Use of A Catheter with A Large Side Hole or Cleft in Selective Catheterization of Small Branch Arteries

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Abstract
Selective catheterization of some branch arteries may occasionally be impossible, especially small branches arising from a large parent artery or the aorta with an acute angle at the orifice. A catheter with a large side hole or cleft is a useful device for selecting such branch arteries. This catheter can be made easily during the procedure from a conventional angiographic catheter as individual anatomy requires, and a microcatheter-guidewire system can be advanced into the desired branch artery through the side hole or cleft.

Key words: Selective catheterization, technique, catheter with a large side hole, catheter with a cleft
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Introduction
Selective catheterization of the desired branch artery is key to performing safe and effective vascular interventions. It has become possible to introduce a microcatheter into almost all desired branches due to advances in catheter and guidewire technologies, but several branch arteries may occasionally be impossible to catheterize. This especially occurs in small arteries arising from large parent arteries or the aorta with an acute angle at the orifice. Several catheterization techniques have been reported for arteries that cannot be selected using conventional techniques [1-9]. Among them, the use of a catheter with a large side hole or cleft is simple and facilitates selective catheterization of the desired branch artery (Figs. 1-3) [1, 3, 4]. We describe our experience in this paper.

Branch arteries presenting with difficult catheterization

1. A branch arising from the proximal portion of a major artery at an acute angle

Selective catheterization of a branch artery arising from the proximal portion of a major artery at an acute angle, such as the inferior phrenic artery (IPA) (Fig. 4) or the right renal capsular artery (RCA) (Fig. 5) arising from the celiac or renal artery, is frequently difficult to catheterize with a standard angiographic catheter and coaxial technique [1, 2, 4, 5]. Even if a shepherd hook catheter is pulled back just before it falls out of the celiac or renal artery into the aorta, its tip is still located distally from the orifice of such branches, and a microcatheter cannot be advanced using a coaxial technique. In Japan, several types of angiographic catheters are commercially available with acute angular tips for advancement into the IPA orifice arising from the superior surface of the celiac trunk [6]. Selective catheterization is sometimes difficult because the site of the IPA orifice varies; therefore, several types of angular tip catheters are necessary for varying individual anatomies. In addition, the risk
of intimal injury caused by the catheter tip is also present.

2. A branch arising from the distal portion of a large parent artery at an acute angle

Selective catheterization of a small branch artery arising from the distal portion of a large parent artery at an acute angle, such as the IPA (Fig. 6), RCA (Figs. 7, 8), left gastric artery, or dorsal pancreatic artery (Fig. 9), is also sometimes difficult. In such branch arteries, deep microguidewire advancement is usually difficult because a selective-type microcatheter is soft and cannot support microguidewire manipulation. Additionally, the tip of the current mi-
Figure 4. The right IPA arising from the proximal portion of the celiac artery. A: Arterial phase CT shows the right IPA arising from the proximal portion of the celiac artery (arrowhead). B: Celiac arteriogram. The arrow indicates the right IPA. C: The right IPA was successfully selected using a catheter with a large side hole, and transcatheter arterial chemoembolization (TACE) was performed. The arrow indicates the side hole.

Figure 5. The right RCA arising from the proximal portion of the right renal artery. A: The right renal arteriogram shows the right RCA arising from the proximal portion of the right renal artery (arrow). B: The right RCA was successfully selected using a catheter with a large side hole, and TACE was performed. The arrow indicates the side hole.

Figure 6. The right IPA arising from the distal portion of the celiac artery. A: Arterial phase CT shows the right IPA arising from the distal portion of the celiac artery (arrowhead). B: Celiac arteriogram. The arrow indicates the right IPA. C: The right IPA was successfully selected using a twist catheter with a large side hole. The arrow indicates the side hole.
croguidewire is flaccid, and easily dislodged into the distal parent artery when deep insertion is attempted. The use of a preshaped microguidewire to select such branches has been reported [8], but control of the preshaped tip may be difficult in the tortuous segment and cause intimal injury.

3. A branch arising from the aorta at an acute angle

Small branch arteries arising from the aorta with an acute angle at the orifice, such as the IPA (Figs. 10, 11, 12), adrenal arteries, and lumbar arteries, may occasionally be impossible to catheterize. The tip of a conventional angiographic catheter frequently hits the vessel wall at the angled portion of the orifice in these branches, and a microcatheter-guidewire system cannot be advanced into the vessel lumen [3, 4]. Additionally, there is a risk of intimal injury caused by the angiographic catheter tip or microcatheter-guidewire system (Fig. 10).

Figure 7. The right RCA arising from the segmental artery of the right renal artery. A: Right renal arteriogram shows the right RCA (arrowhead) arising from the segmental artery at an acute angle. B: The branch was successfully selected using a shaped catheter with a large side hole, and TACE was performed. The arrow indicates the side hole (Reprinted with permission from reference 4.).

Figure 8. The right RCA arising from the distal portion of the right renal artery. A: Right renal arteriogram shows the right RCA arising from the lower portion of the right renal artery (arrow) at an acute angle. B: The branch was successfully selected using a shaped catheter with a large side hole, and TACE was performed. The arrow indicates the side hole.
Creation of a catheter with a large side hole or cleft

Although a catheter with a large side hole or cleft is not commercially available, it can be made easily from a common angiographic catheter during the procedure, as individual anatomy requires, since this catheter does not have a specific shape. It should be noted that modification of the angiographic catheter is not approved by the manufacturer, and the operator takes full responsibility when doing so.

1. A catheter with a large side hole

A large hole approximately 3 to 5 mm in length, enough to advance a microcatheter, is created using a surgical scalpel (Feather Safety Razor, Osaka, Japan) at the desired site on an angiographic catheter facing the target vessel orifice (Figs. 1, 3) [1]. To select the IPA or RCA arising from the proximal portion of the celiac or renal artery, the large side hole is usually created near the tip of a shepherd hook catheter (Figs. 4, 5). A 5-F catheter (Hanako Medical, Kobe, Japan) was first used for this purpose [1], but now the large hole can be created in a 4-F catheter (Terumo, Tokyo, Japan, Medikit, Tokyo, Japan, Hanako Medical) [4].

A catheter with a large side-hole can also be applied to
selective catheterization of a small branch arising from the distal portion of a large artery at an acute angle (Figs. 6-9). For this purpose, the side hole is created in a 4-F twist (Hanako Medical) or curved catheter (Terumo), shaped using steam to face the target branch orifice when the catheter is seated in the parent artery. In our experience, a catheter with a large side hole is useful for selective catheterization of the internal mammary (Fig. 13) and iliolumbar arteries (Fig. 14) arising from tortuous parent arteries, which are impossible to catheterize using a conventional coaxial technique. Successful catheterization of the bronchial artery arising from the proximal subclavian artery through a side hole in a headhunter catheter was also reported [9].

2. A catheter with a cleft

During the procedure, a cleft of approximately 3 mm in length is also created with a surgical scalpel at the tip of a 4-F shepherd hook catheter (Hanako Medical, Terumo) (Figs. 2, 3) [3, 4]. The cleft is created at the desired site on the catheter tip according to the vessel angulation as determined by computed tomography and angiographic findings. For example, if the desired artery turns sharply right at the orifice, the cleft is created on the right side of the catheter. Because the catheter tip becomes sharp, there is a potential risk of intimal injury with use (Fig. 10).
Manipulation of a catheter with a large side hole or cleft

1. A catheter with a large side hole

After the catheter is introduced into the parent artery, the side hole is positioned at the desired branch orifice by injection of contrast material. The side hole is larger than the end hole, so the contrast material flows through and is easily recognized. When the desired branch is opacified with contrast material, the catheter is held in place and a microguidewire is introduced through the side hole into the desired branch. The microcatheter can then be advanced over the wire.

There are several advantages to using a catheter with a large side hole. First, this catheter is introduced deep into the major artery, which stabilizes the catheter and eases positioning of the side hole. Second, as the microguidewire...
passes through the side hole, it faces the target branch artery’s orifice due to the side hole position. Third, the catheter shaft can support microcatheter-guidewire manipulation up to the side hole. Finally, the risk of intimal injury caused by the catheter may be low because it does not have a sharp angled tip.

2. A catheter with a cleft

This catheter has a sharp edge and should be manipulated carefully in the aorta. When a catheter with a cleft is inserted into the desired artery, the microcatheter-guidewire system is advanced through the catheter. The angled tip of the microguidewire is positioned facing the cleft and can be advanced easily into the target branch. The microcatheter is then advanced over the wire, through the cleft, and into the vessel.

Technical tips for safe use of a catheter with a large side hole or cleft

Although a larger-sized side hole can facilitate microguidewire-catheter system advancement, it reduces the rigidity of the catheter; the side hole size is therefore critical. If the catheter is kinked at the side hole, it is difficult to advance the microguidewire. Inappropriate manipulation of the kinked catheter may also cause intimal injury in the target artery, sever the catheter tip, or damage the microcatheter-guidewire system. The use of a 5-F catheter is recommended in such cases.

If the desired branch artery is not opacified with contrast material, the side hole may not be placed near the orifice of the target branch. In such a condition, re-shaping the angiographic catheter with steam or creation of a side hole in a new catheter is recommended.

At the end of the procedure, the microcatheter should be removed before the catheter with the large side hole is withdrawn. If the microcatheter and catheter are withdrawn together, they cannot be removed through the sheath and there is a risk of severing the microcatheter.

Conclusion

A catheter with a side hole or cleft is a useful device for selective catheterization of desired small branch arteries that cannot be catheterized using a conventional technique. Interventional radiologists should be familiar with this technique in order to perform safe and effective procedures.

Conflict of interest: The authors declare that they have no conflicts of interest to report.

References