Original Article

Delayed Gastric Emptying among Indian Patients with Non-Diabetic Chronic Kidney Disease

Abstract

Introduction: Upper gastrointestinal symptoms such as nausea, vomiting, abdominal bloating, and poor appetite are more frequent among chronic kidney disease (CKD) patients and may contribute to poor nutritional intake and malnutrition. Delayed gastric emptying (GE), one of the important contributors to these symptoms, has not been evaluated systematically in different stages of non-diabetic CKD, among Indian patients. **Materials and Methods:** This hospital-based, cross-sectional analytical study aimed to find out the frequency of delayed GE in non-diabetic CKD (stages: 3,4,5) patients and also to study the correlation between delayed GE and symptoms of gastroparesis, autonomic neuropathy and nutritional parameters. Patients were subjected to evaluation of symptoms of gastroparesis by standardized questionnaire (gastroparesis cardinal symptom index), nutritional status (by anthropometric measures and serum albumin), autonomic function by heart rate variability (HRV) and GE by gastric scintigraphy with a standardized solid rice idli (savory cake) meal labeled with technetium-99m sulfur colloid. **Results:** Of the 89 non-diabetic CKD (stages-3,4,5) patients evaluated, 22 (≈25%) had delayed GE and 8 (≈9%) rapid GE. Prevalence of delayed GE was higher among stage 5 (15/49, 31%) compared to stages 3 and 4 (7/40, 17.5%), though the difference was statistically insignificant. There was no association between delayed GE and symptoms of gastroparesis and autonomic neuropathy. Though not statistically significant, nutritional parameters (body mass index, skinfold thickness, and serum albumin) were poorer in the delayed GE group compared to the rest. **Conclusion:** Delayed GE, irrespective of symptoms, may contribute to malnutrition and hence should be looked for in non-diabetic CKD patients with unexplained malnutrition.

Keywords: *Autonomic neuropathy, chronic kidney disease, gastric emptying, gastric scintigraphy, idli meal*

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Introduction

Chronic kidney disease (CKD) prevalence is increasing in India, contributing to a significant burden on the healthcare system and increased healthcare costs. Compared to general population, upper gastrointestinal symptoms such as nausea, vomiting, retching, abdominal bloating/pain, and loss of appetite are more common among CKD patients.[1] These symptoms may contribute to poor nutritional intake, malnutrition and poor psychological well-being.[1-3] Malnutrition in CKD contributes to increased morbidity and mortality. The exact pathophysiological mechanisms behind these upper gastrointestinal symptoms in CKD are still under investigation. Apart from uremic toxins and chronic inflammation, delayed gastric emptying (GE) is one of the important contributors to these symptoms and its treatment may improve symptoms and quality of life.[3-5] Different studies, employing different methods for evaluation of GE, have reported delayed GE in 35–70% of CKD patients.[5,6] Detection and treatment of delayed GE have been reported to improve nutrition in non-diabetic CKD patients on dialysis.[7,8] Symptomatic delayed GE, otherwise known as gastroparesis, has been reported to increase morbidity and hospitalizations in CKD patients on peritoneal dialysis.[9]

Although few studies have evaluated GE in patients with CKD, most of them have involved end-stage kidney disease patients on either maintenance hemodialysis[3,6-8,10] or peritoneal dialysis.[6-8,11] To the best of our knowledge, only one small Indian study has evaluated GE in non-diabetic CKD patients

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so far.[5] However, the prevalence of upper gastrointestinal symptoms and abnormalities of GE have not been studied systematically in different stages of non-diabetic CKD, among Indian patients. Studies have reported a poor correlation between symptoms suggestive of delayed GE and objectively documented delayed GE in CKD patients.[5-7,10,12] Different studies have employed different methods for evaluation of GE, making a comparison between them difficult. The gold standard test recommended for studying GE is gastric emptying scintigraphy (GES) carried out with a solid meal such as egg (chicken egg) white sandwich labeled with Technitium-99m sulfur colloid and the test has been recommended to be carried out hourly for four hours.[13] There is a paucity of data on the contribution of autonomic neuropathy to delayed GE among non-diabetic CKD patients. With this background, the primary objective of the present study was to find out the frequency of delayed GE in non-diabetic CKD stage 3, 4,5 patients. The secondary objectives were to study the correlation between scintigraphically documented delayed GE and symptoms of gastroparesis and autonomic dysfunction and also to assess the impact of delayed GE on nutritional status among non-diabetic CKD (stage 3, 4, 5) patients.

Materials and Methods

This cross-sectional analytical study was conducted between January 2017 and February 2018, at a tertiary care teaching hospital located in southern India. Adult non-diabetic CKD patients aged between 18 and 65 years, with an estimated glomerular filtration rate (GFR) of <60 mL/min/1.73 m^2 body surface area (i.e., CKD stages 3, 4, and 5) were included in the study, irrespective of the presence or absence of upper gastrointestinal symptoms suggestive of delayed GE. GFR was estimated by the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation for adults[14] and the serum creatinine was measured during steady-state renal function. Acutely ill/hospitalized patients, those with known peptic ulcer disease, hypothyroidism/hyperthyroidism, urinary tract infection, inflammatory bowel disease, connective tissue diseases, prior vagotomy/gastrojejunostomy/bariatric surgery, concomitant therapy that could have altered gastric motility/caused acute worsening of renal function and pregnant and lactating women were excluded from the study. The study was approved by the institute scientific and ethics committees and written informed consent was obtained from all participants of the study.

Study patients were recruited from medicine and nephrology outpatient clinics and convenience sampling was followed. All patients underwent detailed clinical and laboratory assessments, including plasma glucose and thyroid function tests. All study patients had undergone dietary counseling in medicine and nephrology outpatient clinics. However, their dietary intake could not be supervised. The burden of symptoms suggestive of delayed GE over the previous three months was assessed by a standardized self-administered questionnaire- the Gastroparesis Cardinal Symptom Index (GCSI).[15] GCSI comprises three subscales: nausea/vomiting (three items), fullness/early satiety (four items) and bloating (two items). Symptom severity was rated by the patients as follows: none (0), very mild (1), mild (2), moderate (3), severe (4) and very severe (5). GCSI total score was calculated from the average of three symptom subscales and it ranged from 0 to 5, higher scores reflecting greater symptom severity. Nutritional status was assessed by anthropometric parameters such as body mass index (BMI), skinfold thickness and mid-arm circumference. Skinfold thickness was measured using Idass™ skinfold caliper at five different body sites (biceps, triceps, subscapular region, abdomen and thigh), according to National Health and Nutrition Examination Survey (NHANES) guidelines.[16] Mid-arm circumference was measured in the right arm. In those with upper limb arteriovenous (AV) fistula, mid-arm circumference and skinfold thickness were measured in the other limb. All anthropometric measurements were taken on the day following hemodialysis in those on maintenance dialysis.

Autonomic function was assessed based on heart rate variability (HRV). HRV was assessed by time domain and frequency domain variables. Time domain variables such as standard deviation of all NN or RR intervals (SDNN) and RMSSD (square root of mean of sum of squares of differences between adjacent NN intervals) reflect parasympathetic tone. Frequency domain parameters included very low frequency (VLF), low frequency (LF), high frequency (HF) and total power (TP). VLF, LF and HF contribute to TP, which represents resting HRV. LF mainly indicates sympathetic tone and HF parasympathetic activity in an individual. LF/HF reflects the overall balance between sympathetic and parasympathetic tones.

GES was carried out between 8 am and 12 pm on a different day, after the assessment of GCSI and HRV. After 10–12 h of overnight fasting, a standardized solid rice idli (a type of savory rice cake) meal labeled with 1 mCi of Technitium-99m sulfur colloid was administered. Further information on this meal and normative data on GE derived from healthy controls have been reported earlier.[17] The meal consisted of three idlis prepared from 60 g of MTR™ premixed rice idli formula and 60 mLwater (caloric content ≈215 kcal, fat content ≈3% by weight). Patients were instructed to consume the meal within 10 min, with 10 g of coconut chutney and were asked not to consume other food or beverages for subsequent 3 h. The radiolabeled meal intake was supervised to ensure complete ingestion of meal. Smokers were instructed not to smoke on the day of scintigraphy. GES was carried out for 3 h and 1-minute images of the abdominal region were captured under Siemens T6 dual-head gamma camera using a 128 × 128 matrix immediately post-meal, 30 min, 1 h, 2 h and 3 h after the intake of meal. Percentage retention

was calculated by drawing a region of interest around the stomach in the geometric mean images. Normative data for GES and HRV have been established in our hospital from 30 healthy adults (18 men and 12 women, age range 24–58 years). Based on GES carried out with radiolabeled solid idli meal in 30 healthy controls, gastric retention of >10% radiotracer activity at 3 h was indicative of delayed GE. Similarly, retention of <30% radiotracer activity at 1 hour indicated rapid GE.[17]

Statistical analysis

A sample size of 89 was estimated, with an expected prevalence of delayed GE of 35% among non-diabetic CKD patients,[6] with 5% level of significance and 5% absolute precision. GES profile data has been expressed as frequencies and percentages. The association of delayed GE with symptoms of gastroparesis was assessed by Mann-Whitney U test. The comparison of continuous parameters such as BMI, skinfold thickness and mid-arm circumference in relation to delayed GE was carried out by using independent student t-test. Comparison of HRV test variables with GE was done with Mann-Whitney U test. HRV test parameters were compared between stage 5 CKD and stages 3 and 4 CKD using Mann-Whitney U test. The association between delayed GE and CKD stage was assessed by using Chi-square test/Fisher's exact test. Statistical tests were done using Statistical Package for the Social Sciences (SPSS) software version 19 and analyses were done at 5% level of significance and a *P* value of <0.05 was considered significant.

Results

Initially, 163 CKD (stages 3, 4 and 5) patients without known diabetes were screened for eligibility [Figure 1]. Out of them, 89 non-diabetic CKD patients completed symptom evaluation by GCSI, HRV and GES testing and were finally included for analysis. Their characteristics are shown in Table 1. The age of study patients ranged from 19 to 65 years and nearly three fourths (65/89, 73%) were in the age-group of 40–65 years. Out of 49 stage 5 CKD patients, 33 (67.3%) were on renal replacement therapy and all of them were on maintenance hemodialysis.

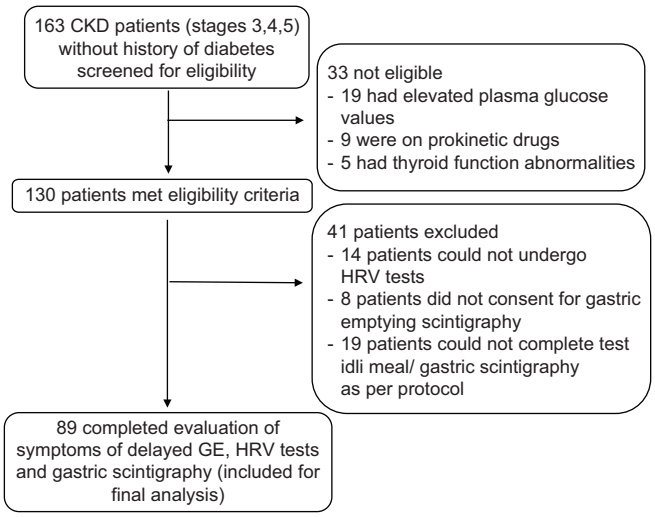

Figure 1: Shows recruitment of study patients

Results of gastric emptying (GE) scintigraphy

Out of the 89 non-diabetic CKD patients, two-thirds (59) had normal GE, one-fourth (22) had delayed GE (defined by gastric retention of >10% radiotracer activity at the end of 3 hours) and 8 (9%) had rapid GE (defined as <30% radiotracer retention at the end of 1 hour). The median age among those with and without delayed GE was 48.5 (42.3–57.0) and 51 (37.0–58.5) years respectively. Thus, there was no association of age with delayed GE (*P* = 0.91, Mann-Whitney U test). Although there was a marginally higher prevalence of delayed GE among males compared to females [27.4% (17/62) vs. 18.5% (5/27)], the difference in delayed GE between two sexes was not statistically significant (*P* = 0.371, Chi-square test). In this study, 20% (4/20) of stage 3, 15% (3/20) of stage 4 and ≈31% (15/49) of stage 5 CKD patients showed delayed GE. Thus, although delayed GE was more prevalent among stage 5 compared to stages 3 and 4 CKD patients, the difference was not statistically significant (*P* = 0.21, Fisher's exact test). Out of 49 stage 5 CKD patients, 33 were on maintenance hemodialysis and 16 were dialysis naïve at study enrollment. Among stage 5 CKD patients, the prevalence of delayed GE was significantly higher in those who were on maintenance

Table 1: Characteristics of chronic kidney disease (CKD) patients enrolled in the study (*n*=89)

Parameter	Value
Age (years)-median (IQR)	50 (38-57)
Males- no. (%)	62 (69.7)
CKD duration† (months)-no. (%)	
<1	26 (29.2)
1-12	41 (46.1)
12.1-24	12 (13.5)
24.1-36	6 (6.7)
36.1-48	4 (4.4)
CKD stage‡ - no. (%)	
Stage 3	20 (22.5)
Stage 4	20 (22.5)
Stage 5	49 (55.0)
Renal replacement therapy# no. (%)	33 (37.1)
GCSI total score- median (IQR)	0.88 (0.63-1.16)
BMI (kg/m^2) - mean±SD	22.11±2.25
Mid-arm circumference (cm)- mean±SD	27.17±2.32
Serum albumin (g/L)- mean±SD	34.2±6.9

BMI: Body mass index, GCSI: Gastroparesis cardinal symptom index, SD: Standard deviation, IQR: Interquartile range. †CKD duration from diagnosis and at the time of enrollment. ‡At enrollment. #All had stage 5 CKD and were on maintenance hemodialysis at enrollment

hemodialysis for >2 weeks compared to patients who were either dialysis naïve or newly initiated on hemodialysis for ≤2 weeks [14/28 (57.1%) vs. 1/21 (4.8%) respectively, $P = 0.0006$ (Fisher's exact test)].

Eight (≈9%) study patients had rapid GE and their median age was 45 (36–60) years. Among them, 3 were males and 5 were females, 6 had stage 5 CKD (3 were on maintenance hemodialysis) and one each had stage 4 and stage 3 CKD.

GE and symptoms of gastroparesis

Table 2 shows prevalence of upper gastrointestinal symptoms suggestive of gastroparesis among CKD patients with and without scintigraphically documented delayed GE. In general, study patients had minimal symptoms (median GCSI total score: 0.88 [0.63–1.16]). There was no clinically significant difference in gastroparesis symptom scores between patients with and without delayed GE, though the symptom scores were slightly higher in the former group [Table 2].Patients with rapid GE also had minimal upper gastrointestinal symptoms similar to those with delayed GE.

GE and heart rate variability

Time domain variables such as SDNN, RMSSD and frequency domain parameters such as VLF, LF, HF and TP were studied in 89 study patients [Table 3]. There was an overall decrease in the HRV, sympathetic and parasympathetic tone among patients. There was no significant difference in HRV parameters between CKD patients with and without delayed GE[Table 3], suggesting that delayed GE group did not have a higher burden of autonomic dysfunction compared to the rest. Though both sympathetic and parasympathetic activities were reduced to a greater extent in stage 5 CKD compared to stages 3 and 4, the differences were not statistically significant.

GE and nutritional parameters

Table 4 shows nutritional parameters among 89 CKD patients enrolled in the study, in relation to GE. Although nutritional parameters such as BMI, mid-arm circumference, skinfold thickness and serum albumin were lower in patients with delayed GE compared to those without delayed GE, the differences were not statistically significant. Even among 49 stage-5 CKD patients, though all nutritional parameters were lower in patients with delayed GE compared to those without delayed GE, the differences were not statistically significant [Table 5].

Discussion

Delayed GE has been studied well in type 1 and 2 diabetic patients, with and without nephropathy and CKD. However, there is a paucity of data on delayed GE in non-diabetic CKD patients, especially from India. The present study sought to find out the frequency of delayed GE in stage 3, 4 and 5 non-diabetic CKD, using the recommended GES with a standardized solid meal. We administered standardized rice idli meal instead of other test meals that are more widely used in the west such as egg (chicken egg) white sandwich, chicken liver and minced beef.[18]The latter test meals would have been less culturally acceptable to our study patients. Rice idli meal is easy to prepare, has the advantage of being gluten-free and has been established as a solid test meal for GES in earlier Indian studies.[17,19] Though guidelines recommend continuing GES study up to 4h,[13,18] we could not extend the study for 4h because of small meal size, faster GE for rice idli meal and logistic constraints. Faster GE for rice idli meal in the present study, compared to egg white-bread meal,[13,18] can be explained based on the lower protein content in the former. We chose to use the CKD-EPI creatinine equation for estimation of GFR, as it has been shown to perform better compared to four-variable Modification of Diet in Renal Disease (MDRD) and Cockroft-Gault formulae in Indian CKD patients.[20]

Table 2: Symptoms of delayed gastric emptying (GE) among CKD patients with and without delayed GE (*n*=89)

Subscale parameter	Symptoms assessed	Delayed gastric emptying (*n*=22)		No delayed gastric emptying (*n*=67)		†*P* value
		Median	IQR	Median	IQR	
Nausea/ vomiting	-Nausea -Retching -Vomiting	1.495	1.0-2.0	0.66	0.33-1.0	0.0020*
Postprandial fullness/early satiety	-Not able to finish normal sized meal -Stomach fullness -Feeling extremely full after meals -Loss of appetite	1.125	1.0-1.44	1.0	0.5-1.0	0.0045*
Abdominal bloating	-Bloating -Stomach visibly larger	1.0	0.125-1.0	0.5	0.5-1.0	0.6579
GCSI total score		1.16	0.84-1.36	0.83	0.58-1.07	0.0123*

†The symptom scores have been expressed as medians with IQR. GCSI: Gastroparesis cardinal symptom index. †Mann-Whitney U test has been used to compare the symptom scores between the two groups. *Though *P* value is statistically significant, there was no clinically significant difference in symptom severity between those with and without delayed GE

Table 3: HRV parameters among study patients in relation to delayed GE (*n*=89)

Parameters	No delayed GE (*n*=67)			Delayed GE (*n*=22)			[a]*P* value
	Median	Percentiles		Median	Percentiles		
		25	75		25	75	
Mean RR (ms)	794.5	712.5	901.3	716.6	633.5	814	0.5054
Mean HR (/min)	75.47	64.27	83.86	83.51	74.03	97.59	0.4678
SDNN (ms)	25.5	15	40.7	34.8	17	103.9	0.5748
RMSSD (ms)	16.9	7.3	29.1	17.45	9.6	41.9	0.4691
VLF (ms^2)	213	102	415	258.5	99	1776	0.4361
LF (ms^2)	69	26	172	54.5	24	237	0.4422
HF (ms^2)	56	14	241	48.5	15	620	0.5106
TP (ms^2)	367	179	965	539	170	1946	0.3233
LF/HF	1.46	0.604	2.74	1.28	0.463	2.501	0.3541
LF (nu)	59.1	37.7	73.3	61.75	42.8	72.7	0.3862
HF (nu)	39.9	26.7	62.3	45.5	28.56	67.7	0.4848

HRV: Heart rate variability, GE: Gastric emptying, RR: Electrocardiographic RR interval, HR: Heart rate, SDNN: Standard deviation of NN intervals, RMSSD: Root mean square of the successive differences, LF: Low frequency, VLF: Very low frequency, HF: High frequency, TP: Total power, LF/HF: Low-frequency to high-frequency ratio, LF (nu): Low frequency (numerical units), HF (nu): High frequency (numerical units). The autonomic function test data has been expressed as median with 25th and 75th percentiles. [a]Mann-Whitney U test has been performed to compare the parameters between the two groups

Table 4: Nutritional parameters among study patients in relation to delayed GE (*n*=89)

Nutritional parameter	No delayed GE (*n*=67)	Delayed GE (*n*=22)	**P* value
BMI (kg/m^2)-mean (± SD)	22.3 (±2.29)	21.5 (±2.04)	0.1635
Triceps SFT (mm)-mean (± SD)	12.3 (±2.7)	11.5 (±2.42)	0.2183
Biceps SFT (mm)-mean (± SD)	9.98 (±2.22)	9.22 (±2.15)	0.1664
Subscapular SFT (mm)-mean (± SD)	8.19 (±2.06)	7.5 (±2.08)	0.2383
Abdomen SFT (mm)-mean (± SD)	18.14 (±4.72)	16.09 (±3.1)	0.0598
Thigh SFT (mm)-mean (± SD)	17.19 (±4.7)	15 (±3.12)	0.0679
Mid-arm circumference (cm)-mean (± SD)	27.3 (±3.01)	26.1 (±1.57)	0.0567
Serum albumin (g/L)-mean (± SD)	35.0 (±7.1)	32.6 (±5.9)	0.2045

GE: Gastric emptying, BMI: Body mass index, SFT: Skinfold thickness, SD: Standard deviation. *With student's *t*-test (for two independent groups)

Table 5: Nutritional parameters among stage 5 CKD patients in relation to delayed GE (*n*=49)

Nutritional parameter	No delayed GE (*n*=34)	Delayed GE (*n*=15)	**P* value
BMI (kg/m^2)-mean (± SD)	22.26 (±2.61)	21.25 (±2.18)	0.195
Triceps SFT (mm)-mean (± SD)	11.75 (±3.00)	11 (±2.20)	0.3987
Biceps SFT (mm)-mean (± SD)	9.50 (±2.68)	8.73 (±2.05)	0.3289
Subscapular SFT (mm)-mean (± SD)	7.82 (±2.30)	7.2 (±1.89)	0.3629
Abdomen SFT (mm)-mean (± SD)	17.29 (±5.18)	15.33 (±2.71)	0.3318
Thigh SFT (mm)-mean (± SD)	16.26 (±4.89)	14.33 (±2.89)	0.0812
Mid-arm circumference (cm)-mean (± SD)	26.83 (±2.33)	25.9 (±1.47)	0.2358
Ser. albumin (g/L)-mean (± SD)	34.4 (±6.9)	32.5 (±6.1)	0.1524

GE: Gastric emptying, BMI: Body mass index, SFT: Skin fold thickness, SD: Standard deviation. *With student's *t*-test (for two independent groups)

Different methods used for estimation of GFR for CKD staging, differences in test meals and methods used for assessment of GE and different populations of CKD patients studied make the comparison of the present study with previous ones difficult. Another Indian study[5] involving 32 non-diabetic CKD patients and employing Technitium-99m sulfur colloid labeled bread and mixed fruit jam meal has reported a higher prevalence of delayed GE of 69%, compared to 25% prevalence noted in the present study. The same study used GE $T_{1/2}$(half-time of emptying) instead of percentage retention of radiotracer at three or four hours to diagnose delayed GE, which can explain the differences in reported prevalence of delayed GE. It should be noted that GE $T_{1/2}$may be less accurate and hence not preferable for evaluation of delayed GE compared to percentage retention of radiotracer at fixed

time points.[18] A Swedish study,[6] employing fluoroscopic evaluation of GE of spherical radiopaque markers, has reported a 36% prevalence of delayed GE among CKD patients. Barring a Brazilian study,[21] several previous studies[5,6,9,11,12,22] have reported an increased prevalence of delayed GE among CKD patients. Delayed GE was more frequent in male CKD patients in the Swedish study,[6] similar to findings in the present study. Delayed GE was not limited to stage 5 CKD alone and seen in stages 3 and 4 as well in the present study. However, the prevalence was higher in stage 5 (albeit statistically insignificant) compared to stages 3 and 4 (31% vs 17.5%). There is a lack of information from previous studies on the frequency of delayed GE in different stages of CKD. One interesting finding from the present study is the occurrence of rapid GE in 9% of CKD patients, which has not been reported so far. Additionally, symptoms in patients with rapid GE didn't differ from those in patients with delayed GE. This is not surprising given the fact that rapid emptying of stomach contents and the resultant acute small bowel distention may produce abdominal bloating/discomfort, nausea and vomiting, the symptoms seen in delayed GE as well.[18]

Consistent with findings in the present study, several previous studies[5,6,8,12] have reported poor or no correlation between upper gastrointestinal symptoms and delayed GE. Several other factors in CKD such as uremic toxins, changes in the chemical composition of saliva, chronic inflammation, impaired gastric accommodation and visceral afferent hypersensitivity resulting from autonomic neuropathy may also be responsible for upper gastrointestinal symptoms, apart from delayed GE.[4,17,23] However, low overall symptom severity among patients in this study[median GCSI total score: 0.88 (interquartile range: 0.63–1.16), Table 1]might have confounded the lack of association between delayed GE and symptoms. Few studies[3,22,24] have found a correlation between delayed GE and dyspeptic symptoms. Among stage 5 CKD patients, delayed GE was not affected by hemodialysis in the present study and was, in fact, higher among patients on hemodialysis for >2 weeks compared to the rest. Though few studies have reported no increase in the prevalence of delayed GE among hemodialysed CKD patients compared to healthy controls,[10,25] other studies[12,21] have not shown reduced rates of delayed GE among hemodialysed CKD patients compared to others yet to be initiated on dialysis. Another study,[26]similar to the present study, has reported the persistence of impaired GE despite adequate hemodialysis.

There was a decrease in the HRV, sympathetic and parasympathetic tones among CKD patients compared to healthy controls in the present study, similar to findings in an earlier study.[27] However, there was no difference in the burden of autonomic dysfunction between CKD patients with and without delayed GE, contrary to findings in another Indian study.[5] The latter study used different methods for assessing GE and autonomic function, which can explain the difference in findings.

Anthropometric measures and serum albumin in the present study were similar to those reported in another Indian study evaluating nutritional status among CKD patients.[28]In the present study, though not statistically significant, delayed GE group had poorer nutrition (as suggested by lower anthropometric measures and serum albumin) compared to the rest [Tables 4 and 5]. Similar findings of more severe malnutrition among CKD patients with delayed GE have been reported in earlier studies.[8,11,26] This reemphasizes the fact that delayed GE may partly contribute to malnutrition in CKD patients. Additionally, efforts aimed at improving delayed GE with prokinetic drugs in CKD patients[7,8] have shown beneficial effects on nutrition. Hence, it is advisable that CKD patients with unexplained malnutrition should be evaluated for delayed GE with GES.

Limitations

This hospital-based study may not reflect the true picture of delayed GE among non-diabetic CKD patients in the community. The observed frequency of delayed GE among CKD patients in the present study was lower than the frequency assumed for calculating sample size. Nearly a third of patients enrolled initially had to be excluded from final analysis as they could not complete the study [Figure 1] and this might have affected the results. GES could not be extended up to 4 h as per recommendations, because of small meal size and logistic constraints. However, this probably would not have significantly affected the results as GE at 3 h correlates well with GE at 4 h.[29]

Conclusion

Nearly a quarter of patients with non-diabetic CKD (stages 3, 4, 5) showed delayed GE, the frequency of which was higher in stage 5 compared to stages 3 and 4. There was no association between delayed GE and symptoms suggestive of gastroparesis and autonomic neuropathy. Though not statistically significant, delayed GE was associated with poorer anthropometric measures and lower serum albumin levels among non-diabetic CKD patients. Non-diabetic CKD patients with unexplained malnutrition should be screened for delayed GE with GES, irrespective of symptoms of gastroparesis.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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