REVIEW ARTICLE

Techniques to Overcome Difficulty in Device Deliverability to Lesion in Complex PCI

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Abstract: Percutaneous Coronary Intervention (PCI) has revolutionized the management of Coronary Artery Disease and has become the preferred modality of revascularization in a majority of cases. Nevertheless, situations are encountered frequently where device deliverability to coronary lesions entails technical difficulties due to varied anatomies and lesional complexities like tortuosity, calcifications, length of lesions and vessel morphology. While continuous technological refinements are occurring in PCI hardware armamentarium and stent designs, a number of techniques and their modifications and variations have evolved to increase the applicability of PCI to difficult lesions.

The present article envisages a thorough review of all aspects of improving successful device deliverability in complex PCI with prominent emphasis on increasing the backup support of Guide Catheters which is the primary factor of success in difficult coronary lesions.

Keywords: Percutaneous Coronary Intervention (PCI), Drug-Eluting Stents (DES), Chronic Total Occlusion (CTO), Transradial Interventions (TRI), mother- child technique, guideliner, buddy wire, anchor balloon.

1. INTRODUCTION

Despite continued advancement in the design of interventional hardware, technical troubles during stent delivery still occur in 2.7% to 3.3 % [1]. Characteristics associated with stent delivery failure include vessel tortuosity, lesion severity, lesion length, calcifications, Chronic Total Occlusion (CTO), or lesions located distal to a previously implanted stent, stent length and structure, or poor guiding catheter support in dilated aortic root, or in unadjusted angle of take-off of the proximal segment of the target coronary artery [2]. Failure occurs more so in Transradial Interventions (TRI) and lack of guide catheter support is one of the main reasons for conversion to the femoral approach in about 7% of cases [3].

Many techniques have evolved over time to overcome challenges associated with complex anatomies and lesions. This paper intends to review the most commonly applied techniques and describe their relative advantages and a comparative analysis of each technique in various clinical situations.

2. GUIDE CATHETER SELECTION AND MODIFICATION

Selection of an appropriate Guide Catheter (GC) is the single most important step that determines the success of an interventional procedure. A careful thought needs to be given for Guide selection after taking multiple factors into consideration including patient characteristics, route of procedure, target vessel and lesion characteristics as well as the interventional hardware that would be needed. However, the most important factor that governs the GC selection is the backup support required for the procedure and the choice between active and passive backup [4].

2.1. Passive Support

It refers to the back-up support obtained when a catheter is inserted into a coronary artery and left there. Other than the material and construction of the GC, passive support depends on two important factors namely size and shape. In general, larger sized catheters (7F and 8F) provide higher passive back-up than smaller sized GC such as 5F, while that of 6F is intermediate. Another factor determining the passive backup is the shape of the catheter such as the extra-backup catheters like Amplatzer, Voda, EBU, XB. Though providing stronger backup than conventional catheters like Judkins, they can be more traumatic to coronary ostium and need careful manipulation to minimize complications.

2.2. Active Support

This entails the operator manipulating the catheter to improve support. Most common of such maneuvers involve deep seating a catheter to facilitate stent delivery. Here, smaller sized catheters such as 4F and 5F have the advantage of deep intubation in comparison to larger catheters. Deep intubation is usually reserved for complex bailout procedures

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and can be performed either with an appropriately sized catheter already engaged (5F or rarely 6F), or as part of "mother-child" technique (described later). It is usually accomplished with "Rail-Road" technique where the catheter is advanced over the shaft of an interventional device (balloon or stent). For deep seating in LAD a counter-clockwise rotation to the catheter is applied, while for RCA and LCX its clockwise rotation.

Another important maneuver to increase active support is the Rotational Amplatz Maneuver that can be applied to Judkins guide by gently pushing it and rotating it so that the curve sits well in Aortic Sinus and simulates the shape of Amplatz guide. Unlike deep seating, Amplatzing a Right Judkins requires counter-clockwise rotation and a Left Judkins clockwise rotation.

Important adverse events that need to be kept in consideration while employing active support maneuvers include dissection, flow obstruction and air embolism.

3. BUDDY WIRE, GLIDING WIRE AND ANCHOR WIRE TECHNIQUES

If, after having a proper Guide in position, any need for further backup is required then the Buddy Wire technique is the first to be used. The technique involves placing a second guide wire parallel to already in-place guide wire. In anchor wire technique a second wire is inserted in a non-target vessel to anchor the guiding catheter, while in gliding wire technique a second hydrophilic wire is inserted in order to allow the stent to glide over the hydrophilic coating of the second wire. A combination of Buddy wire and Anchor wire can be used during a procedure for enhanced support. A "Double Buddy" wire technique has also been described where 2 buddy wires are used in addition to the main guidewire for enhanced support and device deliverability [5].

The buddy wire is especially useful in tortuous vessels where it straightens the vessel tortuosity and acts as a track which directs the stent away from the vessel wall, thereby facilitating the delivery of angioplasty equipment. This was stated by Shamoon *et al.* who described successful use of Buddy wire technique to facilitate the delivery of Rotablator burr after facing difficulty in a proximally tortuous vessel [5, 6].

- Buddy wire can stabilise the ostial positioning of the guiding catheter and hence is useful in Ostial lesions as well as vessels with difficult take-off or anomalous origin from the aorta and SVG grafts [5].
- Buddy wire technique is used in reduction of balloon slippage that can occur in up to 25% cases of in-stent re-stenoses. In this particular setting, it is important to select a guide wire without hydrophilic coating as a buddy wire to maximise the stabilising effect of the second guide wire on the balloon [5].
- The technique has been used to inflate an under-deployed stent as "focused force angioplasty" [6].

4. ANCHOR BALLOON TECHNIQUE

This technique involves the use of an extra balloon for anchorage, in addition to the stent to be deployed, and hence it is important to understand that it can only be accomplished with a larger guide that can accommodate extra balloon.

- *Classic Anchor Balloon Technique*: It was initially described by Fujita as inflation of a balloon in the side branch of a target coronary vessel *i.e.* inflating a balloon to further stabilize the "Anchor wire" [7].
- *Coaxial Anchoring*: A balloon is inflated proximally in the target coronary vessel to enhance the penetration capacity of a guide wire especially for CTO.
- *Distal Anchoring*: A balloon is inflated distal to or at the target lesion to enhance support for equipment delivery [8].

In most cases, the balloon should be inflated within the target lesion to minimize the risk for target artery injury. If one needs to perform Anchor Balloon Technique for proximal stent delivery in a coronary with distally implanted stent, then this Anchor balloon technique should be done into a drug eluting stent only shortly after its implantation to be sure to benefit from the properties of the drug to prevent restenosis [7-11].

Guide Exchange: Occasionally it may be necessary to change the GC to a different type or size after a guidewire was crossed with difficulty and needs to be kept in-situ. In this scenario either a guide-wire extension can be used to facilitate the exchange or Japanese Blow Technique used. Here a syringe filled with saline is attached to the end of the guide and injected continuously to maintain wire position, under Fluoro guidance, while removing the guide [12, 13].

5. MOTHER-CHILD TECHNIQUE AND GUIDE EXTENSION

While a large Guide Catheter provides good passive support, it may not be useful for deeper intubation. On the other hand, a smaller catheter may be used for deep intubation but provides poor back-up support on its own. Mother-Child Technique combines the advantages of both and involves a longer "Child Catheter" introduced within a bigger and conventional length "Mother Catheter". Takahashi *et al.* first described the 5-in-6 F Mother-Child system in which a 120 cm long 5 F catheter was inserted into 100 cm, 6F catheter to augment its backup support [14]. Subsequently, it was demonstrated that a 4F "child catheter" provided superior trackability and stent deliverability even in tortuous vessels [15].

Important considerations that need to be understood in application of "Mother-Child" technique pertain to the sizes of the "child" and "mother" catheters as well as the length of intubation of the "child catheter". These can be summarized as follows [16, 17] (Figs. **1** and **2**).

- *Size of the "Child Catheter"*: Incremental backup provided is greater using 5F "child catheter", as compared to 4 F, and is better suited where strong back-up is required especially in trans-radial interventions. However, 4 F has superior track ability, less tendency to traumatize vessel or compromise flow and may be better suited for tortuous, small or proximally diseased vessels, calcified or angulated lesions where a 5

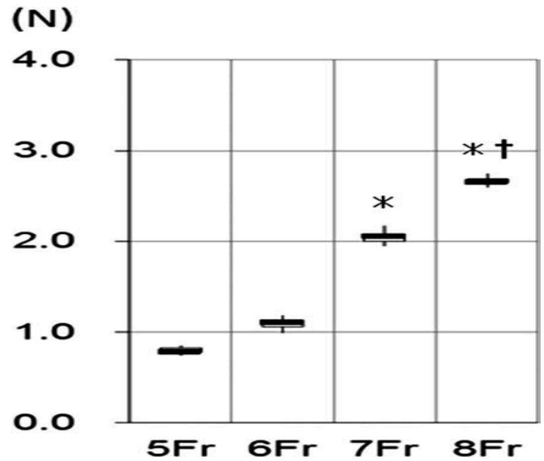

Fig. (1). Backup support of the regular guiding catheters. The backup support of the 5- and 6-Fr guiding catheters was significantly lower than that of the 7- and 8-Fr catheters (*p < 0.0001), and the backup support of the 7-Fr catheter was lower than that of the 8-Fr catheter (†P < 0.005) [16]. *(A higher resolution / colour version of this figure is available in the electronic copy of the article).*

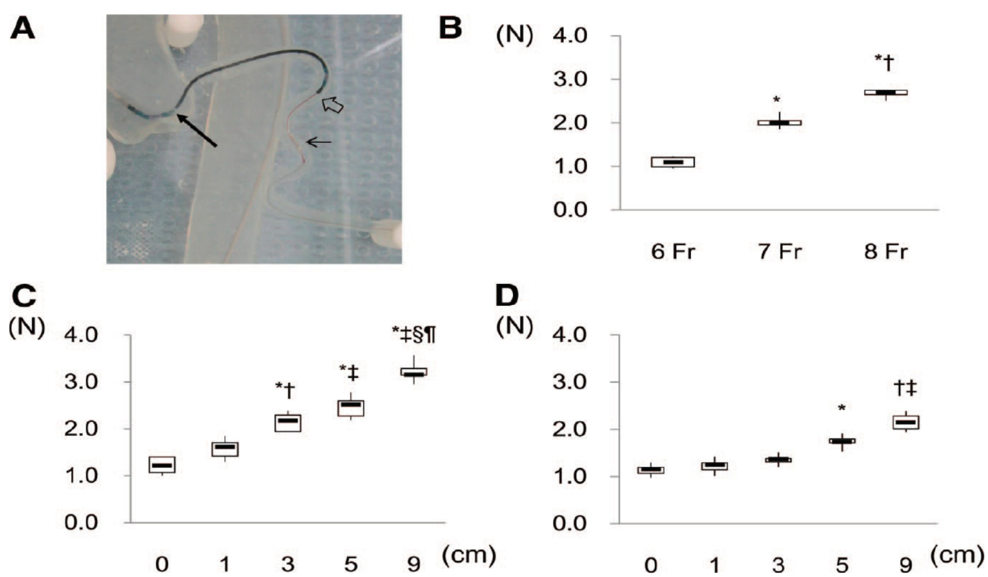

Fig. (2). Backup support of mother-child system. **A,** *In vitro* measurement of backup support. The maximal backup support means pushing force of the gauge machine when the mother guiding catheter disengaged from the coronary ostium (large arrow). **B,** Backup support of a conventional guiding system. The backup support of conventional 6F, 7F, and 8F guiding catheters was evaluated without use of a child catheter (**P*_0.0001 *versus* 6F; †*P*_0.005 *versus* 7F). **C,** Backup support of the 5-in-6 system. By extending a 5F child catheter _3 cm, the backup support of the 5-in-6 system significantly increased (**P*_0.0001 *versus* 0 cm; †*P*_0.05 *versus* 1 cm; ‡*P*_0.0001 *versus* 1 cm; §*P*_0.0001 *versus* 3 cm; and ¶*P*_0.0005 *versus* 5 cm). **D,** Backup support of the 4-in-6 system. By extending a 4F child catheter _5 cm, the backup support of the 4-in-6 system significantly increased (**P*_0.01 *versus* 0 cm; †*P*_0.0001 *versus* 0 and 1 cm; ‡*P*_0.0001 *versus* 3 cm).. *(A higher resolution / colour version of this figure is available in the electronic copy of the article).*

F catheter will be associated with increased adverse events.

- *Size of the "Mother Catheter"*: The incremental backup provided by any given "child catheter" is inversely proportional to the size of the "mother catheter". A large catheter like a 7 or 8F guide already has a good backup which is only minimally increased further by "mother -child" technique that, on the other hand, significantly increases the backup support of a 6 F guide. Hence using "mother-child" technique for augmenting backup is more useful when using a 6F guide especially in Transradial procedures. While this technique may not increase the back-up of a larger 7 or 8 F guide, but it can help in situations where deep intubation of the smaller "child catheter" is useful, such as in tortuous vessels.

- *Length of Intubation of "Child Catheter"*: The support is directly related to the depth of intubation. For example, insertion of a 5FR guide catheter 15mm into a 6FR catheter doubles the back up support, and 5-cm advancement of the 5-Fr child catheter out of a 6-Fr mother catheter produces the support power equivalent to the 7-Fr guiding catheter. With 9-cm advancement may be equivalent to the support provided by an 8-Fr guiding catheter alone.

5.1. Hardware And Guide Extensions for "Mother-Child" Technique

A. *5 F "Child Catheter"*: It is currently manufactured only by Terumo. It is 120 cm long with an outer diameter of 1.73 mm. As a result it can be accommodated only by catheters with an inner diameter of more than 1.8 mm. Currently available 6F guide catheters which meet such a requirement include Launcher (*Medtronic*), Taiga (*Medtronic*), Heartrail (*Terumo*) and Taiga (*Terumo*) [16, 17].

B. *4 F "Child Catheter"*: Three different manufacturers offer 4 F "child catheter" that include Kiwami (*Terumo*), Cokatte Catheter (*Asahi Intec*), and the i-Works (*Medikit*). While all three catheters have same length (120 cm) and inner dimensions (1.27 mm), the only difference is the outer dimension. The Cokatte Catheter has an outer dimension of 1.5 mm, in comparison to 1.43 mm of the other two as a result of which only the latter two catheters can be used with a 5 Fr "Mother" Guide.

C. *Guideliner*TM: It is basically a guide extension with a monorail design analogous to a rapid exchange balloon catheter that works on the basis of "mother-child" principle. It is a 145 cm device with a 20 cm single lumen catheter attached to a stainless steel shaft. In the newer version (V2) the rapid exchange section is increased to 25 cm. It can be used as a rapid exchange device over an exchange length (300 cm) or 180 cm guidewire. It is available in 6F, 7F and 8F sizes along with recent introduction of a 5.5F size to be used with a 6F Guide [18-20].

5.2. Technical Aspects Of "Mother And Child" Technique

5.2.1. Classical Mother and Child Technique

The 'Y' haemostatic valve is disconnected from the guiding catheter and a small haemostable valve is connected to mother guiding catheter. A child catheter is introduced into the guiding catheter over the wire. After the wire protrudes out of the child guiding catheter, the haemostatic valve is reconnected to the child guiding catheter [21].

Meticulous care should be taken in the manipulation and advancement of the child catheters to avoid complications like local air embolism, intimal disruption, arterial dissection, perforation of vessel wall, vascular occlusion, arterial thrombosis, distal embolisation, myocardial infarction, and arterial spasm.

Careful withdrawing and introducing balloon and stents is necessary to avoid sucking air into the catheter which can be injected distally. Thus, vigorous aspiration after set-up of the MC system is required to minimize these possibilities.

While inserting a child catheter, careful monitoring of the tip of the wire under fluoroscopy is mandatory, especially when using stiff wires.

*5.2.2. Guideliner*TM *Catheter*

It can be introduced through the 'Y' haemostatic valve and must be advanced over the 0.014 inch guidewire, analogous to a rapid-exchange balloon catheter [22]. For extra precaution "rail-roading" over a balloon can be used to avoid dissection. There is no need to remove and reconnect the Y connector, less risk of air embolism, easier control of the mother catheter, more selective injection, easier advancement and removal ability to advance a stent further beyond the catheter tip [23].

Introduction of the GuideLinerTM into arteries with functional calibers < 2.5 mm, cerebral arteries and the venous system is not recommended by the manufacturer.

It is recommended, as a precaution, not to introduce the catheter more than 10 cm beyond the tip, as the GuideLinerTM can get stuck in the guide catheter (generally in the second curvature of the catheter). An intubation beyond 20 cm completely externalizes the tube with the metal collar to the vessel, causing severe damage [22].

It is recommended to be careful with the passage of higher-profile stents through the metal collar. In case of resistance while advancing the stent, the location of the stent in relation to the metallic collar of the GL should be checked and the stent should be inspected for damage. If the collar is located at a bend in the catheter, the GL should be retrieved gently into a straight section of the mother guide in order to allow more coaxial alignment of the collar [24-27].

5.2.3. Maneuvers For Deep Intubation Of Child Catheter

A. *Direct Engagement*: Child inner catheter is advanced into the vessel over either a coronary wire, or a wire and a balloon catheter with the balloon uninflated in the distal vessel.

B. *Anchor Technique*: First a balloon is placed at the distal culprit lesion. Then the balloon is inflated at 4 to 6 ATM to insert a child inner catheter slowly. By using the anchor technique between a balloon and a child inner catheter, deep intubation of a child inner catheter can be accomplished. The final position of a child inner catheter is proximal to the inflated balloon.

C. *Distal Balloon Deflation Technique*: First, a balloon is placed at the distal culprit lesion and a child inner catheter is also placed at the proximal lesion. Just after the deflation of the balloon, a child inner catheter can be passed beyond the deflated balloon. The final position of a 4 Fr inner catheter is distal to the inflated balloon [23].

5.2.4. Maneuvers to Increase Support for Equipment Delivery

A. *''Swan-Neck'' maneuver*: The vessel is first wired to secure its position. The extension catheter is then progressively advanced and the mother guide allowed to completely back out and down until it makes a contact with the opposite aortic wall. For additional increase of support further backing out of guide catheter is allowed until it makes contact with the aortic valve which provides significant backup support [18].

B. *"Rail Road" Technique*: By this technique deep intubation of guide catheter is done over the extension device of child catheter for increasing back up support [18].

In DOCA-TRI study by I Zhang *et al.* 187 patients with unsuccessful stent or balloon delivery after successful wiring of target vessel received further treatment with a 5-in-6 Double Catheter technique or by a conventional buddy-wire or balloon-anchoring approach. The primary endpoint of technical success was significantly higher in the DC group than control group (97.9% and 39.8%, p<0.001). Fifty-six patients (60.2%) in the control group achieved successful PCI with bailout use of a DC technique. This study concluded that the use of a 5-in-6 DC technique offers better support for complex Transradial PCI than a conventional buddy-wire or balloon-anchoring approach [21].

Vasim Farooq *et al.* did a study based on Trans radial graft interventions with the help of Proxis™, Heartrail device and Guideliner extension device. Depths of deep intubation varied from 30 to 138 mm (mean 61 mm) with no related complications observed. The only problem was the occurrence of slow reflow in seven cases (23%) despite distal protection in six of these cases. Distal embolization and slow reflow were associated with balloon dilation and stenting of the target graft disease and were not related to deep intubation of a guide catheter extension system in any case [18].

6. LESION PREPARATION AND PLAQUE MODIFICATION

Pre-dilation with a compliant or a non-compliant balloon usually works in less complex cases but may not be adequate in lesions with significant calcification. Complex coronary lesion interventions can benefit from pre-treatment with scoring devices to minimise balloon slippage, alter calcification, increase artery compliance and enhance stent deliverability [28, 29].

6.1. Cutting and Scoring Balloons

With regular balloon inflation the entire balloon surface contacts the vessel wall disrupting endothelium, non-uniformly compressing plaque and causing arterial wall damage. Cutting and Angioscuplt Balloons feature atherotomes or blades mounted on a balloon that provide longitudinal incisions in the plaque and thereby increasing lumen diameter at lower inflation pressures thus decreasing the risk of a neoproliferative response and restenosis. Lesion modification with scoring balloon prior to DES implantation facilitates stent expansion that may provide better long term vessel patency and eliminate late DES related adverse events. In bifurcation lesion intervention, prior plaque debulking can avoid the need for complex stenting and may provide a good long-term outcome.

6.2. Atherectomy

Moderate to severely calcified lesions often require an atherectomy strategy for optimal lesion preparation.

- Rotational atherectomy has been the most widely used atherectomy modality till now. It expands lumen diameter through the mechanism of calcium ablation and achieving plaque modification. Rotablator atherectomy system is available through Boston Scientific Corporation and incorporates a diamond-tipped elliptical burr, which spins concentrically as it advances in a forward direction. A cocktail consisting of RotaGlide lubricant (Boston Scientific Corporation), verapamil, nitroglycerin, and heparin can be infused during ablation to reduce vasospasm. The Rotablator system is controlled by a console, activated by a foot pedal and available crown sizes vary from 1.25 to 2.5 mm. Adequately sized guide catheter selection is important to accommodate the appropriate size of the burr.
- Orbital Atherectomy utilizes centrifugal forces to increase the lumen diameter by differentially ablating calcium. Its mechanism allows continuous flow of blood and saline during orbit, decreasing heat generation. Diamondback 360 coronary orbital atherectomy system of Cardiovascular Systems, Inc. uses a diamond-coated, eccentrically mounted burr that rotates over a ViperWire guidewire (Cardiovascular Systems, Inc.) at 80,000 rpm on low speed and 120,000 rpm on high speed. The standard crown size is 1.25 mm. ViperSlide lubricant (Cardiovascular Systems, Inc.) is infused during ablation.
- ELCA coronary laser atherectomy catheter of Spectranetics Corporation uses a specialized catheter to deliver high-energy light beam in short pulses, vaporizing thrombi, and debulking plaque. The ELCA device is approved for the treatment of lesions that previously failed PCI, total occlusions traversable by a guidewire, occluded saphenous vein grafts, in-stent restenosis prior to brachytherapy, ostial lesions, long lesions (> 20 mm), and moderately calcified lesions.

7. CTO: SPECIAL CONSIDERATIONS

The approach, whether Antegrade or Retrograde, that is to be employed in CTO PCI as well as the interventional hardware that is anticipated to be used determines the size of the GC to be used as well as the route of the approach. Usually 7F and 8F guides are used and amongst these, the ones appropriately shaped for strong backup depending on the vessel and lesion complexity are chosen. Special considerations in CTO guide selection include use of shorter length guides (80-90 cm) and a longer (45 cm or even 90cm) sheath, the latter further augmenting the support of the GC.

The usual techniques of Anchor wire, Anchor ballooning and “Mother-Child” can be used incase further backup is required. However, it needs to be noted that while Co-Axial anchoring can be employed in CTO for wire crossing, the same is usually accomplished by using a microcatheter or an over-the-wire balloon that has the advantage of facilitating the wire exchange as well. Additionally, the Anchor Balloon technique using a side branch needs special mention in the case it supplies collaterals and inflating a balloon in this situation may suppress distal opacification [10, 30].

While a detailed mention of the wiring choice and crossing techniques in CTO is beyond the scope of this article, an important technique to mention in Retrograde CTO is the Wire Externalisation and Snaring. This technique offers exceptional support for ballooning and stenting in difficult cases and basically involves “wiring the antegrade guide with retrogradely crossed wire”. After lesion crossing with wire or reverse CART, an Antegrade Guide is established and the retrogradely crossed wire advanced into the antegrade guide. The wire may be trapped in the Antegrade guide before advancing the channel dilator and subsequently externalized. Sometimes it may be difficult to "wire the antegrade" guide especially in Aorto-Ostial disease in which case it is better to snare the wire. This can be accomplished either in the Aorta (En Snare 3 snare system) or in the vessel (Amplatz Goose Neck Snare) [29].

8. THE ROLE OF INTRACORONARY IMAGING

Coronary Angiogram can deliver a plane image of the lesion but vivid 3 dimensional model of the lesion is more informative from intervention point of view. Coronary Angiogram has its own drawbacks when there is plan to open complex lesions. Determination of Lesion Anatomy needs experience limited by inter-operator variability.

Intravascular imaging has the advantage of greater spatial resolution. Lesion architecture could be better delineated. It can be helpful in difficult procedures for instance suboptimal ostial views, overlapping vessel and contrast streaming artifact. Lesions classification through Intravascular imaging utilizes techniques like Intravascular Ultrasound (IVUS), Optical Coherence Tomography (OCT) and Fractional Flow Reserve (FFR) [31].

IVUS technology uses high-frequency sound waves through a single catheter to create 3D images of the lesion. IVUS determines stenosis severity, vessel calcification, sizing vessel, discerning the stent failure and characterizing lesion composition. IVUS has problems of artifacts like guide wire artifact, acoustic shadowing, ring down artifact *etc*. IVUS is an essential tool during rotablation.

OCT image uses near infrared light through a single fiber optic wire. It has higher axial and lateral resolution. OCT has problems of artifacts including guide wire artifact, residual intraluminal blood resulting in light attenuation, sunflower effect and artifacts from air bubbles. Scoring balloon catheter device is composed of, a minimally compliant balloon and three nitinol spiral wires. Spiral wires score the luminal surface during balloon expansion. OCT is used to demonstrate the effect on plaque as well as neointimal hyperplasia scoring and to achieve appropriate lumen size after dilatation [32].

Fractional Flow Reserve (FFR) technique measures pressure differences across a narrowing, which determines the severity of stenosis leading to ischemia. FFR is an absolute number; a value of 0.80 means that a given stenosis causes a 20% drop in blood pressure. FFR has advantages over coronary angiography, intravascular ultrasound or CT coronary angiography For instance, it considers collateral flow, which can reveal a functionally unimportant blockage. FFR provides real-time effects of a narrowed vessel along with possibility of simultaneous PCI. It is an invasive procedure whereas noninvasive cardiac stress testing could also provide similar information [33].

An anatomical map of vessel is critical in determining the lesion severity and stent size. These techniques produce cross-sectional imagery to determine accurate vessel size, diffuse disease, eccentricity, calcification, thrombus, necrotic cores, dissections, morphology of true lumen and plaque [34].

The 2011 guideline for PCI from the ACC, American Heart Association and Society for Cardiovascular Angiography and Interventions recommends the use of IVUS for evaluating indeterminate left main lesions and indeterminate non-left main lesions (50 to 70% stenosis) and etiology of ISR and stent thrombosis [35].

9. INDIAN PERSPECTIVE

Interventionists in India have to overcome challenges beyond the ones posed by lesion complexity alone, and mostly pertain to the impact of ethnicity as well as financial constraints due to the lack of social security and health insurance.

Uniqueness imposed by ethnicity frequently lead to difficulties in Transradial approach due to the tendency to radial spasm as well as Tortuous Subclavian and Dilated Aorta. This poses challenges in using a larger guide in Transradial Interventions. However, use of smaller guides with "mother-child" technique can overcome this difficulty and provide strong backup force comparable to larger guide, with added advantage of easier engagement as well as possibility of deeper intubation if feasible. This can be further augmented by using Buddy wire and Balloon anchoring techniques. It would be worthwhile to use shorter 6F guides that could be quickly upgraded to "Mother-Child" technique in case of difficulty, or the operator be well versed with the technique of "Guide Shortening" to save time and avoid frequent guide exchanges.

The implications of financial constraints, with the frequent occurrence of diffusely diseased vessels mean that Indian operators may not have the luxury of multiple, small, flexible stents but may have to contend with large and/or inflexible stents. Additionally, due to less frequent use of IVUS/OCT, to reduce the cost of the procedure, there may be underestimation of calcification and lesion severity solely on the basis of Angiography. Hence in view of these daunting challenges, it is important for an Interventionist in India to be well versed with all these techniques to overcome difficulty in stent delivery in complex cases. Last, but not the least, it needs to be stressed that an operator should proceed only after a thorough assessment of the case keeping in mind the patient factors, lesion complexity as well as a mind map of anticipated difficulties and bailout plans in case of difficulty.

CONCLUSION

In spite of advancement in stent design and guiding catheter technology, there are frequent occasions where successful device deliverability is hampered due to lesional complexity leading to procedural failures and suboptimal outcomes. With different techniques and hardware, it is now possible to improve success rates in most cases. These new techniques and technologies come with a different price tags and complications. Hence it is imperative to have thorough understanding of all factors and techniques to facilitate the success of PCI in complex coronary anatomies. In general preferences need to be individualized and sequence could be extra backup guide, Buddy wire, Anchor balloon, Rapid exchange extension catheter, monorail, Mother and Child catheter and finally combination of these techniques.

Summarized approach provided in the following description is going to give overall concept to act as brief guidelines for an interventionist doing a complex procedure in a particular patient. The approach also depends upon coronary anatomy, origin, calcification, location of lesion from ostium, previous stenosis, coronary ectasia in addition to aorta size, tortuosity of iliac and subclavian arteries *etc*.

Table 1. Steps might help while going for difficult lesion intervention.

A) Preparation before procedure	B) If you are held up during procedure
Step 1:- Use bigger guide. Step 2:- Take longer sheath. Step 3:- Utilize extra backup guide. Step 4:- Extra support wire.	Step 1:- Exchange the soft wire with stiffer wire through the micro Cather. Step 2:- Buddy wire technique. Step 3:- Anchor wires technique. Step 4:- Mother and child technique. Step 5:- Anchor balloon technique. Step 6:- Deep engage the guide with anchor balloon technology or Mother and child technology.

In general, following steps might help while going for difficult lesion intervention (Table **1**).

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

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