

Coronary Artery Bypass Graft (CABG)

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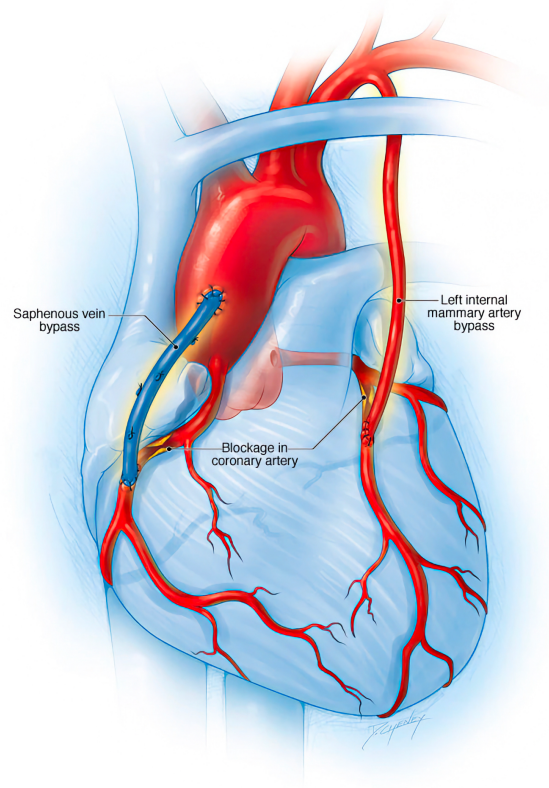
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Background

Coronary artery bypass graft (CABG) surgery is performed for the treatment of coronary artery atherosclerosis. Evaluation of CABG interventions is an important component of postmortem evaluation of the cardiovascular system.

There are two types of CABG procedure

- Internal mammary artery (IMA) graft, wherein an IMA is transected and its distal end is then sutured into a coronary artery distal to that artery's site of stenosis, forming the "distal anastomosis"
- Saphenous vein graft, wherein a segment of saphenous vein is harvested from the leg and one end is then sutured into the ascending aorta, forming the "proximal anastomosis", and the other end is sutured into a coronary artery distal to the artery's site of stenosis, forming the "distal anastomosis"



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(Image Credit: [Mayo Clinic](#))

A person may have had one or more CABG procedures at one or more points in time, and one or both types of CABG surgery may have been employed in surgical management of atherosclerotic heart disease.

Quick Tips at Time of Autopsy

Clinical History

- The terms “triple” or “quadruple” bypass refer to the number of target vessel anastomoses (i.e., the number of vessels that are bypassed), rather than the number of graft conduits

External examination

- Clues to the presence of CABG surgery on external examination include a midline sternal scar and a scar on the medial lower extremity(ies) in the vicinity of the saphenous vein(s)

Gross examination

- IMA grafts should be identified at the time of removing the chest plate during dissection. Their proximal ends will have to be transected as the chest plate is removed. Clamping any definitive or suspected IMA at the time of chest plate removal facilitates IMA identification and evaluation during subsequent heart examination
- The heart can be dissected from the organ block in the usual fashion. If there is no ascending aorta pathology then the heart including proximal great vessels can be removed from the chest block in the usual fashion, leaving about 4.0 cm of ascending aorta attached to the heart
- Remove fibrous tissue and residual pericardium from the around the heart by carefully lysing all adhesions in order to reveal the epicardial surface, native coronary arteries, and bypass grafts. Keep all dissected tissues handy in case they include part(s) of a CABG that were inadvertently excised
- Make two longitudinal incisions, one along each lateral aspect of the ascending aorta, to form a “clam shell” with anterior and posterior flaps of the ascending aorta. Visualize the aortic valve cusps, sinuses of Valsalva, and native coronary artery ostia. Document any graft attachment sites

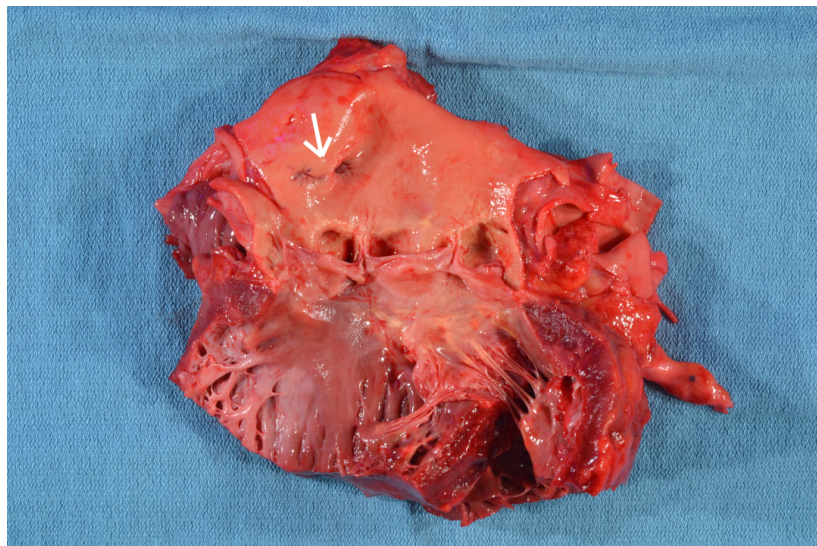


Image: Aortic valve with two graft insertion points with associated sutures.
(Image credit: Meagan Chambers/University of Washington)

- Identify any proximal aortocoronary artery bypass graft ostia, which will almost always reside in the anterior ascending aorta, about 2-3 cm above the aortic valve. These ostia are characterized by small round defects, with diameters similar to those of the native coronary artery ostia, which are surrounded by sutures. Gentle probing can be used to differentiate patent from closed ostia, as well as to determine angle of take-off from the aorta, but deep and vigorous probing should be avoided as it can dislodge potentially pathologic atherosclerotic plaque and/or thrombus
- Note that in order to perform any CABG surgery, the heart had to be placed on cardiopulmonary bypass, and so there will almost always be a healed defect in the anterior ascending aorta, probably containing one or more sutures, which represents the cannulation site for cardiopulmonary bypass. This is not a proximal aortocoronary bypass anastomosis
- Trace all bypass graft vessels from either 1) their proximal anastomosis origin on the aorta or 2) as an internal mammary artery to their distal anastomosis site on an affected coronary artery. Evaluate the integrity of any proximal and distal anastomoses as well as the palpable pliability of the bypass vessels
- Remove the three native epicardial coronary arteries in the usual fashion. Ideally, each bypass graft will be taken off and kept in distal continuity with the native coronary artery it serves. In cases of aortocoronary artery bypass grafts, the proximal end of the graft vessel can be transected just distal to the proximal aortocoronary anastomosis. In cases of IMA grafts the vessel will already be mobilized for removal with the native coronary artery it serves (usually the LAD)

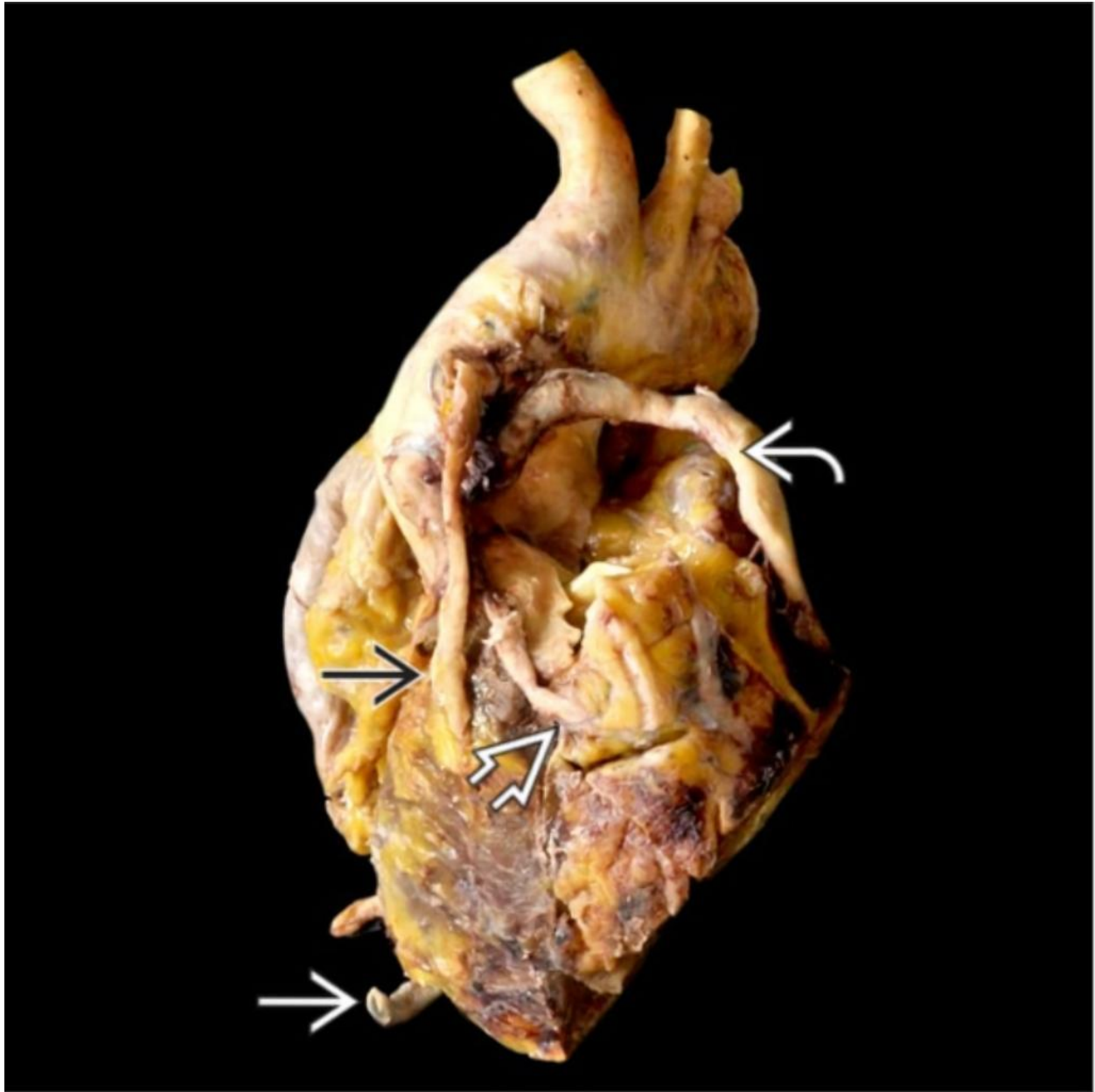


IMAGE: Anterior view of autopsied heart shows aorticoronary saphenous vein grafts to right coronary (thin black arrow), left anterior descending (LAD) (fat white arrow), and obtuse marginal (thin white curved arrow) targets. An additional posterior descending graft (thin white straight arrow) has been cut. (Image credit: Dylan Miller via ExpertPath: <https://app.expertpath.com/document/coronary-artery-bypass-grafting>, accessed 2023)

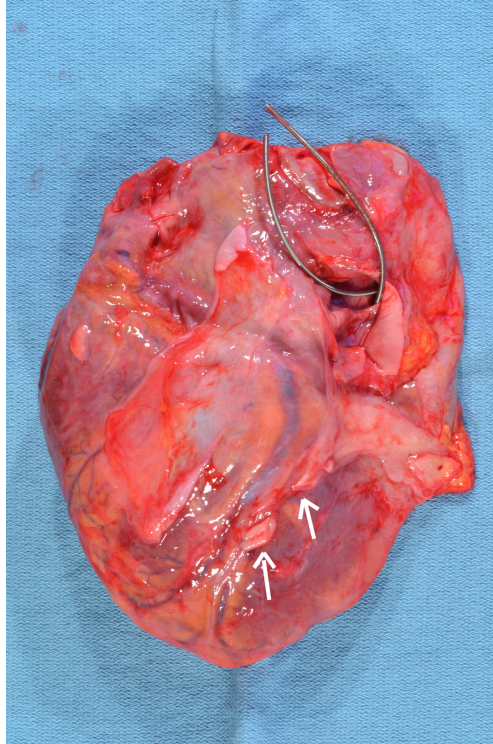


Image: View of CABG heart at autopsy; transected graft vessel present at white arrows. (Image credit: Dr. Meagan Chambers/University of Washington)

- Sections to submit for histology: Fix, decalcify as appropriate, and serially section the native coronary arteries and graft vessels. Submit for histology the most stenotic regions of each native coronary artery and any abnormal areas within each graft vessel. Sections of native coronary artery (e.g., 3 most stenotic sections) and sections of the graft vessel to that vessel (e.g., 3 sections showing pathology, or randomly selected section) can be submitted in one cassette for each artery. One should become familiar with atherosclerosis in native vessels, arterialization of venous graft vessels, and atherosclerosis in graft vessels

[Click here for examples of Gross Descriptions](#)

Quick Tips at Time of Histology Evaluation

- Evaluate sections for plaques, thrombosis, recanalization, etc. Reporting a % stenosis can be done grossly or microscopically

- The internal mammary artery graft has a characteristic multi laminar elastic artery wall with concentric layers of elastic fibers within the media (as visualized on VVG or similar special stain) while other arterial grafts such as the radial artery will have a single internal elastic lamina

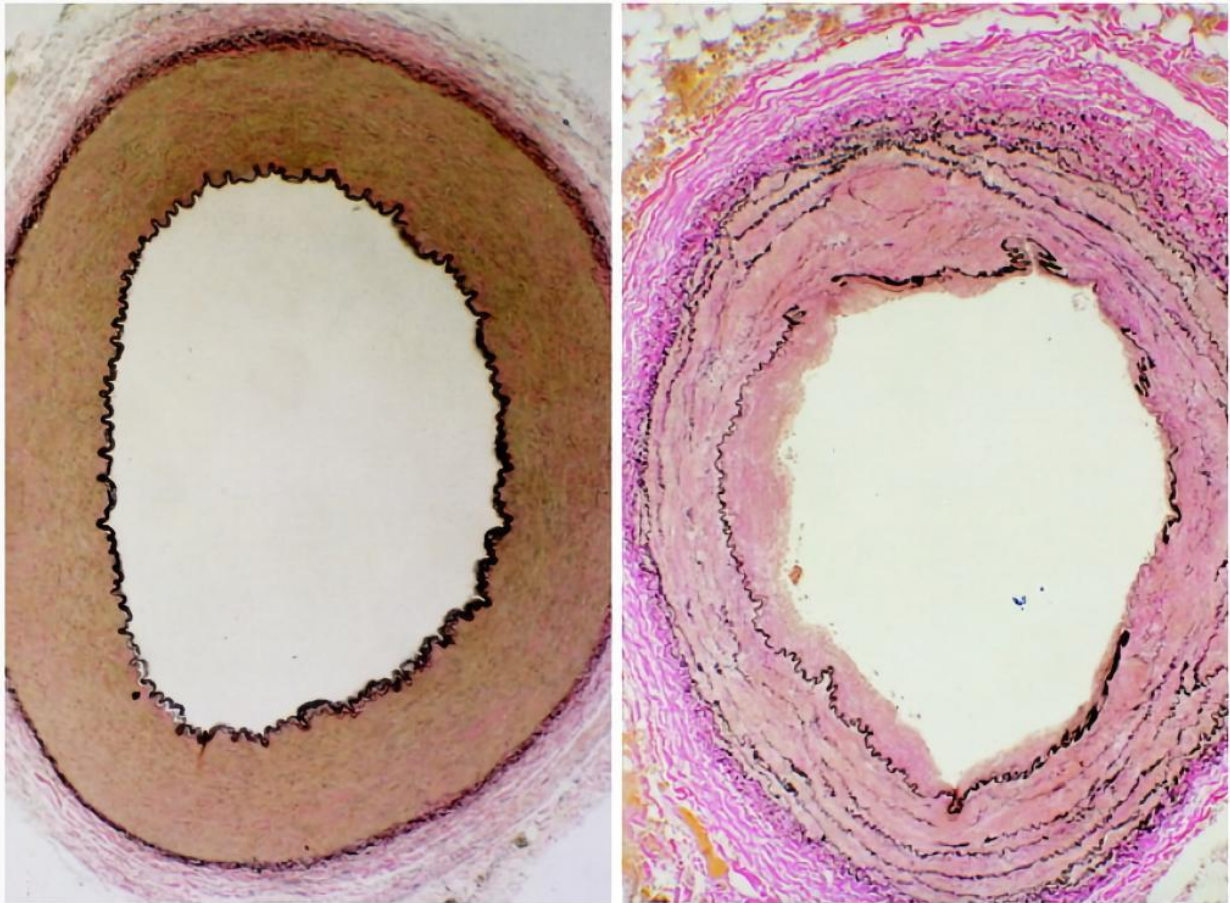


Image: (Left) Radial artery cross section with distinct internal and external elastic lamina. (Right) Internal mammary artery with characteristic multi-layered elastic lamina. (Image credit: modified from Ruengsakulrach 1999)

- Venous grafts have a single elastic lamina and adventitial smooth muscle bundles. Arterialization can cause a distinct internal elastic lamina, intimal fibroplasia, and plaques
- The anastomosis will have a “figure 8” composed of partial lumens from the native and graft vessels. Paired suture holes can be useful landmarks (“snake eyes”)

Quick Tips at Time of Reporting

- The convention for CABG labeling is to hyphenate the target vessel first, then the graft vessel (LAD-D1-LIMA would be a left internal mammary graft to the 1st diagonal branch of the LAD)

[Click here for examples of incorporating CABG findings into the autopsy report](#)

Clinical Tidbits

- 90% of internal mammary artery grafts are patent at 10 years, while only 20-30% of saphenous vein grafts are patent at 10 years
- Early complications include kinking or acute thrombosis (secondary to hypercoagulability). Late complications include fibrointimal proliferation and atheromatous plaques
- CABG has largely been replaced by stenting and other less invasive procedures, but it is still done in cases of multiple heart pathologies requiring open heart surgery (such as valve replacement and coronary artery disease), left main coronary disease (due to higher rates of complications), and multifocal vessel disease

Recommended References

- Miller, Dyllan. Coronary Artery Bypass Grafting. ExpertPath. Accessed 2023. (ExpertPath Login Required)
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Additional Citations:

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