Uses of the multi-functional probing catheter in the recannalisation of chronic total occlusions

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Abstract

This paper discusses the uses of the Multi-functional probing catheter™ (Boston Scientific, Scimed) in the arena of percutaneous coronary intervention with specific reference to treating chronic total occlusions. This catheter is essentially a speedy monorail balloon without the balloon mounted on the end. Thus, it has a short monorail/rapid exchange port which exits at the distal tip of the catheter, and an over-the-wire port which exits proximally at the side of the catheter.

Tackling chronic total occlusions often results in the creation of a false passage intramurally rendering it difficult to redirect the guide-wire into the true lumen. The Multi-functional probing catheter™ allows introduction of a second wire in a different direction from this lumen via the over-the-wire port. The benefits of this equipment for guide-wire support and wire exchange are examined. In addition, this support catheter allows distal vessel visualisation, confirming intraluminal wire position. A further use of this catheter is for intracoronary drug delivery especially in the context of vascular spasm, no reflow or thrombotic occlusion.

The use of the Multi-functional probing catheter™ in two chronic total occlusion interventions cases is discussed in detail.

Key words: coronary, intervention, guide-wire, occlusion.

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Introduction

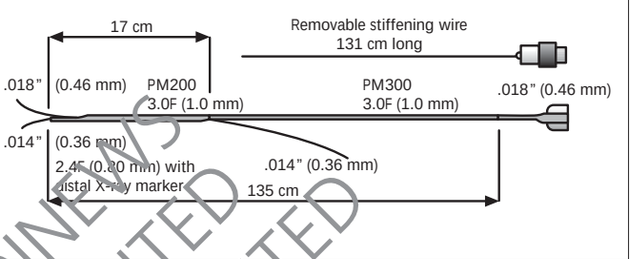
In this era of increasingly complex coronary interventions, operators require a repertoire of strategies to tackle lesions that cannot be treated with simple techniques.

There is an increasing trend for percutaneous revascularisation in multi-vessel disease, although the presence of a chronic total occlusion is the most frequently cited reason to refer a patient with multi-vessel disease for coronary artery bypass grafting, as it has been perceived that treating such lesions percutaneously is associated with both poor short- and long-term outcomes.[1] In the past, restenosis rates for this subset of patients have been unacceptably high (> 50%), although this has largely been overcome with the advent of drug-eluting stents.[2] Thus, the major remaining obstacle is successfully passing a guide-wire into the distal vessel.

Recently, an evolution in the interventional approach to chronic total occlusions has resulted in dramatically improved acute success rates (reportedly as high as 85–90%).[3] Central to this technique is the concept of 'piercing' the calcified fibrous cap of the occlusion, navigating directly through the softer material in the centre of the occlusion and, once again, piercing and exiting the cap, passing the wire into the distal vessel.[3] This strategy is fundamentally different from a more conventional approach whereby an attempt is made to pass a wire with active rotation through a theoretical pre-existing channel, believed to be the true lumen, into the distal vessel. With the latter technique, exit of the wire into the sub-intimal space frequently occurs and subsequent wire manipulation results in the creation of a false track, making re-entry into the main lumen a major challenge.

Central to the former strategy is the use of ultra-stiff wires, the simultaneous use of multiple guide-wires, if required and, importantly, a support catheter. The Multi-functional probing catheter™ (Boston Scientific, Scimed) is one such catheter, with a number of applications in current interventional practice. Our impression is that this catheter is underused and the purpose of this paper is to highlight some of its potential uses in the context of chronic total occlusions.

Figure 1. The multi-functional probing catheter



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Essentially, the catheter is a speedy monorail balloon without the balloon mounted on the end (figure 1). It has two ports – a short monorail/rapid exchange port which exits at the distal tip of the catheter, and an over-the-wire port which exits approximately 3 mm proximal to the tip of the catheter at the side. Each port accommodates a standard 0.014-inch guide-wire. The monorail system and handling of this catheter is similar to that of balloon systems, with which all interventionalists are familiar.

Wire exchanges

It has been suggested that a support catheter, such as the Multi-functional probing catheter™, should be used in all chronic total occlusion cases for a number of reasons, including the facilitation of wire exchanges.

It may be necessary to change a guide-wire if the tip becomes distorted rendering it difficult to manoeuvre, or it may become apparent that a more supportive guide-wire is required in a tortuous vessel. However, it is generally undesirable to re-traverse the vessel. Provided an exchange length wire has been used, or a standard length wire can be extended (for example, ACS wires using the Doc Extension [ACS,Guidant]), an 'over-the-wire' balloon can be used to change the wires. In many units, over-the-wire balloons are not used routinely and this may result in a reluctance to change suboptimal equipment, potentially adding to the complexity and difficulty of the case.

A preferable strategy may be the use of the Multi-functional probing catheter™. Once inserted to the desired target, using the monorail port, an exchange length wire can then be inserted using the over-the-wire port, following which the original wire may be withdrawn. Alternatively, a standard length wire may be used and the probing catheter 'blown off' the guide-wire without disturbing the wire position within the distal vessel. This may be achieved by pulling the probing catheter back as far as possible so that only the proximal tip of the wire is visible, loosening the 'O' ring of the Y-connector, and either placing a 10 ml luer lock syringe filled with heparinised normal saline, or an indeflator onto the over-the-wire port. By squeezing gently on the syringe, or creating low positive pressure with the indeflator, the probing catheter can be removed, under continuous fluoroscopy, with the wire maintaining its position across the lesion. The Crosswire™ (Terumo Interventional Systems) is particularly useful in this context, as it not only has a hydrophilic coating throughout its length facilitating probing catheter exchange, but is also relatively stiff allowing passage into the distal vessel.

The aggressive, stiff wires currently used with the penetration strategy for chronic total occlusions outlined above could potentially cause damage to the vessel proximal to the occlusion. In some cases, where vessels are highly tortuous or diffusely diseased, it may be preferable to traverse the proximal portion of the vessel with a floppy, atraumatic wire. Passage of a support catheter, such as the probing catheter, enables such a wire to then be directly exchanged for the preferred stiff wire.

Use of the probing catheter as the guide-wire penetrates the occlusion is important, as it provides crucial support and also allows superior transmission of torque to the tip of the guide-wire, enabling it to be manoeuvred through the lesion, and reducing the tendency to deviate into the subintimal space.

Notwithstanding, it is relatively common for guide-wires to create a false passage intramurally and, following this, it may become difficult to redirect the guide-wire into the true lumen. In the past, the wire would then be removed and then reintroduced, in an attempt to find a channel within the true lumen. Unfortunately, such manipulation of wires within the subintimal space frequently results in enlargement of the false passage and, often, frank vessel dissection. An alternative approach is to leave the first wire *in situ* and introduce a second wire. This helps prevent the second wire from re-entering the false passage, serves as a road map, and acts as an anchor giving the second wire more 'pushability', facilitating its passage through the occlusion.

The dual lumen design of the probing catheter makes this an ideal support catheter in this context. Furthermore, the position of the side port, 3 mm proximal to the tip, allows the second wire to be passed in a different direction from the established lumen.

Distal vessel visualisation

It is frequently unclear when intervening on chronic total occlusions whether the guide-wire is intraluminal, intramural or has perforated the vessel. If a balloon is used for support, either the wire can be removed and contrast injected down the lumen with the subsequent need to rewire the distal vessel, or the balloon may be inflated in the hope that it is within the lesion and a contrast injection used to determine distal wire position. This may result in extension of a dissection should the wire be intramural, or transform a minor wire exit into a major perforation, potentially resulting in cardiac tamponade.

By using a probing catheter for support, it is possible to gently inject dilute contrast medium via the over-the-wire port to opacify the distal wire position, although care must be taken when injecting contrast to ensure that the side port is distal to the lesion before attempting to inject contrast or any other medium to minimise risks associated with intramural injection.

Intracoronary injections

After the recannalisation of chronic total occlusions, it is not uncommon for 'no reflow' to occur, which may be associated with serious adverse consequences. Treatment strategies are currently limited and, in such situations, injection of vasodilators and antiplatelet agents through the guide catheter may not reach the distal vessel. However, drugs may be delivered directly and safely to the distal target with potentially more effect by injecting down the over-the-wire port of the probing catheter.

Case 1

The following case illustrates several uses of the probing catheter during a percutaneous interventional procedure to an occluded ostial left anterior descending artery (LAD) (figure 2a). The left main stem was intubated with an 8F JL4 SH guide. A

Figure 2. Case 1: **a:** shows the ostial left anterior descending artery (LAD) occlusion; **b:** shows distal injection of contrast through the probing catheter revealing the wire position to be within a large diagonal branch; and **c:** shows the post-procedural successful intervention to the LAD, and also the diagonal branch

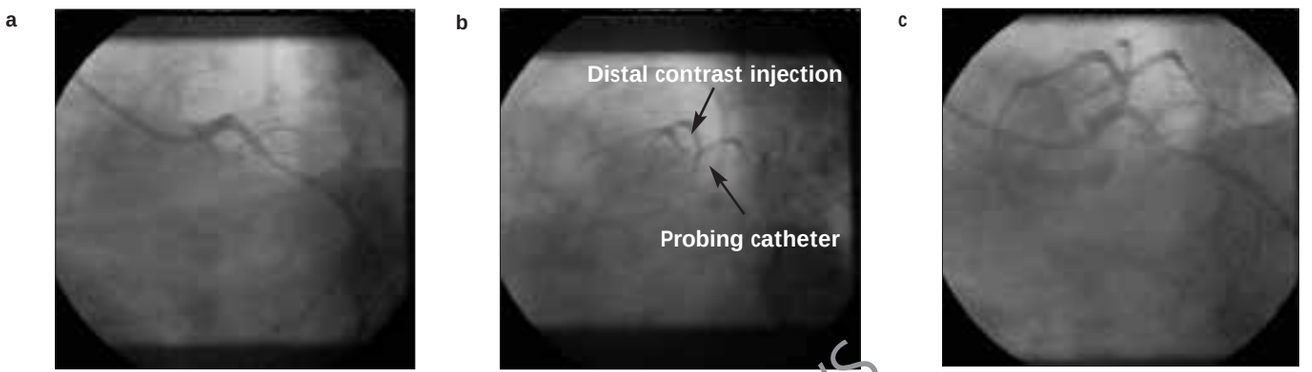
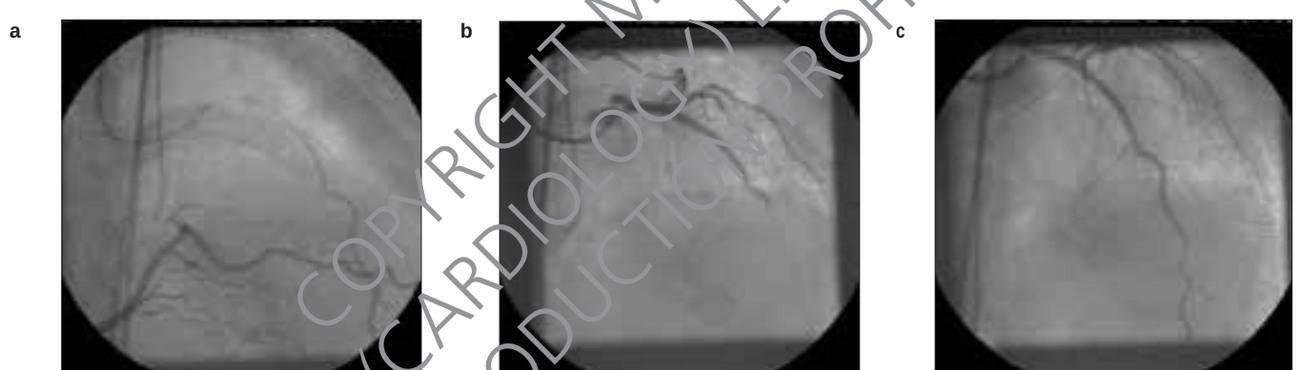


Figure 3. Case 2: **a:** shows bilateral coronary injections of an occluded left anterior descending artery (LAD) revealing the distal LAD and initial wire position in the septal branch; **b:** shows the abrupt cut-off of contrast in the mid-LAD due to spasm and 'no reflow'; and **c:** shows the restoration of distal flow following administration of intracoronary verapamil delivered to the distal vessel by the probing catheter



conventional guide-wire was unable to cross the occlusion without support. Use of the probing catheter (inserted over the monorail port) enabled the occlusion to be crossed. The distal wire position, however, was unclear and the probing catheter was, therefore, advanced across the occlusion and dilute contrast was injected through the over-the-wire port (figure 2b). This figure clearly shows that the wire was in a large diagonal branch and not in the LAD.

The probing catheter was kept in this position and attempts were made to redirect the wire into the LAD, albeit unsuccessfully. A Crosswire™ with a sharp distal bend at the tip was therefore introduced through the over-the-wire port of the probing catheter and into the LAD. The probing catheter was then 'blown off' the Crosswire™ as described above. The LAD was predilated with a 2.5 mm balloon. A 3.5x20 mm Express 2 stent was subsequently deployed at 14 atmospheres with an excellent final angiographic result in the LAD (figure 2c).

Case 2

In the following case, stenting of an occluded LAD resulted in severe vascular spasm. Figure 3a shows the initial view of the distal LAD visualised by bilateral intracoronary contrast injections. A Luge™ wire (Boston Scientific) was passed to the distal vessel and the wire position was confirmed by right coronary injection. The occlusion was pre-dilated with a 2x20 mm Crosssail® balloon (Guidant) and successfully stented with a 2.5x24 mm Taxus™ stent (Boston Scientific), distally, and a 3x16 mm Taxus™ stent, proximally. This resulted in loss of coronary flow (figure 3b). Repeated doses of intracoronary nitrates were ineffective in relieving the distal spasm. Multiple

Key messages

- The Multi-functional probing catheter™ is a dual lumen catheter with a number of useful applications in PCI practice:
  - Guide wire support
  - Wire exchange
  - Side-branch access
  - Distal vessel visualisation
  - Selective intra-coronary drug delivery

further balloon inflations were therefore undertaken using 2x20 mm Crosssail® balloon, proximally, and 2.5x20 mm Crosssail® balloon, distally. However, poor epicardial flow persisted. A Multi-functional probing catheter™ was therefore passed into the distal vessel and verapamil (200 mcg) was injected via the over-the-wire port with subsequent rapid relief of the vascular obstruction (figure 3c). Abciximab (Reopro®) was given immediately post-procedure and an intra-aortic balloon pump was inserted prophylactically to maximise coronary perfusion. The peak creatinine kinase level post-procedure was 110 IU/L and the patient was discharged home after an uneventful post-operative course at 48 hours.

Summary

In conclusion, the Multi-functional probing catheter™ is invaluable in a contemporary strategy for tackling chronic total occlusions. Familiarity with its applications in terms of wire exchanges, wire support, distal vessel visualisation and drug delivery may extend its use to additional subsets of complex coronary intervention.

Conflict of interest

None declared.

References

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BOOK REVIEW

Cardiac CT, PET and MR

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These are exciting times for cardiovascular imaging. Increasingly, non-invasive imaging modalities are being used to assess cardiac structure and function, and coronary anatomy. In some cases, these techniques are now genuine alternatives to the gold standard investigation of conventional coronary angiography. This book is therefore a unique and well-timed publication which comprehensively describes the merits of each of the three major imaging techniques – computed tomography (CT), positron emission tomography (PET) and magnetic resonance (MR) - and provides examples of the outstanding quality of images that these modalities provide.

In the first section, there is a clearly written account of the techniques, instrumentation and protocols of each modality. Essential background physics is summarised for each technique in a succinct and readable style. The second section looks at clinical applications of each technique, based on current evidence. It describes well the great strength of CT for imaging the coronary arteries, the importance of PET in quantitative perfusion assessment and metabolic function, and the great benefit of cardiac MR in assessing myocardial function, perfusion and viability without radiation exposure. There is also an up-to-date account of the ability of MR to image the coronary arteries and atheromatous plaque. A fascinating perspective on the future development of these techniques is provided in the final section on hybrid CT/PET and MR/PET scanners, which may evolve to utilise the benefits of the two imaging modalities simultaneously.

The chapters are written by some of the most famous and widely published authors in each field. As a result, each section is authoritative yet frank and honest. While discussing the strength of their technique, each author is able to describe its current limitations. Although there is not a chapter which directly compares the three imaging modalities, the book explains clearly why one particular test is ideal in one clinical setting but not another. No technique is a 'one-stop-shop' and each technique has further to evolve, possibly in combination with one of the others.

This is an excellent and important reference for all those involved with cardiac imaging and vital for all those training in this field. It will be ideal for clinical referrers for these examinations. It will also be a useful source of information for those cardiologists, radiologists and nuclear medicine physicians with a specialist interest in one of these techniques, not only to reinforce the benefits of their own modality but also to identify those patients that may, in fact, be better assessed by one of the other imaging techniques.

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