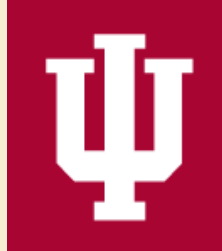


Carotid-Subclavian Bypass for Type 2 Kommerell Diverticulum



INDIANA UNIVERSITY
SCHOOL OF MEDICINE

Baze Conway SAA, Alex Steed CAA, Christopher Mueller MD, Nicholas Staehler MD
Indiana University School of Medicine and Indiana University Health, Indianapolis, Indiana



Indiana University Health

Learning Objectives

- Identify and review the anatomical & physiological characteristics of a Type 2 Kommerell diverticulum.
- Discuss the presentation & associated comorbidities of a Type 2 Kommerell diverticulum
- Explain the anesthetic considerations & perioperative management of a patient with a Type 2 Kommerell diverticulum.

Introduction

In this case, a 58-year-old female patient with a history of Kommerell diverticulum presented for a left carotid-subclavian bypass, which was the first surgery of a two-stage operation. The second operation would involve a right thoracotomy with descending aortic resection and repair of the Kommerell diverticulum.

Perioperative Course

Induction

- After discussion among the anesthesia care team, it was determined that rapid sequence induction with video laryngoscopy was the best course of action due to the patient's elevated risk of aspiration.
- The patient was ramped & positioned in slight reverse Trendelenburg position due to her orthopnea, and preoxygenated for 5 min with 15 L/min O₂.
- Induction drugs:** propofol 150 mg, lidocaine 100 mg, fentanyl 100 mcg, and rocuronium 60 mg.
- Cricoid pressure was applied, and bag mask ventilation was avoided. The patient was successfully intubated with a size 7.0 ETT without difficulty.
- Monitors/Access:** ASA standard monitors. A right radial arterial line was placed after induction. Neuromonitoring for SSEPs in right median nerve only per surgeon's request (left arm was prepped for surgery.) 20g IV in right hand and 18g IV in right forearm.

Maintenance

- General anesthesia was maintained with 0.8 to 1 MAC of sevoflurane throughout the case. The neuromonitoring team requested a consistent level of volatile agent throughout the case, so only small adjustments were made until emergence.
- Neuromuscular blockade was maintained with rocuronium, which was re-dosed intermittently based on TOF monitoring.
- 12,000 units of heparin were given prior to left common & internal carotid artery clamping per the surgeon's request.
- 0.4 mg of hydromorphone was given for pain control just after incision. The case proceeded uneventfully, and the patient's vital signs remained stable throughout the procedure. Mean arterial pressure was maintained within 20% of the patient's baseline throughout the case without the use of any antihypertensives or vasopressors.

Emergence/Postoperative Course

- Heparin was reversed with 100 mg of protamine.
- Despite some observed respiratory effort, zero train-of-four (TOF) or post-tetanic twitches were detected using a peripheral nerve stimulator prior to reversal of neuromuscular blockade.
- 400 mg of sugammadex was administered, and robust spontaneous ventilation was observed. Adequate reversal of neuromuscular blockade was confirmed by 5 seconds of sustained tetany at 50 Hz.
- During closure and emergence, neuromonitoring staff reported a critical decrease in SSEP amplitude in the right median nerve. This was unexpected based on the patient's stable and uneventful perioperative course. No clear cause could be immediately determined.
- Upon emergence the patient was extubated and taken to the CV ICU. A neurology consult was obtained, and a bedside neurological exam was performed once the patient was coherent enough to follow commands.
- The patient's neurological function was found to be unchanged from baseline in all extremities, so it was determined that the observed critical decrease in SSEP amplitude was likely a false reading.

Normal Aortic Arch Anatomy vs. Type 2 Kommerell Diverticulum (1,3)

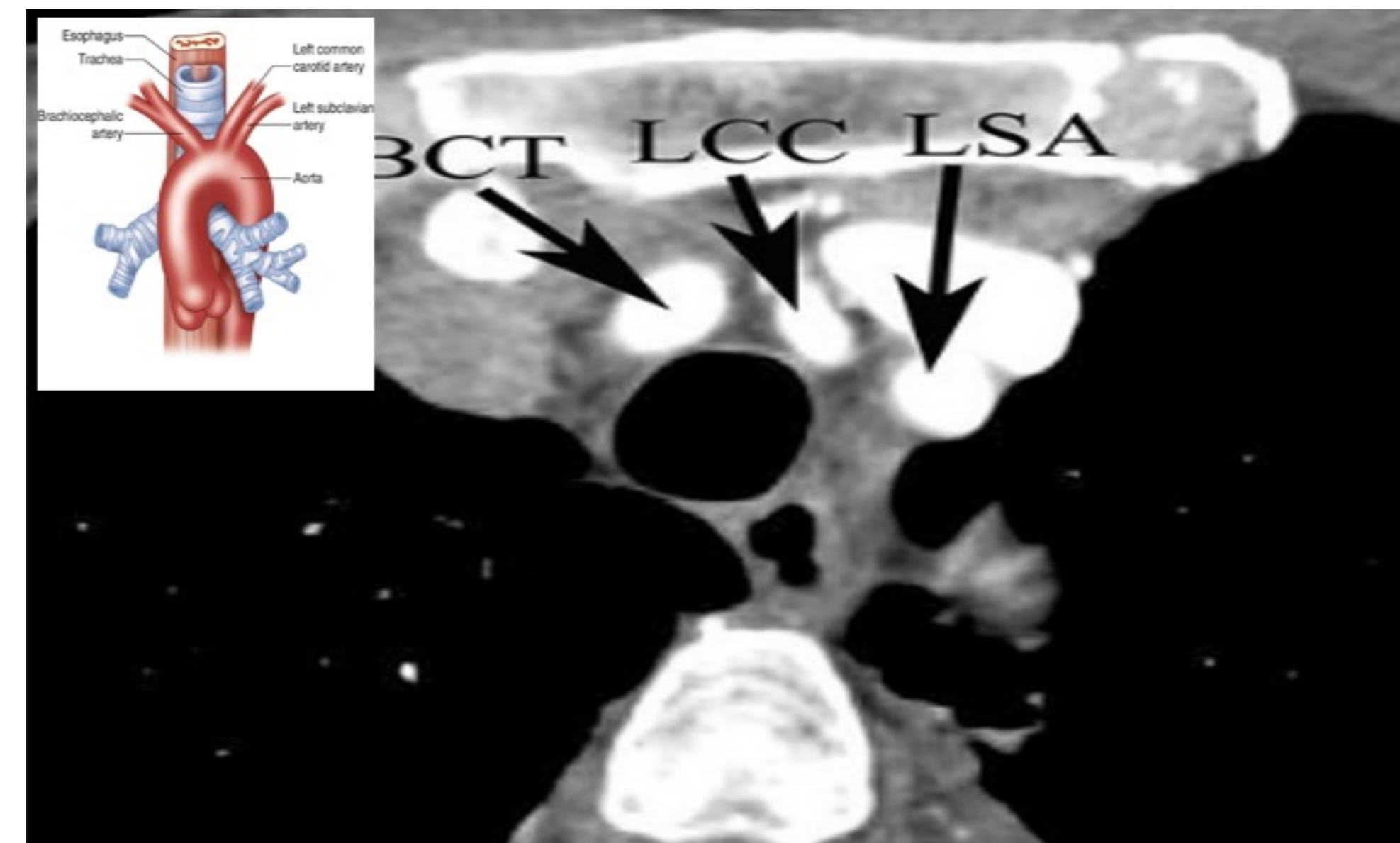


Figure 1: CT imaging of a patient with normal aortic arch anatomy. (1)

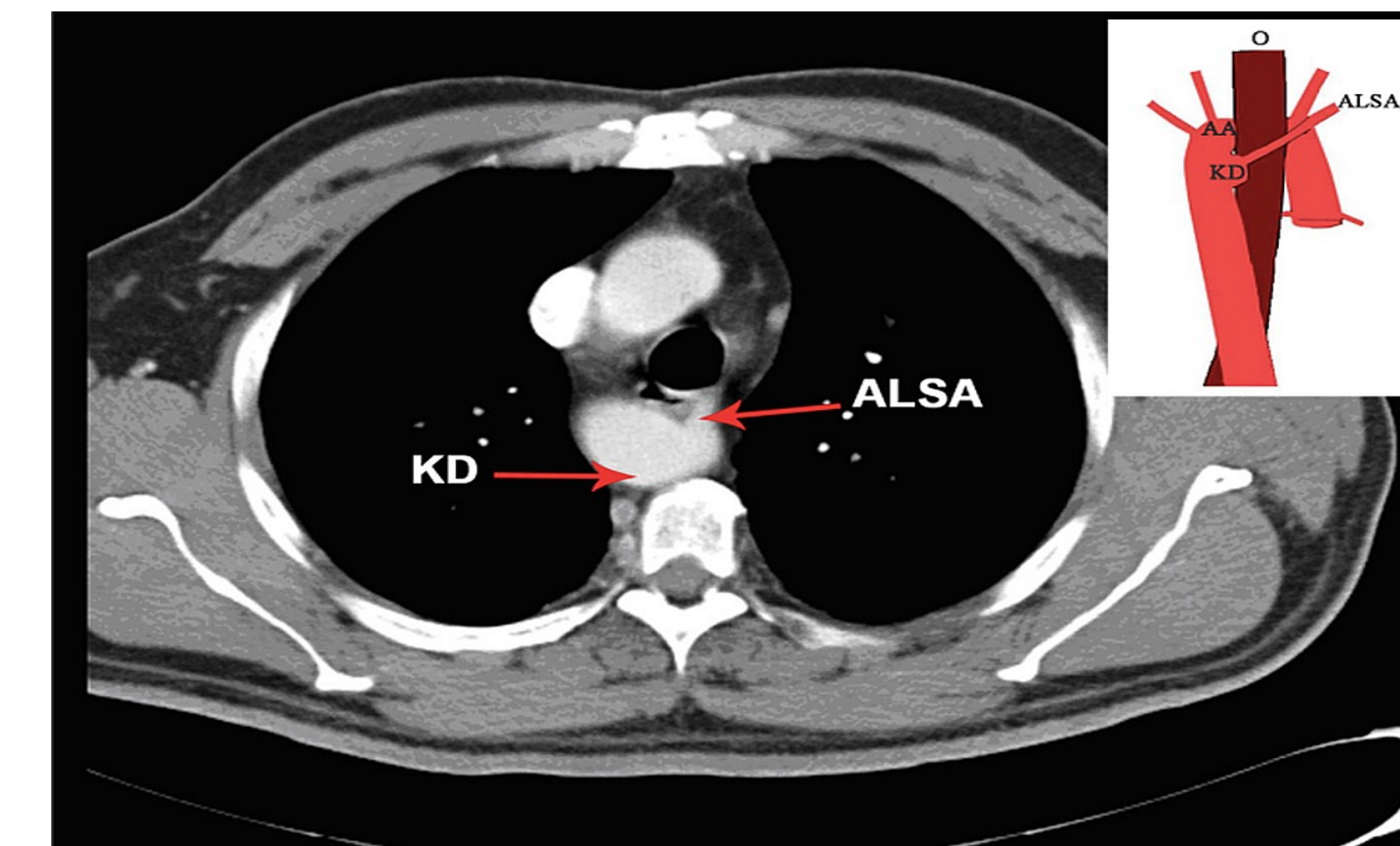


Figure 2: CT imaging of a patient with a Type 2 Kommerell Diverticulum.

Discussion

Type 2 Kommerell Diverticulum: Pathophysiology

- Based on the results of her chest CT, the patient was diagnosed with a Type 2 Kommerell diverticulum—a congenital right-sided aortic arch with a left aberrant subclavian artery (LASA) and aneurysmal dilation at the proximal LASA. This congenital defect is quite rare, with an estimated incidence of about 0.05%. (4)
 - The aberrant subclavian artery often runs posterior to the esophagus, and may also be located between the esophagus and trachea.
 - Patients may be asymptomatic from childhood well into adulthood. However, as the aneurysm grows over time & compresses the esophagus and/or trachea, patients frequently develop symptoms of dysphagia & orthopnea.

- A 2017 retrospective study published in the International Journal of Cardiology assessed the presentation and comorbidities of patients diagnosed with a congenital right aortic arch and left aberrant subclavian artery. This study examined records over an 8 year period at a large tertiary care center to identify patients with LASA. (4)
 - 78% of identified LASA patients had additional congenital heart diseases, with the most common comorbidity being tetralogy of Fallot (27%).
 - 91% of patients identified LASA patients had symptoms of esophageal remodeling and/or compression.
 - Kommerell diverticulum was present in 67% of identified patients with a left aberrant subclavian artery. A similar study published in 1970 with a larger sample size found the incidence of Kommerell diverticulum to be 100% in patients with LASA. (5)

Anesthetic Considerations (2)

- Dysphagia**—the extent/severity of the patient's dysphagia should be determined in the preoperative interview. Rapid sequence induction may be indicated if the patient reports severe dysphagia. Placement and suctioning of an orogastric tube after induction may be utilized to clear any residual food particles in the esophagus and reduce aspiration risk on emergence.
- Orthopnea**—these patients may be unable to lie flat. Consider ramping and/or reverse Trendelenburg positioning during induction and extubation.

Discussion (cont.)

Anesthetic Considerations (cont.) (2)

- Kommerell Diverticulum**—anesthetic management should be approached similarly to a patient with a thoracic aortic aneurysm. Careful perioperative blood pressure management is critical:
 - An arterial line should be placed for close monitoring of blood pressure. Vasopressors and vasodilators should be readily available and prepared/diluted.
 - Establish good communication with the surgical team about blood pressure goals during various parts of the case.
 - Avoid excessive hypertension, as this could lead to aneurysmal rupture or graft rupture postoperatively—ensure that pain control and anesthetic depth are adequate at all times.
 - Hypotension should also be avoided—especially during carotid & subclavian artery clamping—in order to maintain adequate cerebral perfusion pressure.
- Cardiovascular Comorbidities**—although limited research exists on this rare congenital disease, some studies do suggest that patients with Type 2 Kommerell Diverticulum are likely to have additional congenital heart disease (2,3.) A thorough preoperative chart review & patient interview should be conducted to rule out the existence of any concomitant cardiovascular disease, and anesthetic plan should be carefully tailored accordingly.

Preoperative Assessment: H&P

History

- A few months prior to receiving her diagnosis of Type 2 Kommerell Diverticulum, the patient reported a 5-year history of dysphagia, reflux, and orthopnea to her primary care physician. CT imaging showed a previously undiagnosed congenital right-sided aortic arch with an aberrant left subclavian artery, which had a 2.2 cm Kommerell diverticulum at its proximal base.
- Additional past medical history included morbid obesity, hypertension, GERD, and thyroid carcinoma with an uneventful thyroidectomy in Jan. 2022.

Physical Exam & Assessment

- Vitals: Height 154 cm, Weight 127.4 kg, BMI 52.1, HR 59 bpm, BP 139/70.
- CBC, BMP, and EKG were all unremarkable & within normal limits.
- Echocardiogram from Sept. 2022 was otherwise unremarkable.
- Normal heart rate and rhythm, no gallop or murmur. Lungs clear to auscultation bilaterally.
- Airway: Mallampati I, normal teeth, normal mouth opening, thyromental distance > 3 cm, adequate neck range of motion.
- Significant orthopnea—unable to lie any flatter than 45 degrees without significant shortness of breath.
- The patient also reported significant difficulty swallowing, and stated that she would often regurgitate food that was lodged in her esophagus several hours after eating.

References

- Aboulhoda, B. E., Ahmed, R. K., & Awad, A. S. (2019). Clinically-relevant morphometric parameters and anatomical variations of the aortic arch branching pattern. *Surgical and Radiologic Anatomy*, 41(7), 731-744. <https://doi.org/10.1007/s00276-019-02215-w>
- Hines, R. L., & Jones, S. B. (2021). Vascular disease. In *Stoelting's anesthesia and Co-existing disease* (8th ed., pp. 245-272). Elsevier Health Sciences.
- Pandalai, U., Pillay, M., Moorthy, S., Sukumaran, T. T., Ramakrishnan, S., Gopalakrishnan, A., & Gopalakrishna Pillai, A. K. (2021). Anatomical variations of the aortic arch: A computerized tomography-based study. *Cureus*. <https://doi.org/10.7759/cureus.13115>
- Tyczyński, P., Michalowska, I., Wolny, R., Dobrowolski, P., Łazarczyk, H., Rybicka, J., Hoffman, P. (2017). Left aberrant subclavian artery: systematic study in adult patients. *International Journal of Cardiology*, 240, 183-186. <https://doi.org/10.1016/j.ijcard.2017.04.052>
- Yang, C., Shu, C., Li, M., Li, Q., & Kopp, R. (2012). Aberrant subclavian artery pathologies and Kommerell's diverticulum: A review and analysis of published Endovascular/Hybrid treatment options. *Journal of Endovascular Therapy*, 19(3), 373-382.