

# Sequential Preoperative Ipsilateral Portal and Arterial Embolization in Patients with Colorectal Liver Metastases

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## Abstract

*Background:* Preoperative portal vein embolization (PVE) induces ipsilateral atrophy of the hepatic parenchyma to be resected, as well as contralateral compensatory hypertrophy of the residual liver. However, there are two potential problems with this technique: inadequate contralateral hypertrophy and tumor progression while waiting for the non-embolized liver to hypertrophy. We devised a strategy to deal with these two problems by performing an ipsilateral hepatic artery embolization 6 weeks after an unsatisfactory PVE in an effort to accelerate the hypertrophy of the remnant liver.

*Materials and Methods:* Two patients with colorectal liver metastases underwent to this sequential preoperative treatment in order to achieve resectability of their metastatic disease.

*Results:* Both patients successfully underwent major hepatic resection.

*Conclusions:* In our experience sequential ipsilateral portal vein and hepatic artery embolization extended the indications for liver resection for metastatic colorectal cancer.

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The small remnant liver is frequently responsible for morbidity and mortality after major liver resection. Surgical and radiological techniques have been developed to augment remnant liver volume preoperatively, thus ensuring safety after liver resection. Preoperative portal vein embolization (PVE) was devised in 1982 to extend the indications for major liver resection in patients with a  $\leq 20\%$  functional residual volume compared to the total volume.<sup>1,2</sup> Portal vein embolization induces ipsilateral atrophy of the hepatic parenchyma to be resected, as well as contralateral compensatory hypertrophy of the residual liver. The PVE procedure induces permanent portal vein occlusion with a low complication rate. Morphometric studies show that hepatocytes in the embol-

ized lobe undergo apoptosis rather than necrosis, whereas cells in the non-embolized lobe proliferate actively within 2 weeks of the embolization. The consensus is that approximately 4–6 weeks after PVE the future remnant liver increases about 30%–35% in terms of functional mass.<sup>3</sup> However, there are two potential problems with this technique: First, what should be done if the prospective remnant volume does not increase sufficiently to sustain life? How should tumor progression be dealt with while waiting for the non-embolized liver to hypertrophy?<sup>4</sup>

We devised a strategy to deal with these two problems by performing an ipsilateral hepatic artery embolization 6 weeks after an unsatisfactory PVE in an effort to accelerate the hypertrophy of the remnant liver. Our rationale was based on the knowledge that after cessation of portal flow there is a compensatory increase in the arterial flow

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**Table 1.**  
Volumes of the future remnant liver at different stages calculated by computed tomography scan

ID	Future remnant liver volume before PVE (cc)	Future remnant liver volume after PVE (cc)	Future remnant liver volume after HAE (cc)
Patient 1	379	505	916
Patient 2	302	344	521

PVE: portal vein embolization; HAE: hepatic artery embolization.

to the embolized segments resulting in rapid tumor growth; moreover, the presence of arteriportal shunts could potentially attenuate the effects of PVE.

## MATERIALS AND METHODS

### Patient 1

A.A. is a 62-year-old man (height: 170 cm; weight: 79.4 kg) with a history of anterior resection performed in April of 2004 for rectal cancer. At that time a computed tomography (CT) scan showed a single bulky synchronous metastasis occupying the entire anatomic right lobe (segment 4–8). The volume of the left lobe was estimated to be 379 cc with volumetric CT scan.

Percutaneous embolization of the right portal vein branches plus the branches supplying segment IV was performed using microspheres (300–500  $\mu\text{m}$ ) and metallic coils to increase the volume of the left lobe. A CT scan performed 6 weeks later showed a left lobe volume of 505 cc. Selective embolization of the right hepatic artery was then performed using microspheres (300–500  $\mu\text{m}$ ) and Gelfoam sponge. A CT scan performed 3 weeks later showed a left lobe volume of 916 cc (Table 1).

On August 31, 2004, the patient underwent an extended right hepatectomy; the postoperative course was uneventful, and he was discharged home 8 days later.

### Patient 2

S.N. is a 70-year-old man (height: 161 cm; weight: 70 kg) with a history of rectal cancer surgically treated with anterior rectal resection in July 2002. During the follow-up, an abdominal CT scan, done in September 2004, showed three metastatic liver lesions in segment V and VI with a mean diameter of 2–3 cm. The volume of the left hemiliver (segment 2–4) was estimated to be 302 cc with volumetric CT scan.

Selective percutaneous embolization of the right portal vein branches was performed using microspheres and metallic coils. A CT scan performed 6 weeks later showed a left hemiliver volume of 344 cc.

Subsequently selective embolization of the right hepatic artery was performed using microspheres (300–500  $\mu\text{m}$ ) and metallic coils. A CT scan performed 3 weeks later showed a left hemiliver volume of 521 cc (Table 1).

On January 20, 2005, the patient underwent a formal right hepatectomy; the postoperative course was uneventful, and he was discharged home 12 days later.

## DISCUSSION

In our experience sequential ipsilateral portal vein and hepatic artery embolization extended the indications for liver resection for metastatic colorectal cancer. In healthy liver, metastatic tumor growth in the non-embolized parenchyma is more rapid than hepatic growth after PVE,<sup>4</sup> and there is wide variation in growth rate during hepatic regeneration or hypertrophy after PVE. The possibility of performing complete vascular inflow occlusion in the part of liver to be resected simultaneously accomplishes safe contralateral hypertrophy and better control of tumor growth. However, we reserved this sequential combined ipsilateral embolization for cases where the tumor was located in the embolized part of the liver, because we do not know the effect of this approach on tumor overgrowth when the tumor is located in the non-embolized part of the parenchyma. Based on our observation in selected cases without cirrhosis or cholestasis, it is worthwhile to pursue a sequential ipsilateral portal vein and hepatic artery embolization if the remnant liver does not reach a satisfactory volume 6 weeks after PVE. To our knowledge this is first time that such an approach has ever been reported in the English literature.

## REFERENCES

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