ORIGINAL RESEARCH PAPER

Clinical Anatomy

A STUDY OF FOSSA OVALIS : HOW THE MORPHOMETRY AND LOCATION AFFECTS TRANSSEPTAL APPROACH TO LEFT ATRIUM.

KEY WORDS: Fossa Ovalis (FO), Transseptal (TS) approach, PFO (Patent Foramen Ovale)

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ABSTRACT

Background- Fossa Ovalis (FO) surrounded by limbus are embryological remnants in inter atrial septum of heart. By Trans-septal approach, towards the left heart chambers, floor of FO is punctured to perform various types of diagnostic and therapeutic procedures. Variable position and morphometry of FO remains main challenge. **Materials and Methods–** 30 heart specimens were procured from properly embalmed cadavers. FO was Inspected in interior of the right atrium. Shapes, diameters, position of FO were determined by Vernier callipers. Probe patency test was performed in cases of Patent Foramen Ovale (PFO). **Result-** occurrence of PFO is 23.3% (7 out of 30 hearts). The average transverse diameter of FO was 11.68 mm and average vertical diameter was 13.70 mm. Most of the FOs ware oval with longer vertical diameter. In 26 cases (86.6%) limbus is raised and in 4 it is totally flat with the surface of IAS. In 22 hearts, wall of FO were thinner than rest of inter atrial septum (IAS). In one case Chiari strands are found in the floor of FO. **Conclusion–** Raised limbus of FO prevents slipping of needle while puncturing. Small FO, Chiari strands or multiple cardiac anomalies are unfavourable for TS puncture. To perform Left atrial pressure measurement, and in different cardiac surgeries proper visualization and knowledge of FO is very important.

1. INTRODUCTION

1.1 Embryological Significance

Fossa ovalis (FO) is an oval depression in the interatrial septum (IAS) of heart within the right atrium. Limbus is a rim surrounding the fossa mostly towards its antero-superior aspect. During development the floor of the fossa and the limbus are successively derivatives of septum primum and septum secondum.(1)

1.2 Clinical Significance

In recent years the location and morphometric dimensions of FO are becoming more relevant in the field of interventional cardiology. Through this fossa, atrial septal puncture (Transseptal –TS) is done for cardiac catheterisation to reach left heart compartments. Therapeutic procedures such as balloon mitral valvuloplasty, antegrade balloon aortic valvuloplasty, and ablation of arrhythmias in the Left Atrium (LA) are the common indications for Transseptal approach through fossa ovalis.(2)

During these procedures the main challenge is to locate the fossa ovalis and pass the catheter through it uneventfully. The success of TS approach depends on these.(3) Recently detection of fossa ovalis is done by new radiological procedures like ICE (intracardiac echocardiography) and fluoroscopy.(4) So in this study I am going to inspect 30 cadaveric heart specimens to locate the position of fossa ovalis (FO). Different morphometric parameters are highlighted to understand the clinical importance of FO.

METHOD AND MATERIALS

In current study 30 apparently normal adult hearts irrespective of exact age and sex are collected from the department of Anatomy, Sri Ramkrishna Institute of Medical Sciences and Sanaka Hospital, Durgapur. All of these heart specimens were procured from properly embalmed cadavers. Inspection of interior of the right atrium was done by giving incision along right border of heart i.e. from SVC opening to IVC opening.

Parameters which are observed –

1. Shape (circular or oval) and Size of FO (diameters in mm) with the help of vernier callipers
2. Location of FO and relative thickness of the floor
3. Extent and location of limbus.
4. Probe patency was confirmed (if any).
5. Thickness of FO in comparison with IAS.

Then Right surface of interatrial septum and FO was photographed.

RESULT

Parameters of Fossa Ovalis

1. Shape- Out of the 30 hearts studied 24 (80%) FOs were oval, rest of the 6 (20%) were round.
2. Size - average transverse diameter was found to be 11.68 mm and average vertical diameter was 13.70 mm
3. Location - in the middle of the IAS in 19 cases (63.3%), displaced to the opening of the inferior vena cava in 8 (26.6%) and displaced upward close to superior vena cava only in 3 hearts.
4. Probe patency - occurrence of PFO is 23.3% (7 out of 30 hearts) in which one heart presents with vertical Chiari strands (**figure 1**) in the floor of FO with fenestrated appearance. Probe patency was noted in all cases.
5. Limbus - I found in 26 cases (86.6%) limbus is raised and in 4 it is totally flat with the surface of IAS. In 8 cases (26.6%) margins are raised all over (**figure 2**) and in 15 cases (50%) limbus are prominent antero superiorly.
6. Floor thickness – on palpation it feels in 22 hearts, wall of FO were thinner than rest of IAS. In 6 cases throughout the IAS wall had same thickness and in rest of 2 cases FO floor was thicker than the rest of IAS.

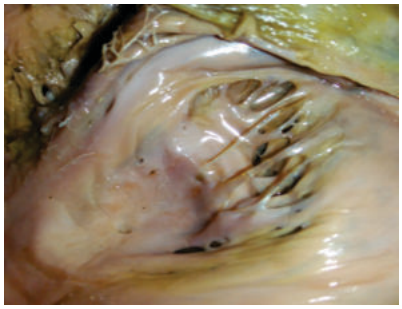

Figure 1: Chiari strands in the floor of FO

Figure2: all over raised Limbus Fossa ovalis

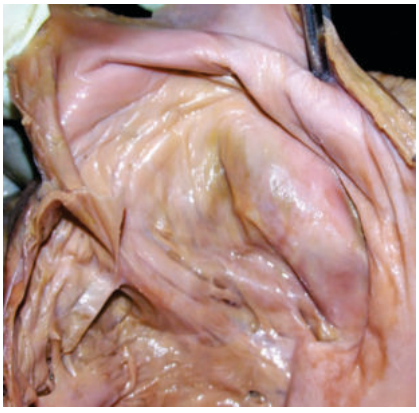

Figure3 : flat limbus

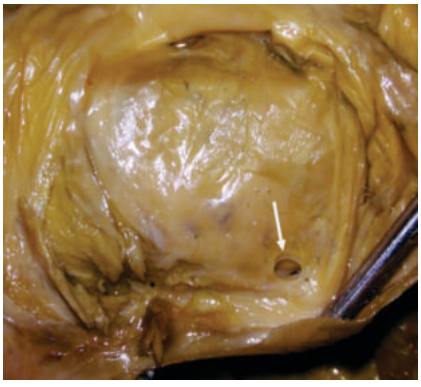

Figure 4 : Patent Foramen Ovale (Probe patency test positive)- white arrow

DISCUSSION

1.Embryology

The IAS formed from septum primum and septum secundum. The two septa maintains an aperture in between till birth - foramen ovale. The foramen allows right-to-left shunt of blood throughout gestation to bypass highly resistant pulmonary circulation.

Though functional closure is early after birth, anatomical closure occurs by the third month by adhesion of the septum primum and septum secundum. In one third cases the foramen remains patent even after birth. Most of these cases of patent foramen ovale (PFO) does not have any anatomical shunt, rather only probe patency test may be positive.[5]

2.Clinical Importance

Fossa ovalis being a landmark in the inter-atrial septum, is clinically important from various aspects.

In various intra cardiac procedures we can put a catheter into various chambers of the heart across the valves. Left atrium is most difficult to catheterise. Neither the pulmonary artery nor the left Ventricle is suitable for catheter access.

That's why presently the preferred method to access the left atrium is transseptal (TS) approach, in which catheter is passed subsequently through Femoral vein, inferior vena cava and the right atrium. Then the interatrial septum is punctured through Fossa Ovalis (FO). This is the prime clinical importance of FO.

Percutaneous puncture of the interatrial septum for left heart catheterization was first reported in 1959 [6,7]. Initially it was used for measurement of LA pressure. [2] Gradually the TS approach gained popularity due to its safety and feasibility [8]. But this process becomes complicated in patients with cardiac anomalies or with small fossa ovalis. The rate of complication is 2% to 6% while performing TS left atrial catheterisation as reported by previous studies. [9,10]. According to Takeshi Hanaoka et al, proper identification of the fossa ovalis would reduce complication rate.[11] So the current study deals with location and various morphological aspects of FO.

In almost two-thirds of patients, the wall of the fossa is so thin, that catheter can be manipulated into the LA with gentle pressure and rotation. It is documented that in 25% cases, the probe Patency test through fossa ovalis becomes positive without any significant physiological shunt. It is known as patent foramen ovale [PFO]. These subjects may not require needle puncture [12,13].After locating the fossa ovalis the probe could be passed through the congenital defect. In the current study, occurrence of PFO is 23.3% (7 out of 30 hearts) whereas it was in 22% cases found by Joshi et al. [14]

According to Kydd et al[15] dimensions of FO were : anteroposterior – 17 mm and superoinferior – 19.4 mm, whereas in the present study, average transverse diameter was found to be 11.68 mm and average vertical diameter was 13.70 mm. In the study by SD Joshi et al. [14] the FO dimensions were: average transverse diameter- 14.53 mm and average vertical diameter- 12.60 mm which are comparable to our findings. Comparison of these 2 studies also reflects racial variation. In this regard T Hanaoka et al [11] have found that the vertical diameter is more important than transverse diameter as during TS approach while puncturing the FO the catheter and needle tends to shift superiorly rather than having sideways movement. In that study out of 19 cases 17 (89%) FO were punctured towards it upper pole while performing TS approach. In this regard another valuable information is- in current study 80% (24) FOs were vertically oval shaped which corroborates with the study by Joshi et al where they found 82 % fosse were oval. [14] So the knowledge of the vertical dimension of FO is of utmost important.

In current study a case was found where multiple strands were present at the fenestrated floor of FO. These are Chiari strands, which are remnants of right venous valve. They are mostly directed in vertical plane. Definitely this was a case of Atrial septal defect (ASD) as well as PFO.[16] These strands are believed to predispose paradoxical embolism [17]. In an Indian study it is found that the occurrence of Chiari strands is – 3.75% that is 3 out of 80 cadaveric heart specimens. [18] In a study of 106 patients with PFO who were operated by KC Chan et al, 10 patients (9. 4%) had either multiple fenestrations in the floor of the fossa ovalis or multiple strands. They have suggested that these defects may not be suitable for TS catheter closure of PFO as it is often not possible to determine the size of the defect accurately before the procedure.[19] Definitely Cardiac catheter could be entrapped by strands of Chiari network [18] making this condition unfavourable for any kind of TS approach.

Intracardiac echocardiography (ICE) had recently evolved as the best procedure to locate FO. Under direct visualization by ICE it is observed that when the pushing force was applied to the needle and catheter after touching the FO wall, the tip slipped cranially to be trapped at the upper edge of the FO,

before finally being inserted into the wall.[11] So of course an raised limbus present superiorly is better than the plain flat surface of limbus. In the study by Joshi et al it is found that 46 out of 50 (92%) of 30 heart specimens have raised margin of FO. Among them limbus is raised throughout the periphery in 11 cases (22%) and in other 22 cases (44%) limbus is raised antero-superiorly. In 13 more cases limbus is prominent superiorly.[14] in the current study I found in 8 cases (26.6%) margins are raised all over and in 15 cases (50%) limbus is prominent antero superiorly. According to K C Chan et al during percutaneous closure of PFO the raised rim of FO is very helpful to complete the process successfully.[19] From this knowledge it could be confirmed that TS approach is safe in most of the patients because most of the time limbus is raised.

In the current study, out of 30 cadaveric heart specimens the FO is located in the middle of the IAS in 19(63.3%), displaced to the opening of the inferior vena cava in 8 (26.6%) and displaced upward close to superior vena cava in 3. Kanani SD et al [21] had found about 57.5% cases (23 out of the 40 hearts) FO occupied the middle of the interatrial wall, displaced to the mouth of the inferior vena cava in 13 (32.5%) cases and displaced towards the mouth of the superior vena cava in 04. Most of the researchers have emphasized proper localization of FO. Graham et al noted that complications like cardiac perforation was mainly due to inadequate localization of the FO particularly if the needle slipped posteriorly, perforation of the posterior right atrial wall or aorta could be dangerous.[21] How the knowledge of location of FO increases the success rate in TS approach that is reflected from a retrospective review of 1279 transseptal catheterizations from a single centre over a 10-year period. They have found a 90% overall success rate with only 1.3% incidence of serious complications by locating FO properly.[22]

CONCLUSION

Most of the FOs is oval shaped - the vertical diameters are larger. Significantly while puncturing FO, the needle tends to slip superiorly making the vertical diameter more important. Position of FO significantly controls successful TS approach.

Raised limbus is favourable in TS approach. Small, fenestrated or stranded FOs, are unfavourable for TS approach.

Intracardiac echocardiography (ICE) is significantly advantageous, as it helps in successful identification of FO, these reduce complications.[23] Proper localization promotes success. So newer indications like pulmonary vein stenosis intervention, antegrade VSD closure, stent implantation in the right internal carotid artery are coming up which has to be done by TS route.[24]

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