

Standard Japanese CTO Technique

An step-by-step analysis of angiographic views, selection, and strategies for guidewire selection and use.

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Japanese operators are among the leading operators performing percutaneous coronary intervention (PCI) for chronic total occlusion (CTO). The reason for this is likely because Japanese operators have been making continuous innovations and have established new methodology in this field (eg, the controlled antegrade and retrograde subintimal tracking [CART] technique). This article examines the standard Japanese techniques, including guidewire and catheter selection.

Angiograms taken from various angles are also essential. Both the entrance and exit of the CTO must be visualized on multiple planes, preferably perpendicular to each other. If possible, the CTO site should be fixed in the center and visualized without panning the table. Sometimes, certain “tricks” are necessary, such as starting contralateral dye injection and waiting until enough collateral flow is supplied before taking angiograms by pressing the foot switch (Figure 2).

CORONARY ANGIOGRAPHY FOR CTO PCI

To perform PCI for CTO, appropriate coronary angiography (CAG) images must be taken. For example, in a case of a CTO lesion in the right coronary artery (RCA), angiograms focused on the occluded portion must be taken. Generally, in cases of CTO in the RCA, collaterals are often formed from the left coronary artery (LCA). An angiography of the LCA must consider the RCA as well as the LCA; otherwise, a PCI for CTO cannot be performed (Figure 1).

CORRECT INTERPRETATION OF CAG

The next important step is to interpret the properly acquired CAG images to confirm the entrance and exit of the CTO and where the wire is to proceed between these points. The occluded portion of a CTO lesion cannot be visualized on CAG, but based on various pieces of information, it is possible to anticipate the course of the occluded vessel. Calcification and bridging collaterals are good indicators to estimate the course of the vessel. In many cases, the right channel is found in the occlud-

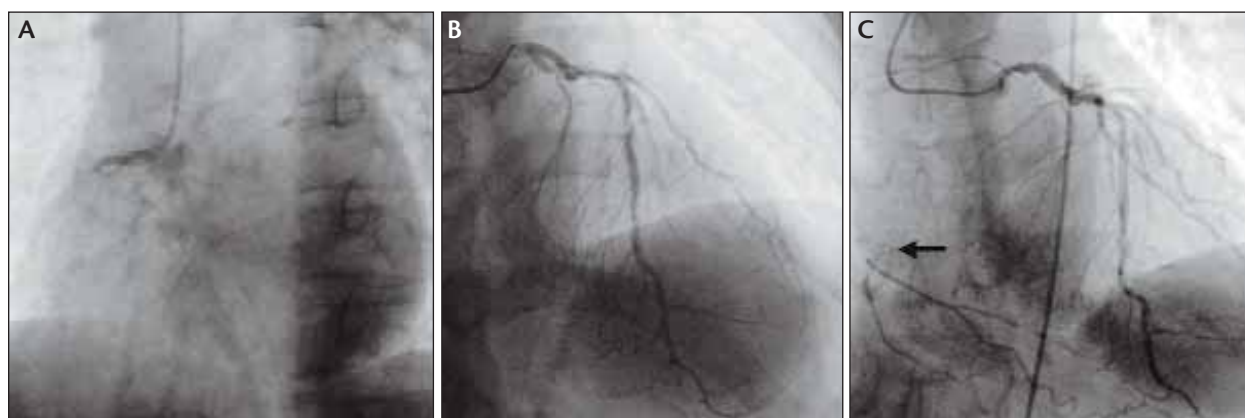


Figure 1. A case of CTO of the RCA (A). Angiography of the LCA in a case of CTO of the RCA (B). Due to panning to see the distal side of the LCA, the distal side of the RCA cannot be observed. Angiography focused on the RCA. The exit of the CTO (arrow) is clearly visible (C).

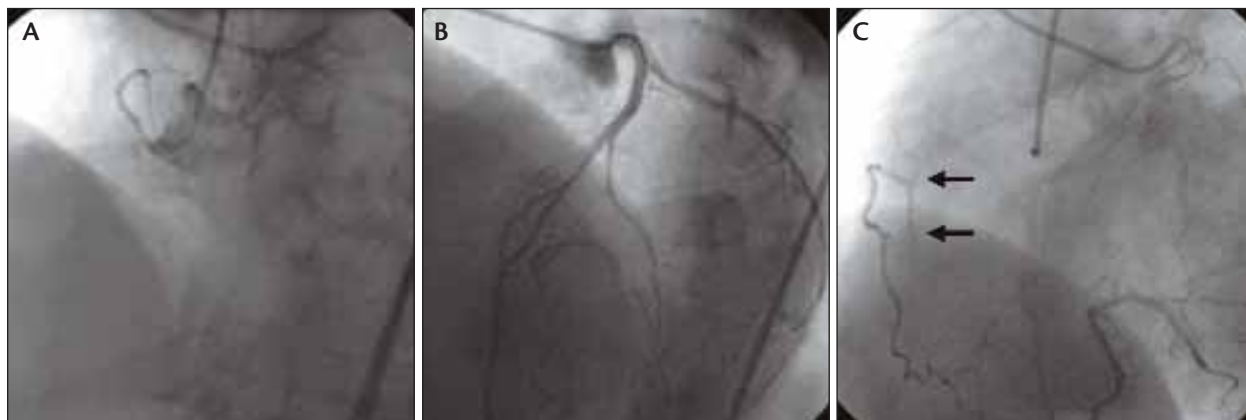


Figure 2. A case of CTO close to the ostium of the RCA (A). The exit of the CTO is located at the bifurcation of the posterolateral branch and posterior descending branch (B). Starting dye injection before taking angiograms makes it possible to visualize the mid-RCA via the right ventricular branch (C).

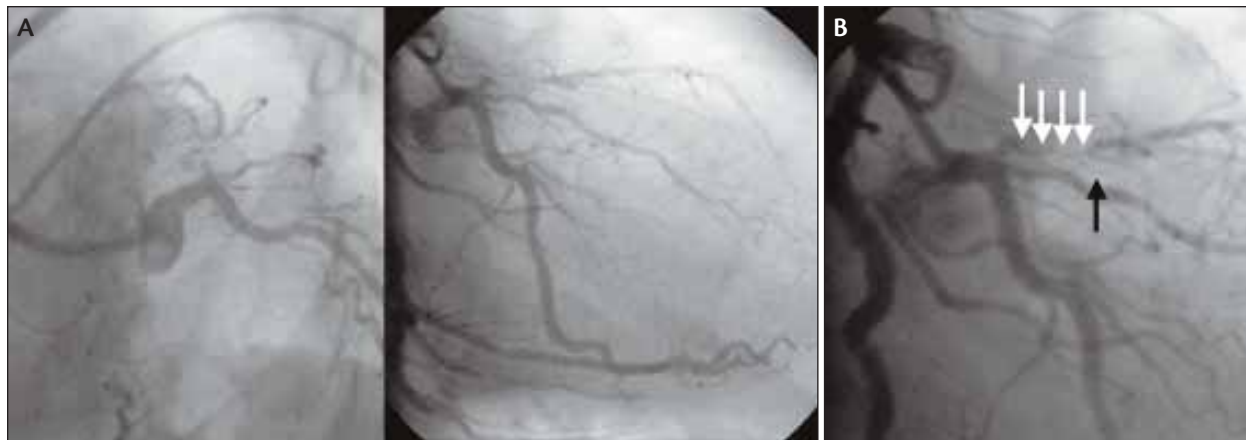


Figure 3. CTO lesion in the proximal LAD (A). The channel indicated by the white arrows had the appearance of a bridging collateral, and on the right anterior oblique caudal view, the true channel seemed to exist on the upper side, closer to the epicardium (B). However, with a septal branch originating from this channel, it was likely to be the true lumen. In the present case, the wire was first introduced to the epicardial side without success. After reading of the CAG for a second time, a soft wire was advanced into this microchannel and revascularization was achieved successfully.

ed portion. Often, microchannels are found in the vicinity of the entrance and exit of the CTO. These channels have to be differentiated from a bridging collateral. If a side branch is found to originate from the channel, its presence is a sign that the channel is likely to be the true lumen (Figure 3).

In some cases, the true lumen exists like an island in a river (Figure 2). Such an island does not necessarily have a certain length. As shown in Figure 4, it may merely be a remnant confluence area of two side branches.

It goes without saying that PCI procedures performed after obtaining such pieces of information and those without them differ in their success rates. Therefore, we perform thorough reading of the CAG images before operation. First, we observe the

images repeatedly at normal speed. Then, we observe all the frames one by one. We spend at least more than half an hour—in many cases about 1 hour—for interpretation of CAG images.

CONTRALATERAL INJECTION

One difference among Japanese operators and European and American operators is whether or not to use contralateral angiography. Japanese operators always perform contralateral angiography if it is necessary to observe the distal side of the CTO. On the contrary, I have experienced cases in Europe and the US where PCI is performed without contralateral dye injection (Figure 5). Performing a PCI procedure without contralateral dye injection may result not only in decreased success rates but may lead to serious com-

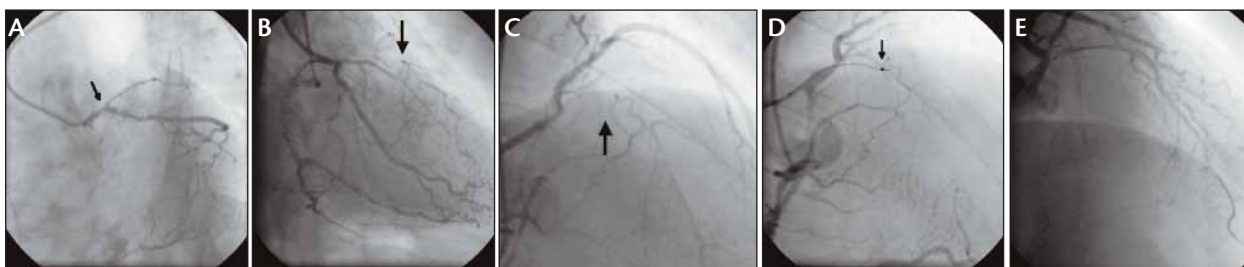


Figure 4. CTO at the ostial LAD (A). The exit of CTO is indicated by the arrow (B). The arrow indicates the point of confluence of the RV branch and septal branch (C). The point of confluence was considered to be the LAD trunk so that the wire was advanced aiming at this point (D). The wire crossed the lesion successfully (E).

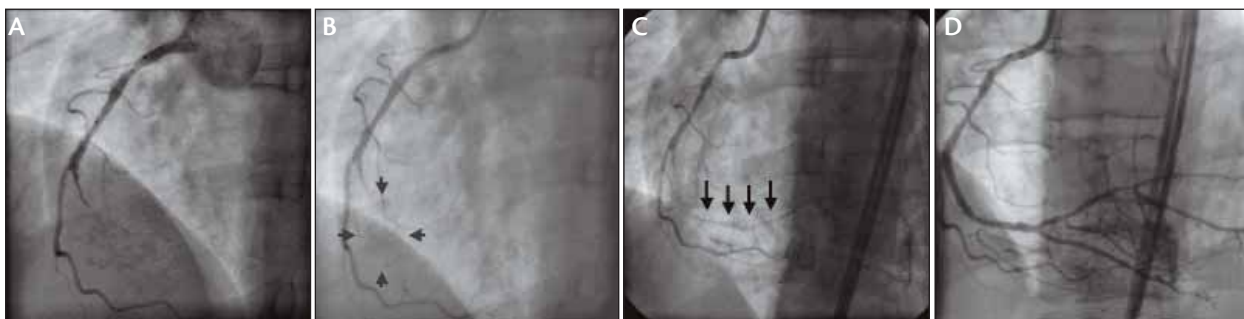


Figure 5. CTO of the RCA (A). Although the RCA distal to the CTO lesion was not visualized, no contralateral dye injection was performed. Unsuccessful PCI was associated with wire perforation and formation of a large hematoma (arrow) (B). Later, a second attempt of PCI was made with contralateral dye injection (C). Revascularization was achieved successfully (D).

plications. The operators who will continue advancing the balloon catheter or other devices would not notice a perforation with the wire, and this would result in massive bleeding and easily cause tamponade.

Even with a contralateral angiography, it is sometimes not possible to obtain a sufficient view of the distal side of the CTO. In such cases, it is necessary to find a specific collateral channel. The most common pattern is the conus branch connecting the left anterior descending artery (LAD) and the RCA. Figure 6 shows a case of CTO at the ostium of the LAD. The LAD is supplied with good collateral flow from the RCA, but the exit of the CTO is not visualized. In this case, dye was injected into the proximal LAD via the conus branch, and to visualize the exit of the CTO, selective angiography of the conus branch is necessary. Sometimes, the distal part of the CTO in the RCA is visualized via the conus branch (Figure 7). The conus branch can originate from a different orifice than the RCA, and in an angiography of the RCA, caution must be used not to overlook the collateral channel. For angiography of this separate conus, an internal mammary artery catheter is often appropriate. In rare cases, there is a collateral route through the atrial branch supplying the distal part of the RCA

(Figure 8). In any of these cases, it is difficult to hold the catheter in place, and it is useful to have the guidewire in place or to use a microcatheter for angiography. If a microcatheter is used, as little as <1 mL of the contrast media is required. In many cases, these collateral routes can be clearly visualized by the multislice CT scan gaining increased recognition for PCI for CTO in recent years.

CHOICE AND HANDLING OF THE GUIDEWIRE

Decisive for success or failure of CTO PCI is whether the guidewire can pass through the CTO lesion. Therefore, the question of choice and maneuvering a guidewire is of extreme importance. However, there is no particular standard for selecting a guidewire. There is no such guidewire with which any CTO lesion can be crossed. Therefore, when choosing a guidewire to use, the operator should use the one that he or she is most used to. The X-treme (Asahi Intecc, Nagoya, Japan) is the guidewire I use first in most cases of CTO. It does not matter if you cannot see microchannels on angiography because pathologically, CTO lesions have microchannels in the occluded segment. The tapered-tip X-treme is very good at tracing these channels. If a microchannel is seen on angiography, the common

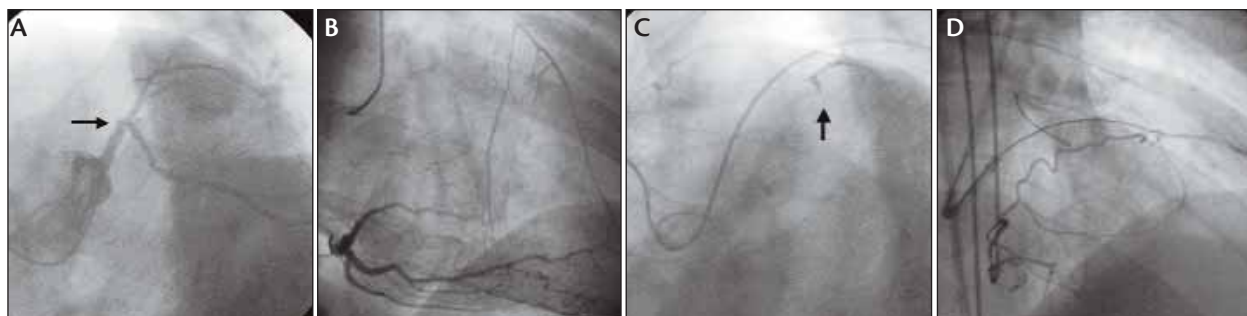


Figure 6. The LAD is occluded at the ostium shown with the arrow (spider view) (A). The LAD distal to the CTO lesion received good collateral flow from the RCA (RAO view), however, the LAD proximal to the CTO showed a to-and-fro flow, and the exit of the CTO was not visible (B). Selective angiography of the conus branch using a microcatheter clearly showed the exit of the CTO (arrow) (spider view) (C). The wire was manipulated under selective angiography of the conus branch (D).

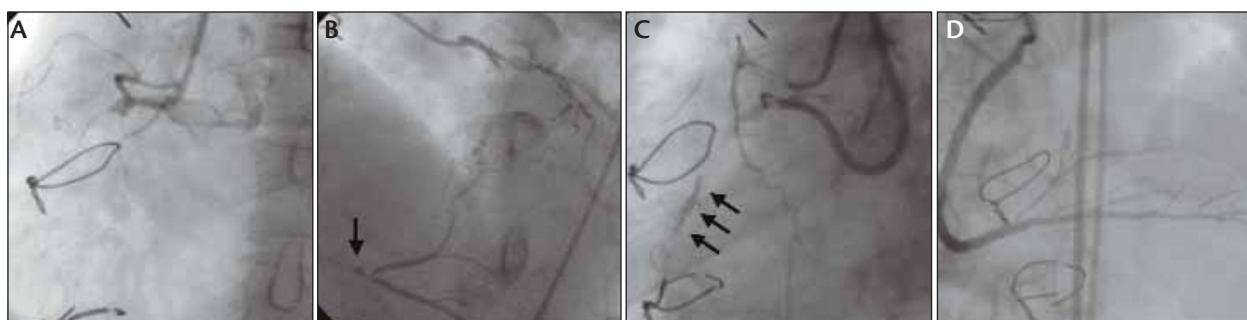


Figure 7. A case of CTO lesion in the proximal RCA (A). The exit of the CTO is near the bifurcation of posterolateral and posterior descending branch (arrow) (B). Selective angiography of the conus branch having a different orifice than that of the RCA shows the RCA trunk (arrow) (C). A microcatheter inserted in a diagnostic 6-F internal mammary artery catheter is used for angiography of the conus branch. Final angiogram (D).

.014-inch wire with a plastic jacket is often most suited. If the lesion cannot be crossed using such lubricous wires, one should not hesitate to go on to the next step. Once having entered the false lumen, it is unlikely to find the true lumen with these wires. There is even the risk of enlarging the subintimal space.

As the next choice of guidewire, I recommend the Miracle series (Abbott Vascular, Santa Clara, CA). When manipulating, never rotate the guidewire excessively. It is recommended to repeat advancing and retrieving the wire little by little. When retrieving the guidewire, it is important to feel the magnitude of friction with your fingers. Depending on the lesion, neither too much nor too little friction is good.

Manipulation of the guidewire at the exit of the CTO is also critical. Just before the guidewire penetrates the distal end of the CTO, angiography from several angles must be taken (Figure 9). If possible, this should be done also immediately after perforation is completed.

The success rate of PCI depends very much on whether such extra efforts are made. However, many operators, including Japanese operators, fail to make

these efforts. In my view, excellent operators have the following points in common with regard to their choice and use of guidewire. First, they manipulate the wires gently. Second, they are patient with the guidewire once the choice is made and do not give up easily. In contrast, operators with low success rates decide too early to step up to the next wire, and I often encounter cases in which a hard wire has entered the false lumen. The third point is that these operators know when to use the Asahi Confianza guidewire family (Abbott Vascular). Japanese top operators are careful about using these wires. Particularly in cases of a very long CTO lesion, or if there are bends in the occluded portion, a wire of the Confianza family should not be used too early. The Miracle series (Abbott Vascular) is more suited to cope with these types of lesions. It is important to know the peculiarities of each wire and use them at the most appropriate occasions.

INTRAVASCULAR ULTRASOUND

Intravascular ultrasound (IVUS) is more frequently used in Japan than in Europe and the US and in cases other

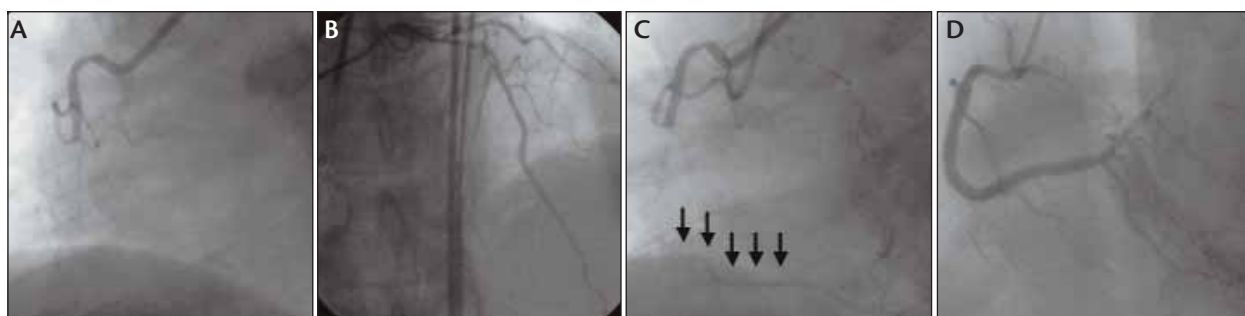


Figure 8. CTO lesion in the proximal RCA (A). The RCA distal to the lesion was not visualized at all with angiography of the LCA (B). The RCA was clearly visualized by selective angiography of the atrial branch (C). Final angiogram (D).

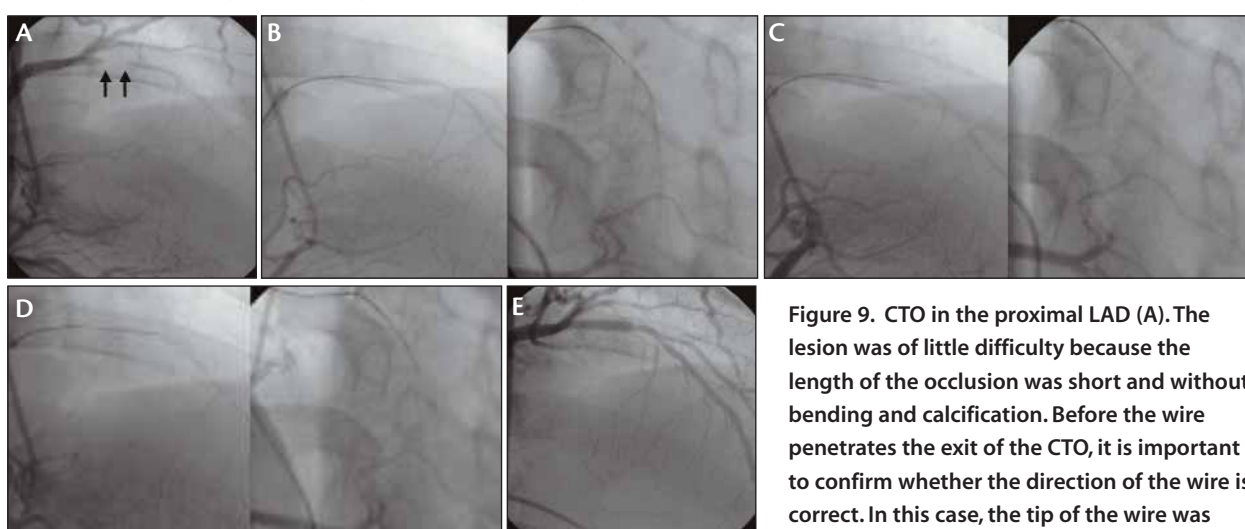


Figure 9. CTO in the proximal LAD (A). The lesion was of little difficulty because the length of the occlusion was short and without bending and calcification. Before the wire penetrates the exit of the CTO, it is important to confirm whether the direction of the wire is correct. In this case, the tip of the wire was directed too downward in the right anterior oblique cranial view (left) and too much to the left on the left anterior oblique cranial view (right) (B). Advancing the wire without correcting the direction would have resulted in entering into the false lumen. The tip of the wire was directed into the right position on multiple planes and confirmed on cine angiography (C). After penetration of the exit of the CTO, the right position is confirmed on cine angiography (D). The wire must always be advanced with utmost caution. Final angiogram (E).

oblique cranial view (left) and too much to the left on the left anterior oblique cranial view (right) (B). Advancing the wire without correcting the direction would have resulted in entering into the false lumen. The tip of the wire was directed into the right position on multiple planes and confirmed on cine angiography (C). After penetration of the exit of the CTO, the right position is confirmed on cine angiography (D). The wire must always be advanced with utmost caution. Final angiogram (E).

than that of CTO. On a routine basis, we use both angiography and IVUS to verify the PCI procedure that we have performed. In cases of CTO treated with PCI, in particular, IVUS shows us where and how the guidewire has actually crossed the lesion. It also shows whether a false lumen was created. Accumulation of such experience improves our expertise in manipulation of guidewires.

Being familiar with the everyday use of IVUS makes our technical wizardry possible to find the entrance to the CTO with IVUS or to lead the guidewire that entered the false lumen into the true lumen by IVUS-guided wiring.

MEDICAL ECONOMICS AND SOCIAL BACKGROUND

In Japan, PCI for CTO is performed more frequently than in Europe and the US for other than scientific

reasons. The medical economic situation in Japan is different from that of Europe and the US. The difference in insurance systems, in particular, is an important factor. In many European countries and the US, the payment of costs for PCI is made under the prospective payment system in which the payment amount for a particular medical service is predetermined and fixed from the beginning. This means that it is more profitable for the hospital if it performs PCI procedures with as little device and contrasting agents as possible. In many countries, doctors are paid more for the more cases they have in their experience. Under these circumstances, both hospitals and doctors are happier if they treat a larger number of easier cases. Difficult cases of CTO that would require longer hours and more devices for PCI procedures are not

welcome. In Japan, on the contrary, payment for medical services is made on a fee-for-service basis, which means that the insurance will reimburse all costs for any device used, and the difference between the amount reimbursed by the insurance and the actual amount paid becomes the profit of the hospital. Furthermore, Japanese doctors are paid fixed salaries so that the number of PCIs they perform is not reflected on the amount they receive. In other words, their income and profit for the hospital do not suffer from longer hours spent for one case of PCI. This means, in Japan, the environment is friendlier if you want to use PCI to treat patients with CTO.

The climate surrounding bypass surgery is also a factor leading to increased use of PCI for CTO. Although the success rate of bypass surgery in Japan has improved, until recently it was not satisfactory; a limited number of surgeons were achieving good results. Under these circumstances, before the introduction of drug-eluting stents, PCI for complicated lesions was preferred over bypass surgery. Although bypass surgery has been widely accepted by the general public in Europe and the US, many Japanese people still shy away from surgical operations and would rather avoid

them. These social factors lead to increased use of PCI for CTO in Japan.

CONCLUSION

PCI for CTO is employed more intensively in Japan than in Europe and the US. While reasons of medical economics and social background certainly play a role in this development, we owe this to the top Japanese operators, although limited in number, who have achieved high success rates of PCI for CTO. The most important factors leading to the high success rates are their efforts in careful interpretation of CAG images that are taken appropriately before the operation, gentle manipulation of the guidewire and avoidance of stepping up to other guidewires too easily, and their daily attitude to never give up and do their best to overcome the challenges they face. ■

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