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Relationship between Trachea, Brachiocephalic trunk and Vagus nerve among fetuses

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ABSTRACT

Respiratory compromise due to tracheal compression by the Brachiocephalic trunk (BT), a condition labeled as Innominate Artery Compression Syndrome, has been attributed to an anomalous origin of this vessel to the left of, and hence crossing, the trachea. The aim of this study was to establish the normal relationship between the BT and trachea in 30 spontaneously aborted human foetuses between 14–35 weeks of gestation. In current study, in all the cases, BT origin was to the left of the trachea, and then crossed trachea from left to right finally dividing further into its branches i.e subclavian artery (SA) and right common carotid artery (RCCA). It was also observed that trachea was crossed over by BT at middle level in 65% fetuses, while in the remaining 35% BT crossed trachea at lower one third level. This finding has clinical significance as during any kind of vascular intervention through vessels of heart, there are more chances of injury to trachea or adjoining structures if it is being crossed over by BT at middle level, rather than at lower one third level. Diameter of RCCA and LCCA was observed to be 1.22 ± 0.88 mm and 1.67 ± 0.83 mm, respectively. Both vagus nerves were found to be lying at distance of 0.76 ± 0.22 mm from the trachea at middle level in 78% of the cases, while in rest of the cases, vagus nerve was found to be lying in close approximation to trachea at the level of middle one third. Thus, more precautions need to be taken during vascular surgeries or tracheostomies in neonates, so as to avoid damage to the vagus nerve

Key words:innominate, fetuses, diameter, trachea, subclavian artery

INTRODUCTION

Isolated variations in anatomy of aortic arch are commonly asymptomatic. However, certain anomalies cause clinically significant symptoms, which commonly arise from pressure effects on trachea or oesophagus. The oppurtunities for endovascular interventions in head and neck and other intracranial territories as well as more complex surgical undertakings in head and neck and upper limb continue to

expand. The importance of anatomical variations observed in course and location of brachiocephalic trunk (BT) and its relationship with trachea, cannot be overestimated as it allows accurate surgical planning and avoid potential complications. Prior knowledge of any kind of variations in branching pattern or dimensions of arch or its branches can help select suitable interventional technique like catheter shape, its diameter etc (1). It can also help in deciding about the route that should be followed, if there is any kind of variation of diameter of aortic arch or its branches or their surrounding structures like vagus nerve etc. The existing literature on variations of BT course, diameter, its relationship with trachea as well as with vagus nerve is quite inadequate. Thus, the aim of this study was to establish the normal relationship between the BT and trachea in fetuses. Current study aims to provide detailed data on dimensions of trachea, its relation with branches of aorta as well as its relation with vagus nerve.

MATERIAL AND METHODS

The material examined consisted of 30 spontaneously aborted human fetuses between 14–35 weeks. The foetuses were fixed in 10% formalin solution and then dissected under a stereoscope at a magnification of 10X. Specimens that had detectable morphological malformations were excluded from the study. In each foetus the dissected aortic arch and its branches were exposed, and their relation with trachea as well as distance of its branches from carina was observed. Diameter of trachea was observed at level of lower border of cricoid cartilaghe, at its middle and at the level of carina. Also, diameter of right and left bronchus and common carotid vessels were observed. Distance between vagus and trachea was observed. Other parameters observed were length of trachea, aortic arch and common carotid artery. All these parameters were recorded with digital vernier caliper. Then, photographs were taken

RESULTS

In all the foetuses, we observed diameter of trachea at level of middle one third, at level of crossing over by either brachiocephalic trunk (BT), or Left common carotid artery (LCCA) or both and at level of carina. It was observed to be 4.87 ± 0.97 mm, 4.67 ± 0.84 mm and 4.69 ± 0.6 mm, respectively. It was observed that tracheal diameter did not vary significantly ($p < 0.05$) at any level with increase in gestational age (Figure 1). We also did not find any significant change ($p > 0.05$) in diameter of trachea at level of crossing over by either BT, or both BT and LCCA. Other parameters observed were diameter of right and left bronchi. Diameter of right and left bronchi was observed to be 2.06 ± 0.43 mm and 1.58 ± 0.46 mm, respectively. Right sided bronchus was observed to be wider as compared to the left sided bronchus.

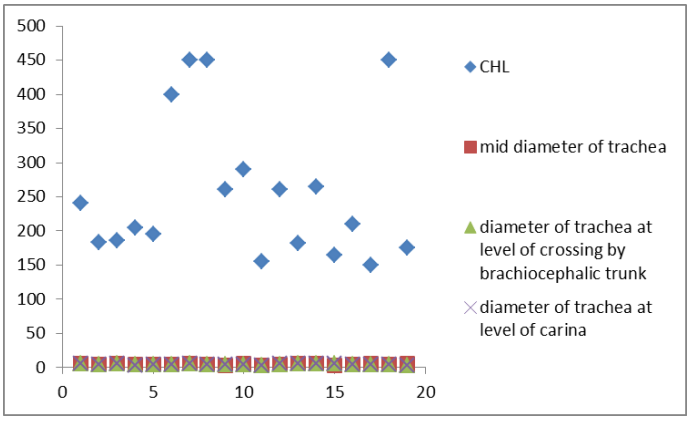

Figure 1 Change in diameter of trachea at middle level, at point of crossing by BT, or LCCA or both and at carina with increasing gestational age in Crown Heel Length (CHL)

BT; Brachiocephalic trunk: LCCA; Left Common Carotid Artery

In current study, in all the cases, BT origin was to the left of the trachea. It was also observed that trachea was crossed over by BT at middle level in 65% fetuses, while in the remaining 35% BT crossed trachea at lower one third level. We further observed diameter of RCCA and LCCA. Diameter of RCCA and LCCA was observed to be 1.22 ± 0.88 mm and 1.67 ± 0.83 mm, respectively. We further observed distance between trachea and right and left vagus nerve, respectively. Both vagus nerves were found to be lying at distance of 0.76 ± 0.22 mm from the trachea at middle level in 78% of the cases, while in rest of the cases, vagus nerve was found to be lying in close approximation to trachea at the level of middle one third. Similarly, RCCA and LCCA were found to be closely associated with vagus nerve in 21% of the cases, while in rest of the cases they were found to be lying at a distance of about 0.56 ± 0.44 mm.

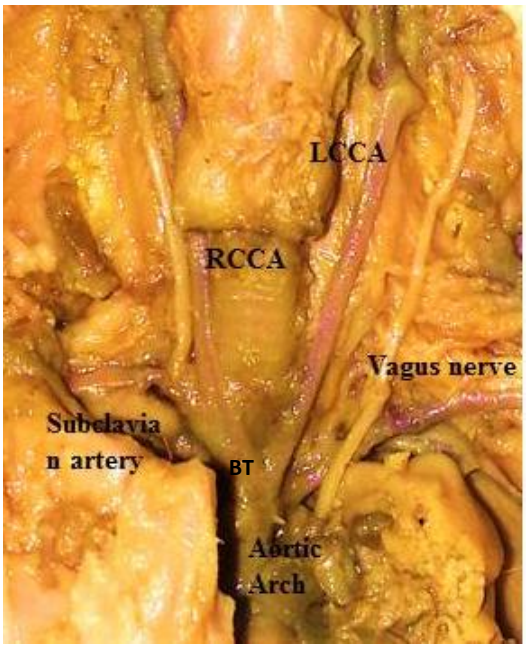

Figure 2 Figure showing relationship between trachea, RCCA, LCCA and vagus nerve and left to right course of BT in relation to trachea

RCCA; Right Common Carotid Artery: For rest of the abbreviations, refer Figure 1

DISCUSSION

Congenital heart disease is an important clinical problem as it remain difficult to treat, usually because of severe co-morbidity like vascular compression of the airway occurring in approximately 1–2% of children with congenital heart disease. It may be caused by congenital anomalies of the great vessels, enlargement of otherwise normal structures or as a result of surgery . One of the major causes of congenital vascular compression is an anomalous innominate artery (2). The aberrant innominate artery originating on the left side and crossing the trachea from the left to the right can cause tracheal indentation and pressure changes in the trachea (3). The syndrome of innominate artery compression of the trachea was first reported in1948 (4). The symptomatic innominate artery syndrome is more likely to arise in cases with a crowded superior mediastinum (5). One of the causes of tracheomalacia is the extrinsic pressure which is caused by aberrant innominate artery. The anatomical patterns seen in children having tracheomalacia may be complex, and as surgical correction is usually required to relieve the compression. Respiratory compromise due to tracheal compression by the BT, a condition labeled as Innominate Artery Compression Syndrome, has been attributed to an anomalous origin of this vessel to the left of, and hence crossing, the trachea. Precise diagnosis and therapy are essential because chronic airway compression in childhood carries a significant morbidity and mortality (6). The aim of this study was to establish the normal relationship between the BT and trachea in fetuses.

In current study, in all the fetuses, BT origin was observed to be lying to the left of the trachea, and then crossing trachea from left to right and then dividing further. Thus, an origin of the BT to the left of the trachea is a normal finding in children and young adults. Other studies also support above finding by stating that a minimal shift in the origin to the left of the trachea is actually normal in children (7). Another study also reported that a large proportion of normal infants have imaging evidence of an anterior impression on the trachea at the level where it is crossed by the innominate artery (6). In another study, an anterior impression on the tracheal air column was seen on lateral chest radiographs in children younger than 2 years of age (7). This finding is less common in older children as there is a tendency for the origin to become progressively more rightward with age (8). In 65% of the cases, BT was seen crossing trachea from left to right at its middle one third level, while in rest of the cases this crossing over took place at level of lower one third of trachea. This finding has clinical significance as during any kind of vascular intervention through vessels of heart, there are more chances of injury to trachea or adjoining structures if it is being crossed over by BT at middle level, rather than at lower one third level. Another important finding is that in the current study, vagus nerve was found to be lying in close approximation to the middle level of trachea in 22% of fetuses, which again implies that more precautions need to be taken during vascular surgeries or tracheostomies in neonates, so as to avoid damage to the vagus nerve, in case it is lying close to the trachea or LCCA or RCCA. A high (cervical) aortic arch may also compress the trachea, but this is extremely rare. However, we did not come across any case with high aortic arch in the current study.

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CONFLICT OF INTEREST:

Authors have no conflict of interest

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