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Original article

The Role of Multi-Detector Computed Tomography in Assessment of Chron's Disease Progression: A Cross-sectional Study

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ABSTRACT

Background: There is a lack of information regarding the correlation between multi-detector computed tomography [MDCT] findings and clinical activity of Chron's disease.

The aim of the work: In this study, we aimed to investigate the correlation between MDCT and the degree of activity of Chron's disease [CD].

Patients and Methods: In this prospective study, a total of 50 patients with CD were recruited. The disease activity was assessed using the Crohn's Disease Activity Index [CDAI]. For MDCT evaluation, we used 256 Multislice CT scanners [Toshiba Medical System, Tochigi-ken, Japan].

Results: Forty-five patients [90%] showed signs of activity, while the other five patients [10%] were in the remission state [showed no signs of activity]. The most common sign of activity was mucosal hyper enhancement [93.3%], followed by mucosal thickening [91%], mesenteric congestion [64.4%], and mesenteric lymphadenopathy [33.3%]. The association analysis showed that there was a statistically significant association between CDAI and signs of activity in MDCT [360 ±64.5 in patients with signs of activity vs. 206.9 ±145.6 in patients with no signs of activity; p <0.001]. In addition, there were statistically significant associations between CDAI and presence of complications and extra-intestinal involvement [p >0.05].

Conclusion: Our study showed that the findings of MDCT are significantly correlated with clinical activity score. Clinical and radiological predictors of severe disease need to be assessed as predictors in future studies.

Keywords: Chron's Disease; Activity Score; MDCT; Multi-detector slices; Enterography.

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* Main subject and any subcategories have been classified according to the research topic.

INTRODUCTION

Inflammatory bowel disease [IBD] has emerged as a global, debilitating, disease with serious health-related and economic consequences. The disorder is usually identified as a chronic, progressive, inflammatory process of the digestive tract [1]. IBD is mainly classified into two separate entities with interacting phenotypes, ulcerative colitis and Chron's disease. Chron's disease is characterized by patchy inflammation that can affect any part within the intestinal tract in a skip-lesions pattern [2]. Previous epidemiological studies showed that the incidence of Chron's disease has increased exponentially in the past few decades, with the highest prevalence in Europe and North America [3].

While the exact cause of IBD is still unclear, various genetic and environmental factors were shown to increase the risk of Chron's disease such as NOD2 and IL23R mutations, smoking, fast foods, obesity, physical inactivity, psychological stress, and certain medications [4,5]. Recent advances in animal models have provided tremendous insights in the complexity of Chron's disease pathogenesis, an impaired immune response to intestinal microbiota, with subsequent release of proinflammatory cytokines, are thought to be the main driven factor for the development of intestinal inflammation and epithelial damage [6]. Clinically, patients with Chron's disease are prone to a wide range of complications such as bowel obstruction, fistulas, malnutrition, sclerosing cholangitis, colon cancer, and death [7]. The combination of characteristics physical findings, capsule endoscopy, radiological evaluation, and histopathology represent the cornerstone for diagnosis of Chron's disease and assessment of its severity [1]. Computed tomography enterography [CTE] is the imaging modality of choice for evaluation of intestinal tract in patients with Chron's disease, the current body of evidence demonstrates that CTE is a valid tool for the primary diagnosis of Chron's disease and evaluation of extraintestinal status with high diagnostic accuracy [8]. With the introduction of multidetector computed tomography [MDCT], the role of CT has expanded in the setting of IBD. MDCT provides excellent evaluation of bowel and extraintestinal structures by thin section scanning providing multiplanar and 3-D images [9].

Additionally, it has the advantage of providing detailed evaluation of bowel vasculature [10]. Recently, a growing body of evidence suggested a potential role of MDCT in the evaluation of inflammatory activity in Chron's disease; CT-based markers were found to correlate significantly with histological inflammatory activity of Chron's disease; thus, providing a promising, non-invasive, tool for the assessment of disease activity in affected patients [11]. However, there is a lack of information regarding the correlation between MDCT findings and clinical activity of Chron's disease

AIM OF THE WORK

In this study, we aimed to investigate the correlation between MDCT and the degree of activity of Chron's disease.

PATIENTS AND METHODS

Patients, Study Design, and Setting: In this prospective study, a total of 50 patients with Chron's disease were recruited from outpatient clinics of Gastroenterology department of Al Zharaa University Hospital through the period from August 2017 to July 2019. The ethical approval was obtained retrospectively from IRB committee of Al Zharaa University Hospital [2020/15/1]. Adult patients [≥ 18 years old] with established diagnosis of Chron's disease according to the diagnostic criteria of the European Crohn's and Colitis Organisation [12]. Patients were included regardless of their gender or treatment plan. Patients with impaired intestinal dilatation, renal impairment, contraindications to iodinated contrast media, and/or contraindications ionizing radiation were excluded. All procedures were done after informed consent from all patients.

Sample Size: The minimum sample size was calculated by using PASS software [PASS 11 citation: Hintze J [2011]. PASS 11. NCSS, LLC. Kaysville, Utah, USA]. Based on the previous report by Minordi and colleagues [13], 100% of patients CDAI >150 had a CT study scored as pathological, compared to 79% of the patients with CDAI <150 . Setting alpha error at 5% and power at 80%. The minimum required sample size for the study was determined to be 36 patients with accounting for 10% dropout rate.

Data Collection and Clinical Severity Assessment: Demographic characteristics, the location of the lesions, disease activity, and MDCT findings were collected from all eligible patients. The disease activity was assessed using the Crohn's Disease Activity Index [CDAI]. CDAI is a numerically-represented evaluation score that assessed the signs and symptoms of Chron's disease, laboratory findings, and extraintestinal complications in the past seven days [Table 1]. A score of less than 150 is considered as a marker remitting disease and a score of more than 450 is considered as a marker of severe disease [14]. The small intestine and colonic involvement of the affected patients was assessed using small bowel endoscopy and colonoscopy [Global Technology, FujiFilm Endoscopy, Japan, 2018], respectively, by expert gastroenterologists.

Table [1]: CDAI items

Items	Score
Patient Reported Stool Pattern	
Average number of liquid or soft stools per day over 7 days	14 points per stool
Using diphenoxylate or loperamide for diarrhea	30 points
Average Abdominal Pain Rating Over 7 days	
None	0
Mild pain	35
Moderate pain	70
Severe pain	105
General Wellbeing Each Day Over 7 days	
Well	0
Slightly below average	49
Poor	98
Very poor	147
Terrible	196
Complications	
Arthritis or arthralgia	20
Iritis or uveitis	20
Erythema nodosum, pyoderma gangrenosum, or aphthous stomatitis	20
Anal fissure, fistula, or abscess	20
Other fistula	20
Temperature over 37.8°C in the last week	20
Finding of an Abdominal Mass	
No mass	0
Possible mass	20
Definite mass	50
Anemia and Weight Change	
Absolute deviation of hematocrit from 47% in males or 42% in females	6 points for each % deviation
Percentage deviation from standard weight	1 point for each % deviation
Total criteria point count	

MDCT Protocol: For evaluation, we used 256 Multislice CT scanners [Toshiba Medical System,

Tochigi-ken, Japan]. Patient was advised to consume liquids and semiliquid diet the day before the procedure. Patients must be fasting from food & drink at least four hours before exam. Then ingested 5 % mannitol solution [about 1400 ml]orally for about 50-70 minute [optimal terminal ileal distention time].Scanning was done from the top of the diaphragm to the lower edge of symphysis pubis using breath –hold technique. Tube voltage was 120 KV, Tube current 160-240 MA .CTE was done with patient supine, Images was acquired with a section thickness of 2.0–2.5 mm and a reconstruction interval of 1.0–1.5 mm displayed. Injection of 100-150 cc of Iodinated IV low osmolar non-ionic contrast administration contrast media at rate 3-4 cc/sec by using high pressure syringe injection. CTE was performed during the enteric phase [45–50 s] after injection and the portal venous phase [70 s after injection]. [Maximum peak small bowel wall enhancement occurs during the enteric phase [50 s post-contrast media injection]. Post processing was done by using a modern PACS and workstation, usually we used axial and coronal reconstruction but sometimes we need sagittal reconstruction. Throughout all cases we checked the distribution and site of bowel involvement, disease activity [evident by mural thickening, hyper enhancement, mesenteric congestion [comb sign], and mesenteric lymphadenopathy], complications [e.g. strictures, fistulae, malignancy], and extra intestinal manifestations [such as cholelithiasis, hepatic steatosis, nephrolithiasis, and sacroiliitis].

Statistical Analysis: We performed a statistical analysis using the statistical package of social science [SPSS, windows version 22]. All continuous quantitative data were presented in mean and standard deviation [SD]. While categorical data were presented in frequencies and percentages. We used student t-test to compare means and Chi-square test to compare frequencies. A p-value of less than 0.05 was considered significant.

RESULTS

In our study, we included 50 patients proven to have Crohn's disease whose age ranges from 15 to 60 years with the mean age 34.6 ± 13.1 SD. The majority of patients were females and the mean age at the onset of the disease was 25.81 ±6.8 years old. Fourteen [28%] patients were smokers. As regards

site of bowel involvement, the most commonly involved region was the distal ileum with ileo-cecal valve involvement in 38 patients [70%], followed by the colon in 11 patients [20%], the jejunum in six patients [12.9 %], and pyloric involvement in two patients [3.7%]. The mean CDAI score was 298.45 ± 113.3 , with only 12 patients [24%] had a score of less than 150. Almost half of the patients underwent surgical treatment [Table 2]. With regard to MDCT findings, 45 patients out of 50 [90%] showed signs of activity, while the other five patients [10%] were in the remission state [showed no signs of activity]. The most common sign of activity was mucosal hyper enhancement [93.3%], followed by mucosal thickening [91%], mesenteric congestion [64.4%], and mesenteric

lymph-adenopathy [33.3%]. Out of 50 Crohn's patients, 18 showed complications in the form of stricture [26%], abscess [4%], fistula, and malignancy. Fifteen patients [30 %] showed extra-intestinal involvement in the form of cholelithiasis [n =6], hepatic steatosis [n =5], nephrolithiasis [n =3], and sacroiliitis [n =1] [Table 3; Figure 1-4]. The association analysis showed that there was a statistically significant association between CDAI and signs of activity in MDCT [360 ± 64.5 in patients with signs of activity vs. 206.9 ± 145.6 in patients with no signs of activity; $p < 0.001$]. In addition, there were statistically significant associations between CDAI and presence of complications and extra-intestinal involvement [$p < 0.05$; Table 4].

Table [2]: Baseline characteristics of the included patients

Variables		Patients [n =50]	
		No.	%
Age in years, Mean \pm SD		34.6 \pm 13.1	
Male		20	40%
Age at onset in years, Mean \pm SD		25.81 \pm 6.8	
Smoking		14	28%
Intestinal Involvement	- Distal ileum with ilio-caecal valve involvement	38	70%
	- Colon	11	20%
	- Jejunum	6	12.9%
	- Pylorus	2	3.7%
Surgical treatment		24	48%
CDAI [mean \pm SD]		298.45 \pm 113.3	

Table [3]: MDCT Features of the included patients

Variables		Patients [n =50]	
		No.	%
Signs of Activity, No. [%]	- Hyper enhancement	42	93.3%
	- Mucosal thickness >3 mm	41	91%
	- Mesenteric congestion[comb sign]	29	64.%
	- Mesenteric lymphadenopathy [short axis > 10 mm]	15	33.3%
Complications, No. [%]	- Stricture	13	26%
	- Abscess	2	4%
	- Fistula	2	4%
	- Malignancy	1	2%
Extra-intestinal Involvement, No [%]		15	30

Table [4]: Associations between MDCT Features and CDAI of the included patients

	Variables	CDAI score	P-value
Signs of Activity	- Yes	360 \pm 64.5	<0.001
	- No	206.9 \pm 145.6	
Complications,	- Yes	382 \pm 103.6	0.01
	- No	247.9 108.7	
Extra-intestinal Involvement	- Yes	389 \pm 101.4	0.002
	- No	217.4 \pm 130.2	

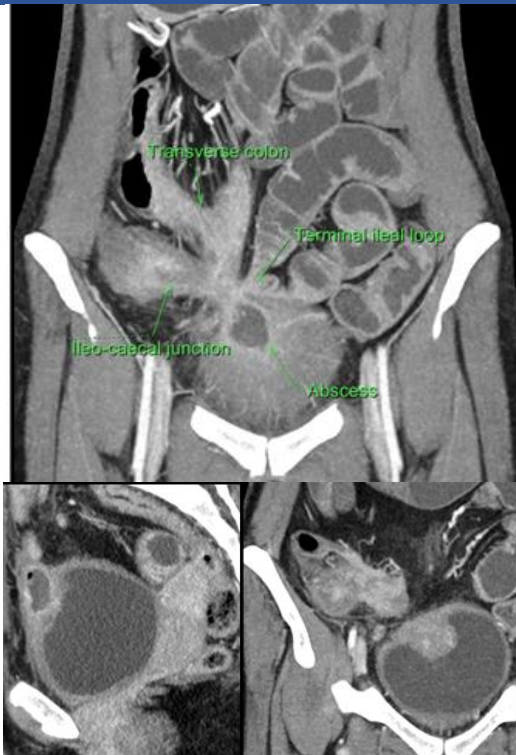


Figure (1): CTE coronal & sagittal views showing complicated Crohn's disease

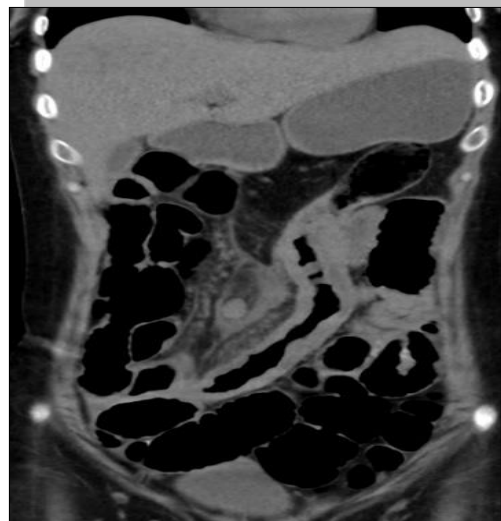


Figure (2): CTE axial & coronal view showing postoperative activity of CD patient



Figure (3): CTE axial & coronal views of CD patient showing ileal skip lesions.

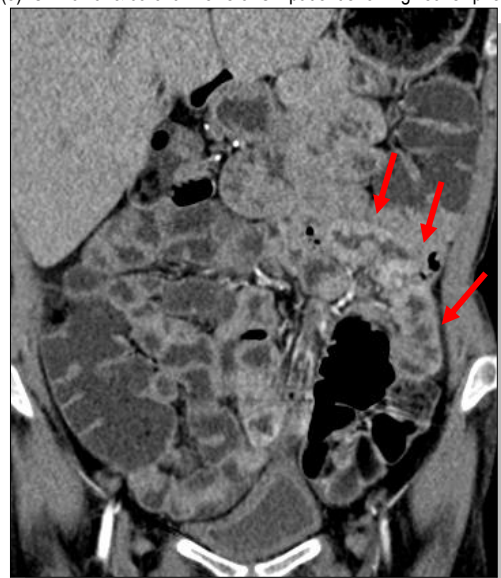


Figure (4): CTE coronal view patient with CD showing jejunal thickening & hyperenhancement

DISCUSSION

There is a lack of information regarding the correlation between MDCT findings and clinical activity of Chron's disease. Therefore, in this study, we aimed to investigate the correlation between MDCT and the degree of activity of Chron's disease. Our analysis demonstrated that the MDCT is a feasible method for assessment of Chron's disease activity and progression, there was a statistically significant association between CDAI and signs of activity in MDCT.

In addition, there were statistically significant associations between CDAI and presence of

complications and extra-intestinal involvement. Accurate prediction of the disease severity and behavior is the cornerstone for determine the treatment strategy in Chron's diseases. Since its introduction in the late 1960s, the CDAI has become the most commonly utilized tool for the assessment of clinical activity in Chron's disease [15]. However, previous reports demonstrated that CDAI poorly predict the clinical behavior and treatment response in Chron's disease [16].

Besides, the CDAI is limited by the need for complex procedure to calculate it, the incorporation of subjective complains in the assessment, and the requirement of the patient to keep a diary for seven days. Thus, the development of newer modalities, which directly assess mucosal injury and structural intestinal damage, becomes critical to improve the outcomes of Chron's disease [17].

MDCT has emerged as an ideal method for assessment of Crohn's disease extent, activity, stage of progression, potential complications, and extra-intestinal involvement [18].

It allows the perfect combination of a short examination time, a single breath hold, accessibility, good imaging quality, and multidirectional display of lesions and mesenteric vascular conditions [19].

Previous reports demonstrated that MDCT features [such as intestinal wall thickening, mural hyper-enhancement, lymphadenopathy, and Comb sign] are positively correlated with both endoscopic and histological features of severe disease [20]. However, limited data are available about the correlation between MDCT findings and clinical activity scores.

In the present study, we found that the signs of activity in MDCT were significantly associated with higher severity score. The presence of complications or extraintestinal manifestations in MDCT were also correlated with higher severity score.

In agreement with our findings, Guidi et al. [21], showed significant correlation between high CDAI score and signs of disease activity in MDCT.

These findings were further supported by two more studies [13, 22].

As mentioned before, patients with Chron's disease are prone to a wide range of complications such as bowel obstruction, fistulas, malnutrition, sclerosing cholangitis, colon cancer, and death [7].

In the present study, the MDCT scan showed that 36% of the patients showed complications in the form of strictures [26%], abscess [4%], fistula [1%], and malignancy [1%]. These findings are in line with Rieder et al. [23], who informed that incidence of complications in patient with Crohn's disease were 50%.

In conclusion, the present study provides further evidence about the utility of MDCT as an excellent modality for assessment of Crohn's disease extent, activity, stage of progression, potential complications, and extra-intestinal involvement. Our study showed that the findings of MDCT are significantly correlated with clinical activity score. Clinical and radiological predictors of sever disease need to be assessed as predictors in future studies.

Financial and Non-financial Relationships and Activities of Interest

None

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