Percutaneous transhepatic portal vein embolization with stenting for perihilar cholangiocarcinoma with severe portal vein stenosis; comparison with usual portal vein embolization

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Aims and objectives

- Most cases of perihilar cholangiocarcinoma require an extended hepatectomy for complete resection [1, 2]. Therefore, preoperative percutaneous transhepatic portal vein embolization (PTPVE) is usually performed to minimize postoperative liver dysfunction before surgery [3].

- Advanced perihilar cholangiocarcinoma often invades into the main portal vein (PV), resulting in main PV stenosis and a decrease in hepatopetal portal flow. In this situation, sufficient hypertrophy of the future remnant liver (FRL) cannot be expected after PTPVE. In such cases, we have attempted to improve portal flow via stent placement at the site of main PV stenosis combined with simultaneous PV embolization.

- The report describes four consecutive cases in which preoperative PTPVE with PV stenting was used for the management of advanced perihilar cholangiocarcinoma with severe PV stenosis secondary to tumor invasion. We evaluated the clinical utility of this procedure when compared with the usual PTPVE procedure in patients without PV stenosis.
Methods and materials

1. Patients

- Our institutional review board approved the retrospective collection of data and analysis for this study, and the need for informed consent from the patients was waived.
- The characteristics of the PTPVE with stenting group were as follows:

1. This group included four consecutive patients with an advanced perihilar cholangiocarcinoma with severe PV stenosis (>70% stenosis) secondary to tumor invasion between July 2007 and April 2013. The patients were 1 man and 3 women (mean age, 52 years; age range, 25-73 years). One patient (case 1) was recurrence of extrahepatic bile duct carcinoma.

2. These patients underwent left hepatic trisegmentectomy and caudate lobectomy combined with resection and reconstruction of the main PV and the right hepatic artery. Two patients (case 1, 2) also underwent combined pancreatoduodenectomy at the same time. The PV stent was removed together with the invaded PV at the time of surgery. There were no patients with chronic liver disease.

3. Their volumetric computed tomography (CT) examination was performed 9 to 24 days (mean, 18 days) after PTPVE.

- Control group of usual PTPVE was as follows:

1. This group included 20 consecutive patients who had undergone PTPVE for advanced perihilar cholangiocarcinoma without PV stenosis between November 2009 and April 2011, and were scheduled to undergo left hepatic trisegmentectomy and caudate lobectomy. The patients were 11 men and 9 women (mean age, 67 years; age range, 46-80 years). Sex and age was not matched to the PTPVE with PV stenting group.

2. The patients with (I) chronic liver disease, (II) severe cholangitis after PTPVE, and/or (III) volumetric CT within 10 days after PTPVE, were excluded.

2. PTPVE and PV Stenting Procedure

PTPVE procedure with and without PV stenting was performed as follows.

- The portal venous system was accessed by an ultrasound-guided percutaneous transhepatic approach (ipsilateral approach) [4]. A 5-Fr (for the usual PTPVE group) or 6-Fr (for the stenting group) vascular sheath was inserted into the main PV. To identify individual branches and anatomic variations, portography was performed (Figure 1, 2). A catheter was inserted into the left and the right anterior PV respectively, subsequently embolization
was performed; absolute ethanol was first injected to occlude the smaller distal portal branches, then 0.035-inch coils were used to occlude the left PV and anterior branches. Embolization was performed until stasis or near-stasis of the portal flow was achieved. The access tract was finally embolized with coils.

- In the stenting group, stent (self-expandable type; n=3, balloon-expandable type; n=1) was deployed from the main PV to the right PV after the left PV embolization. The portal branch of the caudate lobe was also embolized after PV stenting in case 1.

3. Assessments

- Using CT image data, FRL volume and embolized liver (EL) volume were calculated before and after PTPVE. The difference in FRL volume before and after embolization in relation to the FRL volume before embolization (%FRL volume increase), and the difference in EL volume before and after embolization in relation to the EL volume before embolization (%EL atrophy) were calculated according to the following formula described by Lienden et al. [5]:

\[
\text{%FRL volume increase} = \frac{[\text{%FRL (post-PTPVE)} - \text{%FRL (pre-PTPVE)}]}{\text{%FRL (pre-PTPVE)}} \times 100\%
\]

\[
\text{%EL atrophy} = \frac{[\text{%EL (post-PTPVE)} - \text{%EL (pre-PTPVE)}]}{\text{%EL (pre-PTPVE)}} \times 100\%
\]

- In this study, the caudate lobe’s volume was included in the embolized liver’s volume even when the portal branch of the caudate lobe was not embolized.
- The diameter of the PV stenosis was calculated using CT images before and after PTPVE. In addition, PV stenosis rate was judged by portography.
- The increase in %FRL volume and the %EL atrophy of the PTPVE with PV stenting group was compared with those of the usual PTPVE group. Technical and clinical success in the stenting group was also assessed. Technical success was defined as: 1) successful dilation of the main PV stenosis; 2) improvement in portal flow secondary to stent placement; and 3) successful completion of PV embolization without complication. Clinical success was defined as a %FRL volume increase that was equal to or greater than the minimum level of %FRL volume increase in the control group.
- Plasma clearance rate of indocyanine green (ICGK) was assessed before and after PTPVE in all cases. ICGK of the FRL (ICGK-F) was calculated according to the formula: ICGK × proportion of the FRL [6].
Case 1

Fig. 1: Case 1: (a) Contrast-enhanced CT shows the recurrence of extrahepatic bile duct cancer (arrow) invading into the porta hepatis, main PV and common hepatic artery. There is a metallic stent in the common bile duct (arrowhead). (b) Portography shows PV stenosis and reflux in the left gastric vein. (c) Portography after stent placement and left PV embolization shows resolution of PV stenosis and decompression of the associated hepatopetal collateral vein. PV embolization of the caudate lobe and the right anterior segment was subsequently performed.

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**Case 4**

**Fig. 2:** Case 4: (a) Contrast-enhanced CT shows perihilar cholangiocarcinoma (arrow) invading into the main PV and right hepatic artery (not shown). There is severe PV stenosis. (b) Portography shows the main PV stenosis and occlusion of the orifice of the left PV. Cavernous transformation and reflux in the left gastric vein are also recognized. (c) Portography after PV stent placement and embolization of the right anterior segment shows resolution of the PV stenosis, decompression of the portal collateral vessels, and an increase in portal flow to the right posterior segment.

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Results

- The results are summarized in Table 1 and 2. In all patients undergoing PTPVE with stenting, the stent was successfully deployed, and portal flow improved visually on portography and ultrasound. PTPVE was successfully performed and there were no complications associated with the procedure. Therefore, technical success was achieved in all four patients (100%).
- The %FRL volume increase was 18-60% (mean, 33%) in the stenting group and 12-51% (mean, 21%) in the usual PTPVE group. All four patients who underwent PTPVE with stenting exceeded an increase in %FRL volume of 12%, which was the minimum increase in %FRL volume seen in the usual PTPVE group. Therefore, clinical success was also achieved in all four patients (100%). In addition, the ICGK-F values after PTPVE were more than 0.05 in all four cases.
- Collateral portal flow of case 1, 3 and 4 were disappeared or decreased after stent placement.
- In the stenting group, the days from PTPVE to operation were 13 to 50 days (mean, 30 days). All patients underwent planned hepatic resection and achieved R0 resection. Three of the patients did not develop postoperative liver dysfunction and were discharged; however, one patient (case 4) died of postoperative liver dysfunction at 47 days after surgery.
Table 1 Results in the stenting group, No.1

<table>
<thead>
<tr>
<th>Case</th>
<th>Age/Sex</th>
<th>Stent</th>
<th>Stent diameter-length</th>
<th>Pre-PV diameter (stenosis rate)</th>
<th>Post-PV diameter</th>
<th>Complication of PTPVE</th>
<th>Technical success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25/F</td>
<td>SS</td>
<td>12-40mm</td>
<td>5.3mm (75%)</td>
<td>12.9mm</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>2</td>
<td>73/F</td>
<td>SS</td>
<td>12-40mm</td>
<td>4.0mm (70%)</td>
<td>12.5mm</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>60/F</td>
<td>BS</td>
<td>10-37mm</td>
<td>2.3mm (75%)</td>
<td>7.4mm</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>51/M</td>
<td>SS</td>
<td>12-42mm</td>
<td>2.4mm (80%)</td>
<td>12.6mm</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Abbreviations
SS, self-expandable stent; BS, balloon-expandable stent
Pre, pre PTPVE with PV stenting; Post, post PTPVE with PV stenting
PV, portal vein; PTPVE, percutaneous transhepatic portal vein embolization

Table 1

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Table 2 Results in the stenting group, No.2

<table>
<thead>
<tr>
<th>Case</th>
<th>Volumetric CT from PTPVE</th>
<th>Pre-FRL volume</th>
<th>Post-FRL volume</th>
<th>%FRL increase</th>
<th>%EL atrophy</th>
<th>Pre ICGK-F</th>
<th>Post ICGK-F</th>
<th>Clinical success</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 days</td>
<td>594ml</td>
<td>662ml</td>
<td>18%</td>
<td>-15%</td>
<td>0.094</td>
<td>0.106</td>
<td>Yes</td>
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<tr>
<td>2</td>
<td>9 days</td>
<td>250ml</td>
<td>308ml</td>
<td>25%</td>
<td>-9%</td>
<td>0.041</td>
<td>0.052</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>22 days</td>
<td>338ml</td>
<td>348ml</td>
<td>30%</td>
<td>-14%</td>
<td>0.045</td>
<td>0.064</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>24 days</td>
<td>288ml</td>
<td>485ml</td>
<td>60%</td>
<td>-13%</td>
<td>0.032</td>
<td>0.064</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Abbreviations
CT, computed tomography; PTPVE, percutaneous transhepatic portal vein embolization
Pre, pre PTPVE with PV stenting; Post, post PTPVE with PV stenting; FRL, future remnant liver
EL, embolized liver; ICGK-F, indocyanine green clearance rate for future remnant liver

Table 2

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Conclusion

- In the stenting group, the PV stenosis improved after PV stenting, and the %FRL volume increase after PTPVE was comparable to that seen in patients undergoing the usual PTPVE procedure without PV stenting. In addition, ICGK-F values after PTPVE were more than 0.05 in all cases. Thus, they achieved extended hepatectomy for complete resection (R0).

- In conclusion, preoperative PTPVE with portal vein stenting for patients with advanced perihilar cholangiocarcinoma and PV severe stenosis secondary to tumor invasion appears to be feasible and may broaden the indications for surgical resection.
References