Gastric Emptying: A Dog's Dinner

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Despite the introduction of numerous competing diagnostic imaging technologies, nuclear medicine has remained one of the main modalities for the routine clinical assessment of gastric emptying and gastrointestinal (GI) motility. The simple addition of a non-absorbable radiotracer to a meal, or drink provides a means for the quantification of GI motility with comparatively low radiation exposure to the patient and without the addition of dense contrast media or plastic pellets. Over the past 30 years a wide variety of solid and liquid meals have been employed, many of which have not been validated for routine use [1]. The lack of standardisation of gastric emptying procedures is a major failing of the nuclear gastrointestinal community. This was recognised over 10 years ago when an attempt to standardise radionuclide gastric emptying was made by the American Neurogastroenterology and Motility Society and The Society of Nuclear Medicine. This resulted in published consensus recommendations for gastric emptying scintigraphy in 2008 [2]. A standardised protocol was produced for the scintigraphic measurement of solid gastric emptying and normal values were established. The consensus meal comprised an egg sandwich with jam, which was not only unappealing to many patients, but also had some major limitations in that it was not easy to prepare, was of a variable nature, did not comply with all dietary necessities and was not tolerated by many patients. As a result, a wide range of meals are still employed by many nuclear medicine centres.

A recent publication in 2019 by Notghi and Hansrod [3] provided an insight into the diversity of gastric emptying practice in the UK. The survey identified 128 centres that undertook gastric emptying studies, all of which employed a solid meal as the preferred method of assessment. This survey data showed the wide range of meals used with little regard to important factors affecting the final test results. In many centres there has been little of validation of the meal and test procedure, with no regard to the normal range used for assessment of abnormality. 15% of the departments surveyed combined liquid phase emptying with solid emptying. Of 83 departments that provided protocols 49 (59%) used an egg based meal. These were prepared and consumed in various ways, either as scrambled eggs, using one or two whole eggs or just egg white, some cooked in a pan and some cooked in a microwave. This was administered with either brown or white toast, with or without butter or jam accompanied by water or juice. The permutations of meal composition and nature are wide ranging and scientifically diverse. In other words, a real dog's dinner.

Monitoring gastric motility requires a substantial time commitment for nuclear medicine clinics, in the production of a suitable meal, the acquisition of serial images and the analysis of data. In an attempt to reduce the time burden on staff and gamma camera use the 2008 American consensus procedure suggested the measurement of gastric emptying at 4 hours after consumption of the radiolabelled meal. However, many centres still rely on the quantification stomach contents over the entire course of emptying, relying heavily on the measurement of the emptying half time ($T_{50\%}$) for the interpretation. Again, this lack of standardisation is a poor reflection on the current state of nuclear medicine practice and requires urgent attention [4].

Referrals to gastroenterological specialists commonly include dyspeptic symptoms, including postprandial fullness, early satiety, epigastric pain or burning [5]. The pathophysiology of these symptoms has been attributed to alterations in GI phasic motility, gastric accommodation, gastric emptying and intestinal transit. In some patients this has been attributed to increased visceral sensitivity to mechanical (e.g. distension) and chemical stimulation, which may be further affected by psychological issues. Making the correct diagnosis can be difficult and having an objective marker of a functional disorder has been

the target of many years of research. The gastric emptying of an ingested meal is affected by a number of factors including the mass, solid/liquid composition, solid particle size and calorific, fat, protein and fibre content. Whilst it has been generally considered that solid emptying provides a better marker for the assessment of gastric emptying there has been a gradual move towards the investigation of liquid emptying. In 2009 Ziesmann et al [6] recognised the added value of monitoring liquid emptying and more recently Sachdeva et al [7] demonstrated that a high caloric liquid meal could be used as an alternative to a solid meal for gastric emptying scintigraphy. In collaboration with the Nottingham Digestive Diseases Centre, we have undertaken extensive consultation with the gastroenterologists on the most suitable clinical method for the assessment of gastric emptying. Being aware of the impressive capabilities of magnetic resonance imaging for studying the GI tract and GI motility, we considered how a meal could be standardised for use in both scintigraphy and MRI. Given the increasing interest in the use of liquid based meals, the most appropriate solution was to employ a nutrient test drink [8,9].

With regards to the standard US consensus meal, Solnes et al have recently shown that EnsurePlus is a suitable alternative to the standardised egg based gastric emptying meal [10], thus reinforcing our choice of meal. Liquid meals have the advantage of being easy to prepare with the simple introduction of a radiolabel (using 10 MBq Tc-99m-DTPA for gastric emptying, or 5 MBq In-111-DTPA if the procedure is to be followed through for the additional study of whole gut transit). The resulting meal is of a standard composition in terms of liquid consistency, fat content and calorific value and is of a more homogenous nature than solid meals which are more likely to have varying composition and consistency due to the variable nature of the different ingredients and preparation process.

Having determined the composition of the meal it is also important to consider 3 other salient factors when designing the clinical gastric emptying procedure suitable for the referral population. These are

1. The volume of the meal required should provoke symptoms, rather than for the passive observation of gastric emptying.
2. The key quantitative parameters of gastric function to include such as the assessment of early and late phase emptying.
3. Patient symptomatic assessment during the procedure.

Of key interest, our investigations of gastric emptying using an identical liquid test meal monitored by both MRI and scintigraphic imaging showed that MRI produced exquisite anatomical and functional images which was considered of greater value for research purposes, whereas scintigraphy proved to be a more reliable technique for the routine clinical quantitative assessment of gastric function [8]. Further findings from our studies have enabled us to determine methods suitable for the analysis of early and late emptying with normal range values obtained from healthy control subjects employing a 400ml nutrient liquid meal based on 1:1 dilution of Fortisip (Nutricia Ltd, Trowbridge, Wiltshire, UK) with water. In 2014 after further consultation with our gastroenterologists we introduced the routine use of this liquid test meal (Nottingham Test Meal), which was carried out together with patient symptomatic assessment of satiation, bloating, heartburn, nausea and epigastric pain using a visual analogue scale. The review of over 500 investigations using this procedure is almost complete and initial findings show that this meal was well tolerated by 98% of patients.

At the October 2019 BNMS Autumn meeting in Nottingham, a discussion session on gastric emptying concluded that there was still an urgent need to standardise the test procedure and to address the wide disparity in methods used. Given the importance of a standardised optimal test method for gastric emptying (11) we would like to emphasise this as a priority for nuclear medicine practice. Our proposal is that the use of a standard liquid meal with the assessment of early and late emptying and combined with symptomatic assessment, is the way forward. Whilst we are open to further suggestions on the composition of the meal and how the analysis of gastric emptying can be improved, we would like to challenge the nuclear gastroenterology community to contribute to introducing a standardised methodology that can be widely adopted.

It is hoped the British Nuclear Medicine Society can lead on this initiative.

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