Abstract: We present a case of a very rare, aberrant brachiocephalic artery, which crosses the trachea in the neck along the lower border of the thyroid gland. If not noticed while performing open or percutaneous dilatational tracheostomy or any neck surgery, trauma to this vessel and subsequent hemorrhage may be fatal. Vascular compression of the airway causing obstructive symptoms can also occur due to this anomaly. In this report, the case is presented and the clinical significance of this anomaly is emphasized.

Key words: Brachiocephalic Trunk, Anomaly, Tracheostomy, Percutaneous Dilatational Tracheostomy, Anomalous Innominate Artery Syndrome

Introduction:

The arterial pattern of the human body is one of the systems that show a large number of variations. Anomalies of great vessels are incidentally found in the anatomy dissection hall, they cause confusion in interpretation of imaging studies; they produce 'tracheomalacia' and bizarre symptoms by pressing on adjacent structures and cause fatal bleeding complications if accidentally injured at surgery. Presented here is a case of anomalous origin and course of the brachiocephalic artery, which is of clinical importance.

Similar abnormalities of brachiocephalic artery have been rarely reported during anatomy dissections. (Sato I and Sato T, 1983). A case like this is of vital significance during tracheostomy, as it can cause catastrophic hemorrhage as an acute complication. (Ayhan et al, 2004; Mukadam and Hoskins, 2002; Jarvis, 1966; Hori et al, 2004 and Muhammad et al, 2000). It can also cause fatal tracheo-innominate artery fistula as a late complication of tracheostomy. (Kapural et al, 1999; Schlaepfer, 1924). Compression of the trachea can cause airway obstruction. (Gross and Neuhauser, 1948; Hui Y et al, 1999; Yalcinbas YK et al, 2006). It can also lead to fatal bleeding complications during neck surgeries. (Ozlugedik S, 2005; Gross and Ware, 1946)

Material & Methods:

During the dissection of the neck region of a human female cadaver of approximately 60 years age, lean build, Gujarati Indian race, in the Anatomy dissection hall of Government Medical College, Surat, Gujarat, an anomaly of the brachiocephalic artery was found. The dissection was carefully done to clean the artery, measurements were done using an electronic digital caliper, digital photographs and X-Ray images were taken. The specimen is preserved in the museum.

Case Report:

In the region of anterior triangle of the neck, after removal of the skin, superficial fascia, deep fascia and the infra hyoid muscles, the brachiocephalic artery was found crossing the front of the trachea horizontally just below the thyroid gland. In the midline this artery was of 2.08 cm diameter. The left brachiocephalic vein was found running obliquely downwards from the left to the right little above the upper border of the manubrium sterni, close to the lower border of the abnormal brachiocephalic artery in the middle and crossing the front of the initial part of this artery behind the left sternoclavicular joint.
Thus the region in between the lower border of the thyroid gland and the superior border of the manubrium sterni was completely occupied by the abnormal brachiocephalic artery and the little higher placed left brachiocephalic vein. The trachea was completely hidden.

The anterior thoracic wall and brachiocephalic veins were removed carefully to expose the arch of aorta and its branches, heart and lungs (see fig. 1 and 2). The origin of the brachiocephalic artery was located 1.5 cm horizontally to the left of the median plane, as the first branch of the arch of aorta. It coursed upwards towards the left for ½ an inch and then turned acutely with angle of 90 degrees, to the right and crossed the trachea horizontally in front, overlying the 5th, 6th and 7th tracheal rings, along the lower border of the thyroid gland. The total length of the artery was 6.3 cm. The artery became more bulbous at its termination, which was located at a point 0.7 cm to the right of the median plane in front of the trachea, 2.0 cm above the upper border of right sternoclavicular joint. Here the artery divided into the right subclavian artery and the right common carotid artery. The thyroid gland’s left lobe was enlarged such that its base reached the 6th tracheal ring, till the upper border of the anomalous brachiocephalic artery. The Arch of aorta began at the level of the upper border of the second sternocostal articulation from predominantly the left side. The summit of the arch was at the level of superior border of manubrium sterni. Radiography showed that cardiomegally was present with the cardiothoracic ratio being 61%. Tracheal lumen transverse diameter was 1.32 cm with no constriction opposite the anomalous artery.

Discussion:
The brachiocephalic artery is described in standard anatomy textbooks like Gray’s Anatomy (38th edition), as the largest branch of the arch of the aorta, 4 to 5 cm in length, and arises from the arch’s convexity, posterior to the center of the manubrium sterni. It ascends posterolaterally 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 forks into right common carotid and right subclavian arteries. The arch of aorta begins at the level of the upper border of the second sternocostal articulation. The summit of the arch is usually about 2.5 cm below the superior sternal border. At the lower part of the neck the two common carotid arteries are separated from each other by a very narrow interval, which contains the trachea. The size of the tracheal lumen ranges from 0.95 cm to 2.20 cm.

Compared to the normal anatomy, in the present case (see Fig. 1 and 2) the origin of the artery is displaced approximately 2.5 cm, in the left, oblique, superior direction and the course is grossly abnormal because it ascended obliquely upward, backward, and to the left of the trachea for the first half inch and then turns acutely to the right, and crosses horizontally in front of the trachea. This acute turn of the brachiocephalic artery has definitely caused hemodynamic disturbance and subsequent cardiomegally. The dangerous course of the artery in front of the trachea has not compressed the trachea or produced tracheomalacia. The Arch of aorta begins at the normal horizontal level, but with a displacement of half an inch to the left side. The summit of the arch of aorta is at the level of superior border of manubrium sterni, one inch displaced higher than the normal. Normally the cervical portions of the common carotids resemble each other so closely that one description will apply to both but in this case the right common carotid artery is grossly displaced as it originates 3 cm above the upper border of the right sternoclavicular joint and curves upwards along the lower border of the right lobe of the thyroid gland.

Development of the brachiocephalic artery takes place during 6 to 8 weeks. The cranial end of the aortic sac becomes drawn out into right and left limbs as the neck lengthens. The right limb becomes the brachiocephalic artery and the left limb forms that part of the definitive arch of aorta, which lies between the,
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brachiocephalic artery and the left common carotid artery. By 3 years of age, growth of the aortic arch causes the innominate artery to move cephalad, to the right, and anteriorly, away from the trachea. In the present case the right limb of the aortic sac may have developed a little to the left of the mid line and to compensate for this abnormal origin the brachiocephalic artery takes an abnormal course.

The anomalies of branches arising from the aortic arch are due to variations in the extent of the fusion process and abnormal absorption of some of the aortic arches into the aortic sac. Aortic arch anomalies have also been associated with chromosome 22q11 deletion. (Momma et al, 1999)

An aberrant innominate artery located high, crossing the 4th and 5th tracheal rings was observed during a cadaveric neck dissection by Ayhan C et al (2004). Sato I et al (1983) also reported a similar finding. Ozlugedik S et al (2005) reported a case of high-running innominate artery that ascended until the third tracheal ring and coursed horizontally anterior to the trachea in a patient with laryngeal carcinoma.

Such anomaly of the brachiocephalic artery is of vital significance during tracheostomy and even more important in percutaneous dilatational tracheostomy (PDT) which has gained wide acceptance due to its relative speed, simplicity, and the ability to perform it at the bedside but the major disadvantage is the increased risk of peri-operative complication of severe bleeding. Muhammad et al (2000) found 4.8% (out of 497 cases) of PDT procedures were abandoned due to bleeding. Mukadam et al (2002) reported a case of a 1.5 cm diameter aberrant brachiocephalic artery overlying the trachea, precluding a PDT and the procedure was abandoned as tracheostomy was felt to be too risky. Jarvis et al (1966) discovered a similar abnormality but a tube was successfully placed in that case. Hori et al (2004) reported a difficult tracheostomy in a case of tortuous, displaced brachiocephalic artery between the sternothyroid muscle and lower pole of the thyroid gland in a 74-year-old female.

Late complications of tracheostomy occur by erosion of the highly located innominate artery in the neck due to pressure from the tracheostomy tube. This is reported to occur in 4.5% cases (Schlaepfer et al, 1924). The majority of these hemorrhages (78%) occurred within the first 3 weeks after tracheostomy (Kapurul et al, 1999). Massive bleeding may be preceded by smaller sentinel bleeds (Utlely et al, 1972). Therefore a thorough neck examination should be followed by ultrasound scan, doppler study, angiography or magnetic resonance scanning whenever a slightest suspicion of anomalous vascular anatomy is felt, so that the rare but potentially severe risk of hemorrhage can be minimized. In the presence of anatomical variations, open tracheostomy is safer than percutaneous dilatational tracheostomy and should be the procedure of choice.

Even in those cases in which the succession of branches of the aortic arch is “normal”, the position of the origin of the innominate artery may assume surgical significance; tracheal pressure may be the result of origin of the artery farther to the left on the aortic arch (Anson B J, Maddock W G; 1959). According to Goldman S A et al (1997) one of the major causes of congenital vascular tracheal compression, is an anomalous innominate artery. Type II tracheomalacia is caused due to extrinsic defects like pressure from an anomalous brachiocephalic artery, which makes the tracheal wall flaccid and reduces the lumen. Gross and Neuhauser (1951) reported four cases of compression by the innominate artery where it was arising further to the left and posterior on the aorta and forming a ‘sling’ around the lower trachea compressing and buckling it. Gross and Neuhauser (1948) offered “aortopexy” or innominate artery suspension to the sternum as a cure for this obstruction.

Conclusion:

This case is a rare anomaly where the brachiocephalic artery lies directly in the line of incision made for tracheostomy or in the path of the guide wire that is inserted in PDT. Knowledge of variations of great vessels is of vital interest to surgeons because even a minor accidental injury of the vessels causes sudden massive hemorrhage, shock and fatalities in the operation theater. ‘Anomalous Innominate Artery’ should be considered in the differential diagnosis of airway obstruction especially in infants. This case and the discussion on it’s clinical significance illustrates the importance to understand and teach the students that text books of anatomy do not convey immutable facts and diversity and variations is an essential part of human anatomy.

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