JACC: CARDIOVASCULAR INTERVENTIONS
VOL. 8, NO. 15, 2015

ISSN 1936-8798/$36.00
PUBLISHED BY ELSEVIER INC.
http://dx.doi.org/10.1016/j.jcin.2015.07.035

Changes in Left Atrial Appendage Dimensions Following Volume Loading During Percutaneous Left Atrial Appendage Closure

Ryan J. Spencer, MD, Peggy DeJong, MD, Peter Fahmy, MD, Mathieu Lempereur, MD, Michael Y.C. Tsang, MD, Kenneth G. Gin, MD, Pui K. Lee, MD, Parvathy Nair, MD, Teresa S.M. Tsang, MD, John Jue, MD, Jacqueline Saw, MD

ABSTRACT

OBJECTIVES This study sought to determine whether volume loading alters the left atrial appendage (LAA) dimensions in patients undergoing percutaneous LAA closure.

BACKGROUND Percutaneous LAA closure is increasingly performed in patients with atrial fibrillation and contraindications to anticoagulation, to lower their stroke and systemic embolism risk. The safety and efficacy of LAA closure relies on accurate device sizing, which necessitates accurate measurement of LAA dimensions. LAA size may change with volume status, and because patients are fasting for these procedures, intraprocedural measurements may not be representative of true LAA size.

METHODS Thirty-one consecutive patients undergoing percutaneous LAA closure who received volume loading during the procedure were included in this study. After an overnight fast and induction of general anesthesia, patients had their LAA dimensions (orifice and depth) measured by transesophageal echocardiography before and after 500 to 1,000 ml of intravenous normal saline, aiming for a left atrial pressure >12 mm Hg.

RESULTS Successful implantation of LAA closure device was achieved in all patients. The average orifice size of the LAA at baseline was 20.5 mm at 90°, and 22.5 mm at 135°. Following volume loading, the average orifice size of the LAA increased to 22.5 mm at 90°, and 23.5 mm at 135°. The average increase in orifice was 1.9 mm ($p < 0.0001$). The depth of the LAA also increased by an average of 2.5 mm after volume loading ($p < 0.0001$).

CONCLUSIONS Intraprocedural volume loading with saline increased the LAA orifice and depth dimensions during LAA closure. Operators should consider optimizing the left atrial pressure with volume loading before final device sizing. (J Am Coll Cardiol Intv 2015;8:1935–41) © 2015 by the American College of Cardiology Foundation.

Atrial fibrillation (AF) is thought to account for 15% to 20% of all ischemic strokes and, due to an increasingly aging population, is growing in prevalence. Studies predict that by the year 2050, there will be between 12 and 16 million patients with AF in the United States alone (1). AF is associated with a 4- to 5-fold increase risk of ischemic stroke, this being its most devastating complication (2). Although warfarin and the novel oral anticoagulants reduce the risk of ischemic stroke in many patients with AF, they carry significant risks of bleeding and may not be tolerated by all. Accordingly, alternative treatment strategies for reducing the bleeding complications associated

From the Division of Cardiology, Vancouver General Hospital, University of British Columbia, Vancouver, British Columbia, Canada. Dr. Gin is on the advisory boards of Bayer, Pfizer, and Boehringer Ingelheim. Dr. Saw has received unrestricted research grant support from the Canadian Institutes of Health Research, University of British Columbia Division of Cardiology, AstraZeneca, Abbott Vascular, St. Jude Medical, Boston Scientific, and Servier; speaker honoraria from AstraZeneca, St. Jude Medical, Boston Scientific, Bayer, and Sunovion; consultancy and advisory board honoraria from AstraZeneca, St. Jude Medical, Boston Scientific, and Abbott Vascular; and proctorship honoraria from St. Jude Medical and Boston Scientific. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received May 29, 2015; revised manuscript received July 14, 2015, accepted July 30, 2015.

ABBREVIATIONS AND ACRONYMS

ACP = Amplatzer Cardiac Plug

AF = atrial fibrillation

CT = computed tomography

IV = intravenous

LAA = left atrial appendage

TEE = transesophageal echocardiography

with lifelong anticoagulation have been widely sought.

Two randomized controlled trials have shown the safety and efficacy of percutaneous left atrial appendage (LAA) closure, and this procedure has emerged as an alternative for patients with AF and significant stroke risk, who are at increased risk of bleeding (3,4). Percutaneous LAA closure has obvious benefits, including removing the need for ongoing adherence to anticoagulation, eliminating monitoring, decreasing medication interactions, and reducing ongoing bleeding risk. Minimizing periprocedural complications of percutaneous LAA closure is critical in order to offer a favorable risk-benefit ratio to patients. These include access site complications, pericardial effusion and tamponade, residual leak around the device, and embolization of the implanted device. Appropriate sizing of the currently available implantable devices is paramount for both procedural success and to reduce periprocedural complications. Choosing the correctly sized device relies on accurate measurement of LAA size.

SEE PAGE 1942

The 2 most widely implanted LAA closure devices are the WATCHMAN (Boston Scientific, Natick, Massachusetts) and the Amplatzer Cardiac Plug (ACP)/Amulet (St. Jude Medical, Plymouth, Minnesota). Choosing the correct device size is important to achieve proper apposition of the device and its hooks against the LAA wall. An undersized device may result in embolization or residual leak, whereas aggressive oversizing may cause tamponade, or device embolization due to inadequate engagement of the hooks. Hence, accurately measuring the LAA size is integral to safe percutaneous LAA closure. Both transesophageal echocardiography (TEE) and computed tomography (CT) have been used pre-procedurally to measure the depth and orifice diameter of the LAA, and been shown to correlate reasonably well (5). Although CT is usually undertaken in a euvolemic state, pre-procedural and intra-procedural TEE involves at least 6 h of fasting. This may affect the volume status of the patient, which in turn may affect LAA size. Previous studies in animals and patients in sinus rhythm have shown the LAA to be more compliant than the left atrium (6,7), supporting a hypothesis that clinically significant increases in LAA size may occur with volume loading. A single canine study demonstrated small increases in LAA size after volume loading (8), leading to speculation that LAA measurements used for percutaneous closure may be affected by volume status and the fasting state (5).

We hypothesized that volume loading during the procedure (to overcome the fluid restriction pre-procedure) affects LAA dimensions, and thus we routinely administer intravenous (IV) normal saline before sizing measurements. Our study aims to assess the impact of an intravenous fluid bolus on LAA size, and thus determine whether there is clinical utility in optimizing fluid status before measuring maximum LAA dimensions.

METHODS

Thirty-one consecutive patients who underwent percutaneous LAA closure (with either the ACP or WATCHMAN devices) at our center between March 2014 and May 2015 were included in this study. All patients received IV normal saline targeting a left atrial pressure of >12 mm Hg. Indications for LAA closure were nonvalvular AF with contraindications to long-term anticoagulation, with CHADS2 ≥1 and CHADS-VASc ≥2 (in accordance with the American College of Cardiology and the Canadian Cardiovascular Society AF guidelines for oral anticoagulation) (9,10). All patients underwent general anesthesia after a minimum of 6 hours of fasting.

A Philips IE33 echocardiography machine and X7-2t TEE probe (Philips, Andover, Massachusetts) were used to obtain baseline measurements of the LAA orifice diameter and depth before normal saline administration. Measurements were taken as per the manufacturer's guidelines. For ACP/Amulet, the widest landing zone was measured at ~10 mm inside the orifice for ACP and ~12 mm for Amulet. For WATCHMAN, the widest anatomic orifice (from the circumflex artery inferiorly to a point 1 to 2 cm inside the tip of the pulmonary vein ridge superiorly) and the LAA depth were recorded (**Figure 1**). For the purpose of this study, we measured the LAA orifice and depth at 90° and 135°, because these usually produce the largest dimensions; and utilized the WATCHMAN orifice definition to measure the orifice diameter (**Figures 1 and 2**). Measurements were taken when LAA width was greatest, which usually occurs at end-systole.

Following baseline measurements, a 500- to 1,000-ml IV bolus of normal saline was infused. One liter was given unless the patient had known left ventricular dysfunction or there were pre-operative concerns of volume overload, in which case 500 ml was given instead. We proceeded with transseptal puncture during the saline infusion, and the left atrial pressure was measured after transseptal access was achieved. After the infusion was completed, and the left atrial pressure was >12 mm Hg, we then repeated the LAA