Case Report

# Anomalous brachiocephalic trunk crossing the trachea: a rare vascular challenge in tracheostomy-case report and surgical considerations

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## ABSTRACT

A 66-year-old woman with a history of breast cancer diagnosed 2 years ago, hypertension, and hypothyroidism developed progressive quadriparesis and autonomic dysfunction, diagnosed as Guillain-Barré syndrome. She required mechanical ventilation due to severe respiratory distress. Tracheostomy was planned for prolonged ventilator support; however, abnormal neck pulsations at the surgical site raised concern for a vascular anomaly. Doppler ultrasonography and computed tomography angiography revealed a high-riding aberrant brachiocephalic trunk (BCT) traversing anterior to the trachea, altering the standard surgical approach. BCT anomalies, though rare, can pose life-threatening risks during neck surgeries. This case underscores the importance of pre-operative imaging when vascular anomalies are suspected. Recognizing such variations is crucial for surgical planning, enhancing patient safety, and guiding modified procedures to reduce complications.

**Key words:** Brachiocephalic artery, High-riding artery, Innominate artery, Tracheostomy, Vascular anomaly

The brachiocephalic trunk (BCT) is described as the largest branch of the arch of the aorta, 4–5 cm in length, and arises from the arch's convexity, posterior to the center of the manubrium sterni [1]. The BCT or innominate artery (IA) is a mediastinal artery that supplies blood to the arm, head, and neck on the right side of the body. Anatomically, it is the first branch of the aortic arch, and soon after it emerges, the brachiocephalic artery divides into the right common carotid artery (RCA) and the right subclavian artery. It ascends posterolateral to the right, at first anterior to the trachea, then on its right. At the level of the right sternoclavicular joint's upper border, it divides into the right common carotid and right subclavian arteries [2-4]. The anatomical course of the BCT varies among individuals, but its typical path places it in close proximity to vital structures, such as the trachea, esophagus, thyroid gland, and major veins [4]. There is significant surgical significance to the Brachiocephalic artery's origin, branching pattern, and path in relation to the thyroid gland and trachea. Abnormality of the Brachiocephalic artery is rare and has high perioperative morbidity chances [5,6].

One of the most significant concerns regarding the BCT is its potential involvement in tracheostomy-related complications [7,8]. When a patient has upper airway obstruction, extended mechanical ventilation, or respiratory distress, tracheostomy is a common surgical operation used to secure the airway. The BCT is usually placed below the level of a typical tracheostomy incision. On the other hand, an abnormal BCT may be found higher in the neck, crossing in front of the trachea. During the procedure, this may result in unintentional artery damage, which could cause catastrophic hemorrhage and threaten the airway [9].

## CASE PRESENTATION

A 66-year-old woman with a medical history that includes breast cancer 2 years ago (currently undergoing immunotherapy), hypertension, and hypothyroidism, presented with progressive neurological symptoms suggestive of Guillain-Barré syndrome (GBS). Her condition rapidly deteriorated, and by the 2nd day, she developed severe respiratory distress, necessitating mechanical ventilation. To enable long-term airway management and weaning off of mechanical ventilation, a tracheostomy was planned, as her ventilator dependence persisted for longer than the expected recovery period.

During the pre-operative assessment for the procedure, an abnormal pulsation was felt in the neck at

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the surgical site. A radiological referral was sought, and a bedside color Doppler revealed an abnormal large artery running across the surgical site. A computed tomography (CT) angiogram was done, which showed that the brachiocephalic artery ascended into the neck, lying anterior to the trachea and dividing into the RCA and the right subclavian artery just below the right lobe of the thyroid gland (Figs. 1 and 2). The anomalous vessel was found to course anterior to the trachea at the inferior part of the thyroid gland, placing it directly in the standard tracheostomy incision zone.

Tracheostomy was planned in the operation theatre. After positioning the patient with neck extension, an intraoperative Doppler ultrasound was used to precisely map the course of the anomalous vessel and surface markings were made to delineate the vessel's trajectory, ensuring its preservation during the procedure. A modified surgical approach was planned in view of the hemorrhagic risk. A horizontal incision was made at a higher level, just above the level of the aberrant artery. Careful hemostasis was maintained during dissection through the layers to avoid unintentional vascular damage. The aberrant vessel was pushed slightly down, and the Bjork cartilage flap technique was used to offer extra protection. To provide a barrier of protection between the high-riding BCT and the tracheostomy site, an inverted U-shaped anterior tracheal cartilage was carefully raised and hinged inferiorly (Bjork flap). The cartilage flap was then sutured to the skin (Fig. 3) [10]. This flap interposition will prevent direct contact between the tracheostomy tube and the abnormal artery. Complete intraoperative hemostasis was confirmed, and the tracheostomy tube was placed.

The patient was constantly watched during the post-operative phase, and the treatment was completed without any complications. There was no sign of bleeding or airway compromise, and the patient remained hemodynamically stable. The ventilatory assistance was gradually reduced over the next few days, and there were no indications of vascular problems or infection at the tracheostomy site.

## DISCUSSION

The Brachiocephalic artery is the first branch of the aortic arch (from right to left). It can be abnormally long, reaching up to the level of the upper trachea. In about 12% of cases, the RCA arises above the level of the sternoclavicular joint. And when the BCT arises higher, it may incline to the left, rising in front of the trachea; hence, there will be complications following tracheostomy [11]. And this anomalous IA crossing the trachea anteriorly below the thyroid gland is extremely rare. The high-riding brachiocephalic artery could be the persistence of a section of the right fourth aortic arch's proximal segment. As a result, the brachiocephalic artery elongates superiorly [12].

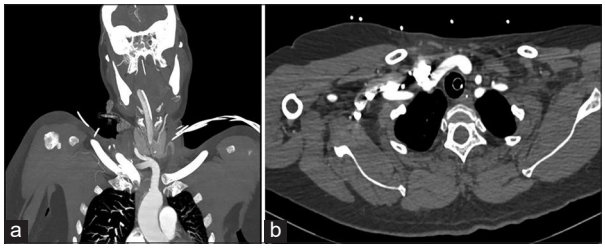


**Figure 1: (a) Computed tomography (CT) angiogram showing coronal view of high-riding brachiocephalic artery; (b) CT angiogram showing axial view of high-riding brachiocephalic artery**

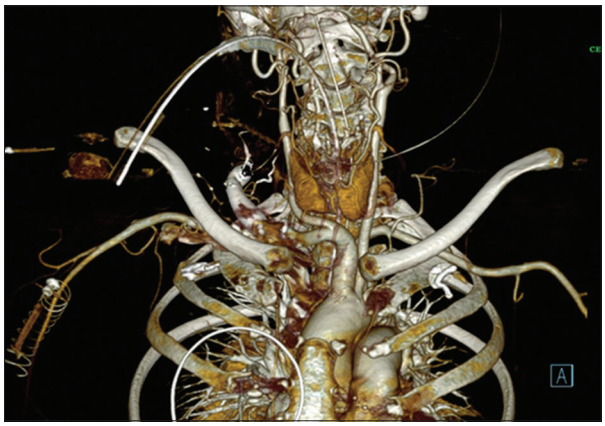


**Figure 2: 3DVRT image showing high-riding brachiocephalic artery**

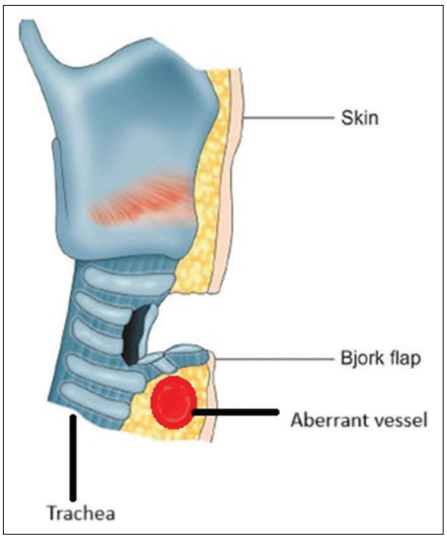


**Figure 3: Bjork cartilage flap technique. **Diagrammatic representation of the Bjork cartilage flap technique aberrant vessel is protected by a cartilage flap**

In our case, the pre-procedural color Doppler followed by CT angiogram helped to prevent potentially life-threatening hemorrhage by detecting the anomaly of the Brachiocephalic artery. Literature has shown that pre-procedural Doppler, along with CT angiogram, is a standard tool for detecting abnormal pulses in the tracheostomy site, and they help to prevent any catastrophic hemorrhage during or post-procedure [7,10,12].

Our case describes the clinical significance of an anomalous BCT and its potential implications during tracheostomy. However, in our case, an anomalous

BCT is present, causing a risk for direct injury during the procedure. Several articles have shown the intraoperative complications arising from unrecognized BCT anomalies [7,8,12-14]. Similarly, a study reported a near-miss case where a high-riding BCT was identified intraoperatively, prompting a surgical modification to avoid vascular injury [7]. Respiratory failure is a life-threatening manifestation of the GBS that occurs in 20–30% of patients with GBS. Delayed tracheostomy in ventilated patients may result in avoidable damage to the vocal cords, laryngeal mucosa, and recurrent laryngeal nerves due to decubitus or local pressure from the endotracheal tube [7,12-14].

Tracheostomy placement is commonly indicated in patients whose condition requires prolonged mechanical ventilation. The standard approach involves an incision at the level of the second or third tracheal ring. In our case, the prior suspicion of the pulsations felt at the site raised immediate suspicion, prompting Doppler ultrasonography followed by CT angiography. This allowed precise localization of the anomalous BCT and facilitated a safer surgical strategy. In our case, to reduce the risk of direct vascular injury, an intraoperative Doppler ultrasound was used to precisely map the course of the anomalous vessel, and surface markings were made to delineate the vessel's trajectory, ensuring its preservation during the procedure. Another study reported a high-riding brachiocephalic artery as a diagnostic dilemma detectable through ultrasound, emphasizing the need for pre-procedural imaging in neck surgeries [15].

Another study described a high-riding IA as a hidden hazard during intensive care unit tracheostomy, which can result in massive hemorrhage if not identified early. Their report emphasizes the need for CT imaging to detect anatomical variations and avoid life-threatening complications during airway procedures [16]. Similarly, a case of tracheo-IA fistula caused by pseudoaneurysm rupture following tracheostomy, highlighting the fatal potential of such anomalies if undiagnosed [17]. In another case series, they demonstrated the use of endovascular stent-grafts to manage acute bleeding from tracheo-IA fistulas, offering a less invasive alternative to open surgical repair in high-risk patients [18]. In addition, several previous cases reported delayed tracheal stenosis from IA compression following decannulation in a post-COVID patient, reinforcing the value of imaging not just pre-operatively but also during follow-up [19]. These studies underscore the need for heightened awareness among surgeons and intensivists about vascular anomalies during tracheostomy. Routine use of Doppler ultrasound and CT angiography in high-risk or atypical cases, along with individualized surgical modifications, such as flap protection, can significantly improve patient outcomes and reduce intraoperative morbidity.

Furthermore, a cartilage flap technique (Bjork flap) was employed to shield the vessel, mitigating the risk of hemorrhage by avoiding direct contact between the tracheostomy tube and the aberrant vessel. To avoid iatrogenic problems, flap techniques have been employed extensively in vascular and airway surgery. Some studies have shown that this surgical approach is successful in mitigating the hemorrhagic chances during the procedure [7,12,14]. To summarize, it's a rare anomaly, pre-operative assessment can guide surgical decision making, and modified surgical techniques, such as cartilage flap protection play an important role in reducing procedural risk and patient safety.

In addition, our case report has several limitations, as it is a case report consisting of a single case; the results and findings cannot be generalized to the population. A larger cohort study is needed to determine the definitive risk factors and management protocols. A comparison with other imaging modalities, such as magnetic resonance angiography, was not carried out. This makes it more difficult to identify vascular irregularities in similar patients using the best pre-operative imaging technique.

This case is reported due to the extreme rarity and potential lethality of an anomalous BCT crossing anterior to the trachea, particularly in a patient requiring tracheostomy. Early recognition through imaging and the application of modified surgical techniques are crucial to prevent life-threatening complications. By documenting our approach, this case aims to enhance awareness among surgeons and intensivists about the importance of vigilant pre-operative assessment and individualized surgical planning in the presence of vascular anomalies.

## CONCLUSION

This case highlights the critical importance of recognizing and managing BCT anomalies during tracheostomy. Pre-operative Doppler and CT angiography helped to identify the high-riding vessel, enabling a modified surgical approach using the Bjork flap to avoid vascular injury. Early imaging and tailored techniques are essential in preventing catastrophic complications in high-risk patients.

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