The Egyptian Journal of Hospital Medicine (April 2021) Vol. 83, Page 1472-1476

Multi Slice CT Cholangiography Using Minimum Intensity Projection in Evaluation of Patients with Biliary Obstruction: Comparison with Percutaneous Trans Hepatic Cholangiography

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ABSTRACT

Background: Evaluation of the diagnostic value of computed tomography (CT) cholangiography with minimum intensity projection (MinIP) in the work up of patients with obstructive biliary disease through correlation with percutaneous trans hepatic cholangiography (PTC) results.

Objective: In this study, we aimed to evaluate the diagnostic value of CT cholangiography with MinIP in the work up of patients with obstructive biliary disease through correlation with PTC results.

Patients and Method: The study included 36 patients (26 males and 10 females), with biliary obstruction. CT cholangiography was done to reach a definite diagnosis for the cause of obstruction and PTC was done during their management plan. Analysis of the image data with (MinIP) images was created on a separate workstation and compared to that of PTC. **Results:** The CT cholangiography using MinIP technique correctly diagnosed the cause of obstruction among all included cases. No significant difference was found between measurements of obstructing lesion size. We had a novel observation about that axial images are significantly better to reveal the obstructing biliary lesion if the cause of obstruction is intrahepatic; while coronal images are significantly better to reveal the obstructing biliary lesion if the cause of obstruction is extrahepatic.

Conclusion: CT cholangiography with MinIP is a complete noninvasive technique that provides projectional images similar to that of PTC without administration of oral specific contrast agents, requires no medications, less operator dependent and no complications were encountered in adequately screened patients.

Keywords: Biliary obstruction, Biliary tract diseases, Cholangiography, CT, MinIP images, PTC.

INTRODUCTION

In patients with biliary obstruction, computed tomography (CT) or ultrasonography are considered as the first modality for diagnosis [(1)]. However, both modalities provide insufficient information on the bile duct abnormalities [(2)].

Magnetic resonance cholangiography (MRC) has witnessed lots of advancement. However, CT continues to be used as the primary imaging modality for the hepatobiliary system because of its wide range of significant information [(3)]. MRC is a sensitive imaging modality but, it is not of choice for patients who have shortness of breath or those who have surgical clips at the site of examination [(4)].

Endoscopic retrograde cholangiography (ERC) and percutaneous trans-hepatic cholangiography (PTC) were considered as the gold standard techniques as they allow direct delineation of the biliary tree and due to their therapeutic effect [(5)]. However, the fact that they are invasive techniques with high rate of complications reduces the rush toward using them as the first imaging modalities for diagnosis of biliary obstruction [(6)]. Advances in the multi slice CT technologies and in the workstation allowed rapid image acquisition and short post processing time for the CT cholangiography [(7)].

To the best of our knowledge, A few articles reported that CT cholangiography using minimum intensity projection (MinIP) technique without cholangiographic contrast agent is as useful and simple imaging modality in evaluation of the biliary tract and the surrounding structures [(8)].

In this study, we aimed to evaluate the diagnostic value of CT cholangiography with MinIP in the work up of patients with obstructive biliary disease through correlation with PTC results.

PATIENTS AND METHODS

This prospective study included 36 patients (26 males and 10 females), age ranged between 32 to 80 years with biliary obstruction, whom ERCP failed or was contraindicated due to medical or surgical causes. CT cholangiography was done to reach a definite diagnosis for the cause of biliary obstruction and PTC was done as a primary step in the process of PTD. CT scans were obtained on a helical CT scanner (Siemens AG, 64 slice, high speed advantage scanner). The scans were obtained with 120 KV, 400 MA, pitch 0.5, 6-mm collimation and 3-mm reconstruction interval. After non enhanced pancreaticobiliary images, 1.5 - 2 mL/kg body weight nonionic contrast media (ultravist) was injected using automatic injector system (MEDRAD) at a rate of 4 mL/sec. With use of a bolus-tracking technique, portal venous phase delay was 40 seconds after the aortic enhancement. Coronal reconstructed CT images were obtained as it corresponds to the anterior-

Received:21 /1 /2021
Accepted:18 /3 /2021

posterior fluoroscopy projection and MinIP can be very helpful to understand the anatomic background.

Analysis of the image data with minimum intensity projection (MinIP) images was created on (syngo multimodality workstation). Auto production of 15 mm slice thickness MinIP images with abdominal window adjustment was done for both axial and coronal images. The processed range of images was saved as a separate sequence. The outline of the region of interest was traced manually using the editing tool in image sections, excluding pelvic organs. Measurement of the size of obstructing lesion in centimeters, maximum radicles diameter and common bile duct (CBD) diameter in millimeters was performed. Grading of radicles was done as follows: An intrahepatic bile duct diameter of 5 mm is called mild, 5-9 mm moderate and >9 mm is called marked dilatation. Image analysis was done for all patients, PTC was used as a gold standard. The interval between CT and PTC ranged from 0 to 9 days (mean= 4.5 days).

Using percutaneous local anesthesia (10 ml of 2% lidocaine), right sided access route was preferred in most cases (23 cases) (63.9%). A peripherally dilated bile duct (as peripheral as possible) was punctured with 18 G Chiba needle, under US guidance. Whereas fluoroscopy (Philips Medical System DMC GmbH) was used for introducer sheath, guide wire and catheter insertion, manipulation, and advancement. 0.035" Terumo guide wire was inserted through the Chiba needle, introducer sheath was placed over the guide wire then contrast media (CM) was injected from the side of the sheath, accurately delineating the site and length of the biliary obstruction.

Ethical consent :

An approval of the study was obtained from Menoufia University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of the operation.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for the Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Wilk test. Qualitative data were represented as frequencies and relative percentages. Chi square test (χ^2) was used to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation), median, and range. Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

On CT cholangiography, the biliary tract has low attenuation in comparison with the surrounding contrast enhanced structures. The CT cholangiography using MinIP technique correctly diagnosed the cause of obstruction among all included cases (Table 1).

Table (1): Causes of biliary obstruction among the studied groups

Cause	The studied cases (N=36)	
	No.	**%**
• **Pancreatic neoplasm**	15	41.7
• **Cholanigocarcinoma**	10	27.8
• **Periampullary malignant lesion**	3	8.3
• **Duodenal mass**	3	8.3
• **Porta hepatis LNs**	1	2.8
• **Post-operative benign biliary tract stricture**	4	11.1

Extrahepatic biliary obstruction was seen in 14 cases (38.9%) while 22 (61.1%) of cases were presented by intrahepatic biliary obstruction. A correct diagnosis for all causes of obstruction was done using CT cholangiography. There was no significant difference found between measurements of obstructing lesion size in cm measured in CT MinIP images and PTC images (Table 2).

Table (2): Comparison between obstructing lesion size measured in CT with MinIP examination and that measured in PTC

Studied variable		Wilcoxon test	P-value
Obstructing lesion size in cm measured in CT:			
Mean ± SD	4.02± 1.82	522	0.602
Median(range)	4.00 (1.00- 7.00)		
Obstructing lesion size in cm measured in PTC:			
Mean ± SD	3.69± 2.03		
Median(range)	4.00 (1.00- 7.00)		

While there was significant difference between CBD diameter measurement using CT MinIP images compared with that measured in PTC images, it was applied to cases with extrahepatic causes of biliary obstruction (22 cases) (Table 3 and Figure 1).

Table (3): Comparison between CBD diameter measured in CT with MinIP examination and that measured in PTC

Studied variable (N= 22)		Paired t-test	P-value
CBD diameter in (mm) measured by CT: Mean ± SD Median (range)	19.41± 4.93 20.00 (10.00- 27.00)	2.30	0.03*
CBD diameter in (mm) measured by PTC: Mean ± SD Median (range)	21.50± 6.80 20.50 (12.00- 37.00)		

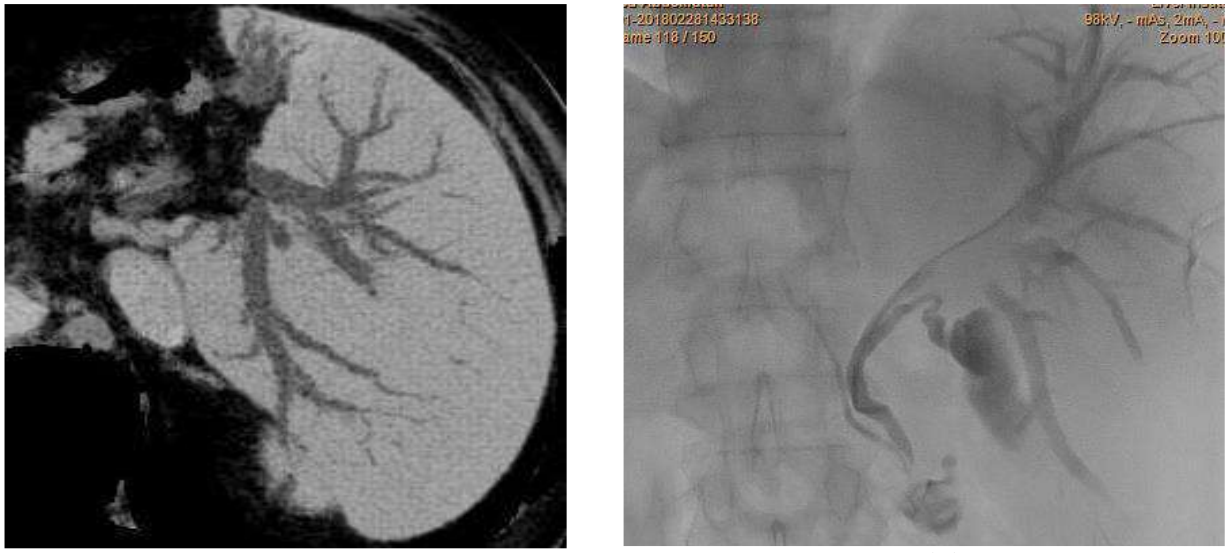
(A) (B)

Figure (1): CBD diameter measured in CT with MinIP images and in PTC images. A case of pancreatic carcinoma, the intrahepatic radicles as well as the CBD are dilated. (A) On CT cholangiography using thin-slab MinIP (coronal oblique 15 mm thickness slab) CBD diameter is less than that measured in PTC images. (B) PTC shows identical imaging findings as compared with CT cholangiographic image while CBD diameter is more than that measured in CT images.

During our study, we had a novel observation about that axial images are significantly better to reveal the obstructing biliary lesion if the cause of obstruction is intrahepatic in 71.4% of cases with intrahepatic obstruction (Figures 2 and 3), while coronal images are significantly better to reveal the obstructing biliary lesion if the cause of obstruction is extrahepatic in 95.5% of cases with extrahepatic obstruction (P value= 0.0001).

(A) (B)

Figure (2): Coronal CT images are better revealing extrahepatic obstructing biliary lesions. A case of pancreatic carcinoma, the intrahepatic radicles as well as the CBD are dilated. Coronal CT images shows identical imaging findings compared to PTC in cases of extrahepatic obstructing biliary lesions. (A) CT cholangiography using thin-slab MinIP (coronal 15 mm thickness slab). (B) PTC image of the same patient.



(A) (B)

Figure (3): Axial CT images are better revealing intrahepatic obstructing biliary lesions. A dextrocardia case with hilar cholangiocarcinoma, the intrahepatic radicles are dilated. Axial CT images shows identical imaging findings compared to PTC in cases of intrahepatic obstructing biliary lesions. (A) CT cholangiography using thin-slab MinIP (Axial 15 mm thickness slab). (B) PTC image of the same patient.

Our study revealed that there was good agreement between radicles grading using CT MinIP and PTC images. The agreement was 100%, 77.8%, 84.6%, and 84.6% between minimal, mild, moderate, and marked between moderate radicles detection in both CT MinIP and PTC images respectively.

Table (4): Comparison between radicles grading by CT with MinIP and PTC

Radicles grading by CT and Radicles grading by PTC Cross tabulation								
			Radicles grading by PTC				**Total**	
			Minimal	Mild	Moderate	Marked		
Radicles grading by CT	Minimal	Count	1	1	0	0	2	K= kappa coefficient = 0.756 P value = 0.0001
		% within Radicles grading by PTC	100.0%	11.1%	0.0%	0.0%	5.6%	
	Mild	Count	0	7	1	0	8	
		% within Radicles grading by PTC	0.0%	77.8%	7.7%	0.0%	22.2%	
	Moderate	Count	0	1	11	2	14	
		% within Radicles grading by PTC	0.0%	11.1%	84.6%	15.4%	38.9%	
	Marked	Count	0	0	1	11	12	
		% within Radicles grading by PTC	0.0%	0.0%	7.7%	84.6%	33.3%	

DISCUSSION

Computed tomography is used as the primary imaging modality for the hepatobiliary diseases as it provides important information about the extent of the disease [(3)]. CT scan gives us a proper diagnosis of a dilated bile duct and helps in evaluating the zone of transition, which indicates the site of obstruction. However, the cross-sectional orientation of the CT image appears to be defective in providing enough information of the biliary anatomy and its complex anatomic relationship [(9)].

Magnetic resonance cholangiopancreatography (MRCP) imaging is non-invasive technique beside that it has the advantage of detailed evaluation of the biliary tract [(10)]. However, MRCP requires respiratory or navigator gating so in patients with shallow respiratory rhythms, respiratory gated image acquisitions may fail to trigger correctly, prolonging scan times, or may result in motion artifact [(11)].

Currently, MinIP images can be displayed on post processing workstations of CT. MinIP technique demonstrates the minimum pixel value along a projection within the range of a slab thickness. This technique reveals the biliary tree more clearly [(12)].

To the best of our knowledge, a few articles reported that CT cholangiography using MinIP technique without cholangiographic contrast agent is as useful and simple imaging modality in evaluation of the biliary tract and the surrounding structures [(13)].

Depending on our study results. It was clear that the diagnostic value of CT cholangiography using 15-mm-thick is helpful and it directed us to the best

management plan. There was no significant difference between the cause of obstruction revealed by CT and PTC, which was considered as the gold standard. All lesions obstructing the biliary tract were correctly diagnosed and well correlated with the comparative studies. The lesions were well delineated, and the size of obstructing lesion was properly measured.

We found that axial images are significantly better to reveal the obstructing biliary lesion if the cause of obstruction is intrahepatic, while coronal images are significantly better to reveal the obstructing biliary lesion if the cause of obstruction is extrahepatic. We could explain that upon the axial orientation of the course of the intrahepatic bile duct, which makes axial images better for revealing the obstructing lesion and the dilated radicles proximal to the lesion. **Kim *et al.* [(9)]** support our point of view that in cases of intrahepatic bile duct stones, axial or axial oblique plane images are more useful than the coronal plane image.

Our study revealed that there was significant difference between CBD diameter measurements using CT MinIP images compared with that measured in PTC images in the setting of extrahepatic causes of biliary obstruction. This could be explained by the real time power of contrast gush during percutaneous trans hepatic cholangiography.

On the other hand, **Magsood *et al.* [(14)]** found that computed tomography scan may overestimate the diameter of the common bile duct compared to magnetic resonance imaging and ultrasound in the setting of acute gallstone pancreatitis.

In spite of the several advantages of CT cholangiography with MinIP technique, our study has some limitations. The greatest proportion of the patients in the study had malignant causes of biliary obstruction, which were confirmed by the typical imaging features of the comparative PTC study. This fact might influence our diagnostic accuracy. However, this limitation did not interfere with the determination of causes and level of obstructions.

CONCLUSIONS

Depending on our study results, we found that CT cholangiography with MinIP in patients with suspected obstructive biliary disease has several advantages for diagnosis and planning for management plan.

CT cholangiography with MinIP is a complete noninvasive technique that provides projectional images similar to that of PTC without administration of oral specific contrast agents, requires no medications, less operator dependent and no complications were encountered in adequately screened patients.

REFERENCES

1. **Ahmetoğlu A, Koşucu P, Kul S *et al.* (2009):** MDCT cholangiography with volume rendering for the assessment of patients with biliary obstruction. Am. J. Roentgenol., 183(5):1327-1332.
2. **Schulte S, Rohrmann A, Foster A (1999):** CT of the extrahepatic bile ducts: Am. J. Roentgenol., 154:79-85.
3. **Goldberg H (1999):** Helical cholangiography: complementary or substitute study for endoscopic retrograde cholangiography? Radiology, 192(3):615-6.
4. **Wong K, Paulson E, Nelson R (2011):** Breath-hold three-dimensional CT of the liver with multi-detector row helical CT. Radiology, 219(1):75-79.
5. **Mueller P, Harbin W, Ferrucci J (1991):** Fine-needle transhepatic cholangiography: reflections after 450 cases. AJR Am J Roentgenol., 136(1):85-90.
6. **Ott D , Gelfand D (1999):** Complications of gastrointestinal radiologic procedures: II. Complications related to biliary tract studies. Gastrointest Radiol., 6(1):47-56.
7. **Zandrino F, Benzi L, Ferretti M *et al.* (2012):** Multislice CT cholangiography without biliary contrast agent: Technique and initial clinical results in the assessment of patients with biliary obstruction. Eur Radiol., 12(5):1155-1161.
8. **Park S, Han J, Kim T *et al.* (2011):** Three-dimensional spiral CT cholangiography with minimum intensity projection in patients with suspected obstructive biliary disease: Comparison with percutaneous transhepatic cholangiography. Abdom Imaging, 26:281-286.
9. **Kim H, Shin H, Lee H *et al.* (2005):** Multislice CT cholangiography using thin-slab minimum intensity projection and multiplanar reformation in the evaluation of patients with suspected biliary obstruction: Preliminary experience. Clin Imaging, 29(1):46-54.
10. **Patel H, Shah A, Khandelwal S *et al.* (2012):** MR cholangiopancreatography at 3.0 T. Radiographics, 29(6):1689-706.
11. **Matsunaga K, Ogasawara G, Tsukano M *et al.* (2013):** Usefulness of the navigator-echo triggering technique for free-breathing three-dimensional magnetic resonance cholangiopancreatography. Magn Reson Imaging, 31(3):396-400.
12. **Raptopoulos V, Prassopoulos P, Chuttani R *et al.* (2005):** Multiplanar CT pancreatography and distal cholangiography with minimum intensity projections. Radiology, 207(2):317-24.
13. **El Badry A, Darwish A, El Fert A *et al.* (2016):** Evaluation of the role of multidetector computed tomography in biliary obstruction. Tanta Med J., 41(4):318-25.
14. **Magsood H, Goussous N, Parthasarathy M *et al.* (2018):** Does Computed Tomography (CT) overestimate common-bile-duct diameter in the evaluation of gallstone pancreatitis? J Pancreas, 17(2):196-200.