian J, Lu Y, Song Y, Liu X. Erectile function after kidney transplantation: a meta-analysis. Transl Androl Urol. 2020;9:1967-1979. doi: 10.21037/tau-20-604.
18. Teng LC, Wang CX, Chen L. Improved erectile function and sex hormone profiles in male Chinese recipients of kidney transplantation. Clin Transplant. 2011;25:265-9. doi: 10.1111/j.1399-0012.2010.01237.x.
19. Capoccia BJ, Shepherd RM, Link DC. G-CSF and AMD3100 mobilize monocytes into the blood that stimulate angiogenesis in vivo through a paracrine mechanism. Blood. 2006;108:2438-45. doi: 10.1182/blood-2006-04-013755.
20. Seiler C, Stoller M, Pitt B, Meier P. The human coronary collateral circulation: development and clinical importance. Eur Heart J. 2013;34:2674-82. doi: 10.1093/eurheartj/eht195.