CLINICAL STUDY

Comparison of Clinical Outcomes following Glue versus Polyvinyl Alcohol Portal Vein Embolization for Hypertrophy of the Future Liver Remnant prior to Right Hepatectomy

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ABSTRACT

Purpose: To report outcomes after portal vein embolization (PVE) and right hepatectomy in patients receiving embolization with *N*-butyl cyanoacrylate (NBCA) glue + central AMPLATZER Vascular Plug (AVP; glue group) or polyvinyl alcohol (PVA) particles ± coils (PVA group).

Materials and Methods: Between March 2008 and August 2013, all patients having PVE with NBCA + AVP or PVA ± coils before right hepatectomy were retrospectively reviewed; 85 patients underwent PVE with NBCA + AVP (n = 45) or PVA ± coils (n = 40). The groups were compared using Mann-Whitney *U* and χ^2 tests.

Results: Technical success of embolization was 100%. Degree of hypertrophy (16.2% ± 7.8 vs 12.3% ± 7.62, $P = .009$) and kinetic growth rate (3.5%/wk ± 2.0 vs 2.6%/wk ± 1.9, $P = .016$) were greater in the glue group versus the PVA group. Contrast volume (66.1 mL ± 44.8 vs 189.87 mL ± 62.6, $P < .001$) and fluoroscopy time (11.2 min ± 7.8 vs 23.49 min ± 11.7, $P < .001$) were significantly less during the PVE procedure in the glue group. Surgical outcomes were comparable between groups, including the number of patients unable to go onto surgery ($P = 1.0$), surgical complications ($P = .30$), length of hospital stay ($P = .68$), and intensive care unit admissions ($P = .71$). There was 1 major complication (hepatic abscess) in each group after PVE.

Conclusions: PVE performed with NBCA + AVP compared with PVA ± coils resulted in greater degree of hypertrophy of the future liver remnant, less fluoroscopic time and contrast volume, and similar complication rates.

ABBREVIATIONS

AVP = AMPLATZER Vascular Plug, BSA = body surface area, CBD = common bile duct, FLR = future liver remnant, KGR = kinetic growth rate, NBCA = *N*-butyl cyanoacrylate, PVA = polyvinyl alcohol, PVE = portal vein embolization, sFLR = standardized future liver remnant

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Many patients with hepatocellular carcinoma or metastatic disease are not surgical candidates for hepatectomy because of inadequate future liver remnant (FLR) volume. A generally accepted minimum value of 20%–25% FLR volume is often used in patients with normal healthy liver (1,2). This value is increased to 40% in cirrhotic livers because of decreased liver tissue function (1). Portal vein embolization (PVE) is now being used to allow for hypertrophy of the FLR given the less invasive nature and improved hypertrophy compared with portal vein ligation (1). To date, various embolization agents, including gelatin sponge, alcohol, polyvinyl alcohol (PVA) particles, and *N*-butyl cyanoacrylate (NBCA) glue, have been used for PVE (1,3,4).

More recently, PVE has been performed with the addition of proximal coils or a central AMPLATZER Vascular Plug (AVP; St. Jude Medical Inc, St Paul, Minnesota) (5,6). Although studies have demonstrated increased liver hypertrophy using NBCA glue compared with PVA particles, this use of this agent can lead to nontarget embolization (5,7). The use of a central AVP in addition to glue is thought to minimize left portal vein nontarget embolization via nitinol mesh glue entrapment (7). Moreover, a central plug may reduce recanalization rates, which have been reported with PVE performed using PVA particles alone (7–9). Around 2010, a gradual change in practice occurred in our institution with a transition from PVA particles to glue embolization. The aim of this retrospective study is to report the procedural and surgical outcomes after PVE comparing NBCA (Histoacryl; Trudell Medical International, London, Canada) + AVP (glue group) and PVA particles ± coils (PVA group).

MATERIALS AND METHODS

Patients

This retrospective cohort study was approved by the local Research Ethics Board, and all patients provided informed consent for embolization. All patients who underwent PVE before right hepatectomy between March 2008 and August 2013 were included. PVE was planned when FLR was < 30% for noncirrhotic patients receiving chemotherapy or > 40% for cirrhotic patients. Patients who had staged hepatectomy or any type of liver resection before PVE or before imaging following PVE were excluded. Other exclusion criteria included embolization with both NBCA glue and PVA particles, PVE with NBCA glue and coils, PVE performed with NBCA glue only, PVE of the left lobe, surgery performed at another institution, missing body surface area (BSA) values, no imaging following PVE, and clinical or imaging evidence of biliary obstruction.

Study inclusion criteria were met by 126 patients. There were 41 patients excluded because of variant portal vein anatomy altering embolization technique or other reasons, including prior hepatic wedge resection before PVE for 2-stage hepatectomy (n = 15), embolization with both NBCA glue and PVA particles (n = 7), NBCA glue embolization followed by coils (n = 2), NBCA glue embolization only (n = 1), left lobe PVE (n = 1), surgery performed at another institution (n = 4), unavailable BSA values (n = 10), and no imaging following PVE (n = 1).

The glue group included 45 patients. The PVA group included 40 patients, with 20 patients having PVE with PVA particles only. In both groups, hepatocellular carcinoma (glue group, n = 15; PVA group, n = 15), colorectal cancer metastases (glue group, n = 18; PVA group, n = 15), and cholangiocarcinoma (glue group, n = 11; PVA group, n = 3) were the predominant tumor types. The glue group also included non–colorectal cancer metastatic lesions from leiomyosarcoma (n = 1), malignant phyllodes tumor (n = 1), ovarian adenocarcinoma (n = 1), and gallbladder adenocarcinoma (n = 1). The PVA group also included non–colorectal cancer metastatic lesions from leiomyosarcoma (n = 2), breast adenocarcinoma (n = 1), testicular seminoma (n = 2), and carcinoid tumor (n = 1). All patients with cirrhosis were Child-Pugh class A. Two patients in the PVA group and 10 patients in the glue group had prior liver intervention. In the PVA group, both patients had percutaneous biliary drains and a common bile duct (CBD) stent. In the glue group, 1 patient had prior radiofrequency ablation of a single colorectal metastatic lesion in segment II. Another patient had emergent embolization of the right hepatic artery using PVA particles for a hemorrhagic hepatoma 72 days before PVE. Additional interventions included percutaneous biliary drain (n = 2), CBD stent (n = 2), and biliary drain with CBD stent (n = 4). Prophylactic antibiotics were used at the discretion of the interventional radiologist based on patient risk factors, including prior percutaneous biliary drain, CBD stent, or recent hepatic arterial embolization. Prophylactic antibiotics were used in 5 (11.1%) patients in the glue group and 5 (12.5%) patients in the PVA group.

Volume Measurements

Most patients (glue group, n = 28 of 45; PVA group, n = 31 of 40) underwent an enhanced multiphase computed tomography (CT) scan before PVE. The remainder had contrast-enhanced magnetic resonance (MR) imaging (glue group, n = 17 of 45; PVA group, n = 9 of 40). Image acquisition protocols are reported in **Appendix A** (available online at *www.jvir.org*). Patients were imaged before PVE (glue group, 37.2 d ± 32.7; PVA group, 40.1 d ± 37.5) and approximately 4–6 weeks (glue group, 35.1 d ± 10.2; PVA group, 36.6 d ± 12.3) after PVE to assess the degree of hypertrophy. The volume of the left lobe of the liver (segments II, III, and IV) and segment I was measured using the semiautomatic Vitrea