coronary procedures performed by a single operator in our institution and were included in this analysis. Patient and procedure characteristics included in the analysis are shown in Table 1. The dose of radiation received by the operator in Cathlab B was on average 71% lower than that received in Cathlab A. By univariate analysis, the operator radiation dose was significantly associated with the arterial approach used ($p = 0.008$), the performance of angioplasty on at least 1 coronary lesion ($p < 0.0001$), and total x-ray time ($p < 0.0001$), but was not associated with body mass index ($p = 0.14$). By multivariate analysis adjusted for the operator, the cathlab where the procedure took place was independently associated with the operator's radiation dose ($p < 0.0001$), as was the use of the radial approach ($p = 0.0003$). Conversely, angioplasty of at least 1 lesion ($p = 0.20$) and body mass index ($p = 0.20$) were not found to be related to operator radiation exposure. Our study of unselected patients undergoing invasive coronary procedures demonstrates that operator radiation exposure is significantly reduced in cathlabs equipped with the ClarityIQ technology. In view of the deterministic and stochastic risks to which operators are exposed during invasive procedures, these findings should prompt catheterization laboratories to modernize their equipment.

*Laurent Faroux, MD
Thierry Blanpain
Pierre Nazeyrollas, MD, PhD
Sophie Tassan-Mangina, MD
Virginie Heroguelle, MD
Christophe Tourneux
Florian Baudin, MD
Damien Metz, MD, PhD

*Department of Cardiology
Reims University Hospital
Avenue du Général Koenig
51092 Reims cedex
France
E-mail: laurent.faroux88@gmail.com

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RESEARCH CORRESPONDENCE

A Pilot Study for Left Atrial Appendage Occlusion Guided by 3-Dimensional Rotational Angiography Alone

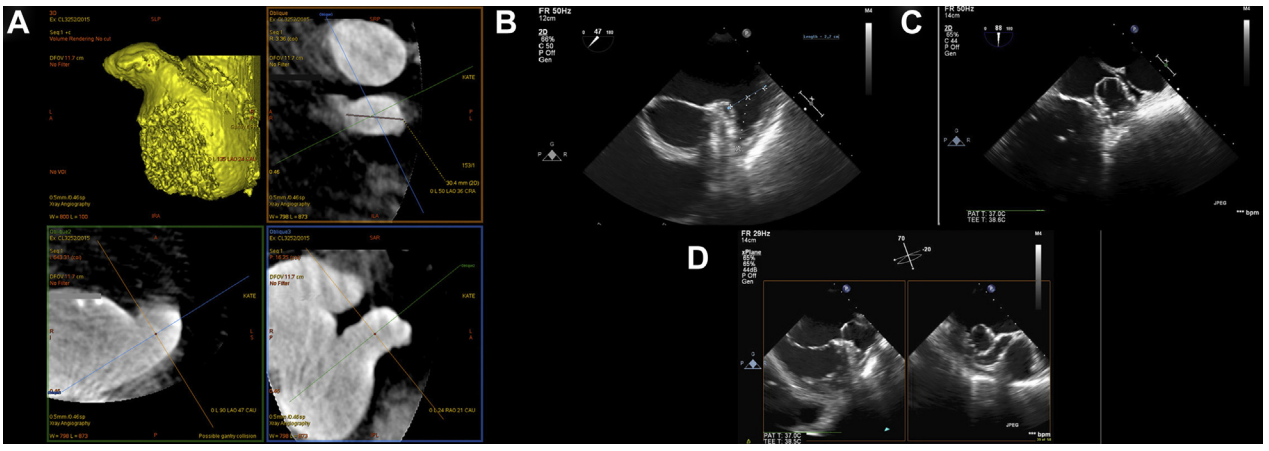
Percutaneous exclusion of the left atrial appendage (LAA) by LAA occlusion is a nonpharmacological alternative for stroke prevention in patients at risk for thrombus formation (1). The procedure is mainly facilitated by 2-dimensional transesophageal echocardiography (TEE) in combination with fluoroscopy, which remains the imaging modality of choice today (2,3). Alternatively, 3-dimensional rotational angiography (3DRA) allows 3-dimensional reconstruction of the LAA volume with high accuracy in real time (4,5). As a pilot study, we prospectively evaluated the use and safety of 3DRA in providing adequate guidance as an alternative to TEE during LAA occlusion, with the operator blinded to TEE.

We designed a workflow where the entire procedure was performed using 3DRA and fluoroscopy alone, with TEE as a safety back-up. LAA thrombus was excluded by the TEE operator at the beginning of the procedure, while keeping the implanting operator blinded. At 4 pre-specified break points (transseptal puncture, size selection, deployment, release) the TEE operator was instructed to unblind the operator if and only if an immediate safety risk for the patient was perceived. A total of 20 procedures were performed in a pilot setting. Out of these, 1 was aborted because of access problems in extreme obesity. In all remaining cases device sizing, deployment, stability, and leak assessment were performed using fluoroscopy and 3DRA alone. In 1 patient, the LAA ostium proved to be too large to be occluded with even the largest size device. This was identified without TEE unblinding, and device release was never attempted.

Retrospective analysis of TEE and 3DRA datasets showed a mean maximum LAA ostial diameter of 21 ± 3 mm with TEE versus 24.3 ± 3.5 mm with 3DRA ($p < 0.05$; $R^2 = 0.64$). In all cases the largest diameter in any particular patient was observed in the 3DRA dataset (systemic bias, TEE underestimating diameter by 3.45 mm compared with 3DRA).

The device was successfully deployed in 19 of 19 attempts, and successfully released in 18 of 19 deployments. As mentioned, in 1 patient device release was never attempted because of complete lack of device compression (and thus device stability) in a

FIGURE 1 **TEE and 3-Dimensional Rotational Angiography Images From the Single Nonimplantable Patient**



There was no stability of the device in the appendage. **(A)** Three-dimensional appendage segmentation. Multiplanar reconstruction at the neck of the appendage. Maximum diameter is 30.5 mm. **(B)** Two-dimensional TEE at 47° plane. Maximum diameter is 27 mm. **(C)** TEE view of device in the left atrial appendage after deployment, showing lack of compression. **(D)** Biplane view of the deployed device in the appendage, showing lack of stability. TEE = transesophageal echocardiography.

very large LAA ostium. Maximum TEE diameter in this patient was 27 mm, suggesting an anatomy suitable for implant. 3DRA dimensions correctly identified the patient as nonimplantable with a maximum diameter of 30.5 mm, as validated by actual device unsheathing and confirmation of inadequate stability (Figure 1). There were no safety issues in any of the procedures. Furthermore, no procedures were unblinded: transseptal puncture, device sizing, device deployment, and device release were successfully and safely executed without the use of TEE in 19 patients (in the patient with lack of compression, device release was aborted without TEE unblinding).

No patients experienced new symptoms at 6 weeks follow-up. TEE at follow-up revealed peri-device flow in 5 patients, with a vena contracta jet width ≤5 mm in all cases. These were considered clinically irrelevant and did not lead to a change in management. No thrombus or device dislodgement was observed.

The current study is limited in sample size and observational in nature. The procedures were all performed by an operator having performed >50 previous LAA occlusion procedures and findings may therefore not translate to a novel operator.

In conclusion, the results show that a workflow without direct TEE feedback may be feasible in specific settings, and that important sizing issues exist using 2-dimensional TEE datasets alone.

*Tom De Potter, MD
Sofia Chatzikyriakou, MD, PhD
Etel Silva, PhD
Guy Van Camp, MD, PhD
Martin Penicka, MD, PhD
*Cardiovascular Center
OLV Hospital
Moorselbaan 164
9300 Aalst
Belgium
E-mail: tom.de.potter@olvz-aalst.be

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