Choice of guiding catheters and guidewires

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Werner Frossmann-1929
X-ray for angioraphy (1950-1970)

Cine frame from the first selective coronary arteriogram recorded by F. Mason Sones, Jr, on October 30, 1958.

Cheng T O Circulation. 2003;107:e42
On the shoulder of pioneers, we have witnessed the birth of a sub-speciality.

Cardiovascular medicine has been forever transformed.

Patient outcomes have never been better!!
**HISTORY AND ORIGIN OF “CATHETER”**

Late Latin, from Greek:

KATHETER, came from KATHIENAI,

kathe- *to send down* : kat-, kata-, cata- + hienai- *to send*.

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**DEFINITION:**

A **catheter** is a hollow flexible tube that can be inserted into a body cavity, duct or vessel. Catheters thereby allow injection of fluids. The process of inserting a catheter is **catheterization**.
**Guide catheter construction**

**Ideal characteristics of catheters**

- Better Torque Control
- Strength
- Radiopacity
- Flexible
- Atraumatic Tip
- Low Surface frictional resistance for good trackability over guide wire.
**PARTS OF A CATHETER**

- HUB
- BODY
- TIP

**FRENCH CATHETER SCALE:**

The French catheter scale (most correctly abbreviated as Fr, but also often abbreviated as FR or F) is commonly used to measure the outer diameter of cylindrical medical instruments including catheters, needles etc.

In the French Gauge system as it is also known, the diameter in millimeters of the catheter can be determined by dividing the French size by 3, thus an increasing French size corresponds with a larger diameter catheter. The following equations summarize the relationships:

\[ D(\text{mm}) = \frac{\text{Fr}}{3} \quad \text{or} \quad \text{Fr} = D(\text{mm}) \times 3 \]

- Most commonly in adult Diagnostic Catheters of 5 – 7 Fr is used.

**MEASUREMENT:**
Guiding catheter

• For each given size of, its ID is either a standard, large or giant lumen

• Larger sizes –
  o better opacification of the contrast
  o better guide support
  o allow pressure monitoring
  ➢ increased risk of ostial trauma, vascular complications and the possibility of kinking of catheter shaft

TYPES OF CATHETERS:

CLASSIFICATION:
Catheters can be classified depending on

✓ SIDE HOLES:
  - : Single Hole
    - : End Hole with side holes.
    - : Blocked end with side holes only.

✓ 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.
CATHETERS CAN BE BROADLY CLASSIFIED UNDER THESE GROUPS:

- **DIAGNOSTIC CATHETERS**
  Used for Angiographs.

- **GUIDING CATHETERS**
  Used for Angioplasty.

  • Guiding catheters are like angiography catheters only difference is that guiding catheters are more *stiffer & firm* as it carries Balloon catheters, PTCA wires and stent delivery system.

  • Mild stiffness comes due to the wire braided design.

  • Good Push ability.

  • Good Tractability.
Guiding catheter configuration

Which catheter to choose?
Factors for catheter choice

- Access site: femoral/radial
- Location of ostium: R/L/IMA/SVG
- Anatomy: Patient size/ diameter of aorta
- Equipment required: kissing/bifurcation intervention
- Back-up
- Side holes

Guiding catheter construction

Diagram showing the anatomy and construction of a guiding catheter with labels for primary curve, secondary curve, Judkins Left, and curve length P-S distance (cm).
Guiding catheter selection-LAD

Proper Fit

We should have like 45 degrees at the angle while resting against the contralateral wall.
Tip orientation with different curve lengths

- Shorter curves fit superior orientation
- Longer curves fit inferior orientation

So what you think about that?

**Too long**
What to do?
Decrease curve length by 0.5

**Too short**
What to do?
Increase curve length by 1

The improper fit
RCA ostial take-off

Horizontal  Inferior  Superior

Right coronary curves
Guiding catheter selection - RCA

Anterior origin:
MP

Normal:
JR 4.0

Lateral origin:
AL 1.0 or 2.0

Guiding catheter selection - SVGs and IMAs
Bypass graft curves

LIMA

LIMA:
JR 4.0 OR
LIMA catheter
SVG- LAD/LCX

Superior take off: JR 4.0
OR
LCB

Horizontal origin: JR 4.0
OR
MP

SVG to RCA

Horizontal origin: JR 4.0
OR
MP

Inferior take-off:
MP
LCA- Back up support

- Extra back up (EBU) curves:
  - Broad secondary curve that braces against the contralateral wall for better back-up support
  - Co-axial support

Amplatz coronary family

- Sometimes help
- Need extra-cautious manipulation
Backup force

• 3 factors
  o Catheter size
  o Area of contact made by cath on Ao
  o Angle (theta) of cath on the reverse side of Ao

• The angle (theta) determines the force that can dislodge the guiding catheter.
If this angle is ≈90º, it results in a greater backup force. Therefore a lower position is preferable as the point of contact on the reverse side of the aorta because the angle approaches 90º.
**Child in Mother Technique**

- 110cm long 5Fr guide (Child) in 100cm long 6Fr/7Fr guide catheter (Mother)
- May provide up-to 70% more support
- Trauma to vessel → dissection
- Air embolism usually occurring during intubation of child catheter.

**Important issues:**

- Access:
  - Femoral: long sheath is sometimes essential in special situations: iliac tortuosity, AAA.
  - Radial: use slippery wire with visualization of wire tip while advancing catheter.
  - Co-axial positioning of catheter tip is of extreme importance.
  - To disengage Amplatz Left catheter: push in and rotate instead of pulling out.
Important issues- pressure tracing from guiding catheter

N.B: side holes allow perfusion but don’t prevent catheter induced injury of coronary ostia.

Radial approach
Guide Catheter Related Complications

**Embolization**
- Air
- Atheroma
- Thrombus

**Dissection**
- Coronary Artery
- Subclavian or IMA
- Aortic root
- Abdominal Aorta
- Iliac Artery

Atheroembolus

**Clinical Features**
- Unrelenting Ischemia after injection
- Slow flow in recipient vessel

**Associated Conditions**
- Calcified Aorta
- Abdominal aortic atherosclerosis or aneurysm
- Peripheral Vascular Disease

Treatment: Supportive, Treatment of Ischemia
Air Embolus

Clinical Features
- Acute Ischemia after Coronary Injection
- Transient Symptoms

Associated Conditions
- Large Diameter Catheters
- No “bleed back”
- Air visible in coronary

Treatment: Support Circulation, Aspirate air, Coronary Injection

Thromboembolus

Clinical Features
- Acute Ischemia
- Vessel “cut off”

Associated Conditions
- Multiple catheters exchanges
- Prolonged procedure
- Suboptimal anticoagulation

Treatment: Thrombectomy, Thrombolysis, Balloon Fragmentation
Thromboembolism

Coronary dissection
Iatrogenic Aortic Dissection

- Rare Complication
- Secondary to guide catheter trauma, injection of wedged catheter or balloon rupture

Class 1: Limited to coronary cusp
Class 2: Limited to cusp and proximal ascending aorta
Class 3: Extending to Aortic Arch

Take Home messages

- Ensure Co-Axial positioning at ostium
- Knowledge of the anatomy is vital
- Try to use the smallest possible diameter
- Try to have all sizes of all catheters in your cathlab
- Be gentle!
- Pressure is your best friend
How to choose between the different guidewires??

Complications of guidewires
Complications of guidewires

Historic background

• In 1977, professor Grüntzig performed the first coronary angioplasty using a blunt, closed-end, inner balloon catheter with a short guidewire attached to its tip.
• The safe crossing of severe stenoses with this large, non-manoeuvrable catheter was limited. Moreover with this system it was impossible to perform independent movements of the wire and balloon.
• In 1982 Simpson et al reported the first experience with a new over-the-wire balloon system.
• Since then, guidewire technology has rapidly advanced.
• Guidewires have the following functions:
  • – To track through the vessel,
  • – To access the lesion,
  • – To cross the lesion atraumatically,
  • – To provide support for interventional devices.

Guidewire performance

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque control</td>
<td>Is an ability to apply rotational force at a proximal end of a guidewire and have that force transmitted efficiently to achieve proper control at the distal end</td>
</tr>
<tr>
<td>Trackability</td>
<td>Is an ability of a wire to follow the wire tip around curves and bends without bucking or kinking, to navigate anatomy of vasculature</td>
</tr>
<tr>
<td>Steerability</td>
<td>Is an ability of a guidewire tip to be delivered to the desired position in a vessel</td>
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<tr>
<td>Flexibility</td>
<td>Is an ability to bend with direct pressure</td>
</tr>
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<td>Prolapse tendency</td>
<td>Tendency of the body of a wire not to follow the tip around bends</td>
</tr>
<tr>
<td>Radiopacity/visibility</td>
<td>Is an ability to visualise a guidewire or guidewire tip under fluoroscopy.</td>
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<tr>
<td>Tactile feedback</td>
<td>Is tactile sensation on a proximal end of a guidewire that physician has that tells him what the distal end of the guidewire is doing</td>
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<tr>
<td>Crossing</td>
<td>Is an ability of a guidewire to cross lesion with little or no resistance</td>
</tr>
<tr>
<td>Support</td>
<td>Is an ability of a guidewire to support a passage of another device or system over it</td>
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</table>
• Structure of the guidewire

CORE

The inner part of the guidewire that extends through the shaft of the wire from the proximal to the distal part where it begins to taper.
It is the stiffest part of the wire that gives the stability and steerability to the guidewire from its proximal end to the distal tip.

Core material

– **Stainless steel:**
  provides excellent support
  Better transmission of push force and torque characteristics
  **BUT**
  Less flexible
  More susceptible to kinking.

– **Nitinol:**
  Excellent flexibility
  More durable than stainless steel
  **BUT**
  Less torqueable.
Core diameter

Larger diameters improve the support, and allow 1:1 torque response.
Smaller diameters enhance the flexibility of the wire.

Core taper

The core of a guidewire usually is tapered along its length.
Shorter taper and smaller numbers of widely spaced gradual tapers enhance the support and transmission of push force.
Longer tapers and larger numbers of more segmental tapering enhance the flexibility.
• TIP

• The tip is the distal end of a guidewire.
• **One-piece core or core-to-tip design:**
  • The core extends all the way to the tip.
  • Less flexible
  • These wires have precise steering and tip control.
• **Two-piece or shaping ribbon design:**
  • The core stops just short of the distal tip.
  • Very flexible
  • Less reliable torque control.

• Coating

• The purpose of the coating is:
  • To reduce frictions helping the wire negotiate tortuous anatomy.
  • To improve deliverability of interventional equipment over the wire.

• Two types of coatings are used:
  • **Hydrophilic coatings**
    • They provide a lubricious, low friction feel inside the vessel and more trackability. They are recommended for operators with some experience as they carry the risk for subintimal movement, dissection and perforation of coronary artery.
  • **Hydrophobic coatings**
    • These are silicone based coatings which repel water and are applied on the working length of the wire, with the exception of the distal tip. Silicone coating has higher friction, more stable feel inside the vessel.
• Classification of guidewires
  • There is no uniform clinical classification of guidewires. However, guidewires could be classified by tip flexibility, device support and coating type.

• BY TIP FLEXIBILITY
  • – Floppy
    • ChoICE™ Floppy - Boston Scientific, Natick, MA, USA;
    • IQ™ - Boston Scientific; Mailman - Boston Scientific;
    • Asahi Soft - Abbott Vascular, Redwood City, CA, USA;
    • Hi-Torque Balance - Abbott Vascular;
    • Hi-Torque Balance Middleweight - Abbott Vascular;
    • Hi-Torque Transverse - Abbott Vascular; Wizdom® ST - Cordis, Johnson & Johnson, Warren, NJ, USA
  • – Intermediate
    • ChoICE™ Intermediate - Boston Scientific;
    • Hi-Torque Intermediate - Abbott Vascular; Stabilizer® - Cordis
  • – Standard
    • ChoICE™ Standard - Boston Scientific;
    • Shinobi® - Cordis

• BY DEVICE SUPPORT
  • Light
    • ChoICE™ Floppy - Boston Scientific
    • ChoICE™ PT Floppy - Boston Scientific
    • Asahi Light - Abbott Vascular
    • Hi-Torque Whisper LS - Abbott Vascular
    • Hi-Torque Balance - Abbott Vascular
    • Wizdom® - Cordis
  • Moderate support
    • IQ™ - Boston Scientific
    • PT Graphix™ - Boston Scientific
    • Luge™ - Boston Scientific
    • Hi-Torque Whisper MS - Abbott Vascular
    • Hi-Torque Balance Middleweight - Abbott Vascular; Stabilizer® - Cordis
  • Extra support
    • ChoICE™ Extra Support - Boston Scientific
    • ChoICE™ PT Extra Support - Boston Scientific
    • Asahi Grand Slam - Abbott Vascular
    • Hi-Torque Whisper ES - Abbott Vascular
    • Hi-Torque Balance Heavyweight - Abbott Vascular
    • Stabilizer® Plus - Cordis
BY COATING TYPE

- Hydrophilic coating
  ChoICE™ PT Floppy - Boston Scientific
  PT Graphix™ - Boston Scientific
  Asahi Fielder - Abbott Vascular

- Hydrophobic coating
  IQ™ - Boston Scientific
  Asahi Soft - Abbott Vascular

Guidewire manipulation

- SHAPING THE WIRE TIP
• **STEERING OF THE WIRE THROUGH THE VESSEL**
  • *Small* alternating rotations to the left and right are used
  • The ideal wire can maintain 1:1 torque response. *Torque response* is especially important in tortuosity.
  • *Free wire tip motions* are important.
  • Avoid excessive rotations to prevent the wire tip fracture.
  • Dye injection
  • Usage of different angiographic views can help to cross the lesion safely and successfully

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**Selection of guidewires**

• **The selection of a guidewire**
  • Guidewire selection is an essential component in a successful coronary intervention.
  • Although the guidewire selection is influenced by criteria related to the vessel anatomy, the lesion morphology and the devices to be used, in real life scenario the guidewire selection is based upon operator's experience and preference.
  • Rather than trying to use all wires that are on the market, it is more common for the operator to become an expert with a limited number of wires.
Left main intervention

- **WIRES FOR LEFT MAIN PCI**
  - The choice of a guidewire is not of critical importance.
  - Wire selection usually includes spring tip guidewire designed for frontline lesions, for example, ChoICE™ Floppy (Boston Scientific), Hi-Torque Balance Middleweight (Abbott Vascular)

Wires for bifurcation PCI

- **WIRES FOR BIFURCATION PCI**
  - The ChoICE™ Floppy (Boston Scientific), Hi-Torque Balance Middleweight (Abbott Vascular) will be the initial wires to use.
  - In many cases we can perform successful PCI using only floppy wires and adequate other interventional devices
Some tips and tricks

• Before the guidewire insertion into the side branch it is important to choose the most appropriate angiographic view.

• Accessing the side branch before stent implantation:
  • The CholCE™ Floppy (Boston Scientific), Hi-Torque Balance Middleweight (Abbott Vascular) will be the initial wires to use
  • In the presence of difficulties accessing the side branch some hydrophilic wires such as the CholCE™ PT Floppy (Boston Scientific), PT Graphix™ (Boston Scientific) or Asahi Fielder (Abbott Vascular) may become useful.

BUT put in mind ........

• it is important to monitor the distal position of the wire tip.
• These wires also should not to be jailed because of the risk of wire rupture during pullback. Therefore after accessing the side branch with hydrophilic wire and angulation modification, it is possible to exchange for floppy wire.
Tip shaping

Tip Shaping (I)

Tip shaping is important for approaching acute-angled side branches from both antegrade and retrograde approaches. To advance the guidewire through these side branches, double-bend shaping is recommended.

Second Curve
(3–5mm)

First Curve
(0.5–1mm)
After stent implantation, we recommend to Looping wire technique with making a loop of the distal segment of the wire is recommended before approaching the main vessel stent and advancing the wire through it.

**Wires for dissections**

**WIRE FOR DISSECTIONS**
Wires like a ChoICE™ Floppy or Asahi Soft might be suitable for crossing a spiral dissection. The parallel wire technique can be recommended if a dissection plane is entered with the first.
Wires for calcified lesions

• Our practice is to start with ChoICE™ Floppy (Boston Scientific).

• If it fails to cross the lesion, the next step is to choose floppy hydrophilic wire such as the ChoICE™ PT Floppy (Boston Scientific) or Asahi Fielder (Abbott Vascular).

• In order to advance the stent over the less supportive wire we use plaque modification and lesion preparation with cutting balloons.

• Rotablation can be a good option provided good experience with the procedure.

Tortuous anatomy

• WIRES FOR TORTUOUS ANATOMY

• In most cases we apply the same strategy as in calcified lesions and start with a very floppy wire. In addition, sometimes supportive wire (buddy wire) for device delivery could be used.
The usage of a buddy wire that is advanced in a different vessel may provide additional support. Insertion of guidewires in tortuous coronary arteries frequently induces vessel wall straightening and shortening which can lead to appearance of false lesions or coronary pseudo-stenosis in the angiography. Pullback of the guidewire normally leads to resolution of these "lesions"
Please....

• Go slow
• Schedule procedure when you have enough time to do the case
• Take multiple angiographic projections
• Think about what you are seeing
• Don’t be afraid to stop and bring the patient back later

Take home message

• There are multiple factors that contribute to a successful coronary intervention and appropriate guidewire selection is one of them.
• The guidewire market is very broad and floating. Variation in structure of guidewire can create significant differences in wire performance that affects the suitability of a particular wire in varying clinical situations.
• However it is more reasonable to focus on selected guidewires and to understand their properties rather than trying to use all of them.
Remember the date!!

8 - 9 May 2014
Fairmont Towers Hotel
Cairo – Egypt

• Thank you for attention