

## Renal diseases and Ramadan: A review of the literature

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**Abstract: Background & Aim:** Changes in the dietary pattern and the timing of medications during the Ramadan fast could influence the outcomes of renal diseases in fasting patients. The aim of this study was to review the literature on the effects of fasting during Ramadan on kidney diseases. **Methods:** Citations were extracted from PubMed and the Medline database from 1991 through 2013 using the keywords “renal diseases”, “Ramadan” and “fasting”. The First International Congress on Ramadan and Health was also reviewed. **Results:** High temperatures, rather than Ramadan fasting, appear to be a risk factor for nephrolithiasis. Ramadan fasting may be injurious to renal tubules in pre-dialysis patients with chronic kidney disease (CKD), but the patients on peritoneal dialysis did not experience any serious complications from fasting. Fasting on non-hemodialysis days may expose patients to weight gain and hyperkalemia with no significant acute complications. The hyperkalemia reported by ESRD patients during fasting was not significant and could be due to insulinopenia and a defective response to epinephrine. Fasting for Ramadan does not appear to adversely affect graft function or increase rejection rates among the kidney transplant recipients who have had stable graft function for 1y. **Conclusion:** There was not enough evidence to suggest that fasting has harmful effects on patients with renal disease or renal transplantation. Most patients with stable renal diseases or a functioning transplant can fast without experiencing significant deterioration in renal function. The patients with CKD with or without dialysis are at risk of hyperkalemia while fasting, especially if they have diabetes. Therefore, CKD patients should be meticulously followed during Ramadan, adhere to a proper diet, continue taking medications and receiving dialysis; they should stop fasting if any deterioration occurs.

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### 1. Introduction

Ramadan fasting is an act of worship that serves as the fourth pillar of Islam (1). It occurs in the 9<sup>th</sup> lunar month of the Islamic calendar. It is a holy time and the most important month for Muslims. Fasting is obligatory for all healthy adult Muslims during Ramadan. Muslims abstain from food and drink from dawn until after sunset (2). The duration of the daily fast varies from 13 to 18 h/day (3). Considering that Islam has over one billion followers worldwide, it can be assumed that hundreds of millions of people fast during Ramadan each year (3). Not only does Ramadan fasting discipline the body by refraining from eating and drinking, it also requires restraining every part of one's physical body. The mouth and ears are protected from gossip and profanity, and all sexual thoughts and activities during fasting hours are also forbidden (3). Fasting that endangers health is not in accordance with Islamic jurisprudence. Islam has exemption from fasting for travelers. An example of a “prophylactic” exemption from fasting is related to one's state of health: if fasting would lead to illness or deterioration in health, then it should not be performed. An illness is another excuse to forego fasting; this exemption is particularly relevant if fasting worsens one's illness or delays recovery. It is primarily the physician's decision whether a

patient is required/able to fast. First, it is important to know whether fasting will cause or hasten death or morbidity. Second, the physician needs to decide whether it is safe to fast in disease-free or stable periods of chronic illnesses and whether the patient's therapy schedule could be safely adjusted to allow safe fasting (1). Physicians have a responsibility to answer patients' religious questions about fasting, including those related to the nature of intervention and the expected outcome, to offer evidence-based advice and to allow for the patient to consult with religious leaders (1).

### 2. Study Search Strategy and Selection Methods

All of the published studies addressing the effect of fasting during Ramadan on kidney diseases between 1991 and 2013 were reviewed. The review included relevant English-language articles that were identified in searches of two databases [PubMed and Medline] using the keywords “renal diseases”, “Ramadan” and “fasting”. Original research and reviews about adult patients with renal diseases were considered for the review. The inclusion criteria comprised reports of original studies and reviews about adult patients fasting during Ramadan despite renal diseases, data collected from a control period before or after Ramadan, and data collected during

Ramadan. The exclusion criteria included case studies, letters to editors, and articles that reported data from the periods before and after Ramadan only. Seventeen articles that met the criteria for inclusion were reviewed (Table 1). In addition, proceedings from the First International Congress on Ramadan and Health (Casablanca, Morocco, 1994) and the Second International Congress on Ramadan and Health (Turkey, 1997) were also reviewed.

### 3. The Effect of Fasting on Healthy Kidneys

The effects of dietary and fluid restrictions on health and well-being have been studied in patients with various illnesses in addition to normal healthy individuals in many countries. During the daylight hours of Ramadan fasting, practicing Muslims are undoubtedly dehydrated, but it is not clear whether they are chronically dehydrated during the month of Ramadan. To date, no detrimental effects on health have been directly attributed to negative water balance at the levels that may occur during Ramadan. A reduction in drug compliance was an inherent negative aspect of the fast.

The biological changes during Ramadan are expected. Some studies have reported substantial weight loss, signs of dehydration, increased serum concentrations of uric acid, etc. However, these changes are unlikely to have significant harmful consequences on healthy individuals, because generations of Muslims have undertaken fasting year after year. During Ramadan, urinary volume, osmolarity pH, nitrogen, solute and electrolyte excretion remain normal (4). The changes in serum urea and creatinine have been minimal and not statistically significant (6). There is only a slight increase in uric acid during prolonged fasting because of the decreased glomerular filtration rate (GFR) and uric acid clearance (6-8). Due to the nature of Ramadan fasting, which is short-lasting and intermittent, Ramadan fasting does not cause significant changes in serum sodium and potassium (6). In experimental prolonged fasting, urinary excretion of 25 meq potassium per day has been observed; however, serum potassium remains normal (8). Another study showed that there is decrease in potassium urine excretion by the morning (10). As a consequence of this decrease, the plasma concentration levels of potassium increase throughout the afternoon, but this change is met by an increase in excretion that becomes more effective during the fourth week of Ramadan (10).

A Malaysian group studied tubular functions among healthy persons during Ramadan fasting. They found that the tubular dysfunctions that occurred during fasting were temporary and that the

body rapidly adapted to fasting. These results were attributed to the regimen of altered meal times and activity during Ramadan (11). Alfaraj *et al.* (12) evaluated the combined effect of Ramadan fasting and the short-term use of different non-steroidal anti-inflammatory drugs (NSAIDs) on renal function in healthy volunteers. Measurements of serum and urinary markers of renal function were taken before fasting and after 10 days of fasting while using NSAIDs and five days after stopping the use of NSAIDs. The results showed slight changes in serum and urine measurements while fasting and using NSAIDs. These changes were within the normal range and were noted in all of the study groups, including the control group. The authors concluded that the short-term use of NSAIDs in healthy subjects during fasting is not associated with any major adverse effects on renal function.

### 4. Renal Calculi and Ramadan

The seasonal variation in renal stone diseases is well known. The highest reported incidence rates occur during the months of July, August and September, when it is thought that perspiration causes excessive dehydration, which may lead to a higher concentration of lithogenic substances in the urine (13). In addition, the incidence of stone disease is expected to increase in patients with persistently low urinary volumes, especially in warm seasons (14).

Fluid and diet restrictions during the month-long intermittent Ramadan fast can influence the biochemical factors related to stone formation. One study with 90 patients (15) found that fasting patients have urinary crystalluria like patients with known calcium stones. An important study was performed by al-Hadramy (16) in the western region of Saudi Arabia; it tested the effects of Ramadan fasting for 3 consecutive years. Urinary colic cases during this period were recorded on a monthly basis. The data were recorded before, during and after fasting. The results showed a steady increase in urinary stone colic in the hot season, with the maximum rates in the months of June, July and August. A strong correlation was found between urinary stone colic and both temperature and atmospheric pressure, but there was no significant change in relation to Ramadan fasting. The authors suggested that the incidence of renal stones corresponds to the hot summer months rather than fasting during the month of Ramadan. Another study by Basir *et al.* (17) included 574 subjects with stone colic, 398 males (69.3%) and 176 females (30.7%), who were admitted to the two medical centers of a city in a hot region of Iran.

**Table 1. Characteristics and conclusions of the studies on renal diseases and Ramadan**

NO	First author and year	Country	Patients numbers (F/NF)	Weeks of the study in relation to Ramadan	Setting ( patient populations )	Conclusions
1	Bernieh B 1994	Saudi Arabia	45 (11/34)	BR R1,R2,R3,R4 AR	renal transplant fasting during the month of Ramadan	measurement of the concentrating ability of the transplanted kidneys has shown no difference from normal healthy individuals
2	Al-Arfaj HF 1995	Saudi Arabia	117 (117/0)	BR R2,R3 AR	Pt on short term NSAID	Short-term use of Non-Steroidal Anti-inflammatory Drugs in healthy subjects living in air-conditioned environment during fasting was associated with only slight changes in renal function.
3	Al-Hadramy MS 1997	Saudi Arabia	1000 (1000/0)	3 consequent Ramadan seasons; BR-MR-PR	PT with Renal stone colic	There is a clear stone season in this area corresponding to the hot summer months. No significant increase in urinary stone colic was observed in relationship to the fasting month of Ramadan.
4	Abdalla AH 1998	Saudi Arabia	23 (23/0)	BR R1,R2,R3,R4 AR	kidney transplant recipients with normal or impaired graft function	Fasting during the month of Ramadan is not associated with any significant adverse effects in kidney transplant recipients with normal or impaired graft function and it is safe for those patients to fast during Ramadan after 1 year of renal transplantation.
5	Ouziala M 1998	Algeria	14 (14/0)	BR R1,R2,R3,R4 AR	Transplanted patients with stable renal function and controlled blood pressure during the first year	Transplanted patients with stable renal function and controlled blood pressure during the first year can observe fasting.
6	Said T 2003	Kuwait	145 (71/74)	BR R1,R2,R3,R4 AR	kidney transplant recipients with normal renal function	Fasting during the month of Ramadan is safe and on kidney transplant recipients with normal renal function, but diabetic patients should be more cautious.
7	A.Basiri 2004	Iran	574 (574/0)	R1,R2,R3,R4 ( fasting in hot and cold seasons )	Pt with Renal colic	Higher temperature rather than fasting Ramadan is a cause of renalcolic.
8	Einollahi B 2005	Iran	19 (19/0)	BR R1,R2,R3,R4, AR	kidney transplant recipients with normal renal function	Fasting during the month of Ramadan is safe and has no significant harmful effects on kidney transplant recipients with normal renal function.
9	Hala S El-Wakil 2007	Egypt	15 (15/0)	BR R4	patients with chronic kidney disease	Rmadanfasting may be injurious to renal tubules only in patients with chronic kidneydisease.
10	Mohamed Ghalib 2008	Saudi Arabia	68 (35/33)	3 consequent Ramadan seasons	Renal transplant patients.	Patients with creatinine clearance of less than 150 $\mu\text{mol/L}$ can fast safely , safety of fasting in patients with higher levels of serum creatinine cannot be determined
11	YousefBoobes 2009	United Arab Emirates	22 (22/0)	BR R1,R2,R3,R4 AR	kidney transplant recipient for more than one year	It is safe for a kidney transplant recipient for more than one year , with stable kidney function to fast during Ramadan month. Caution is suggested for patients with significant low-estimated GFR who may require more frequent monitoring of renal function
12	Einollahi B 2009	Iran	82 (41/41)	BR R1,R2,R3,R4 AR	Kidney transplant recipients who had normal as well as mild to moderately impaired renal function.	There was no adverse effects of fasting especially on allograft function in kidney recipients who had normal as well as mild to moderate impaired but stable renal function prior to fasting
13	Bernieh B 2010	United Arab Emirates	31 (31/0)	BR MR AR	Chronic renal failure patients on hemodialysis.	Good tolerance and safety of fasting Ramadan in CKD patients.
14	Abdolreza N 2011	Iran	610 (610/0)	R1,R2,R3,R4, AR	Patients with renal calculi	The number of admissions due to renal colic was high during the first two weeks of Ramadan. However, the number of admissions decreased during the last two weeks of Ramadan and this trend continued after Ramadan
15	Miladipour 2012	Iran	57 (57/0)	R1 R2	Patients with calcium calculi	Ramadan fasting causes some changes in urinary metabolites that have different effects on calculus formation. There is not enough evidence that Ramadan fasting increases urinary calculus formation.
16	Salem Qurashi 2012	Saudi Arabia	80 (43/37)	BR AR	Renal transplant recipients	Fasting the month of Ramadan did not adversely affect graft function.
17	Al Wakeel J 2013	Saudi Arabia	31 (31/0)	BR R1,R2,R3,R4	Patients on peritoneal dialysis	Most stable patients on PD can fast, provided that they strictly adhere to their medications and dialysis therapy in addition to the dietary restrictions

R=Ramadan, BR=before Ramadan, PR=post Ramadan , F=fasting, NF=not fasting .

There was a steady increase in urinary stone colic in the hot seasons, with the maximum rate in the month of June. In terms of the lunar calendar (Arabic

months), the maximum rates were observed in the months of Rabi-ol-awal, Shaaban and Jamadi-ol-awal. The lowest numbers of patients were admitted

in Zighadeh and Shawwal. During Ramadan (between October and November), 27 males (62.8%) and 16 females (37.2%) were admitted because of renal colic, and 371 males (62.8%) and 160 females (30.1%) were admitted in the other months ( $p=0.3$ ). Forty-three subjects (7.5%) were admitted during Ramadan, and this number was not significantly different from the mean numbers of admissions during the other months of the lunar year ( $43.3 \pm 17$  patients,  $p=0.14$ ). The mean number of admissions in warm seasons ( $64.4 \pm 3.3$  patients) was significantly higher than during Ramadan ( $p=0.001$ ). There was no significant difference between the mean number of admissions in Ramadan and the mean number of admissions in the cold months ( $36.8 \pm 18$  patients,  $p=0.32$ ). Researchers have concluded that fasting in Ramadan per se does not appear to be a risk factor for lithiasis and that the higher temperature, rather than the fasting, causes the renal colic. A third Iranian study performed by Norouzy *et al.* (18) that included 610 patients (72.3% males and 27.7% females) with renal colic who were admitted to two major teaching hospitals. The results of this study show that admissions due to renal colic were higher during the first two weeks of Ramadan and gradually decreased over the last 2 weeks. It is possible that patients with renal colic symptoms might discontinue fasting after experiencing the pain of renal colic. During this study, the first and second week of Ramadan took place during a summer with high temperatures and low humidity. The fourth week was in the beginning of autumn, when the temperature decreased and the humidity increased. Thus, environmental factors and dietary habits during the month of Ramadan may have an important role, rather than fasting itself.

The effect of Ramadan fasting on 37 male patients with recurrent urinary calcium calculus formation was studied by Miladipour *et al.* (19). The results showed that calcium concentration, the total amounts of calcium, phosphate and magnesium, and urine volume were significantly lower while the participants were fasting than during the non-fasting period. The concentrations of uric acid, citrate, phosphate, sodium, and potassium were significantly higher during fasting. Uric acid supersaturation increased while the participants were fasting, whereas calcium phosphate supersaturation decreased. On the other hand, calcium oxalate supersaturation was not significantly higher during fasting; it actually decreased. There were some changes in the excretion of various urinary lithogenic and inhibitory substances during fasting. Some of the changes that favored decreased lithogenesis included the decreases in the urine calcium concentration and total calcium and phosphate excretion, the increases in the citrate and potassium concentrations, and the decrease in

the supersaturation of calcium phosphate (and even calcium oxalate). Other changes favored an increase in lithogenesis: during fasting, the uric acid, phosphate, and sodium concentrations increased, the uric acid supersaturation increased, and urine volume and magnesium excretion decreased. The concentrations of sodium and potassium increased significantly during fasting, and the change in the potassium concentration was dominant. Total sodium and potassium excretion were not significantly different during fasting, and urine volume significantly decreased during fasting. They concluded that Ramadan fasting causes certain changes in urinary metabolites that have varying effects on calculus formation. An Egyptian study (20) showed that fasting had a protective effect against stone formation with no worsening of renal insufficiency and suggested that patients with kidney stones or urinary tract infections can be allowed to fast. Overall, there is not enough evidence that Ramadan fasting increases urinary calculus formation.

## 5- Ramadan and Chronic Kidney Disease (CKD).

### 5.1. Fasting for Pre-Dialysis Patients

A study was performed with 15 pre-dialysis patients with creatinine clearances below 60 ml/min (21) who fasted during Ramadan for at least two consecutive years during the study period. The patients were compared with 6 healthy control volunteers. The patients were evaluated first before Ramadan (non-fasting phase) then at the end of the month of Ramadan (fasting phase). The changes in the mean blood pressure and the glomerular filtration rate were similar between the CKD patients and the healthy individuals, but the serum potassium levels were higher in the patient group. The consumption of large amounts of food rich in potassium (dates, apricot juice and coffee) at breakfast was the main explanation. Traditional breakfasts may contain up to 80 mmol of potassium in one meal. While fasting, the CKD patients had an increase in renal tubular injuries marked by increased urinary N-acetyl-B-D-glucosaminidase, which could be explained by tubular vulnerability to hemodynamic changes. Diabetes, especially in patients with poor glycemic control, was associated with the tubular injuries detected in the fasting CKD patients. Based on these study findings, Ramadan fasting may injure renal tubules in diabetic pre-dialysis patients with CKD. This group of patients should be meticulously followed during Ramadan fasting.

Another study by Berni *et al.* (22) included data from 31 (19 males and 22 females) CKD patients who elected to fast during Ramadan. Fourteen patients had stage III CKD, 12 had stage IV and 5

had stage V. The mean estimated glomerular filtration rate (e-GFR) was  $29 \pm 16.3$  mL/min. Clinical assessments and renal function tests were performed one month prior to fasting, during fasting and one month later. Medications were taken in two divided doses at sunset and before dawn. All of the patients tolerated fasting for the entire month of Ramadan. The study reported a tendency toward weight reduction and lower systolic and diastolic blood pressure. There was a significant improvement in the GFR during the fast and in the month after the fast. There was a reduction in proteinuria and urinary sodium. The authors concluded that CKD patients tolerated fasting during Ramadan well.

### 5.2 Fasting for Patients on Peritoneal Dialysis

The only study that has addressed the Ramadan fast among patients on peritoneal dialysis (PD) was performed by Al-Wakeel *et al.* (23), who evaluated 31 patients in Saudi Arabia. The patients who elected to fast (18 of 31) fasted for mean duration of 14 hours and received 2 types of modified PD. The results showed that regardless of the type of PD, the patients who fasted during Ramadan did not experience any serious complications. Based on this study, we can conclude that most stable patients on PD can fast, provided that they strictly adhere to their lines of management and are meticulously monitored.

### 5.3 Fasting for Patients on Hemodialysis

Al-Khader and his coworkers (24) studied 40 patients who were on hemodialysis for more than 6 months and elected to fast on non-dialysis days during Ramadan. There was a significant increase in interdialytic weight gain and potassium during Ramadan. The most likely explanation offered by the authors was the increase in food consumption during the evening meal. There were no significant changes in various hemodynamic or biochemical parameters during the fast. The patients did not suffer from any acute complications that required hospital admission. They concluded that fasting on non-dialysis days may be safe, provided that the patients adhere to dietary advice.

Gifford *et al.* (25) performed a study to evaluate the effect of a 26-hour fast on the potassium balance in patients with end-stage renal disease (ESRD) and the response to epinephrine (0.015 micrograms/kg/min) in both normal control subjects ( $N = 9$ ) and ESRD subjects ( $N = 7$ ). Hyperkalemia developed in the ESRD patients after 16 hours of fasting, compared with the control subjects ( $P = 0.02$ ). These results demonstrate that hyperkalemia occurs while ESRD patients are fasting, most likely as the result of insulin openia, and suggest that a diminished response to epinephrine may contribute to hyperkalemia. Patients with chronic renal failure should be advised about the

potential for hyperkalemia, and if they insist on fasting, their renal function and electrolytes should be monitored. They should stop fasting if any deterioration occurs (4). Researchers from Qatar presented their experience managing ESRD patients on hemodialysis at the First International Congress on Health and Ramadan (20), and they reported no worsening of renal function during Ramadan fasting in these patients (20).

## 6. Ramadan Fasting and Renal Transplant Recipients

With the increase in the number of renal transplants performed in Islamic countries as well as the improvements in the quality of life, the safety of fasting during Ramadan is being questioned more often (24-26). Transplant patients have an increased risk of adverse effects related to fasting because of their underlying illness and immunosuppressive medications (27). The major concern for these patients is that dehydration and the accumulation of metabolites may result in irreversible deterioration of renal function or facilitate rejection episodes by inducing changes in the immune system (28).

The first study about fasting during Ramadan for renal transplant recipients was performed by Bernieh *et al.* in 1994 (29). A total of 45 renal transplant recipients were followed at King Fahad Hospital, Madina Al-Munawarah. The researchers studied 11 patients who voluntarily chose to fast during Ramadan. There were seven male patients and four female patients. The patients received transplants between 12 to 62 months before Ramadan, and the mean age of the grafts was  $30 \pm 15.6$  months. All of the patients had normal graft function at the time of study. The patients were receiving maintenance doses of prednisolone, azathioprine and cyclosporine A (CyA). During the month of fasting, the patients took these drugs once daily after breaking the fast at sunset. These patients were advised to return for follow-up visits three times during the month preceding Ramadan, three times during the month of Ramadan and three times in the month following Ramadan. Serum levels of sodium, potassium, urea, creatinine, total protein, albumin, fasting glucose, triglycerides and cholesterol were measured. Blood CyA levels, hemoglobin and total leucocyte counts were monitored at each visit, in addition to the fractional excretion of sodium (FENa). There were no significant changes in the results during and after Ramadan fasting compared with the values before fasting. The fractional excretion of sodium dropped from the values observed before Ramadan, but the change was not statistically significant. Although the sample size was small, this study concluded that transplant patients with stable

renal function can fast during the month of Ramadan without any serious adverse effects.

Abdualla *et al.* (30) evaluated 23 transplant recipients; 17 had normal graft function, and 6 had impaired but stable graft function with plasma creatinine levels ranging from 140-246 and a mean level of 176. The mean post-transplant period was 2.0 years (range: 0.6–6.3). Urinary and serum biochemical parameters, the level of cyclosporine A, and hematocrit were checked weekly during Ramadan and 1 week before and after Ramadan. The statistical analyses revealed no significant changes in the parameters before, during, and after Ramadan. These findings indicate that fasting during the month of Ramadan does not appear to be associated with any significant adverse effects in kidney transplant recipients with normal or impaired graft function, and the authors suggested that it is safe for patients to fast during Ramadan 1 year after renal transplantation.

Arganiet *al.* (31) studied 24 patients and found no significant increase in body weight, blood pressure, or renal function. They concluded that a 12-hour fasting pattern during Ramadan was not harmful to stable renal transplant patients. They recommended that patients be observed carefully during the fast (27). Einollahiet *al.* (32) studied 19 fasting kidney transplant recipients and compared them with 20 matched recipients who did not fast. All of the patients had serum creatinine values below 1.5 mg/dL upon entry into the study. No significant changes were observed in the serum creatinine concentrations of either group during Ramadan, suggesting that fasting during Ramadan is safe for recipients with stable renal function. The same group performed another study comparing 41 kidney transplant recipients who fasted during Ramadan to matched controls. All of the recipients had received a transplant at least 1 year prior to the study, and they had had stable renal function for at least 6 months prior to the study. The mean estimated glomerular filtration rate (GFR) did not change significantly after 30 days of fasting in either group. In the patients with GFR < 60 ml/min, renal function remained stable during Ramadan. The results did not reveal any adverse effects of fasting, especially on allograft function, in the kidney recipients who had normal renal function as well as the patients who had mildly to moderately impaired but stable renal function prior to fasting during Ramadan (33).

Said *et al.* (34) published the largest study on fasting renal transplant recipients, which involved 145 kidney transplant patients (71 patients fasted during Ramadan and 74 did not). Renal function did not change significantly in the two groups during the Ramadan fast. Cyclosporine toxicity was observed in two of the fasting participants, acute rejection

episodes occurred in two participants, and urinary tract infections occurred in two participants. No graft or patient loss occurred in any of the groups. The authors concluded that kidney transplant recipients with normal kidney function can safely fast during Ramadan.

Ghalibet *al.* (35) performed a prospective cohort study to compare 35 fasting participants and 33 non-fasting participants with renal transplants. The results revealed that there were no differences between the fasting and non-fasting participants in terms of the changes in GFR, mean arterial blood pressure or urinary protein excretion between the baseline and the third week of Ramadan. The mean GFR after the third Ramadan did not differ significantly from the mean GFR at baseline in the fasting group. Furthermore, no rejection episodes or renal function deterioration were observed during or soon after Ramadan. The authors concluded that kidney transplant recipient patients with a serum creatinine level less than 150  $\mu\text{mol/L}$  can fast safely.

A study by Boobeset *al.* (36) evaluated 22 kidney transplant recipients peri-Ramadan fasting. The patients had had their transplants for more than one year; they had stable kidney function and no acute illnesses, and the majority ( $n=16$ ) had GFR values > 50 mL/min/1.73m<sup>2</sup>. During Ramadan, medications were taken at sunset and before dawn. Kidney function tests, blood sugar levels, lipid profiles, and cyclosporine levels remained stable throughout the study. The authors concluded that it was safe for renal transplant recipients with stable graft function to fast during the month of Ramadan one year after the transplant; however, caution is advised for the patients with moderately to severely impaired renal function.

Lastly, Qurashiet *al.* (37) performed a prospective cohort study to estimate the glomerular filtration rate in renal transplant patients who fasted and did not fast before and after Ramadan using the Modification of Diet in Renal Disease formula. There were 43 fasting participants and 37 non-fasting participants, and the fasting participants had longer post-transplant times compared with the non-fasting participants ( $P= 0.0001$ ). The 2 groups had similar mean estimated glomerular filtration rates before Ramadan. The fasting patients were advised to drink at least 2.5 L of fluid during the non-fasting hours, and to take the morning dose of immunosuppressive medications after breaking the fast and to take the evening dose just before starting the fast. The blood levels of cyclosporine and tacrolimus were measured before and after Ramadan in the fasting group. No significant differences were detected between the fasting and non-fasting participants in the estimated glomerular filtration rate before Ramadan and 6

months after Ramadan, including all three groups with low, moderate, and high glomerular filtration rates at baseline. The authors concluded that fasting for Ramadan in the heat of August did not adversely affect graft function after a mean follow-up period of  $7.6 \pm 1.3$  months. In 2 published reviews (26, 28), many patients with transplants fasted during Ramadan, and medical professionals reported that they allowed patients with transplantation to fast after 1 year with a functioning graft. Both reviews found weak, non-significant adverse effects related to Ramadan fasting. The 2 reviews suggested that Ramadan fasting is safe for patients with good allograft function. However, the evidence behind these recommendations was weak (28).

### 7. Renal Medications During Ramadan

Counseling patients about their use of medications as well as their suitability for participating in the fast is a major component of health care for Muslim patients (28). Patients on immunosuppressive medications or drugs that are normally taken at the morning should be advised to take these medications when they break the fast and to take the evening dose just before starting the fast (35). The drug levels of cyclosporine and tacrolimus should be measured before and after Ramadan (35).

### 8. Conclusions and Recommendations

- Observing the fast during Ramadan is possible for many chronically ill patients who are stable and under medical supervision. The effect of fasting on health issues should be explained to patients well before the beginning of the holy month.
- Millions of adult Muslims around the world fast during Ramadan. Some of these individuals may have mild, moderate or severe medical conditions. They may seek advice about the feasibility and safety of fasting and/or managing their conditions. Physicians ought to have a working knowledge about the religious rules of the Ramadan fast and their medical implications.
- Due to the nature of Ramadan fasting (i.e., short and intermittent), Ramadan fasting does not cause significant changes in healthy kidneys, even if the patients are taking short-term NSAIDs.
- Fasting in Ramadan per se does not appear to be a risk factor for lithiasis. The higher temperatures, rather than the fast, cause renal colic. Patients with renal calculi may fast Ramadan, and they should be advised to break their fast if they suffer from acute renal colic.

- One study showed that Ramadan fasting is safe for chronic renal disease patients, but another study suggested that fasting may injure renal tubules in CKD patients.
- Because of this controversy, we recommend that pre-dialysis patients be meticulously followed during the Ramadan fast and that the subset of patients with diabetes and significant renal impairment should be advised against fasting. If they insist on fasting, they should be closely monitored.
- Patients with CKD on peritoneal dialysis can fast, provided that they strictly adhere to their medications and dialysis therapy in addition to their dietary restrictions. These patients should be monitored for complications and for an adequate fluid and electrolyte balance.
- For patients on hemodialysis, fasting on non-dialysis days may be safe. Dietary advice becomes increasingly important, especially the recommendation of a low-potassium diet. These patients should be advised about the potential for hyperkalemia, and their renal function and electrolytes should be monitored. They should stop fasting if their condition deteriorates.
- It is safe for patients with stable graft function to fast during Ramadan 1 year after renal transplantation; however, caution is advised for patients with moderately to severely impaired renal function.
- All transplant patients should be followed before Ramadan, weekly during Ramadan, and after Ramadan. Immunosuppressive treatment serum levels should be monitored before and after Ramadan.
- Education programs are needed for health care providers, patients and the public.
- Guidelines on the proper management of renal patients during Ramadan fasting should be proposed to minimize the associated risks.
- Well-constructed intervention studies with sufficient statistical power are needed to verify the proposed guidelines.

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