

## LETTERS TO THE EDITOR

### Postprandial function in gastroparesis

EDITOR,—I read with great interest the article by Fraser *et al* (*Gut* 1994; 35: 172–8) suggesting that the disturbed relation between antral, pyloric, and duodenal pressure waves is a major abnormality of postprandial function in gastroparesis, but showing no relation between gastric emptying and number of antral waves. The casual reader may conclude that Fraser's data refute some of our own work.<sup>1–3</sup> A more careful review of the experimental design and data analysis would suggest this is not the case. We had previously shown that the two hour postprandial antral motility index (that incorporates the number and amplitude of contractions) measured 1 cm proximal to the manometrically identified pylorus, significantly correlated with the rate constant for gastric emptying of solids<sup>1</sup> in health; considerably influenced the duration of the lag time and post-lag emptying rate for solids in gastroparesis<sup>2</sup>; and accounted for about 80% of the variance in emptying of solids in a pharmacological study that mimicked gastric dumping and gastric stasis.<sup>3</sup> Our hypothesis has been that, in the early postprandial period, the distal antral contractions set up the liquid shearing forces that triturate solids (hence influence on lag time) and that after emptying commences, these high amplitude contractions contribute to further trituration of the rest of the solid phase and propulsion of antral contents.

Fraser's experiment and analysis differ appreciably from ours: analysis of contractile activity starts from the end of the lag period, not from the end of meal ingestion, and stops 30 minutes later when a pharmacological intervention occurs. Moreover, Fraser *et al* used only the number of contractions at different sites without considering any role for amplitude or force of those contractions. We would suggest that evaluation of the postprandial handling of solids by the human stomach (a process that may take up to four hours even in healthy subjects) requires a longer period of analysis to prove or disprove the contribution of any specific contractile pattern and should include the initial phase of gastric retention, which is an integral part of the postprandial function of the stomach.

I do not believe that there is an enormous separation between the model proposed by the Adelaide group and our own hypothesis. The more proximal gastric contractions extending >6 cm are of interest and may conceivably represent fundic contractions, which may be further investigated by means of an intragastric barostat. But before we accept these as the propulsive force in the post-lag period, it is worth noting that in gastroparetic patients, the data of Fraser *et al* would suggest that these waves contribute to 20% of the variance in gastric emptying measured simultaneously. There is, however, a philosophical difference in our approaches to these studies of the relation between antro-pyloroduodenal contractions and gastric emptying. Dent's group has a major interest in the physiological contribution of each wave form and resistance to flow patterns; our own perspective has been more clinical as we try

to understand the significance of regional dysfunctions in disease states and to obtain a surrogate estimate of the motor function of the stomach (that is, contractility and emptying). But, as detailed and careful studies are developed to shed light on the propulsive nature of gastric motor events, we ought to avoid the temptation of throwing out the baby with the bath water unless rigorous experimental design and analysis convincingly refute the significant body of evidence accumulated from previous studies.

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- 1 Camilleri M, Malagelada J-R, Brown ML, Becker G, Zinsmeister AR. Relation between antral motility and gastric emptying of solids and liquids in humans. *Am J Physiol* 1985; 249: G580–5.
- 2 Camilleri M, Brown ML, Malagelada J-R. Relationship between impaired gastric emptying and abnormal gastrointestinal motility. *Gastroenterology* 1986; 91: 94–9.
- 3 Prather CM, Camilleri M, Thomforde GM, Forstrom LA, Zinsmeister AR. Gastric axial forces in experimentally-delayed and accelerated gastric emptying. *Am J Physiol* 1993; 264: G928–34.

### Reply

EDITOR,—Professor Camilleri's letter raises a number of important issues relating to the optimal approach to an understanding of the mechanical factors responsible for normal and disordered gastric emptying in humans. While we do not wish to suggest that the manometric and radioisotopic methods used to evaluate gastric motor function by Professor Camilleri and his colleagues are not useful, it is our belief, based on insights from recent studies, that for substantial advances in this area to occur, important modifications to conventional strategies are now required.

Gastric emptying is a complex process that entails storage of ingesta, mixing with gastric secretions, grinding of solid food to small particles, and delivery of chyme into the small intestine at a rate designed to optimise digestion and absorption. Studies in which motility and transpyloric flow have been measured concurrently show that gastric emptying is predominantly pulsatile, rather than continuous, and that not all gastric contractions result in transpyloric flow.<sup>1</sup> The substantial second to second variations in both the volume and frequency of flow episodes reflect changes in the relations between motor events in different regions of the stomach and proximal small intestine.<sup>1,2</sup> We believe that both transpyloric and intragastric flow are critically dependent on patterns of lumen occlusion resulting from muscular contractions, because lumen occlusion prevents antegrade or retrograde flow.<sup>3</sup> Accordingly, we have placed considerable emphasis on definition and evaluation of the spatial and temporal organisation of patterns of lumen occlusion.<sup>4–8</sup> Though many distal stomach contractions have a peristaltic pattern of time of onset, this rarely translates into a peristaltic pattern of onset of contraction induced lumen occlusion.<sup>2</sup> This is distinctly different from the oesophagus. Studies using a sleeve sensor and a closely spaced side hole array to evaluate pyloric motility show that pressure waves localised to the pylorus probably play a significant part in the regulation of gastric emptying, in conjunction with other motor components.<sup>4</sup> A detailed analysis supports

our view that the narrow (about 4 mm) zone of pyloric contraction cannot be defined adequately with conventional side hole manometric techniques alone.<sup>9</sup>

As no motor component can be considered to exert the dominant control, propulsive or retardant, over normal gastric emptying,<sup>1,2</sup> it is not unexpected that a measurement such as the motility index, combining both the amplitude and frequency of pressure waves in a single region of the stomach, accounts for only a comparatively small proportion of the rate of gastric emptying, as shown in elegant studies performed by Professor Camilleri *et al*.<sup>10</sup> The strong correlation seen in one study referred to by Professor Camilleri was derived from motor events recorded during stimulated and inhibited gastric emptying, which we believe limits the inferences that can be drawn.<sup>11</sup> We also do not wish to suggest that 'long' antral pressure waves are the only, or even the major, propulsive force in gastric emptying and have suggested that non-lumen occlusive contractions generated by the proximal stomach are probably important.<sup>2,12</sup> We believe that the impact of a specific motor pattern on transpyloric flow is best evaluated by correlating short term patterns of flow with these motor events rather than the use of motility indices derived from pressures recorded over long time intervals.

In patients with gastroparesis it is insufficient to focus on evaluation of antral motor function. While a reduction in fasting and postprandial antral pressure waves occurs frequently in these patients<sup>13</sup> this is by no means universal.<sup>7</sup> More importantly, a number of motor abnormalities in other regions (proximal stomach, pylorus, and small intestine) have been reported both by Professor Camilleri and his coworkers, and others.<sup>14–16</sup> Gastroparesis is therefore best considered to result from a spectrum of motor abnormalities, which include antral hypomotility, but also disordered proximal gastric tone, pyloric and proximal small intestinal function, and the organisation of motor events in different motor regions.<sup>2</sup> This is not surprising given the diverse aetiologies of delayed gastric emptying. Clearly we need correlative measurements that take all of these functional aspects into account to identify what is most important in any individual patient.

The mechanisms by which gastrokinetic drugs increase gastric emptying in patients with gastroparesis are poorly defined and the emphasis of our study was to investigate the effects of cisapride on antro-pyloroduodenal motility in patients with gastroparesis.<sup>7</sup> These drugs seem to act primarily by changing the organisation of gastric contractions to an expulsive pattern.

An optimal strategy for the evaluation of both normal and disordered gastric mechanics dictates that measurements of the temporal and spatial organisation of both lumen and non-lumen occlusive muscular contractions in different regions of the stomach and proximal small intestine and transpyloric flow are made concurrently, so that the relation between mechanical events and gastric emptying can be evaluated on a short term and, ideally, second by second, basis. Such an approach is now feasible in animals<sup>1</sup> and should be the goal of future studies in humans.<sup>2</sup>

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