Treating Diffuse Lesions

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Introduction

Since Gruentzig's first Percutaneous Transluminal Coronary Angioplasty (PTCA) procedures in 1977, Percutaneous Coronary Intervention (PCI) has increasingly been applied in ever more complex lesions and across a broader therapeutic spectrum of treatments in the setting of ischemic heart disease, such as angina pectoris and myocardial infarction. This expansion in indications, however, has been accompanied by the emergence of a clearer picture of the limits of these same percutaneous techniques. Heavily-calcified lesions, ostial lesions, diffuse disease and lesions at bifurcations continue to ask difficult questions of conventional balloon angioplasty, and are associated with low rates for procedural rates and high rates of restenosis. The relatively- recent introduction of intracoronary stents was a giant step forward in terms of increased procedural success and reduced chronic restenosis, but these devices have so far failed to meet the different challenges posed by heavy calcification, diffuse disease and lesions in small vessels. Not only do these types of lesions continue to resist adequate treatment by stenting, but a new clinical entity, diffuse in-stent restenosis (ISR), has appeared, further complicating the picture. Here, I set out the treatment strategies we use at our institution for diffuse coronary artery stenosis.

Importance of IVUS for Diffuse Disease

A diffuse lesion is, generally speaking, any lesion 2cm or more in length. The increased use of IVUS in PCI procedures has taught us that there is often atheromatous plaque present even in vessels that look "normal" on angiography, and that in arteries undergoing PCI, it is rare to find a part of the vessel without some atheromatous plaque covering. Performing standard PCI for these kinds of atherosclerotic lesions often results in dissection or hematoma, and the use of coronary angiography and IVUS is very important for decision-making if complications are to be avoided; specifically IVUS tells us where to dilate and what size device to use. IVUS can also provide key information before any intervention takes place. We recommend an aggressive policy of routine IVUS use before all intervention in vessels with diffuse disease, wherever possible. At our institution, we routinely consult IVUS for debulking cases with DCA or rotablator, and for diffuse lesions, and use the IVUS findings to identify target vessel diameter, plaque morphology, the presence of otherwise of calcification or vessel shrinkage (negative remodeling), and to inform decision-making on device -type and -size specifically tailored to the lesion.

PCI and Restenosis

We know that restenosis is a localized tissue response to the injury and stretch caused by intervention in

the coronary artery. That response is not limited to the intima and media (intimal hyperplasia = smooth muscle cell proliferation and secretion of inter-cellular cement), but extends also to the adventitia and contributes to chronic negative remodeling. Elastic recoil is also a contributory factor in the development of restenosis, when vessel dilatation is insufficient during PCI. In Japan today, the PCI strategies thought to result in lower restenosis are conventional PTCA but with a bigger balloon and longer dilatation, stenting, debulking (restenosis rate is inversely related to the volume of plaque removed), pre-stent debulking, and the Cutting Balloon. Treatment for diffuse disease will usually comprise one of more of these strategies, depending on the actual lesion.

Diffuse Disease and Restenosis

Diffuse lesions also vary considerably in terms of actual morphology. From the point of view of preventing restenosis, “the bigger the better” theory largely holds, and clearly leads to lower restenosis rates, but your ultimate goal is combining a debulking device with one of the many stents available to obtain the smoothest possible lumen, sized as close as possible to the original target lesion diameter, using IVUS. Single short stents result in lower restenosis rates, while stents >/=20mm long and multiple stent-implantation are associated with high rates of restenosis. Once created, diffuse disease is very hard to treat, so a useful strategy for minimizing restenosis is to debulk with DCA or a rotablator, and then dilate your stent at low pressure (>/=10atm) to obtain full circular expansion and apposition. This technique need not be applied only to diffuse lesions, but is one of the guiding principles of PCI. Another consideration is that diffuse disease often occurs when there is tortuosity in the vessel, and care should be taken when implanting the stent to make sure it conforms as much as possible to the original vessel shape, so that blood flow continues uninterrupted, reducing the risk of acute complications or chronic restenosis. You may find that coil stents, like the S670/660 devices, work well in this setting, and are also easy-to-use in side-branches.

Treating Side-branches

Generally speaking, when you are dealing with a side-branch that is stenosed (but dilatable with a 1.5mm balloon) or occluded and anticipate difficulty getting a guidewire to cross it later, use a guidewire to protect the side-branch before you intervene at all in the main vessel. Similarly, stenosis inside a side-branch carries a high risk of occlusion of the branch, so before stenting the main trunk, pre-dilate the side-branch with a conventional balloon to reduce the risk of occlusion later, and if, in the worst case scenario, the branch has already occluded, select a stent with struts that you will be able to get a guidewire through, so as to leave yourself the option of reperfusing the vessel with a balloon. Balloon selection too should be made on the basis of good balloon re-wrap (important for re-use) and a high-degree of crossability.

1. **Diffuse disease in large vessels >/= 3.0mm**

    1-1. **Linear lesions**:If vessel diameter distal to the lesion is large also, the restenosis rate even for conventional PTCA is relatively low, and good results can usually be obtained by ballooning alone. Still, avoiding plaque shift and elastic recoil are the key, and a large-diameter balloon long enough to cover the whole lesion must be used. Then, for any subsequent flaps caused, spot-stenting should be more than adequate. When debulking, a very large vessel diameter may mean that stand-alone rotablation will ne ineffective against preventing restenosis, so use DCA if possible. And as excised volume and the restenosis rate are inversely proportional, use IVUS to debulk as much atheroma as you can (down to <40% of what the plaque area was when you started).

    1-2. **Tortuous lesions**:It will depend to some extent on the degree of tortuosity, but for these lesions, PTCA+ stenting will probably be better than DCA or rotablator. You may be able to get a smooth lumen dilatation without spiral dissection using just a PTCA balloon, with a long balloon one-size (0.5mm) down from the size used in 1-1 above, and assuming you can dilate fully. However, you will probably need to put a stent in the event of insufficient dilatation or elastic recoil, and similarly, depending on lesion morphology, a high atheroma burden or high risk of dissection may mean that you have no choice but to put in a long stent. When you have to stent, we recommend you go for a stent with very good conformability.

2. **Diffuse disease in relatively small vessels </= 3.0mm**

    2-1. **Lesions caused by atheromatous plaque**: These are usually treated by some combination of rotablator/DCA/conventional ballooning/stenting, but lesions of this kind </= 3.0mm, rotablator may well be the most effective.

    2-2. **Lesions caused by vessel shrinkage**: Conventional balloon angioplasty followed by stenting is the most appropriate strategy for lesions that IVUS suggests are a result of negative remodeling.

3. **Diffuse disease with accompanying ulceration or aneurysm**: These lesions are usually indicated for PTCA + Stenting, but DCA may also be an option, and where possible, debulking + stenting may be effective for keeping down the restenosis rate. For superficial concentric calcified plaque, as you sometimes encounter, choose a rotablator sized to the size of the fully-expanded stent, and debulk prior to putting the stent in.

4. **Diffuse disease in saphenous vein grafts**:For lesions in SVGs that form some time after surgery, treatment entails a high risk of the embolization of a large amount of debris, and no-reflow. If at all possible, treat the native artery. If you must tackle these lesions, use the RESQUE™ device or some other distal protection device in concert with a fairy small diameter balloon and/or stent and

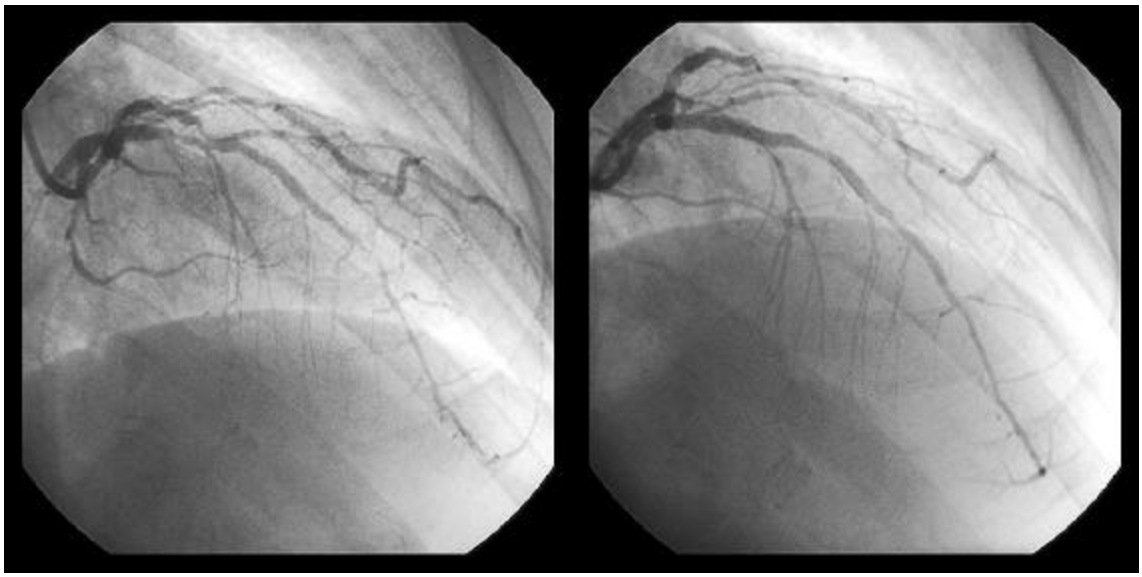
try to obtain a sufficient lumen with the minimum of disruption; as far as possible, let sleeping dogs lie. These lesions tend to be quite soft, and direct stenting can also be effective for keeping complications to a minimum. A stent with a large metal surface area may also be indicated for this kind of disease. Avoid self-expanding stents, because these have only a limited scaffolding effect against the soft debris inside the lesions.

5. **Diffuse disease bifurcating at a side-branch**:Refer to the section on “Treating Side-Branches”

Case Reports

1. **LAD with diffuse stenosis**: (Figs. 1- 2)

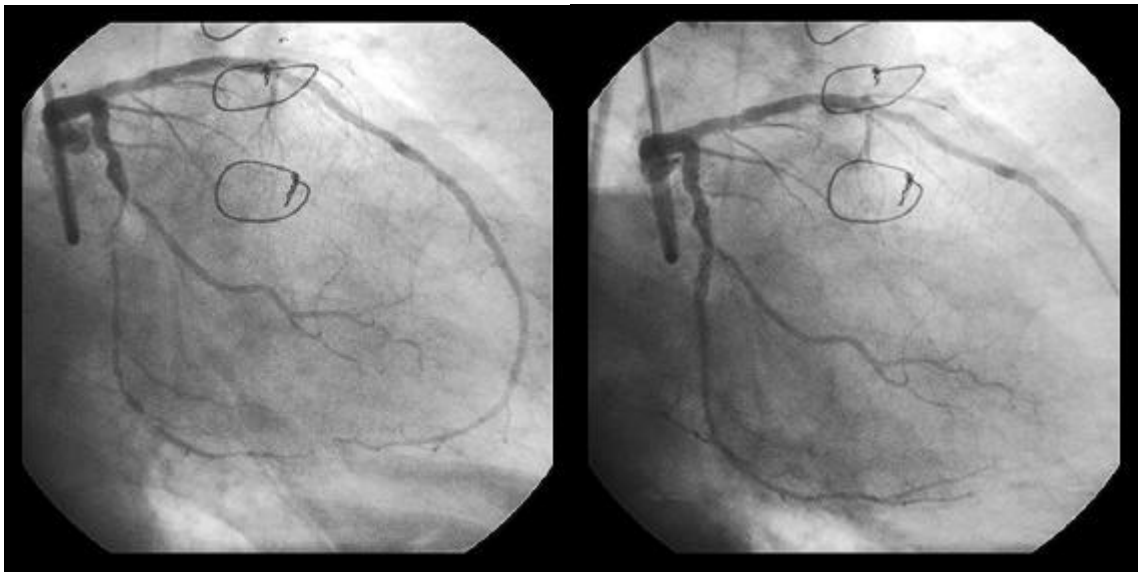
   A 61yo male, with UAP, OMI (post), with triple-vessel disease and previous intervention in the RCA and LCX. On this occasion, patient underwent PCI at LAD #6, #8. IVUS showed no severe calcification but some shrinkage at #8. Conventional 2.0x 40mm balloon dilated at #6-#8 followed by 4.0mm MultiLink stent implantation at #6, and a 2.5x 12mm S660 at #8, at the site of constriction, to complete the procedure (Fig.2). Long-term follow-up has shown 50% restenosis at #8 but no TLR as yet.



2. **LCX with diffuse stenosis** (Figs. 3- 4)

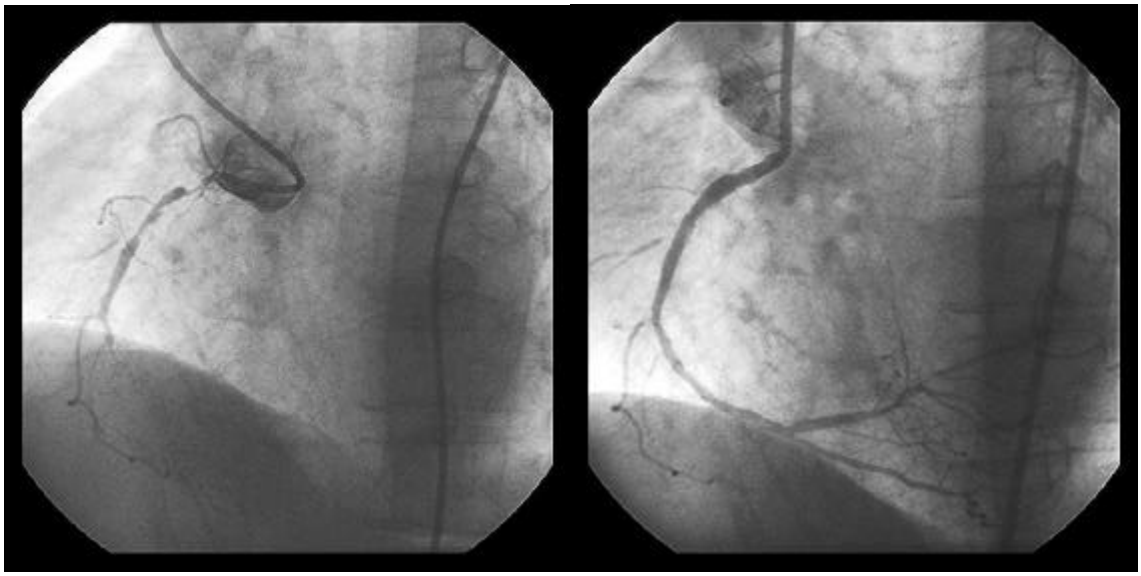
   A 78yo male with OMI (inf.) and previous triple-SVG CABG. Subsequent episodes of angina led to re-catheterization, revealing occlusion of SVG to LCx. Due to long duration occlusion of SVG, decision taken to intervene at LCx #12, #13 and #15, with diffuse 99% DS, and TIMI-2 (Fig.3). Lesion was crossed with a Traverse guidewire but IVUS catheter stalled proximal to lesion. Therefore, a 1.25mm burr, 180,000rpm rotablator was used to ablate #13-#15 and #12. IVUS catheter consequently passed, revealing vessel diameter of 2.6~ 2.0mm. Vessel was dilated at the ablated portion with a conventional 2.5x 40mm balloon (balloon indentation disappearing at 40psi). Procedure was completed by implantation of a 2.5x 20mm Wiktor-i stent at #11- #13 in response to recoil there (Fig.4). Follow-up shows no restenosis at long-term,

and even some positive remodeling at #15.



3. **RCA with diffuse stenosis** (Figs. 5- 6)

A 71yo female with OMI (inf.), CHF, DM and CRF (HD), with triple-vessel disease undergoing PCI for stenosis at RCA #1 and #3 (Fig.5). IVUS revealed calcification and diffuse disease, and rotablation performed. IVUS also showed that RCA diameter was 3.9mm, but because of poor left-ventricular function (LVEF 29%), small burr sizes of first 1.5mm and then 2.15mm selected to avoid slow-flow, and the lesion ablated to the distal part of #3. Adjunctive ballooning then done with a 3.5x 40mm PTCA balloon and a 4.0mm Multilink stent implanted at #1 (Fig.6). PCI on other vessels then performed, and at 4 months post-procedure, patient has improved EF of 45% and restenosis in the RCA alone at #1, of 50%.



In Summary

The strategies set out above are those we currently employ at our institution for diffuse coronary artery disease, though I must add that for these types of lesions, no strategy can claim to be as safe as conventional balloon angioplasty. The strategy of multiple inflations with a long balloon, with

spot-stenting kept in reserve in the event of intimal flap or dissection, has enduring appeal, not least from the point of view of safety and restenosis rates. Certainly, spot-stenting is associated with lower restenosis rates than long-stenting, and is probably your best first-strategy, especially when you are unsure how to proceed. Avoid plaque shift by selecting a balloon long enough to cover the entire lesion, and make full use of IVUS to match your balloon size to that of the vessel itself. Getting those two dimensions right and achieving full expansion should enable you to prevent elastic recoil and therefore minimize restenosis.