Feasibility of a Sheathless Arterial Access Using a 4-F Catheter and a Triaxial System for Transcatheter Arterial Chemoembolization for Hepatocellular Carcinoma

1) Department of Radiology, School of Medicine, Keio University, Japan
2) Department of Radiology, Hiratsuka City Hospital, Japan

Sota Oguro¹, Seishi Nakatsuka¹, Masanori Inoue¹, Hideki Yashiro², Masashi Tamura¹, Masahiro Jinzaki¹

Abstract

Purpose: This study evaluated the feasibility of sheathless access using the combination of a 4-F catheter and a triaxial system for transcatheter arterial chemoembolization (TACE).

Materials and Methods: A total of 35 of 53 patients were selected to undergo TACE of hepatocellular carcinoma (HCC) using a triaxial system that included a 4-F shepherd hook catheter, a 2.7-2.9-F high-flow microcatheter, and a 1.7-1.9-F microcatheter without using a sheath introducer. Feasibility was defined as successful completion of the procedure without using another microcatheter or switching to another system. The duration of manual compression after catheter removal was set to 10 minutes. Two hours and 1 hour of bed rest after the procedure were prescribed for 24 and 11 patients, respectively.

Results: TACE using a triaxial system without a sheath introducer was feasible in 34/35 cases (97%). A small amount of bleeding around the catheter at the puncture site was observed during the procedure in 3 cases. No other hemorrhagic complications were observed 5 days after the procedure.

Conclusion: Sheathless arterial access using the combination of a 4-F catheter and a triaxial system for TACE of HCC was shown to be both feasible and safe. Additionally, using the triaxial system resulted in hemostasis within 1-2 hours of bed rest after catheter removal.

Key words: transcatheter arterial chemoembolization, triaxial system, sheathless access, hepatocellular carcinoma

(Interventional Radiology 2016; 1: 39-44)

Introduction

Transcatheter arterial chemoembolization (TACE) is an effective treatment option for unresectable hepatocellular carcinoma (HCC) [1-3]. Sheath catheters or sheath introducers thicker than 6-F had been used commonly for TACE [4]. However, recent improvements in angiographic devices have enabled the use of a system with a smaller profile to prevent hemorrhagic complications at the puncture site [5]. Yagyu et al. reported the feasibility of TACE using a 3.5-F sheath introducer, and this small-profile system contributed to a shorter compression time or a shorter bed-rest period after the procedure [6]. However, the 3.5-F catheter is occasionally difficult to manipulate because of its lack of rigidity. Additionally, selection of the celiac artery was impossible in certain cases because the orifice of the celiac artery was constricted [5, 6].

A triaxial system that passes through a 4-F catheter is now available in Japan, and has been used in various interventional procedures [7, 8]. In the triaxial system, a 2.7-2.9-F high-flow microcatheter passes through the 4-F catheter, and a 1.7-1.9-F microcatheter is positioned using the 2.7-2.9-F high-flow catheter. This triaxial system provides supe-
rior stability for advancing the microcatheter and increases its rigidity and controllability. These features enable superselective catheterization of small arteries [8]. Shimohira et al. reported the usefulness of this triaxial system using a 4-F sheath introducer for TACE, and observed that this tool might contribute to an increased rate of local HCC control [9]. We hypothesized that the celiac artery and superior mesenteric artery could be catheterized using a 4-F catheter without a sheath introducer if a 4-F catheter was used as part of the guiding sheath, even though the outer diameter of the 4-F catheter (1.33 mm) is smaller than that of the 3.5-F sheath introducer (1.60 mm) (S-ONE sheath, Terumo Clinical Supply, Gifu, Japan). This study evaluated the feasibility and safety of sheathless arterial access using the combination of a 4-F catheter and a triaxial system for TACE of HCC.

Materials and Methods

Study population

This retrospective study was conducted with the approval of the institutional review board. The requirement for informed patient consent was waived. Patients who underwent TACE administered by the first author as a planned treatment of the hepatic or right inferior phrenic artery deriving from the celiac artery from July 2014 to March 2016 were selected for inclusion. The exclusion criteria were suspected extrahepatic blood supply to the tumor other than the right inferior phrenic artery, based on pre-procedural dynamic CT and severe arteriosclerosis. A total of 245 TACE procedures for the treatment of HCC were performed from July 2014 to March 2016, and 53 of these were performed by the first author (S.O.), who had 14 years of experience in interventional radiology. A 4-F catheter and a triaxial system were used to perform 35 of the 53 TACE procedures (66%) (Figure 1). One procedure was excluded due to severe arteriosclerosis, in which a tortuous aorta and stenosis of the celiac artery orifice due to calcification were observed. Seventeen procedures were excluded due to an extrahepatic blood supply to the tumor based on pre-procedural dynamic CT. In those 17 procedures, the extrahepatic blood supply was from an internal mammary artery in 4 cases, an inferior phrenic artery derived from the aorta in 8, a right renal capsular artery in 4, and a left gastric artery derived from the aorta in 1.

A total of 35 patients were treated with the combination of a 4-F catheter and a triaxial system. The characteristics of these patients are shown in Table 1. All of the patients were diagnosed with HCC based on dynamic CT or magnetic resonance imaging (MRI). Clopidogrel, cilostazol, aspirin, and warfarin were being used by 3 patients, 1 patient, 3 patients, and 1 patient, respectively. The patients who were using clopidogrel discontinued its use for a washout period of 5 days before the procedure. The platelet count was more than 6 × 10^4/μl in 26 cases, 3 to 6 × 10^4/μl in 8 cases, and less than 3 × 10^4/μl in 1 case. The mean platelet count was 11.0 × 10^4/μl, and the median platelet count was 8.8 × 10^4/μl.

TACE procedure

Arterial access was gained percutaneously at the femoral artery. An approximately 3-mm skin incision was made at the puncture site, where the femoral artery was punctured using an 18-G introducer needle (Surflo, Terumo, Tokyo, Ja-
pan), and a 0.035-inch-diameter, 150-cm-long guidewire (Radiofocus, Terumo, Tokyo, Japan) was inserted into the aorta. Then, a 4.0-F shepherd hook catheter (Medikit, Tokyo, Japan) was inserted over the wire via the femoral artery without a sheath introducer. To prevent the 4-F catheter from bending near the puncture site without a sheath, a 0.035-inch guidewire was inserted into the catheter to improve the rigidity of the shaft of the 4-F catheter during manipulation. Manipulation of the 4-F shepherd hook catheter was restricted to catheterization at the orifice of the superior mesenteric or celiac artery to reduce the risk of intimal damage and local complications at the arterial puncture site.

CT during arterial portography (CTAP) was performed using a 4-F shepherd hook catheter. If any branch of the hepatic artery was derived from the superior mesenteric artery, a 2.7-F high-flow microcatheter (Shirabe; Piolax, Yokohama, Japan) or a 2.9-F high-flow microcatheter (Carry León high-flow, UTM Co., Aichi, Japan) was advanced distally to the orifice of the replaced hepatic artery, and CTAP was then performed. Next, CT during hepatic arteriography (CTHA) was performed after the high-flow microcatheter had been advanced to the common or proper hepatic artery. Then, superselective TACE was performed using a combination of a high-flow microcatheter, a selective microcatheter (non-taper MARVEL, 1.9-F, Tokai Medical, Kasugai, Japan, or Carry León selective, 1.7-F, UTM Co., Aichi, Japan), and a 0.016-inch guidewire (ASAHI Meister, Asahi Intecc, Seto, Japan).

**Manual compression and bed rest after the procedure**

The duration of manual compression to promote hemostasis after catheter removal was set to 10 minutes in all cases. Kato et al. reported that 2 hours of bed rest is sufficient for patients undergoing transfemoral noncardiac angiography using a 4- or 5-F sheath [10]. Therefore, 2 hours of complete bed rest in the supine position was prescribed for 24 patients from July 2014 to August 2015. After confirming the absence of bleeding complications in those 24 patients, 1 hour of complete supine bed rest was prescribed for 11 patients from September 2015 to March 2016. The operator checked for the presence of a hematoma both immediately and 1-2 hours after the procedure. A nurse reassessed the presence of a hematoma in the morning on post-procedure days 1 and 5.

**Evaluation and Data Analysis**

Feasibility was defined as successful completion of the procedure without using another microcatheter or switching to another system, including a different preshaped 4-F catheter or a 4/5-F system using a sheath introducer [6]. We also measured the duration of the procedure.

Catheter selectivity was defined according to the smallest artery that was accessed during the procedure, such as the main (proper, right or left) hepatic branch, the segmental arteries, the subsegmental or sub-subsegmental arteries, or more distal branches.

**Results**

The target tumors were located in the right lobe of the liver in 13 cases, in the left lobe in 4 cases, and in both lobes in 18 cases. TACE using a triaxial system without a sheath introducer was feasible in 34/35 cases (97%). The celiac and superior mesenteric arteries were successfully catheterized in all of the cases; however, catheterization of A1 was impossible in 1 case because A1 sharply branched from the right hepatic artery. Therefore, another preshaped 1.9-F conventional microcatheter (ASAHI Tellus, Screwed right, Asahi Intecc, Seto, Japan) was used to catheterize A1. The mean TACE procedure duration was 179 ± 32 minutes.

Catheter selectivity accessed the subsegmental artery in 6 (17%) cases, the sub-subsegmental artery in 13 (37%) cases, and more distal branches in 16 (46%) cases.

Slight bleeding at the puncture site during the procedure was observed in 3 cases, and the puncture site was compressed by hand for 10 minutes. Stenosis or occlusion at the orifice of the celiac artery caused by compression of the median arcuate ligament was observed in 1 case each, and the high-flow microcatheter was advanced to the common or proper hepatic artery through a shepherd hook catheter in those cases. In 1 case in which the celiac artery was occluded, catheterization of the hepatic arteries using a microcatheter was achieved via an anterior pancreaticoduodenal arterial arcade (Figure 2). An example of good superselective TACE is shown in Figure 3.

After the procedure, hemostasis at the puncture site was achieved by manual compression for 10 minutes in all cases. Complete supine bed rest for 2 hours was prescribed in 24 procedures, with rest for 1 hour in 11 procedures. Small hematomas at the puncture site in the aforementioned 3 cases did not expand after 10 minutes of compression. No other hemorrhagic complications were observed 5 days after the procedure.

**Discussion**

TACE using a 4-F shepherd hook catheter, a 2.7-2.9-F high-flow microcatheter, and a 1.7-1.9-F microcatheter was successfully performed in the majority of cases without requiring a sheath introducer. Several single-center case series have reported that transradial percutaneous intervention can be performed using a sheathless technique [11, 12]. Bayard et al. performed transfemoral percutaneous coronary intervention using a 5-F guide catheter without a sheath [13]. Although patients do not need to move their arms during percutaneous coronary intervention, the patients in our series were required to move their arms to undergo CTA/CTAP or cone beam CT, and this movement raises potential concerns about catheter dislodgement if a transradial approach were applied. Thus, a transfemoral approach might be safer than a transradial approach when performing TACE.

Yagyu et al. reported that the success rate of reaching the
target artery using a 3.5-F sheath introducer was 93% [6]. The first advantage of our system is that the outer diameter of the 4-F catheter is smaller than that of the 3.5-F sheath. The 3.5-F sheath introducer has an outer diameter of 1.60 mm (or 4.8 F), but the outer diameter of the 4-F catheter is 1.33 mm. Therefore, the cross-sectional area of the 4-F catheter is 31% smaller than that of the 3.5-F sheath introducer, and this smaller outer diameter might reduce the risk of puncture site hemorrhage after a TACE procedure. Hemostasis was achieved after 10 minutes of manual compression, even in 9 patients whose platelet count was less than 6 × 10^4/μl. Additionally, the patients in this study required only 1-2 hours of bed rest. Therefore, this sheathless method should be recommended for patients with coagulopathy or for those who are unable to maintain complete bed rest be-

Figure 2. A 74-year-old man with hepatocellular carcinoma (HCC). a: A catheter was implanted 3 years prior to treatment of HCC associated with a portal vein tumor thrombus, which resulted in catheter occlusion. Transcatheter arterial chemoembolization (TACE) was performed to address the residual HCC in the left lobe. There was stenosis by nature at the orifice of the celiac artery because of compression by the median arcuate ligament, and occlusion occurred after reservoir catheter placement. Digital subtraction angiography from the superior mesenteric artery showed a hepatic artery via anastomotic arteries. b: A 2.9-F high-flow microcatheter was inserted through a 4-F shepherd hook catheter and was advanced to the proper hepatic artery through the superior mesenteric artery and anterior inferior pancreaticoduodenal anastomotic artery. Digital subtraction angiography from the common hepatic artery showed a tumor, indicated by the arrow.

Figure 3. A 56-year-old man with hepatocellular carcinoma (HCC). a: A common hepatic arteriogram depicts the middle and left hepatic arteries after placement of a 2.9-F high-flow microcatheter through a 4-F shepherd hook catheter. The arrow indicates the tumor. An arterial branch feeding the tumor is indicated by the arrowheads. b: A branch of the A4 hepatic artery was catheterized, and transcatheter arterial chemoembolization was performed. An enhanced portion of the HCC tumor is denoted by the arrow.
cause of dementia or hepatic encephalopathy.

The second advantage of the proposed sheathless catheterization technique over the 3.5-F system is that a 4-F catheter can more readily catheterize the celiac and superior mesenteric arteries because it is more easily manipulated.

A third advantage of our system is that sufficient CTAP and CTHA images can be obtained for all of the anatomical variations, given that a high-flow microcatheter can be advanced into a 4-F catheter [6]. Although the tip of the 4-F shepherd hook catheter was placed at the orifice of the celiac or superior mesenteric artery, the high-flow microcatheter was easily advanced to the common or proper hepatic artery. Contrast media (140 mg/ml) can be injected through the high-flow microcatheter at a rate of up to 4 ml/sec, and in this study, the digital subtraction angiography, CTHA, and CTAP images were excellent in all of the cases.

The fourth advantage is that the triaxial system provides superior stability for microcatheter advancement, as well as increased catheter rigidity and controllability [8]. Yagyu et al. reported that TACE could be performed from a sub-subsegmental artery in only 16% of cases [6]. In this study, TACE from the sub-subsegmental artery was successful in more than 80% of cases when the tip of the 4-F shepherd hook catheter was placed at the orifice of the celiac or superior mesenteric artery.

However, there are also several disadvantages to this technique. The first is that a 4-F catheter with a triaxial system is more expensive than a 3.5-F system. However, Yagyu et al. used several 3.5-F catheters to prevent retrograde movement when it was difficult to insert the microcatheter into the target artery [6]. This triaxial system can be performed on all anatomical variations and does not require many different types of preshaped catheters. The triaxial system could reduce the number of catheters prepared for a given procedure, thereby utilizing fewer pieces of equipment than traditional techniques.

The second disadvantage is the possibility of hematoma formation at the puncture site during the procedure. Manipulation of the 4-F shepherd hook catheter without the use of a sheath introducer was difficult in some cases because of reduced rigidity compared to that in techniques using a sheath. Additionally, insertion or twisting of the 4-F catheter without a sheath might cause hematoma at the puncture site. However, inserting the 0.035-inch guidewire into the 4-F catheter added rigidity. In this study, the celiac artery and superior mesenteric artery were successfully catheterized in all cases without severe hemorrhagic adverse events.

This study has several limitations. The patient cohort was small. Therefore, further studies are required to validate our procedure. Additionally, the first author performed TACE on 53 cases during the study period but used the novel sheathless technique in only 35 of the cases, potentially introducing selection bias into the study results.

In conclusion, attaining sheathless arterial access using the combination of a 4-F catheter and a triaxial system for TACE of HCC was shown to be both feasible and safe. Hemostasis was achieved following only 1-2 hours of bed rest because of the low-profile nature of this procedure.

**Compliance with Ethical Standards:** This study was not funded by any grants or funds.

**Conflict of interest:** All Authors declares that they have no conflict of interest.

**References**

13. Bayard YL, Jakob D, Meier B. All comers 5 French transfemoral