Implementation of Intravascular Ultrasound for Percutaneous Coronary Interventions

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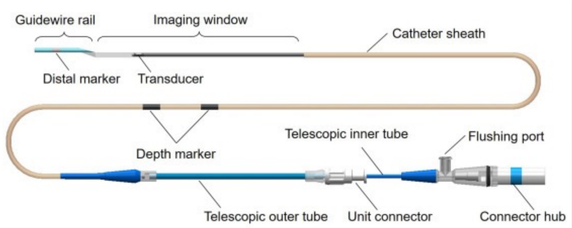
What is Intravascular Ultrasound (IVUS)?

- Uses high-frequency sound waves (10-60 MHz) to produce cross-sectional images of a vessel
- Specialized transducer catheters are inserted into coronary arteries over guidewires
- The transducer sends & receives ultrasonic signals & converts into images
- Images are collected as catheter is pulled through a lesion site while scanning radially & longitudinally
- Used in conjunction with angiography
- Can identify plaque composition & distribution
- Can determine positive or negative remodeling of a vessel

(Seki, Sakaguchi, & Iguchi, 2020, p. 97)



IVUS imaging catheter (Seki, Sakaguchi, & Iguchi, 2020, p. 98)

What is a Percutaneous Coronary Intervention (PCI)?

- Consists of dilation of the heart's coronary arteries using balloons & stents
- Requires use of sheaths, catheters, & guidewires to gain arterial access
- Done for treatment of coronary artery disease (CAD) to revascularize arteries
- Performed under angiography by an interventional cardiologist with help from a cardiovascular technologist in the Cardiac Catheterization Laboratory (CCL)
- Can be enhanced with use of IVUS & fractional flow reserve (FFR)
- Reduces possibility of future coronary artery bypass graft (CABG) surgery

Advantages to using IVUS for PCIs

- No additional radiation
- Creates cross-sectional image of vessels
  - Allows for better visualization & measurements of lesion
- Minimally invasive
  - Decreased risk of infection

Indications for IVUS

Pre-PCI:

- To evaluate lesion site & composition/ distribution of plaque
- Collect measurements of distal reference lumen diameter
- Calculate stent size & postdilation balloon size

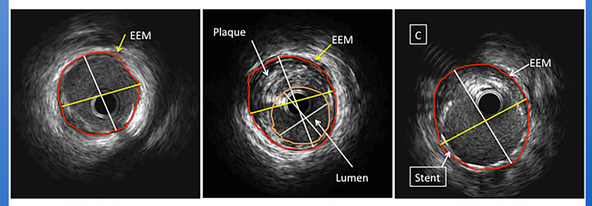
(Hassan, Dohi, & Daida, 2016, p. 47)

Post-PCI:

- To determine optimal stent expansion (OSE)
- Assess for edge dissection, edge stenosis, & stent malapposition

(Case et al., 2021, para. 5.5)

There are no definitive contraindications to IVUS



IVUS images & measurements pre-PCI & post-PCI (Hakim et al., 2021, p. 239)

Indications for PCIs

- ST-segment elevation myocardial infarction (STEMI)
- Unstable angina or non-STEMI
- Stent restenosis
- High-grade lesion in a significant vessel

Contraindications for PCIs

- Noncompliance with antiplatelet therapy
- Unsuitable or high-risk coronary anatomy
- Numerous stent restenoses
- Bleeding diathesis

(Kern, Sorajja, & Lim, 2016, p. 419)

Research & Results

- The ULTIMATE trial compared 3-year outcomes between IVUS-guided stent placement & angiographic-guidance
- IVUS-guided group had decreased risk of:
  - Target vessel failure (TVF)
  - Clinically driven target vessel revascularization (TVR)
  - Target lesion failure (TLF)
  - Stent thrombosis (ST)

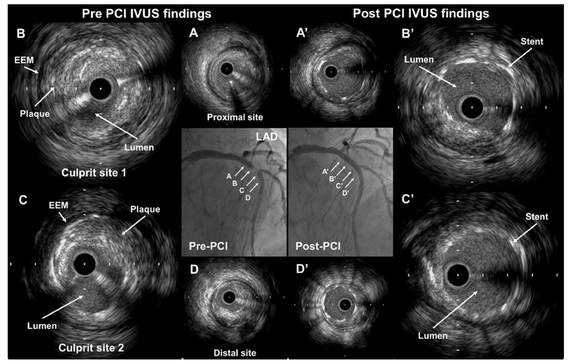
(Gao et al., 2021, Table 2)

- Research done on IVUS-guided PCIs for treatment of STEMIs shows decreased risk for in-hospital death & CABG
- IVUS was only performed on 5.5% (14,105) of study population (252,970)
- Produced better patient outcomes but with increased hospital cost

(Megaly et al., 2020, p. 5)

- Research was done to determine if optimal stent expansion (OSE) was achievable under IVUS guidance
- 50% of participants received IVUS guidance & 50% received angiographic guidance
- The IVUS-guided group has less chance of:
  - Stent under expansion
  - Stent malapposition
  - Residual reference segment stenosis
- The IVUS group also received larger & longer stents with greater:
  - Minimum stent area (MSA)
  - Average stent area (ASA)
  - Stent volume index (SVI)

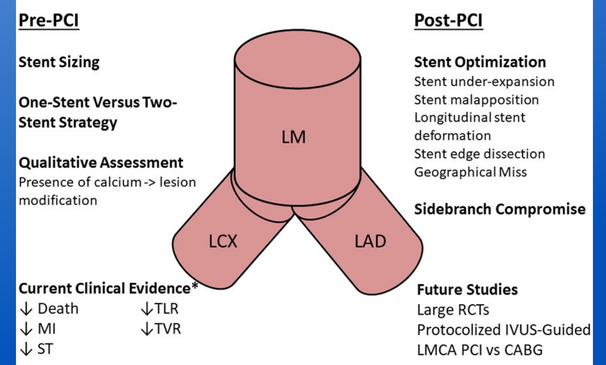
(Hakim et al., 2021, Table 3)



Center: Angiographic images of a left anterior descending (LAD) artery lesion. Images A-D: Pre-PCI IVUS images of lesion. Images A'-D': Post-PCI IVUS images of lesion. (Hassan, Dohi, & Daida, 2016, p. 47)

Discussion

- IVUS-guided PCIs produce better patient outcomes than angiographic guidance alone
  - Decreased risk of death, TVF, TLF, TVR, & ST
- Using IVUS before PCIs increases stent size & postdilation balloon size
  - More accurate measurements can be collected of lesion sites
  - Measurements used to calculate appropriate stent size for each lesion
- Using IVUS after PCIs can detect stent complications that can worsen patient outcomes
  - Detects stent under expansion, edge dissections, & stent malapposition



Graphical overview of IVUS use & outcomes. LM- Left main artery. LCX- Left circumflex artery. LAD- Left anterior descending artery. (Case et al., 2021, p.168)

Conclusion

IVUS:

- Uses a specialized transducer catheter to produce cross-sectional ultrasound images of the heart's vessels
- Is a more accurate & less invasive way to effectively treat CAD
- Can be used for treatment of STEMIs, left main coronary artery (LMCA) disease, & general CAD
- Is not a widely implemented tool in the CCL due to IVUS being relatively new & unfamiliar
- Use during PCIs is growing, proving to provide better treatment & improve long-term patient outcomes

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