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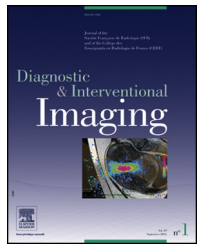

ORIGINAL ARTICLE / *Cardiovascular imaging*

Preoperative portal vein embolization with a combination of trisacryl microspheres, gelfoam and coils

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KEYWORDS
Portal vein embolization;
Contralateral approach;
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Abstract
Purpose: To evaluate the safety and efficiency of preoperative portal vein embolization (PVE) with a combination of trisacryl microspheres, gelfoam and coils for inducing lobar hypertrophy in hepatobiliary malignancy patients.
Materials and methods: PVE was performed by a percutaneous left approach in 63 patients with hepatic malignancy (hepatocarcinoma = 38, colorectal metastasis = 14, cholangiocarcinoma = 11). The indication of PVE and surgery was evaluated by hepatic tumor board take into consideration to the tumor extension and the hepatic volume on initial and post-embolization CT-scans. The total functional liver volume (TELV) and future liver remnant (FLR) volume were measured before and 24 ± 5 days after PVE to assess FLR, TELV and FLR/TELV ratios. Efficiency evaluation was based on FLR increase, the ability to perform the hepatectomy and the hepatic function after surgery. Safety evaluation was determined by clinical and biological follow-up after embolization and surgery.
Results: PVE was successful in all the patients. The mean FLR volume increases by 57 ± 56% after embolization (449 ± 180 cm^3 to 663 ± 254cm^3) ($P < 0.0001$). The FLR/TELV ratio increases by 11% after PVE (25 ± 8% to 36 ± 12%). Three minors' complications were registered without impact on surgery, and four patients developed portal hypertension. Forty-nine patients underwent hepatectomy; none of them developed liver failure. Surgery was not performed in 14 patients due to tumor progression ($n = 9$), inadequate hypertrophy of FLR ($n = 1$) and portal hypertension ($n = 4$).
Conclusion: Preoperative PVE with a combination of trisacryl microspheres, gelfoam and coils is a safe and effective method for inducing contralateral hypertrophy before right hepatectomy in patients with advanced hepatobiliary malignancy.

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Major hepatectomy (resection of four or more liver segments) is associated with increased morbidity and mortality mainly due to liver insufficiency. Portal vein embolization (PVE) is intended to obtain hypertrophy of future liver remnant to minimize the risk of postoperative liver failure.

PVE is a well-established procedure, but it is extremely variable from one center to another, probably because there is no consensus in the literature on which embolic agent induces the greatest degree of liver hypertrophy after PVE [1]. Many embolic agents have been used in the literature, such as n-butyl cyanoacrylate (NCBA), microparticles, coils, alcohol, nitinol plugs [2]. At the beginning of the study, no clinical study had demonstrated an advantage of one embolic agent compared to the others. However, a very recent retrospective study [3] seems to demonstrate that the use NCBA could induce a better hypertrophy than using microparticles plus coils.

Although it is a common practice in many institutions to use a combination of particulates and coils to perform the embolization, PVE using a combination of trisacryl microspheres, gelfoam and coils has never been described in the literature.

Our objective was to analyze the outcomes of PVE before right hepatectomy, in terms of liver hypertrophy, resection rates, and complications after embolization with a combination of trisacryl microspheres, gelfoam and coils.

Material and methods

Patients

A retrospective monocentric study was performed, including all patients undergoing PVE for liver malignancy who required right hepatectomy, between February 2009 and January 2013. Our local ethics committee approved the retrospective analysis of the data, and all patients gave their written informed consent for the procedure. The indications of right hepatectomy or extended hepatectomy and presurgery embolization were elaborated through a case-by-case discussion at the weekly meeting of the multidisciplinary hepatobiliary tumor board (including hepatologists, oncologists, liver surgeons and interventional radiologists).

Pre-embolization CT was performed to determine the extent of hepatobiliary disease, the presence or absence of extra-hepatic disease and/or distant metastasis, the portal vein and hepatic artery permeability, the presence or absence of portal vein variants, and biliary obstruction.

The portal vein embolization was suggested according to the hepatic volumetry and underlying hepatic disease [1]. In case of healthy liver, the Future Liver Remnant (FLR) should be at least 25% of the total liver volume; whereas in case of liver cirrhosis, the FLR must be at least 40% of liver volume. For patients undergoing previous chemotherapy, the FLR should be at least 30% of liver volume [1]. For three patients, although the volume of FLR was over 25%, on a non-cirrhotic liver, the portal vein embolization had been performed anyway. The portal vein embolization was determined for these three patients because the tumor was a hilar cholangiocarcinoma, with dilatation of intrahepatic bile ducts that can lead to a poorer liver regeneration after unprepared surgery.

We did not take into account the complexity of the resection in calculating the necessary percentage of functional liver volume.

Exclusion criteria were as follows: unresectable tumor (arterial invasion, bilobar disease, stage IV hilar cholangiocarcinoma), metastatic disease (extra-hepatic or lymphadenopathy), portal vein occlusion and/or renal failure.

Endoscopic ($n = 2$) or percutaneous ($n = 7$) biliary drainage was performed in patients with biliary obstruction at least 1 week before PVE, associated with short intravenous antibiotic therapy (ceftriaxone and metronidazole antibiotics) immediately before the procedure and during the next 2 days.

Portal vein embolization

Embolization was performed under general anesthesia by one of the three vascular and interventional radiology faculty members. For the percutaneous approach in our institution, we use a platelet count greater than 50,000/mL and Prothrombin Time greater than 50%, as recommended in the literature [1]. Otherwise, patients were transfused with appropriate factors.

The portal venous system was accessed percutaneously under sonographic and fluoroscopic guidance using a contralateral approach.

A 22-gauge Chiba needle (Neff Percutaneous Access Set®; Cook, Bloomington, Indiana, USA) was introduced into a distal portal vein and then, thanks a 5-F vascular sheath used to facilitate subsequent catheter exchanges.

Flush portography was performed with a 5-F catheter (Cook, Europe; Bjaeverskov, Denmark) or a 5-F cobra-shaped catheter (Cobra®; Terumo, Tokyo, Japan) in the main portal vein (Fig. 1). Anteroposterior, right and left anterior oblique projections, were obtained as needed to delineate the portal vein anatomy.

Selective right anterior and posterior portal vein injections were performed. In each branch, trisacryl microspheres (Embosphere®; Biosphere Medical, Roissy, France) ranging from 300 to 1200 microns were administered in a stepwise fashion: smaller particles were used first to occlude the distal branches, and larger particles were used subsequently to occlude the more proximal branches. The larger particles were not used until the forward portal blood flow was substantially reduced. Additional embolization with gelatin sponge particles (Gelitaspon®; Gelita Medical BV, Amsterdam, the Netherlands) was performed until near-complete stasis was achieved. Then, 0.035-inch coils (Tornado® or Nester® or both, Cook Medical, Bloomington, Indiana, USA) were placed within the proximal right anterior and posterior portal veins branches or the right portal vein (if long enough) to further reduce the portal inflow that could lead to recanalization. If a right hepatectomy extended to the segment IV was planned, the same procedure was performed to occlude segment IV of the liver.

A final portogram was obtained with the flush catheter positioned in the main portal vein to assess the completeness of the embolization (Fig. 2).