DOUBLE CONTRAST PERCUTANEOUS TRANSEPHATIC CHOLANGIOGRAPHIC CT IN PATIENTS WITH OBSTRUCTIVE JAUNDICE: AN INITIAL EXPERIENCE OF SEVEN CASES

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Purpose: To explore the technical feasibility of double contrast percutaneous transhepatic cholangiographic CT (DC-PTC-CT) in patients with bile duct obstruction.

Methods: Seven patients with bile duct obstructive diseases were studied, including 5 males and 3 females, ranging in age from 24 yrs to 74 yrs (average: 47.7 yrs). There were 5 cases of hilar cholangiocarcinoma, 1 case of sclerosing cholangitis, and 1 case of malignant transformation of adenoma at the distal end of the common bile duct. PTC was carried out initially, involving injection of 30ml 4.5-6.0mg I iohexol. After the bile duct system was filled, CT scan was performed, and further followed by enhanced CT with intravenous injection of 300mg/ml contrast agent. Arterial phase, venous phase, and parenchymal phase acquisitions were obtained. Raw CT images were viewed and multiplanar reconstruction (MPR), maximum intensity projection (MIP), and volume rendering (VR) image post-processing were performed.

Results: DC-PTC-CT was performed successfully and bile duct drainage was carried out. Mild lesion enhancement was demonstrated in three cases in arterial phase, while all seven cases demonstrated enhancement of various degrees in venous phase. The lesions lead to track-like, asymmetrical or irregular bile duct obstructive narrowing, and in one case intra-luminal filling defect. Reliable diagnosis was suggested in all cases. MPR, MIP and VR images were useful in demonstrating precise lesion location and for surgical planning.

Conclusion: In patients with bile duct obstruction, DC-PTC-CT is a feasible technique offering both important diagnostic value and drainage application.

Key-words: Bile ducts, stenosis or obstruction – Jaundice.
reported that the main advantage of CT cholangiography to MRI and MRC was the superior mapping of the biliary tree (20), in other respects the two modalities were considered equivalent for the therapeutic planning (21).

Gaining access to the biliary tract by minimal invasive image-guided techniques is one of the most used procedures for interventional radiologists to manage biliary bile duct obstructive diseases. For patients with obstructive jaundice requiring bile duct decompression and drainage, we explored the diagnostic value of double contrast CT with percutaneous transhepatic cholangiography together with intravenous contrast agent injection. We termed this technique double contrast percutaneous transhepatic cholangiographic CT (DC-PTC-CT). Our initial clinical experience with DC-PTC-CT is reported in this paper.

Materials and methods

DC-PTC-CT was carried out in seven cases, composed of five males and two females, aged 24-74 yrs (mean: 47.7). These seven cases included 5 cases of hilar cholangiocarcinoma, one case of sclerosing cholangitis, and one case of malignant transformation of adenoma at the distal end of the bile duct. The patients had highly elevated serum bilirubin. The detailed information of these 7 cases is listed in table I. Before procedures, prothrombin time and platelet count were checked to be in competent range. All patients received broad-spectrum antibiotics. PTC was performed with the guidance of an X-ray DSA unit. The puncture site was right mid-axillary 8th-9th rib space. Under local anaesthesia, a small cut was made to the skin. Then the puncture needle was introduced horizontally toward vertebral 11 and 12, and stopped when the needle tip reached a distance of 2 cm to the right border of vertebral. Diluted contrast material was gently infiltrated while retracting the needle until a bile duct was opacified. A micro-guidewire was introduced via the puncture needle to one of the major intra-hepatic biliary duct or the common biliary duct, and a catheter was introduced for contrast agent injection and the micro-guidewire was removed. When the bile duct system was filled with contrast agent satisfactorily under DSA fluoroscopy, the catheter position was fixed, and the patient underwent CT examinations. The contrast agent for PTC was iohexol (‘Omnipaque 300’, GE) diluted with normal saline to 4.5-6.0 mlg/ml (density: 200 Hu) in six cases. In one initial case (case 1), a higher concentration (30 mlg/ml) was used resulting in beam hardening CT artefact.

After the filling of contrast agent in the bile duct system, CT was performed before and after intravenous contrast agent administration. For intravenously contrast enhanced CT, iohexol (300 mlg/ml) of 1.5 ml/kg body weight was used. The total contrast volume was 70-120 ml, injected at the rate of 3-5 ml/sec. The completion of contrast agent injection was followed by a flush with 30-50 ml normal saline at the same rate. Bolus tracking technique was used for arterial phase acquisition, a region-of-interest (ROI) was placed on the aorta just above the diaphragm. Acquisition was started 6 sec later than the threshold reached 120 Hu. Venous phase was performed 15 sec after the arterial phase. Delayed phase acquisition was obtained 3-5 min later. CT was performed with a Toshiba Aquilion 16 slices scanner, using a standard abdominal protocol with FOV of 40 cm*40 cm, collimation of 1-mm, and a pitch of 0.9.

CT image post-processing was performed with Vitrea 2 Imaging Software (Vital Images, Minneapolis,

<p>| Table I. — General information of the seven patients who underwent double contrast percutaneous transhepatic cholangiographic CT. |
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<table>
<thead>
<tr>
<th>sex</th>
<th>age</th>
<th>Symptoms</th>
<th>Serum total bilirubin*</th>
<th>Final diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>F</td>
<td>33</td>
<td>Cutaneous and sclera jaundice, yellow urine for two weeks</td>
<td>176.5 µmol/L</td>
</tr>
<tr>
<td>Case 2</td>
<td>M</td>
<td>74</td>
<td>Cutaneous and sclera jaundice, yellow urine for 10 days</td>
<td>52.4 µmol/L</td>
</tr>
<tr>
<td>Case 3</td>
<td>M</td>
<td>43</td>
<td>Recurrent upper abdominal discomfort with sclera jaundice and yellow urine for 1 month</td>
<td>21.2 µmol/L</td>
</tr>
<tr>
<td>Case 4</td>
<td>F</td>
<td>48</td>
<td>Recurrent upper abdominal pain for 1 month Progressive jaundice 9 days.</td>
<td>52.4 µmol/L</td>
</tr>
<tr>
<td>Case 5</td>
<td>M</td>
<td>51</td>
<td>Progressive jaundice for &gt; one month</td>
<td>315.7 µmol/L</td>
</tr>
<tr>
<td>Case 6</td>
<td>M</td>
<td>61</td>
<td>Recurrent fever, with progressive sclera jaundice and yellow urine for &gt; one month</td>
<td>100.9 µmol/L</td>
</tr>
<tr>
<td>Case 7</td>
<td>M</td>
<td>24</td>
<td>Two years post colon cancer surgery. Progressive jaundice for two weeks</td>
<td>18.2 µmol/L</td>
</tr>
</tbody>
</table>

* reference value in authors’ institution < 9 µmol/L.
The reconstructed images had a slice thickness of 1 mm. Maximum intensity projection (MIP), multi-planar reconstruction (MPR), and volume rendering (VR) images were reviewed in additional to source images.

All the seven cases had percutaneous transhepatic choangiographic drainage treatment. For this, a standard guidewire was introduced through the cholangiographic catheter. The cholangiographic catheter was removed and a biliary drainage catheter drainage catheter posterior hepatic duct, and too high concentration of contrast agent was used, the choangiographic results were not optimial. However, the lesion location and lesion diagnosis were still being able to be made. The remaining six cases had satisfactory double contrast PTC-CT. PTC-CT demonstrated dilated intra-hepatic bile duct for all seven cases, the lesion cannot be clearly shown (Fig. 1A, 2A). With DC-PTC-CT, the lesion locations can be demonstrated precisely i.e. 5 cases in the bile duct at hepatic hilum level.

Results

In the first case of our series, as PTC catheter was introduced too deeply to superior segment of right
1 case involved both intra- and extrahepatic bile duct (case 3), and 1 case at the distal end of the common bile duct (case 6). In 3 cases, arterial phase contrast CT showed lesion mild enhancement (Fig. 1B, Fig. 2B). In the other 4 cases, there was no apparent enhancement in arterial phase. Venous phase contrast CT demonstrated enhancement of lesion with various degrees for all the seven
cases (Fig. 1C, 2C). DC-PTC-CT, demonstrated track-like bile duct wall thickening with lumen narrowing in 3 cases (case 1, 5, 7), epiphenal or irregular bile duct wall thickening with lumen narrowing in 2 cases (case 2, 4), symmetrical bile duct wall thickening with lumen narrowing in 1 case (case 3), and intraluminal filling defect in one case (case 6). There was no apparent enhancement for all the 7 cases in parenchymal phase. With three cases of hilar cholangiocarcinoma, tumour infiltration of the surrounding liver was observed.

In all cases, MPR and MIP images helped demonstrate the lesion and precise locations of these lesions. While VR was able to demonstrate the location of the lesion, it could not demonstrate the bile duct wall and extra-mural lesion, nor the lesion within the lumen. On the other hand, although the bile duct system and remnant anatomy could be easily deduced on the transverse source and MPR and MIP images, they were depicted in its entirety most clearly on the VR images (Fig. 1D, 2D).

In all seven cases, clinical symptoms improved with the drainage, and in all cases, correct diagnosis was suggested and later confirmed with later surgery or follow-up. No case had adverse reactions during the DC-PTC-CT procedure.

Discussion

Bile duct system is small in size with high tortuosity in its course. Although there are a number of techniques to demonstrate the bile duct, most are good at demonstrating the location of obstruction and the changes within the lumen while cannot demonstrate the bile duct wall itself well. Some techniques suffer from sub-optimal spatial resolution. Ultrasound can demonstrate dilatation of the bile duct system, but it is can be of limited value in lesion diagnosis and differential diagnosis, and often is inconclusive for hilar lesions. Of the 7 cases in this study, all underwent ultrasound test initially. However, none of the cases ultrasound was able to diagnose the nature of lesion. X-ray PTC and ERCP demonstrate the bile duct system proximal or distal to the obstruction and intra-luminal changes, however, they cannot demonstrate the changes in the wall and extra- or intraluminal changes. In some cases due to sub-optimal spatial resolution and respiration artifacts, MRI/MRC may not demonstrate periductal-infiltrating lesions well.

With DC-PTC-CT, high resolution CT image can demonstrate the bile duct wall and extra-lumenal changes including the changes in the surrounding liver parenchyma. Intravenously enhanced CT can demonstrate the blood supply status of the lesion. After filling of contrast agent in the bile duct, MPR and MIP can demonstrate symmetrical or asymmetrical track-like, tapering narrowing, or abrupt narrowing of the bile duct wall and lumen. When lesion infiltrate extra-murally or infiltrate surrounding liver parenchyma, extra-mural lesion enhancement can be observed.

DC-PTC-CT can be helpful in lesion differential diagnosis. There are many causes with bile duct obstruction, with the common ones being stone, cholangiocarcinoma, and cholangitis. When stones contain sufficient calcium, CT is also able to make the diagnosis. However, CT has difficulties in demonstrating negative biliary stone. Concentrated biliary fluid may also demonstrate stone-like appearance. With stones of mixed components and irregular shapes, particularly with surrounding secondary inflammation, it is difficult for MRC or CT to make correct diagnosis. Combined with 3D image post-processing techniques, DC-PTC-CT is able to provide information of lesion's blood supply, growth pattern and lesion extent, and is able to make a more accurate differential diagnosis. Lesion enhancement excludes bile duct stone. In case 6 in this series, PCT CT demonstrated filling defect within bile duct lumen, and diagnosis was not able to be made. Double contrast CT indicated there was lesion enhancement. A diagnosis of adenoma or adenocarcinoma was reached.

Through the experience of this series, we found that the success and quality of DC-PTC-CT depend on successful catheter induction, proper concentration of contrast agent, and skilled image reconstruction. The concentration of contrast agent for PTC is important for quality demonstration of bile duct system in CT. Too high concentration can lead to artefact, while too low concentration does not fulfil the purpose of contrast. The experience gained from this series is 4.5-6.0 ml/mi solution is suitable for biliary contrast.

DC-PTC-CT also offers the drainage treatment for jaundice. Patients with obstructive jaundice tend to have various degrees of liver function compromise. In addition to fulfill the purpose of diagnosis, particularly for the patients with selective surgery plan, drainage treatment for jaundice can help improve liver function, and lead to lower mobility or mortality (22, 23). In all our cases, clinical symptom improved with the drainage after DC-PTC-CT procedure.

There are a few limitations with DC-PTC-CT technique. PTC-CT is an invasive technique also involving radiation. In our institution, PTC under the guidance of DSA and CT scans were performed in the separate units of radiology department. To move the patient from DSA unit and CT unit is not convenient. This difficulty can be overcome with an interventional CT unit where a CT scanner and a radiofluoroscopic system are combined together.

In conclusion, the technical feasibility and clinical application of DC-PTC-CT in bile duct obstruction patients was explored in this study. DC-PTC-CT can provide mapping of the biliary tree and a reliable diagnosis. Particularly, DC-PTC-CT is suitable for patients with severe jaundice and bile duct drainage is part of the therapeutic plan. In terms of diagnostic performance, further head-to-head comparison with other techniques such as MRI/MRC remained to be carried out.

Acknowledgement

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References