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Research Article

PERSISTENT EUSTACHIAN VALVE IN ADULTS- A CADAVERIC STUDY

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ABSTRACT
The blood flow through the inferior vena cava is guarded by the Eustachian valve. In utero, it directs the oxygenated blood from inferior vena cava across the patent foramen ovale into the systemic circulation. The Eustachian valve (valvula venae cavae inferioris) is a remnant of the embryonic right valve of the sinus venosus. A persistent Eustachian valve can be benign or may be the sites for thrombus formation. 40 hearts were dissected from formalin fixed adult human cadavers and were studied for the presence of persistent Eustachian valve. It was observed that 27 out of 40 specimens of heart showed the presence of a persistent Eustachian valve. The valve showed variations like being either ridge like or membranous or associated with fine network of strands called as the Chiari network. It can be concluded that these interesting networks (Chiari network) are common and not very rare. In Eustachian valve associated with patent foramen ovale great attention should be paid while operating atrial septal defect.

Key Words: *Eustachian Valve, Chiari Network, Sinus Venosus*

INTRODUCTION
Eustachian valve (EV) guards the blood flow through the inferior vena cava (Rosse and Rosse, 1997). In utero, it directs the oxygen rich blood from inferior vena cava to foramen ovale. After the closure of foramen ovale it does not have a specific function. It is usually absent or inconspicuous and has no function in adults (Yavuz *et al.*, 2002). Eustachius in 1563 was first to describe and classify its variations. He found it to be either partly replaced by interlacing fibers or consisted of crescent of tissue or was minute (Powell and Mullaney, 1960). However there is a large variability in size, shape, thickness, length and extent of Eustachian valve (Maddury *et al.*, 2009). A prominent congenital remnant of Eustachian valve was described by Hans Chiari, in 1897, as a network of fine strands, called as Chiari network (Dissmann *et al.*, 2006). Chiari network is found in 1.5- 3% of hearts on routine biopsy (Goedde *et al.*, 1990).Chiari network consists of reticulated network of fibers originating from Eustachian valve connecting to different parts of right atrium (Loukas *et al.*, 2010). It may show attachment to upper part of right atrium, to interatrial septum or to the tubercle of Lower (Dissmann *et al.*, 2006). However, on rare occasions, it may be associated with thrombus formation, infective endocarditis or tumours (Maddury *et al.*, 2009). A persistent Eustachian valve is a frequent finding in patients with patent foramen ovale. In such cases, by directing the blood flow from inferior vena cava to interatrial septum, it may prevent spontaneous closure of foramen ovale (Schuchlenz *et al.*, 2004).

The sinuatrial orifice, is flanked on each side by a valvular fold, the right and left venous valves. Dorsocranially, the valves fuse forming a ridge known as the septum spurium. As the right sinus horn is incorporated into the wall of the atrium, the left venous valve and the septum spurium fuse with the developing interatrial septum (Sadler, 2010).The cranial part of the right sinoatrial valve forms crista terminalis (Moore and Persaud, 2008). The inferior portion develops into the valve of inferior vena cava (Eustachian valve) and the valve of coronary sinus (Thebasian valve). If there is incomplete resorption of right sinus valve, it leads to a persistent Eustachian valve. A reticulated network of fibers, called as the Chiari network, connecting to different parts of right atrium, is the result of incomplete resorption of septum spurium (Loukas *et al.*, 2010).

MATERIALS AND METHODS

40 formalin fixed hearts were studied from adult human cadavers in the Department of Anatomy, Christian Medical College and Hospital, Ludhiana. The right atrium was opened and the interior of it was examined to see the Eustachian valve. The variations in the valve were noted, observations were tabulated and the photographs were taken.

RESULTS AND DISCUSSION

Results

Out of 40 specimens, in 27 specimens Eustachian valve was seen to be present. In 13 hearts it was absent. In these 27 specimens, the size and thickness of Eustachian valve varied. It was either thin crescent like or thick ridge or was seen as a network of fibers (Chiari network) associated with or without EV. Out of 27 cases where it was present, in 11 cases the valve was membranous crescent like. In 10 cases, it was seen to be thick ridge like. In 6 cases Chiari network was seen. Out of the 6 specimens, in one specimen the network of fibers was seen extending from Eustachian valve to fossa ovalis. In three specimens, it extended from Eustachian valve to the coronary sinus opening covering its entire orifice. There was a specimen where Chiari network extended from Thebasian valve to interatrial septum and it passed over the orifice of coronary sinus. An extensive Chiari network was seen in a case where it extended from Thebasian valve till opening of inferior vena cava covering the entire orifice of inferior vena cava.

Figure 1: Chiari network covering the orifice of Inferior vena cava

FO Fossa ovalis
CN Chiari network
CS Coronary sinus
TV Thebasian valve
IVC Inferior vena cava

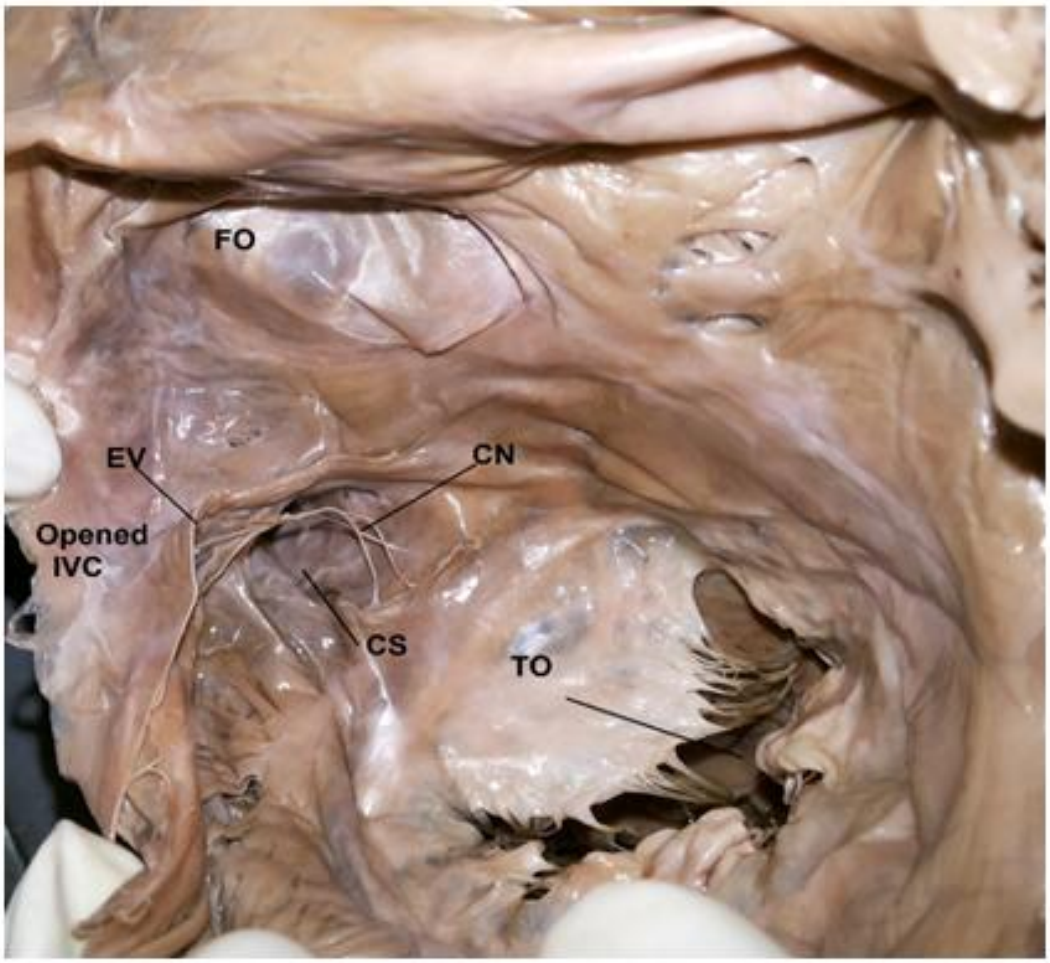

Figure 2: Chiari network extending from EV and covering the orifice of coronary sinus.

FO- Fossa ovalis
CN- Chiari network
TO- Tricuspid orifice
CS- Coronary sinus
IVC- Inferior vena cava
EV- Eustachian valve

Discussion

In majority of adults, Eustachian valve is either inconspicuous or appears as a thin crescentic fold originating at the orifice of IVC.

Maddury *et al.*, (2009) concluded that a persistent EV is mainly a benign entity but can rarely harbor pathology. Infective endocarditis and pulmonary embolism are the major complications of EV pathology (Maddury *et al.*, 2009). A persistent Eustachian valve is a frequent finding in patients with patent foramen ovale (Powell and Mullaney, 1960).

If the Eustachian and Thebasian valve persist as an unduly prominent membrane, it could obstruct tricuspid orifice and divert the inferior vena cava, coronary sinus or even the superior vena cava blood into the left atrium and thus retain its designed role during fetal circulation (Raffa, 1992).

Table 1: Showing comparison of present findings with previous authors

Findings	Name of author	Number of cases	Percentage
Absent EV	Hellerstein *et al.,* (1951)	32/150	21.3
	Powell *et al.,* (1960)	3/100	3
	Present study (2013)	13/40	32.5
Membranous EV	Hellerstein *et al.,* (1951)	38/150	25.4
	Schuchlenz *et al.,* (2004)	174/306	57
	Present study (2013)	11/40	27.5
Ridge like EV	Hellerstein *et al.,* (1951)	71/150	47.3
	Powell *et al.,* (1960)	8/100	8
	Present study (2013)	10/40	25
Chiari network	Hellerstein *et al.,* (1951)	5/150	4.7
	Powell *et al.,* (1960)	24/83	28.9
	Schuchlenz *et al.,* (2004)	2/306	0.65
	Present study (2013)	6/40	15

An absent EV was seen in 32.5% of cases in the present study. Membranous EV was noted in 27.5% of cases which is comparable with the findings of Hellerstein *et al.,* (1951) who also did cadaveric study. A membranous EV was also reported by Raffa *et al.,* (1992), and Yavuz *et al.,* (2002) as a case study. Ridge like EV was observed in 25% of cases. Studies also report that persistent Eustachian valve is a frequent finding with persistent foramen ovale which may prevent its closure and indirectly predispose to paradoxical embolism (Schuchlenz *et al.,* 2004). Previous studies show that central cyanosis was found in children having ASD with the presence of large Eustachian valve and Thebasian valve (Raffa, 1992). Goedde *et al.,* (1990), Cooke *et al.,* (1999) and Dissman *et al.,* (2006) have also reported the presence of Chiari network as a case study. Yater (1936) observed the reticular network may trap thromboemboli originating in the peripheral venous circulation. Goedde *et al.,* (1990) and Ducharme *et al.,* (1997) observed that Chiari network should be considered in the differential diagnosis of right atrial mass in adults. The present study shows the presence of Chiari network in 15% of specimens. The findings of the previous authors in the above study are based mostly on transoesophageal echocardiography. Only a few authors have done the cadaveric study. The literature based on cadaveric study is very less. That is a probable reason for the difference in the findings of present study as compared to previous studies. Because the echocardiography must have been done only on the symptomatic patients whereas the cases

in which EV was absent or in which it was large but benign were missed as they might not have reported to the clinician.

Conclusion

It can be concluded that these interesting networks are common and not very rare. These can be benign or silent. These fibers sometimes get torn during life and may break free (Powell and Mullaney, 1960). They may be the sites for thrombus formation and in addition, very distinct cases of right atrial myxoma or papillary fibroelastoma, originating from EV have also been reported (Yavuz *et al.,* 2002). In Eustachian valve associated with patent foramen ovale great attention should be paid while operating ASD as a large Eustachian valve can be mistaken for the lower margin of ASD. Otherwise in such a case, closure of the ASD into the Eustachian valve may then divert the inferior vena cava blood into left atrium permanently (Ducharme *et al.,* 1997). More research based on cadaveric study needs to be done regarding persistent Eustachian valve.

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