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ORIGINAL RESEARCH

AN ANATOMICAL PERSPECTIVE OF LIGAMENTUM ARTERIOSUM AND ITS CLINICAL SIGNIFICANCE

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ABSTRACT

Aim: To measure various dimensions of ligamentum arteriosum as well as observe postnatal anatomical changes of ligamentum arteriosum and discuss clinical significance of it.

Methods: 35 heart specimens were studied in Department of Anatomy of Akash medical college. Different shapes as well as length and width of ligamentum arteriosum was measured. Ligamentum arteriosum, aortic arch and pulmonary trunk were incised and looked for ridges, dimples, calcification and atherosclerotic patch. Histological examination of ligamentum arteriosum was also studied in 2 specimens.

Results: cylindrical shape was observed in all specimens of ligamentum arteriosum. The average length and width was measured as 12.02mm and 3.73mm respectively. Ligamentum arteriosum was found to be obliterated in 7 specimens whereas calcified in 3 specimens. Dimples and atherosclerotic patch was observed in luminal surface of pulmonary trunk and aorta respectively. Ligamentum arteriosum was presented as muscular artery in microscopic examination.

Conclusion: ligamentum arteriosum is clinically important structure. Details about its characteristics and clinical co relations may be helpful to the clinicians.

Key words: Ligamentum arteriosum, Ductus arteriosum, Calcification, Atherosclerosis

INTRODUCTION

Ligamentum arteriosum is fibrous remnant of ductus arteriosus (DA), an important vessel in foetal circulation. It carries the deoxygenated blood from pulmonary artery to descending aorta [1]. Though DA is present between two main elastic arteries histologically it appears as muscular artery [2].

Developmentally DA is derived from distal part of sixth pair of aortic arch arteries [3]. In the early stages of embryo arterial duct present on both right and left sides. Right arterial duct

undergo atrophy around fifth to sixth week and left one persists and forms DA [4]. It directly transfers the blood from pulmonary artery to descending aorta as lungs are not well developed [5].

It starts occluding soon after birth [4]. Physiological or functional closure occurs first due to constriction of smooth muscle cells. This results into loss of blood flow through the duct which causes hypoxia and ultimately atrophy of smooth muscle cells present in tunica media [3]. Lastly the muscular artery(DA) is converted into the band of elastic and fibrous tissue ligamentum arteriosum (LA) [4].

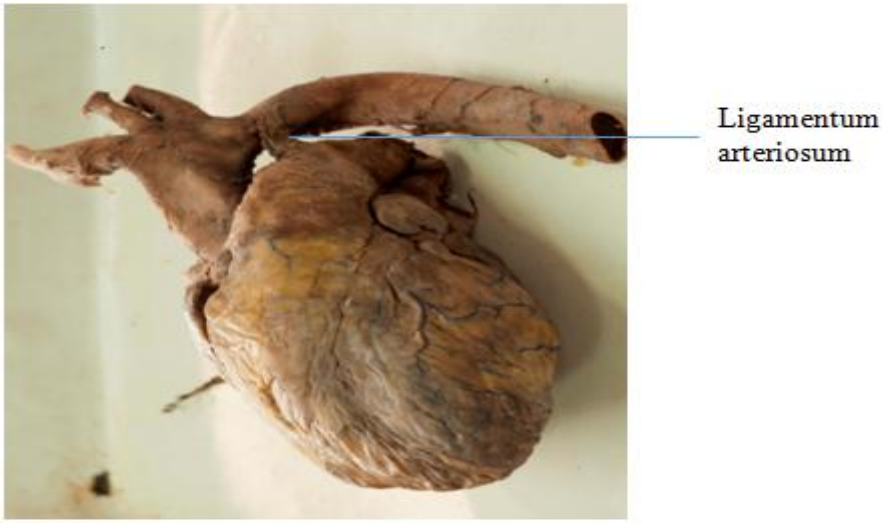
Occasionally closure doesn't occur properly and leads to formation of patent ductus arteriosus (PDA). This persistent patent ductus arteriosus allows blood from aorta to pass into pulmonary artery causing left ventricular overload and decreased lung compliance [3].

Normally DA occludes and forms ligamentum arteriosumwhich extends between pulmonary artery and descending thoracic aorta beyond the origin of left subclavian artery. The area where the LA attaches to descending aorta is called as aortic isthmus [3]. Dimensions of LA like Length and width can differ from person to person[5]. Various shapes of LA like tubular/cylindrical, funnel and conical have been observed [6]. A ridge and dimple was observed in the luminal surface of aorta and pulmonary artery respectively in few studies[1]. In adults changes like calcification, chondrification and fat deposition have been observed in course of LA[6]. Non patent LA remains unseen for a long time after birth and on computed tomography can mimic as thoracic aorta transection[7]. Ligamentum arteriosum calcification (LAC) is a normal finding in children as well as in adults and can be mistaken as pathological mediastinal calcifications on computed tomography [8].Various pathological conditions like atherosclerosis, embolism and aneurysm can develop into the ligamentum arteriosum[5]. Increasing understanding of LA and its correlation with clinical manifestations which can develop into it helps the clinicians for early diagnosis and treatment. The goal of the present study is to revisit the anatomy and clinical significance of LA.

MATERIALS & METHODS

Heart specimens from 35 cadavers were analysed in Akash medical college. These cadavers were once used by medical students and were in the age group of 25-70 years. In each cadaver the heart was looked for any other gross deformity. Ligamentum arteriosum was noted in 12 specimens (figure 1).

Fig 1: Illustration showing ligamentum arteriosum



Heart specimens were visually assessed for the shape of LA and further classified into different shapes like cylindrical or tubular, funnel or conical. Length and width of each LA was measured using digital verniercaliper with error of 0.002mm. The length of LA was measured between its attachment to aorta and pulmonary trunk and at the midpoint of LA width was measured. We cut LA in the middle part and looked for the presence of lumen. The aortic arch and pulmonary trunk were also incised & opened to examine any markings, ridges and atherosclerotic patch. Lumen was suspected in the middle of LA in two cases on macroscopic examination. These two specimens were send for histological examination and slides were stained with Haematoxylin and Eosin stain.

RESULTS

LA was cylindrical in shape in all the specimens. The average length of LA was 12.02mm whereas width was 3.73mm. we observed obliterated LA in 7 (58%) specimens, calcified LA in 3 (25%). Pronounced ridge was not observed on the luminal surface of aorta but an atherosclerotic plaque was seen in one of the specimens in the aorta near the attachment of LA (figure 2).

Fig 2: Illustration showing an atherosclerotic patch on luminal surface of aorta

We noticed dimples on the luminal surface of pulmonary trunk in 2 specimens (figure 3).

Fig 3: Illustration showing dimple on the luminal surface of pulmonary artery

In 2 (17%) specimens very small opening was noted in the middle of LA which was too small to measure. In both specimens LA was closed at aortic and pulmonary ends. LA was presented as muscular artery in microscopic examination. Three layers of artery, tunica intima, media and adventitia along with stellate shaped microscopic lumen was visible. Endothelial layer was not observed and many intimal cushions are observed in the tunica intima. Internal elastic lamina was disrupted. Tunica media was filled with collagen and elastic fibres with few muscle fibres. Chondrification or calcification was not seen in both cases.

DISCUSSION

The mean length and width of LA was measured as 12.02mm and 3.73mm respectively. The data obtained from the present study was compared with other studies by different authors (Table 1).

Table 1: Comparison of Dimensions of Ligamentum Arteriosum with other Studies

Name of study	Length (mm)	Width (mm)
Ghosh A et al	15.89	2.79
Kerri keet et al	14.65	2.86
Dixit et al	15.3	4.4
Bhatnagar et al	15.47	-
Jagger &Wollenet et al	8	3
Present study	12.02	3.73

Length of LA was lower than the studies done by Ghosh et al. [9], Bhatnagar et al. [10], Dixit et al. [5], keet et al. [1] but greater than studies done by Jaggger&Wollen et al. [6] In the present study width of LA was greater than the studies done by Ghosh et al.[9], keet et al. [1] and Jaggger&Wollen et al.[6] but lower than the studies done by Dixit et al.[5] Shape of LA in our study was cylindrical an all the specimens whereas Dixit et al [5] noticed 5 cylindrical and 3 conical type of LA and Jaggger&Wollen et al.[6] observed 2 cylindrical and 3 window type LA. The dissimilarity between the present study and the other studies seem to be related to sample size, different race and geographical differences. As per the literature closure of the LA is not influenced by variation in the length and width of LA[1].

We noticed in two cases dimples were present on the luminal surface of pulmonary artery at the site of attachment of LA. Similar findings were also observed by Bhatnagar et al [10]and keet et al.[1] These dimples may represent a remnant of constricted ostium of DA(ductus arteriosus) into the pulmonary artery.

An atherosclerotic plaque was observed inside the aortic lumen near the site of attachment of LA in one specimen. Charles E &Mauli E et al. [11] in their study demonstrated atherosclerotic involvement of aortic isthmus in 32 of the 40 cadavers. Jagger &Wollmen et al. [6] and Charles E &Mauli E et al. [11] suggested that atherosclerosis preferentially occurs at the aortic end of normally closed DA and these changes are clinically significant. These plaques can give rise to multiple systemic emboli. On the contrary sometimes the recurrent peripheral emboli were observed in patients with normal thoracic aorta without any atherosclerotic changes. In these cases thrombus was arising from LA at the aortic isthmus. It was speculated that derangement of endothelium or remaining ductal tissue at aortic isthmus can lead to development of thrombus [12].

Calcification of LA was reported in the literature. We noticed calcified LA in 3 (25%) specimens. These findings are greater than the keet et al.(16.7%)[1] and Hong et al (11.2%)[13] but lesser than &Wimpfheimer et al. (48%) [14]. Durst – Zivkovic was the first to put forward the calcification of LA. It occurs due to mucinous degeneration of wall of LA [15] and may develop within few months or many years [14]. Ligamentum arteriosum calcification (LAC) is asymptomatic [15] and rarely present clinically however it is found commonly in adults on

chest CT (computerised tomography) scan[14]. LAC has similar appearance to oesophageal perforation induced by foreign body and difficult to differentiate between them on chest CT scan[15].

During the microscopic examination of LA differentiation between tunica intima and media was difficult and a mass of hyaline material and collagen and elastic fibres was observed. Degenerative changes were more pronounced. Smooth muscle cells were sparsely present and observed more towards the external layer of DA. A small slit-like lumen was observed in the centre and was surrounded by many intimal cushions. This microscopic lumen was also observed by Jager and Wollenmen[6] as well as Ho and Anderson [16]. They suggested that the obliteration begins at aortic and pulmonary ends of DA due to which small, microscopic lumen may remain for longer time and not suggestive of any pathology. Sometimes obliteration occurs lately at aortic end of LA and progressive dilation of the duct take place due to constant blood pressure from aorta and results into formation of aneurysm. Reduced intimal cushion formation can also cause weakening of the ductal wall and lead to development of aneurysm of LA [17]. Aneurysm of DA is a rare condition particularly in adults. Fatal complications like burst, embolism, infection and erosion into surrounding structures can occur in aneurysm of LA [18]. Hoarseness of voice (Ortner's syndrome) can occur because of compression of recurrent laryngeal nerve by aneurysm of LA [19]. Other clinical pathologies which may develop into the persistent non patent ligamentum arteriosum are infectiveendarteritis and coarctation of aorta [5]. Yokoyama et al. [20] suggested that the ductal tissue extends into the aorta in the form of rings to develop the coarctation of aorta.

Thus LA in adults remains silent and unseen for a long duration and can form many clinical pathologies [5].

LIMITATION OF THE STUDY

Less number of heart specimens were studied as well as gender differentiation of the sample was not done. These are the limitations of the study.

CONCLUSION

Awareness of the presence of small and silent LA and clinical conditions which can manifest into it can help cardiovascular surgeons, radiologists and paediatricians in differential diagnosis and proper management of patients.

CONFLICT OF INTEREST

None

REFERENCES

1. Keet Kerri, Gunston G, Alexander R. Variation in the Anatomy of the Ligamentum Arteriosum in a South African Sample. Eur. J. Anat. 2018; 22 (2): 119-125
2. Ovali F. Molecular and Mechanical Mechanisms Regulating Ductus Arteriosus Closure in Pre-term Infants. Frontiers in paediatrics. Aug 2020; vol 8: 516
3. Gournay V. The Ductus Arteriosus: Physiology, Regulation, and Functional and Congenital Anomalies. Archives of Cardiovascular Disease 2011; 104: 578—585

4. H Matsui, McCarthy KP, Ho SY. Morphology of the Patent Arterial Duct: Features Relevant to Treatment. Images Paediatric cardiology 2008 Jan – Mar;10(1):27-38
5. Dixit D, Dnyanesh S, Patel M P, Dnyanesh D. K., Shirol V S., Singel T C. Developmental and Functional Correlation of A Persistent Non-Patent Ligamentum Arteriosum in Adult Human Heart Biomirror Jan 2012; vol 3(01): 1-4
6. Jager BV, Wollenman jr O. An Anatomical Study of the Closure of the Ductus Arteriosus. Am J Pathol,1942;18(4): 595 -613.
7. Apostolakis E, Baikoussis N G, Kalogeropoulou C, Koletsis E, Koniari I, Karnabatidis D, Karanikolas M. Remnant of a Non-patent Ductus Arteriosus Mimicking Traumatic Thoracic Aorta Transection: A Case Report. Journal of Cardiothoracic Surgery 2010; 5:24
8. Bisceglia M, Donaldson J S. Calcification of the Ligamentum Arteriosum in Children: A Normal Finding on CT. American Journal of Radiology February 1991;156:351-352,
9. Ghosh A, Chaudhury S. Cadaveric Measurments of the Left Recurrent Laryngeal Nerve, Ligamentum Arteriosum, Aortic Arch and Pulmonary Artery in the Thorax with Clinical Implications and Comparison between Two Sexes in the American Population. Cureus June2019; 11(6). e 4828.
10. Bhatnagar KP, Wagner CE, Austin EH. An Unusually Long Ligamentum Arteriosum. Ann Anat. 1996; 178(5): 467 -470
11. Martin CE, Fisher RD, Page D, Bender Jr. HW. Preferential Atherosclerosis at the Aortic Junction of the Ligamentum Arteriosum: Clinical Significance and Pathological Correlation. Ann of Thorac Surgery Jul1976; Vol 22(1): 66-73
12. Hirata Y, Minoru Ono, TetsuroMorota, Shinichi Takamoto. Recurrent Embolism Caused by Floating Thrombus Originating from the Ligamentum Arteriosum. European Journal of Cardiothoracic Surgery 2003;24: 452–454
13. Hong G S, Goo H W, Song J W. Prevalence of Ligamentum Arteriosum Calcification on Multi - section Spiral CT and Digital Radiography. Int J Cardiovasc Imaging 2012; 28(1): 61 -67.
14. Wimpfheimer, Linda B H, Nogah H. Calcification of the Ligamentum Arteriosum in Adults: CT Features. J Comput Assist Tomogr. 199; 20(1):34-7.
15. Chu X Y, Cui Y, Gao Z. Ligamentum Arteriosum Calcification that Presented as an Esophageal Perforation Caused by Duck Bone Ingestion. Journal of International Medical Research 2020; 48(5): 1-5.
16. HO SY, Anderson RH. Anatomical Closure of the Ductus Arteriosus: a study in 35 specimens. J Anat. 1979; 128(4): 829 -836.
17. GP 2010 Pontone G, Andreini D, Bartorelli AL, Dainese L, Fusari M, Biglioli P. Incidental Detection of a Giant Ductus Arteriosus Aneurysm by low- dose Multidetector Computed Tomography in an Aymptomatic Adult. Journal of Vascular Surgery 2010; 51(5): 1260- 1264.
18. Danza FM, Fusco A, Breda M, Enrico B, Lemmo G, Colavita N. Ductus Arteriosus Aneurysm in an Adult. American Journal of Radiology 1984; 143: 131-133.
19. Goswami A, Das A.A spontaneous partially thrombosed ductal aneurysm presenting with left recurrent laryngeal nerve palsy. Acta Oto- Laryngologica Case Reports 2020; 5(1): 23-37.
20. Yokoyama U, Ichikawa Y, Minamisawa S, Ishikawa Y. pathology and molecular mechanisms of coarctation of the aorta and its association with the ductus arteriosus . Journal of Physiolsci 2017; 67:259-270.