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Technical Note

Portsmouth protocol for intraoperative ultrasound of the small bowel in Crohn's disease

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Running head: Intraoperative ultrasound in Crohn's disease.

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ABSTRACT:

INTRODUCTION: Bowel preservation is paramount in Crohn's disease surgery as affected patients are typically young adults at risk of having several abdominal surgical procedures during their lifetime. Intraoperative assessment of extent and location of Crohn's disease is not standardised and is left to a mixture of surgeons 'experience, tactile feedback, macroscopic appearance and preoperative imaging. The aim of this study was to describe the technical steps of a standardised protocol for intraoperative ultrasound assessment of the small bowel in patients undergoing surgery for ileocolonic Crohn's Disease.

TECHNIQUE: After laparoscopic mobilisation of the bowel a periumbilical incision is performed for extracorporeal division of the mesentery and the resection and anastomosis. A gastrointestinal consultant radiologist, with expertise in Crohn's disease imaging and abdominal ultrasound performs the full intraoperative assessment of the small bowel, by applying directly on the bowel a sterile probe, prior to resection being performed by the surgeon. The bowel is assessed through the wound protector with a sterile technique and the length, location and number of segments is documented together with further quantitative assessment using the (MREnterography or ultrasound in Crohn's disease) METRIC scoring guide.

RESULTS: A step by step protocol for intraoperative ultrasound evaluation of the entire small bowel has been described.

CONCLUSIONS: A standardised approach to intraoperative evaluation of extent and location of Crohn's disease is desirable. Intraoperative ultrasound may provide added value for assessment of proximal and multifocal Crohn's disease.

Keywords: Crohn's disease, colorectal surgery, ileocaecal resection, intraoperative ultrasound, small bowel.

Introduction:

Crohn's Disease (CD) is a chronic condition that causes inflammation of the digestive system that can occur anywhere in the gastrointestinal tract, but typically involves the distal ileum or colon. Despite many advances in the multidisciplinary management of CD there is still a significant risk of surgical resection for lack of response to medical management or complications during the lifetime of a patient [1]. Over 80% of patients diagnosed with primary ileocolic CD have a surgical resection within 10 years of their diagnosis, with approximately 40 to 50% of patients likely needing further operations within 10 to 15 years [2].

Many diagnostic modalities are available to plan the surgical treatment and include a combination of colonoscopy, abdominal ultrasound scan (USS), Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). In view of the chronic nature of CD patients may require repeated radiological investigations. Where possible, imaging modalities that do not involve ionizing radiation should be used [3] and USS and particularly MRI offer high diagnostic accuracy.

On the other hand, intraoperative assessment of extent and location of CD is not standardised and is left to a mixture of surgeons 'experience, tactile feedback, macroscopic appearance and preoperative imaging. This can result in intra- and inter-observer variability, affecting the length of small bowel removed at surgery and the management of occult disease, which is a concern in patients at risk of several abdominal surgeries and short bowel syndrome [4].

Moreover, incorrect intraoperative “mapping” of the extent of disease may mislead the multidisciplinary decision making on postoperative maintenance treatment, potentially increasing the chances for the patients to have a recurrence of disease and eventually needing further surgery.

For these reasons, a standardised approach to intraoperative evaluation of extent and location of CD is desirable, based on reliable and reproducible techniques, minimising the risk of surgical recurrence, optimising the decision making on maintenance treatment and follow-up, protecting patients from unnecessary extended small bowel resections.

Bowel ultrasound has become accepted, in recent years, as a non-invasive, radiation-free and easily repeatable imaging technique for morphological assessment of the transmural inflammation of the small and large intestine in CD [5]. The trans-abdominal USS, often performed preoperatively in patients with CD usually visualises the terminal ileum, and in expert hands has an accuracy equivalent to MRI within the distal small bowel [6], although the proximal ileum and jejunum may not be satisfactorily visualised due to their deeper location and overlying bowel loops [7] with MRI representing the preferred technique for detection of proximal lesions and preoperative assessment [3]. Intra-operative USS allows the probe to be placed directly on the small bowel surface during the surgery, with no adverse events directly resulting from the intraoperative USS being reported in preliminary studies [8] and when the intraoperative USS is used to assess other abdominal organs during minimally invasive surgery [9]. The aim of this study is to describe the technical steps of a standardised protocol for intraoperative USS assessment of the small bowel in patients undergoing surgery for ileocolonic CD.

Technique:

Patients undergo laparoscopic or single incision ileocaecal resection, according to a standardised technique [4, 10]. The right colon, hepatic flexure and small bowel up to the third part of the duodenum, are mobilised laparoscopically. Intra-abdominal fistulae are also divided intra-corporeally. At this stage, as per our standard practice, a periumbilical midline incision is performed to allow the extracorporeal division of the mesentery and the resection and anastomosis after application of the wound protector. The full length of the small bowel is assessed macroscopically by the operating surgeon and the areas of CD to be resected and the presence and location of other sites of disease are documented.

At this stage a gastrointestinal radiologist, with expertise in CD imaging and abdominal USS repeats the full intraoperative assessment of the small bowel. A sterile USS probe is applied directly on the bowel wall and mesentery (Figure 1). The surgeon assists in delivering the mobilised bowel in the wound protector ensuring lack of traction on the mesentery. In case of bulky mesenteric disease, resection of the ileocaecal specimen can be required prior to completion of the ultrasound assessment of the entire small bowel.

The ultrasound probe is prepared using sterile ultrasound jelly and then covered with a sterile probe cover. Segment by segment, the small bowel is assessed using a high frequency linear ultrasound probe through the wound protector, while the abdomen is covered with sterile laparotomy packs. Direct application on the bowel of sterile ultrasound jelly is usually not required, as applying saline solution via a bladder syringe ensures satisfactory acoustic coupling.

The length, location and number of CD segments is documented together with further quantitative assessment using the (MREnterography or ultrasound in Crohn's disease) METRIC scoring guide [6]. The criteria assessed include: presence and number of lymph nodes, bowel wall thickness, functional obstruction, mesenteric fat echogenicity (Figure 2,

Figure 3), submucosal layer thickness, echogenicity and clarity, mucosal layer thickness, ulceration, doppler vascular pattern (Figure 4), peristalsis related to stricturing.

The findings of the surgeon and the radiologist are documented, focusing on length of small bowel affected by disease in centimetres and location and extent of other sites of disease, with reference distance estimated in centimetres using a sterile ruler, from the landmarks of the duodenojejunal flexure and ileocecal valve. Following macroscopic and ultrasound assessment the bowel ends to be resected are divided at a 2 cm distance from a palpable diseased mesenteric margin and a side to side ileo-colic anastomosis is fashioned. Finally, the bowel is gently pushed back into the abdominal cavity and relaparoscopy is performed to ensure haemostasis.

Discussion:

We describe the technique for standardised intraoperative USS assessment of the small bowel during CD surgery. In the feasibility study in progress in our Department (Assessing the Feasibility and Safety of Using Intraoperative Ultrasound in Ileocolic Crohn's Disease – The IUSS CROHN Study - NCT03939117) the extent of resection is decided intraoperatively by the surgeon according to the “gold standard” of care, which is macroscopic evaluation and tactile feedback. No changes occur in this feasibility study to the length of bowel which is resected, as to date, macroscopic evaluation by the surgeon is the accepted standard practice. However, in order not to miss any significant findings, before performing the resection the surgeon is informed of the USS findings and reviews the small bowel to make sure the safest option is chosen.

Preoperative imaging and endoscopy are essential to plan the surgical strategy, especially in the challenging cases of multifocal disease, where the intraoperative USS may provide added value. In fact, intraoperative detection of CD related strictures is not standardised with

described methods including palpation of the small bowel segments, passage of a 20-French Foley catheter or of a calibration ball and intraoperative endoscopy [11]. The widely adopted method consisting in the passage of an inflated Foley catheter along the bowel lumen has risks of enteric content spillage, with the proximal bowel being difficult to reach [12]. The intraoperative USS can safely access the proximal bowel without need for enterotomies, at the expense of fifteen additional minutes required for completion of the intraoperative USS during our initial experience.

It is important to consider that CD surgery aims to treat the symptomatic strictures, which may also be easily recognised by the signs of mesenteric thickening or upstream bowel dilatation, with preference for bowel sparing techniques such as strictureplasties over resection in case of multifocal stricturing disease.

Our findings suggest that a standardised protocol for intraoperative USS assessment of small bowel in CD may guide a tailored surgical approach based on reliable assessment of extent of CD, with the next phase of the study evaluating how the intraoperative USS may affect the intraoperative surgical strategy, with particular attention to undiagnosed disease at preoperative imaging.

Ethics:

The study protocol was reviewed and approved by the Wessex Ethics Committee. Informed consent was obtained from the patients.

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Figure 1. The ultrasound probe is applied directly on the small bowel with a sterile technique



Figure 2. Preoperative USS. The white line demonstrates margin of "fat wrapping"



Figure 3. Intraoperative USS. The white arrows demonstrate the interface between mesenteric fat and "fat wrapping" not clearly seen on the preoperative USS

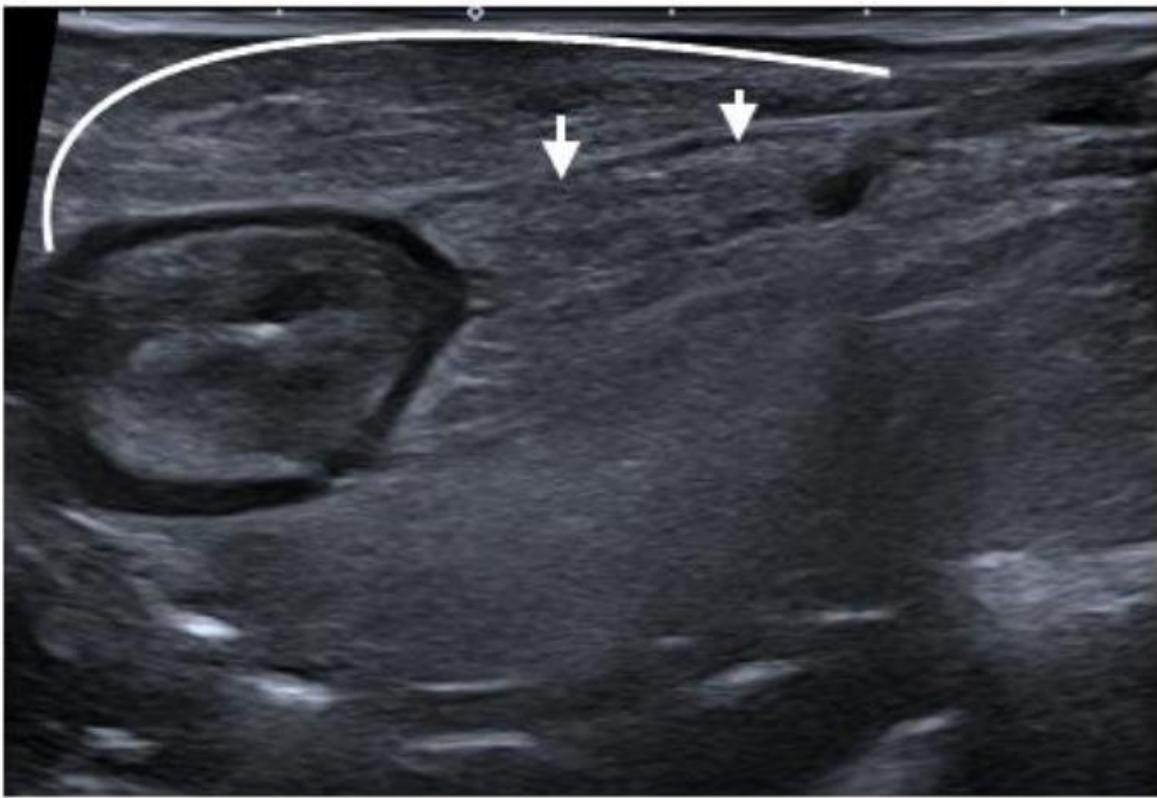


Figure 4. Intraoperative Superb Microvascular Imaging (SMI) assessment. Assessment of perfusion intraoperatively

