# A New Technique for Superselective Catheterization of Arteries: Preshaping of a Micro-Guide Wire into a Shepherd's Hook Form

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**Objective:** We wanted to introduce a new technique for superselective catheterization of arteries with preshaping of a micro-guide wire into a shepherd's hook form, and this is useful for superselection of small arteries branching at an acute angle from a large parent artery for the treatment of tumors and hemorrhages.

**Materials and Methods:** We developed a superselective catheterization technique by using preshaping of a micro-guide wire into a shepherd's hook form. We encountered six patients in our practice for whom we failed to catheterize the small tumor-feeding arteries that branched at an acute angle from wide parent arteries during chemoembolization of hepatocellular carcinoma; the parent arteries were the right inferior phrenic artery (n = 4) and the left gastric artery (n = 1) from the celiac axis with celiac stenosis due to compression by the median arcuate ligament and the proper hepatic artery from the gastroduodenal artery (n = 1) in a patient who had celiac axis occlusion with collateral circulation via the pancreaticoduodenal arcade from the superior mesenteric artery. In these consecutive six patients, we tested the usefulness of this new technique with employing preshaping of a micro-guide wire into a shepherd's hook form for superselective catheterization of targeted vessels.

**Results:** The target arteries were successfully catheterized and satisfactory transcatheter arterial chemoembolization was performed in all six patients. There were no significant complications such as arterial dissection.

**Conclusion:** We developed a technique that is effective for superselection of vessels with preshaping of micro-guide wire into a shepherd's hook form, and we successfully applied it during chemoembolization of hepatocellular carcinoma. This technique can be useful for superselection of small arteries that branch from a large parent artery at acute angles for the treatment of tumors and hemorrhages.

**Index terms:**
Angiography
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Arteries, stenosis or obstruction
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Superselective catheterization of a target artery is prerequisite for achieving effective transcatheter arterial chemoembolization (TACE) in hepatocellular carcinoma patients and for performing transcatheter arterial embolization (TAE) in patients who are experiencing gastrointestinal bleeding. There have been remarkable advances in the low-profile coaxial catheter system, including the introduction of a hydrophilic coating. We can now select small target vessels more easily without inducing spasms and then selectively embolize them.

Yet sometimes, when a target branch vessel arises at a steep acute angle from a wide parent artery, it can be technically difficult to advance a micro-guide wire into the branch vessel or to advance a microcatheter over the inserted micro-guide wire.

Consequently, the patient and the operator may be exposed to more radiation, and the patient may be given more contrast media; repetitive manipulation of devices in the vessel can result in damage to the blood vessels or failure of catheterization.

We developed a useful superselective catheterization technique by using preshaping of micro-guide wire into a shepherd's hook form to overcome this challenging situation. Herein, we report on our experience with employing this technique during chemoembolization of hepatocellular carcinomas when conventional techniques failed to superselectively catheterize a tumor-feeding artery that branched at an acute angle.

## MATERIALS AND METHODS

### *Patient Group*

This retrospective study received institutional review board approval. From February 2003 to August 2004, six patients with hepatocellular carcinoma underwent TACE with use of preshaping of micro-guide wire into a shepherd's hook form and they were included in this study. This technique was used when conventional techniques failed during superselective catheterization of target branch vessels that arose at a steep acute angle from a wide parent artery.

The patient population included six men who ranged in age from 37 to 71 (mean age: 54 years). For five cases, hepatocellular carcinoma had been diagnosed by the typical CT and angiographic findings. The postoperative pathologic diagnosis was available in one case. The target arteries were the right inferior phrenic artery (n = 4) and the left gastric artery (n = 1) from the celiac axis with celiac stenosis due to compression by the median arcuate ligament and the proper hepatic artery from the gastroduodenal artery (n = 1) in a patient suffering from celiac axis occlusion with collateral circulation via the pancreaticoduodenal arcade from the superior mesenteric artery.

### *Techniques*

A series of schematic diagrams illustrate the concept of this technique (Fig. 1). A 0.016-inch micro-guide wire (Conic-16 Torque wire guide; Cook, Bloomington, IN) and a microcatheter (Microferret-18; Cook, Bloomington, IN) were used for this technique. First, the tip of a micro-guide wire is preshaped like a shepherd's hook via manual manipulation. The 3 cm length tip of the micro-guide wire is made of spring coil, and this allows the micro-guide wire to recover its preshaped form when it is released from the end hole of a microcatheter.

In a wide parent artery, the shepherd hook shape of the micro-guide wire can be formed by the conventional method that's used when shaping a conventional angiographic catheter in the aorta (Fig. 1A).

Once the shape is formed, a side branch vessel arising at an acute angle can be selected by retracting the micro-guide wire during torque control of the wire tip position (Figs. 1B, C). The micro-guide wire may be advanced further and a microcatheter can follow the deeply inserted micro-guide wire (Figs. 1E, F). TACE was performed with an emulsion of iodized oil and doxorubicin hydrochloride along with gelatin sponge particles, as has been described in detail elsewhere (1–3).

### *Representative Case*

The patient was a 52-year-old male with multiple nodular hepatocellular carcinomas in segments 4 and 8, according to Couinaud's liver segment classification (Fig. 2A). On the celiac angiography, the celiac trunk showed severe stenosis due to compression by the median arcuate ligament, and the left gastric artery originated at an acute angle from the poststenotic dilated segment of the celiac trunk (Fig. 2B). The tumor in hepatic segment 4 was supplied by the replaced left hepatic artery from the left gastric artery (Fig. 2C). Because of the acute angle and the poststenotic dilatation, it was impossible to catheterize the left gastric artery with using conventional techniques. After positioning a 5-Fr RH catheter (Cook, Bloomington, IN) at the orifice of the celiac trunk, a microcatheter (Microferret-18; Cook, Bloomington, IN) was placed in the proximal segment of the celiac trunk and a 0.016-inch micro-guide wire (Conic-16 Torque wire guide; Cook, Bloomington, IN) was manually shaped to take the form of a shepherd's hook. The preshaped micro-guide wire was advanced into the poststenotic dilated segment of the celiac trunk beyond the distal opening of the microcatheter and the orifice of the left gastric artery. The micro-guide wire successfully recovered its preshaped shepherd's hook form by employing the same maneuver that's used in shaping a conventional angiographic catheter in the aorta (Fig. 2D). Next, the micro-guide wire was retracted until the tip of the micro-guide wire passed the orifice of the left gastric artery (Figs. 2E, F). Once the tip of the micro-guide wire passed the orifice, we then advanced it further, with meticulous torque control, into the distal part of the left gastric artery. Finally, the microcatheter was successfully placed in the segmental hepatic artery that supplied the tumor, and segmental chemoembolization was then performed (Figs. 2G–I).

## RESULTS

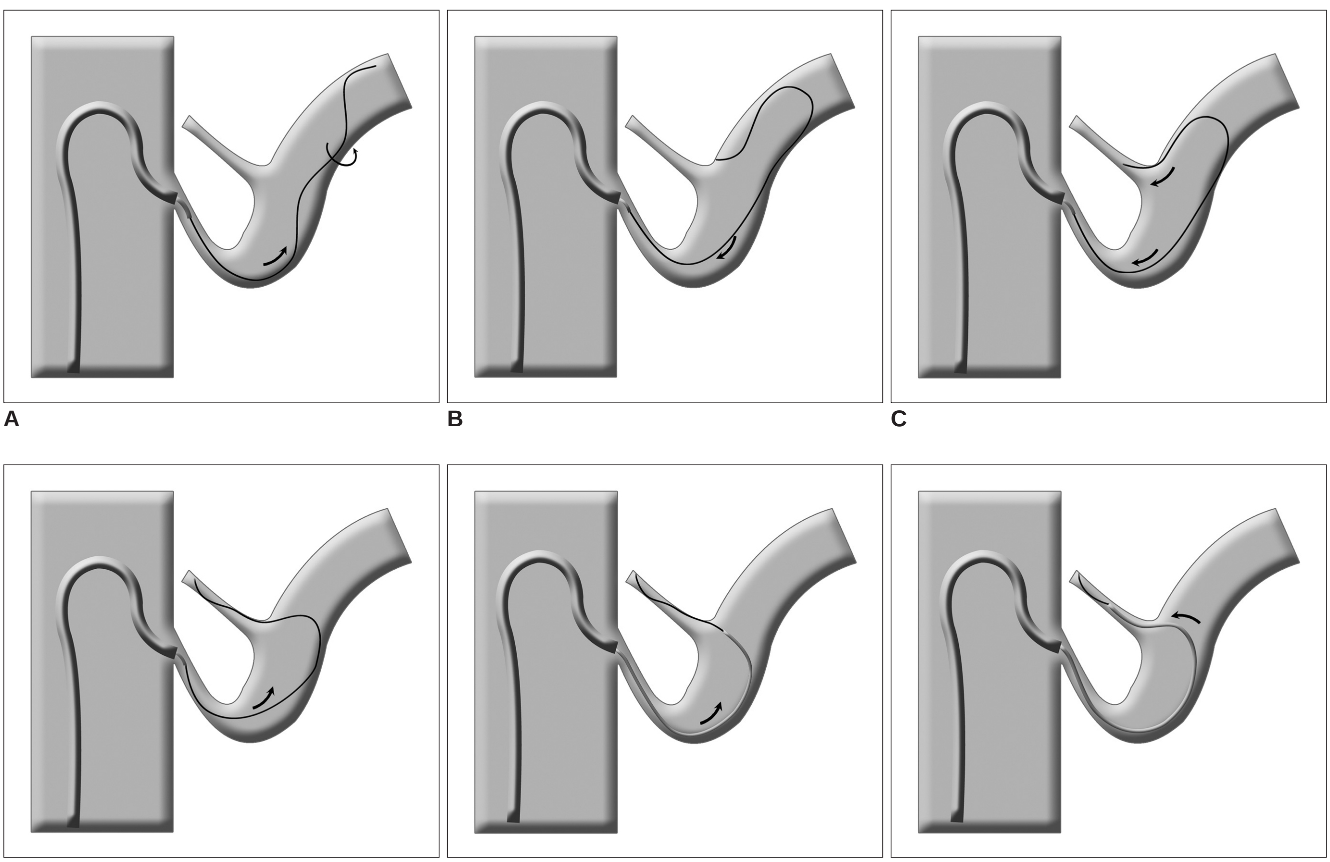
Selective catheterizations of the targeted arteries were achieved in all six patients. Satisfactory TACE procedures were performed for all the patients. In one case in which the approach to the proper hepatic artery was done through the pancreaticoduodenal artery, multiple tumor stainings were noted on the angiography, so superselection of the feeding arteries was not possible. For the other five cases, the feeding arteries, which included four right inferior phrenic arteries and one left hepatic artery, were properly selected and satisfactory chemoembolizations were achieved. There were no significant complications such as arterial dissection.

## DISCUSSION

The recent development of better coaxial microcatheters, guide wires and digital angiographic equipment have enabled more peripheral superselective catheterization of distal vessels, and so this permits more selective vascular intervention. Yet radiologists are now faced with more challenging situations for performing superselective catheterization with the growing demand for superselective catheterization using microcatheters.

One of these challenging situations is to catheterize branch vessels that originate from a large parent artery at an acute angle.

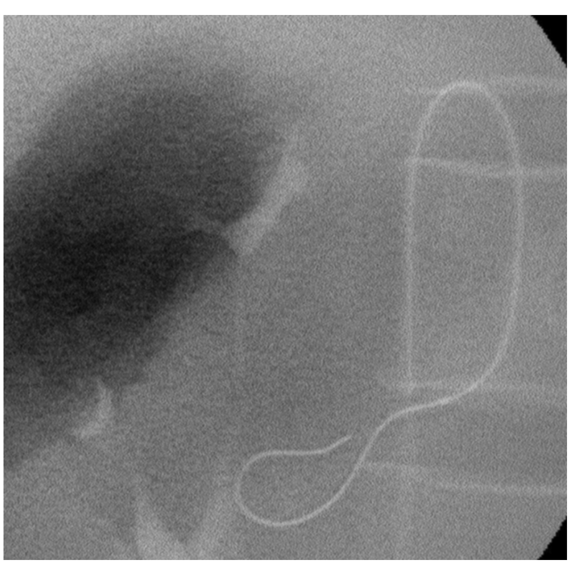
For chemoembolization of hepatic tumors, it has become a routine procedure to superselect multiple tumor feeding arteries with microcatheters, including aberrant



A B C D E F

**Fig. 1.** Conceptual illustrations of selective catheterization with use of preshaping of a micro-guide wire into a sphepherd's hook form.
**A.** The micro-guide wire advances through the stenotic segment of the greater vessel into the distal portion that shows post-stenotic dilatation. It then rotates to recover its preshaped form.
**B.** After recovery of the preshaped shepherd's hook form, the micro-guide wire is pulled back.
**C.** During its backward movement, the tip of the micro-guide wire catches the opening of the targeted vessel, such as right inferior phrenic artery.
**D.** After the tip catches the opening of the targeted vessel, micro-guide wire advances into it.
**E.** As the wire stays in the targeted vessel, the microcatheter advances coaxially.
**F.** Finally, the micro-guide wire and microcatheter proceed together into the target vessel.

A B C D



E

**Fig. 2.** Selection of the left gastric artery from the celiac artery with preshaping of a micro-guide wire into a shepherd's hook form.
**A.** Two viable tumors are seen in segment 4 and segment 8 of the liver during the arterial phase of contrast-enhanced CT (open arrows).
**B.** The angiographic image shows stenosis of the proximal celiac artery due to the external compression by the median arcuate ligament and the post-stenotic dilatation (open arrows). The left gastric artery arises at an acute angle at the proximal segment of the celiac artery (open arrowhead).
**C.** The replaced left hepatic artery from the left gastric artery supplies the tumor in segment 4.
**D.** The micro-guide wire recovers its preshaped form after passing the opening of the microcatheter in the dilated segment of celiac artery.
**E.** The micro-guide wire is being retracted.

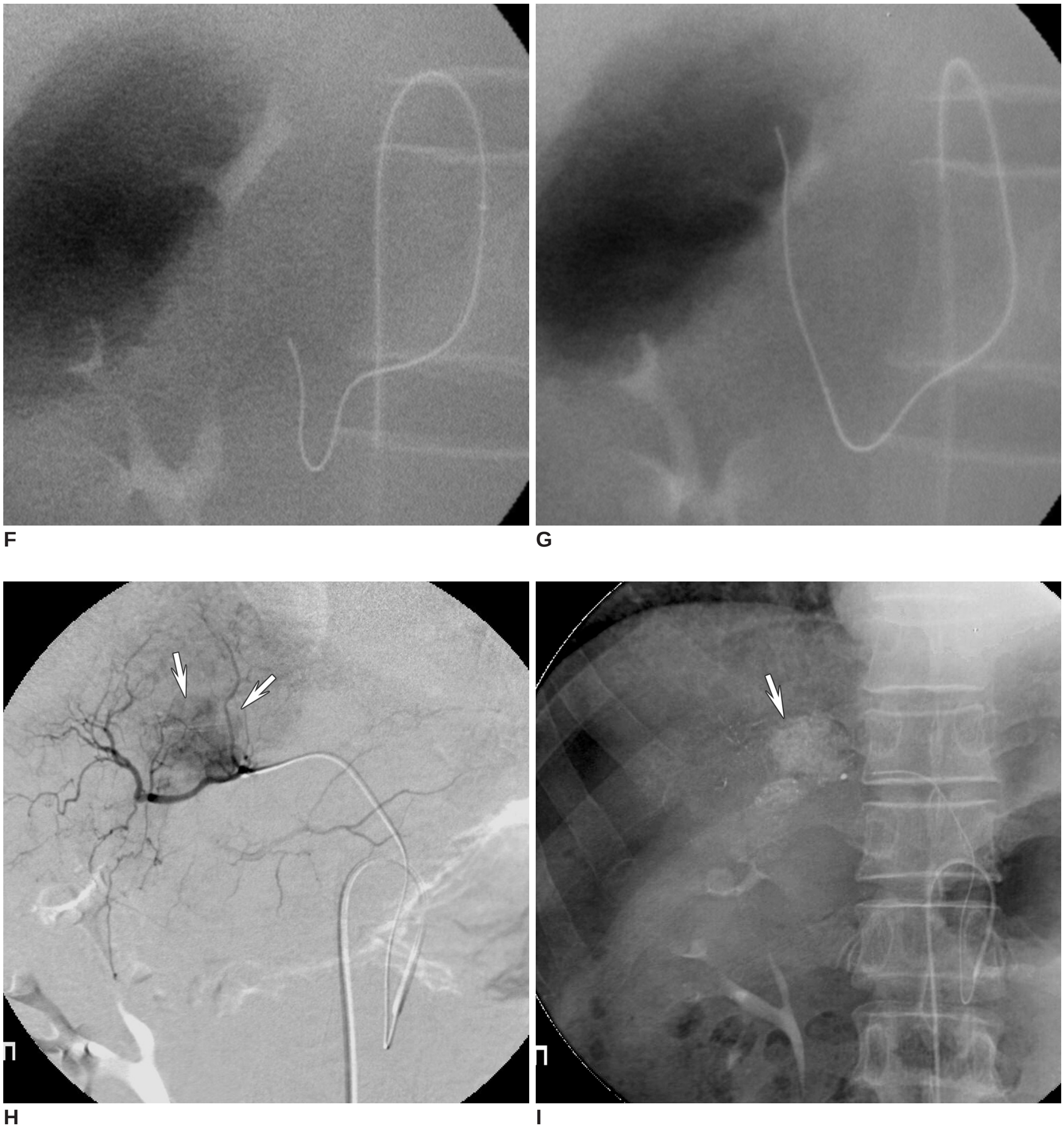



**Fig. 2. F.** The tip of the micro-guide wire passes through the orifice of the right inferior phrenic artery.
**G.** The micro-guide wire is placed in the proximal portion of the right inferior phrenic artery and the microcatheter advances coaxially.
**H.** A tumor in segment 4 is well demonstrated angiographically.
**I.** Successful chemoembolization was done for the tumor in segment 4.

hepatic arteries and extrahepatic collateral vessels. Among the extrahepatic collaterals, the right inferior phrenic artery most frequently supplies hepatic tumors (4). The most common site of origin of the right inferior phrenic artery is the proximal segment of the celiac axis. Unfortunately, the origin of the celiac axis is frequently compressed by the median arcuate ligament of the diaphragm and the celiac axis shows steep downward angulation and poststenotic dilatation, and occasionally complete occlusion (5). In the case of significant celiac axis stenosis by median arcuate ligament compression and poststenotic dilatation, it is rather challenging to perform superselective catheterization of the right inferior phrenic artery and the left gastric artery originating from the ascending part of the dilated celiac axis in the posterosuperior direction.

Several techniques have been developed that are useful to selectively catheterize those arteries originating at acute angles. Miyayama et al. developed a catheter with a large side hole for selective catheterization of the inferior phrenic artery that originated from the proximal portion of the celiac trunk (6). Won et al. also developed a side-hole technique with using a 5-Fr catheter and microcatheters to select bronchial arteries of an anomalous origin or a nonbronchial systemic artery originating from the proximal subclavian arteries (7).

Still, these methods require structural modification of angiographic catheters and a side-hole should be created in the proper position. Kwon et al. developed a microcatheter loop technique for accessing the proper hepatic artery through the pancreaticoduodenal arcade when selective catheterization of the proper hepatic artery through the common hepatic artery was not possible due to complete occlusion of the celiac axis (8). Kiyosue et al. developed a turn-back technique for catheterizing arteries that originate at acute angles (9). With using this technique, the microcatheter forms a turn in the parent artery and the tip of the microcatheter and the micro-guide wire access the target artery in a retrograde manner. But these methods cannot be easily used in the case of accompanying celiac stenosis because they need enough space to 'turn back' the microcatheters and guide wires. Also, the length of the microcatheter and micro-guide wire forms an unpredictable shape and so it difficult to control the torque. For the inexperienced angiographer, there is increased risk of arterial dissection as a result of repeated attempts at catheterizing the celiac axis when the trunk is significantly compressed or occluded. It's been recommended to use appropriate catheterization techniques to minimize arterial injury (8). With using our technique, the risk of intimal injury caused by the catheter will be reduced because the catheter does not have a sharp angled tip. It is not so technically difficult to preshape the micro-guide wire like a shepherd's hook via manual manipulation. However, the lumen of the parent artery should be large enough for the micro-guide wire to recover its preshaped form, although this does not matter in the case of celiac artery stenosis because the stenosis usually results in post-stenotic dilatation. For all the patients in our study, their targeted arteries were successfully catheterized and satisfactory TACEs were performed.

There are some limitations in our study. First, a relatively small number of patients were included in our study, and we did not test the diverse kinds of shapeable micro-guide wires and microcatheters. Therefore, technical failures and complications that were not encountered in our study may occur in a larger series. Second, it was an uncontrolled study, and randomized comparison with other techniques was not performed.

In conclusion, we have developed an effective technique for the superselection of vessels with use of preshaping of a micro-guide wire into a shepherd's hook form, and we successfully applied it for chemoembolization of hepatocellular carcinoma. This technique can be useful for superselection of small arteries that branch at acute angles from a large parent artery during the treatment of tumors and hemorrhages.

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