The Use of Transoesophageal Echocardiography for Guiding Left Atrial Appendage Occlusion: Impact on Radiation Exposure

Savvas Toumanidis, MD, PhD, Ioannis Matthaios, MD*, Eleftherios Sideris, MD, Spyridon Moulopoulos, MD,PhD

Abstract
The aim of this study was primarily to determine if left atrial appendage (LAA) occlusion guided mainly by transoesophageal echocardiography (TEE) is a feasible and safe method and secondly to quantify radiation exposure during the procedure.

Six consecutive patients who underwent LAA occlusion over a period of 12 months were included. TEE was used as the primary imaging technique and fluoroscopy helped as an imaging adjunct. The mean dose area product (DAP) of all procedures was retrospectively compared with the radiation exposure of other interventional procedures held in the same period, in the same laboratory. Deployment of the devise was successful in all patients and no complications occurred during the procedure. The mean DAP was 35.10 Gy*cm². This value is less than radiation exposure during percutaneous transluminal angioplasty (PTCA) (239 procedures, mean DAP: 67.64 Gy*cm²) and less than primary PTCA (264 procedures, mean DAP: 70.95 Gy*cm²). However, it remains higher than radiation exposure during coronary angiography (492 procedures, mean DAP: 31.50 Gy*cm²), ablation (23 procedures, mean DAP: 31.81Gy*cm²) and permanent pacemaker implantation (84 procedures, mean DAP: 3.41Gy*cm²).

In conclusion, this study highlights the potential safety and efficacy of TEE for guiding LAA occlusion and demonstrates the less radiation exposure that is required, compared with similar complex procedures such as PTCA and primary PTCA.

Keywords — interventional cardiology, left atrial appendage, transcatheter patch, transoesophageal echocardiography, radiation.

Cite this article as: Toumanidis S, Matthaios I, Sideris E, and Moulopoulos S. The use of transoesophageal echocardiography for guiding left atrial appendage occlusion: impact on radiation exposure. JCvD 2014;2(2):45-49.

I. INTRODUCTION
The exposure to ionizing radiation during interventions in a catheterization laboratory (cath lab) has a cumulative effect and is proven to increase the stochastic risk of cancer for both, patient and laboratory staff.¹ The European Society of Cardiology in a very recent position paper, for the first time outlined doses and risks of common cardiology examinations and urged cardiologists to reduce patient radiation exposure.²

However, as the number and complexity of interventions increase, so does the exposure of patients and staff to the harmful effects of ionizing radiation. This is a significant concern and has opened the way for additional imaging methods during interventions in the cath lab in order to reduce exposure to ionizing radiation. Echocardiography is an efficient, easily transportable and well-validated imaging technique, which has been gaining ground in the cath lab in an effort to achieve better outcomes and radiation reduction. Echocardiography is considered a valuable imaging adjunct during structural heart disease interventions such atrial and ventricular septal defects closure but is less used in others, including left atrial appendage (LAA) occlusion.

The rationale of occluding the LAA lies in the fact that it is considered the main site of thrombus formation that causes ischemic strokes in patients suffering from atrial fibrillation (AF).³,⁴ The closure can now be achieved with the use of transcatheter devices under the guidance of fluoroscopy. However data in the international literature about radiation exposure during these procedures are very limited.

The aim of this study was primarily to determine if LAA occlusion guided mainly by transoesophageal echocardiography (TEE) is a feasible and safely method and secondly to quantify radiation exposure during the procedure.

II. METHODS
Study Design
During a 12 months period, 6 consecutive patients, who underwent percutaneous closure of LAA, were retrospectively evaluated for the outcome and the radiation dose used for the procedure. All patients had AF, a CHA²DS²-VASc Score >2 and were contraindicated for long-term anticoagulation. All

Department of Clinical Therapeutics, Medical School, National and Kapodistrian University of Athens, “Alexandra” Hospital, 80 Vas. Sophias Ave, Athens 11528, Greece.
Athenian Institute of Pediatric Cardiology, Athens, Greece;
*Correspondence to Matthaios Ioannis (e-mail):giannismat@gmail.com
procedures were in accordance with institutional guidelines and informed consent was obtained from each patient.

In all cases, LAA occlusion was guided primarily with the use of TEE and fluoroscopy was used as an adjunct. Due to the lack of data on radiation doses in patients undergoing LAA occlusion guided mainly by fluoroscopy, the average radiation dose for all invasive procedures performed over the same period in the same laboratory was recorded for comparison. To evaluate the dose, we used the dose area product (DAP), measured in Gy·cm². DAP is the product of the dose in air in a given plane and the area of the irradiating beam. It is independent of the distance from the X-ray source because the decrease in dose with distance offsets the increase in area. DAP has been used as a quantity for estimating patient skin dose and also establishing the stochastic risk to patients, characterized by the effective dose.6

Intraoperative Equipment

All cardiac procedures were performed in a cath lab equipped with a monoplane Philips Integris CV-9 (Germany) angiographic X-ray unit. This digital cardiac imaging system has an integrated DAP-meter, mounted in the X-ray tube housing.

The procedures were guided with the use of a multiplanar transoesophageal probe (6T - 5 MHz) connected to a Vivid i General Electric (Israel) ultrasound system.

A Transcatheter Patch (TP) (Custom Medical Devices, Greece) was used as the occlusion device (Figure 1). TP is a frameless, balloon-deliverable device used for the occlusion of heart defects. The patches are tailored from polyurethane foam and the supporting balloon is made from Latex, inflated to diameters of 15 to 25 mm by diluted contrast. The TP normally attaches to the cardiac tissue by fibrin formation within 48 hours. It is bio-absorbable and is eliminated from the body within 1 year.7 The newer immediately released model of the TP was used for the above procedures.

Operative Technique

All patients who underwent LAA obliteration had a TEE 24 hours prior to procedure to evaluate the anatomy of the LAA, the size of it’s ostium and to exclude the presence of thrombus. All LAA procedures were performed in the same cath lab and by the same experienced interventional cardiologist. The occlusion was guided by a cardiologist experienced in TEE. All other interventional procedures were performed by 5 different interventional cardiologists.

Sedation was used as needed (iv. midazolam) and probe intubation was done using local anaesthesia with lidocaine 2% spray. When the probe was in place and the interatrial septum could be visualized clearly the procedure could start.

Local anesthesia was used in the right femoral groin and a 11F valved sheath was inserted in the right common femoral vein. Anticoagulation was maintained with iv. heparin with a target activated clotting time at 300-350 s. A guide wire was advanced along the inferior vena cava to the right atrium. The atrial septum was perforated using standard trans-septal puncture techniques (Figure 2i-iii). A multipurpose catheter was advanced in the LAA. A 0.035-inch exchange wire was positioned deeply in the appendage, and a 13-F long Mullins sheath (Cook, Bloomington, Indiana) was advanced to the appendage over the guidewire (Figure 2iv).

Figure 1. The transcatheter patch

Figure 2. TEE 4-chamber view during LAA occlusion.

i) The guidewire (arrow) is in the right atrium (RA). LA = left atrium; RV = Right ventricle; LV = Left ventricle.

ii) The guidewire (arrow) perforates the interatrial septum (IAS). AO=Aorta.

iii) The guidewire (arrow) is in the left atrium (LA). AV = Aortic valve.

iv) A 13F long Mullins sheath (arrow) was advanced to the LAA over the guidewire.

Subsequently the device complex was advanced through the long sheath over the guidewire into the LAA. The balloon was inflated until it stretched the LAA (3 to 10 ml of injectable volume corresponds to patch diameter 14 to 25 mm), (Figure 3i). During all these manipulations the patch position was monitored via TEE. If the occlusion was complete without
leakage, the catheter assembly was retracted through the introducing sheath and the device was released. The position and stability of the patch was confirmed by pulling lightly on the retrieval thread under echocardiography. The interventional cardiologist had no restrictions switching to fluoroscopic guidance at any time during the procedures (Figure 3ii).

After the procedure the patient was observed overnight in the intensive care unit, and an aspirin regimen (100 mg daily) was prescribed for 7 days. Patients were followed-up with a TEE 24 hours after implantation (Figure 4) and primary physician carried out clinical follow-up for at least 1 year. Additional TEEs were obtained in selected cases.

**III. RESULTS**

During a 12 months period 6 consecutive patients underwent LAA occlusion and the mean DAP was 35.1±13.88 Gy*cm². The device was deployed safely in all 6 patients and 24 hours post implantation no procedure complications occurred as confirmed by TEE. Although the interventional cardiologist had the convenience to switch to fluoroscopic guidance at any time during the procedures, this was retained to a minimum.

During the same period and in the same cath lab, 5 interventional cardiologists performed 492 coronary angiograms with mean DAP 31.5±48.54 Gy*cm², 239 percutaneous transluminal angioplasties (PTCA) with mean DAP 67.64±53.22 Gy*cm², 264 primary PTCA with mean DAP 70.95±46.84 Gy*cm², 84 implantations of permanent pacemaker with mean DAP 3.41±4.24 Gy*cm² and 23 ablation procedures with mean DAP 31.81±48.54 Gy*cm². The mean radiation dose for each procedure is shown in figure 5.

**IV. DISCUSSION**

Atrial fibrillation is the most common arrhythmia and also the most common cause of embolic stroke in cases with nonvalvular disease. These strokes are caused by thrombi
formed mainly in the LAA and criteria have been defined for patients who are at high risk for thrombosis. \(^9\) Percutaneous occlusion of the LAA seems a rational method and a possible alternative to longterm anticoagulation and an increasing number of new devices for LAA occlusion, such as the transcatheter patch, have been started to emerge. However these procedures require an extensive expertise and, due to their complexity also require prolonged fluoroscopy. Over the last years, a number of studies involving interventions for structural heart diseases, such as atrial septal defect occlusions, have demonstrated that echocardiography can help as an imaging adjunct to the cath lab and, to some extent, even replace fluoroscopy. These studies are mainly focused on relatively simple structural heart diseases such as atrial septal defects. \(^{10,13}\)

In this study, we try to determine if occlusion of the LAA guided mainly by TEE is feasible and safe and to quantify radiation exposure. Furthermore, we recorded radiation for all other procedures performed in the same cath lab, during the same period to help us extract useful conclusions. Data analysis revealed that during LAA occlusion, mean radiation exposure (mean DAP) was 35.1 Gy*cm\(^2\). This value is less than radiation exposure during PTCA (67.64 Gy*cm\(^2\)) and less than primary PTCA (70.95 Gy*cm\(^2\)). However it remains higher than radiation dose during coronary angiography (31.50 Gy*cm\(^2\)), ablation procedures (31.81 Gy*cm\(^2\)) and the implantation of permanent pacemaker (3.41 Gy*cm\(^2\)). These DAP doses are consistent with the mean doses demonstrated in studies investigating radiation exposure in the cath lab. \(^{14-16}\)

Although it seems that the radiation dose is not low enough, despite the main use of echocardiography, we have to take into account that in most centers this procedure is primarily guided by fluoroscopy and angiography. It is also crucial to consider the complexity of the procedure and the time it requires. It seems more appropriate to compare LAA occlusion with similar complex procedures such as PTCA and primary PTCA and from this point of view it seems that LAA occlusion with TEE guidance is a radiation limiting technique.

Although TEE can be used as the primary imaging modality, procedural safety currently requires at least minimal fluoroscopy. This may also have to do with the fact that most interventional cardiologists still depend on fluoroscopy and find it difficult to rely solely on a different source of imaging. Moreover, it is necessary to emphasize that no contrast agent was administered to the patients during the occlusions. This is of great importance if we consider that a large portion of AF patients are elderly with comorbidities and more vulnerable to contrast induced nephropathy. \(^{17}\)

We believe that qualitative TEE views and easy-to-handle and view devices justify the transcatheter closure of LAA with guidance mainly by TEE. The next rational step seems to be the use of real time three dimensional TEE which may eliminate the need for fluoroscopy. This step is consistent with the ALARA principle (As Low As Reasonably Achievable) for radiation exposure. \(^{18}\) As it is stated in the recent position paper of the European Society of Cardiology, it is necessary to minimize patient dose in order to offset the radiation risk with the benefit of the interventional procedure. \(^2\)

A limitation of this study concerns the lack of data for the dose of radiation exposure during LAA occlusion using other devices and the lack of data regarding radiation exposure with the use of fluoroscopy as the main imaging technique. So we were unable to perform direct comparison to quantify radiation reduction statistically. We demonstrated the doses of other interventional procedures in an effort to make qualitative comparisons.

However it is necessary to point out that there is also a lack of data in the international literature regarding the radiation dose during LAA occlusion, so it was difficult to compare our findings with the results of other researchers.

\section*{V. CONCLUSIONS}

The increasing complexity of procedures performed in the cath lab has increased the need for supplementary imaging techniques to achieve better accuracy, prevent complication and reduce the radiation dose. This study demonstrates the safety and efficacy of TEE for guiding LAA occlusion using the TP and reducing the need for excessive radiation exposure compared with same complex procedures as PTCA and primary PTCA. A prospective study randomizing patients to either the fluoroscopic or the echocardiographic guidance method alone is needed to validate our results.

\section*{References}


