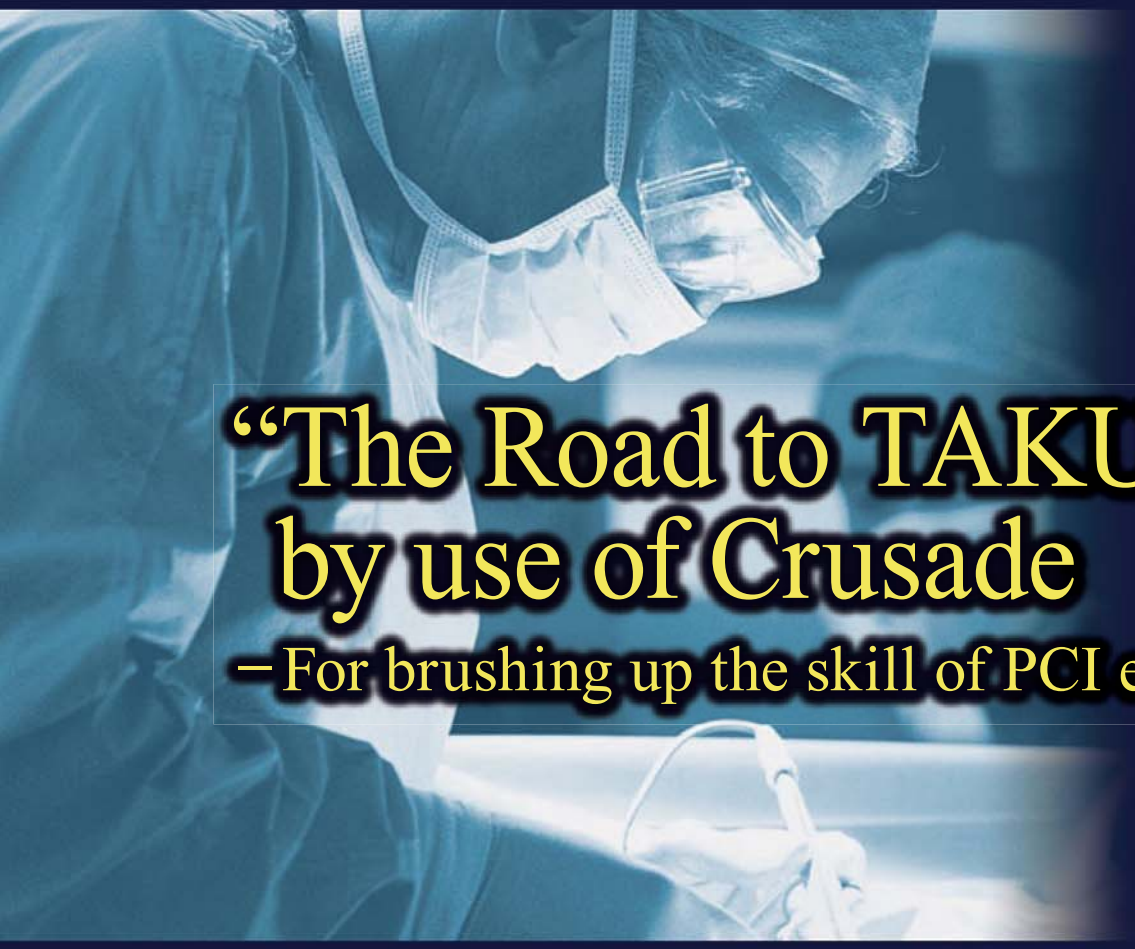

"The Road to TAKUMI" by use of Crusade

–For brushing up the skill of PCI experts–

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Yotsuba Circulation Clinic

Effectiveness of Crusade in Complex PCI

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Crusade – Practical usage –

Dr. Osamu KATO
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TAKUMI "Decision at Bifurcation"

This pamphlet is an edited summary of a luncheon seminar held in CCT2010 on January 29, 2010 (Saturday).

KANEKA MEDICAL PRODUCTS

Effectiveness of Crusade in Complex PCI

Dr. Takashi OTANI
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Effectiveness of Crusade

Crusade is a guidewire supporting catheter for coronary artery having two guidewire lumens. It enables high guidewire maneuverability and easy access to side branches.

Crusade is frequently used in percutaneous coronary interventions for complex lesions (complex PCI) mainly because its use of two wires stabilizes PCI. It helps stabilize the guiding catheter, is effective in landmarking the bifurcation and protecting the side branch, and enables secure stent deployment in combination with intravascular ultrasound (IVUS), reduction in contrast medium, and a smooth kissing balloon technique (KBT) after stent deployment. It is also effective in penetrating a calcified legion and treating chronic total occlusion (CTO), dissection, and perforation (Fig. 1).

Example uses of Crusade are reported below:

- Stabilization of the guiding catheter
- Landmarking the bifurcation
  - Protection of the side branch
  - KBT after stent deployment
  - Stent deployment under the guide of IVUS
  - Reduction in contrast medium
- Improvement in the stent (balloon) success rate
  - Calcified lesions, diffuse lesions, and bend lesions
- CTO lesions
- Treatment of various complications
  - Dissection, perforation

Fig. 1 Significance of using Crusade in complex PCI.

Case 1: Stent deployment in a calcified lesion (post CABG)

This is a case having a past history of diabetes in which the bypass to the left anterior descending branch (LAD) was occluded after coronary artery bypass grafting (CABG). 75% stenosis in the left coronary artery main trunk (LMT) (**Fig. 2A**) and 90% stenosis along with calcification in LAD #7 (**Fig. 2B**) were observed. The saphenous vein graft to the left circumflex branch (LCX) was patent.

After the wire was crossed, the balloon was inflated but ruptured and a PET balloon was used and inflated. The LAD was highly calcified and it was difficult to insert the stent and advance the second wire distally (**Fig. 2C**). Crusade was thus used so that the wires would not be entangled. Two wires were additionally placed, one into the septal branch and one into the diagonal branch, proximally to the lesion (**Fig. 2D**), and the stent was successfully inserted with those three wires.

In this kind of procedure, it is important to maintain the fixation of the wires using a trapping method with a 2.5-mm balloon when Crusade is withdrawn.

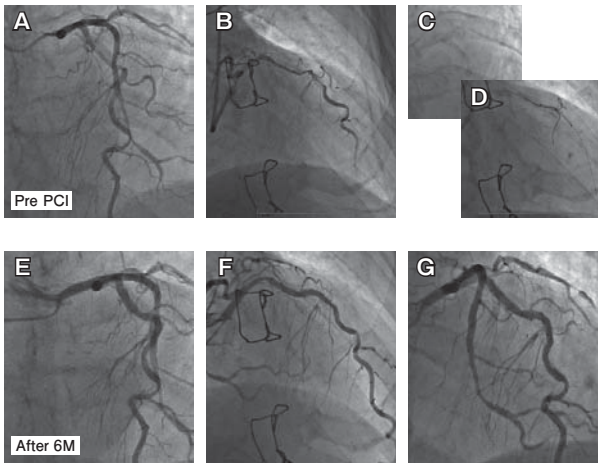

Fig. 2 Case 1: Calcification is observed in the LAD. CABG has been performed.

Case 2: Reduction of contrast medium in diabetic nephropathy

The patient was an elderly woman aged 87 years with unstable angina pectoris and cardiac failure accompanied by hypertension, diabetic nephropathy, and peripheral arterial disease (PAD). Decreased renal function with a serum creatinine level of 1.3 mg/dL was observed and the goal was set to suppress the dose of contrast medium.

99% and 90% stenoses were observed in the circumflex

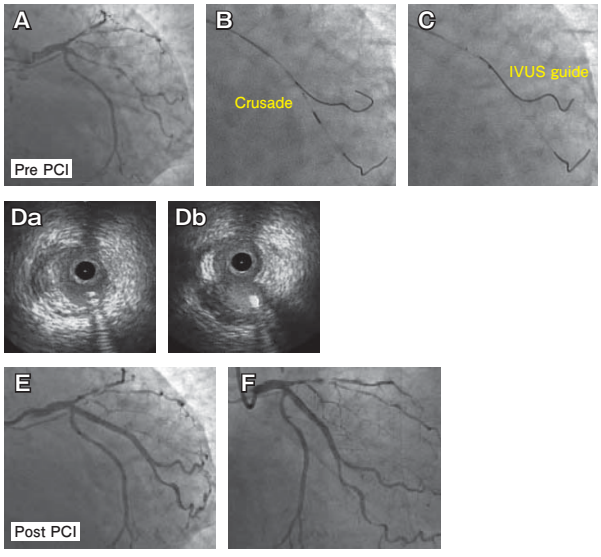

Fig. 3 Case 2: An elderly woman with unstable angina pectoris. Decreased renal function was observed.

branch (CX) (**Fig. 3A**). After angiography, the wire was crossed up to the end of the stenosis site, and Crusade was used to pass a marker wire additionally to the distal branch (**Fig. 3B**). The bifurcation was marked using the two wires and IVUS and distal positioning and sizing of the stent were performed. Appropriate stent deployment without unnecessary angiography was possible (**Fig. 3C, Da, Db**). The final dose of contrast medium was about 15 mL and successfully minimized.

This is a case in which the use of Crusade enabled the distal bifurcation to be reached without entanglement of the wires for a complex lesion and subsequent procedures were facilitated.

Case 3: Complex PCI

The patient was an elderly man aged 74 years. This is a very complicated case with triple vessel disease (TVD) and CTO in the RCA. 90% stenosis in #1 and CTO in #2 were observed (**Fig. 4A, B**). Significant stenosis was observed at the bifurcation of the LAD and first diagonal branch (D1) (**Fig. 4C**), the retrograde approach was considered difficult, and therefore an antegrade approach was selected.

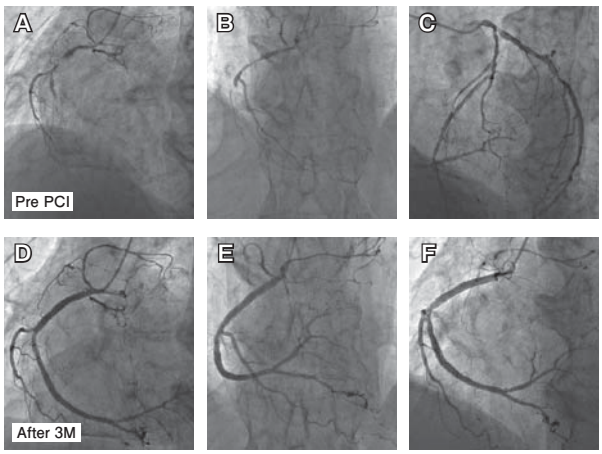

Fig. 4 Case 3: A case with CTO in RCA.

Episode 1: For CTO in the RCA (**Fig. 5A**), the right ventricular branch (RV) was secured by the first wire, an ordinary microcatheter was successfully penetrated into #2, and the wire was advanced to the acute marginal branch (AM) (**Fig. 5B**). Selection of the path to RCA main vessel #3 was difficult but by having Crusade placed over the wire, which had been advanced to the AM (**Fig. 5C**), and the second wire manipulated through the side hole of Crusade, the change of the direction to the main vessel was made possible relatively easily.

The wire was changed to X-treme and crossing to the direction of the posterior descending branch (4PD) was successful but the flow in the direction of the posterolateral branch (4AV) was delayed after plain old balloon angioplasty (POBA).

Crusade was again used to cross the wire in the 4AV (**Fig. 5Ea**). After DES insertion into #3-#1 (**Fig. 5Eb-Ed**), the use of Crusade facilitated recrossing into the 4AV and additional inflation without entanglement of the wires despite the manipulation over the stent struts (**Fig. 5Fa, Fb**).

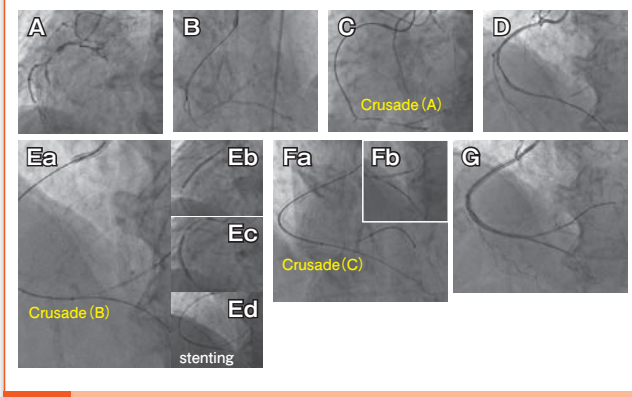

Fig. 5 Case 3: Episode 1

Episode 2: During the procedure of episode 1, slight wire perforation occurred in part of the 4PD to the septal branches (**Fig. 6Aa, Ab**). Crusade was also effective in coil embolization for this perforation. With the wire placed in the PD, Crusade was placed over and another wire was advanced to the bleeding site (**Fig. 6B**). This was then switched over to a microcatheter (**Fig. 6Ca**), a coil was placed (**Fig. 6Cb**), and hemostasis was successfully obtained (**Fig. 6D, E**).

This was a complicated case but Crusade incorporated into as part of the procedure allowed stable manipulation, completion of treatment while maintaining general health, and good patency in the chronic phase (**Fig. 4D-F**).

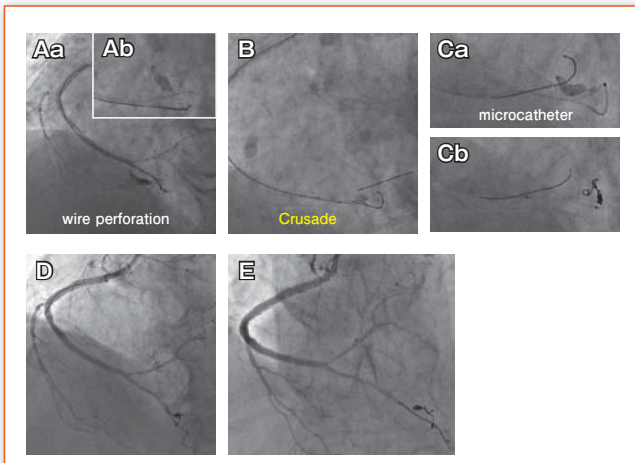

Fig. 6 Case 3: Episode 2

Features of Crusade and points to keep in mind

The greatest advantage of using Crusade is the ability to secure the side branch without entanglement of the wires, which helps to achieve the aforementioned double-wire method for complex PCI securely.

However, since the interval between the tip of Crusade and the guide wire port is about 20 cm, careful attention is required during withdrawal. Key steps are as follows: First, apply 12-15 atoms using the inflator. Use a fluoroscopic monitor to confirm that the wire will not move. Then withdraw the wire to the monorail lumen. Apply slight pressure, check the position of the wire again by fluoroscopy, and confirm the tip of Crusade coming out of the Y-connector. Fix two wires firmly outside the body, and finally withdraw Crusade.

Crusade – Practical usage –

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Reverse wire technique

In the treatment of chronic total occlusion (CTO), I perform wire insertion into the side branch using a procedure called the **reverse wire technique**. The reverse wire technique has been performed by Dr. Osamu Kato in live cases and was reported by Dr. Tomohiro Kawasaki in the CCI journal. I was taught the procedure by Dr. Yoichi Nozaki. I then applied it to CTO-PCI. I always use Crusade in CTO-PCI and obtain good results.

I will first explain the ordinary reverse wire technique. In Dr. Kawasaki's original method, the site 2-3 cm from the tip of the wire (Dr. Kawasaki reported 5 cm but the guidewire may be fractured with 5 cm. I have reconfirmed that Dr. Kawasaki actually uses bending of 2-3 cm.) is bent in a hairpin shape and the wire is inserted without the use of Crusade. **When the technique is applied to CTO, however, the wire needs to be advanced into the occlusion site in a bending state and therefore Crusade is required (Fig. 1). I use a bending site about 30 mm from the tip and an angle of about 45° (Fig. 1 ②).** As stated above, if the distance from the tip is too far, the wire may break and careful attention is required.

The wire in the main branch is passed through the first lumen of Crusade and the reverse wire is passed through the second lumen (Fig. 1 ③) with the wires inserted while folded over (Fig. 1 ④). When the reverse wire is beyond the bifurcation, Crusade is withdrawn (Fig. 2), the wire is pulled and its tip is inserted into the side branch while rotary manipulation is sometimes performed (Fig. 3). Then the wire is slowly pulled to advance the tip forward (Fig. 4).

This method is very useful for wire crossing when the side branch is sharply bent and is reversed to a hairpin shape. The following case presentation explains how the reverse wire technique is applied to CTO-PCI:

Case 1

This is a case with CTO in right coronary artery (RCA) #1 (**Fig. 5A**).

The wire was not easily passed but the right ventricular branch was just barely caught. However, it was confirmed that the wire was crossed in the true lumen of the slightly distal site to the right ventricular branch instead of the tip of the true lumen of the distal site (**Fig. 5B**). Another wire was used to try wire crossing into the true lumen of the RCA main branch but it was inserted into the false lumen and could not be advanced (**Fig. 5C**). Thus, the reverse wire technique with Crusade was used to try wire crossing into the true lumen of the RCA main branch.

As explained earlier, the reverse wire that crossed in the right ventricular branch together with Crusade was used and advanced to the right ventricular branch. When

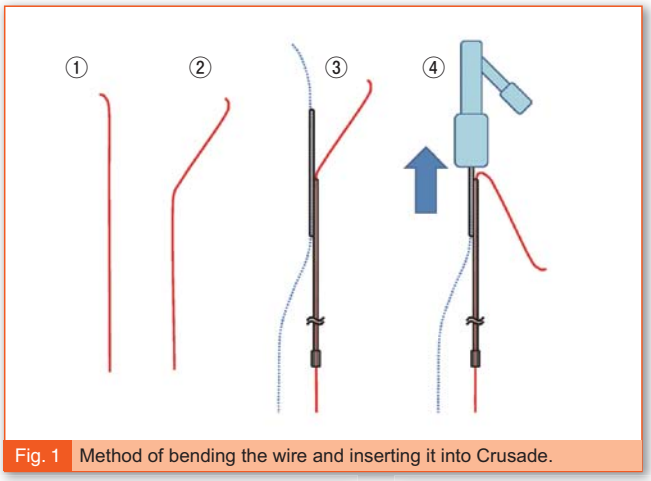

Fig. 1 Method of bending the wire and inserting it into Crusade.

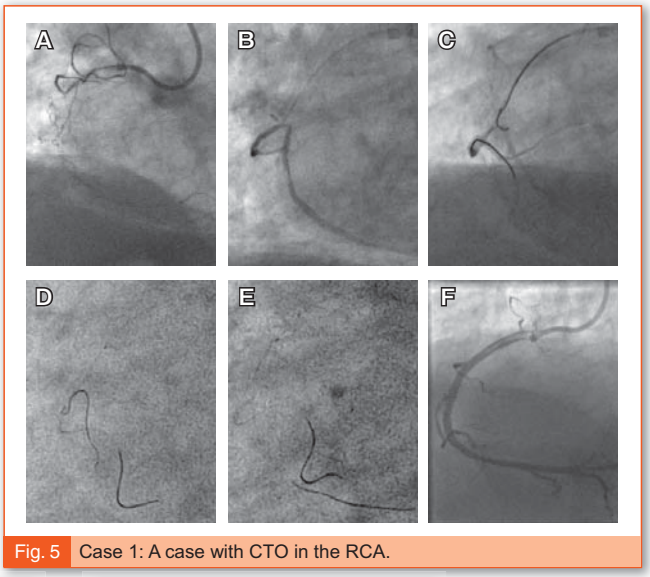

Fig. 5 Case 1: A case with CTO in the RCA.

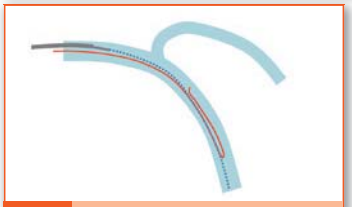

Fig. 2 Withdraw Crusade while the reverse wire is left distal to the bifurcation.

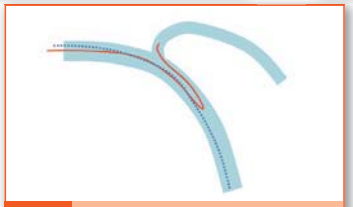

Fig. 3 Pull the wire and place the tip into the side branch.

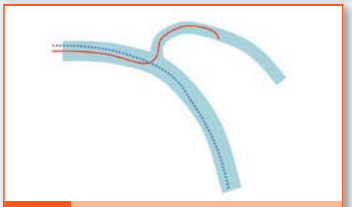

Fig. 4 Gradually withdraw the wire further.

Crusade was then withdrawn and the reverse wire was retracted, the tip of the reverse wire began to advance easily into the true lumen of the RCA main branch (**Fig. 5D**). The reverse wire was further retracted while being rotated, the bending portion of the reverse wire was advanced into the true lumen of the RCA main branch, and the wire was advanced easily into the true lumen of the distal site of the RCA thereafter (**Fig. 5E**).

Final angiography confirmed that no large dissection was produced and good results were obtained (**Fig. 5F**). The reverse wire technique using Crusade may be very useful in situations like this case.

Case 2

CTO in #3. A case of CTO with a large side branch at the proximal end of the distal true lumen as in Case 1 (**Fig. 6A**).

The wire was passed through the posterior descending branch (PDA) (**Fig. 6B**) but it was confirmed from the cranial view that the wire was crossed in the true lumen more than 2 mm distal to the proximal end of the distal true lumen (**Fig. 6C**). Proceeding as normal would require repeated wire manipulation to the occlusion site and therefore reverse wiring (reverse wire technique) using Crusade was selected. Careful attention is needed in a case like this because changing the direction of the wire tip is relatively easy but departure or damping may occur when the wire extends from the position shown in **Fig. 6E**.

Since reverse wiring dilates the branch so as to push away plaque on the proximal side of the bifurcation, the entrance of the side branch is often dilated cleanly and in this case the entrance of the PDA showed good dilation (**Fig. 6F**).

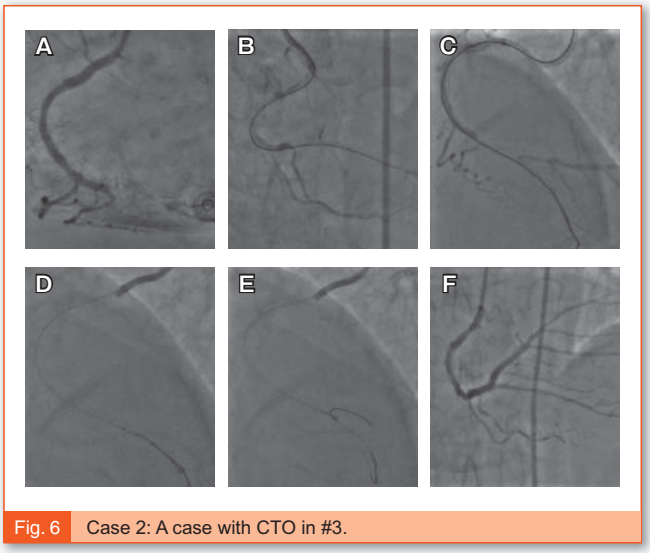

Fig. 6 Case 2: A case with CTO in #3.

Case 3

A troublesome case of reverse wiring is presented. This was a CTO lesion at a site distal to RCA (**Fig. 7A**).

X-treme wire was advanced relatively smoothly and passed through the true lumen of the PDA at a site more distal to the end of the distal true lumen but it was difficult to pass the wire through the site distal to RCA and therefore reverse wiring was performed. When trying to extend the reverse wire, an abnormality was felt and confirmation revealed that the wire broke off (**Fig. 7B**). The cause of the break was considered due to the distance from the tip of the wire to the bending site being 55 mm, which is clearly longer than the usual 20-30 mm.

The broken wire was withdrawn by inserting two wires and rolling it up.

The reverse wire bent at an appropriate position was then crossed at the site distal to RCA, the stent was placed, and treatment was completed (**Fig. 7C**).

Fig. 7 Case 3: A case with a CTO lesion at a site distal to RCA.

The key to successful Crusade withdrawal

As this has already been explained by Dr. Otani, I will be brief in my description.

I usually use the Nanto method because the use of an extension wire requires an assistant and much labor. **The important point to follow when pulling Crusade by applying pressure is to always switch the right and left hands when it is caught once at the port exit of the monorail lumen (Fig. 8A, B).**

Dr. Otani used a method in which he temporarily reduced pressure, but I withdraw it at 10-15 atoms since no problems occur if I switch my right and left hands calmly.

Finally, Crusade is a necessity for me. It is not so popular in foreign countries but I always place it in my suitcase so it is ready to be use.

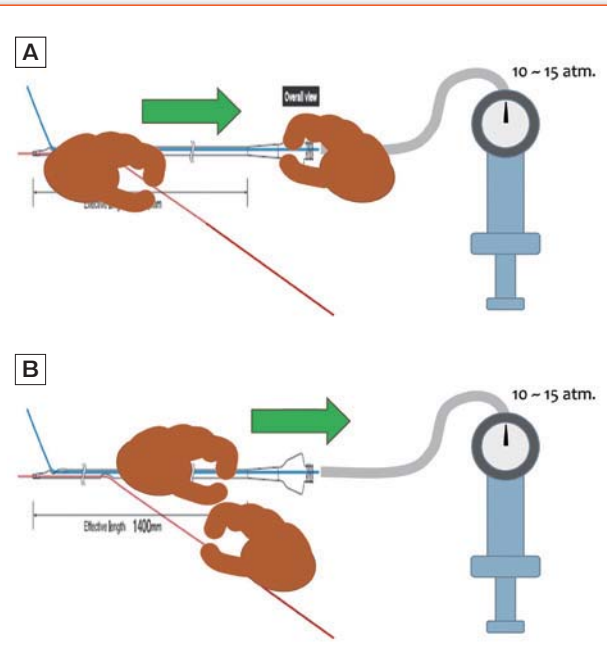

Fig. 8 Withdrawal of Crusade using the Nanto method. Pull Crusade by applying pressure and switch the right and left hands when it is caught at the port exit.

TAKUMI "Decision at Bifurcation"

Dr. Osamu KATO
Toyohashi Heart Center

Before Crusade became available, I used the multiprobing sheath but it was discontinued. The advantages of having replaced the multiprobing sheath with Crusade include better sliding of the wire in the OTW lumen, better maneuverability, and its relative ease of use.

I will describe here the usefulness of Crusade, focusing on (1) wire exchange, (2) coaxial backup for guidewire handling, and (3) multiple wire technique, from among the technical issues experienced in modern percutaneous coronary intervention for complex lesions (complex PCI) (Fig. 1-3).

- wire exchange, reshaping wire tip during procedure
- coaxial backup for guidewire handling
- multiple wire technique
  - buddy wire technique
  - side branch protection in bifurcation stenting
  - SPRIT stenting
  - parallel wire technique

Fig. 1 Technical Issues in Modern Complex PCI - need for Crusade -

- to put another wire leaving the prior wire
- unable to deliver a catheter for exchange beyond the lesion
- key to success
  - avoid wire twisting
  - minimize damage of the 2nd wire

Fig. 2 Wire exchange/ Reshaping

- prevention of wire twisting
- coaxial backup to the 2nd wire for better maneuverability
- easy wire exchange

Fig. 3 Usefulness of Crusade in multiple wire technique

Wire exchange

The number of wires that use polymer materials has increased recently but these wires need to be exchanged with a coil wire during the procedure because of possible complications such as perforation. In wire exchange or reshaping the wire tip, the wire is withdrawn once and a new wire is reinserted but the new wire may give out before it reaches the target site.

The use of Crusade enables the wire to be quickly exchanged, twisting in the second wire insertion to be avoided and wire damage prevention.

Coaxial backup

In cases where sufficient backup to the guide catheter is not obtained, coaxial backup to the guidewire is not obtained and the guidewire becomes unstable and cannot be minutely controlled. In this case, Crusade is often used to give coaxial backup to the second wire for better maneuverability.

In simple PCI, the wire advances easily and no special attention is required. However, when sophisticated guidewire manipulation is required, Crusade is an indispensable device and one cannot underestimate its importance in improving the technical level of PCI.

First, the outline of procedures followed when not using Crusade is illustrated. As an example, when the left circumflex branch (LCX) bends outward from the left coronary main trunk (LMT) and there is a lesion ahead of it (**Fig. 4A**), the guide catheter stays pointing slightly left and the wire will bend and advance into the LCX. When the guidewire is inserted into the side branch proximal to the lesion and the guide catheter and the branch are extended, the curve of the LCX origin straightens slightly and the guide is slightly stabilized (**Fig. 4B**). However, this is not yet sufficient. If manipulation of second wire advancement is performed in this condition, the wire becomes looped or extended, hindering maneuverability (**Fig. 4C**).

In contrast, by using Crusade (Fig. 5A), the second wire can be fixed at the LCX origin (Fig. 5B), the origin of wire manipulation is secured, and the manipulation is stabilized (Fig. 5C). This perfectly illustrates the advantage of using Crusade and forms the basis of its usefulness.

Multiple wire technique

Complex PCI requires a multiple wire technique, for which Crusade is useful because it prevents wire twisting, provides coaxial backup, and makes wire exchange easy.

Main techniques include the buddy wire technique, side branch protection in bifurcation stenting, SPRIT stenting, the parallel wire technique, and a special technique presented by Dr. Sumitsuji.

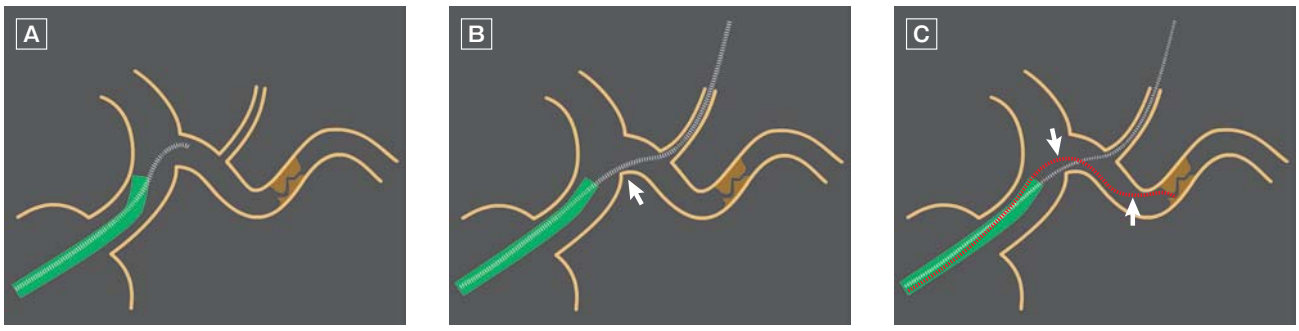

Fig. 4 Second-wire manipulation in coaxial backup not using Crusade.

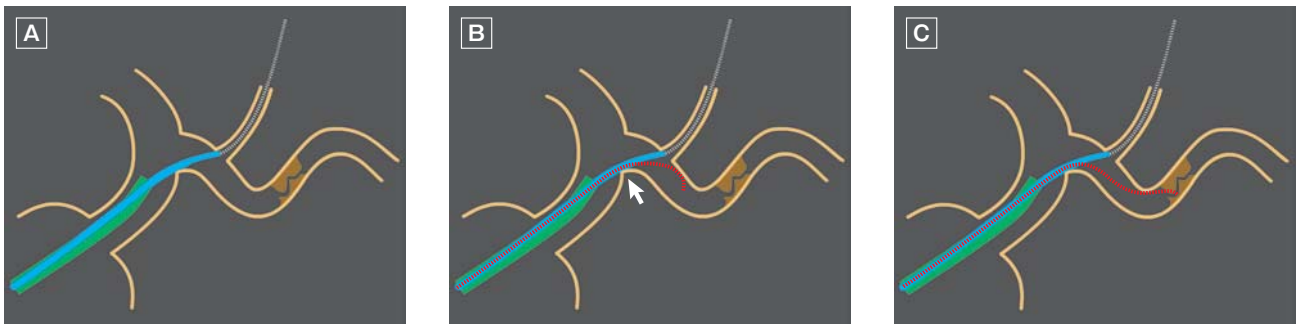

Fig. 5 Second-wire manipulation in coaxial backup using Crusade.

Getting familiar with using Crusade

It seems there are many doctors nowadays who are familiar with bare wire and feel that using Crusade takes too much time. However, if you get familiar with the procedure, it takes only one or two minutes. As stated earlier, if you want to brush up your skills to the next technical level, you should get familiar with how to use it. If you use only the bare wire for the procedure, your technique will not improve.

As was emphasized by Dr. Otani and Dr. Sumitsuji, withdrawal of Crusade using the Nanto method requires some special maneuvering. The Nanto method is convenient but wire twisting during withdrawal may occur and it is quite difficult to be resolved once it does. I withdraw it by balloon trapping method almost 100% of the time.

When Crusade is used in CTO, digging with a parallel wire is often performed. I perform a delicate procedure that allows no displacement of the position of the wire tip in the CTO portion. It is not uncommon for the wire to come out in the Nanto method, but balloon trapping method ensures wire fixation and there is no displacement of the tip position. I think a 2.5-mm balloon is appropriate for an 8 Fr guiding catheter. I often use this size balloon in the procedures I perform. It is more convenient than the Nanto method and I recommend it.

In the special usage (reverse wire technique) reported by Dr. Sumitsuji, if the tip of the second wire bends at a sharp angle and creates a kink, the wire may break or it may become more difficult to extend and bring the wire to a part farther in while rotating after insertion. To avoid this, it is desirable to bend the tip of the wire not completely but at about three points so as to form a small loop.

Case presentation

A case of step-by-step crossing using Crusade is presented. A subtotal occlusion lesion in the LCX is diffusely observed (**Fig. 6**).

With one wire already inserted (**Fig. 7**), Crusade was used to give coaxial backup to the second wire (**Fig. 7**). Since this case was complicated, the bifurcation site was again confirmed by IVUS and another wire was advanced using Crusade (**Fig. 8, right**). Eventually, three wires were brought in parallel (**Fig. 9**).

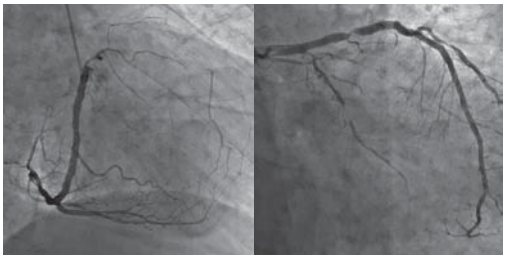

Fig. 6 Subtotal occlusion lesion in LCX.

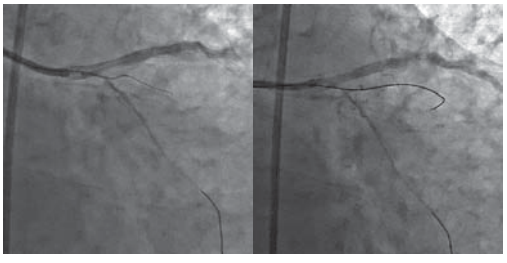

Fig. 7 Crusade was used to give backup to the second wire.

When insertion and withdrawal of Crusade are repeated, the conventional method takes time but the use of balloon trapping method (**Fig. 10**) facilitates withdrawal with no displacement of the wire tip. Thus, it is considered that Crusade is indispensable in step-by-step procedures as well.

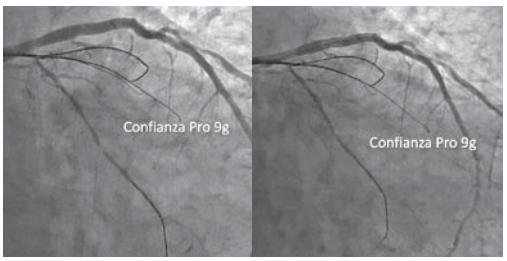

Fig. 9 Parallel wire technique.

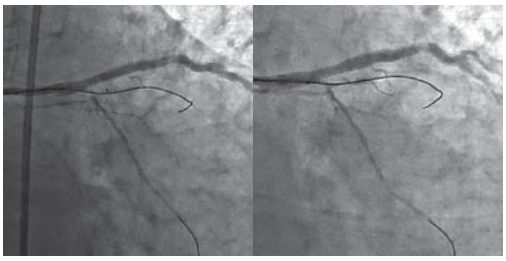

Fig. 8 One more wire was inserted using Crusade.

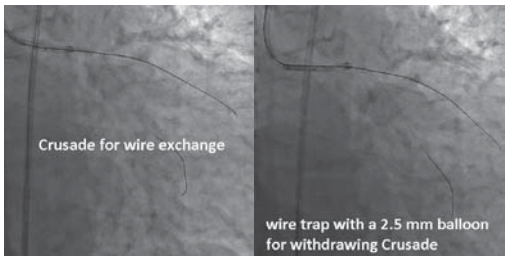

Fig. 10 Withdrawal of Crusade by balloon trapping method.

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