Abdominal Radiology (2019) 44:3195–3199
https://doi.org/10.1007/s00261-019-02072-6

INTERVENTIONAL RADIOLOGY

Application of side-hole catheter technique for transradial arterial chemoembolization in patients with hepatocellular carcinoma

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Published online: 29 May 2019

Abstract

Purpose The purpose of this study was to retrospectively evaluate the efficacy and safety of side-hole catheter technique for transarterial chemoembolization (TACE) via transradial artery access (TRA) in patients with hepatocellular carcinoma.

Materials and methods From November 2015 to August 2017, a total of 1040 TACE procedures were performed via TRA for hepatocellular carcinoma. In 10 (1%) of these 1040 TACE procedures via TRA, conventional microcatheter technique (CMT) failed and side-hole catheter technique was attempted.

Results Ten procedures of selective catheterizations by CMT failed due to the poor stability of the angiographic catheters or the target artery arising from the very proximal portion of the parent artery. These arteries included the right inferior phrenic artery in eight patients, one left gastric artery, and one right renal capsular artery. Cobra or MPA catheter with the microcatheter through the side-hole yielded a technical success rate of 100%. No procedure-related complications were observed. The mean time required to catheterize the target artery with the side-hole catheter was 9.5 min (5–15 min).

Conclusion Side-hole catheter technique may enable the completion of chemoembolization in cases that a potential tumor-feeding vessel cannot be catheterized by means of CMT for TACE via TRA.

Keywords Chemoembolization · Therapeutic · Carcinoma · Hepatocellular · Radial artery · Femoral artery · Catheters

Introduction

Although transfemoral artery access (TFA) is the most widely used approach of transarterial chemoembolization (TACE) for hepatocellular carcinoma (HCC), a growing number of TACE procedures for HCC via transradial artery access (TRA) are performed because of emerging evidence favoring TRA versus TFA in recent studies, such as higher patient satisfaction, lower radiation exposure, and lower complication rate [1–4]. However, it is well known that arterial catheterization is one of the most basic and essential procedures of TACE for HCC and intentional superselective catheterization of the tumor-feeding arteries may be at times extremely difficult or restricted by anatomical difficulty [5], and this is more evident in procedures via TRA due to longer distance (poor torque control and stability) and poor availability of angiographic catheters. Side-hole catheter technique via TFA has been successfully applied in several reports [6–8], but as far as we know, this technique via TRA has not been reported. Therefore, the purpose of this study is to retrospectively evaluate the efficacy and safety of side-hole catheter technique for TACE via TRA in patients with HCC.

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Materials and methods

Patient characteristics

Institutional review board approval was obtained for this retrospective study. For this type of study, formal consent is not required. From December 2015 to August 2017, a total of 1040 TACE procedures in 483 patients with HCC were performed via TRA. Among them, selective catheterization of a target artery with a 5-F angiographic catheter and a coaxial microcatheter initially failed in 10 procedures (1%)

of 10 patients (2%) while carrying out a complete evaluation of the tumor-feeding arteries. The ten patients' ages were in the range of 52–72 years (mean ± SD, 61 ± 7 years). Eight were men and two were women. Table 1 shows the clinical characteristics of the patients.

Procedures

The patient's left arm was abducted to 70°–90°. The left radial artery was punctured with the use of a Radifocus

Table 1 Patient characteristics and results

Case No.	Age (y.o.)/gender	Disease	Targeted artery	Intentional treatment	Conventional microcatheter techniques (CMT)	Anatomical difficulty of targeted artery	Duration of side-hole catheter technique (min)	Complications
1	66/female	HCC	RIPA	TACE	Cobra	Originating steeply from the proximal portion of the celiac artery	13	none
2	52/male	HCC	LGA	TACE	Cobra	Originating steeply from the proximal portion of the celiac artery	15	None
3	53/male	HCC	RIPA	TACE	Cobra	Originating steeply from the proximal portion of the celiac artery	10	None
4	53/male	HCC	RRCA	TACE	MPA	Poor stability of the angiographic catheter	9	None
5	68/male	HCC	RIPA	TACE	MPA	Originating steeply from the proximal portion of the celiac artery	8	None
6	62/male	HCC	RIPA	TACE	MPA	Originating steeply from the proximal portion of the celiac artery	5	None
7	64/female	HCC	RIPA	TACE	Cobra	Originating steeply from the proximal portion of the celiac artery	7	None
8	72/male	HCC	RIPA	TACE	MPA	Originating steeply from the proximal portion of the celiac artery	6	None
9	60/male	HCC	RIPA	TACE	MPA	Originating steeply from the proximal portion of the celiac artery	12	None
10	60/male	HCC	RIPA	TACE	MPA	Originating steeply from the proximal portion of the celiac artery	10	None

HCC hepatocellular carcinoma, *RIPA* right inferior phrenic artery, *LGA* left gastric artery, *RRCA* right renal capsular artery

Transradial kit (Terumo, Japan). The kit includes a 21-gage short needle, a 0.025-inch nitinol wire, and a 5-F hydrophilic sheath. After access was secured, 250 µg of nitroglycerin and 1500–3000 IU of heparin were administered through the sheath. Under direct fluoroscopic visualization, a 0.035-inch angled J-tip Glidewire (150 cm in length, Terumo, Japan) and a 5-F, 120-cm Cobra catheter (Terumo, Japan) or a 5-F, 125-cm MPA catheter (Cordis, USA) were advanced coaxially into the descending aorta, and selective catheterization and angiography of the celiac trunk, the hepatic artery, and superior mesenteric artery was performed. For superselective catheterization and angiography, a 2.8-F microcatheter (135 cm or 150 cm in length; Renegade HiFlo Straight, Boston Scientific, Natick, Mass, USA) was used. When conventional microcatheter technique (CMT) failed, a side hole of approximately 3–5 mm was created in the 5-F angiographic catheter with use of a surgical scissor. The location of the side hole was created in the lesser curvature sides according to the direction of the origin of the target artery. Then, angiography of the celiac artery was performed by injecting contrast material at a sufficient rate to allow it to reflux to the origin of the target artery. The level of the side hole was adjusted by repositioning the catheter until the side hole was directed toward the origin of the target artery. A 0.018-inch guidewire (Transend, Boston Scientific, USA) was passed through side hole into the target artery and a 2.8-F microcatheter was advanced over the guide wire (Fig. 1). TACE was performed with an emulsion of lipiodol (Lipiodol Ultrafluide; Guerbet, Aulnay-Sous-Bois, France) and doxorubicin hydrochloride, followed by administration of gelatin sponge particles (150–350 µm, Gelfoam, Alicon, Hangzhou, China) mixed with contrast material until flow stasis of the tumor-feeding arteries was achieved. For hemostasis after the sheath has been removed, a special tourniquet (WORK, SANYOU, Hangzhou, China) designed for radial artery was applied for 2 h, and the reversed Barbeau test was performed to rule out excessive radial artery occlusive compression (confirmed by the presence of oximetry pulse waveform during compression of the ulnar artery). The follow-up period ranged from 12 to 37 months (mean, 22 months).

Results

The side-hole catheter technique was applied in 10 (1%) of the 1040 procedures that failed to catheterize the target arteries selectively. These arteries included the right inferior phrenic artery (RIPA) in eight patients and the left gastric artery in one patient, which arose from the very proximal portion of the celiac trunk, and the angiographic catheter was either advanced deeper into the celiac trunk or drawn back to the abdominal aorta in most of the cases (Fig. 2). The last artery was the right renal capsular artery (RRCA), which arose from the right renal artery and supplied the intrahepatic residual tumor (Fig. 3). Superselective catheterization of this RRCA with CMT failed due to the poor stability of the angiographic catheter. In failed cases with CMT, superselective catheterization through the side hole yielded a technical success rate of 100%. The mean time required to catheterize the target artery with the side-hole catheter

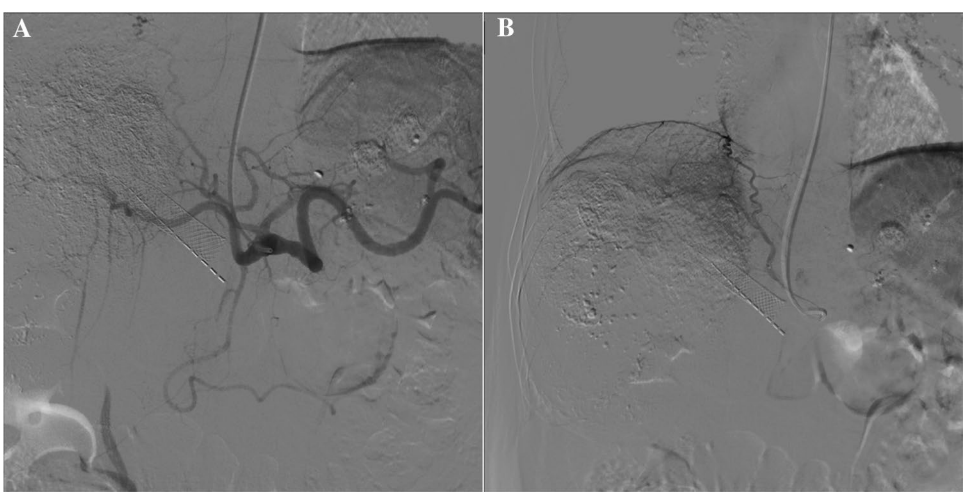

Fig. 1 Images of a 66-year-old woman with hepatocellular carcinoma and portal tumor thrombus (patient 1). She was treated with combination of percutaneous stent placement with a strip of Iodine-125 seeds and TACE. **a** Celiac arteriogram showed that the right inferior phrenic artery originated from the proximal portion of the celiac trunk at an acute angle. **b** A side hole was created at the lesser curvature side of a 5-F Cobra catheter. A microguide wire and a microcatheter were advanced through the side hole. Selective angiography via the microcatheter shows a contrast blush supplied from the right inferior phrenic artery. Subsequently, TACE was performed with an emulsion of lipiodol and doxorubicin hydrochloride, followed by administration of sponge particles mixed with contrast material

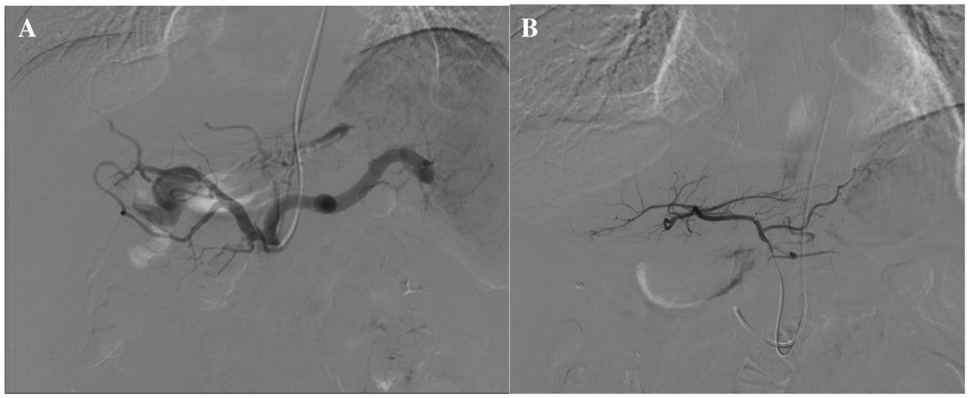

Fig. 2 Images of a 52-year-old man with hepatocellular carcinoma (patient 2). **a** Celiac arteriogram showed that the replaced left hepatic artery (LHA) arose from the left gastric artery (LGA), which opened at the root of the celiac artery. **b** Selective angiography via the microcatheter through the side hole was performed to evaluate the blood supply of the tumor

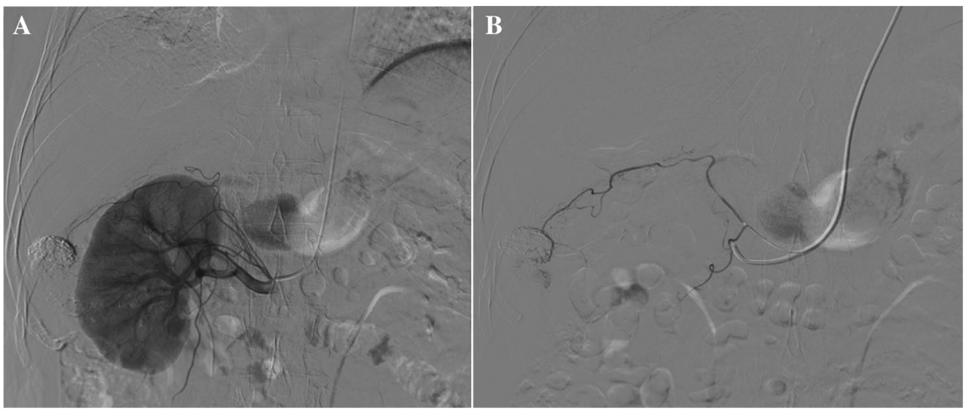

Fig. 3 Images of a 53-year-old man with hepatocellular carcinoma treated with TACE (patient 4). **a** Angiography showed the right renal capsular artery arose from the right renal artery and supplied the intrahepatic residual tumor. The microcatheter could not be advanced deeper into the tumor-feeding branch because of the poor stability of the angiographic catheter. **b** Superselective catheterization was successful using the side-hole catheter technique, and angiography via the microcatheter showed tumor stain

was 9.5 min (5–15 min). There were no procedure-related complications during follow-up. The results are summarized in Table 1.

Discussion

Transradial catheterization was first described by Rander in 1948 [9]. Shiozawa et al. retrospectively compared TRA with TFA in hepatic intra-arterial therapy and demonstrated comparable efficacy (98.3% technical success with TRA) [3]. Yamada et al. suggested that TRA was the preferred access for the majority of patients and was associated with less radiation exposure to the operator [1, 4]. In our center, TRA has now been routinely chosen for TACE. However, catheterization of a desired small branch artery via TRA is sometimes uneasy because of aforementioned anatomic conditions, especially with extrahepatic artery supply. Among diverse extrahepatic collateral vessels, the IPA is one of the most commonly found [10], and the IPA, when arising from the very proximal portion of the celiac trunk, is sometimes difficult to catheterize selectively with CMT, even via transfemoral artery approach. In our study, 8 of 10 target arteries were IPAs. The side-hole catheter technique via TFA has been proved efficacious and safe [6–8], which markedly increased success rate and reduced catheterization time. We applied this technique via TRA and achieved the similar results.

Some other techniques such as "shepherd's hook technique" [11] and "turn back technique" [12] have been applied to select the IPA via TFA. However, in most of our cases, the arteries arose from the proximal portion of the large artery with an acute angle, which led to poor catheter stability. We considered that the side-hole catheter technique could immobilize the angiographic catheter easily.

The side-hole catheter technique via TRA has several advantages over CMT. First, a certain portion of the injected contrast material draining through the side hole leads to improved image quality of angiography and optimal level of the side hole. Second, side-hole catheter could help assuming a stable position while conventional 5F catheter's tip location was not easy to immobilize due to lack of sufficient support. Superselection of the artery with the microcatheter through the side hole was feasible with the stable position and enough supporting force.

There are several limitations to this report. First, it was a relatively small case series. Technical failure and complications not encountered in our series may occur in larger series. Second, other techniques such as "shepherd's hook technique" and "turn back technique" may play a role in such difficult cases. A comparison study between these techniques via TRA could be more valuable. Third, in our institution, only MPA or Cobra catheter could be obtained currently, and we believed that some catheters with side hole or radial-specific catheter for TACE via TRA could be helpful in the future.

In conclusion, side-hole catheter technique may be useful in superselective catheterization of inaccessible arteries due to anatomical difficulties for TACE via TRA, obviating an additional arterial access in the lower extremity.

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