Preoperative Portal Vein Embolization in Hepatobiliary Tract Malignancy: An Experience at King Chulalongkorn Memorial Hospital

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Background: *Major hepatic resections are increasingly performed for both primary and secondary liver cancers nowadays. However, morbidity from these operations is still high. One of the dreadful complications, sometimes lead to fatality, is postoperative liver failure. There are many factors which are associated with this complication such as chronic liver disease, low residual liver volume after resection. Portal vein embolization (PVE) is the procedure which increases the liver volume of the non-embolized lobe. Now, PVE has gained acceptance in many centers to overcome or reduce this complication. This report described the authors' experiences of PVE since 2001 at King Chulalongkorn Memorial Hospital.*
Material and Method: *The records of 10 patients who had PVE were reviewed. CT volumetry of the liver was done before and after procedure. The authors calculated future liver remnant from CT volumetry and compared this volume to standard liver volume. The postoperative complications and hospital courses of these patients were also recorded.*
Results: *Mean growth of future liver remnant (FLR) ratio after PVE was 13.7 $\pm$ 6.2% (median 13, range 4-25). There was no major complication after PVE. Six patients underwent liver resection and there was no major complication or mortality. No one had persistent hyperbilirubinemia 2 weeks after operation.*
Conclusion: *The PVE is the useful and safe optional procedure to increase future liver remnant volume. It not only reduces the postoperative liver failure but increases the chance for curative resection.*

Keywords: *Portal vein embolization, Hepatectomy*

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Better perioperative care and improved resection techniques have led to the increasing use of major hepatic resection in the treatment of primary and secondary liver cancer. The mortality rate after major hepatic resection in specialized centers is low but morbidity rate remains high.One of the potentially fatal complications is postoperative liver failure, its occurrence varying from 0%-32% in various centers[1-5]. There are many ways to circumvent this complication such as good preoperative assessment of functional liver reserve by prognostic scoring or by ICG clearance test, prevention of poor perfusion of the liver during operation and ensuring adequate liver volume after resection. Portal vein embolization (PVE), first reported by Makuuchi et al, is the procedure that increases the volume of non-embolized lobe by the hypertrophy-atrophy phenomenon; an atrophy of the embolized lobe with a compensatory hypertrophy of the lobe to be preserved. There are many reports on the efficacy of PVE which was well tolerated with low complication and reduced incidence of postoperative liver failure[6-10]. The authors describe experiences of portal vein embolization that has been done, the authors believe, for the first case series in Thailand at King Chulalongkorn Memorial Hospital.

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Material and Method

From January 2001, 10 patients with cholangiocarcinoma or hepatic metastasis had portal vein embolization (PVE) before operation. The reason for performing PVE was small future liver remnant volume estimated by CT volumetry. In obstructive jaundice patients, PVE was performed after serum bilirubin was less than 5 mg% following percutaneous transhepatic biliary drainage (PTBD). PVE of the resected lobe (right or left portal vein) was performed by percutaneous contralateral portal vein approach under ultrasonographic guide using fibrin glue as embolized agent. CT scan of the liver was scheduled at 2 weeks after the procedure in every case. CT volumetry calculating future liver remnant volume was recorded before and after PVE. Hepatic resection was planned in all cases 3-6 weeks after the PVE. The patients' clinical outcomes after PVE and surgery, future liver remnant volumes and ratios of future liver remnant volume to standard liver volume were recorded.

Statistics

Data are expressed as mean $\pm$ standard deviation unless stated otherwise.

Definitions

Abnormal liver status means serum bilirubin post PTBD > 5 mg%

Postoperative liver failure means serum bilirumin after surgery > 5 mg%

Resectability rate means ratio of post PVE resectable cases to total unresectable cases due to low remnant volume x 100

Future liver remnant volume (FLR) means estimated liver volume left in the patients after resection.

Small future liver remnant volume means FLR accounted for less than 25% to 35%[10,13,15-17] of the whole liver in patients with normal liver parenchyma and less than 40%[7,10] in patients with chronic liver disease or damaged liver.

Standard liver volume (SLV) is calculated using Urata's formula[11] based on the patient's body surface area as follows:

$$SLV\ (cm^3) = 706.2 \times BSA\ (m^2) + 2.4$$

CT scan volumetric measurements[12,13]

CT scans of the liver were obtained using a Siemens model. Serial transverse scans at 0.8 cm intervals from the dome of liver to the most inferior part of the organ with enhancement by intravenous bolus injection of contrast were obtained. Each slice of the liver was traced with a cursor and the corresponding area was calculated by computer. The middle hepatic vein and gall bladder were used as landmarks to define the borders between the right and left livers. The future liver remnant volume was calculated by multiplying the area of non-PVE segments by the interval thickness. There were 2 patients who had CT scan from another hospital. In these 2 cases, the authors drew the copy paper from CT films and scanned into the computer by using the photoshop program version 6.0 with the histogram function to measure the area of liver in the pixels and then converted to squared centimeter. After multiplying all drawing areas by interval thickness, future liver remnant volumes were the results.

Results

PVE were performed in 10 patients, 7 males and 3 females, all of whom were previously categorized as unresectable cases due to small future liver remnant volume after planned resection. Five patients had cholangiocarcinoma, 4 had colorectal liver metastasis and one had multiple metastatic GIST nodules. Some patients had underlying systemic diseases which interfered with liver regeneration, 3 patients with diabetes mellitus and 3 patients with previous chemotherapy.

Clinical course after PVE and complications

PVE was performed successfully in all 10 patients, 9 right and 1 left portal vein (Table 1). There were no immediate complications associated with the procedure.

The bilirubin level after PVE was transiently elevated but the level returned to normal by the second week except one case in whom the elevation of serum bilirubin level was due to intersegmental obstruction of bile duct from cholangiocarcinoma which needed further PTBD intervention. The interval from PTBD to PVE procedure depended on the time taken for serum bilirubin level to fall to the required 5 mg% or less. Median time after PVE to surgery was 3 weeks (range 2-6 weeks).

Liver growth after PVE

The mean ratio of future liver remnant in pre PVE and post PVE stage to standard liver volume was 33.4% and 49.1% respectively. Mean growth of FLR ratio after PVE was 13.7 $\pm$ 6.2% (median 13%, range 4%-25%) as shown in Table 2 and Fig. 1. One patient who had longstanding obstructive jaundice after PVE

Table 1. PVE in cholangiocarcinoma and metastatic tumors

Patient No.	Age (yr) and Sex	Tumor	PTBD	DM	Chemo	Interval from PTBD to PVE	Embolized portal V.	Bilirubin	
								Before PVE	After PVE 2 wk
1	M	CCA	No	Yes	No	-	Rt.	0.7	0.8
2	M	CRLM	No	Yes	Yes	-	Rt.	0.8	0.8
3	F	CRLM	No	No	Yes	-	Rt.	0.8	0.8
4	M	CCA	Yes	No	No	10 weeks	Rt.	4.8	10.3**
5	M	CCA	Yes	No	No	6 weeks	Rt.	3.7	2.5
6	F	CRLM	No	No	No	-	Rt.	0.5	0.5
7	M	GIST	No	No	No	-	Rt.	0.6	0.7
8	M	CCA	Yes	No	No	3 weeks	Rt.	4.1	3.9
9	F	CRLM	No	No	Yes	-	Lt.	0.7	0.8
10	M	CCA	Yes	Yes	No	4 weeks	Rt.	0.8	1.7

CCA = cholangiocarcinoma, CRLM = colorectal liver metastasis, GIST = gastrointestinal stromal tumor
** = patient developed intersegmental obstruction

Table 2. PVE: resection, volume change and post op complications

Patient No.	Resection	Time from PVE to operation	FLR/SLV (%)		BSA	Increase ratio	Post operative complications
			Pre-PVE	Post-PVE			
1	Extended Rt.hepatectomy	6 weeks	15%	32%	1.83	17%	Rt.pleural effusion
2	Rt.hepataectomy	2 weeks	39%	64%	1.90	25%	None
3	Rt. hepatectomy	3 weeks	19%	30%	1.44	11%	None
4	-	-	36%	40%	1.72	4%	-
5	Rt.hepatectomy	2 weeks	33%	44%	1.53	11%	None
6	Rt.hepatectomy	6 weeks	24%	39%	1.69	15%	None
7	-	4 weeks	17%	32%	1.69	15%	-
8	Extended Rt. hepatectomy	3 weeks	20%	41%	1.59	21%	None
9	-	-	26%	34%	1.49	8%	-
10	-	3 weeks	28%	38%	1.72	10%	-

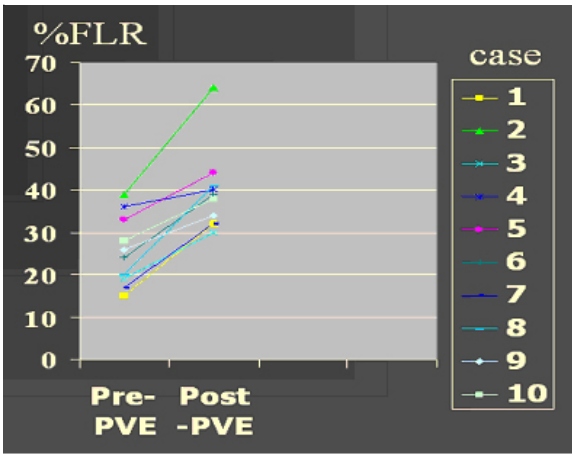

Fig. 1 Future liver remnant ratio before and after PVE

had gained 4% increase of FLR post PVE and was not a surgical candidate because of intersegmental obstruction from chalangiocarcinoma.

Clinical outcomes after surgery

After PVE it was deemed adviseable to resect only 6 out of 10 cases. There were no major postoperative complications especially postoperative liver failure except one minor complication (right pleural effusion). All resected specimens had free margins. There was no persistent hyperbilirubinemia after 2 weeks postoperatively and no 30-day mortality.

Discussion

Portal vein embolization (PVE), first reported by Makuuchi et al, is the procedure that increases the volume of non-embolized by the hypertrophy atrophy

phenomenon. Since then, there have been many reports which describe the application and benefit of PVE[6-10]. However, from the authors search from internet and domestic journal, no case series of PVE in Thailand were discovered. So, the present report, the authors believe, might be the first case series in Thailand.

The present study focused on the change in future liver remnant volume after PVE that was considered to be one of the important factors in postoperative liver failure after major hepatic resection. There are many studies showing that PVE improves the chance for resection with low procedure related morbidity[10]. The present study, despite the small number of cases, showed that PVE was safe in all patients who had bilirubin below 5 mg%. In 4 patients, resection was not performed after PVE because of advanced cancer.

In the present study, although most patients (8 in 10 patients) were considered to have damaged liver (i.e., chemotherapy, major steatosis or cholestasis) and 3 patients had diabetes which could limit liver regeneration of the non embolized lobe[9,10,14], the mean increase in future liver remnant volume ratio (FLR/TELV) 2 to 6 weeks after PVE was 13.7 $\pm$ 6.2% (median 13%, range 4%-25%) which was in accordance with other series that reported a mean increase of 12 $\pm$ 5% 2 to 9 weeks after PVE[10].

After PVE, six patients (60%) underwent major hepatic resection with no mortality and postoperative liver failure. There was only one patient who developed minor complication. Four patients who did not undergo hepatic resection had peritoneal seeding in 2 cases (CCA, GIST), intersegmental duct obstruction (CCA) and new lesion developed in the right lobe (CRLM of left lobe of the liver) though imaging of all 4 patients before PVE did not demonstrate any tumor progression which contraindicated to surgery. The present result supports the role of PVE in the planning of major hepatic resection in patients with damaged liver and small liver remnant volume. The exact quantification of the minimal functional hepatic volume required to avoid postoperative complication is still unknown. In several studies including the present study, PVE was performed when FLR accounted for less than 25% to 35%[10,13,15-17] of the whole liver in patients with normal liver parenchyma and less than 40%[7,10] in patients with chronic liver disease or damaged liver. This preliminary report suggests that PVE has a beneficial role in hepatic surgery in the new era of safe major hepatic resection.

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การทำเอ็มโบไลเซชั่นของเส้นเลือดดำพอร์ตัลในมะเร็งของตับและระบบทางเดินน้ำดี: ประสบการณ์โรงพยาบาลจุฬาลงกรณ์

บุญชู ศิริจินดากุล, บัณฑูร นนทสูติ, พีระ เทียนไพฑูรย์, สุภนิติ์ นิวาตวงศ์, อรรควัชร์ จันทร์ฉาย

***ที่มา**: การผ่าตัดตับเป็นหัตถการที่ทำมากขึ้นในปัจจุบัน สำหรับการรักษามะเร็งตับปฐมภูมิและทุติยภูมิ อย่างไรก็ดี ภาวะแทรกซ้อนจากการผ่าตัดยังอยู่ในอัตราที่ค่อนข้างสูง ภาวะตับวายภายหลังการผ่าตัดเป็นหนึ่งในภาวะแทรกซ้อนที่เกิดจากการผ่าตัด ซึ่งบางครั้งอาจนำมาสู่อัตราตายได้ ปริมาณของเนื้อตับที่เหลือภายหลังการผ่าตัดเป็นปัจจัยหนึ่งที่มีผลต่อการเกิดภาวะตับวายภายหลังการผ่าตัด ถ้าปริมาณตับที่เหลือมีน้อย การเกิดภาวะดังกล่าวจะยิ่งสูงขึ้น มาตรการหนึ่งที่ช่วยลดภาวะดังกล่าวนี้ คือ การเพิ่มปริมาณเนื้อตับที่เหลือโดยการทำเอ็มโบไลเซชั่น ของเส้นเลือดดำพอร์ตัลข้างที่จะตัด ในการศึกษานี้ได้รายงานเบื้องต้นถึงผลของการเอ็มโบไลเซชั่นของเส้นเลือดดำพอร์ตัลที่โรงพยาบาลจุฬาลงกรณ์*

***วัสดุและวิธีการ**: ศึกษาทบทวนผู้ป่วยที่ได้รับการทำเอ็มโบไลเซชั่นของเส้นเลือดดำพอร์ตัล จำนวน 10 รายตั้งแต่ปี พ.ศ. 2001 โดยเก็บข้อมูลของปริมาณเนื้อตับที่เหลือที่ได้จากการคำนวณจากภาพเอกซเรย์คอมพิวเตอร์ของตับก่อนและหลังทำเอ็มโบไลเซชั่น เปรียบเทียบปริมาณเนื้อตับที่เหลือกับปริมาณเนื้อตับมาตรฐานรวมถึง ภาวะแทรกซ้อนจากการทำ เอ็มโบไลเซชั่นและผลของการผ่าตัด*

***ผลการศึกษา**: อัตราการเพิ่มปริมาณของเนื้อตับที่เหลือโดยเฉลี่ยภายหลังการทำเอ็มโบไลเซชั่นของเส้นเลือดดำพอร์ตัล คือ 13.7 $\pm$ 6.2% (4-25%) ไม่มีภาวะแทรกซ้อนเกิดขึ้นจากการทำเอ็มโบไลเซชั่น มีผู้ป่วย 6 คน จากจำนวน 10 คน สามารถผ่าตัดตัดตับได้และไม่มีภาวะแทรกซ้อนที่สำคัญที่เกิดขึ้นจากผ่าตัดโดยเฉพาะอย่างยิ่งภาวะตับวายภายหลังการผ่าตัด*

***สรุป**: การทำเอ็มโบไลเซชั่นของเส้นเลือดดำพอร์ตัล เป็นหัตถการที่มีประโยชน์และปลอดภัยในการเพิ่มปริมาณเนื้อตับที่เหลือ ซึ่งนอกจากจะช่วยลดภาวะตับวายภายหลังการผ่าตัดแล้ว ยังอาจจะช่วยเพิ่มโอกาสการผ่าตัดตัดตับได้*