A semiquantitative score for the evaluation of CT enterography in patients with Crohn's disease: correlation with endoscopic and clinical findings

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Aims and objectives

CT Enterography (CTE) is a fundamental tool for the management of patients with Crohn's Disease (CD), allowing for a panoramic evaluation of disease extension and accurate detection of complications even in a sub-clinical stage [1; 2].

Imaging findings in CTE of patients with CD have been already described and correlated to clinical, endoscopic or laboratory data [3; 4]. However, a structured and standardized evaluation of CTE findings improves diagnostic accuracy and communication with referring physician [4-6]. Several scoring systems, based on different assumptions are available for the evaluation of disease activity, mainly used in experimental setting or in a well-defined clinical condition [7-9].

The aim of this study is to set a semi-quantitative score for the evaluation of inflammatory activity in CTE examinations of patients with CD, and its correlation with endoscopic and laboratory data.

Methods and materials

Derivation of Inflammatory Score (I-Score)

We propose a semiquantitative score on a scale 0-4, based on the literature review, by considering intestinal and extraintestinal findings. To reduce variability, we evaluate qualitative parameters on a 3-point scale (0 = absent; 2 = marked - diffuse) and minimize or standardize numeric variables.

Among intestinal findings, mural thickening (>3 mm) has a low sensitivity (29-67%) and a good specificity (80%-89%) for detection of active CD [10; 11]. Wall enhancement has a higher sensitivity (80%-86%) and a specificity of 82% -86% for active CD [10; 12]. The layered aspect has a low sensitivity (47-60%) and a specificity of 78-89% for active inflammation in CD [11; 13].

Among extraintestinal findings, comb sign has low sensitivity and high specificity (89-100%) for active inflammation [10; 11]. Creeping fat has a low sensitivity and a specificity of 93-96% for active disease in association with wall enhancement [10; 11; 14]. The perienteric fat stranding is considered a finding of active inflammation [3]. Discordant data are available on lymph nodes (LN) [3; 15].

The i-Score is on a 5-point scale (I0 = not involved segment; I4, severe radiological inflammatory activity). To detect the disease localization in a given intestinal segment (I1 vs I0), we consider the wall thickening (>3 mm), while the presence of inflammatory activity (I2 vs I1) is characterized by wall enhancement. The presence of at least two wall layers is the target sign in active inflammation (I Score #2) [4]. The wall enhancement is absent when comparable to not involved loops and marked (grade 2) when similar to vessels.

The extraintestinal findings have the same weight in categorization of active inflammation (I2, I3, I4. Comb sign is graded as 2 for increased number of enlarged vasa recta [16]. LN are pathological (grade 1) if increased in number, diameter (short axis > 10 mm), or both (grade 2). If perivisceral stranding and creeping fat are diffuse, they are graded 2. I2 has up to 2 extraintestinal findings graded 1. I3 has more than 2 extraintestinal findings with maximum grade of 2, or 2 extraintestinal findings with one graded 2. The I4 has more than two extraintestinal findings and at least two graded as 2.

The I-Score is summarized in Table 1.

Finally, stenosis was defined by measuring the diameters of involved segments (D_{IS}) and close non-involved segments (D_{NIS}) as (D_{IS} / D_{NIS})<0.5 [17].

Patient Selection

Inclusion criteria: patients older than 18 y.o. with known CD who underwent to CTE between June 2017 and August 2018 and endoscopy within 2 weeks from CTE. All patients included had also laboratory data within 2 weeks from CTE: C-reactive protein (CRP) and fecal calprotectin (FC) were recorded. Exclusion Criteria: previous intestinal resection, contraindication to contrast material, lack of clinical, laboratory or endoscopic data.

CTE Scanning Protocol

Patient preparation included the administration of polyethylene glicole 1 hour before the examination (Water solution of Macrogol per os, Macro P, Alfasigma, Milan, Italy) and a spasmolytic agent (Hyoscine Butylbromide, 20 mg iv, Buscopan, Boehringer Ingelheim, Barcelona, Spain).

CtE examinations were performed with a 64-row LightSpeed VCT (GE Healthcare, Milwaukee, WI) with the following parameters: 120 kVp, modulated mA, pitch: 0.984:1, kernel standard, slice thickness (ST) 2.5 mm, slice spacing (SP) 1.25 mm. The enterographic phase was acquired at 45-55 s after administration of contrast material (Iopamidol 370 mgI/ml, 1.5 ml/kg body weight at 2,5 - 4 ml/s; Iopamiro 370, Bracco, Milan, Italy), and completed with multiplanar reconstructions.

Image evaluation, Reference Standard and Data Analysis

The i-Score was calculated on intestinal and extraintestinal findings (Table 1) by two radiologists in consensus (10 and 5 years of experience in gastrointestinal imaging).

Endoscopies were evaluated as per SES-CD score in each involved segment, and active disease was considered as SES-CD #3.

I-Scores and stenoses were correlated with endoscopic data with ROC Curve Analysis. I-Scores were correlated with laboratory data with non-parametric tests. Statistical analysis

was performed with MedCalc v12.5 (MedCalc Software, Ostend, Belgium) and significant p were set at $p<0.05$.

Images for this section:

Intestinal findings	• Thickness	≤ 3 mm	> 3 mm	> 3 mm	> 3 mm	> 3 mm
	• Enhancement	-	0	1	≤2	2
	• Layers	-	-	≤2	≥ 2	≥ 2

Table 1: I-Score. The I-Score is on a 5-point scale assigned on rating of intestinal and extraintestinal CTE findings related to inflammation. Qualitative imaging findings are rated on a 3-point scale (0 = Absent; 2 = marked or diffuse).

Results

Patients demographics, imaging findings, laboratory and endoscopic data are reported in Table 2.A total of 48 patients with a median age of 49 years were included. A total of 63 intestinal segments were evaluated.

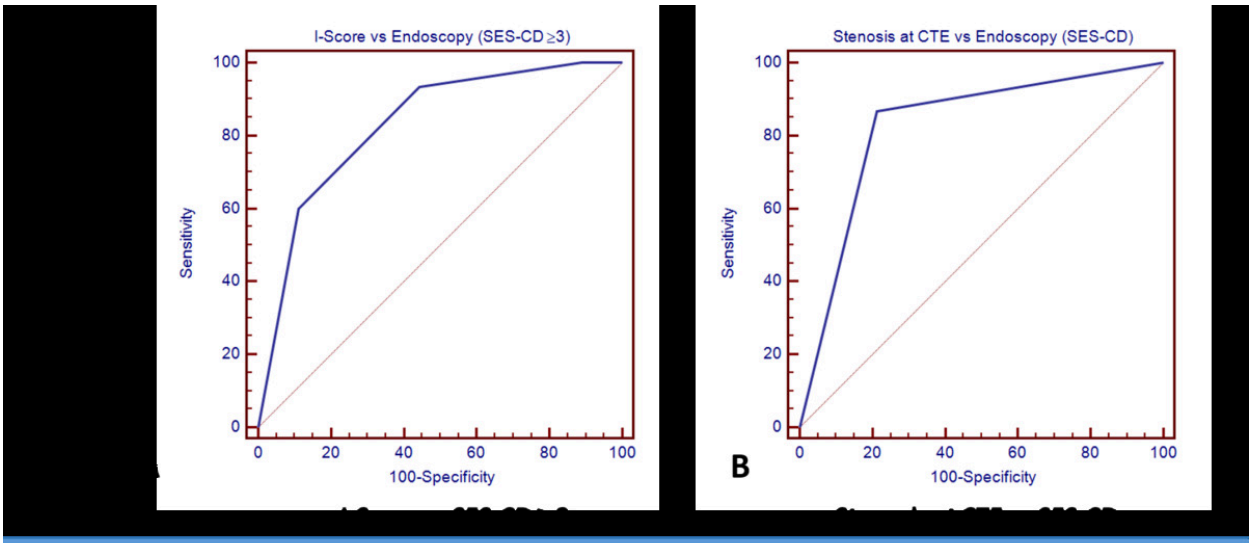
ROC curve analysis of I-Score and stenoses toward endoscopic data are reported in Figure 1.

Values of CRP and FC were stratified with I-Score categories by using Kruskal-Wallis Test, as shown in Figure 2.

Images for this section:

Patients (No. = 48)	**Sex**	20M / 28F
	Age (years)	49 (38 – 64)
	Intestinal segments evaluated	63
Laboratory	**CRP >0,6 mg/dl**	29
	Fecal Calprotectin >100 mg/kg	30

Table 2: Patients Demographics, I-Score, Laboratory and Endoscopy. 25-75p: Interquartile Range.



Cutoff Criterion	**I-Score > 2**	**Present**
Specificity	**55.6%**	**78.8%**
p	**<0.0001**	**<0.0001**

Fig. 1: ROC curves of I-Score (A) and Stenoses (B) evaluated at CTE with endoscopy and SES-CD Score as reference. AUC: Area Under Curve.

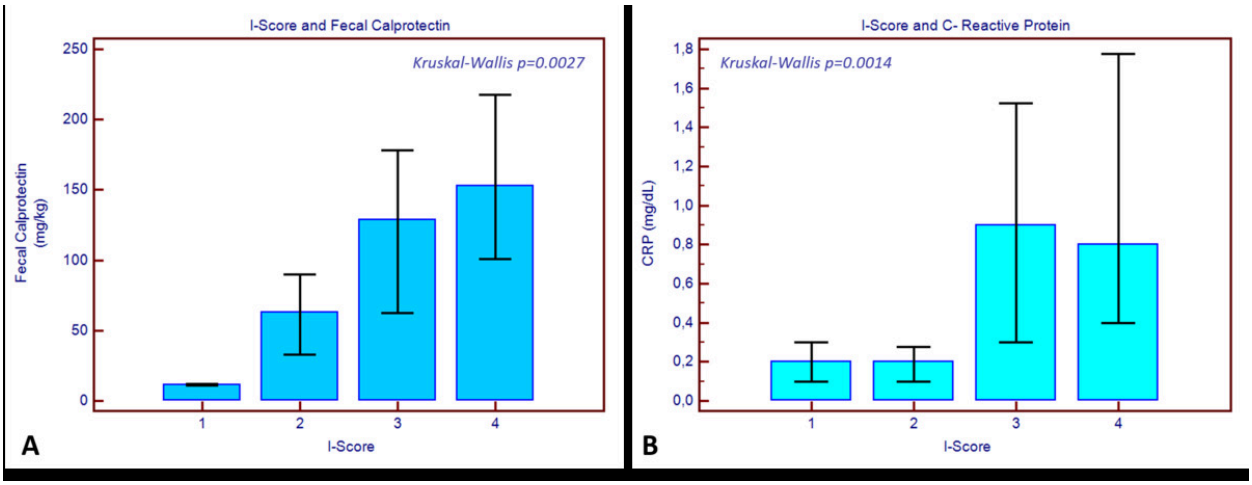


Fig. 2: Kruskal - Wallis Test for stratification of Fecal Calprotectin (A) and C-Reactive Protein (CRP) with I-Score categories. Significant differences in CRP and Fecal Calprotectin values at different I-Score categories were detected. Bars: Median value. Error Bars: Interquartile Range.

Conclusion

The proposed I-Score demonstrated high sensitivity in detection of active inflammation at CTE, when compared with endoscopy. Stenoses, defined as the diameter of involved segment as half of lumen of segments nearby, demonstrated high sensitivity and specificity when compared to endoscopy.

The proposed I-Score is able to stratify values of CRP and FC.

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