Imaging of Complications of Thoracic and Cardiovascular Surgery

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KEYWORDS

• Iatrogenic • Complication • Computed tomography • Surgery • Cardiac • Thoracic • Aorta • Valve

KEY POINTS

- Iatrogenic causes of complications following thoracic and cardiovascular surgery are an important source of potentially preventable patient morbidity and mortality.
- Iatrogenic complications common to cardiothoracic surgery, regardless of technique, include hemorrhage, hemothorax, hemopericardium, retained foreign body, lung injury, and nerve damage.
- Most iatrogenic complications manifest in the early postoperative period; however, diagnosis can be challenging because clinical symptoms are often nonspecific.
- Imaging plays a critical role in the diagnosis of thoracic and cardiovascular complications. Early detection often permits timely management to minimize patient morbidity.

INTRODUCTION

Surgery entails risk and, despite advances in technology and patient care, complications are expected in the course of operative treatment. A complication is generally defined as any untoward event that is not part of the expected surgical procedure or postoperative recovery, potentially leading to increased morbidity or mortality. Iatrogenic complications can be considered those directly related to physician error in surgical technique or clinical judgment. Iatrogenic causes constitute a small but important source of complications, in that they are potentially preventable and potentially treatable if identified in the early postoperative course. Given the prevalence of pulmonary and cardiovascular diseases, thoracic and cardiac surgeries represent some of the most commonly performed procedures in the United States and worldwide; therefore, although severe iatrogenic complications are uncommon, a large number of patients are still affected, leading to unnecessary increased morbidity or mortality.

The diagnosis of iatrogenic complications can be challenging. The spectrum of disease and clinical presentation can be diverse. Furthermore, it is often difficult to distinguish iatrogenic complications from those representing normal variations in surgical outcomes. The type of iatrogenic complications may vary by patient population, surgeon, and surgical operative team. It is important for radiologists to consider the iatrogenic etiology of complications in postoperative imaging evaluation. Radiologists should not use accusatory or inflammatory language in reporting, and should work to cultivate close and trusting relationships with their surgical colleagues. Fostering an environment conducive to the free discussion of

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errors, be they diagnostic or surgical, can facilitate improved patient care. This article reviews iatrogenic complications that can be encountered in thoracic and cardiovascular surgery, with an emphasis on their underlying mechanisms and imaging features.

IATROGENIC COMPLICATIONS

Iatrogenic complications constitute a small percentage of the overall complications associated with thoracic and cardiovascular surgery. Although some complications may be unique to specific technical components of an operation, many are ubiquitous and independent of surgical technique. These consequences tend to encompass the complications for which consent is generally obtained before any interventional procedure (bleeding, infection, and injury to surrounding structures), but may have idiosyncratic clinical manifestations in the chest (**Box 1**). Hemorrhage-related complications, retained foreign body, lung injury, and nerve damage are detailed herein, whereas infection is addressed in later sections as it pertains to specific pulmonary and cardiovascular iatrogenic surgical complications.

Hemorrhage

Hemorrhage following thoracic or cardiovascular surgery is typically iatrogenic, but may also be associated with underlying coagulopathy. Whereas venous bleeding is typically self-limited, arterial hemorrhage can be life-threatening. Fortunately, significant bleeding after thoracic surgery is rare, occurring in fewer than 3% of patients after thoracotomy, and in only approximately 1% following video-assisted thoracoscopic surgery (VATS), with an overall mortality rate from hemorrhage of 0.1%.[1,2] The incidence of postoperative bleeding is slightly higher for cardiovascular surgery, with up to 20% of patients requiring blood transfusion for hemorrhage postoperatively.[3] Reoperation rates for bleeding complications after coronary artery bypass grafting (CABG) and open surgical repair of the thoracic aorta are 2% and 8%, respectively.[4,5]

Postoperative hemorrhage following thoracotomy most often results from inadequate hemostasis of a bronchial artery or chest-wall systemic artery. Hemorrhage after cardiac surgery may be attributable to failed vascular anastomoses (coronary, aortic) or inadvertent injury of regional vessels. The manifestations of postsurgical bleeding are variable. For cardiothoracic procedures, common presentations include mediastinal or chest-wall hematoma, hemothorax, and hemopericardium.

Box 1
General iatrogenic complications in thoracic and cardiovascular surgery

- Hemorrhage
- Hemothorax
- Hemopericardium
- Infection (mediastinitis, empyema)
- Lung herniation
- Nerve damage (phrenic, recurrent laryngeal, lateral thoracic, intercostal)

Hemothorax

Hemothorax is a common postsurgical complication. A small amount of hemorrhage into the pleural space is anticipated during routine surgery, and some components of blood draining from a chest tube is expected. However, sanguineous chest-tube output of greater than 1500 mL in a 24-hour period, or greater than 200 mL/h for 2 to 4 hours, indicates active bleeding and should prompt surgical exploration.[6] Hemothorax most often presents at imaging as a rapidly enlarging pleural collection in the immediate postoperative period, often appreciable on chest radiography (**Fig. 1**). Noncontrast chest computed tomography (CT) depicts the presence of pleural fluid but confirms hemothorax only in some cases, as the appearance of hemothorax at CT is variable.[7,8] Small amounts of blood may appear as minimal areas of high attenuation within pleural fluid, often with the blood products layering dependently with lower attenuating simple fluid above it, resulting in a fluid-fluid or hematocrit level. If bleeding is extensive, hemothorax may present as a large, complex, loculated collection of mixed attenuation. As hemothorax evolves and becomes defibrinated, the collection can be indistinguishable from simple pleural fluid.

Hemopericardium

Hemopericardium is the presence of blood within the pericardial space. It is most commonly attributable to blunt or penetrating thoracic trauma; however, aortic dissection, ruptured aortic aneurysm, and malignancy are also possible causes. Iatrogenic injury represents an important etiologic mechanism, and is most often encountered after cardiovascular surgery or as a complication of central-line placement (**Fig. 2**). Active hemorrhage into the pericardial space is of particular clinical significance because it can rapidly lead to tamponade and circulatory collapse, even with a relatively low total volume of hemorrhage.