

# Quantified terminal ileal motility as a biomarker of Crohn's Disease activity assessed using Magnetic Resonance Enterography: A prospective study

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## Purpose

The purpose of this study was to prospectively investigate the relationship between terminal ileal (TI) motility and endoscopically assessed inflammatory activity in data collected at the AMC, the Netherlands, and UCL, UK as part of the VIGOR++ study. Previous, retrospective studies have suggested a moderate negative correlation although limitations in terms of the time between MRI, and endoscopy, low patient numbers and incomplete patient history made interpretation of the results difficult[1], [2].

## Methods

**Patients:** 95 patients in total were identified, 39 from UCL (24 Female, median age (32, range 18 to 64) and 56 from AMC (30 Female, median age (37, range 19 to 68). All subjects had prior diagnosis of CD.

**MRI Protocol:** All patients were scanned at 3T on a Philips Achieva (UCL) and Ingenia (AMC) MRI scanners using manufacturers body coils. Patients received 800ml 2% mannitol 3 hours prior to the examination and another 1600ml 1 hour before the scan. For motility analysis a 2D BTFE motility sequence was used over a 21.7s breath-hold with a temporal resolution of 1 slice/1.09s, 1cm slice thickness, TR = 1.97ms, TE = 0.98ms covering the TI.

**ROI placement:** A polygonal ROI was placed within the last 5cm of the terminal ileum by an experienced radiologist (5 yrs MRE experience) blinded to the histopathological data, without reviewing the dynamic series.

**Motility assessment:** A previously well-validated optic-flow and registration based technique to quantify motility was used. Registration deformation fields, acting as a surrogate for motility, were analysed through taking the SD Jacobian averaged under the ROI[3].

**Histopathological grading:** All patients underwent ileocolonoscopy within a median of 4 days of their MRI (range 0 to 19). At least three biopsies of the TI were taken and the highest score assessed according to eAIS inflammatory index.

**Statistical analysis:** Data was checked for normality using Shapiro-Wilk testing (alpha 0.05). 1) Mann-Whitney U-Test was used to compare inflamed vs. non-inflamed groups. 2) Spearman's rank correlation was performed to examine the relationship between motility and inflammation. 3) ROC analysis was performed to examine the predictive capabilities of TI motility as an evaluator for inflammatory activity.

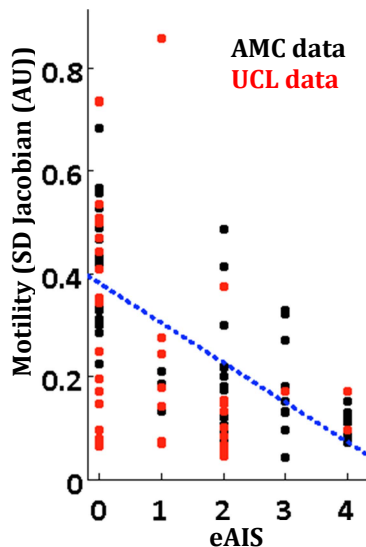


Figure 1. Correlation between motility (AU) & inflammation (eAIS)

## Results:

The median eAIS score across the cohort was 1.4 (range 0 to 4) and motility 0.25 (range 0.042 to 0.858). By institution (UCL: median eAIS = 1 (range 0 to 4), median motility = 0.17AU (range 0.046 to 0.858AU), AMC: median eAIS = 2 (range = 0 to 4), median motility = 0.2AU (range 0.042 to 0.684AU).

1) The median motility score of subjects with inflammation (eAIS >1) was 0.13AU (range 0.042 to 0.858) and without inflammation was 0.38AU (range 0.07 to 0.74).

A statistically significant difference in motility score between groups was 0.25AU (P <0.001).

2) Correlation revealed a statistically significant negative relationship between the eAIS and motility with R = -0.54 (P < 0.001).

3) Discriminant analysis was performed to evaluate the ability of motility to classify eAIS ≥ 1. The Receiver operator characteristic area under curve was 0.83 (95%CI: 0.74–0.93) on the original population and 0.82 (95%CI: 0.71–0.92) following leave-one-out analysis.

## Summary:

To our knowledge, this is the first time small bowel motility assessment has been performed prospectively across two sites, demonstrating, a significant negative relationship between inflammatory activity and bowel motility. Further ROC analysis showed that motility assessment has the ability to classify up to 82% of the inflammatory activity in the TI, supporting the use of computer aided image analysis as a tool to help radiologists objectively evaluate Crohn's disease activity.

[1] J. L. Cullmann, S. et al. , "MR imaging in Crohn's disease: correlation of MR motility measurement with histopathology in the terminal ileum.," *Neurogastroenterol. Motil.*, 2013. [2] A. Menys, et al., "Quantified terminal ileal motility during MR enterography as a potential biomarker of Crohn's disease activity: a preliminary study.," *Eur. Radiol.*, 2012. [3] F. Odille, et al., "Quantitative assessment of small bowel motility by nonrigid registration of dynamic MR images.," *Magn. Reson. Med.*, 2012.