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Impact of Structured Computerized Tomography Reporting on Quality of Budd-Chiari Syndrome

ABSTRACT

Introduction: Radiological reporting has a key role on the patient management with vital components which needs to be addressed to decided specific treatment plan. The structured reporting of Budd-Chiari syndrome (BCS) addresses the key questions and points of gastroenterologists, in terms of mentioning about the exact pathology, associated features, and presence or absence of complications which are presented as checklist in format, thus making sure they are addressed in all reports irrespective of reporting radiologist. **Aims and Objectives:** The aim of this pilot study was to assess the clinical feasibility, diagnostic yield, and advantage of structured reporting for routine computerized tomography (CT) reading in patients with BCS as compared to traditional free-text reporting, to see the interobserver agreement for the standardized reporting format within the radiologist, and to evaluate the radiologist to communicate the results to the referring gastroenterologist distinctly and conveniently. **Setting and Design:** This was a descriptive study. **Materials and Methods:** This descriptive feasibility pilot study was approved by the Institutional Review Board. Thirty consecutive patients of the age group 22–60 years with equal distribution of male and female patients with a first diagnosis of BCS (on ultrasound and clinical examination) were retroprospectively included. All the 30 CT studies were performed on 64 slice CT (Phillips's Brilliance 64 slice CT scan from Phillips Healthcare, India) with a dedicated triple phase protocol at our institute from January 2019 to December 2019. The triple phase protocol consisted of plain scan, arterial phase (22 s), portal phase (45 s), and venous phase (60 s) and was modified to add an early delayed sequence at 3 min followed by a delayed scan at 7 min to look for excretion of contrast. Contrast dosage was on a weight-by-weight and case-by-case basis. The structured reporting was done by one radiologist in training (SM) and two senior radiologists (AJ and AS) who did not conduct previous radiological reporting and were blinded to patients' clinical information as well as written reports. The freestyle reporting was done by two other radiologists (VS and MM) who did not conduct previous radiological reporting and were blinded to patients' clinical information as well as written reports. Appendix 1 summarizes the 11 liver-related and 7 non-liver-related contents. The CT findings were classified into four categories, namely, congruent, partially congruent, incongruent, and not mentioned in freestyle report. The definitions for evaluation of the liver- and non-liver-related contents were adapted from Bink *et al*. and are summarized in Appendix 2. The structured reporting format developed for structured reporting of BCS is shown in Appendix 3. **Conclusion:** In this pilot feasibility study, the structured standardized reporting on BCS was feasible for radiological routine and as it provides reproducible and more complete diagnostic information compared to the traditional freestyle reporting. In very rare cases, non-liver-related additional findings may be overlooked on account of using predefined reporting templates. A secondary check will help in addressing the findings which are not requested after completing the template. The completed structured standardized reporting template needs to be used in daily clinical practice and need feedback is needed from referring specialties to address the required information.

Key words: Budd Chiari syndrome, Hepatic veins, Structured report, Template

INTRODUCTION

Radiology reports play a very important role in the management of patents and help referring clinician to decide most appropriate treatment for patient. Traditional reports have inhomogeneity of language, under or over reporting of non-essential information, style and narration of information, and lack of clarity sometimes hampers the information the radiologist want to convey to the clinicians. The structured report aids in clarifying these problems by better communicating the information to clinicians by having more

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homogeneity.[1-5] This study explored the current and future role of structured reporting in radiology in the diagnosis of Budd-Chiari syndrome (BCS). This article also discusses the obstacles to the use of structured reports and highlights ways to overcome some of those challenges.

Structured reporting is the key element for the radiologists' contributing to their patient outcomes ascertaining the significance of their work. Many international and national radiological societies and organization are emphasizing on structured reporting. Standardization in the form of tabulation and charts conveys the information which is easy to read and interpret.[6-7]

This causes lesser confusion and prevents ambiguity. This also helps in quantifying automatic parameters such as tumor staging and laboratory data.

This article outlines the standard protocol, tables, definitions, images, and systematic evolution for template reporting style. The use of structured reporting is endorsed and structured reporting templates can be translated and adapted as needed.

The structured or template reports by entering specific fields help address relevant information in an easily readable format and ensure completeness of the required information that is essential for patient management.[8-10] This report needs to be concise, to the point and should have sufficient clarity to help referring physicians to decide the management of patient.[11-13]

The standardized template format reporting will ease the patient management by conveying important information to the referring gastroenterologist taking these reporting templates to the next level.[14] The obstruction of two or more hepatic veins (HV) and/or inferior vena cava (IVC) leads to increase in hepatic sinusoidal pressure, this increases pressure will cause back pressure, that is, portal hypertension.[15] BCS occurs commonly in young adults, majority of these patients have hematological abnormality or malignancy. Various causes of BCS include myeloproliferative disorders, JAK2 V617F mutation, Factor V Leiden mutation, oral contraceptive pills, pregnancy, antiphospholipid antibodies, paroxysmal nocturnal hemoglobinuria, and protein C and S deficiency. Clinically, it presents with acute, subacute, or chronic manifestations. Patients develop ascites, hepatomegaly, and portal hypertension.

The acute condition, it results from thrombosis of hepatic veins which enlarged and may be associated with IVC thrombosis. Subacute and chronic conditions result in fibrosis and cord-like hepatic veins.[16] Membranous occlusion of IVC and HV, presenting as the chronic form of the disease, is more common in Indians.[17] In spite of this, recent studies have documented prevalence of hypercoagulable state to be rising trends as an etiology of BCS in Indian patients; causing changing the spectrum of BCS in patients.

BCS also occurs in secondary involvement of the IVC and HV secondary to kidney, liver, or suprarenal gland tumors and metastasis. The parenchymal changes in BCS are secondary to obstruction of the HV, which leads to an increase in sinusoidal pressure with resultant reduced HV perfusion resulting in ischemia, necrosis of hepatocytes (especially in perivenular zone) which, in turn, leads to hepatic fibrosis, nodular regenerative hyperplasia, and cirrhosis.[18,19] The recent advance in interventional radiological management in techniques, hardware, and continuing research helps in changing management protocol of BCS, with surgery being offered to patients not suitable, for radiological interventions or those with acute liver failure requiring liver transplantation. The present article gives insight into various imaging findings and interventional techniques employed in the management of BCS. The definitions for evaluation of the liver- and non-liver-related contents were adapted from Bink *et al.*[20] and are summarized in Appendix 2.

RESULTS

In the present study, a total of 30 patients were included in the study. The mean age of our study patients was 35.13 ± 15.19 years. Equal gender distribution was noted, with 50% (15/30) males and 50% (15/30) females. The radiological diagnosis in all these 30 reports was identical in freestyle and structured report, however, the important components such as cord-like HV or its chronic thrombosis and thrombosis/narrowing of the lumen of IVC have been addressed differently in freestyle and structured reports. This affects management as well as follow-up studies.

Liver-related items

Table 1 summarizes the comparative results of freestyle and structured reporting findings of all liver-related items. Congruent findings were present in all items and ranged from 20% to 93%. Partially congruent findings were noted in all items (range: 5–26%). Non-congruent findings were 3–6.6% in 7/19 items. In the freestyle reports, findings were not mentioned in 6/19 items (3–6%).

Size of liver

There were about 80% congruency and 20% partial incongruency in freestyle and structured reporting, which was mostly related to observer variance in measurement of liver size in coronal section with slight differences in normalcy and abnormal size measurement. Fortunately, all the scans were measured correctly, with slight incongruency in the categorization. Although this does not affect management of the patient, it may affect follow-up scans and comparisons.

Enhancement pattern

This category was divided into heterogeneous and flip-flop enhancement pattern due to their importance in management of BCS patients. Structured reporting addresses both heterogeneous and flip-flop enhancement pattern, while freestyle reporting mentions incorrect interpretation in 10% of cases. Of these, 3% did not mention the enhancement pattern of any type at all. The freestyle reported flip-flop enhancement incorrectly in 11% of reports while the heterogeneous type was incorrectly reported in 3% of reports. Figure 1a shows one of the cases with flip-flop pattern of enhancement.

Table 1: Findings of liver-related parameters

Out of 30 patients (%)	Size	Margins/ border	Heterogenous enhancement	Flip flop enhancement	Focal lesion	CRL ratio	HVs thrombus	HVs ostial narrowing	HVs cord-like	IVC	Portal vein	Intrahepatic collaterals
Congruent	24 (80%)	22 (73.3%)	16 (53.3%)	6 (65%)	5 (60%)	24 (80%)	20 (66.6%)	20 (66.6%)	20 (66.6%)	24 (80%)	28 (93.3%)	27 (90%)
Partially congruent	6 (20%)	5 (16.6%	3 (10%)	2 (24%)	1 (10%)	6 (20%)	8 (26.6%)	6 (20%)	5 (16.6%)	5 (16.6%)	2 (6.6%)	3 (10%)
Non congruent	0	2 (6.6%)	1 (3%)	1 (11%)	0	0	1 (3.3%)	2 (6.6%)	3 (10%)	1 (3.3%)	0	0
Not mentioned	0	1 (3.3%)	1 (3%)	0	2 (20%)	0	1 (3.3%)	2 (6.6%)	2 (6.6%)	0	0	0

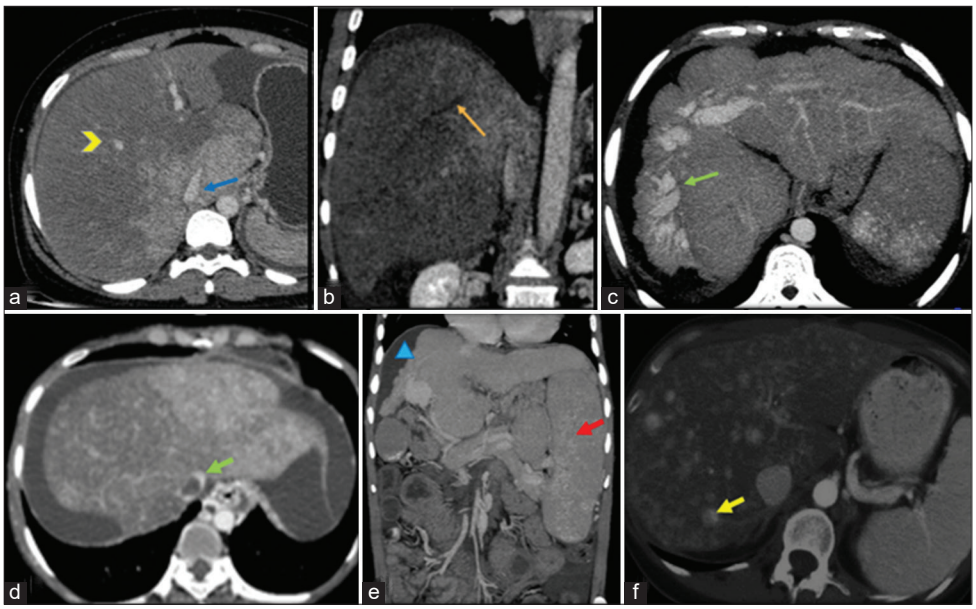

Figure 1: Axial, sagittal and coronal venous phase CT images of different patients showing liver related items (A-D and F) and non-liver related items (E). (a) Flip-flop enhancement pattern (yellow arrowhead) and IVC narrowing (blue arrow), (b) MHV thrombosis (orange arrow), (c) Intrahepatic collaterals (green arrow), (d) Acute thrombosis of IVC (green arrow), (e) Ascites (blue triangle) and splenomegaly with gamna gandy bodies (red arrow), (f) Regenerative nodule (yellow arrow)

Hepatic veins

Both, freestyle and structured reporting, showed 66.66% congruency in correct labeling and categorization of the hepatic veins, that is, thrombosed, cord like, or stenosis of their ostium. The freestyle reports failed to mention the HV thrombosis, ostial narrowing, or cord-like nature in 3.3%, 6.6%, and 6.6% of cases, respectively. In 1–3.3% of cases, the freestyle reporting incorrectly labeled collaterals or branches of portal veins as HV involvement. Two of our cases in Figure 1b and e showing HV thrombosis and non-visualization of all the three hepatic veins, respectively.

Margin/border of liver

Incorrect interpretation of both irregularity and nodularity of liver margins or mentioning either one of them, when both were present, that is, partially congruent, was seen in 16.6% of cases.

However, 6.6% of non-congruency was reported. In 3.3% of cases, findings were not reported, all of which were from freestyle reporting. Figure 1c shows one of the patients with surface irregularity and nodularity of liver.

Intrahepatic collaterals

Intrahepatic collaterals were mentioned in all the freestyle reporting cases, but with partial incongruency in burden and locations in 10% of cases. One of our case, as shown in Figure 1c, shows intrahepatic collaterals.

IVC

Both freestyle and structured reporting showed 80% congruency in correct labeling and categorization of IVC. In 16.6% of freestyle reports, the IVC was incorrectly categorized into mild-to-severe type or the residual diameter. The IVC was incorrectly labeled as narrowed in freestyle report in 3.3% of

cases. Figure 1a and d, two of our cases, shows IVC narrowing and IVC thrombosis.

Focal lesion

The freestyle reporting failed to pick up the focal lesions, that is, regenerative nodules in 20% of cases. About 10% of the freestyle reports have reporting errors in size and location of focal lesion in liver parenchyma (partial incongruency). Figure 1f shows a regenerative nodule in liver in one of our patients.

Portal vein

There is partial incongruency in the measurement of portal vein diameter noted in 6.6% of free style reports.

Caudate-right lobe ratio (CRL) ratio

With respect to the CRL ratio, though 20% of reports showed slight variation, the interpretation remained the same.

Non-liver-related items

Table 2 summarizes the comparative results of freestyle and structured reporting findings of all non-liver-related items. It revealed congruent findings in all items (range: 80–100%). Partially congruent findings were noted in 5 items ranging from 3% to 20%. Non-congruent findings ranged between 3% and 3.3% in 2 out of 7 items. In only 1 of 7 items, the findings in freestyle reports were not mentioned.

Extrahepatic collaterals

In 96.6% of cases, findings mentioning extrahepatic collaterals were congruent in freestyle and structured reporting, while in 3.3%, there was partial incongruency in terms of burden and locations of collaterals.

Splenic size

There was congruency in 96% of cases in both freestyle and structured reporting in terms of splenic size. In 3.3% of cases of freestyle reporting, there was slight variation in size – partial incongruency. There were no reports reporting incongruency.

Splenic parenchymal enhancement and splenic vein

There was congruency in all cases in both freestyle and structured reporting.

Splenic focal lesion

Freestyle reporting was able to identify lesions in all cases. However, there was 3.4% partial incongruency in freestyle and structured report due to improper categorization of lesions. There was no non-congruency noted. Figure 1e depicts one of our case showing Gamna-Gandy bodies and mild splenomegaly.

Ascites and colopathy

Ascites was mentioned in both structured and freestyle reporting. Colopathy was not mentioned in 3.3% of cases of freestyle reporting. There was partial congruency of 10% in identification of ascites and 20% for colopathy. Figure 2 represents the findings relating to the 11 liver-related and 7 non-liver-related items and 2 subitems, including heterogeneous enhancement and flip-flop pattern of enhancement.

Findings not reported in the structured report

Freestyle reporting missed HV ostial stenosis and cord-like HV in two cases, HV thrombosis in one case, focal liver lesions in two cases, and colopathy in one case. These findings were clear and were addressed in all cases in the structured reporting system.

DISCUSSION

In this study, structured reporting in patients with a diagnosis of BCS was done in a considerably shorter time than the freestyle reporting. When comparing the freestyle reporting, structured reporting describes the liver-related items and non-liver-related items in the concise and tabulated way. Although structured reporting cannot fully exclude all individual reading errors, it helps in significant reduction in incompleteness of abdominal reporting. In this section, the reporting radiologist experiences that structured reporting modifies the way to look over radiological examinations.

Our study results are concordant with those of other studies showing superiority of structured reports that provide superior description and resolve clinical questions, evaluation, as well as the confidence of referring physicians.[6,21,22] Brook *et al*.[21] compared structured versus traditional reports of multiphasic computerized tomography (CT) for the ability to assess for resectability of pancreatic carcinoma. They found that structured reports provided more complete reporting of 12

Table 2: Findings of non-liver related parameters

Out of 30 patients (%)	Non-liver related parameters						
	Extrahepatic collaterals	Splenic size	Splenic parenchymal enhancement	Splenic focal lesion	Splenic vein	Ascitis	Colopathy
Congruent	29 (96.6%)	28 (93.2%)	3 (100%)	29 (96.6%)	30 (100%)	26 (86.6%)	22 (73.6%)
Partially congruent	1 (3.3%)	2 (6.8%)	0	1 (3.4%)	0	3 (10%)	6 (20%)
Non congruent	0	0	0	0	0	1 (3.3%)	1 (3.3%)
Not mentioned	0	0	0	0	0	0	1 (3.3%)

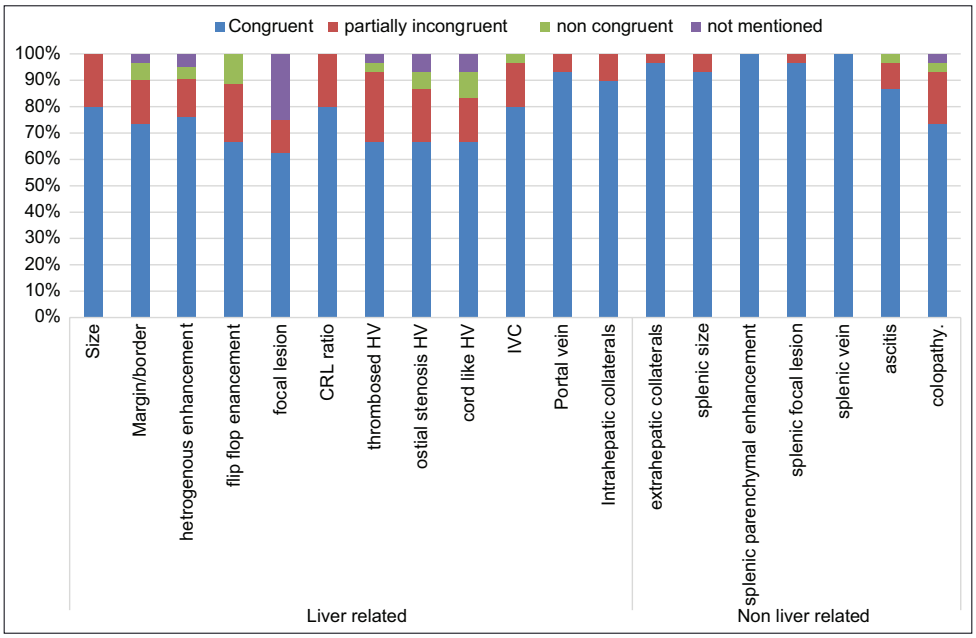

Figure 2: Represents the liver (11 items), non-liver related (7 items) factors and 2 sub-items (heterogenous enhancement and flip flop pattern of enhancement).

key features (7.3 of 12 features for non-structured reports vs. 10.6 of 12 features for structured reports) ($P < 0.01$), and they increased the sufficiency of information needed for surgical planning.

Ellerman *et al*.[23] did a similar analysis by comparing the ability of structured and traditional magnetic resonance imaging (MRI) reports to predict osteochondritis dissecans lesion stability. International Cartilage Repair Society criteria were used in the structured template. Radiologic impressions were compared with arthroscopic findings, and the overall accuracy increased from 53% to 76% when readers used the structured template as opposed to traditional reports. Dickerson *et al*.[24] also compared the differences in report thoroughness and satisfaction between reports obtained before and after template implementation that described multiple sclerosis findings on brain MRI examinations utilizing a 12-item structured reporting template. The authors were able to show that reports obtained after template implementation yielded a significant increase in multiple sclerosis – relevant findings and positive ratings by neurologists. Reports obtained after template implementation mentioned 11.1 findings, whereas those obtained before implementation mentioned 5.8 findings ($P < 0.001$). The post-template reports also were more likely to receive positive ratings, compared with the pre-template reports (56% vs. 28%; $P = 0.01$).

Other authors have also shown that structured reports are preferred, clearer, and result in greater inter-reader agreement.[6,7,25] The subjective observation of the reporting radiologist was, that using a structured template type of format helps to from a "checklist" of the components needs to be completed as an intellectual task. This helps in the completion of the list and reduces the chance of missing or overlooking the secondary findings which are not checked for with enough effort. Although the structured reporting template causes reduction of omission rate in reporting, the methods of radiological analyzing of all structures without any secondary influence have additional value. By no means can the experience and knowledge of a radiologist be replaced completely by structured reports or artificial intelligence in their current form.[26]

The liver size, intrahepatic venovenous collaterals, ascites, extrahepatic collaterals, CRL ratio, and IVC are the parameters with highest percentage of congruency. Non-liver-related parameters such as splenic parenchymal enhancement pattern and splenic vein achieved 100% congruence. These are few of the items with no missing important information in freestyle reporting.

About 70–80% congruence rate is seen in non-liver-related items such as colopathy and splenic focal lesion. The basic reporting of BCS can be performed with above-mentioned parameters but freestyle reporting misses important items. In our patients, no acute dangerous or emergency findings were overlooked or unaddressed; however, the completeness in terms of information provided by the free-text reporting was substantially lower. Consequently, the quality of report is again an issue. Structured reporting must answer all queries and items, if not done or not designed to do so, important information on the status of HV, liver, focal liver lesions, and IVC status will be overlooked.

The current template of structured standardized reporting system was made keeping this in mind. In addition, the information provided to referring physicians is enhanced by

adding appropriate relevant images along with the written report.

The status of HV-like thrombosis, ostial narrowing, and cord-like morphology is substantially more important findings; however, the percent of congruency is significantly low in freestyle reporting, which, in turn, affects management. As a result, structured reporting will fill the gap in radiological reporting and clinical management. Focal liver lesions also have low congruency in both types of reporting. Thus, the reporting of liver-related items has overall lesser degree of congruency than non-liver-related items. However, structured reporting covers all aspects.[27]

CONCLUSION

In this pilot feasibility study, the structured standardised reporting on BCS was feasible for radiological routine and as it provides reproducible and more complete diagnostic information compared to the traditional free-style reporting. In very rare cases, non-liver related additional findings may be overlooked on account of using predefined reporting templates. A secondary check will help in addressing the findings which are not requested after completing the template. The completed structured standardised reporting template needs to be used in day to day clinical practice and need feedback is needed from referring specialties to address the required information.

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