

Embryological aspects and surgical implications on variations of left vertebral artery origin

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Abstract

Background: Anatomic and morphological variations of the vertebral artery are of immense importance in surgery, angiography and all non-invasive procedures. Objective of this study was to elucidate the anatomic variations in origin of vertebral artery and its implications in the field of surgery. **Methods:** The study was undertaken in Anatomy/Gynaecology department of GMC Thrissur Institute/ from January 2015 to December 2015, for a period of one year. The study comprised of around 50 fetuses where the fetal dissection was done by thoracotomy and midline neck incision. Vertebral artery was traced up to its entry in foramen transversarium. Since the arteries were slender, further tracing was found difficult. **Results:** Of the 50 fetuses dissected, one male and one female foetus showed anomalous origin of left vertebral artery from arch of aorta (4% anomalous artery). The vertebral arteries originated between left common carotid and left subclavian artery. The length of each vertebral artery till its entrance to foramen transversarium was 2.5cm. The artery of female foetus entered C4 foramen transversarium and of male foetus to C5 foramen transversarium. **Conclusion:** In conclusion, it is therefore important to be aware of this rare variation in the origin and course of left vertebral artery as it might have serious implications in surgical and angiographic procedures.

Keywords: Vertebral artery, Foetus, Anatomic variations.

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Introduction

Vertebral artery (VA) originating from first part of subclavian artery has intracranial and extracranial parts. It extends throughout neck from its origin possessing four parts [1]. The first part of VA is in scaleno-vertebral triangle, second part in foramen transversarium of cervical vertebra, third part in sub-occipital triangle, fourth part entering cranial cavity through foramen magnum [2]. VA enters the skull through foramen magnum and passes on the ventral surface of medulla oblongata. At the lower border of pons, it joins with its fellow to form basilar artery. When the anterior brain circulation is by carotid system, the posterior brain circulation is by vertebral system which accounts to about 30% of blood supply

of brain [3]. The common carotid artery and vertebral vein lie in front of the vertebral artery. The seventh cervical transverse process, inferior cervical ganglion, and ventral rami of seventh and eighth cervical nerve lie posterior to VA [4]. Anatomical explanations of dissection (rupture of the internal layer of artery causing weakness of the arterial wall with the subsequent aneurysmal dilation or rupture) of left VA originating from aorta may be due to defects in arterial wall and changes in the hemodynamics. Vertebral artery arising from subclavian artery may have anomalous origin from arch of aorta. The branches of arch of aorta develop during 5th-6th week of gestation. By 8th week transformation of adult arterial system occur. This happens by degeneration, hypertrophy or by anastomoses of arteries [5]. The complexity in embryonal development accounts for anomalies. Embryologic variations of the aortic arch is also related to the pathophysiology of the aortic dissection [6]. Anomalous origin of the VA accounts for changes in

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cerebral hemodynamics and the stress may be more in the artery taking its origin from arch of aorta due to direct arterial pulsatile flow. Abnormal vascular courses can cause radicular pain due to their contact with nearby neural structures [7]. In 1960s, the development of angiography enabled to detect the normal vascular anatomy and its variations. CT and MRI which developed later provided detailed information on vascular variations which also included VA variations and related pathologies [7]. Significance of vertebral artery in four vessel angiography and diagnostic interventions points to the importance of its anatomic variations. In view of this, the objective of this study was to elucidate the anatomic variations in origin of vertebral artery. Anomalies of arch of aorta are also associated with chromosomal anomalies like chromosome 22q 11 deletion [8]. Vascular endothelial growth factor-A164/165 and placental growth factor are also associated with development of blood vessel.

Materials and Methods

The study was undertaken in Anatomy and Gynaecology Department of Government Medical College, Thrissur from the period of January (2015) to December (2015), for a period of one year. The study comprised of around 50 fetuses on which the foetal dissection was done by thoracotomy and midline neck incision. Vertebral artery was traced up to its entry in foramen transversarium. Since the arteries were slender, further tracing was found difficult.

Results

Table 1 to 3 showed Gender, Weight and Age profile of the total study population. Out of study, 50 populations are 24 male and 26 are female showing 48% male and 52% female percentages. In weight profile comparison Mean weight of male were 1159 g and female 1062.5 g. In age profile comparison, mean age were of male 32.45 week and female 30.43 week.

Table 1: Gender profile of the study population

SN	Gender	n	%
1	Male	24	48
2	Female	26	52
Total		50	100

Table 2: Weight profile (g) of the study population

SN	Gender	n	Total weight (g)	Mean weight (g)
1	Male	11/24	12750	1159
2	Female	16/26	17000	1062.5
Total		27	29750	2221.5

Table 3: Age profile (weeks) of the study population

SN	Gender	n	Total age (week)	Mean age (week)
1	Male	11/24	357	32.45
2	Female	16/26	487	30.43
Total		27	844	62.88

Of the 50 fetuses dissected, two fetuses (Figure 1) showed anomalous origin of left vertebral artery from arch of aorta (4% anomalous artery). The vertebral arteries originated between left common carotid and left subclavian artery. The length of each vertebral artery till its entrance to foramen was 2.5cm. The artery of female foetus entered C4 foramen transversarium and of male foetus to C5 foramen transversarium.



Fig 1: Showing the origin of left vertebral artery from aortic arch

Discussion

Literature shows the frequency of origin of the left vertebral artery from aortic arch in the range of about 1%-3%. Komiyama et al (2001) reported the incidence of arterial dissection of the vertebral artery of aortic origin and vertebral artery of subclavian origin. The vascular sources pertaining to variability in origin of left vertebral artery are arch of aorta and subclavian artery and the variability of single left vertebral artery was twice the variability of right vertebral artery [9]. This suggestion favours current study in that the anomalous arteries originated from left side. Further hypothesis suggested by the above study was that variability of single left or right vertebral artery being more frequent than bilateral variability of vertebral artery, three times more for left side. Origin of left vertebral artery from arch of aorta suggest that part of aortic arch arises from 7th cervical intersegmental artery or there is increased absorption of embryonic tissue of left subclavian artery at its origin from aortic arch. According to studies by Yuan-Min, elaborate data analysis showed that there were more left than right vertebral arteries arising from arch of aorta and more unilateral than bilateral arteries which favour present study [10]. Most left vertebral artery originating from aortic arch proximal to subclavian artery entered foramen transversarium at level of C4 or C5 vertebra [11], which is similar to the finding in this study also. This high level of entry to vertebral foramen may cause stress to the proximal part of the vertebral artery of aortic origin as origin from aorta may cause direct pulsatile flow whereas the origin from subclavian artery may dampen the force of flow. Genetic aspects-22q 11 deletion is reported in anomalous origin of vessels from arch of aorta. Developmental variation of blood vessels may also be linked to growth factors such as vascular endothelial growth factor –A164/165 and placental growth factor [12]. Prior identification of vascular anomalies through diagnostic interventions is necessary for endovascular interventions and radiological purposes especially when using stents for carotid artery, vertebral artery [13]. Anomalous origin of vessels affect hemodynamics predisposing to aneurysm and cerebrovascular accidents including cerebral infarcts. Patients with aberrant origin of vertebral artery were reported with cerebral infarcts, cerebral haemorrhage, ischemic cerebrovascular disease, vertebrobasilar insufficiency [14]. Unanticipated VA injury may result in various symptoms though in some may remain asymptomatic due to good collateral circulation while in some leading to vertebro-basilar ischemia or bleeding [15]. Left

vertebral artery of aortic origin is seen associated with high incidence of arterial dissection. Cervical radiculopathy can develop due to vascular malformations. Vertebral artery loop is one of the causes [16]. Though people with left vertebral artery originating from aorta are asymptomatic, rarely they may present with ataxia during head rotation with its entrance at C4 level (foramen transversarium) [17].

Conclusion

In conclusion, it is therefore important to be aware of this rare variation in the origin and course of left vertebral artery as it might have serious implication in surgical and angiographic procedures.

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