Preoperative CT in Re-operative Sternotomy for Cardiac Surgery: What the Surgeon Wants to Know

Exhibit type: Educational

Authors:
David Grant, D.O.*
Rachael Edwards, M.D.*
Josh Hermsen, M.D.**
Greg Kicska, M.D.*

*University of Washington Medical Center
Seattle, WA
Department of Radiology

**University of Washington Medical Center
Seattle, WA
Department of Cardiothoracic Surgery
Author Disclosures

None.
Learning Objectives / Outcomes

- Review risks associated with re-operative cardiac surgery
- Discuss role of CT in the preoperative assessment of re-operative cardiac surgery
- Identify patients at risk for re-entry complications
Risks of Re-operative Cardiac Surgery

• In a study by Salomon et al, re-operative coronary bypass surgery patients were shown to have:
  • higher operative mortality
  • increased perioperative and long-term mortality
  • decreased relief of cardiac symptoms.

• According to a large review of more than 2000 catastrophic bleeding complications, the most commonly injured structures include:
  • Right ventricle (39%)
  • Saphenous vein graft (20%)
  • Aorta (15%)
  • Internal mammary artery (12%)
  • Brachiocephalic vein (6%)

Risks of Re-operative Cardiac Surgery

- Initial operation: 2% mortality
- Re-operation: 3.7 – 15% mortality

- Increased operative mortality
- Increased perioperative and long term mortality
- Decreased relief of cardiac symptoms
Risks of Re-operative Cardiac Surgery

• CT technique may differ depending upon pre-operative concern:
   Any of the below exams may be ECG gated
   All exams obtained at 0.625mm or thinner allowing for multi-planar and volume rendered reformats
  • Non-contrast chest
    • Anaphylactic contrast allergy
    • Evaluate mediastinal and atherosclerotic calcification
    • Overview of mediastinal anatomy posterior to sternum
  • Venous phase contrast enhanced chest
    • Venous anatomy
    • Overview of mediastinal anatomy posterior to sternum
  • CTA chest
    • Arterial anatomy including coronary arteries, bypass grafts, and internal mammary arteries
    • Overview of mediastinal anatomy posterior to sternum
Risks of Re-operative Cardiac Surgery

- CT may reveal high risk anatomy that alters the surgeon’s approach which may include:
  - Obtain access to groin vessels with cut-down prior to sternotomy
  - Place patient on cardiopulmonary bypass via groin access prior to sternotomy

Aortic cannula in place (green arrow)

Right ventricular outflow patch (blue arrow) which was located immediately deep to the sternum
Role of CT in Preoperative Planning

- Preoperative CT decreases number of vascular injuries upon re-entry sternotomy
  - Assess proximity of major vascular structures to inner table of sternum
    - brachiocephalic vein
    - aorta
    - right ventricle
    - bypass grafts
    - coronary arteries

Measure from inner table of sternum to anterior most aspect of structure of interest (left brachiocephalic vein, above)

Role of CT in Preoperative Planning

- Preoperative CT decreases number of vascular injuries upon re-entry sternotomy
  - Any vascular structure within 10 mm of the inner table of the sternum is considered at high risk for injury
  - Structures within 3 mm inner table of the sternum are considered at high risk for adherence

Role of CT in Preoperative Planning

- Preoperative CT decreases number of vascular injuries upon re-entry sternotomy
  - Any vascular structure within 10 mm of the inner table of the sternum is considered at high risk for injury
  - Structures within 3 mm inner table of the sternum are considered at high risk for adherence

Right coronary artery saphenous vein bypass graft located <10mm deep to bony protuberance from posterior sternum
Role of CT in Preoperative Planning

- Preoperative CT decreases number of vascular injuries upon re-entry sternotomy
  - Any vascular structure within 10 mm of the inner table of the sternum is considered at high risk for injury
  - Structures within 3 mm inner table of the sternum are considered at high risk for adherence

Outflow conduit (red arrow) of left ventricular assist device located < 10mm deep to sternum
Role of CT in Preoperative Planning

- Preoperative CT decreases number of vascular injuries upon re-entry sternotomy
  - Any vascular structure within 10 mm of the inner table of the sternum is considered at high risk for injury
  - Structures within 3 mm inner table of the sternum are considered at high risk for adherence

Conus branch off right coronary artery travelling in fat anterior to the heart
Role of CT in Preoperative Planning

- Preoperative CT decreases number of vascular injuries upon re-entry sternotomy
  - Any vascular structure within 10 mm of the inner table of the sternum is considered at high risk for injury
  - Structures within 3 mm inner table of the sternum are considered at high risk for adherence

Note the large saphenous vein graft aneurysm (white arrow) and LIMA graft (red arrow) which are both positioned a few millimeters of the inner table of the sternum. Also note the patent RIMA graft (green arrow).
Role of CT in Preoperative Planning

- Preoperative CT decreases number of vascular injuries upon re-entry sternotomy

Free wall of the right ventricle located <10 mm from the inner table of sternum adjacent to sternotomy wire
Preoperative Assessment of the Ascending Aorta

- Well established correlation exists between presence of ascending aortic plaque and risk of stroke
  - Qualitative assessment of amount and location of plaque should be performed.
  - Presence of plaque may lead to an off the pump technique or alternate cannulation site
- Aorta should also be assessed for proximity to inner table of sternum and for evidence of aneurysm or dissection

Patient with history of bicuspid aortic valve, post repair, with aortic aneurysm adjacent to sternum

Preoperative Assessment of the Ascending Aorta

- Preoperative CT has been utilized to assess amount of atherosclerosis of the ascending aorta to decrease risk of neurologic events

Patient without atherosclerotic calcification of the aorta

Patient with minimal ascending aortic calcification, located posteriorly

Patient with heavily calcified ascending aorta

3D reformat accentuating calcification
Patency and Location of Bypass Grafts

- Patency and location of bypass grafts (LIMA, RIMA, saphenous vein grafts) has been successfully demonstrated with multidetector CT
  - Patients with a patent left internal mammary graft are typically “graft dependent” and injury can result in a high perioperative myocardial infarction rate (up to 50%)

Note the large saphenous vein graft aneurysm (white arrow) and LIMA graft (red arrow) which are both positioned a few millimeters of the inner table of the sternum. Also note the patent RIMA graft (blue arrow).

Role of CT in Preoperative Planning

- Preoperative CT is beneficial in determining patency of coronary artery bypass grafts

ECG gated CTA demonstrates occluded saphenous vein graft (red arrow) and patent left internal mammary artery bypass graft (green arrow)
Summary of Preoperative Assessment of Vascular Structures and Sternum

Proposed dictation template for pre-operative evaluation:

Re-do sternotomy:

Distances and location description from posterior table of manubrium/sternum:
Left brachiocephalic vein: [ ] mm
Right coronary artery: [ ] mm
Right ventricular wall: [ ] mm
Coronary artery bypass grafts: [ ] mm
Anterior most portion of ascending aorta: [ ] mm
Other: (includes conduits) [ ] mm

Descriptive criteria:
Calcification in the fat anterior to the heart: [none/mild/moderate/severe]
Calcification of ascending aortic calcification: [none/mild/moderate/severe]
Calcification of the RVOT/pulmonary arteries: [none/mild/moderate/severe]
Summary of Preoperative Assessment of Vascular Structures and Sternum

• Close proximity of thoracic vasculature and grafts to the inner table of the sternum increases the risk of injury and catastrophic hemorrhage or intraoperative myocardial infarction

• Key structures which should be identified include:
  • Left Brachiocephalic Vein
  • Ascending aorta
  • Right coronary artery
  • Coronary artery bypass grafts
  • Right atrium or ventricle

• High risk features have been described as proximity of the structure within 10 mm of the inner table of the sternum
  • Location within 3 mm of the sternum has been associated with adherence
References


