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Cardiac Magnetic Resonance Imaging is a Promising Modality for Left Atrial Appendage Occlusion Planning

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Abstract

The preprocedural imaging before the left atrial appendage closure device is critical for selecting the appropriate device for the appropriate patient. CT scans and TEE have been used in the past for preprocedural imaging. In this report, the authors used cardiac MRI as a pre procedural planning tool in the wake of scarcity of contrast availability.

Cardiac Magnetic Resonance Imaging is a Promising Modality for Left Atrial Appendage Occlusion Planning

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Abstract

The preprocedural imaging before the left atrial appendage closure device is critical for selecting the appropriate device for the appropriate patient. CT scans and TEE have been used in the past for preprocedural imaging. In this report, the authors used cardiac MRI as a pre procedural planning tool in the wake of contrast unavailability.

Left Atrial Appendage Occlusion as a Modern Alternative to Anticoagulation

An ideal paradigm of targeted device-based therapy to replace systemic anticoagulation

to prevent stroke in patients with nonvalvular atrial fibrillation has resulted in immense interest and innovation to cut, clip, chop, close, isolate, occlude and obliterate the enigmatic left atrial appendage (LAA). LAA occlusion (LAAO) has been demonstrated as an alternative to anticoagulation for stroke risk reduction in the setting of non-valvular atrial fibrillation [1]. While real-world data has shown low procedural risks [2], there has been a robust effort to improve the efficacy, efficiency, and safety of LAAO. This has led to an interest in enhanced procedural planning and research into the optimal anti-thrombotic regimen post-implantation.

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A significant contributor to the mystery and complexity of LAAO is the anatomical considerations of the LAA. It is a widely heterogeneous structure with a diverse range of morphologies, sizes, and the potential for multiple lobes [3]. Beyond its heterogeneous nature, the LAA is a thin-walled structure that is prone to perforation and procedural complications.

Variations in Procedural Planning Modalities

Due to the variable anatomy of any given patient's LAA, pre-procedural planning is imperative to select the correct device size and ensure the feasibility and safety of implantation. Initially, device sizing and procedural guidance were conducted with trans-esophageal echocardiography (TEE) [4]. However, TEE during the procedure often requires general anesthesia necessitating overnight observation, and has been shown to undersize the estimated LAA orifice, leading to incorrect device size selection [5]. These pitfalls led to the advent of computed tomography (CT) for procedural planning and device selection [6]. Given its cross-sectional nature, CT appears to provide a better estimation of the diameter of the LAA orifice and the general area, allowing for careful device selection [7]. However, CT also has drawbacks, mainly the need for iodinated contrast, which limits its use in patients with chronic renal disease.

MRI as a Promising Planning Modality Alternative

Dallan et al. describe a unique series utilizing cardiac magnetic resonance imaging (CMR) as a strategy for LAAO procedural planning [8]. The authors should be commended for developing a novel strategy for effective procedural planning in the face of unique circumstances limiting the availability of iodinated contrast and, therefore, the availability of CT. The series is well described, and 100% of patients had successful implantation, demonstrating the technical feasibility of the modality. All patients were discharged the same day following implantation. Notably, there were no immediate procedural complications or adverse events at three months post-implant. The authors appropriately acknowledge the limitations of a small series at a high-volume center with experienced proceduralists. These data suggest that CMR may be an effective alternative to current imaging modalities for LAAO procedural planning with more investigation.

As with any novel series, potential challenges should be anticipated. While CMR has become more available in recent years, many centers worldwide do not have same-day access nor the radiology support required to utilize CMR as a routine, same-day procedural planning modality. CMR is typically considerably more expensive than a CT or TEE, limiting widespread adoption. Further, in 2 cases (20%), LAA size was overestimated, and a smaller device had to be exchanged based on angiography sizing. This is considerably higher than more extensive series utilizing CT [7] and could increase the average number of devices per procedure and cost. While no LAA thrombi were described in this report, and it stands to reason that CMR should be able to evaluate for thrombus effectively, this would need to be further investigated in a more extensive series.

Future Directions

Percutaneous cardiac procedure volumes have exploded in recent years as technical capabilities grow and more devices come to market. The primary goals of any procedure should be safety and efficacy. Efficiency and low cost must also be the aims as healthcare expenditures continue to grow ever higher. As procedures have expanded, so have correlating imaging techniques to enhance planning and meet those essential objectives. In LAAO procedures in particular, the critical information imaging modalities provide is the relevant anatomy of the LAA and how that impacts device selection. Given the excellent structural resolution of CMR and the data demonstrated by Dallan et al., CMR should be a safe and effective option in the future. We would suspect that with more experience, sizing accuracy would approach that of CT, improving the average number of devices needed per case and thereby lowering associated costs.

The cost of CMR may come down over time, and availability should improve. CMR certainly has the advantage of availability for patients with renal disease unable to receive significant contrast loads and can be obtained without general anesthesia. It may be of particular use when a patient with renal disease desires same-day discharge or has an aversion to TEE. The authors highlight CMR's added information over CT,

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such as myocardial fibrosis and structural remodeling. It may be that CMR has enhanced utility in combined procedures, for instance, where an LAAO is performed with an ablation [9].

Beyond strictly procedural planning, CMR may have a use in the overall assessment of the LAA. There have been efforts to define better stroke risk based on imaging of the LAA [10], and CMR would seem to be an unexplored modality in this regard. CMR may also be helpful in post-LAAO follow-up, explicitly looking for device leaks, device thrombus, or evidence of endothelialization [11].

For the immediate future, CT is likely to remain the most utilized modality for LAAO planning. However, with more investigation, CMR should become a viable alternative and another tool for LAAO procedural planning.

References

1. Reddy, V.Y., et al., *5-Year Outcomes After Left Atrial Appendage Closure.* Journal of the American College of Cardiology, 2017.**70** (24): p. 2964-2975.

2. Khalil, F., et al., *Utilization and procedural adverse outcomes associated with Watchman device implantation.* Europace, 2021.**23** (2): p. 247-253.

3. Beigel, R., et al., *The Left Atrial Appendage: Anatomy, Function, and Noninvasive Evaluation.* JACC: Cardiovascular Imaging, 2014. **7** (12): p. 1251-1265.

4. Möbius-Winkler, S., et al., *Percutaneous left atrial appendage closure: Technical aspects and prevention of periprocedural complications with the watchman device.* World J Cardiol, 2015.**7** (2): p. 65-75.

5. Rajwani, A., et al., *CT sizing for left atrial appendage closure is associated with favourable outcomes for procedural safety.*European Heart Journal - Cardiovascular Imaging, 2016. **18** (12): p. 1361-1368.

6. Korsholm, K., et al., *Expert Recommendations on Cardiac Computed Tomography for Planning Transcatheter Left Atrial Appendage Occlusion.* JACC: Cardiovascular Interventions, 2020. **13** (3): p. 277-292.

7. Nadeem, F., et al., *A New WATCHMAN Sizing Algorithm Utilizing Cardiac CTA.* Cardiovascular Revascularization Medicine, 2021.**33** : p. 13-19.

8. Dallan, L.A.P., et al., *Novel Cardiac Magnetic Resonance Imaging-Based Sizing for Left Atrial Appendage Closure.* Journal of Cardiovascular Electrophysiology, 2022.

9. Kuchynka, P., et al., *The Role of Magnetic Resonance Imaging and Cardiac Computed Tomography in the Assessment of Left Atrial Anatomy, Size, and Function.* Biomed Res Int, 2015. **2015** : p. 247865.

10. Yaghi, S., et al., *Left Atrial Appendage Morphology Improves Prediction of Stagnant Flow and Stroke Risk in Atrial Fibrillation.*Circ Arrhythm Electrophysiol, 2020. **13** (2): p. e008074.

11. Hong, S.N., et al., *Cardiac Magnetic Resonance Imaging and the WATCHMAN Device.* Journal of the American College of Cardiology, 2010.**55** (24): p. 2785-2785.