The Role of Cardiac Imaging in Stroke Prevention

Francesco Santoro, MD[a], Luigi Di Biase, MD, PhD[a,b,c,d], Pasquale Santangeli, MD[a,b], Riccardo Ieva, MD[a], J. David Burkhardt, MD[b], Andrea Natale, MD, FACC, FHRS[b,d,e,f,g,h,*]

KEYWORDS

• Stroke prevention • Imaging • Atrial fibrillation • Thrombi • Left atrial appendage closure device • Left ventricular dysfunction • Valve disease

KEY POINTS

- CHADS2 and CHA2DS2-VASc scores are the cornerstone of the management of anticoagulation therapy in patients with atrial fibrillation (AF), but moderate-risk or low-risk patients need a different stratification, in which instance cardiac imaging can be useful.
- Imaging tools available for AF management include transthoracic echocardiography (TTE), which identifies conditions that predispose patients to AF or its progression, and transesophageal echocardiography (TEE), which can detect left atrium or left atrial appendage (LAA) thrombi and their resolution, and evaluate valve disease.
- Cardiac computed tomography and magnetic resonance imaging (MRI) can both add further information about the LAA, such as size and morphology.
- Imaging tools, chiefly TEE, are useful for anatomic screening, device implantation guidance, and follow-up surveillance in LAA closure.
- Left ventricular systolic dysfunction, especially during acute myocardial infarction with segmental wall immobility, but also in chronic disease, could lead to formation of left ventricular thrombus. Early recognition through echocardiographic evaluation (TTE or TEE) or MRI can be useful.
- Potential links have been found between patients with a previous history of stroke/transient ischemic attack and native valve disease (especially with rheumatic mitral valve disease). Echocardiography through TEE or TTE is currently the best tool with which to study and identify valve abnormalities.

INTRODUCTION

Stroke is a global health problem, affecting 15 million individuals worldwide annually, of whom 5 million die and 5 million become permanently disabled.[1] Two recent systematic and comprehensive reviews of a large volume of data showed that the incidence rate of stroke has decreased by

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[a] Department of Cardiology, University of Foggia, viale L Pinto, 1, 71100, Foggia, Italy; [b] Texas Cardiac Arrhythmia Institute, Heart & Vascular Department, St. David's Medical Center, 3000 N. IH 35 Suite 720, 78705, Austin, TX, USA; [c] Division of Cardiology and Montefiore-Einstein Center for Heart and Vascular Care, Montefiore Medical Center, Albert Einstein College of Medicine, 111 East 210th Street, 10467, Bronx, New York, NY, USA; [d] Department of Biomedical Engineering, Cockrell School of Engineering, The University of Texas at Austin, 107 W. Dean Keeton, BME Building, 78712, Austin, TX, USA; [e] EP Services, California Pacific Medical Center, 2100 Webster Street, 94115, San Francisco, CA, USA; [f] Division of Cardiology, Stanford Arrhythmia Service, Stanford University, 300 Pasteur Drive, 94305, Stanford, CA, USA; [g] Division of Cardiovascular Medicine, Case Western Reserve University, University Hospitals of Cleveland, 11100 Euclid Avenue, 44106-5038 Cleveland, OH, USA; [h] Interventional Electrophysiology, Department of Cardiology, Scripps Clinic, 10666 N Torrey Pines Road, 92037, La Jolla, CA, USA

* Corresponding author. North I-35, Suite 720, Austin, TX 78705.

E-mail address: dr.natale@gmail.com

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42% in high-income countries in the past 4 decades, thanks to appropriate prevention, but has increased by more than 100% in low-income and middle-income countries in the same time period.[2,3]

Patients who survive a previous minor stroke or transient ischemic attack (TIA) are at an increased risk of subsequent vascular events and stroke.[4] The rate of recurrent stroke after the initial one is estimated at 3% to 10% in 30 days, 5% to 14% in 1 year, and 20% to 40% in 5 years.[5] In comparison with the initial episode, the recurrent stroke tends to be more severe.[6] Therefore, prevention of secondary stroke is of paramount clinical and economic importance.[7] The major secondary measures of stroke prevention, as manifested in the most recent American Heart Association (AHA)/American Stroke Association guidelines,[8] include the control of modifiable risk factors (eg, hypertension, diabetes, cigarette smoking, alcohol consumption, unhealthy dietary habits, and obesity), drug intervention for atherosclerotic disease, antithrombotic treatments for cardioembolism, and the use of antiplatelet agents for noncardioembolic stroke.

There are several links between heart disease and stroke. Twenty percent of ischemic strokes are caused by cardiogenic cerebral embolism. The main sources of emboli are the left atrium (LA) and the left atrial appendage (LAA) during AF, acute or chronic left ventricular (LV) dysfunction, native valve disease, the presence of prosthetic valves (mitral and aortic), and, probably, complex aortic plaques. There is a history of nonvalvular AF in about one-half of cases, valvular heart disease in one-fourth, and LV mural thrombus in almost one-third.[9]

Cardiac imaging might help to stratify a patient's risk and provide appropriate treatment.

ATRIAL FIBRILLATION AND ASSESSMENT OF LEFT ATRIAL FUNCTION

Stroke is the most serious complication of AF, and occurs in 5% of non-anticoagulated patients every year. The risk of stroke in patients with AF increases substantially with age, from 1.5% in individuals aged 50 to 59 years to 23,5% for those aged 80 to 89 years.[10] In addition, AF-associated strokes confer the worst outcomes.[11] Moreover, 15% of patients with AF suffer silent cerebral infarcts,[12] the implications of which are not known, but which likely could be responsible for dementia and Alzheimer disease.

Stroke prevention in patients with AF is based on the use of anticoagulation with warfarin, which reduces the risk of stroke by 60%,[13] and more recently on the use of novel anticoagulants,[14] such as the direct thrombin inhibitor dabigatran[15] or the selective factor Xa inhibitors apixaban and rivaroxaban.

Two clinical scores (CHADS2[16] and CHA2DS2-VASc[17]) constitute the cornerstone of the management of anticoagulation therapy in AF patients. CHADS2 is an acronym for Congestive heart failure, Hypertension, Age older than 75, Diabetes mellitus, and prior Stroke. Each of these risk factors counts as 1 point except for history of stroke, which counts as 2 points. Patients with a score of 2 or higher have to be treated with oral anticoagulation therapy (OAC) while those with a score of 1 can be treated with aspirin or OAC. CHA2DS2-Vasc represents an evolution of the previous score by the inclusion additional "stroke risk modifier" factors. These additional risk factors, counting 1 point, include age 65 to 74, female gender, and vascular disease (previous myocardial infarction [MI], peripheral arterial disease, or aortic plaque); furthermore, "age 75 and above" also has extra weight, with 2 points. The therapeutic approach is the same as for CHADS2, considering 2 points as the cutoff for starting OAC while patients with 1 point can be treated with aspirin or OAC.

These scores are useful for defining AF high-risk patients for stroke, but moderate-risk or low-risk patients need a different stratification, for which cardiac imaging can be useful (**Table 1**).

Transthoracic Echocardiography

Transthoracic echocardiography (TTE) identifies conditions that predispose patients to AF (mitral valve disease [stenosis or insufficiency] and LV systolic dysfunction) or its progression as LA size or volume. This information can influence the subsequent management strategies; For example, increased LA volume is associated with a low probability of successful cardioversion for chronic AF and/or maintenance of normal sinus rhythm[18,19] and with AF recurrence after catheter ablation.[20] TTE should be performed in the emergency room in patients with AF to assess for signs of acute heart failure, compromised LV function and valvular function, and right ventricular pressure. TTE can provide useful information to guide clinical decision making, but cannot be used to exclude thrombus in the LAA.

Transesophageal Echocardiography

Transesophageal echocardiography (TEE) is probably the most useful imaging tool in the context of stroke prevention in AF patients. TEE can detect LA or LAA thrombi, and their resolution, with high sensitivity and specificity.[21] It can also provide accurate information about the LAA (such as its