5. Percutaneous coronary intervention (PCI) for Left Main Trunk Disease
b) Ostial lesions
i) Rotablator / Stent / Cutting Balloon

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1) Introduction

The left main trunk (LMT) is a vital and problematic area. Coronary interventions in this area require a higher level of expertise in every respect (such as in strategy-selection and the execution of procedure) than for equivalent surgery in other parts of the coronary vasculature. Every effort must be made to avoid restenosis in order to avoid the need for further revascularization. Not only do the individual surgical procedures need to be carried out meticulously, so does the follow-up.

In this chapter, we focus on aorto-ostial lesions in the LMT, and present our experience and some actual studies in order to describe the indications, detailed strategies, techniques to be used and the follow-up methods.

2) Preparation

In our institution, patients undergoing elective PCI for LMT disease are hospitalized on the day of the operation. This is also true for interventions in other parts of the coronary vasculature. All patients take ticlopidine and aspirin in advance, which is also the case for ordinary PCI. In general, intravenous anesthetics or sedatives are not used. Intra-aortic balloon pumping (IABP), percutaneous cardiopulmonary support (PCPS), and a temporary pacing catheter must be on standby. It is safer to begin intervention using IABP in high-risk cases such as those in which the lesion is severely calcified, in which the lesion is complicated (by tortuosity), cardiac function is impaired (LVEF<40%), or the patient has multivessel disease. In cases involving multivessel diseases, especially those involving a severe lesion in the right coronary artery or significantly impaired cardiac function, PCI is often performed using a temporary pacing system (although this is not mandatory). We have never used PCPS, except for acute myocardial infarction (AMI).

3) Guide catheter

a) *Selection:* We mainly use a 10F guide catheter for LMT lesions so that we can use appropriate devices, such as Directional Coronary Atherectomy (DCA) devices or rotablators. Even if it is judged (based on lesion type) that DCA or large-burr rotablator is not indicated, we use an 8F or larger catheter inserted via the groin. If a 10F catheter is used, it is better to use a long sheath type because it is easier to maneuver. We often use a JCL, VL or AL1 because they provide excellent support.

However, if there is an extremely severe stenosis at the ostium of the LMT, an 8F or 10F guide catheter sometimes cannot be engaged. In these cases, a 6F AL1 may be useful.

On rare occasions, we approach the lesion from the brachial artery or radial artery; however, the diameter of the brachial artery is small and the range of devices that can be used is limited. This means that back-up devices such as assisted circulation systems or pacing catheters cannot be used if needed in response to sudden unexpected changes. We therefore do not think that it is appropriate to approach the LMT lesions from the brachial artery for PCI.

b) *Maneuvering:* Rotate the guide catheter anti-clockwise at the left Valsalva sinus, move the catheter close to the ostium so that the catheter is co-axially aligned with the LMT, and engage it into the ostium. If the ostial stenosis is too severe for the catheter to be engaged, or the catheter becomes wedged, adjust the direction of the tip of the catheter so that the catheter can be co-axially aligned with the LMT near the ostium, and set the catheter firmly and as close to the ostium as possible. Be careful not to engage it forcefully because it may cause injury at the ostium. If the catheter and the LMT are co-axially aligned, there will be firm support when inserting the guidewire through the coronary artery, making it easier to insert other devices.

4) Guidewire

a) *Selection:* There are no particular rules for selecting guidewires, however, you should use a guidewire that provides firm support (e.g. Grand Slam) if there is a possibility of DCA. In other cases, you may choose a suitable guidewire to match the shape of the distal end. Replace the guidewire with a rotawire if and when a rotablator is used.

b) *Maneuvering:* Maneuvering is the same as for ordinary PCI. However, you must make sure that the guide catheter doesn't disengage from the ostium when the guidewire crosses (as maneuvering the guidewire would then become impossible). You must also avoid the guide catheter getting too deep-seated and causing the ostium to become occluded. If the guide catheter is suspended near the ostium after the guidewire crosses to the distal end, blood flow in the coronary artery will be well maintained. If plaque dissection is observed, be careful not to widen the false lumen.

The arterio-posterior (AP) view and the straight caudal view provide a good view of the guidewire as it passes through the LMT. Nonetheless, it is important to check the entire image of the guidewire from the right anterior oblique (RAO) view after the guidewire has crossed to the distal end.

(Figure 1)

Figure 1

• If the guide catheter cannot be engaged into the ostium due to ostial stenosis, the guidewire should cross while the catheter is co-axially suspended near the ostium.

5) Intravascular ultrasonography (IVUS)

If possible, use pre-procedural IVUS, as useful information such as blood vessel diameter, lumen diameter, calcification, and plaque volume and shape is often obtained. Such information cannot be obtained through angiography. Therefore, we consider that IVUS is a must for the selection of suitably sized devices.

6) Strategies

As described above, it should be kept in mind that prognosis for patients who have undergone PCI in the LMT is typically not as good as that for patients who have undergone PCI in other areas.

Our data suggest that the larger the post-operative lumen area in the cross-section of the blood vessel, or the smaller the residual plaque area in proportion to the cross-sectional area of the blood vessel, the lower the revascularization rate. (This will later be described in detail). These parameters can be assessed with IVUS. Doing your best to achieve a larger lumen area and a smaller proportion of residual plaque is one of the factors that will improve the prognosis.

A series of procedures are conducted by means of one of the following strategies, or a combination of the following strategies selected on the basis of the considerations outlined above.

- DCA/Rotablator (debulking)
- Dilatation by means of a Cutting Balloon
- Conventional balloon angioplasty
- Stenting

The following notes relate to each device. We will describe DCA in the next chapter.

a) Rotablator

Indications include highly calcified LMT ostial lesions and LMT ostial lesions with in-stent-restenosis. A rotablator is particularly useful in cases where there is inadequate dilatation, dislocation and stent deformity. Some of the disadvantages of this device include: the size of the burr that is currently available is limited to 2.5 mm or less; 'ablation particles' accumulate at the distal end, which reduces blood flow; and the guidewire must be replaced with a rotawire by means of a wire-exchange device.

In the case of ostial lesions, a burr often cannot be inserted into the vessel. In these cases, the guide catheter must be suspended and used as a platform. If this method doesn't work, withdraw the guide catheter slightly so that it is aligned with the coronary artery. This may help to achieve co-axial positioning.

(Figure 2)

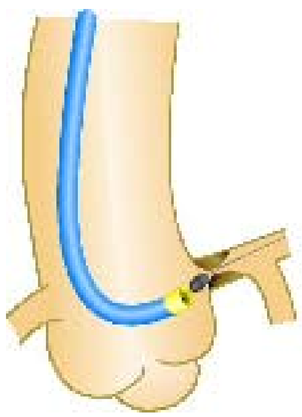
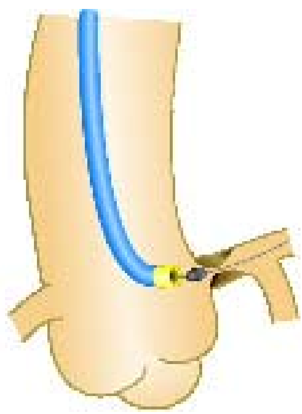


Figure 2

① Guide catheter

If the guide catheter is withdrawn slightly, the burr is co-axially aligned with the blood vessel, thus making maneuvering easier.



② "Co-axial"

If the catheter is co-axially aligned, it will easily enter and pass along the blood vessel.

With regard to maneuvering techniques, the rotablator requires sure and quick handling. We use a 'pecking motion' in which the rotablator shuttles between the platform and the lesion 100 - 200 times per minute. With this method, the duration of the contact between the burr and the lesion decreases with each shuttle movement, the burr maintains its rotational speed very well, and blood flow is not likely to be reduced. We think this method is also very useful for lesions other than the LMT, and as such, we use this method quite often.
We allow approximately 10 seconds for each cooling period, which is the same as for other lesions. If systolic pressure decreases by more than 10 mmHg, or the speed of the burr decreases by more than 2000 bpm, stop the rotablator and observe what is happening.
As explained above, the rotablator can widen the diameter of the lesion by only 2.5 mm, and therefore, the rate of restenosis is comparatively high if the rotablator is the only device used during the PCI.

It is desirable to dilate the vessel using other devices following the use of the rotablator.

b) Cutting Balloon

Indications for this device include cases in which a large amount of plaque is present, but for which debulking cannot be conducted due to severe calcification or because it is impossible to insert your devices. In this method, the 'debulking effect' is achieved by tearing the plaque. The size of the device is determined by measuring the diameter of the blood vessel using IVUS. A 4 × 10 mm Cutting Balloon is often used because the diameter of the LMT is large. The Cutting Balloon procedure is the same as for a conventional balloon procedure. However, if the lumen is small, it is more difficult to insert the Cutting Balloon than to insert a conventional balloon, so more careful maneuvering is necessary. Perform several dilatations of approximately 30-second duration. If systolic pressure decreases to 100 mmHg or less, or decreases by more than 10 mmHg from baseline, stop and wait for recovery. As high-pressure dilatation is not an option with this device, it is often necessary to carry out additional dilatation using a high-pressure balloon or a stent.

c) Stenting

The most important points in maneuvering your stent are:
1) precise positioning
2) dilating it as much as possible with at as high pressure as possible.
If the first stent has been dislocated, it is sometimes difficult to implant another stent in the area between the aorto-ostium and the LMT body. Therefore, it is necessary to view the positioning of the stent from at least two angles (e.g. AP view and LAO caudal view) in order to implant it correctly. This is particularly so in the case of severe calcification or a severely tortuous lesion because it is often difficult to put a stent in in the most appropriate position. In such cases, it is important to undertake thorough debulking or pre-dilatation prior to stenting, if possible.
In general, the diameter of the LMT is large (a diameter of more than 5 mm is not uncommon) and large stents and large balloons at high pressures can be used. Ideally, choose a stent of diameter > 3.5 mm. Use high pressure to dilate the blood vessel fully (preferably 15 - 20 atm or more) in both the pre-dilatation

procedure and the actual dilatation procedure.

As the aorto-ostium consists of a large amount of elastic fibers, elastic recoil occurs readily. Tubular stents are therefore suitable for this procedure.

(Figure 3)

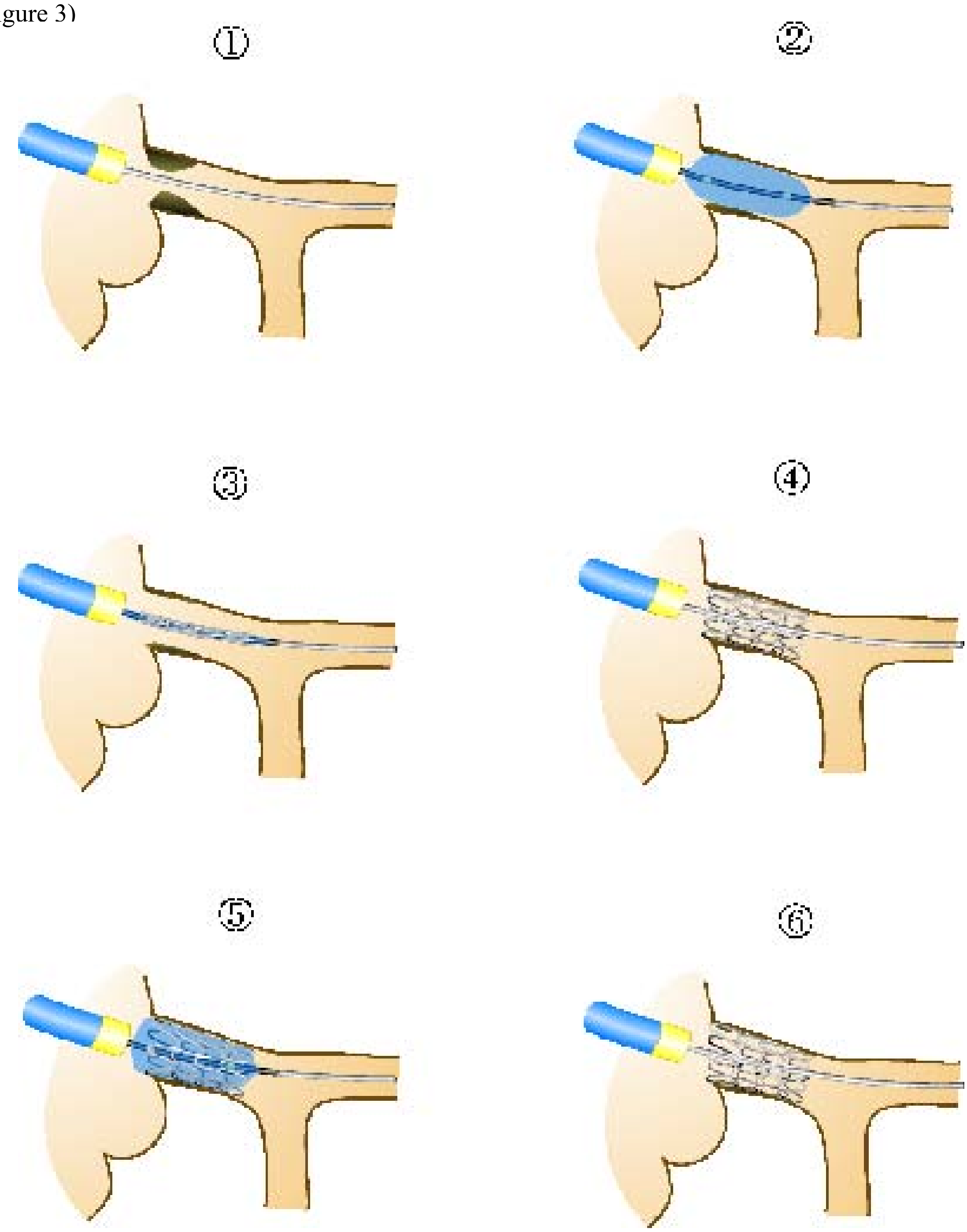


Figure 3

① Pass the guidewire into the left anterior descending (LAD).

② Inflate the balloon.

③ Deploy the stent.

④ Deploy the stent.

⑤ Withdraw the balloon into the aorta, then dilate the stent.

⑥ Completion

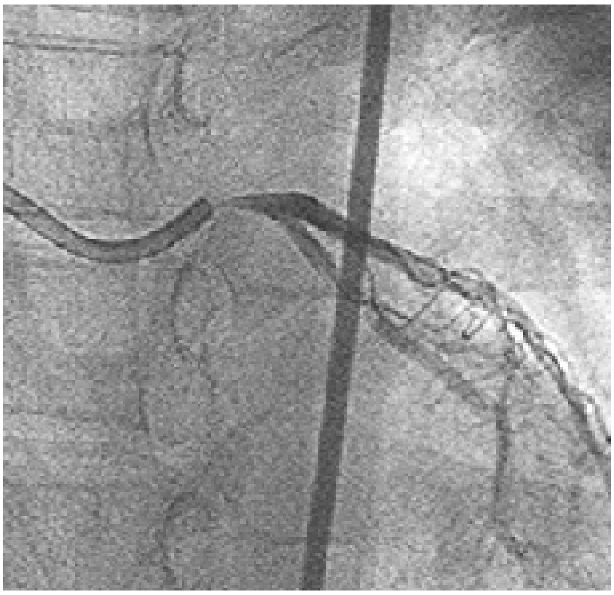
7) Post-operative care

If there are no changes in hemodynamics or cardiovascular function, and no significant complications are observed during or following the operation, we remove the sheath two hours after the operation (which is the same as for ordinary PCI) and stop IABP. The patient is then required to remain at rest for four hours. If there are no problems, the patient is discharged the following day.

Conduct follow-up coronary angiography (CAG) at 2 - 3 months, 4 - 6 months and one year after the operation, if possible. Conduct IVUS in addition to CAG, if necessary.

8) Case example

A 19-year-old female patient suffering from aortitis syndrome reported chest pains from the day prior to the consultation. Cardiac catheterization was performed because a significant ST depression was observed in the exercise electrocardiogram taken during the consultation. Aortic regurgitation (Sellers III) and severe stenosis at the ostium of the LMT were observed. An NIR/Elite 3.5 × 9 mm was implanted because strong recoil occurred during the PTCA. However, as restenosis occurred every 1 - 2 months, a coronary artery bypass graft-aortic valve replacement (CABG-AVR) was ultimately performed.
(Static image 1-① and ②)



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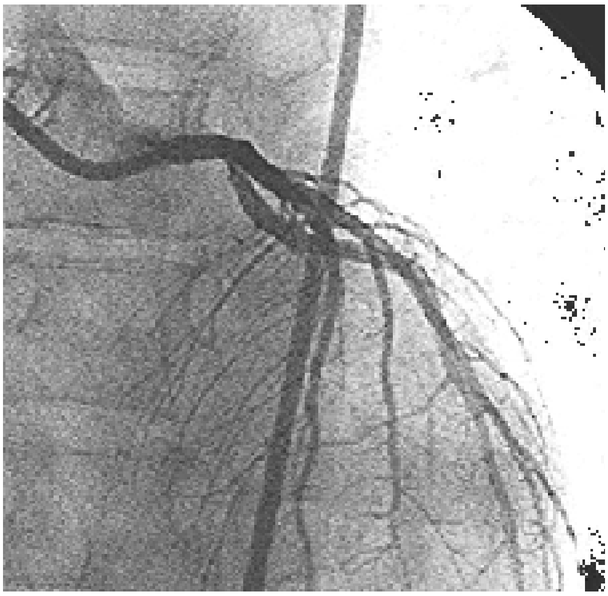

Static image 1-②

9) Clinical results

The procedural success rate for all cases, with the exception of AMI, was 100%. The rate of major adverse cardiac events (MACE), including in-hospital death, was 0%. The rate of death during the follow-up period was 0%, and our target lesion revascularization rate (TLR rate) was 22%. In most cases, patients were discharged from the hospital two days after the procedure, without complications. We think this result is not inferior to PCI in other areas.

10) Conclusion

In the past, CABG was the method of choice for revascularization of the LMT. However, as better devices have been developed and the techniques of operators and co-medical staff have improved, PCI is now becoming the dominant method. In particular, the ostial lesion that we have focused on in this chapter is a comparatively simple LMT lesion, and PCI can be performed safely by avoiding forceful maneuvering and by correct use of each device.

Our data suggest that if the post-procedural lumen area is more than 10 mm^2 (by IVUS), or post-procedural residual plaque area (%-plaque area) is 50% or less of the cross-sectional area of the blood vessel, TLR is limited to approximately 10%. It is therefore anticipated that the condition of the patient during the follow-up period would be improved by making the lumen larger and reducing residual plaque.

The advantages of PCI over CABG include a reduction in the physical and mental burden placed on the patient, a reduction in the duration of hospitalization (most cases require two days), and the ease with which the operation can be repeated. On the other hand, the cost of some PCIs is considerably more than current CABG, especially off-pump CABG, and highly accurate techniques are still required despite the availability of improved devices, especially for PCI in the LMT.

We think that issues to be resolved in the future include: selecting cases on the basis of the indications, drawing up appropriate strategies, implementing accurate techniques, and improving cost-performance.