CLINICAL STUDY

Quantification of Blood Pressure Changes in the Vascular Compartment When Using an Anti-Reflux Catheter during Chemoembolization versus Radioembolization: A Retrospective Case Series

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ABSTRACT

Purpose: To assess whether blood pressure changes in the downstream vascular compartment are greater with transarterial chemoembolization than transarterial radioembolization (TARE) when using an anti-reflux catheter.

Materials and Methods: The Surefire Infusion System (Surefire Medical, Inc, Westminster, Colorado) was used for lobar and sublobar administration in 51 drug-eluting embolic transarterial chemoembolization and 55 TARE procedures (22 with resin microspheres [TARE/resin] and 33 with glass microspheres [TARE/glass]). Of patients receiving transarterial chemoembolization and TARE/glass, 97% had hepatocellular carcinomas; 87% of patients receiving TARE/resin had metastases. The absolute (mm Hg) and relative (%) changes in the systemic-hepatic arterial pressure difference (SHAPD) were calculated from simultaneous blood pressure measurements obtained from the femoral artery vascular sheath and the antireflux catheter before, after, and, when feasible, during transarterial chemoembolization or TARE.

Results: Transarterial chemoembolization was associated with a significant reduction in SHAPD compared with TARE (13 mm Hg ± 1.7 vs −4.3 mm Hg ± 1.5; $P < .001$). A reduction in SHAPD led to early termination of 55.6% of lobar and 53.3% of sublobar transarterial chemoembolization procedures compared with only 5.5% of lobar TARE/resin and no TARE/glass procedures. TARE/resin procedures were associated with a significantly greater change in SHAPD compared with TARE/glass procedures (0.9 mm Hg ± 2.7 vs −8.0 mm Hg ± 1.5; $P = .0035$).

Conclusions: Hepatic arterial pressures in the treated vascular compartment increased more after transarterial chemoembolization than after TARE, suggesting that transarterial chemoembolization resulted in more embolic obstruction of the targeted vascular compartment than TARE.

ABBREVIATIONS

ANOVA = analysis of variance, DEE = drug-eluting embolic, HCC = hepatocellular carcinoma, ICC = intrahepatic cholangiocarcinoma, mCRC = metastatic colorectal carcinoma, SHAPD = systemic-hepatic artery pressure difference, SIS = Surefire Infusion System, TARE = transarterial radioembolization, 3-D = three-dimensional, ^{90}Y = yttrium-90

When using an antireflux catheter, 2 distinct vascular compartments have been demonstrated: (*a*) the vascular territory downstream from the device and (*b*) the rest of the systemic arteries. When the device is deployed, the mean blood pressure in the downstream vascular territory is consistently and significantly reduced relative to the systemic arterial system ($P = .00000001$) (1,2). This systemic-hepatic artery pressure difference (SHAPD) is

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typically 15–20 mm Hg (1,2). When using an antireflux catheter during lobar drug-eluting embolic (DEE) transarterial chemoembolization, the blood pressure in the treated compartment often increases with administration of the embolic volume (3). This increase in pressure, which translates into a decrease in SHAPD, likely reflects the degree to which the embolic material obstructs blood flow within the treated vascular bed (2,3). Xu et al (2) also documented downstream reduction in fluid pressure after deployment of the Surefire Infusion System (SIS; Surefire Medical, Inc, Westminster, Colorado) and progressive quasilinear reduction of this pressure difference as the 17 hepatic outflow arteries were sequentially clamped to simulate progressive embolic occlusion of the vascular compartment. Yttrium-90 (^{90}Y) transarterial radioembolization (TARE) uses microspheres significantly smaller in diameter (25–35 μm) than used in transarterial chemoembolization (commonly 100–300μm). Because of this, TARE has been considered a microembolization technique, as the smaller microspheres achieve embolization more distally into the precapillary arterioles, and the cross-sectional area of the vascular tree increases distally with ramification (4). TARE could be expected to result in less embolic obstruction of the target vascular compartment than transarterial chemoembolization, resulting in a more modest decrease in SHAPD than with transarterial chemoembolization. The present study addressed the hypothesis that the SHAPD reduction observed after TARE would be less than that observed after transarterial chemoembolization. We tested this hypothesis by retrospectively comparing SHAPD changes in consecutive patients who underwent lobar or sublobar transarterial chemoembolization, TARE with resin microspheres (TARE/resin), or TARE with glass microspheres (TARE/glass) procedures to treat either primary or metastatic liver malignancies.

MATERIALS AND METHODS

Patients

The institutional review board approved this retrospective study, which is compliant with the Health Insurance Portability and Accountability Act of 1996. This retrospective study included 71 patients treated between January 1, 2012, and June 30, 2015, for liver cancer with transarterial chemoembolization or TARE using the SIS antireflux catheter to reduce the risk of nontarget embolization. The SIS devices used included the MT, ST, and LT; the Precision model was unavailable at the time. The SIS was used in 31 patients who underwent transarterial chemoembolization (30 for hepatocellular carcinoma [HCC], 1 for intrahepatic cholangiocarcinoma [ICC]), 15 patients who underwent TARE/resin (2 for ICC, 5 for metastatic colorectal carcinoma [mCRC], 6 for metastatic neuroendocrine tumor, and 2 for other metastases), and 31 patients who underwent TARE/glass procedures (30 for HCC, 1 for ICC). Six patients who underwent both transarterial chemoembolization and TARE/glass procedures using the SIS device were counted twice. The respective numbers of lobar and sublobar administrations were 36 (70.5%) and 15 (29.5%) for transarterial chemoembolization, 25 (75.8%) and 8 (24.2%) for TARE/resin, and 18 (81.8%) and 4 (18.2%) for TARE/glass. **Table 1** lists patient demographic data and relevant prior therapies.

Electronic medical record data collected included overall survival from the time of the first SIS-assisted transarterial chemoembolization or TARE procedure, cause of death, and maximum liver-related toxicity within 90 days of transarterial chemoembolization or TARE using Common Terminology Criteria for Adverse Events (version 4.0) (5).

Procedure Selection

A multidisciplinary tumor board made the decision to treat with transarterial chemoembolization or TARE. Patients selected for transarterial chemoembolization or TARE had no medical contraindications and were not candidates for potentially curative resection or ablation. Treatment guidelines for the selection of therapy were as follows. For patients with HCC, the default transcatheter therapy was transarterial chemoembolization, including cases of bridge-to-liver transplant strategy. TARE/glass was reserved for niche applications in which the available literature supported probable superiority over transarterial chemoembolization for HCC: (*a*) main or lobar portal vein invasion or thrombosis, (*b*) T3 to T2 downstage-to-liver transplant strategy, (*c*) high-activity treatment of 1 or 2 segments (radiation segmentectomy), (*d*) high-activity treatment of 1 lobe (radiation lobectomy), and (*e*) incomplete response or tumor progression after at least 2 prior transarterial chemoembolization procedures. TARE/resin was used for liver metastases primarily from mCRC or metastatic neuroendocrine tumor.

The SIS antireflux microcatheter was used to reduce the risk of nontarget delivery of embolic agents in cases with hepaticoenteric arteries arising either upstream, where the SIS was used to prevent retrograde reflux of blood, or downstream, where the SIS was used to encourage hepatopetal flow by reducing blood pressure in the targeted vascular territory. The SIS antireflux microcatheter was not used in cases where hepaticoenteric arteries at risk for nontarget embolization were absent or in cases of tortuous arterial anatomy.

Transarterial Chemoembolization Technique

For DEE preparation, 2 mg of 100–300 μm DEE beads (LC Beads; Biocompatibles, Ltd, Surrey, United Kingdom) was loaded with 50 mg of doxorubicin. Iodixanol iodinated contrast agent 320 mg/mL (Visipaque 320; GE Healthcare, Princeton, New Jersey) was added for a