Dynamic Contrast Enhanced MRI Evaluation of Crohn's Disease Activity: A Histopathological Correlation

S. Punwani[1,2], M. Rodriguez-Justo[3], A. Bainbridge[4], E. De Vita[4,5], R. Greenhalgh[2], S. Halligan[1,2], and S. Taylor[1,2]

[1]Department of Medicine, University College London, London, United Kingdom, [2]Department of Radiology, University College London Hospital, London, United Kingdom, [3]Department of Histopathology, University College London Hospital, London, United Kingdom, [4]Medical Physics and Bioengineering Department, University College London, London, United Kingdom, [5]Medical Physics and Bioengineering Department, University College London Hospital, London, United Kingdom

Aim: To correlate in-vivo DCE-MRI parameters with histologically determined mural acute inflammatory change in small bowel resection specimens from patients with known ileal Crohn's disease.

Introduction: Assessing the activity of Crohn's disease is fundamental to optimum patient management. However, clinical assessment of acute inflammation is relatively subjective [1]. Biochemical markers such as ESR and CRP are useful adjuncts [2] but again do not in themselves always differentiate reliably between active and chronic disease. Conventional radiological investigations though providing useful information such as documentation of acute ulceration, involve relatively high doses of radiation [3] and provide little information regarding extramural manifestations. MRI has been advocated as a potentially useful investigation for assessment of those with Crohn's disease [4-6]. As yet enteric MR appearances in Crohn's disease remain to be histopathologically validated and a quantitative MRI reference standard gauging disease activity has yet to be established. It is presumed that increased contrast enhancement reflects active inflammation but most assessments have been made against a clinical reference standard which is not always reliable. Furthermore, there is good evidence suggesting a possible ischaemic aetiology for acute Crohn's disease [7]. This study examines the relationship between a histopahtologically determined acute inflammatory score (AIS) and semi-quantitative DCE-MRI parameters (enhancement ratio (ERdyn) and slope of enhancement (SoE) [8]) in patients with known ileal Crohn's disease undergoing elective surgery for small bowel related complications.

Methods: Ethical permission was obtained. Nine consecutive patients (>16 yrs age) with a known previous histopathological diagnosis of small bowel Crohn's disease undergoing elective surgery for related complications were recruited. Patients were 'nil by mouth' for four hours prior to the study. Oral contrast (1200 mls of 0.2% locust bean gum + 2% mannitol) was administered 40 minutes prior to image acquisition. Intravenous spasmolytic (20mg Buscopan, Boehringer Ingelheim, Germany) was injected immediately prior to examination. MRI data were acquired on a 1.5T Siemens Avanto (Erlangen, Germany) using the manufacturer's body and spine array coils. HASTE and TrueFISP images were reviewed by a consultant radiologist and the diseased small bowel segment destined for surgical resection identified. For DCE MRI a 2D spoiled gradient echo sequence in the coronal orientation (TR/TE: 11/3.2 ms; flip angle 35^{o}; field of view 360mm x 270 mm, in-plane resolution 1.45 x1.45 mm , slice thickness 6mm) was used. Baseline images were collected during a 30 second breath hold. A single dose (10ml) of Magnevist (Berlex Laboratories, NJ, USA) and saline chaser (10ml) was injected at 3ml/s immediately followed by the acquisition of single-slice DCE MRI data every 3 seconds during a 30s breath-hold. Further data was acquired during gentle breathing in 3-slice data sets (every 6 seconds) collected for 5 minutes. Regions of interest (ROIs) were manually placed in the abnormal bowel wall and shifted to keep the anatomical position constant during the free breathing time course. Signal enhancement curves corrected for contrast agent dose were used to extract SoE and ERdyn. Post surgical small bowel resection specimens were scanned to enable detailed imaging-histopathology matching. Histological sections were taken through the area of bowel corresponding to the MRI ROI placement site and grading of mucosal ulceration (0-3), oedema (0-3) and quantitiy (0-3) and depth (0-4) of neutrophilic infiltration was performed to derive an acute inflammatory score (0-13) [9]. Correlation between histopathological and MRI data was assessed using Kendalls rank correlation coefficient.

Results: Fig 1 shows a typical example of normal (*Left*) and inflamed (*Right*) small bowel histology. AIS ranged from 0 to 10, SoE from 0.05 to 0.40 kg/ml/s and ERdyn from 7.1 to 14.9 kg/ml. As AIS increased the slope of enhancement and ERdyn on DCE-MRI images of the corresponding section of bowel both decreased (p=0.07 and p=0.08 respectively) (Fig 2).

Conclusion: SoE and ERdyn demonstrated a trend towards inverse correlation with AIS, contradicting previous reported positive correlation based on the non disease site specific clinical standard of reference (Chron's Disease Activity Index (CDAI)) [8]. Preliminary data presented in this paper suggest that *delayed* enhancement or *reduced* maximal enhancement of small bowel reflects a greater degree of acute inflammatory change in patients with known ileal Crohn's disease consistent with the hypothesis of reduced blood flow contributing to histopathological changes in acute disease [7].

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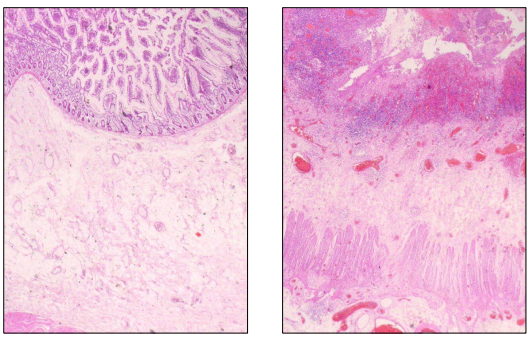

Fig 1: *Left* – Normal bowel wall (AIS=0); *Right* – Inflammed bowel wall (AIS=8).

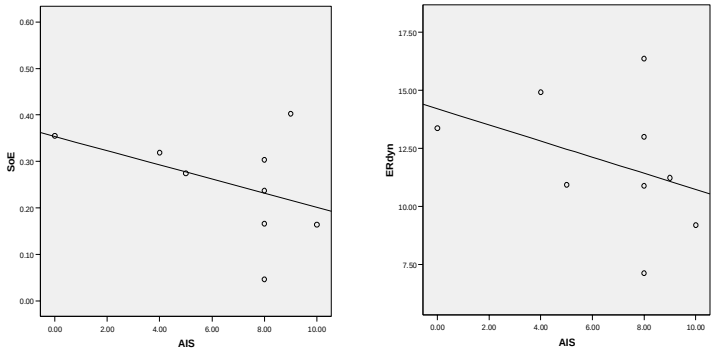

Fig 2: *Left* – SoE vs AIS; *Right* – ERdyn vs AIS.