10 How to treat small vessels

Strategy for Lesions in Small Vessels

Etsuo Tuchikane,M.D.　Osaka Medical Center for Cancer and Cardiovascular Center

1. **Introduction**

For the purposes of this report, “small vessel lesions” are defined as those that occur where reference vessel diameters are less than 3.0mm on angiography. These lesions broadly classify into two groups according to the size of the reference vessel. The first group is those found in “true” small vessels with an angiographic size <3.0mm (including both proximal and distal areas), with a media to media distance (hereafter M-M) of </=3.5mm. These lesions are usually located at the mid-to-distal portion of the main coronary artery or in its branches. The second group contains lesions observed in apparently small vessels that are in fact found under IVUS to be large vessels containing diffuse plaque extending from the target site; these vessels usually have M-M>/= 3.5mm, including at the lesion site. This group of lesions is often located in the proximal portion of the coronary artery; it is also often observed in DM patients. The treatment strategies for these two groups are addressed separately in this report.

2. PCI Strategy for “True” Small Vessels

The advent of the stent has brought the expansion of development of PCI, but the effectiveness of stents in true small vessels can not yet be said to be entirely satisfactory. One of the reasons is that stenting in small vessels, where sufficient space for adequate stent expansion is not available, prevents full dilation of the device. In addition to angiography, IVUS is an excellent tool for identifying lesions in these true small vessels.

The use of IVUS in small vessels offers two advantages; it provides information about both (1) true vessel diameter and (2) any superficial calcification that might inhibit dilatation of your PTCA balloon or stent.

When trying to quantify true vessel diameter, experience teaches us that some lesions in proximal main arteries have M-M >3mm when viewed with IVUS, even though angiography has classed them small vessels. Arterial remodeling is likely to have taken place in these vessels. For distal lesions in side branches with comparatively large diameters or large diffusion areas, bear in mind that these vessels often narrow very rapidly. In short, true small vessels are easily missed by angiography alone. It is also difficult, in many cases, to determine the existence of superficial calcification (see (2) above) when relying solely on the calcification degree observed by angiography. We therefore have an aggressive policy of using IVUS in lesions where true vessel size is difficult to determine by angiography alone, or for lesions where a moderate to high degree of angiographic calcification has been observed.

The following Table outlines strategy for “true” small vessels.

<Table>　IVUS Guided PCI for Small Vessels

IVUS Media to Media / Superficiaol Calficication	3mm≦M to M<3.5mm	M to M<3mm
	Stent effective	Stent not effective
None or Arch of Calc<180°	POBA, Cutting Balloon (CB), POBA+Stent	POBA, CB ***No Stent except bail out use***
Arch of Calc≧180°	POBA+Stent Rotational Atherectomy (RA)+POBA RA+Stent	RA+POBA

In the IVUS example, it is important to pay attention to the M-M and superficial calcification at both the lesion and control or reference sites. Primary Stenting is a very effective strategy for lesions in which the M-M at the distal reference site is >/=3mm and there is limited superficial calcification. These are the lesions that see constrictive remodeling. When the arc of superficial calcification exceeds 270°primary stenting may well result in incomplete dilation and an increased probability of serious dissection. These cases are therefore better indicated for Rotational Atherectomy (RA), followed by conventional PTCA or stenting (Case 2), assuming the distal control site M-M is >3mm. If your distal control M-M is <3mm, devices other than stents should be preferred.

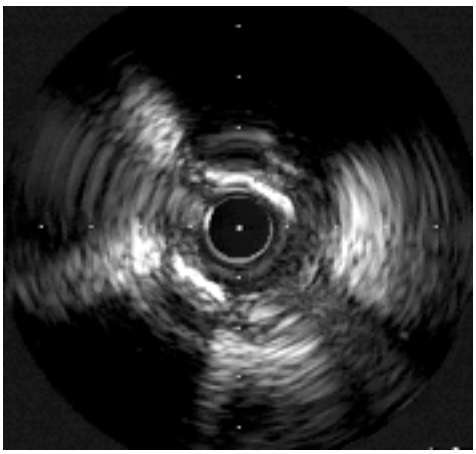
By contrast, for simple lesions, for which PCI can be guided sufficiently by angiography alone, conventional PTCA, Cutting Balloon Angioplasty or primary stenting represent the best options.

Other than as a last resort in an emergency (i.e. bail-out stenting), stenting is not advisable when the target lesion is treatable only with a 2.5mm or smaller stent (whether for procedures guided solely by angiography and or by both angiography and IVUS). The restenosis rate for these lesions is prohibitively high.

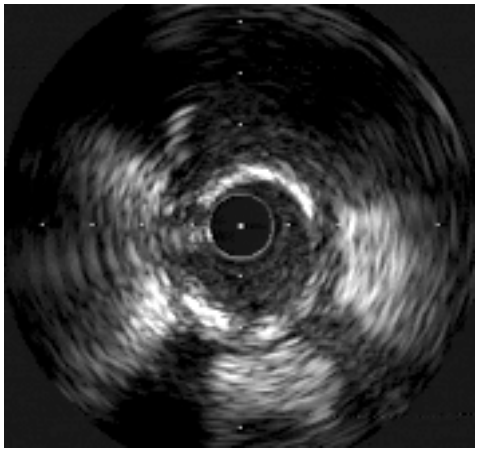
Case 1; *Rotational Atherectomy with Adjunctive Cutting Balloon Angioplasty (CBA)*
In this patient, the LAD had mild angiographic calcification, as well as a lesion extending from a diagonal branch with a comparatively large diameter (see video). IVUS was performed to obtain precise information about the calcification and true vessel diameter. The arc of superficial calcification at the lesion was <180°and M-M 3.5mm at the distal control site, though M-M immediately distal to the septal branch was as small as 3mm (by IVUS). Against this background, primary stenting may have been indicated in terms of vessel diameter, but the technique would not have solved the problem of how to treat the disease in the diagonal branch. In this case, a good result was achieved by ablating with RA (with an IVUS-guided burr size of 2.15mm) and following up with a 3.25mm CB (6 atm). No chronic-phase restenosis has been observed under follow-up IVUS (see video).

Case1Procedure

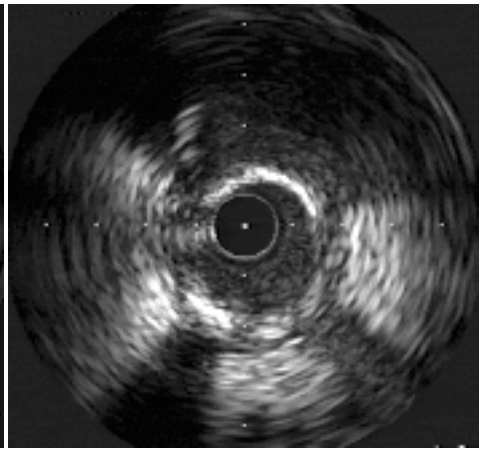
Case1Follow-up



Case1 IVUS Pre



Case1 IVUS Post



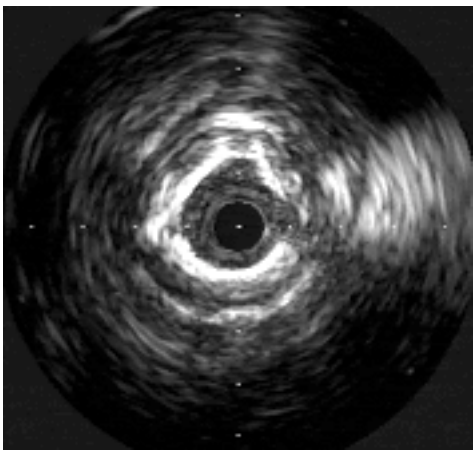
Case1 IVUS Follow-up

Case 2; *Rotational Atherectomy and Adjunctive Stenting Without Balloon Pre-dilation*

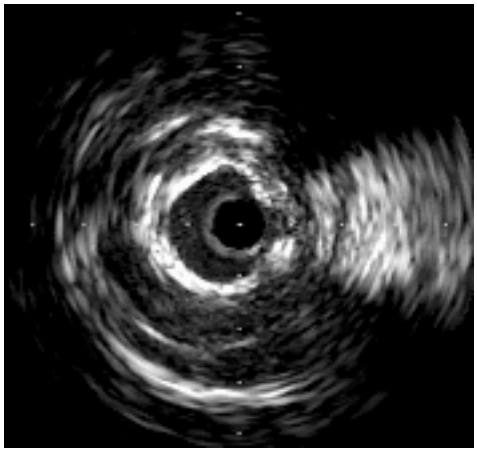
This is a chronic dialysis patient. Moderate calcification was observed in the LAD under angiography (see video) and IVUS performed. The arc of superficial calcification at the lesion approached 360°with diffuse calcification along the lesion; RA was performed using burr sizes of 1.5mm and 2.0mm. Minimum M-M distance at the lesion site was as large as 3.5mm and good expansion was achieved using a 3.5mm x 9mm NIR stent at 8atm and 12atm for implantation and post-dilatation, respectively). IVUS has no detected any restenosis at long-term follow-up. (See video).

Case2Procedure

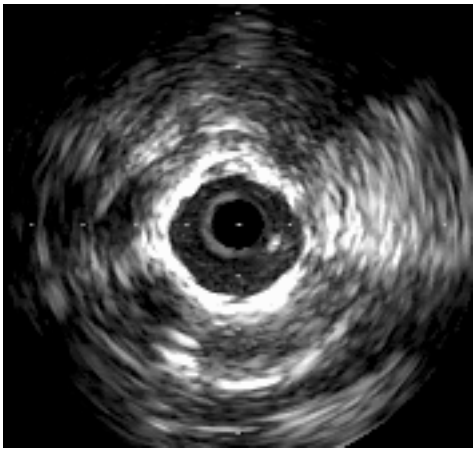
Case2Follow-up



Case2 IVUS



Case2 IVUS PostRA

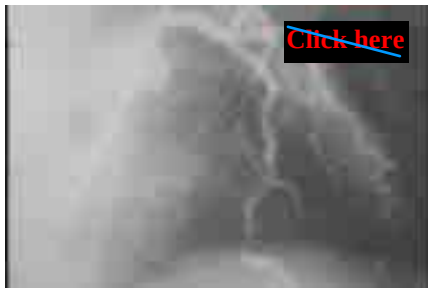


Case2 IVUS Final

Case 3; *PTCA alone*

This was an AHA/ACC-class type A lesion, located in the distal LAD and seen by angiography; a conventional 2.75mm PTCA balloon was selected as being the correct size for the lesion (see video). Cilostazol (200 mg/day) was administered to inhibit post-operative restenosis. No chronic-phase restenosis has been observed (see video). The use of a stent is best avoided in cases where the vessel will not permit the use of a stent >/=3mm.

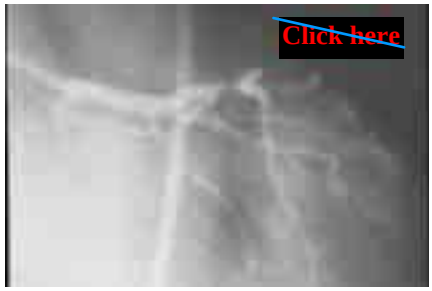
Case3Procedure



Case3Follow-up

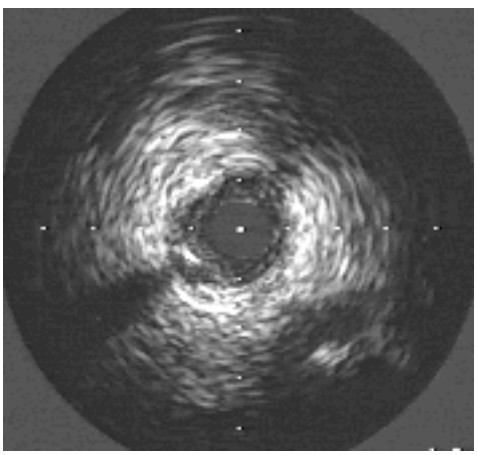
Case 4; Stand-alone Cutting Balloon (CB)

This lesion was in a high lateral branch and was correctly identified by angiography. IVUS was also used for the selection of appropriate device type and size. The lesion showed a negative remodeling pattern of a minimum M-M at the lesion site of 2.1mm, and at the distal control site of M-M 3 mm (by IVUS). M-M at the distal control site is usually indicated for a 2.75-3.0mm Cutting Balloon, but a 2.5mm CB (6 atm) was selected for this procedure to avoid the risk of perforation since IVUS found no plaque at either 5 or 11 o'clock of the lesion. Restenosis has been detected by IVUS at long-term follow-up (see video).

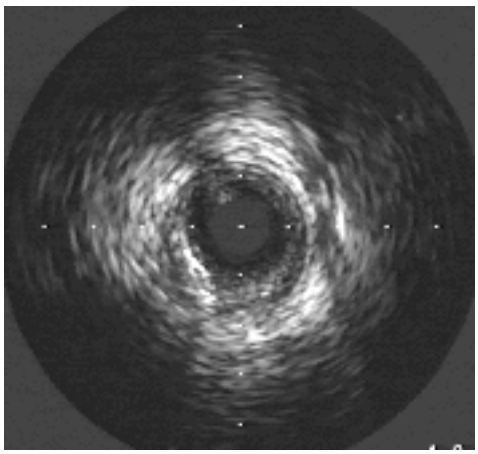


Case4Procedure

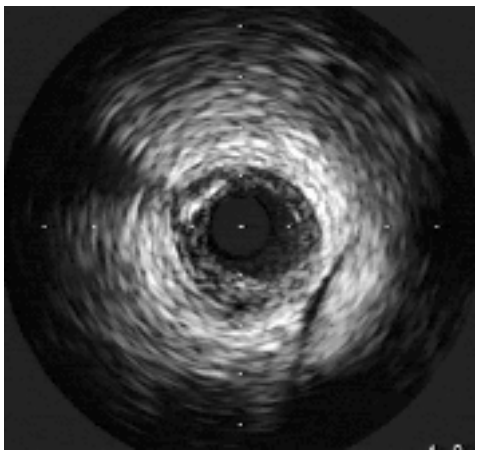
Case4Follow-up



Case4 IVUS Pre



Case4 IVUS Post



Case4 IVUS Follow-up

3. PCI Strategy For "Apparent Small Vessels"

On IVUS, we have often encountered so-called plaque-rich vessels, which have diffuse plaque all the way up to the control site and M-M of >/=3.5 mm, even if the M-M is <3.0mm on angiography. This is common with LAD proximal lesions, especially in DM patients. Only IVUS can detect them.

If small vessels are found to have proximal lesions, IVUS should always be performed. If the vessels are diagnosed to be "false" small vessels by IVUS, the strategy should be determined based on the characteristics of the plaque. It is obvious that smaller vessels have longer lesion, whether they are true or false small vessels.

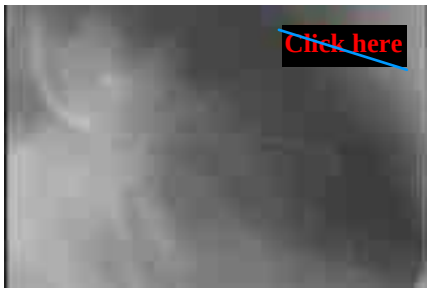
Since long lesion length alone is a reliable predictor of restenosis, simply covering the entire lesion with stent(s) is absolutely contra-indicated. Aggressive debulking using DCA is recommended if the plaque does not exhibit a high degree of calcification (superficial and <180°). Once debulking has attained a goal of an inner lumen area >8.0mm^2, or if the remaining plaque area has been reduced to around 50% or less on IVUS, finish the procedure with DCA alone is probably your best strategy. If a small amount of plaque remains, spot stenting after DCA may be effective. But if this plaque exhibits calcification, especially superficial calcification >180°treatment with conventional PTBA, CBA or if possible, RA is recommended. If soft plaque is detected contra-lateral to superficial calcification, debulking just that portion with DCA may be a good idea. In any case, provisional spot stenting should be performed if required. In false small vessels, it is important always to keep long-term prognosis in mind when selecting and implementing strategies. Full coverage of the lesion by the stent may look good, but it will increase the risk of cardiac events and, as a result, increase the probability of repeat revascularization, owing to the high restenosis rate of these diffuse lesions.

Also, a stent (or stents) positioned in a proximal coronary artery often makes it difficult to perform repeat revascularization and hampers later treatment strategy. In some cases, refractory in-stent restenosis will be induced by stenting. Multiple or full stent coverage is typically contraindicated for false (or apparent) small vessels.

Case 5; DCA and Stenting

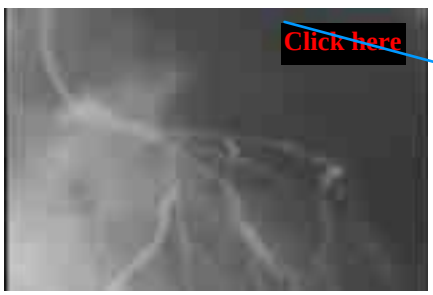
This was a proximal LAD lesion with a control diameter <3.0mm on angiography (See video-1). IVUS showed it was a fibrous plaque-rich lesion with no calcification extending to the ostium. DCA was performed using a 7F GTO up to a maximum of 40psi, under IVUS guidance (See video-2). Since the minimum lumen area was 5.35mm^2 (by IVUS), a 3.5mm Multilink stent was inserted at 10atm. As a result, an 8.18mm^2 inner lumen area was obtained and the procedure concluded (IVUS) (See video-3). Some diffuse in-stent neointimal proliferation with late-loss was observed at long-term but no restenosis as yet by IVUS (See video-4).

Case5v1



Case5v2

Case5v3



Case5v4

4. Summary

Small-vessel lesions tend to have high restenosis rates. Different surgeons have different preferences among the available treatment options. Treatment strategy for these lesions may often differ considerably from operator to operator. For PCI, device selection should be done with full reference to lesion morphology, in addition to patient background. IVUS should play a significant role in the selection of treatment options and materials. Of course there are some lesions unsuitable for IVUS evaluation.

Some very distal lesions can not be reached with IVUS, and balloon angioplasty is the only option available. The morphology of some calcified lesions also precludes the use of IVUS; use RA in these cases. With the exception of these, however, IVUS-guided intervention is of great use in small vessels.