Guidewires

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Agenda

• Components of a guidewire.
• Types of guidewires.
• Indications of each type.
• Complications of guidewires.
Historical Perspective

*Grüntzig* performed the first coronary angioplasty in 1977 using a short, non-independently movable guidewire. The balloon and the guidewire were advanced as a single unit with limited manoeuvrability.

In 1982 Simpson reported the use of an independently movable, flexible-tipped guidewire within the over-the-wire balloon dilation catheter to facilitate the selection of the target vessel.

Guidewire technology has since advanced significantly, with a wide selection for different lesion characteristics and vessel anatomies.

Guide wire - construction

Multi-layer constructions:

1. **Central Core**: usually stainless steel/or nitinol. Tapers at variable points towards wire tip to impart differential stiffness along wire’s length
2. **Distal tip**: (varies in length; usually radio-opaque material e.g. platinum/iridium alloys): gives flexibility and allows wire tip to be shaped per operator requirements
3. **Coating**: most wires – silicone/teflon outer coating to aid easy advancement. The hydrophilic polymer coating becomes a gel when wet to reduce surface friction and increase wire ‘slipperiness’
Central core

Longest & stiffest portion of guidewire

Tapers distally to a variable extent
- 2-piece core - distal part of core does not reach distal tip of wire → shaping ribbon, extends to distal tip
- 1-piece core - tapered core reaches distal tip weld

2-piece → easy shaping & durable shape memory

1-piece → better force transmission to tip & greater “tactile response” for operator
Central core

**Stainless steel**
- superior torque characteristics, can deliver more push, provides good shapeability of tip
- more susceptible to kinking

**Durasteel**
- better tip shape retention and durability

**Nitinol**
- pliable but supportive, less torquability than stainless steel
- generally considered kink resistant & have a tendency to return to their original shape, making them potentially less susceptible to deformation during prolonged use

Distal tip

- Flexible, radio-opaque part
- Consists of spring coil extending from distal untapered part of central core to distal tip weld
- Integrates tapered core barrel (as well as shaping ribbon in 2-piece wire)
- Spring coil-variable length (1-25cm) with a radio-opaque section located at its terminal end
- Distal tip weld- short (≤2mm)compact cap forming the true distal end of the wire - to ↓ trauma while the wire is traversing vessels
Wire Coating
(hydrophilic/hydrophobic)

Hydrophobic:

• Repels water - Requires no wetting
• ↓ friction, ↑ trackability
• Preserves tactile feel, allows easier anchor ability / parking specially in CTO
• Silicone, Teflon

Hydrophilic:

Attracts water - needs lubrication
Thin, slippery, non-solid when dry → becomes a gel when wet
○ ↓ friction → glide through tortuousities
○ ↑ trackability
○ ↓ Thrombogenicity
➢ ↓ 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
Properties Of An Ideal Guidewire

- Push transmission/steerability
- Torque transmission/torquability
- Body support/trackability
- Tip support/mobility
- Flexibility
- Tip durability/elasticity
- Tip visibility and markers
- Tactile feedback
- Prolapse tendency

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>DEFINITION AND REMARKS</th>
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<tbody>
<tr>
<td>Trackability</td>
<td>Ability to follow the wire tip around vessel curves or bends without kinking or buckling</td>
</tr>
<tr>
<td>Steerability</td>
<td>Ability of guidewire tip to be delivered to the desired position in a vessel. Achieving this requires a combination of all the physical properties of the guidewire and skill of the operator</td>
</tr>
<tr>
<td>Torque control</td>
<td>Ability to transmit rotational force from the proximal end (i.e., operator’s hand) to distal guidewire tip. Wires made of stainless steel core with one-piece core-to-tip design tend to have better torque transmission</td>
</tr>
<tr>
<td>Crossing</td>
<td>Ability to cross lesion with little or no resistance. The more lubricious the guidewire, the easier it can cross the lesion with little resistance. In terms of lubricity, hydrophilic coating &gt; hydrophobic coating &gt; no coating, polymer cover &gt; spring-coil tip</td>
</tr>
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<td>Flexibility</td>
<td>Ability to bend with direct pressure</td>
</tr>
<tr>
<td>Prolapse tendency</td>
<td>Tendency of the body of a guidewire not to follow the tip around bends. Wires with core-to-tip (uncoiled) design and more gentle transition (longer tapering) tend to have less prolapse tendency</td>
</tr>
<tr>
<td>Tactile feedback</td>
<td>The “feel” or “tactile sensation” of the guidewire tip as perceived by the operator. This is better appreciated with coil-tipped wires than with polymer-tipped wires. Less lubricious wires provide greater tactile feedback</td>
</tr>
<tr>
<td>Support</td>
<td>Ability to support the passage of another device or system</td>
</tr>
<tr>
<td>Malleability</td>
<td>Ability to be bent or shaped without breaking</td>
</tr>
<tr>
<td>Radiopacit/ visibility</td>
<td>Ability to be visualised under fluoroscopy. Platinum at the end of a guidewire enhances radiopacity. The radiopaque tip is useful as a marker, measure of length, and helps maintain focus on the lesion while the tip is in the periphery of the visual field</td>
</tr>
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<td>Durability</td>
<td>Ability to resist kink and retain shape. Durable wires that retain tip shape well can be used for PCI in multiple vessels, and hence are more cost-effective. Wires made of Nitinol core material are generally more kink-resistant than stainless steel wires</td>
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<td>Penetration</td>
<td>Usually referred to as the ability of CTO guidewire to make an entry and penetrate through the fibrous cap of a totally occluded lesion. It is determined by tip load and tip dimension, further affected by tip coating</td>
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<td>Pushability</td>
<td>Ability of a wire to be advanced or pushed through chronic total occlusion, or a complex lesion with heavy calcification and tough fibrous tissues</td>
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Trackability: Ability to follow the wire tip around vessel curves or bends without kinking or buckling.

Steerability: Ability of guidewire tip to be delivered to the desired position in a vessel. Achieving this required a combination of physical properties of the guidewire and skill of the operator.

Torque control: Ability to transmit rotational force from the proximal end (operator’s hane) to the distal guidewire tip. Wires made of stainless steel core with one–piece core-to-tip design tend to have better torque transmission.

Crossing: Ability to cross lesion with little or no resistance. The more lubricious the guidewire, the easier it can cross the lesion with little resistance. In terms of lubricity, hydrophilic coating > hydrophobic coating > no coating; polymer cover > spring coil tip.

Flexibility: Ability to bend with direct pressure.

Prolapse tendency: Tendency of the body of a guidewire not to follow the tip around bends. Wires with core-to-tip design and more gentle transition (longer taperrring) tend to have less prolapse tendency.
**Malleability**: Ability to be bent without breaking.

**Radio-opacity/visibility**: Ability to be visualised under fluoroscopy. Platinum at the end of a guidewire enhances radioopacity. The radio-opaque tip is useful as a marker, measure of length, and helps maintain focus on the lesion while the tip is in the periphery of the visual field.

**Durability**: Ability to resist kink and retain shape. Durable wires that retain tip shape well can be used for PCI in multiple vessel, and hence are more cost-effective. Wires made of Nitinol core material are generally more kink resistant than stainless steel wires.

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**Penetration**: Usually referred to as the ability of CTO wires to make an entry and penetrate through the fibrous cap of a totally occluded lesion. It is determined by the tip load and tip dimension, further affected by tip coating.

**Pushability**: Ability of a guidewire to be advanced or pushed through CTO, or a complex lesion with heavy calcification and tough fibrous tissues.

**Tactile feedback**: The ‘feel’ or ‘tactile sensation’ of the guidewire as perceived by the operator. This is better appreciated with coil-tipped wires than polymer-tipped wires. Less lubricious wires provide greater tactile feedback.

**Support**: Ability to support the passage of another device or system.
SHAPING THE WIRE TIP

• A bend at the tip of the guidewire allows it to be manipulated.

• The most common way of shaping the guidewire is to draw it over the thumb and index finger, a guidewire introducer or a needle.

• It is important to minimize the amount of force applied to the wire to avoid damaging the structure and solidity of the wire.

• The shape of the distal tip can mimic the take-off of the vessel or the curve of the artery. (Usually a simple J-curve with a distal bend that approximates the vessel diameter)
Shapeability and shaping memory

Shapeability - allows to modify its distal tip conformation

Shaping memory - ability of tip to return back to its basal conformation after having been exposed to deformation & stress

- Both do not necessarily go in parallel
- 1-piece core wires - easier to shape (↑memory - nitinol core)
- 2-piece core + shaping ribbon - easier to shape & ↑memory

Classification of guidewires

There is no uniform classification of coronary guidewires.

Based on:

1. Tip flexibility (floppy/soft, intermediate, stiff).
2. Tip coating (hydrophilic, hydrophobic, no coating).
3. Tip style (one-piece core-to-tip, two-piece core with shaping ribbon).
4. Tip tapering (tapered, untapered).
5. Core construction material (stainless steel, Nitinol, high-tensile stainless steel).
6. Device support (light, moderate support, extra support).
7. Target lesion type (workhorse/frontline wires, CTO wires, wires for tortuous lesions, etc.).
8. Specific purpose guidewires, e.g., pressure wire, marker wire (with markers or length indicators), rotablator wire, wiggle wire, etc.
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 – 0.5-1.0 g
- Extra support - >1.0 g
- Floppy - <0.5g
Types (cont.)

• **Workhorse wire**: default choice - balance btw stiffness/support & flexible tip – majority lesions

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

• **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
• Asahi Light / Medium

• Choice Floppy
• PT series
• Pilot 50
• Galeo
Balance Middleweight Universal wire
(ABBOTT Vascular)

• Quite steerable - tip is suitable for bending in a “J” configuration for distal advancement into the distal vessel bed with minimal trauma while still maintaining some torque
• Shape retention relatively poor - any J configuration tends to become magnified over time → consequent loss in steerability
• Moderately torquable - progression - minimal friction (light hydrophilic coating) - dye injection may also be helpful to propagate distal advancement
• Suitable for rapid, uncomplicated interventions
• Low risk to cause dissections/distal perforations
• Support - low to moderate

Balance Middleweight wires

• From the generation previous to the Universal
• Lack light hydrophilic coating at the tip → more steerability but requires greater effort for distal advancement
• More direct tactile feedback (v/s more automatic progression – universal)
• Support - moderate
• Power steering
**CholCE® Floppy Guide Wire**  
(Boston Scientific)

**Overview**
Combines a hydrophilic-coated polymer sleeve with a soft tip and flexible body - excellent for frontline and tortuous anatomy cases.

- **Tip Flexibility/Style:** Floppy/Spring coil
- **Tip Radiopacity:** 3cm
- **Rail Support:** Light
- **Core Material:** Unibody stainless steel
- **Coating:** Hydrophilic: distal 3cm spring coils uncoated
- **Extension:** Magnet Exchange Device

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**PT²® Moderate Support Guide Wire**

**Overview**
Offers increased resiliency with the ability to help steer and deliver devices in tortuous anatomy and highly resistant lesions.

- **Tip Flexibility/Style:** Intermediate/Polymer
- **Tip Radiopacity:** 2cm
- **Rail Support:** Moderate
- **Core Material:** Linear elastic nitinol
- **Coating:** Hydrophilic
- **Extension:** AddWire® Extension Wire
Galeo® guide wire (Biotronik)

<table>
<thead>
<tr>
<th>Galeo / Galeo Hydro Coronary Guide Wires</th>
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<tr>
<td>Diameter</td>
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<tr>
<td>Length</td>
</tr>
<tr>
<td>Core wire material</td>
</tr>
<tr>
<td>Proximal coil</td>
</tr>
<tr>
<td>Distal coil</td>
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<tr>
<td>Proximal (shaft) coating</td>
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<tr>
<td>Distal coatings</td>
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<tr>
<td></td>
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<tr>
<td>Range of tip flexibilities</td>
</tr>
<tr>
<td>Range of support levels</td>
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Runthrough NS® wire (Terumo)

unique dual core design
• main shaft core of SS & a distal core of nitinol alloy, which extends into a nitinol shaping ribbon
distal tip is hydrophilic coated
HI-TORQUE PILOT 50 Guide Wire
(Abbott Vascular)

Tip load: 1.5g
Radiopaque length: 3 cm
Outside diameter: 0.014"
Tip Outside diameter: 0.014"
Coating: Hydrophilic
Tip style: Core to tip
Polymer cover: Full Polymer Cover
Core Material: DURASTEEL Stainless Steel

HI-TORQUE PILOT 200 Guide Wire

Tip load: 4.1g
Radiopaque length: 3 cm
Outside diameter: 0.014"
Tip Outside diameter: 0.014"
Coating: Hydrophilic
Tip style: Core to tip
Polymer cover: Full Polymer
CORE MATERIAL: DURASTEEL Stainless steel
Persuader

- Stainless Steel crossing wires
- Available in both Silicone and Hydrophilic coating
- Available in both 180 and 300 cm
- Available in 3, 6 and 9 gram tip stiffness

Guidewire Strategies for Approaching CTO

A) Guidewires for Approaching Micro-channels
   - Crosswire NT
   - Whisper / Pilot
   - Rinato
   - Shinobi / Shinobi Plus
   - ChoICE PT / ChoICE PT ES
   - PT Graphix
   - PT2

B) Guidewires for Drilling Strategy
   - Persuader
   - Miracle Bros
   - Cross-It

C) Guidewires for Penetrating Strategy
   - Cross IT
   - Conquest Pro

D) Guidewires for Retrograde Technique
   - Fielder/FielderFC
   - X-treme
   - Whisper
   - ChoICE PT2
   - Runthrough / Runthrough Hypercoat
CTO

- Start with the **intermediate wire**
- This provides 3g of distal force and moderate support
- Conventional stainless steel core wire with 30mm of tip radio-opacity and 0.014 in. Diameter
- If this wire fails to cross, → miracle series

**Intermediate Wire (Asahi)**

**Intermediate AG142000**

- Tip load ......................... 3.0 g
- Tip radiopacity .................. 3 cm
- PTFE coating over the shaft
Miracle series (Asahi Intecc)

- 0.014 in wires - specifically designed for CTO
- 110mm of distal tip radio-opacity for optimal visualization
- Come in 4 versions of ↑ distal force:
  - 3g, 4.5g, 6g, 12g

Miracle 3  AG14M050

- Tip load ............................ 3.0 g
- Tip radiopacity .................... 11 cm
- PTFE coating over the shaft
Conquest series (Asahi Intecc)

The next evolution- tapered tip Conquest wire (Confianza)
- Has a distal tip diameter of only 0.009 in
- The distal tip is radio-opaque for 200mm
- Provides 9g of distal force

Conquest Pro (Confianza Pro)
- Also tapered to 0.009 in
- Provides 9g of force
- Hydrophilic-coated for the distal 20 cm

Tip tapering is proposed to help the wire find and navigate microchannels in the occluded segment, while the hydrophilic coating of the Conquest Pro reduces the tip friction by about one-third
**Conquest AG143090**

- Tip load: 9.0 g
- Tip radiopacity: 20 cm
- Tip outer diameter: 0.009 inch (0.23 mm)
- PTFE coating over the shaft

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**Fielder™ / Fielder FC™ (Asahi Intec Co.)**

- Special guidewire - distal coil coated with polymer sleeve & further coated with a hydrophilic coating
- Provides advanced slip performance & trackability for highly stenosed lesion & tortuous vessels
- Very good torque performance
- Combines both slide and torque performance
- Primary wire used in the retrograde technique of recanalization of CTO
Fielder™ / Fielder FC™ (Asahi Intec Co.)

Special guidewire - distal coil coated with polymer sleeve & further coated with a hydrophilic coating

Provides advanced slip performance & trackability for highly stenosed lesion & tortuous vessels

Very good torque performance

Combines both slide and torque performance

Primary wire used in the retrograde technique of recanalization of CTO

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**Fielder AGP140000**

Tip load .............................. 1.0 g
Tip radiopacity ...................... 3 cm
Polymer sleeve length .......... 22 cm
SLIP COAT coating over the spring coil
PTFE coating over the shaft
**Fielder FC  AGP140001**

- Tip load ............................ 0.8 g
- Tip radiopacity .................... 3 cm
- Polymer sleeve length ...... 20 cm
- SLIP COAT coating over the spring coil
- PTFE coating over the shaft

**Fielder XT  AGP140002**

- Tip load ............................ 0.8 g
- Tip radiopacity .................... 16 cm
- Polymer sleeve length ...... 16 cm
- Tip outer diameter ...... 0.009 inch (0.23 mm)
- SLIP COAT® coating over the spring coil
- PTFE coating over the shaft
Optimum guide wire positioning

- Should be placed as distally as possible in the target vessel
- Allows extra support when crossing with balloon/stent catheters
- ↓ chance of the wire becoming displaced backwards across the lesion and necessitating re-crossing
- Avoid vessel perforation when positioning wires with hydrophilic coatings very distally
Tips and tricks

- Avoid excessive rotation
- Maintain free movement of wire tip
- Withdraw or reposition if needed
- Avoid undue force

What can go wrong?

- Plaque embolization
- Arterial perforation
- Acute vessel closure
- Sub-intimal wire placement
- Wire fracture
- Wire tip entrapment

Complications of Guidewires

- Plaque embolization.
- Arterial dissection and perforation.
- Acute closure due to vasospasm.
- Subintimal wire placement.
- Wire fracture.
- Wire tip entrapment.

Complications may be managed with medication (reversal of anticoagulation with protamine sulphate) or additional device use (balloons, stents, coils, covered stents) or even bypass surgery.
Case scenarios for different wires

Which guidewire would you prefer?
A) BMW
B) Pilot 150
C) PT2
D) Conquest
Which guidewire would you prefer?
A) BMW
B) Pilot 150
C) PT2
D) Galeo

Which guidewire would you prefer?
A) BMW
B) Galeo
C) PT2
D) Pilot 200
Which guidewire would you prefer to attack this tortuous anatomy?
A) Galeo
B) Choice floppy
C) PT2
D) Pilot 150

Which guidewire would you prefer in the side branch?
A) BMW
B) Pilot 50
C) PT2
D) Pilot 150
Which guidewire would you prefer to start with in this CTO?
A) BMW
B) Galeo
C) PT2
D) Asahi intermediate

Which guidewire would you prefer when doing this retrograde approach for CTO?
A) BMW
B) Galeo
C) Fielder series
D) Pilot 200
Which guidewire would you prefer to enter the true lumen in this dissection?
A) BMW
B) Fielder
C) PT2
D) Pilot 200

Conclusion
Wire Selection

By varying size and length of the core wire, it is possible to create different wire flexibility & rail support

**Distal tip** = designed to allow the guide wire to cross the lesion

<table>
<thead>
<tr>
<th>Clinical Situation (Lesion Type)</th>
<th>Distal Tip Stiffness Model</th>
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<tbody>
<tr>
<td>Simple to Complex PTCA</td>
<td>Floppy</td>
</tr>
<tr>
<td>Complex PTCA</td>
<td>Intermediate</td>
</tr>
<tr>
<td>CTO</td>
<td>Standard</td>
</tr>
</tbody>
</table>

**Rail Support** = designed to allow the devices to cross the lesion

<table>
<thead>
<tr>
<th>Clinical application</th>
<th>Rail Support</th>
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</thead>
<tbody>
<tr>
<td>Least rail support: POBA</td>
<td>Light Support</td>
</tr>
<tr>
<td>Stent delivery</td>
<td>Moderate Support</td>
</tr>
<tr>
<td>Added support for Stent delivery</td>
<td>Extra Support</td>
</tr>
<tr>
<td>(Designed for the first generation of stents)</td>
<td></td>
</tr>
<tr>
<td>Vessel Straightening</td>
<td>Super Support</td>
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</tbody>
</table>

Categories of Guidewires

**Standard Cases/AMI**
- BMW
- Cougar
- Floppy II
- PT2
- Prowater

**Tortuous Cases-Hydrophilic**
- Whisper
- PT2
- Cougar LS
- Zinger Light
- Zinger Marker

**Extra Support Cases**
- BHW
- Extra S’Port
- Thunder
- Zinger Support

**Tough Crossing Cases-CTO**
- Miracle wires
- Choice PT
- Cross-it wires
- Pilot wires
- Provia 3-6-9
Guidewires Selection

Select a guide wire that traverses the coronary anatomy
- safely
- independently
- without vessel trauma

Take into account:
- access to lesion
- crossing support
- platform for device manipulation

Guide wire selection is influenced by:
- Vessel anatomy
- Lesion location
- Lesion morphology
- Device selection
- Operators preference

Concentric vs eccentric
Focal vs diffuse
Soft vs calcified
Length

Thank You