CLINICAL STUDY

Portal Vein Embolization in the Setting of Staged Hepatectomy with Preservation of Segment IV ± I Only for Bilobar Colorectal Liver Metastases: Safety, Efficacy, and Clinical Outcomes

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ABSTRACT

Purpose: To assess frequency of adverse events, efficacy, and clinical outcomes of percutaneous portal vein embolization (PVE) in patients with bilobar colorectal liver metastases undergoing staged hepatectomy with preservation of segment IV ± I only.

Materials and Methods: Retrospective analysis was performed of 40 consecutive patients who underwent right PVE after successful left lobectomy between 2005 and 2013. Rates of adverse events, future liver remnant (FLR) > 30% compared with baseline liver volume, clinical success (completion of staged hepatectomy with clearance of liver metastases), and overall survival were analyzed.

Results: PVE was performed using polyvinyl alcohol particles (n = 7; 17.5%), particles plus coils (n = 23; 57.5%), and *N*-butyl cyanoacrylate glue plus ethiodized oil (n = 10; 25%). Technical success was 100%. After PVE, 20% (n = 8) of patients exhibited portal venous thrombosis, ranging from isolated intrahepatic portal branch thrombosis to massive thrombosis of the main portal vein (n = 3) and responsible for periportal cavernoma and portal hypertension in 5 patients. Of patients, 23 (57.5%) had FLR ≥ 30%, and 21 (52.5%) had clinical success. Six patients had significant stenosis or occlusion of the left portal vein or biliary system after original left lobectomy, which was independently associated with FLR < 30% ($R^2 = 0.24$). Clinical success was the only independent variable associated with survival ($R^2 = 0.25$).

Conclusions: PVE for staged hepatectomy with preservation of segment IV ± I only is technically feasible, leading to adequate hypertrophy and clinical success rates in these patients with poor oncologic prognosis. Portal venous thrombosis is greater after the procedure than in the setting of standard PVE.

ABBREVIATIONS

CI = confidence interval, CLRM = colorectal liver metastases, FLR = future liver remnant, IQR = interquartile range, NBCA = *N*-butyl cyanoacrylate, OR = odds ratio, OS = overall survival, PVA = polyvinyl alcohol, PVE = portal vein embolization

Advances in multidisciplinary care have considerably expanded the criteria for resectability of colorectal liver metastases (CRLM), and several strategies have been developed to convert unresectable disease into potentially curative multiple-stage liver resections. The primary aim of liver resection is to ensure that the future liver remnant (FLR) will be sufficient to avoid post-operative liver failure. In cases of bilobar disease, a

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2-stage resection approach has been previously described (1–5). In this approach, the first stage comprises segmental or complete resections of the left lateral liver with or without the caudate and includes the clearance of any tumors from segment IV using resection or local ablative therapies. The patient is allowed to recover from surgery before a right-side portal vein embolization (PVE) is performed via an ipsilateral approach, followed by a right hepatectomy (operative stage 2) with preservation of the middle hepatic vein. This approach ensures that growth between resections will occur in segment IV ± I, whereas if a right PVE is carried out first, there is no assurance that the increase in volume will occur in central segments (6).

Percutaneous PVE is acknowledged to be a safe and effective procedure, often resulting in adequate hypertrophy of the FLR in patients with insufficient liver reserve (7). However, the frequency of adverse events related to this procedure as well as its efficacy is not well established in the specific setting of staged hepatectomy with preservation of segment IV ± I only. Prior studies were limited by small numbers of patients and heterogeneities in the staged resection technique applied, limiting the generalizability of results (8–10). In particular, a previous study by Huang et al (10) found that the frequency of adverse events of PVE was not different in the setting of staged versus single hepatectomy. However, in their study, the first stage of hepatectomy for most patients did not consist of complete resection of the left liver lobe but instead parenchymal-sparing segmental resections. The aim of the present study is to assess the frequency of adverse events, efficacy, and clinical outcomes of percutaneous PVE in patients with bilobar CRLM when a staged hepatectomy with preservation of segment IV ± I only was planned.

MATERIALS AND METHODS

Patients

Institutional review board approval was obtained and the requirement for informed consent was waived for this retrospective study. From January 2005 to January 2013, 76 patients with bilobar CRLM were placed on a staged resection pathway at an urban multispecialty academic medical center (McGill University Hospital Center). Patients were included if a staged hepatectomy strategy was considered to treat multiple bilobar CRLM that could not be resected in 1 laparotomy, as long as clearance of metastases could be considered in segments IV and possibly I using wedge resections or thermal ablation techniques. There were 36 patients excluded because of (*i*) staged hepatectomy performed without the need for PVE (n = 25); (*ii*) nonstandard approach for staged hepatectomy, mostly involving a right PVE followed by a right hepatectomy plus clearance of the left lobe of the liver using wedge resections or ablative therapy (in this approach, the PVE is performed in the same setting as routine PVE) (n = 8); or (*iii*) missing data or incomplete follow-up (n = 3). This left 40 patients for inclusion in the study; demographic and clinical data of the included patients are shown in the Table.

Staged Hepatectomy Pathway

The standard approach to managing these patients was as follows. After patients underwent computed tomography (CT) scanning of the chest, abdomen, and pelvis, they were given neoadjuvant chemotherapy (8). Patients were then discussed at a multidisciplinary hepatopancreatobiliary tumor board meeting. Staged resection was planned in patients with good performance status (Eastern Cooperative Oncology Group performance status < 2) (11) and liver-only disease (with the exception of resectable lung disease) wherein all disease could potentially be resected or ablated using a staged approach. Chemotherapy was discontinued approximately 6 weeks before the first hepatic resection. Stage 1 of the sequence consisted of a left lateral liver resection with or without resection of the caudate lobe and the clearance of any tumors from segment IV; this was performed laparoscopically if possible. Following a postoperative recovery period (mean 28 d; range, 5–169 d), right-side PVE was performed (as described subsequently), followed by CT scan to confirm adequate FLR hypertrophy. With a 2-stage PVE, an intermediate CT scan was performed. The mean time interval between the first PVE procedure and the follow-up CT scan was 28 days (range, 18–57 d), and the mean time interval for patients with 2-stage PVE was 64 days (range, 24–106 d). If any delays occurred as a result of longer recovery periods, patients would receive 1 or 2 cycles of chemotherapy and then proceed to right hepatectomy (stage 2) with preservation of the middle hepatic vein followed by adjuvant chemotherapy to complete a total of 12 cycles.

Table. Demographic and Clinical Data of Study Population

Demographic and Clinical Data	Study Population (n = 40)
Male sex	26 (65)
Age, y	57.4 ± 10.6 (26–78)
Site of primary colon (vs rectum)	31 (77.5)
Synchronous liver metastases (vs metachronous)	32 (80)
Baseline number of lesions	7.8 ± 5 (2–25)
Largest lesion at diagnosis (cm)	4.7 ± 2.1 (1.3–10.1)
Neoadjuvant chemotherapy	37 (92.5)
Number of cycles	7.2 ± 5.4 (0–17)
Oxaliplatin-based	27 (67.5)
Irinotecan-based	10 (25)
Bevacizumab	23 (57.5)

Note–Results are expressed as number (percentage) for categorical variables and mean ± SD (range) for quantitative variables.