Angioplasty – Renal Artery

Ryoichi Tanaka, M.D., Ph.D.
Iwate Medical University, Morioka, Japan
Katsutoshi Takayama, M.D., Ph.D.
Depertment of Radiology and Interventional neuroradiology, Ishinkai Yao General Hospital, Osaka, Japan

Introduction

Percutaneous transluminal renal angioplasty (PTRA) has been a less invasive treatment option for renal artery stenosis. However, due to recent improvements in medical therapy, some trials found PTRA results to be negative. However, PTRA is still an important procedure for treating renovascular hypertension and we should continue to pay attention to its efficacy and indication.

Diagnosis of renal artery stenosis

Renal artery stenosis (RAS) reduces renal blood pressure, activates renin-angiotensin-aldosterone system, and causes systemic hypertension.

The detection of renal artery stenosis begins with a suspicion of secondary hypertension.

According to the recent ESC guidelines[1)], major clinical signs of RAS include refractory hypertension, unexplained renal failure, and flash pulmonary edema. Additionally, hypertension in young patients and rapid worsening of hypertension in elder patients are also important clinical signs **(Table1)**.

When RAS is suspected, duplex ultrasonography is the first choice for detecting lesions. Increased peak systolic velocity (PSV > 180 cm/sec) and/or Renal / Aortic PSV Ratio (RAR > 3.5) are used to determine relevant RAS, and corresponds to ≥60% angiographic RAS [2)].

Both CTA and MRA have demonstrated equally high sensitivities for the detection of hemodynamically significant stenosis. However, the requirement of iodinated contrast media on CT and the use of gadolinium on MRI are concerns in treating patients with renal dysfunction. Non-contrast MRA is an alternative, but may over-estimate lesion severity. Nevertheless, CTA and MRA have better potentials in evaluating lesions at accessory renal arteries than duplex ultrasonography.

Indications of PTRA

Indications of PTRA are shown in **Table 2.3**

In short, the base inclusion criterion is to have hemodynamically significant RAS. In the determination of hemodynamically significant RAS, duplex ultrasonography is the most important as mentioned above.

The occurrence of hemodynamically significant RAS can be confirmed by criteria such as: resistant hypertension to medical therapy alone, exacerbating hypertension, malignant hypertension, hypertension with idiopathic unilateral kidney atrophy, and FMD (refer to Table 1 for further details). However, according to 2017 ESC guidelines, routine revascularization is not recommended in RAS secondary to atherosclerosis, therefore indication should be evaluated carefully.

The bilateral RAS and solitary functioning kidney are also included for the indications. Furthermore, cardiac disturbance syndromes such as idiopathic pulmonary edema which develop suddenly, repeated heart failure, and unstable angina are also noteworthy [3, 4].

For arteriosclerosis RAS, stent use is indicated in patients who meet criteria for intervention. And for fibromuscular dysplasia RAS (FMD-RAS), PTA (with "bailout" stent use) is also indicated. (ACCF/AHA guideline, Class I, level of evidence B)

Renal artery stenosis may also cause ischemic nephropathy, but PTRA is not recommended for the prevention of renal impairment.

Indication of renal artery stenting

As indicated in ACCF/AHA guideline, renal artery stent for ostial arteriosclerotic RAS are recommended.

For FMD-RAS, the use of balloon angioplasty is favorable; therefore, stent use is limited as a "bailout" option, i.e. as a last resort. The location of FMD-RAS varies from the proximal to the middle of the renal artery and not ostial. Bending or stretching can be seen especially in the middle segment of renal artery due to the significant mobility of the kidney while breathing. Stenting at this bending portion might be a risk of stent fracture[5, 6].

For RAS due to Takayasu disease, renal artery stenting is not recommended in cases without flow-limited dissection and/or residual significant stenosis after balloon angioplasty, because stenting can result in lower patency rates and higher occlusion rates than those not stented[7].

Procedure of PTRA

At least 1 week before PTRA, 100 mg aspirin and 1 other antiplatelet agent (i.e. clopidogrel 75 mg/day) should be administered and continued for at least 30 days after procedure. Unfractionated heparin is administered during the procedure to maintain an activated clotting time (ACT) over 250 s or two to three times compared to baseline ACT. After procedure, heparin does not need to be administered.

Because of the recent trend to the smaller interventional system, a 0.018- or 0.014-inch guidewire system is used for the standard procedure. These fine guidewires provide less support than the 0.035-inch guidewire, so that the access to the renal artery via femoral artery is difficult in extremely caudal angulated off-takes of the

renal artery. In such cases, brachial or radial access should be considered.

A 6-Fr guiding catheter is mostly used for renal artery intervention. The most frequently used guiding catheter configuration is "Renal Double Curve" or "Hockey Stick." However, in cases with smaller aortic diameters, which are typically seen in most Asian populations, "Renal Double Curve 1", "IMA", or "Judkins right" is appropriate.

A 4-Fr diagnostic catheter is used as a coaxial system for the selection of renal artery **(Figure 1)**. Non-touch technique is protective method for avoiding plaque disruption **(Figure 2)** but the use of this technique is not effective in torturous aorta and sometimes makes the control of catheter direction difficult. The most important point is the careful and protective management of the guiding catheter and guidewires during the procedure.

When inserting the stent to the renal artery, it is better to advance the guiding catheter past the lesion. Advancing the guiding catheter while slowly deflating the pre-dilatation balloon better ensures smooth insertion of the guiding catheter tip to the distal renal artery across the lesion. This technique is also useful for inserting the catheter tip into the stent placed at the ostium of the renal artery **(Figure 3)**.

Follow-up

The follow-up is done by tracing the change of blood pressure and medication dose. When a blood pressure drops immediately after the procedure, close follow-up is required. Tracing renal function is also important. Since the duplex sonography can detect changes in renal blood flow non-invasively, this modality is also the first choice of functional and anatomical imaging in follow-up period.

The reduction of the blood pressure or medication dose is achieved in almost 70% of cases. However, the number of patients who became drug free is very small, and a multi-disciplinary approach is required.

Conclusion

Although the indication of PTRA has been very limited according to 2017 ESC guidelines, PTRA still has important indications for cardiac disturbance syndrome and FMD.

In conclusion, interventional radiologists would benefit from familiarizing themselves with PTRA procedure.

Table 1. Clinical situations raising suspicion for renal artery disease

Clinical presentation
Onset of hypertension before the age of 30 years
Onset of severe hypertension after the age of 55 years, when associated with CKD or heart failure
Hypertension and abdominal bruit
Rapid and persistent worsening of previously controlled hypertension
Resistant hypertension (i.e. other secondary form unlikely and target not achieved despite four drugs classes including diuretic and a mineralocorticoid-receptor antagonist in appropriate doses)
Hypertensive crisis(i.e. acute renal failure, acute heart failure, hypersensitive encephalopathy, or grade 3-4 retinopathy)
New azotemia or worsening renal function after treatment with RAAS blockers
Unexplained atrophic kidney or size discrepancy or unexplained renal failure
Flash pulmonary edema

CKD = chronic kidney disease; RAAS = renin-angiotensin-aldosterone system.

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Table 2. Indications for Percutaneous Transluminal Renal Angioplasty

JSH2014 Guidelines	ACCF/AHA Guideline
1. Hemodynamically significant RAS	
i. Resistant hypertension to medical therapy alone	Class IIa
ii. Exacerbating hypertension	Class IIa
iii. Malignant hypertension	Class IIa
iv. Hypertension with idiopathic unilateral kidney atrophy	Class IIa
v. Idiopathic pulmonary edema that suddenly develops	Class I
vi. Repeated heart failure	Class I
vii. Unstable angina	Class IIa
viii. fibromuscular dysplasia	Class I
2. Bilateral RAS	Class IIa
3. Progressive CKD with RAS of a solitary functioning kidney	Class IIa

Table 3. Recommendations for treatment strategies for renal artery disease on 2017 ESC Guidelines

Revascularization	Class	Level
Routine revascularization is not recommended in RAS secondary to atherosclerosis.	III	A
In cases of hypertension and/or signs of renal impairment related to renal arterial fibromuscular dysplasia, balloon angioplasty with bailout stenting should be considered.	IIa	B
Balloon angioplasty, with or without stenting, may be considered in selected patients with RAS and unexplained recurrent congestive heart failure or sudden pulmonary oedema.	IIb	C
In the case of an indication for revascularization, surgical revascularization should be considered for patients with complex anatomy of the renal arteries, after a failed endovascular procedure or during open aortic surgery.	IIa	B

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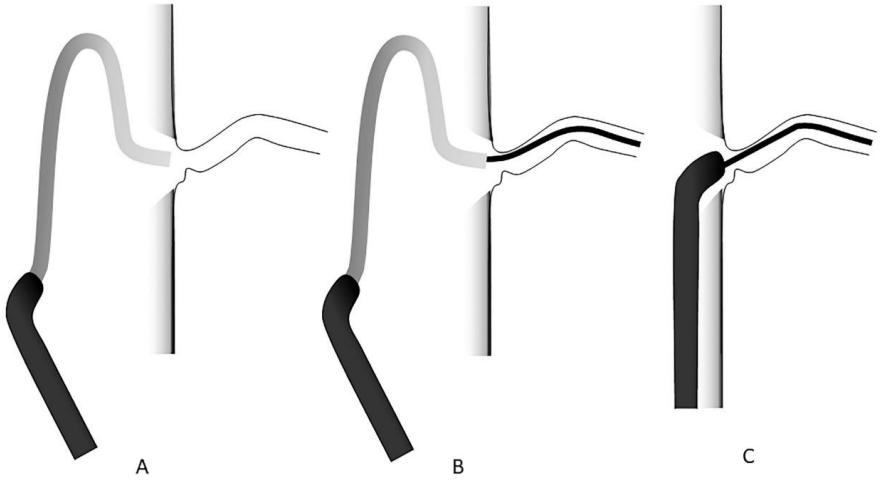

Figure 1. Coaxial technique to select the renal artery

Diagnostic imaging catheter (longer than the guiding catheter) is inserted in the guiding catheter and select the renal artery (A). The guidewire (typically 0.035-inch guidewire) inserted and pass through the lesion (B). Withdrawing the imaging catheter and advancing the guiding catheter with the support of the guidewire (C). When the lesion is tight and in case with need exchanging the guidewire, advancing the imaging catheter to the distal of the renal artery is the alternative use after (B).

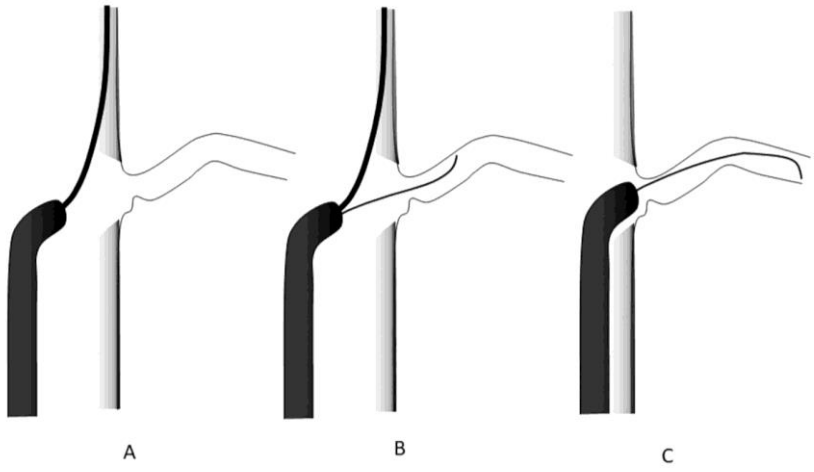

Figure 2. Non-touch technique

Inserting 0.035-inch guidewire through the guiding catheter. The guidewire left in the aorta support the guiding catheter tip without attaching to the atheroma (A). Careful selection of renal artery with the smaller diameter guidewire (B). After the selection of renal artery by the guidewire, support wire is removed. Then the guiding catheter can select the ostium of the renal artery without attaching atheroma at the adjacent to the ostium of renal artery (C).

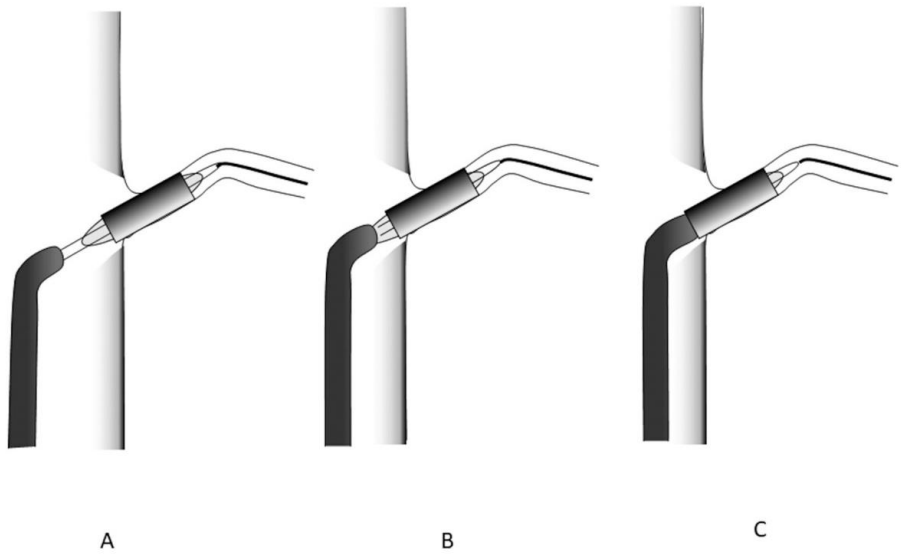

Figure 3. Navigation of the guiding catheter into the stent
After the dilatation of the lesion (stent), release the balloon lumen to the atmospheric pressure without completely deflation (A). Then, advance the catheter tip at the shoulder of the balloon (B). With supporting balloon catheter, advance the guiding catheter slowly (C). When the deflation of the balloon was not effectively achieved, then slowly deflate the balloon with in-deflation device.

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