Introduction to PCI: What to expect?

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Blood vessel with artherosclerosis treated with balloon angioplasty & coronary stent

A guide wire with a deflated balloon is passed through the catheter in the narrowed artery.

The balloon is then inflated to open the narrowed artery and the stent expands around the balloon.

The balloon is removed and the stent is left in place to keep the artery open.
History of Coronary Angioplasty

- In 1711, Stephen Hales conducted the first cardiac catheterisation of a horse using brass pipes, a glass tube and the trachea of a goose.

- **WERNER FORSSMAN** – First Human Catheterization – 1929

- In the early 1940's, Andre F Cournand, working in New York, began utilizing right heart catheterisation for investigation of cardiac function in both normal and diseased patients.

- **Andreas Gruentzig** – First Coronary Angioplasty - 1977
What Is Coronary Angioplasty?

- Over time, a fatty substance called plaque can build up in arteries, causing them to harden and narrow & this condition is called atherosclerosis.

- Coronary angioplasty is a procedure used to open blocked or narrowed coronary (heart) arteries.
Other Names for Coronary Angioplasty

- Percutaneous coronary intervention (PCI)
- Percutaneous intervention
- Percutaneous transluminal angioplasty
- Percutaneous transluminal coronary angioplasty
- Balloon angioplasty
- Coronary artery angioplasty
Cath Lab Equipment

- Image intensifier
- X-ray monitor
- Power injector
- Physiologic monitor
- X-ray table
- X-ray tube
- C-arm
- X-ray shield
COMPLETE APPARATUS

- Needle
- Guide Wire
- Sheath
- Catheter
Puncture needles

Used to cannulate or puncture the artery.

Usual Sizes include 18 G, 19 G, 20 G, 21 G.

The selection of the Size depends on the guide wire going to be inserted through that needle port.

*Seldinger Needle*
Femoral sheath

- Sheath
- Dilator
- Wire 0.038”
Sheath: various length & sizes

- 4F – Red
- 5F – Grey
- 6F – Green
- 7F – Orange
- 8F – Blue
- 9F – Black
- 10F – Purple
- 11F – Yellow
- 12F – Dark blue
- 13F – Dark Green
- 14F – Pink

1F = 1/3 mm or 0.33 mm
Shape of the Tip:
J Tip / Straight Tip
Sheath: various length & sizes

- Standard sheath (10cm/12cm)
- Long sheath (16cm/23cm/25cm)
- Arrow sheath (12cm/24/cm/35cm/45cm/65cm)
- Shuttle sheath (90cm)
- Balkin sheath (40cm)
- Mullins sheath (63cm)
Radial sheaths

RADIAL SHEATH #6F TERUMO
• Sheath + dilator
• Blade
• Angiocath 20G
• Terumo wire 0.025”

RADIAL SHEATH #6F AVANTI (CORDIS)
• Sheath + dilator
• Puncture needle 21G
• Wire 0.021”
2 commonly used needle types

2-component Seldinger needle (Terumo)
Seldinger “through and through”

Single component “front-wall needle” (Avanti)
Modified Seldinger: a true anterior wall puncture only
Modified seldinger’s technique
Arrow Sheath

- Commonly used for tortuous artery
- To allow the catheter to go up easily but sometimes in very tortuous Aorta, an extra stiff wire is needed.
A **catheter** is a hollow flexible tube that can be inserted into a body cavity, duct or vessel. Catheters thereby allow drainage or injection of fluids, distend a passageway or provide access by surgical instruments. The process of inserting a catheter is **catheterization**.
Catheter Construction

Hub  Strain Relief  Body Length in cm indicates usable length  Proximal Tip  Distal Tip
Catheter construction

- **Hub** - connects catheter to syringe or power injector
- **Strain Relief** - reinforcement near the hub to prevent kinking
- **Body** - the main part of the catheter
- **Proximal Tip** - the catheter curve that supports cannulation
- **Distal Tip** - the soft end of the catheter
- **Sideholes** - create cloud of contrast medium and improve stability during injection
Catheter curves
TYPES OF CATHETERS

CLASSIFICATION:

a) SIDE HOLES:
   > Single Hole
   > End Hole with side holes.
   > Blocked end with side holes only.

b) SIZES:
Abdominal – 6-80 cm
Thoracic or Carotid Arteries – 100-120 cm

NOTE: Size depends on:
   > age of the patient
   > selective or super selective study
   > size of the vessels.

NOTE: Ideal practice is to use the smallest diameter catheter feasible for any particular study to minimize the risk of arterial damage by the procedure.
TYPES OF CATHETERS

SHAPES

- Straight Catheter
- Pigtailed Catheter
- Cobra Shaped Catheter
- Side Winder Catheters (Shepherd)
VARIOUS CURVES OF CATHETERS

- Judkins Right 3.5
- JR 4
- JR 5
- JR 6
- Amplatz Right 1 (ARMOD1)
- Multipurpose 1 (MPA1)
- Amplatz Right Moderate (ARMOD)
- MPB1
- AR2
Native arteries

LCA
- Judkins Left
- Amplatz Left
- Castillo
- Optitorque
- Extra Back-up (XB)

RCA
- Judkins Right
- Amplatz Right/Left
- Multipurpose 1
- Castillo
- Optitorque
- Extra Curve Right (ECR)
- Hockey Stick
Anatomy of coronary ostia
Judkins left catheter

- Have a special pre-shaped double curve and end-hole tip
- Size of the catheter (3.5, 4.0, 5.0, 6.0)
- The size of JL is selected depending on the length and width of the ascending aorta
Judkins right catheter

- Is sized by the length of the secondary curve, and it comes in 3.5, 4.0, and 5.0.
RCA: anatomical variations

Horizontal take-off  Vertical take-off  Superior take-off
Grafts

IMA to LAD:
- Internal Mammary Arte
- Judkins Right

SVG to LCA:
- Judkins Right
- Amplatz Left
- Left Coronary Bypass

SVG to RCA:
- Multipurpose
- Judkins Right
- Left Coronary Bypass
Grafts
GUIDEWIRE

- Coating
- Coil
- Shaft
- Core
- Taper
- Tip
Types Of Guidewires

- Depending on tip load- Balanced, Extra support, Floppy
- Tip load- force needed to bend a wire when exerted on a straight guide wire tip, at 1 cm from the tip
  - Balanced – 0.5-0.9g
  - Extra support - >0.9g
  - Floppy - <0.5g
Guide wire - construction

• Most - calibre of 0.014 inch
• 3 main components of guidewire design:
  — central core
  — outer covering
  — flexible distal tip
• The wire tip may be further subdivided into spring coil & short distal tip weld
• Also, all guidewires have a specific surface coating applied
Central core

- Stainless steel
- Durasteel - better tip shape retention and durability
- Nitinol
Wire Coating-hydrophilic/hydrophobic

Hydrophobic

• Repels water - requires no actuation/wetting
• ↓ friction (to ½ V/S no coating), ↑ trackability
• Preserves tactile feel, allows easier anchorability / parking - esp CTO
• Silicone, Teflon
Hydrophilic wire

- Attracts water - needs lubrication
- Thin, slippery, non-solid when dry → becomes a gel when wet
  - ↓ friction (% no coating) → glide through tortuous
  - ↑ trackability
  - ↓ Thrombogenic
  - ↓ tactile feel- ↑ risk of perforation
  - Tendency to stick to angioplasty cath

- Useful in negotiating tortuous lesions and in “finding microchannels” in total occlusions

- Lubricity is highest with hydrophilic wires, less with Silicone coating and least with PTFE or Teflon coating
• **Workhorse wire**: default choice - balance btw stiffness/support & flexible tip – majority lesions

• **Stiff wires**: offer extra support for tortuous/calcified coronary lesions

• **Floppy wires**: when vessel trauma is a concern (e.g. re-crossing a dissected lesion)
Workhorse (frontline) Guidewires

- ATW/ATW Marker
- Stabilizer
- BMW / BMW Universal
- Zinger
- Cougar XT
- Asahi Light / Medium
- Asahi Standard
- Asahi Prowater Flex
- Choice Floppy
- Luge
- IQ
- Forte Floppy
- Runthrough NS
- Asahi Sion
Angioplasty balloon types

- Monorail vs over the wire system
- Compliance vs non compliance
Construction of the balloon catheter (monorail vs over the wire type)
(a) A compliant balloon tends to be oversized at the edges, with less dilatation at the obstructive segment of the lesion (‘dog-boning’)
(b) A noncompliant balloon gives a predictable amount of pressure at the lesion without uncontrolled radial and longitudinal growth
Coronary Stent
What is a Stent

- A small, mesh-like device made of metal
- Acts as a support or scaffold, in keeping the vessel open
- Stent helps to improve blood flow to the heart muscle and reduce the pain of angina
- 80% of patients who have balloon angioplasty will have a stent placed as well.
Stent deployment

A. Stent

B. Expanded stent, inflated balloon

C. Stenting

Stent insertion

Stent expansion

Stent remains in coronary artery
TYPES OF STENTS

- Metal composition
- Open v/s closed cell designs
- Thickness of struts
- Eluting drugs
Open cell stents

- Multiple repeating modules are linked at certain points of the design, giving flexibility but less metal : artery coverage
Closed cell stent

- Modern closed-cell stents have relatively large cells
Bare metal stent (BMS)

Bare metal stents:
- cheaper & traditional method
- has an increased rate of re-narrowing due to growth of scar tissue in the stent, a condition called **in-stent restenosis** (ISR) but lower **stent thrombosis** incidence
- commonly used for shorter and bigger vessels
- Dual antiplatelet treatment (1-3 mths)
Drug eluting stents (DES)

**Drug-eluting stents**

- Coated with medications that are slowly released to block the body's ability to form scar tissue around the stent. The medication is delivered directly to the site of the artery blockage.

- Lower incidence of *instent restenosis* but higher risk of *stent thrombosis*.

- Dual antiplatelet treatment 6-12 mths
Stent insertion
Stent expansion
Stent remains in coronary artery
Common terms used during PCI

a) TIMI flow: is a scoring system from 0-3 referring to levels of coronary blood flow assessed during PCI (0 = absence flow, 3 = normal flow)

b) AHA/ACCA coronary lesion (A-C)
# AHA/ACCA Coronary lesion classification

## Characteristics of ACC/AHA Type A, B and C lesions

### TYPE A LESIONS: (High success, > 85%; low risk)
- Discrete (<10 mm length)
- Concentric
- Readily accessible
- Nonangulated segment <45 degrees
- Smooth contour
- Little or no calcification
- Less than totally occlusive
- Notostial in location
- No major branch involvement
- Absence of thrombus

### TYPE B LESIONS (Moderate success, 60 to 85%; moderate risk)
- Tubular (10-20 mm length)
- Eccentric
- Moderate tortuosity of prox. segment
- Moderately angulated, 45-90°
- Irregular contour
- Moderate to heavy calcification
- Ostial in location
- Bifurcation lesions requiring double guidewires
- Some thrombus present
- Total occlusion < 3 months old

### TYPE C LESIONS (low success, < 60%; high risk)
- Diffuse (>2 cm length)
- Excessive tortuosity of prox. segment
- Extremely angulated, >90 degrees
- Inability to protect major side branch
- Degenerated vein grafts with friable lesions.
- Total occlusion > 3 months old
c) **Primary PCI**: coronary angioplasty performed in an emergency setting to treat ST elevation myocardial infarction

d) **Rescue PCI**: mechanical reperfusion (PCI) for failed fibrinolysis
e) Chronic Total Occlusion (CTO)

A complete blockage of a coronary artery, typically described as >99% stenosed with a duration >3 months.
Coronary perforation occurs when a dissection or intimal tear propagates outward sufficient to completely penetrate the arterial wall.
Summary of Key Points

- Percutaneous coronary angioplasty has evolved significantly since its first introduction in 1977.

- Person who works within the cath lab area should be familiar with the cath lab settings and the instruments used.

- This will help to enhance and understand the principle behind every angioplasty performed hence productivity and good results can be achieved whilst avoiding complications.

- We must be aware that there are different types of catheters, balloons, stents that can be used in different circumstances depending on several factors.

- We must also be well versed with the common terms used during the angioplasty procedure.