Difficult Stent Delivery

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Introduction

Stent delivery remains challenging in complex coronary anatomy in around 5% of PCIs, despite colossal technical advances in the field of interventional cardiology. Unsuccessful stent placement is associated with inferior short and long-term outcomes. Failure of stent deployment may lead to stent embolization during withdrawal maneuvers. It is imperative to identify these lesions and plan stent delivery meticulously.

Characteristics Associated with Stent Delivery Failure

The following characteristics are associated with stent delivery failure:

- Vessel tortuosity—iliac, femoral, and coronary
- Lesion severity
- Lesion length
- Coronary calcifications (before and at the lesion)
- Stent length
- Poor guiding catheter support
- Previously deployed stents

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Steps to Help Prevent Difficulties in Stent Delivery

The following approaches/techniques are used to help prevent difficulty with stent delivery:

- Long sheath
- Appropriate guide selection
- Lesion preparation/plaque modification
  - Low-profile balloon
  - High-pressure NC balloon
  - Cutting balloon
  - Atherectomy devices

Long Sheath

- Anticipate the need for a long sheath. Rotations and manipulations at the proximal end may not transmit to the distal end of devices and guide in excessively tortuous iliac and femoral arteries. A long sheath, preferably 45 cm will improve guide support. Initially place the sheath tip in the descending aorta and advance further if extra backup is required.

Appropriate Guide Selection

- Coaxial engagement is the key for stable guide position and it is imperative to choose the correct guide to provide passive support. (Fig. 15.1) Active support is provided by deep seating the guide (see Chap. 7 Guiding Catheter Selection). A larger guide catheter diameter provides better support.

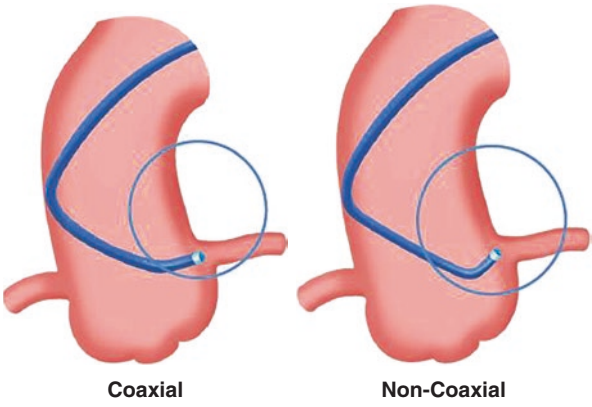

Fig. 15.1 Coaxial guide engagement

Table 15.1 Comparison between Guidezilla and Guideliner V3

Features	Guidezilla II	Guideliner V3
Proximal shaft	Stainless steel hypotube	Stainless steel ribbon
Coating	Silicon wipe	Z-glide
Collar	Platinum iridium	All polymer
Collar transition	17 cm Half-pipe	6 mm Hypotube transition
Marker band	Distal marker band Radiopaque collar	Distal marker Proximal marker
Size (ID in mm)	6 F(1.45), 7 F(1.60), 8 F(1.83)	6 F(1.42), 7 F(1.57), 8 F(1.80)

Adequate Lesion Preparation

- This is the most important step. Adequate predilation with high-pressure balloons or cutting balloons must be performed prior to stent insertion. If you have trouble passing even a small (1.2/8 mm) compliant balloon or a microcatheter, then consider plaque modification techniques like rotational or orbital atherectomy/Excimer laser coronary atherectomy (ELCA)/Intravascular Lithotripsy.

Stepwise Approach to Facilitate Stent Delivery

The following approaches/techniques are used to facilitate stent delivery:

- Deep seating the guide
- Deep inspiration
- Buddy wire or changing the wire
- Guide support extension catheters
- Change stent length
- Buddy Balloon
- Buddy-in-jail technique
- Miscellaneous
- PTCA alone

Deep Seating Guide [1, 2]

- Deep intubation of the guide into the coronary artery improves backup support and pushability of devices regardless of the anatomy of the coronary vessel and the morphology of the lesions. Use this technique with caution in diffusely diseased or small proximal vessels, as it is prone to cause dissection. The guide should be gently maneuvered into the coronaries over the shaft of a PTCA balloon or stent delivery catheter to minimize the endothelial trauma, which may occasionally result in ostial stenosis.

Deep Inspiration [3, 4]

- The easiest maneuver to try is deep inspiration. Deep inspiration displaces the diaphragm and the heart into a vertical position and straightens the coronary tree slightly, which facilitates balloon and stent delivery. It may not be feasible in a deeply sedated patient.

Changing Wire

- Changing wires remains one of the simplest and less expensive strategies for difficult stent delivery. A long stent loaded on a floppy wire may not have enough support for its passage, in which case changing to a firmer wire might be useful. However, in certain cases stents loaded on extra support wire may push against the wall of a heavily calcified and angulated lesion, making the stent passage difficult. Changing to a less firm wire might be helpful in this situation. A microcatheter is useful here for changing wires across a difficult-to-cross lesion (see Chap. 8).
- Runthrough™, BMW™, and Luge Prowater™ are examples of firm, nonhydrophilic wires.
- Fielder™, Whisper™, and Choice PT™ are examples of floppy, hydrophilic wires.
- Mailman™ and Grandslam™ are examples of extra support wires.
- Hi-Torque Wiggle Wire™ (Fig. 15.2) is a specialty wire with its unique feature of 60 mm of sinusoidal shaping, which starts 60 mm from the distal tip, which alleviates the friction by altering the angle of contact between the balloon and the body of the stent [5].

Buddy Wire

- A second wire, *buddy wire technique*, may help to straighten the vessel and improve the guiding catheter coaxiality. A variant of the buddy wire technique is the *gliding wire technique*, where a second hydrophilic wire is inserted to allow the stent to glide over the hydrophilic coating of the second wire. Another variant is the *anchor wire technique*, where a second wire is inserted in a non-target

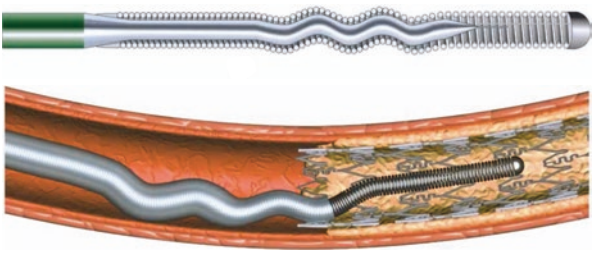

Fig. 15.2 Hi-Torque Wiggle Wire™

vessel of the left system or a branch of the vessel for the right coronary system. The extra guide wire will anchor and stabilize the guide catheter.

Guide Support Extension Catheters

- Guideliner V3™
  - As a "mother and child" system (catheter inside a catheter), the Guideliner V3™ is a 25 cm guide extension connected to a pushrod with a 17 cm "half-pipe" collar, which helps in deep seating for added backup guiding catheter support in challenging cases to facilitate device delivery (Fig. 15.3) [6]. It also allows coaxial alignment when a difficult coronary ostium takeoff prevents guiding catheter placement. Sometimes, the Guideliner is advanced deep into the coronary artery with the help of an anchor balloon to facilitate stent delivery, especially long stents (balloon anchoring technique). Guideliner Balloon Assisted Tracking (GBAT) can be utilized when the anchoring technique fails. It involves tracking of the Guideliner over a nominally inflated noncompliant balloon partially protruding from its tip.
  - It is contraindicated in vessels with <2.5 mm diameter. It should be considered either to increase backup support or enable stent delivery when problems are encountered using conventional techniques or upfront in the setting of very complex disease.
- Guidezilla™ II
  - Support extension catheter provides additional backup support and facilitates easy delivery of ancillary devices. Balloon-assisted tracking *(also known as the Inch-worming technique)* involves advancing the Guidezilla II over a recently deflated balloon for further advancement down the artery. Never advance the Guidezilla II Catheter more than 15 cm beyond the tip of the

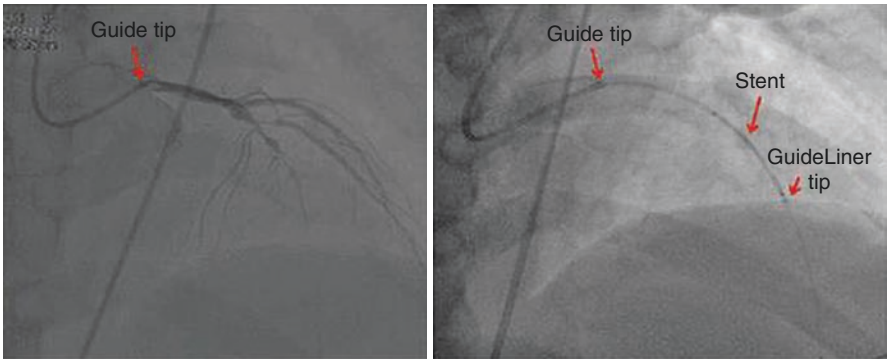

Fig. 15.3 Guideliner: deep seating for stent delivery

guide catheter. Complications include pressure dampening, balloon kinking, distal marker tip dislodgement, coronary stent damage/stripping, coronary artery ischemia or dissection, and/or occlusion may occur [7].

Change Stent Length

- A less attractive and expensive option is changing to one or two shorter stents or a different stent type with better flexibility.

Buddy Balloon [8]

- Non-inflated/Inflated: *Anchor balloon technique* (Fig. 15.4). It was initiated in PCI of chronic total occlusions and is achieved by inflating a balloon in a non-target vessel to obtain enough support to cross a lesion. There is a risk of

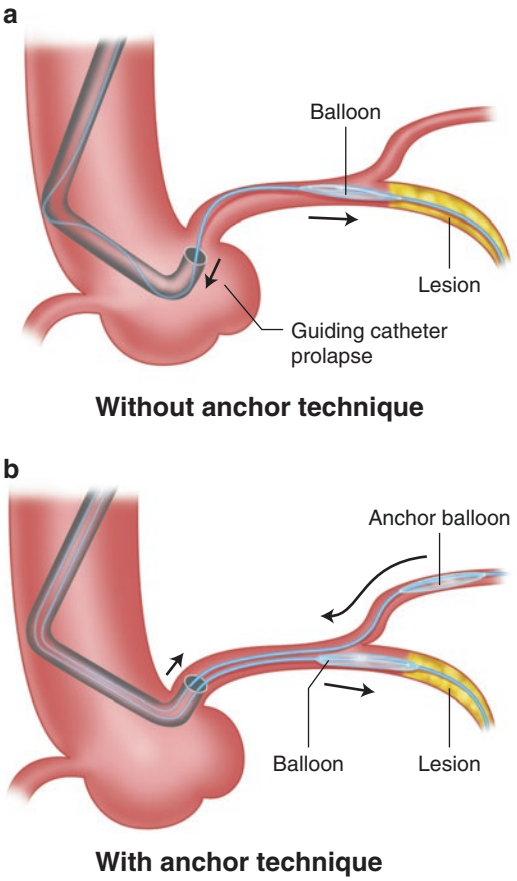

Fig. 15.4 Anchor balloon technique for stent delivery

injury to the ostium of the coronary artery by the guiding catheter and the non-target vessel by an anchor balloon. It may not be feasible in all cases due to poor support by non-axial traction and failure of an appropriate non-target vessel.

Buddy-in-Jail Wire Technique [9]

- The buddy-in-jail technique is rarely used because of the availability of guide support extension catheters (Fig. 15.5). It is useful when all the standard techniques fail to deliver the stent to a distal stenosis and there is additional proximal stenosis that the interventionalist intends to stent. A second non-hydrophilic coated buddy wire of at least medium support is wired to the distal vessel. The proximal vessel is then stented and the buddy wire is jailed. The jailed in buddy wire provides the support to deliver the distal stent through the proximally placed stent by the following mechanisms:
- The guiding catheter will be anchored more securely within the ostium of the vessel.
- The jailed buddy wire may straighten the proximal portion of the vessel and minimize the wire bias.
- The jailed wire will provide a stiff rail for stent tracking.
  - A non-coated buddy wire should be used and the radiopaque portion of the wire should not be jailed. The proximal stent should be deployed using only modest pressure (12 atm or less) to minimize the risk of wire entrapment or fracture. Before deployment of the distal stent, the jailed buddy wire should be removed to avoid "double jailing." The proximal stent must be postdilated at the end.

Miscellaneous

- Rotaglide facilitated stent delivery—Application of Rotaglide solution over the stent surface reduces the catheter friction, thereby facilitating stent delivery in challenging coronary anatomy [10].
- Partial Balloon Inflation technique—Constant and steady pressure applied at the Tuohy-Borst hemostatic valve while gently inflating the balloon at lower pressures (2–3) atm, helps in achieving the successful stent delivery to target lesion [11].

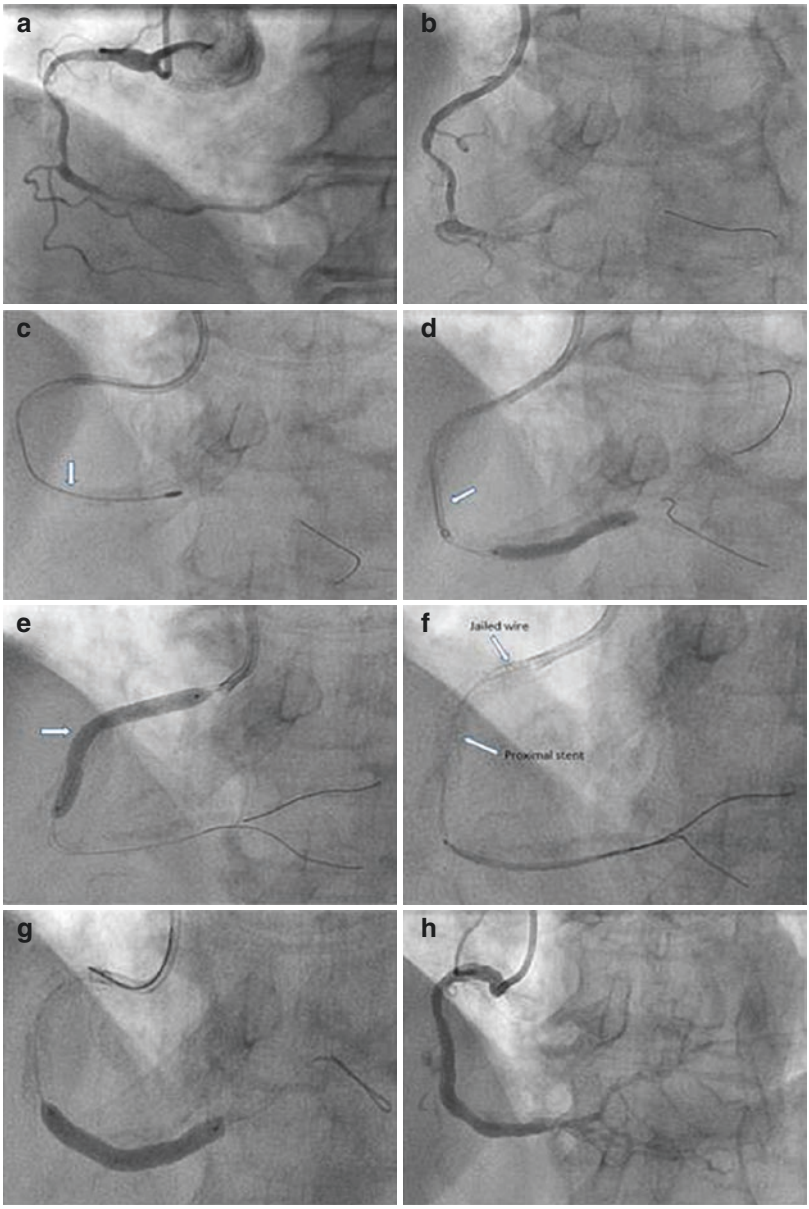

Fig. 15.5 Buddy-in-jail wire technique. (**a**) Selective RCA angiogram showing severe calcific stenosis of proximal and distal RCA. (**b**) Wire being exchanged with help of a microcatheter. (**c**) Rotablation performed using 1.25 mm burr (arrow). (**d**) Predilation performed after tracking the balloon distally with help of a Guidezilla guide support catheter. (**e**) Stent (arrow) being deployed in proximal RCA while jailing one of the wire. (**f**) Distal stent being tracked distally with the help of the jailed wire. (**g**) Deployment of distal stent after removing the previously jailed wire. (**h**) Final angiographic result

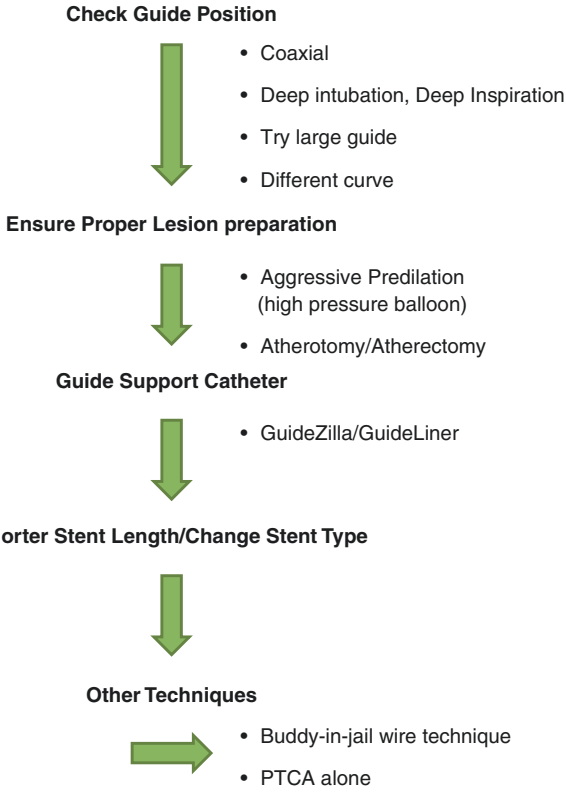

Fig. 15.6 Our institutional stepwise approach for difficult stent delivery

Settling for PTCA Without Stent

- Rarely, when all measure fails, provisional PTCA with optimal results confirmed by intravascular ultrasound or fractional flow reserve may be the best solution.
- See below, Fig. 15.6 for our Institutional stepwise approach for facilitating stent delivery.

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