Prospective Comparison of Hydrogel-coated Microcoils versus Fibered Platinum Microcoils in the Prophylactic Embolization of the Gastroduodenal Artery before Yttrium-90 Radioembolization

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ABSTRACT

Purpose: To prospectively assess the performance of hydrogel-coated versus fibered microcoils in the prophylactic occlusion of the gastroduodenal artery (GDA) before yttrium-90 (^{90}Y) radioembolization.

Materials and Methods: A total of 43 patients were randomized to receive fibered microcoils (n = 15), detachable hydrogel-coated microcoils (n = 13), or pushable hydrogel-coated microcoils (n = 15). Numbers of coils used, duration, dose–area product (DAP), contrast agent load, and coil migration were assessed. At the time of yttrium-90 (^{90}Y) radioembolization, persistent GDA occlusion was analyzed.

Results: In all patients, the embolized GDA was still completely occluded at the time of ^{90}Y radioembolization. Mean numbers of microcoils used per patient were 11.5 (fibered microcoils), 2.9 (detachable hydrocoils), and 5.5 (pushable hydrocoils), with all numbers significantly different ($P < .0001$). Mean DAPs were 16,283 mGy/cm^2 ± 16,545 (standard deviation) for fibered microcoils, 13,786 mGy/cm^2 ± 5,990 for detachable hydrocoils, and 35,757 mGy/cm^2 ± 74,493 for pushable hydrocoils ($P = .87$). Mean durations of GDA coil embolization were 20 minutes for fibered microcoils, 25 minutes for detachable hydrocoils, and 32 minutes for pushable hydrocoils ($P = .0015$). Mean contrast agent loads were 9 mL for fibered microcoils, 11 mL for pushable hydrocoils, and 7 mL for detachable hydrocoils ($P = .13$). One case of coil migration occurred with each type.

Conclusions: Hydrogel-coated and fibered microcoils are equally effective for prophylactic occlusion of the GDA before radioembolization. The number of coils used is higher with fibered microcoils compared with pushable and detachable hydrocoils, but the reduced number of hydrocoils comes at the cost of increased procedure duration.

ABBREVIATIONS

DAP = dose–area product, GDA = gastroduodenal artery, SIRT = selective internal radiation therapy

Selective internal radiation therapy (SIRT) is a promising catheter-directed therapy that uses yttrium-90 (^{90}Y) microspheres infused into the hepatic artery for the palliative management of primary (1–3) and secondary (4–11) liver tumors. To avoid potential complications of nontarget ^{90}Y microsphere embolization into gastroduodenal or other enteric arteries, prophylactic occlusion of these nonhepatic arteries may be considered during a workup angiographic evaluation. Indeed, one of the most feared complications related to SIRT is radiation-induced gastroduodenal ulcer, which may not heal despite optimal medical treatment associated with high doses of proton pump inhibitors (12–14). The most frequently embolized arteries before ^{90}Y microsphere delivery are the gastroduodenal artery (GDA), followed by the right gastric, accessory left gastric, and retroduodenal arteries (15).

Proximal vessel embolization is most frequently done with the use of pushable fibered microcoils, although other

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occlusive devices like detachable microcoils (Interlock detachable coil; Boston Scientific, Natick, Massachusetts) or plugs (AMPLATZER Vascular Plug, AGA Medical, Minneapolis, Minnesota) have been proven to be effective in the prophylactic occlusion of the GDA before SIRT (16,17).

Hydrocoils are recently developed 0.018-inch microcoils available as pushable and detachable occlusive devices. The hydrocoil consists of a radiopaque, platinum-based microcoil coated with bioactive polymers that expand when they have come in contact with physiologic serum or blood, thereby enabling increased volumetric filling (18). Their potential advantages compared with fibered microcoils are that they increase the packing density, as already demonstrated for filling of intracranial aneurysms (19), and their potential to obtain the same embolic/occlusive effect as fibered microcoils but with a reduced number of coils required. The latter hypothesis has never been tested for peripheral artery purposes. Therefore, the present study was conducted to compare the performance of hydrocoils versus fibered microcoils in the prophylactic occlusion of the GDA before ^{90}Y microsphere delivery.

MATERIALS AND METHODS

Study Design

We performed a prospective, randomized single-center study comparing two types of hydrogel-coated microcoils and one type of fibered platinum microcoil for the protective occlusion of the GDA before SIRT. This prospective, randomized study can be considered as a phase II trial, and 15 patients were randomly assigned to receive each type of coil by means of sealed envelopes. This study was approved by the local ethical committee, and each patient gave written informed consent to the attending interventional radiologist before the start of the workup procedure.

Comparison among the three groups included the total procedure time and the total contrast agent load for GDA coil occlusion; the dose–area product (DAP) for complete coil occlusion of the GDA; the persistent, effective occlusion of the GDA at the time of the SIRT procedure; the number of coils used to stop the antegrade flow in the gastroepiploic artery; the number of coils used to completely occlude the GDA to its origin without residual opacification of any proximal GDA side branches; and the total length of all coils used to occlude the GDA. The GDA coil occlusion procedure started when angiographic mapping of the celiac trunk and superior mesenteric artery were completed, and ended when completion angiography of the GDA was performed after placement of the last coil in the proximal GDA. No cone-beam computed tomography (CT) was used to guide the GDA coil occlusion procedure.

Patient Demographics

Between March 2009 and October 2011, 52 patients were selected for SIRT of liver tumors with the use of resin-based ^{90}Y-microspheres (Sirtex, Lane Cove, Australia). Nine patients (17%) were excluded from the study. Of these nine, four were excluded because of reversed flow in the GDA, two were excluded because of previous surgical ligation of the GDA, one was excluded because of the presence of coils in the GDA associated with previous chemoembolization, and two were excluded because the aberrant anatomy of the celiac trunk and superior mesenteric artery did not require GDA coil embolization. In total, 43 patients were included in the study.

All patients had liver-only malignancies and no therapeutic options other than SIRT, as confirmed by magnetic resonance imaging for primary liver tumors and by [^{18}F]fluorodeoxyglucose positron emission tomography/CT for the following secondary liver tumors: hepatocellular carcinoma (n = 8), cholangiocarcinoma (n = 5), epithelioid hemangioendothelioma (n = 1), colorectal metastases (n = 24), neuroendocrine metastases (n = 2), metastases from small-bowel adenocarcinoma (n = 1), and metastases from malignant melanoma (n = 2).

The procedural parameters recorded for further evaluation during angiographic workup included the total procedure time, the total contrast agent load, DAP for complete coil occlusion of the GDA, GDA diameter, number of coils used to stop antegrade flow in the gastroepiploic artery, and number of coils used to completely occlude the proximal GDA to its origin without residual opacification of any proximal GDA side branches. Finally, a calculation was made of the total length of inserted microcoils for complete occlusion of the GDA. During the therapeutic SIRT procedure, the status of occlusion of the GDA was also recorded for each patient.

Embolization Procedure

All embolization procedures were performed under local anesthesia through a 4-F vascular sheath (Boston Scientific) introduced into the right common femoral artery. After angiographic mapping of the celiac trunk, the superior mesenteric artery, and the end branches by means of a 4-F Simmons I catheter (Glidecath; Terumo Europe, Leuven, Belgium), the GDA was cannulated with a microcatheter (Progreat 2.7; Terumo Europe). The microcoils used in this study were as follows: 0.018-inch fibered platinum microcoils (Target microcoils; Boston Scientific) with a complex helical or vortex shape, lengths of 2, 3, 4, and 6 cm, and widths of 4, 6 (complex helical), and 5.5 mm; and 0.018-inch pushable and detachable microcoils (Terumo Europe). The length of these hydrogel microcoils varied between 3, 4, 5, 6, 10, and 20 cm, whereas the widths of hydrogel coils were between 3 and 6 mm. The preparation of the microcoils depended on the type of coils: the fibered microcoils were loaded within the microcatheter without specific preparation, the pushable hydrocoils were hydrated within the cartridge with saline solution for 3 minutes before being loaded in the microcatheter as described in the instructions for use (warnings