ORIGINAL ARTICLE

Gastric Emptying Patterns in Type 2 Diabetes Mellitus Patients with Symptoms of Gastroparesis and the Impact of Levosulpiride on These Patterns

Ravi Kant[1*], Kavya NP[2], Rashi Mittal[3], Vinay Tulsian[4], Vandana Dhingra[5]

Received: 21 February 2025; *Accepted:* 28 March 2025

Abstract

Background: Diabetes mellitus (DM) is a global health concern with rising prevalence, particularly in India, where undiagnosed cases are significant. A common yet often overlooked complication, diabetic gastroparesis impairs gastric motility and significantly reduces quality of life. Current treatments focus on symptom management, but the relationship between gastric motility patterns and therapeutic outcomes remains underexplored. This study evaluates the efficacy of levosulpiride in managing diabetic gastroparesis and its impact on gastric scintigraphy patterns.

Methods: This analytical observational study included 27 adult patients with type 2 DM (T2DM) and gastroparesis, conducted at a tertiary care hospital in North India from April 2021 to 2022. Patients received 25 mg levosulpiride thrice daily for 4 weeks. Gastroparesis symptoms were assessed using the Gastroparesis Cardinal Symptom Index (GCSI). Gastric motility was evaluated *via* gastric scintigraphy before and after treatment. Changes in GCSI scores and scintigraphy patterns were analyzed using paired *t*-tests and the Stuart–Maxwell test.

Results: Participants (mean age 56.41 ± 9.48 years) showed significant improvement in GCSI scores (11.48 ± 3.02 to 6.04 ± 2.08, $p < 0.001$). Gastric scintigraphy revealed significant changes, with 66.7% of patients demonstrating normalized motility patterns posttreatment ($\chi^2 = 14.000$, $p = 0.016$). While delayed gastric emptying persisted in some cases, levosulpiride alleviated key symptoms like nausea, vomiting, and early satiety.

Conclusion: Levosulpiride significantly alleviated symptoms of diabetic gastroparesis, as evidenced by reduced GCSI scores and improvements in gastric scintigraphy patterns. Despite minimal changes in delayed gastric emptying, the drug's effect on motility dysfunction highlights its therapeutic potential. This study underscores the importance of focusing on motility patterns in symptom management, suggesting levosulpiride as a promising option for targeted treatment of diabetic gastroparesis.

Journal of The Association of Physicians of India (2025): 10.59556/japi.73.1078

Introduction

Diabetes mellitus (DM) is a significant global health challenge, affecting over half a billion individuals worldwide. Projections indicate that the prevalence of DM, currently estimated at 10.5% among adults aged 20–79 years, may rise to 12.2% by 2045.[1,2] This increasing prevalence, driven by factors such as population growth, aging, urbanization, and lifestyle changes, has positioned DM as a leading cause of morbidity and mortality globally. In India alone, the number of individuals with diabetes is projected to increase from 77 million in 2019 to nearly 134 million by 2045, with over 50% of cases remaining undiagnosed.[3]

Diabetes-related neuropathy is a common complication that affects multiple organ systems, including the cardiovascular, nervous, gastrointestinal (GI), and genitourinary systems.[4] Chronic diabetes can disrupt GI tract functioning and motility, leading to GI autonomic neuropathy, a significant but often overlooked complication. This condition can affect any part of the GI tract, from the esophagus to the large intestine.[5]

Gastroparesis, a multifactorial disorder, is characterized by delayed gastric emptying in the absence of mechanical obstruction.[6] It affects up to 29% of patients with diabetes and is more prevalent in individuals with long-standing diabetes or poor glycemic control. Other causes of gastroparesis include idiopathic origins (36%), surgical complications like vagal nerve injury (13%), hypothyroidism, postviral syndromes, and pharmacological agents (e.g., narcotics, anticholinergics, GLP-1 analogs).[7] The pathophysiology of diabetic gastroparesis involves autonomic nervous system dysfunction, oxidative stress, and the loss of interstitial cells of Cajal, which disrupts coordinated gastric motility.[8–10]

Patients with diabetic gastroparesis may experience symptoms such as nausea, vomiting, retching, stomach fullness, early satiety, bloating, visible abdominal enlargement, and loss of appetite. These symptoms significantly impair quality of life and complicate diabetes management by causing erratic blood glucose levels.[11] The Gastroparesis Cardinal Symptom Index (GCSI) is a validated tool used to quantify these symptoms, grouping them into three categories and scoring each from 0 (absent) to 5 (very severe) based on patient perception.[12]

Managing diabetic gastroparesis remains challenging, focusing primarily on symptom relief, maintaining nutritional status, and improving gastric motility. Prokinetic agents like metoclopramide and domperidone are widely used; however, their long-term use is limited by adverse effects. Levosulpiride, a benzamide derivative with antidopaminergic and prokinetic properties, has shown promise in alleviating gastroparesis symptoms with a relatively favorable safety profile.[13]

Gastric emptying is commonly assessed using gastric emptying scintigraphy (GES), which tracks the passage of a radiolabeled meal through the stomach and quantifies delayed emptying if >10% of the meal remains after 4 hours. Delayed gastric emptying is observed in 32–47% of patients with type 2 diabetes. While techniques like ultrasonography and MRI are available, their use is primarily limited to research settings due to operator dependency.[14]

Despite its significant impact, there is limited research on the correlation between scintigraphic patterns and symptomatic improvement following treatment in diabetic gastroparesis. Understanding this relationship is essential for tailoring therapeutic interventions and optimizing outcomes in these patients.

[1]Professor and Head; [2–4]Junior Resident, Department of General Medicine; [5]Professor, Department of Nuclear Medicine, All India Institute of Medical Science, Rishikesh, Uttarakhand, India; *Corresponding Author

How to cite this article: Kant R, Kavya NP, Mittal R, *et al.* Gastric Emptying Patterns in Type 2 Diabetes Mellitus Patients with Symptoms of Gastroparesis and the Impact of Levosulpiride on These Patterns. J Assoc Physicians India 2025;73(10):15–19.

This study aims to evaluate the efficacy of levosulpiride in alleviating symptoms of diabetic gastroparesis and its impact on gastric motility patterns as observed through gastric scintigraphy. By examining changes in both clinical and imaging parameters, the study seeks to provide a comprehensive understanding of the role of levosulpiride in managing diabetic gastroparesis, contributing to evidence-based treatment approaches for this challenging condition.

Methods

Study Design

This analytical observational study was conducted at the All India Institute of Medical Sciences (AIIMS), Rishikesh, a tertiary public healthcare center, from April 2021 to 2022. The study aimed to evaluate the efficacy of levosulpiride in improving symptoms and altering gastric motility patterns in patients with diabetic gastroparesis.

Study Population

The study included adult patients diagnosed with type 2 diabetes mellitus (T2DM) presenting with symptoms of gastroparesis. Eligible participants were recruited from both inpatient and outpatient services of the Department of Internal Medicine.

Inclusion Criteria

- Adults aged ≥18 years.
- Diagnosed T2DM according to the American Diabetes Association (ADA) criteria.
- Presence of at least two gastroparesis symptoms, such as nausea, vomiting, retching, early satiety, bloating, or abdominal fullness.

Exclusion Criteria

- Gastroparesis secondary to drug-induced causes (e.g., opioids, anticholinergics, GLP-1 analogues).
- History of gastric surgery or vagotomy.
- Thyroid disorders or neurological conditions such as Parkinsonism.
- Chronic smoking (>30 pack-years) or alcohol consumption (>5 years).
- Pregnant or lactating individuals.
- Recent viral infections associated with gastroparesis.

Sample Size and Recruitment

This time-bound study enrolled 27 participants over 1 year. Eligible patients were selected consecutively from the study population after screening against inclusion and exclusion criteria.

Study Procedure

Baseline Evaluation

Participants underwent a detailed clinical assessment, including a medical history, physical examination, and laboratory investigations. The severity of gastroparesis symptoms was measured using the GCSI, a validated tool for quantifying symptom burden. Glycemic parameters (fasting blood sugar, postprandial blood sugar, and HbA1c) and anthropometric data (BMI) were also recorded.

Gastric Emptying Scintigraphy

All participants underwent baseline gastric scintigraphy using a standardized low-fat meal labeled with technetium-99m sulfur colloid. The procedure adhered to standard protocols:

- Preparation: Participants fasted for at least 6 hours before the test, with medications permitted only with minimal water. Smoking was prohibited during the study.
- Procedure:
  - The labeled meal was ingested within 10 minutes.
  - Static and dynamic images were captured at 0, 30, 60, 120, 180, and 240 minutes using a dual-headed gamma camera.
  - Regions of interest (ROI) were manually defined, and radioactivity counts were analyzed.
  - Gastric emptying was quantified, with >10% retention at 4 hours defined as delayed gastric emptying.

Intervention

Participants were prescribed levosulpiride (25 mg three times daily) for 4 weeks. Compliance was ensured through pill counts and weekly telephonic follow-ups. In addition to medication, patients received:

- Dietary counseling: Participants were provided a personalized low-fat, low-fiber diet plan developed by a dietitian, tailored to their cultural and food preferences.
- Glycemic optimization: Blood glucose levels were managed through individualized regimens of insulin or oral hypoglycemic agents.

Follow-up

At the end of the 4-week treatment period, participants were reassessed for symptom severity using the GCSI and underwent repeat gastric scintigraphy. Changes in gastric emptying times and scintigraphy patterns were documented.

Outcome Measures

- Change in GCSI scores before and after treatment.
- Analysis of specific gastric scintigraphy patterns (e.g., abnormal distribution, reduced fundic compliance) before and after treatment.

Statistical Analysis

Data analysis was performed using SPSS version 23. Statistical methods included:

Descriptive Statistics

Mean, median, and standard deviation for continuous variables; frequencies and percentages for categorical variables.

Comparative Analysis

- Paired *t*-tests or Wilcoxon signed-rank tests for pre- and posttreatment comparisons of continuous data.
- Chi-square or Fisher's exact tests for categorical data.

Significance Threshold

A p-value < 0.05 was considered statistically significant.

Ethical Considerations

This study was conducted as a part of a thesis on the topic "Efficacy of Levosulpiride in Type 2 Diabetes Mellitus with Gastric Autonomic Neuropathy Based on Gastric Scintigraphy Patterns: An Analytical Observational Study," which was approved by the Institutional Ethics Committee of AIIMS Rishikesh, an institute of national importance (IEC no. AIIMS/IEC/21/368; approval date: August 13, 2021). Written informed consent was obtained from all participants. Data confidentiality was strictly maintained, and no identifiable patient information was disclosed during publication or presentations.

Results

A total of 27 patients with T2DM and symptoms of gastroparesis were recruited over a period of 1 year. About 13 (48.1%) of the 27 patients were male, while 14 (51.9%) were female. The mean age (years) was 56.41 ± 9.48. The mean duration of diabetes (years) was 11.78 ± 6.20. Other baseline demographics and clinical details are summarized in Table 1. The baseline gastric scintigraphy patterns have been depicted in Figure 1.

The Changes Observed in Gastric Scintigraphy Patterns with Treatment

Following treatment, notable changes were observed in gastric scintigraphy patterns. A total of seven patients (25.9%) transitioned from the abnormal distribution of gastric contents category to the no specific pattern category. Similarly, three patients (11.1%) moved from reduced fundic compliance to no specific pattern, and two patients (7.4%) shifted from antral dysmotility to no specific pattern. Additionally, one patient (3.7%) each transitioned from gastric hurrying and gastroesophageal reflux to the no specific pattern category. These changes in gastric scintigraphy patterns were statistically significant, as confirmed by the Stuart–Maxwell test ($\chi^2 = 14.000$, $p = 0.016$) (Table 2).

The Changes Observed in GCSI Score with Treatment

The average GCSI score significantly decreased from 11.48 ± 3.02 before treatment to 6.04 ± 2.08 after treatment. This reduction was statistically significant, as shown by the paired *t*-test ($t = 14.2$, $p < 0.001$) (Table 3).

Discussion

Diabetic gastroparesis is a common complication in individuals with long-standing DM and presents a barrier to glycemic control. In its severe stages, it can lead to complications such as fluctuations in blood glucose levels, predisposing patients to hypoglycemia and diabetic ketoacidosis. Other complications include malnutrition, electrolyte imbalances, esophagitis, and bezoar formation, all of which contribute to a lower quality of life.[15] Moreover, survival rates are significantly poorer in patients with diabetic gastroparesis compared to those with idiopathic gastroparesis.[16] Antidopaminergic drugs like levosulpiride may offer relief in diabetic gastroparesis by counteracting the inhibitory effects of hyperglycemia on gastric motility, as dopamine receptor stimulation is implicated in this dysfunction. In a study by Mansi et al., levosulpiride was

Table 1: Baseline characteristics of patients

Characteristic	*Mean*
Age (years)	56.41 ± 9.48
BMI (kg/m^2)	27.13 ± 2.28
Duration of diabetes (years)	11.78 ± 6.20
HbA1c (%)	9.69 ± 1.76
Fasting blood sugar (FBS, mg/dL)	195.30 ± 29.32
Postprandial blood sugar (PPBS, mg/dL)	329.37 ± 54.55
GCSI total score (pretreatment)	11.48 ± 3.02
Gastric scintigraphy patterns	
Abnormal distribution	12 (44.4%)
Reduced fundic compliance	6 (22.2%)
Antral dysmotility	2 (7.4%)
Gastric hurrying	2 (7.4%)
Gastroesophageal reflux	1 (3.7%)
No specific pattern	4 (14.8%)
Gastric emptying at 4 hours (%)	88.63 ± 11.03

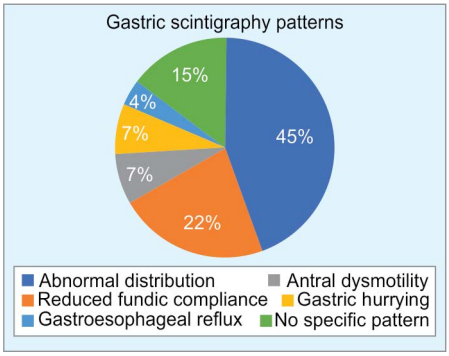

Fig. 1: Baseline scintigraphy pattern observed in the 27 patients

Table 2: Gastric scintigraphy patterns (pre- and posttreatment)

Scintigraphy pattern	*Pretreatment n (%)*	*Posttreatment n (%)*	*Change (%)*
Abnormal gastric content distribution	12 (44.4)	5 (18.5)	–58.3
Reduced fundic compliance	6 (22.2)	3 (11.1)	–50
Antral dysmotility	2 (7.4)	0 (0)	–100
Gastric hurrying	2 (7.4)	0 (0)	–100
Gastroesophageal reflux	1 (3.7)	0 (0)	–100
No specific pattern	4 (14.8)	19 (70.4)	+375

Table 3: GCSI symptom scores (pre- and posttreatment)

Symptom	*Pretreatment mean (SD)*	*Posttreatment mean (SD)*	*p-value*
Nausea	1.67 (0.88)	1.00 (0.55)	<0.001
Retching	0.78 (0.75)	0.37 (0.56)	0.001
Vomiting	0.19 (0.40)	0.00 (0.00)	0.036
Stomach fullness	1.85 (0.95)	0.96 (0.59)	<0.001
Early satiety	0.85 (0.60)	0.56 (0.58)	0.006
Fullness after eating	1.81 (0.68)	1.07 (0.62)	<0.001
Loss of appetite	0.44 (0.51)	0.41 (0.57)	0.766
Bloating	3.04 (0.85)	1.44 (0.64)	<0.001
Belly visibly large	0.85 (0.77)	0.22 (0.42)	<0.001

shown to improve upper GI symptoms and reduce gastric emptying time in diabetic gastroparesis, though gastric emptying was assessed using ultrasonography.[17]

Patterns observed in gastric scintigraphy in patients with functional dyspepsia, such as reduced fundic compliance, abnormal gastric content distribution, gastric hurrying, antral dysmotility, and gastroesophageal reflux, have been well documented.[18] Our study aimed to explore changes in the gastric scintigraphy patterns in diabetic gastroparesis patients before and after treatment with a prokinetic agent, levosulpiride.

This study is, to the best of our knowledge, the first to assess the effects of levosulpiride on gastric scintigraphy patterns in diabetic gastroparesis. A total of 27 participants were included, comprising 13 (48.1%) males and 14 (51.9%) females. The study by Jung et al. on diabetic gastroparesis epidemiology, conducted in Olmsted County, Minnesota, found that women had a significantly higher age-adjusted prevalence of gastroparesis compared to men.[19] However, in our study, there was no significant gender difference. Studies by Stanghellini et al. have also shown that female sex is associated with delayed gastric emptying, regardless of the presence of underlying organic diseases.[20] The mean age of our participants was 56.41 ± 9.48 years, which aligns with findings by Ye et al., who observed that patients with diabetic gastroparesis tend to be older at the time of diagnosis and more likely to be obese or overweight.[21]

Levosulpiride demonstrated a statistically significant improvement in the total GCSI score and in most individual symptoms, except for loss of appetite. Levosulpiride, a substituted benzamide, selectively acts on dopamine D2 receptors and is used in the treatment of dyspepsia and as an atypical antipsychotic and antidepressant. It works by blocking D2 receptors in the presynaptic dopaminergic pathways, improving gastric motility.[17,22] Although no significant improvement in delayed gastric emptying was observed in our study, levosulpiride still led to symptomatic improvement, a result consistent with findings from Mearin et al. The study indicated that various prokinetic agents, including levosulpiride, do not show a clear correlation between symptomatic relief and gastric emptying times. However, levosulpiride, in particular, has been shown to effectively alleviate symptoms like nausea, vomiting, and early satiety, likely due to its action on the chemoreceptor trigger zone, a benefit not shared by cisapride.[23]

Gastric motility relies on coordinated contractions that move food from the fundus to the antrum. Dysfunction in this process, assessable *via* gastric scintigraphy, can present as abnormal gastric content distribution, which was the predominant pattern in our study (44.4%). Although most patients had symptomatic improvement, 18.5% of patients retained this pattern posttreatment. Abnormal distribution often manifested as reduced fundic uptake and early pylorus visibility, reflecting impaired motor function of the distal stomach. Prior studies, such as the study by Urbain et al., highlighted similar patterns, emphasizing the role of antral dysfunction in nonexpulsive contractions and the potential for therapies targeting antral motor activity.[24]

Reduced fundic compliance was the second most common pattern (22.2%), with 50% resolution posttreatment. This aligns with existing literature linking decreased fundic compliance to early satiety and weight loss, observed in approximately 40% of functional dyspepsia cases.[25] Antral dysmotility and gastric hurrying were less frequent (7.4%), with the latter persisting in half of the affected patients. Dysregulated antral activity, crucial for food breakdown and transit, has been associated with postprandial nausea.[26] Gastroesophageal reflux was rare (3.7%) but resolved with levosulpiride therapy. Additionally, 14.8% of patients had no specific motility pattern but showed symptomatic improvement.

At the end of 4 weeks, 66.7% of patients demonstrated no abnormal scintigraphy patterns, with significant improvement in GCSI scores (Stuart–Maxwell test: $\chi^2 = 14.000$, $p = 0.016$). While levosulpiride's prokinetic effects did not directly improve delayed gastric emptying, its influence on abnormal patterns suggests broader therapeutic potential. Importantly, symptomatic improvement in gastroparesis often occurs independently of changes in gastric emptying, emphasizing the value of pattern recognition in scintigraphy.

The results of this study provide new insights into the complex nature of diabetic gastroparesis, particularly in relation to gastric scintigraphy patterns and the therapeutic effects of levosulpiride. Despite the absence of significant improvement in gastric emptying times, the prokinetic effects of levosulpiride led to significant symptomatic relief, particularly in symptoms like nausea, early satiety, and vomiting. These results suggest that levosulpiride may help address specific motility dysfunctions that underlie the symptoms of diabetic gastroparesis, even in the absence of noticeable changes in gastric emptying. This underscores the importance of focusing not only on gastric emptying times but also on patterns of motility dysfunctions when assessing and treating diabetic gastroparesis. Our study contributes to a growing body of evidence indicating that symptomatic relief in diabetic gastroparesis can be achieved through targeted therapies that correct these abnormal patterns, even if they do not directly improve gastric emptying time. Future research should focus on larger sample sizes and long-term follow-up studies to explore the role of levosulpiride in managing motility patterns and to evaluate its potential as a cornerstone of treatment for diabetic gastroparesis.

Limitations

- Small sample size: The study included only 27 participants, which limits the generalizability of the findings. Larger studies are needed to validate the results and ensure their applicability to a broader population.
- Short duration of follow-up: The 4-week follow-up period may not have been sufficient to observe long-term effects of levosulpiride on symptom relief and gastric motility patterns.
- Single-center design: Conducted at a single tertiary care center, the study may not capture variations in patient characteristics and healthcare practices across different settings.
- Limited assessment of long-term safety: The study did not evaluate the long-term safety profile of levosulpiride, particularly concerning adverse effects associated with prolonged use.

Conclusion

Diabetic gastroparesis is a debilitating complication of long-standing diabetes, significantly impairing quality of life and complicating glycemic control. This study demonstrated that levosulpiride, a prokinetic agent, effectively alleviated gastroparesis symptoms such as nausea, vomiting, and early satiety, as reflected in significantly reduced GCSI scores. Despite limited changes in delayed gastric emptying, improvements in gastric scintigraphy patterns, including reductions in abnormal content distribution and fundic compliance issues, highlight levosulpiride's potential in addressing underlying motility dysfunctions.

By focusing on symptom relief and motility abnormalities rather than solely on gastric emptying times, this study offers a nuanced approach to managing diabetic gastroparesis. These findings emphasize the importance of pattern recognition in gastric scintigraphy to optimize therapeutic strategies. Future research with larger sample sizes and longer

follow-up is needed to validate these results and further explore the role of levosulpiride in managing diabetic gastroparesis. This study contributes to the growing body of evidence supporting targeted treatment approaches for this complex condition.

Orcid

Ravi Kant https://orcid.org/0000-0003-1144-4478
Rashi Mittal https://orcid.org/0009-0003-7836-0567
Vinay Tulsian https://orcid.org/0009-0007-4344-185X

References

1. Sun H, Saeedi P, Karuranga S, et al. IDF Diabetes Atlas: global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract 2022;183:109119.
2. American Diabetes Association Professional Practice Committee. 2. Diagnosis and classification of diabetes: standards of care in diabetes—2024. Diabetes Care 2023;47(Suppl 1):S20–S42.
3. Pradeepa R, Mohan V. Epidemiology of type 2 diabetes in India. Indian J Ophthalmol 2021;69(11):2932–2938.
4. Fan W. Epidemiology in diabetes mellitus and cardiovascular disease. Cardiovasc Endocrinol 2017;6(1):8–16.
5. Kempler P, Várkonyi T, Körei AE, et al. Gastrointestinal autonomic neuropathy in diabetes: the unattended borderline between diabetology and gastroenterology. Diabetologia 2016;59(3):401–403.
6. Aswath GS, Foris LA, Ashwath AK, et al. Diabetic Gastroparesis. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2024.
7. Camilleri M, Parkman HP, Shafi MA, et al. Clinical guideline: management of gastroparesis. Am J Gastroenterol 2013;108(1):18–37.
8. Enck P, Frieling T. Pathophysiology of diabetic gastroparesis. Diabetes 1997;46(Suppl 2):S77–S81.
9. Moshiree B, Potter M, Talley NJ. Epidemiology and pathophysiology of gastroparesis. Gastrointest Endosc Clin N Am 2019;29(1):1–14.
10. Iwasaki H, Kajimura M, Osawa S, et al. A deficiency of gastric interstitial cells of Cajal accompanied by decreased expression of neuronal nitric oxide synthase and substance P in patients with type 2 diabetes mellitus. J Gastroenterol 2006;41(11):1076–1087.
11. Krishnasamy S, Abell TL. Diabetic gastroparesis: principles and current trends in management. Diabetes Ther 2018;9(1):1–42.
12. Revicki DA, Rentz AM, Dubois D, et al. Gastroparesis Cardinal Symptom Index (GCSI): development and validation of a patient reported assessment of severity of gastroparesis symptoms. Qual Life Res 2004;13(4):833–844.
13. Du YT, Rayner CK, Jones KL, et al. Gastrointestinal symptoms in diabetes: prevalence, assessment, pathogenesis, and management. Diabetes Care 2018;41(3):627–637.
14. Cline M, Rouphael C. Diagnostic evaluation of gastroparesis. In: Ibele A, Gould J, editors. Gastroparesis: A Comprehensive Approach to Evaluation and Management. Cham: Springer International Publishing; 2020. pp. 33–41.
15. Waseem S, Moshiree B, Draganov PV. Gastroparesis: current diagnostic challenges and management considerations. World J Gastroenterol 2009;15(1):25–37.
16. Dudekula A, Rahim S, Bielefeldt K. Time trends in gastroparesis treatment. Dig Dis Sci 2014;59(11):2656–2665.
17. Mansi C, Savarino V, Vigneri S, et al. Gastrokinetic effects of levosulpiride in dyspeptic patients with diabetic gastroparesis. Am J Gastroenterol 1995;90(11):1989–1993.
18. Ora M, Nazar AH, Parashar A, et al. Gastric emptying scintigraphy: beyond numbers—an observational study to differentiate between various etiologies and a step toward personalized management. Indian J Nucl Med 2019;34(3):194–200.
19. Jung HK, Choung RS, Locke GR 3rd, et al. The incidence, prevalence, and outcomes of patients with gastroparesis in Olmsted County, Minnesota, from 1996 to 2006. Gastroenterology 2009;136(4):1225–1233.
20. Stanghellini V, Tosetti C, Paternico A, et al. Risk indicators of delayed gastric emptying of solids in patients with functional dyspepsia. Gastroenterology 1996;110(4):1036–1042.
21. Ye Y, Jiang B, Manne S, et al. Epidemiology and outcomes of gastroparesis, as documented in general practice records, in the United Kingdom. Gut 2021;70(4):644–653.
22. Mansi C, Borro P, Giacomini M, et al. Comparative effects of levosulpiride and cisapride on gastric emptying and symptoms in patients with functional dyspepsia and gastroparesis. Aliment Pharmacol Ther 2000;14(5):561–569.
23. Mearin F, Rodrigo L, Pérez-Mota A, et al. Levosulpiride and cisapride in the treatment of dysmotility-like functional dyspepsia: a randomized, double-masked trial. Clin Gastroenterol Hepatol 2004;2(4):301–308.
24. Urbain JL, Vekemans MC, Parkman H, et al. Dynamic antral scintigraphy to characterize gastric antral motility in functional dyspepsia. J Nucl Med 1995;36(9):1579–1586.
25. Kindt S, Tack J. Impaired gastric accommodation and its role in dyspepsia. Gut 2006;55(12):1685–1691.
26. Troncon LEA, Herculano JR Jr, Savoldelli RD, et al. Relationships between intragastric food maldistribution, disturbances of antral contractility, and symptoms in functional dyspepsia. Dig Dis Sci 2006;51(3):517–526.