**Ultrasound assessment of small bowel contractility in healthy volunteers**

Version 1.3

**Principal Investigators**

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**1. INTRODUCTION**

Impaired gastrointestinal motility and transit in the absence of mechanical obstruction occurs in approximately 50-80% of critically ill patients[1–3], and recovery of bowel function is difficult to predict. Delayed return of bowel function is associated with adverse outcomes and length of stay[refs].

Despite advances in technology, gastrointestinal motility and function continue to be difficult to assess. A recent systematic review[4] found that there is no gold standard for monitoring of gastrointestinal function in the critically ill. Clinical assessment is often used at the bedside, however no signs or symptoms have been found to correlate well with quantifying gastrointestinal function. Whilst there are various imaging modalities that have been used to assess gastric emptying and intestinal motility, these investigations are often time consuming and not readily available for clinical use[4, 5]. There are no validated imaging methods for bedside monitoring. There are also no validated biomarkers for clinical use.

Gastrointestinal ultrasound is a promising area of study. Ultrasound is non-invasive, rapid, repeatable, readily available, without risk of radiation and with low risk of infectious cross contamination.

Whilst assessment of gastric emptying with ultrasound has been more widely studied, there is a paucity of literature on the ultrasonographic assessment of small bowel contractility in the critically ill. In fact, to the best of the author's knowledge, there are only a handful of studies assessing small bowel contractility even in healthy volunteers.

Von Volkmann et al. (2017)[6] studied 21 patients with familial GUCY2C diarrhoea syndrome (FGDS) and 24 healthy controls. Participants were fasted overnight and a standardized meal was ingested. Occlusive & non-occlusive contractions were measured while fasting and after ingestion of the standardized meal by taking 1 minute recordings in the left upper quadrant (jejunum) & right lower quadrant (ileum). In the healthy controls, only a small number of occlusive and non-occlusive contractions were found overall, which made it difficult to assess any difference between fasting and post-prandial states. Their focus was also on comparing patients with FGDS and healthy controls, where they did find significantly more non-occlusive contractions & in patients with FGDS.

Gimondo & Mirk (1997)[7] assessed 152 participants with duplex doppler. A portion of subjects ingested 1.5L tap water, and another portion ingested a standardized meal. 1 minute recordings of doppler signals at 3 abdominal sites were taken, and using arbitrarily selected cut-off values for amplitude & duration, intestinal movements were classified as probably peristaltic (P waves) or probably non-peristaltic (non-P waves). They found significantly more non-peristaltic waves after ingestion of water or a test meal.

Liu et al. (2013)[8] published a case study of 3 patients describing the ultrasound characteristics of the migrating myoelectric complex. The studied patients had pseudo-obstruction, splenic lymphoma, or alcoholic pancreatitis. Each patient was scanned for approximately 30minutes each. Contraction duration, frequency and propagation velocity was described.

Given the relatively unknown realm of ultrasound assessment of small bowel contractility, this study intends to establish the normal ultrasonographic findings of small bowel motility in healthy volunteers, as the first in a series of studies to investigate the utility of small bowel motility assessment with ultrasound to help predict recovery of bowel function in critically ill and post-operative patients, in order to better inform the provision of enteral or parenteral nutrition.

**2. STUDY OBJECTIVES**

* Primary objective
  + To assess small bowel motility with ultrasound in participants that are fasted
* Secondary objectives
  + To assess small bowel motility after ingestion of 1L of water, a standardised meal, or after chewing gum
  + Curvilinear probe vs. phased array probe

**3. METHODS**

3.1 Participants

* n=20
* Inclusion criteria
  + Healthy volunteers in Australia
  + Age >18yo
* Exclusion criteria
  + Unable to consent
  + History of gastrointestinal disease or surgery (e.g. IBS, IBD, chronic constipation, prior GIT surgery with the exception of appendicectomy)
  + History of diabetes mellitus, hyperthyroidism, hypothyroidism, use of opioids or prokinetics within the last 24h
  + Inability to drink 600mL water, or allergy to the standardised meal or chewing gum
* Recruitment posters and emails asking for volunteers will be distributed to medical students and staff at the Royal Darwin Hospital.

3.2 Procedures

* Participants will be asked to fast for at least 4h, then chew on chewing gum, then ingest the standardized meal, which will consist of 600mL water and two Uncle Toby’s Choc Chip Muesli Bar and 600mL of water
  + Participants will be asked if they have any food intolerances, allergies or dietary needs, and asked to confirm if they will be ok to ingest the provided food and water
  + In the case of any allergic reactions, participants will be advised to present to the emergency department.
* Ultrasound recordings will be taken for 3minutes in the LUQ (jejunum) and RLQ (ileum) at these time points:
  + After fasting for at least 4h
  + After chewing gum for 15minutes
  + 30minutes and 2h after ingestion of the food and water
* Ultrasound recordings will commence once at least two loops of small bowel have been identified
* Where logistically feasible, participants will be scanned by 2 operators to assess reproducibility of results. Otherwise, the same operator will scan the patient twice at each time point. The ultrasound recordings will be de-identified then independently reviewed by at least 2 assessors (who are thus blinded) to determine the number of small bowel contractions.
* Ultrasound probe and machine will be cleaned in between patients as per standard hospital protocol
* During scanning, we would be respectful of gender and cultural norms, tailored to the participant's preferences, with the availability of a chaperone at all times unless declined by the participant

3.3 Measures & Data to be collected

* Patient information
  + Sex
  + Age
* Endpoints
  + Number of occlusive & non-occlusive small bowel contractions
* Definition of end-points (same as von Volkmann[6])
  + Occlusive contraction - active indentation of the bowel wall occluding the lumen
  + Non-occlusive contraction - active indentation in which luminal content can be observed between the anterior and dorsal wall during a contraction

3.4 Data security

The patient data will be kept strictly confidential according to the National Statement on Ethical Conduct in Human Research 2007 and the Australian Code for Responsible Conduct of Research 2018.

* Raw images will be retained for review and scoring by the other researchers. Once this is complete the raw images will be deleted and only the derived parameters retained.
* Patient data will only be transferred and analysed in a de-identified form.
* Individual patients will not be identifiable from the presented or published material.
* Patient research data will be accessed only by the named investigators.
* Electronic records of research data will be retained on password protected computer(s) in databases requiring password access.
* Any hard copies of data will be kept in locked facilities at the Royal Darwin Hospital in the Department of Intensive Care.
* Data will be stored for a minimum of 7years, after which the data will be deleted and any hard copies disposed of in secure confidential waste, unless further approval or request for retention is obtained.
* For participants who withdraw from the study, any collected data will be removed

3.4 Statistical considerations

* Descriptive study
* Matched data on bowel parameters before and after a meal will be analysed by simple paired t tests with 80% power to detect a 0.7 SD change from an expected value of 3 contractions per minute (with prior data suggesting a change of 2SD is likely, this is highly conservative). The parameters will include occlusive and non-occlusive bowel contractions, velocity and frequency of contractions, and time to third contraction, for evaluation of the most predictive parameters.

3.5 Ethical Considerations

The study will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research and the World Medical Association Declaration of Helsinki 2018.

**4. REFERENCES**

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