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Cardiac Catheterization: Percutaneous Coronary Intervention vs Coronary Artery Bypass Grafting

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Introduction

- Coronary artery disease (CAD) is the group of cardiovascular diseases such as angina or myocardial infarction caused by lack of blood flow to the heart muscle.
- Atherosclerosis, the distribution of lesions in vessels such as the coronaries, is a main attribution to CAD, which is the leading cause of mortality in the world.
- Plaque-buildup can cause atherosclerosis resulting in the constriction of vessels leading to less blood flow.
- Percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) are the two revascularization procedures performed to restore blood flow, relieve symptoms, and reduce the risk of future cardiac events.

Cardiac Catheterization

- A minimally invasive procedure involving the introduction of specialized catheters into the heart and the surrounding vessels.
- Performed to identify the anatomy and physiology of the heart with the use of coronary angiography.
- The diagnostic findings can identify coronary artery disease, thrombus, coronary artery flow, and aneurysms.
- The goal of coronary angiography is to develop an interventional plan that best suits the patient.
- Indications for cardiac catheterization include: coronary artery disease, myocardial infarction, sudden cardiovascular death, valvular heart disease, congenital heart disease, aortic dissection, pericardial constriction or tamponade, cardiomyopathy, and initial and follow-up assessment for heart transplant. (Rollins, Long, & Curtis, 2022)



Figure 1, 99% stenosis in LAD, (Heart Vein NYC, n.d., para. 2)

Percutaneous Coronary Intervention

- Stent placement is a procedure that uses balloon dilation and stent insertion to relieve coronary artery stenosis and restore blood flow to the heart.
- Drug-coated and drug-eluting stents reduce or prevent restenosis after vascularization procedure. The balloon and stent should cover the stenosed area when being inflated and deployed.
- Atherectomy is another option in which atherectomy devices are used to remove the plaque deposit or thrombus from within the artery.
- Rotablator is an example of an atherectomy device where a rotational burr is inserted into the artery and crushes the plaque into the size of a blood cell.
- Radiofrequency ablation is another way to treat disorders using low-voltage at a high-frequency to provide a shock to break-up the plaque in or on the outside of the vessel.
- Intravascular ultrasound (IVUS) is a visualization method that visualizes the vessel wall in a full 360-degrees and assists with the ability to decide on size of the device being used. (Rollins, Long, & Curtis, 2022)

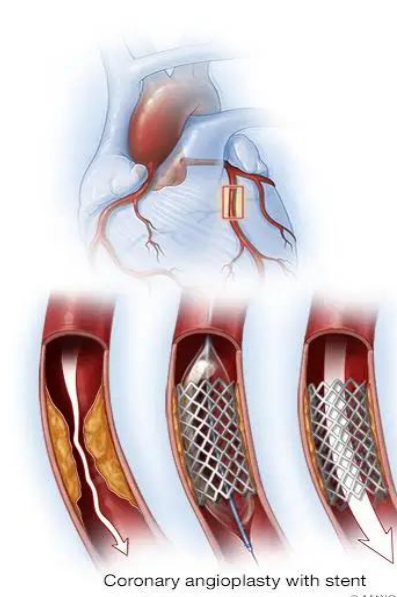


Figure 2, Coronary Angioplasty with stent, (Mayo Clinic, 2019, pg. 713)

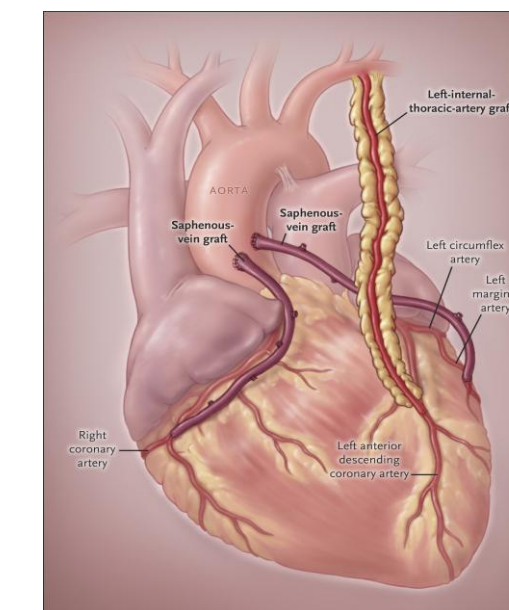


Figure 3, Coronary Artery Bypass Grafting, (New England Journal of Medicine, 2016, para. 3)

Coronary Artery Bypass Grafting

- Coronary artery bypass grafting (CABG) or heart bypass surgery restores blood flow to the heart by attaching healthy blood vessels from a different part of the body.
- The new vessel connects to blood vessels above and below the blocked area to create a new route for blood flow.
- CABG is the gold standard for patients with more severe coronary artery disease such as three-vessel disease, CAD in the left main artery, and diabetes.
- CABG has shown a superiority compared to PCI in patients with three-vessel disease with a lower risk of mortality.
- In recent years CABG has shown improvement in short-term outcomes with a minimally invasive approach. (Journal of the American Heart Association, 2025)

Quality of Life

- Quality of life was measured in patients with CAD who underwent PCI or CABG. Both PCI and CABG showed long-termed improvements in the quality of life based on their specific disease.
- PCI showed better improvements in 1 month while CABG had greater improvements in 12 months. PCI may show better results at 1 month because of its less invasive approach with a shorter stay and faster recovery.
- CABG patients have a sternal wound and may experience pain at their graft site for the first few weeks after the procedure involving cardiac rehabilitation.
- After 6 months PCI no longer showed a better quality of life compared to CABG, 12 months CABG patients showed greater improvement compared to PCI patients, specifically in angina-related symptoms.
- Results were shown from 36-60 months, but there were no significant differences between quality of life in PCI patients and CABG patients. (National Library of Medicine, 2023)

SYNTAX Study

- A trial comparing PCI and CABG was the Synergy between PCI with Taxus and Cardiac Surgery (SYNTAX) study assigning 1800 random patients with multi-vessel or left main coronary artery disease to CABG or PCI and evaluated each result.
- SYNTAX score measures the extent and complexity of CAD and assigns scores based on the complexity with low (≤ 22), intermediate (23 to 32), and high (≥ 33).
- After 5 years, patients who underwent CABG experienced death, myocardial infarction, stroke, or repeat revascularization compared to patients who underwent PCI.
- Patients with three-vessel disease showed a survival benefit of 14.6% compared to PCI with a survival rate of 9.2%. CABG has been identified as class 1 recommendation for patients with multivessel disease by The American College of Cardiology Foundation-American Heart Association.
- PCI has been recently recommended in patients with uncomplicated left main disease, especially if the patient has certain risks associated with CABG surgery. (Vascular Pharmacology, 2024)

Technological Advances

- Previous trials have shown that CABG was superior to PCI in patients with 3-vessel disease.
- Since these trials there have been many advances in the equipment and technology used in CABG and PCI.
- In PCI, fractional flow reserve (FFR) can measure the flow of a stenosed area in a vessel and compare it to the normal flow in the vessel.
- FFR has resulted in improved outcomes for PCI patients and has since become a first recommendation for coronary revascularization.
- Intravascular ultrasound (IVUS) has also shown improvements in PCI with the visualization of the inside of the stent.
- CABG has shown improvements by using arterial grafting primarily compared to venous being used as well.
- The difference is that PCI treats the lesion that is hindering the flow while CABG bypasses the lesion entirely. (The New England Journal of Medicine, 2020)

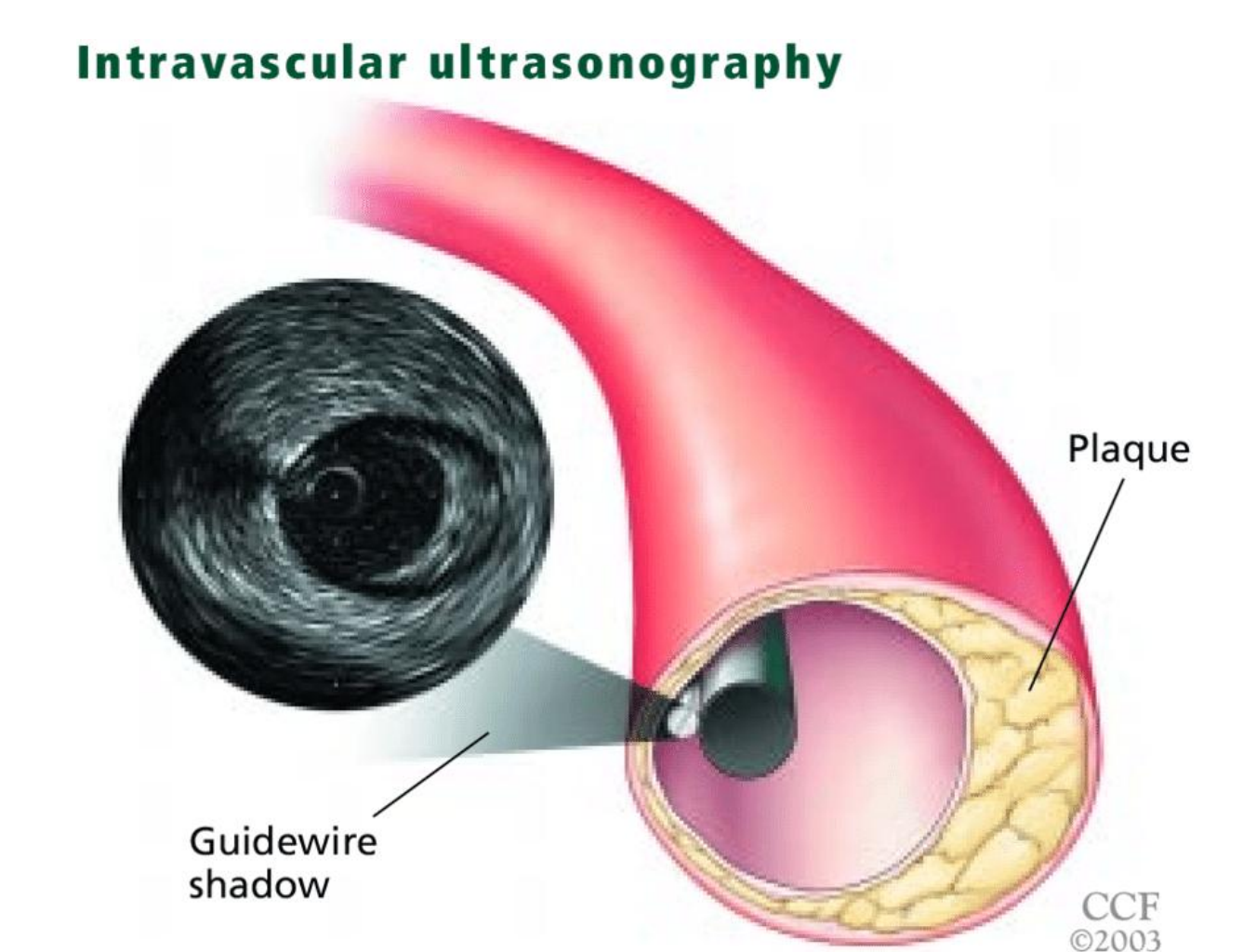


Figure 4, Intravascular Ultrasonography, (Research Gate, 2003, para. 1)

Conclusion

- Cardiac catheterization is an advanced modality involving the use of catheters into the heart and the surrounding vessels.
- Percutaneous coronary intervention is a method placing balloons and stents over a lesion in a vessel to restore blood flow.
- CABG is a surgical procedure that connects a healthy blood vessel to a blocked coronary artery to restore normal blood flow to the heart.
- PCI and CABG both offer significant benefits for patients with coronary artery disease, providing tailored treatment options to achieve the best possible outcomes for each individual.