# Assessment of Small Bowel Motility with Dynamic MRI

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## INTRODUCTION

Although opioids are among the most prescribed analgesics for management of chronic pain patients, the adverse gastro-intestinal (GI) side effects like decreased bowel motility function can be hard to assess and treat. This study aimed to use dynamic Magnetic Resonance Imaging (MRI) to objectively assess water induced small bowel motility to investigate variation between day to day measurements.

## METHODS

Three healthy volunteers were included in a pilot study. Subjects underwent a MRI scanning protocol in the morning on five different days. Dynamic image sequences with a temporal resolution of 0.4 seconds per frame were obtained for 20 seconds periods. Subjects were starving and ingested 1500 mL of water prior to the scanning to distend the bowel and trigger peristaltic movement. Each image in the time series was registered to one reference image. The standard deviation of the resulting deformation fields (Jacobian Determinant) was used as a measure of bowel motility. Small bowel areas were manually segmented and superimposed on the deformation fields and the amount of bowel motility was estimated as the mean deformation for all small bowel areas, where 0 is no movement and 1 is high movement.

**KEYWORDS:**
MRI, Small bowel motilty, Image registration

## METHODS

### Dynamic MRI

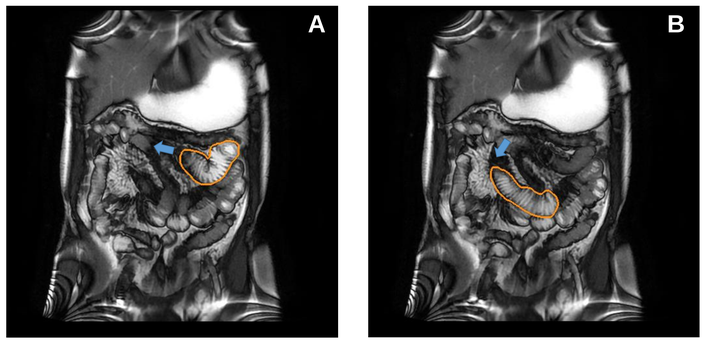


**Figure 1: Abdominal MR images after ingestion of 1500 mL water. White areas show high water concentration. The orange areas show the progression of water. Image (A) is scanned 7.2 seconds before image (B).**

### Image registration and motility map

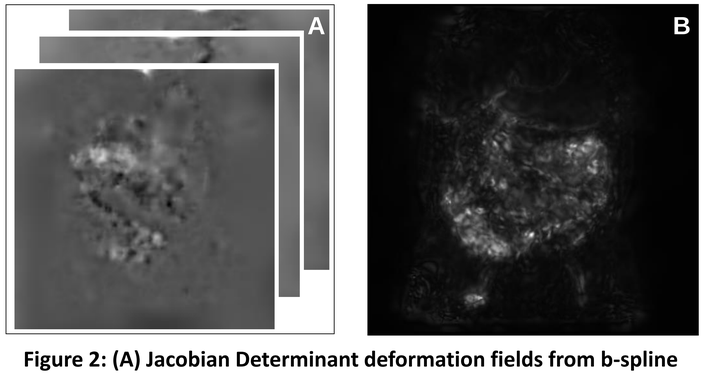


**Figure 2: (A) Jacobian Determinant deformation fields from b-spline image registration. All images in a time series are registered to the median image. (B) Motility map. The standard deviation of all 50 deformation fields from one time series. White areas show high motility and black areas indicate no motility.**

### Segmentation of small bowel

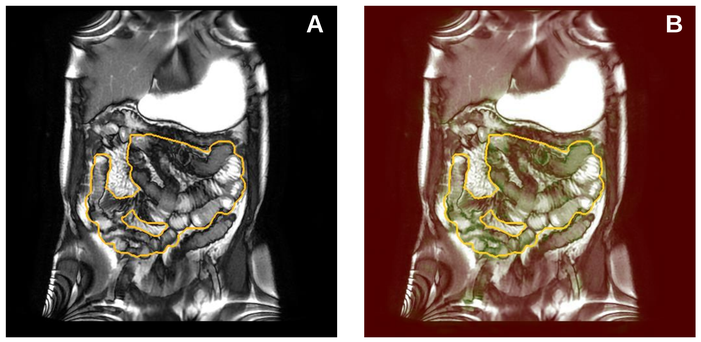


**Figure 3: (A) Manual segmentation of small bowel areas is outlined with yellow color. (B) The motility map from Figure 2.B superimposed on the MR image. Green color indicate high motility.**

## RESULTS

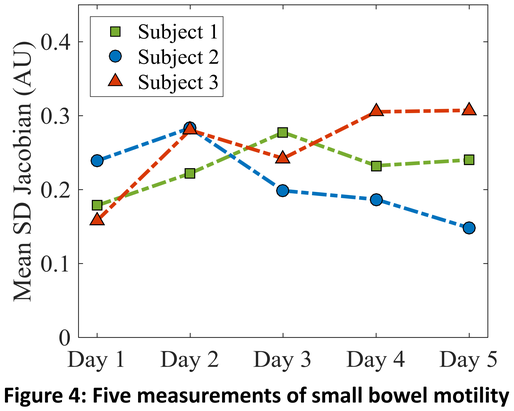


**Figure 4: Five measurements of small bowel motility with the same protocol. The higher the value of mean SD Jacobian, the more bowel activity.**

## RESULTS

The mean motility, range and standard deviation for each subject for all five measurements were:

| Subject | Mean motility (AU) | Range (AU) | STD |
|---|---|---|---|
| 1 | 0.23 | 0.18-0.28 | 0.036 |
| 2 | 0.21 | 0.15-0.28 | 0.052 |
| 3 | 0.26 | 0.16-0.31 | 0.062 |

## DISCUSSION

We investigated variation in small bowel motility measurements in three healthy volunteers. Deformation fields from registration of MR images can be used to assess the amount of peristalsis in the small bowel, however our observations of water induced small bowel peristalsis indicate higher variance between measurements than expected. Explanations for low motility values may be that the ingested water has not sufficiently filled the small bowel to induce peristaltic movements. The natural variation in bowel motilty between days may also have a larger influence on GI physiology than expected. We expect that the method after further optimization can detect drug related changes to small bowel motility.

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