gastrointestinal disorders

MDPI

Communication

Development of a Motility Frailty Index in Patients with Gastroparesis

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Abstract: Introduction: Patients with symptoms (Sx) of gastrointestinal (GI) motor disorders have limitations in physical strength and mobility. We hypothesized that physical frailty correlated with severity of GI symptoms, and that a motility frailty index (MFI) could be constructed. Patients: We conducted a prospective pilot study on 40 patients, (38 F, 2 M, mean age 39.9 years) with the following diagnoses: 10 with diabetes mellitus and 30 with non-diabetic/idiopathic disorders. Upper and lower GI Sx were quantified using an FDA-compliant, traditional patient-reported outcomes (PRO) system. Methods: Patients underwent a series of physical performance measures involving standing balance (SB), usual walk speed (UW), and chair sit-and-stands (CS). A GI motility frailty index (MFI) was constructed by fitting several models with a combination of physical performance measures and correlating with PRO. Pearson's correlation compared the constructed index with the GI Sx PRO to construct a GI MFI. Results: The studied patients collectively showed marked limitations in mobility compared with standard performance values with mean (sd) ratios of SB = 0.87 (0.20), UW = 0.45 (0.13), and CS = 0.38 (0.17). Correlations between physical mobility and GI Sx were noted for upper GI Sx (rho = 0.47, p = 0.002) but not for lower GI Sx. Conclusions: In this pilot study of patients with GI motility disorders, we found increased physical limitations on performance-based testing, which had a statistically significant positive correlation with severity of upper GI motor Sx using a standardized PRO system. A motility frailty index has been constructed that may serve as a basis for better quantifying limitations in patient mobility.

Keywords: gastroparesis; motility; diabetes; mobility; frailty

Citation: Winston, J.; Guzman Rojas, P.; Stocker, A.; Mathur, P.; Lorenz, D.; Daniels, M.; Abell, T. Development of a Motility Frailty Index in Patients with Gastroparesis. *Gastrointest. Disord.* **2021**, *3*, 78–83. https://doi.org/10.3390/gidisord3020008

Academic Editor: Takuji Tanaka

Received: 13 February 2021
Accepted: 22 April 2021
Published: 25 April 2021

1. Introduction

Gastroparesis is a medical condition characterized by delayed gastric emptying of food, which affects approximately 2% of the US population [1]. This condition can significantly affect the patient's quality of life due to reported symptoms like nausea, upper abdominal pain, and early satiety [2]. Even though many of these patients have normal weight profiles or may be considered even overweight or obese by standard measures, they are often nutrient deficient and are at risk for many of the same complications as patients with malnutrition.

In the geriatric literature, frailty exists as a syndrome associated with decreased functional reserve and increased vulnerability to external stressors [3–7]. This predisposes patients to several adverse outcomes, such as increased mortality and morbidity [8,9]. For better assessment of this condition, several frailty indexes have been created. Furthermore, the concept of frailty has been recently expanded to younger patients with specific risk factors and comorbidities.

In the gastroenterology literature, frailty has been evaluated in patients with chronic liver disease as a predictor tool of mortality in patients awaiting liver transplantation. Li et al. evaluated diverse physical performance tests, such as grip strength, chair stands, and balances [10], and from these created a liver frailty index.

While chronic liver disease and gastrointestinal motility disorders have notable differences both in pathogenesis and clinical presentation, they do share some important common threads. Specifically, they are both systemic illnesses that contribute to malnutrition. We hypothesized that a similar index could be created to likewise predict adverse outcomes in our patients with gastroparesis symptoms.

2. Methods

We conducted a prospective pilot study on 40 patients with the following motility primary diagnoses: diabetes mellitus and non-diabetic/idiopathic disorders. Inclusion criteria included willingness to participate in the study with a signed, informed consent; age of 18 years or older; symptoms of gastroparesis for at least 6 months; symptoms refractory or intolerant to antiemetic and prokinetic pharmacologic therapy; at least 6 months of documented pharmacological treatment in diabetic patients; and no evidence of anatomical obstruction of the gastrointestinal tract. Exclusion criteria included previous gastric surgery; history or evidence of rumination syndrome; eating disorder or primary psychiatric disorder; known history of collagen vascular disease; pregnancy; history of prior joint replacement; and inability or unwillingness to participate in the study.

At enrollment, all patients underwent a physical performance battery consisting of walk speed, standing balance, and chair stands. A baseline gastric emptying study was also obtained (Table 1).

Table 1. Baseline Gastric Emptying and EGG results.

Baseline Gastric Emptying Study (Mean % Remaining)	
Liquid 1 h	36.38
Liquid 2 h	18.37
Liquid 4 h	4.92
Solid 1 h	66.28
Solid 2 h	39.57
Solid 4 h	10.38
EGG Pre-Temp Stimulator	
Frequency	4.56
Amplitude (mV)	0.16
EGG Post-Temp Stimulator	
Frequency	4.18
Amplitude (mV)	0.25

Walk speed: measured as the time taken to walk 4 m while moving in a usual gait.

Standing balance testing: measured as the number of seconds a patient was able to balance with their feet in semi-tandem and tandem positions, and with one leg raised.

Timed chair stands: measured as the time it took a subject to rise from a chair with their arms folded across their chest.

Each performance measure was then converted to a ratio for scoring using a validated system [11–15]. The walk ratio was found using walk speed in m/s over two. The balance ratio was calculated by using the total time spent balancing over a total of ninety seconds. The chair stand ratio was found by using the number of stands completed over the time taken to complete that number. An aggregate score of the three physical performance

measures was also calculated using the summation of the three ratios with a continuous range of zero to three.

Performance was compared to standardized values. Upper and lower gastrointestinal symptoms were quantified using an FDA-compliant traditional patient-reported outcomes (PRO) system [16,17].

Statistical Analysis

Patient characteristics are summarized by count/percentages for gender and etiology and by mean/standard deviation for age. The mobility frailty index (MFI) was constructed from linear predictors of the multivariable regression model for two outcomes, upper and lower GI symptoms. Correlations between MFI and GI symptoms were evaluated using Spearman's rho.

3. Results

We studied 40 patients, 38 women, corresponding to 95% of the patients, and 2 male patients. The mean age was 39.9 years with a standard deviation of 15.4. The majority of patients had idiopathic gastroparesis (Table 2).

Table 2. Demographics.

Gender (*n*, %)		
Females	38, 95	
Male	2, 5	
Etiology (*n*, %)		
Diabetic	10, 25	
Non-diabetic	30, 75	
Mean age	39.9	15.4 (SD)

The studied patients collectively showed marked limitations in mobility compared with standard performance values. A healthy young adult shows a walking speed of 1.3–1.4 m/s, (11) compared to our gastroparesis patients with 0.45 m/s. Similar results are found with standing balance (normal PPB score of 1 [12–14] compared to 0.87 in our patients) and chair stands (normal 0.63 (15), compared to 0.38), see Table 3.

Table 3. Physical performance battery results.

	Standing Balance (SB)	**Walk Speed (WS)**	**Chair Stands (CS)**
Mean ratios (SD)	0.87 (0.20)	0.45 (0.13)	0.38 (0.17)
Healthy 40-year-old adult	1.0	1.3	0.65

Physical mobility was further quantified by the following constructed index:

$$\text{Upper GI MFI} = (-0.212 \times \text{SB}) + (6.860 \times \text{WS}) + (-13.639 \times \text{CS}) + 6.54$$

$$\text{Lower GI MFI} = (-4.645 \times \text{SB}) + (0.007 \times \text{WS}) + (-1.149 \times \text{CS}) + 5.4459$$

Correlations between motility frailty index and GI symptoms were noted for upper GI symptoms (rho = 0.47, $p = 0.002$) but not for lower (Table 4).

Table 4. Frailty index correlation with upper and lower GI symptoms.

		Models	
Frailty Index		**Upper Sx**	**Lower Sx**
Upper	Correlation	0.47	0.21
	p-value	0.002	0.19
Lower	Correlation	0.12	0.22
	p-value	0.45	0.17

4. Discussion

The concept of a frailty index is a new and useful tool created to quantify the degree of frailty in patients with diverse comorbidities. Specifically, it takes into consideration objective measurements, such as the physical performance battery (PPB) utilized in our study. However, there are notable difference between the geriatric and gastroenterological perspectives in this regard. While the geriatric literature looks at frailty comprehensively, often examining phenotypes and including areas such as weight loss, exhaustion, physical activity, and grip strength, the liver and now GI literature has focused on physical performance alone.

In this pilot study of patients with gastroparesis we found that the mean PPB scores were lower, compared to a healthy adult with the same age, indicating a higher degree of debility. These increased physical limitations had a statistically significant positive correlation with severity of upper gastrointestinal motor symptoms using a standardized PRO. We believe this finding is caused by undernutrition and deconditioning that comes from persistent and severe symptoms elucidated by gastroparesis patients.

Currently, there is only one study assessing physical activity in patients with gastroparesis. Homko et al. [9] examined 29 patients with gastroparesis and found that those who gained weight had less severe symptoms and reduced physical activity. Sarcopenia could be associated to a decreased weight and/or BMI [18]; however, this can occur in any BMI range [19] and this study was not designed to address this important aspect of frailty, but is one of our goals for future work.

Our patients' average age was 39.9 years, and for this reason the walk speed, standing balance, and chair stands were compared to healthy younger adults with an average age of 40 years. The walk speed was found to be very decreased, in comparison with their healthy peers. In our experience, patients with moderate to severe GI motility disorders are often 'deconditioned' and are found to be similar to frail, elderly patients in terms of physical functioning. This observation is consistent with data on the physical component of GI motility disorders, such as gastroparesis, where severe limitations of physical activity have been documents as part of poor overall quality of life (2).

A motility frailty index (MFI) has been constructed that may serve as a basis for better quantifying limitations in patient mobility. This MFI has potential use in clinical trials to study its association with morbidity and mortality in gastroparesis. Furthermore, it can be a useful tool in clinical care, to identify vulnerable patients that could develop complications and/or increased mortality.

The underlying psychological status of a patient can affect the course of a variety of diseases. Gastroenterological entities are not the exception, as it is well-known that many functional disorders are directly affected by the magnitude of a mental health condition. On the other hand, there have been several studies showing the relationship of depression, for instance, and outcomes in inflammatory bowel disease and, even cirrhosis [20–22]. For this reason, we believe that the psychosocial context of our patients would have affected similarly their reported symptoms, compared to the ones with cirrhosis in previous similar studies.

We acknowledge the limitations to our study: we had a small number of patients and we only assessed three physical performance tests. In the future larger, more comprehensive

studies, perhaps incorporating handgrip strength, nutrition, cognition, measures of fatigue, and expanded physical performance batteries, with a larger number of patients, will be needed to validate the concept of a motility frailty index.

In conclusion, our gastroparesis patients showed increased physical limitations on performance-based testing, which had a statistically significant positive correlation with severity of upper GI motor Sx. A motility frailty index was constructed, which could be a useful tool for better quantifying limitations in patient mobility.

Author Contributions: J.W.: Concept, Data Collection, Data Analysis, Manuscript Preparation, Final Approval. P.G.R.: Data Analysis, Manuscript Preparation, Final Approval. A.S.: Data Collection, Manuscript Preparation, Final Approval. P.M.: Data Collection, Manuscript Preparation, Final Approval. D.L.: Data Analysis, Manuscript Preparation, Final Approval. M.D.: Data Analysis, Manuscript Preparation, Final Approval. T.A.: Concept, Data Collection, Data Analysis, Manuscript Preparation, Final Approval. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: This study was approved by the University of Louisville's Institutional Review Board #17.1019. It was virtually presented as an abstract at Digestive Disease Week 2020.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgments: The authors would like to thank the staff of the Jewish Hospital/University of Louisville Health GI Motility Clinic, Lindsay McElmurray and Kelly Cooper for help with patient identification, Bridget Cannon RN and Tachisha Walls RN for help with protocol administration and Catherine McBride for help with manuscript preparation. They would also like to thank Gwen Windom and Archana Kedar for help with previous pilot work at the University of Mississippi.

Conflicts of Interest: For Thomas Abell: Investigator, Censa, Cindome, Vanda, Allergan; Reviewer, Up to Date; Consultant, Censa and Nuvaira; Stockholder/Founder, ADEPT-GI; Writer: MedStudy; GES Editor: Neuromodulation, Wikistim; Other- Funding from NIH GpCRC. No other disclosures.

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