Heart, Lung and Circulation (2016) 25, 993–999
1443-9506/04/$36.00
http://dx.doi.org/10.1016/j.hlc.2016.02.003

ORIGINAL ARTICLE

Postoperative Atrial Fibrillation after Coronary Artery Bypass Grafting Surgery: A Two-dimensional Speckle Tracking Echocardiography Study

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Received 4 October 2015; received in revised form 6 December 2015; accepted 2 February 2016; online published-ahead-of-print 5 March 2016

Background Postoperative atrial fibrillation (POAF) may develop after coronary artery bypass grafting (CABG). The aim of the study was to explore the relationship between preoperative left atrial function and atrial fibrosis and POAF after CABG.

Methods Forty-eight consecutive patients undergoing CABG (mean age: 61.6 ± 8.9 years, 39 male) were included. All patients were in sinus rhythm during surgery. Patients were followed by continuous electrocardiography monitoring and daily electrocardiogram. Left atrial function was assessed by both conventional and speckle tracking echocardiography. Atrial fibrosis was determined by samples taken from right atrium.

Results Postoperative atrial fibrillation was detected in 13 patients. Female sex and number of bypassed vessels were significantly higher and cardiopulmonary bypass time was significantly longer in patients with POAF. Left atrial volume index (LAVI) was significantly higher while left atrial reservoir strain was significantly lower in POAF patients. The percentage of patients with severe fibrosis was higher in the POAF group. Regression analysis revealed fibrosis and LAVI as independent predictors of POAF. Left atrial volume index $\geq$36 mL/m^2 predicted POAF with a sensitivity of 84.6% and specificity of 68.6% in our cohort.

Conclusion Patients who developed POAF after CABG had more fibrosis, increased LAVI and lower left atrial reservoir strain. Preoperative echocardiography might be helpful in discriminating these patients.

Keywords Postoperative atrial fibrillation • Coronary artery bypass • Fibrosis • Speckle tracking imaging

Introduction

Postoperative atrial fibrillation (POAF) is the most commonly observed arrhythmia after coronary artery bypass grafting (CABG) and is associated with increased morbidity, mortality and prolonged hospitalisation due to haemodynamic instability and thromboembolic complications [1,2]. The exact mechanisms underlying POAF after cardiac surgery are not clearly understood. Intraoperative ischaemia, electrolyte imbalance, increased postoperative sympathetic

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activity, and structural changes in atrial tissue caused by age, hypertension and volume overload are suggested to play a role [3,4].

Left atrial (LA) size, volume and fibrosis are shown to be associated with POAF [5]. Tissue Doppler imaging (TDI) may be used to evaluate LA function. Benedetto et al. [6] showed that peak atrial systolic mitral annular tissue Doppler velocity <9 cm/sec could predict POAF in patients undergoing CABG. However, the use of TDI was somewhat limited by their angle dependency, noise interference, and disturbances caused by myocardial tethering. Two dimensional (2D) speckle tracking echocardiography (STE) is a new angle-independent quantitative technique to evaluate myocardial function by analysing spots on the 2D grayscale ultrasound images of the myocardium. It is a reliable method in assessing atrial deformation and is correlated with Doppler parameters [7–9]. Peak LA longitudinal strain and LA volume index (LAVI) are shown to be independent predictors of POAF developed after cardiac surgery [10,11].

The aim of this study was to evaluate the predictive role of preoperative echocardiography and atrial fibrosis for POAF after CABG.

Methods

The investigation conforms with the principles outlined in the Declaration of Helsinki. The study was approved by the local ethics committee. All participants gave written informed consent.

Patients were selected from among cases referred to the cardiovascular surgery department for elective CABG surgery between April 2013 and November 2013. After the exclusion of patients with left ventricular ejection fraction (LVEF)≤40% (four patients), arrhythmias (seven patients), and significant valvular disease or those requiring valvular surgery (16 patients), the remaining 48 consecutive patients were recruited into the study. All patients were in sinus rhythm during surgery.

A careful medical history was taken including risk factors, medications and smoking habits. All patients were given standard medical treatment including beta blockers, angiotensin converting enzyme inhibitors and statins. All patients underwent detailed physical examination, electrocardiogram (ECG) and transthoracic echocardiography preoperatively. During CABG surgery, biopsy material was taken from the right atrium (RA). Patients were followed postoperatively by continuous telemetric electrocardiography monitoring for 72 hours. After 72 hours, the patients were followed by daily ECG for the following week. The diagnosis of POAF was based on the detection of atrial fibrillation (AF) either by continuous telemetric electrocardiography monitoring or by daily ECG.

Electrocardiographic Evaluation

Standard 12-lead ECGs were recorded daily from all patients before surgery and for seven days after surgery. Electrocardiograms were recorded using 12-channel equipment (Nihon Kohden CardiofaxQ, Europe GmbH, Rosbach, Germany), at a paper speed of 25 mm/s and with 1 mV/cm standardisation. Each ECG was assessed by a single blinded cardiologist for POAF. A new onset AF attack lasting more than 15 minutes was considered as POAF [12].

Standard Echocardiography and 2D Speckle Tracking Echocardiography

All patients underwent echocardiographic study with a commercially available echocardiography device (Vivid 7, GE Vingmed Ultrasound AS, Horten, Norway) by a single experienced blinded cardiologist two days before surgery. All patients were in sinus rhythm during echocardiography. Data acquisition was performed with a 3.5-MHz transducer at a depth of 16 cm in parasternal and apical views. Standard M-mode, 2D and TDI images were obtained during breath-hold, stored in cineloop format from three consecutive beats and transferred to a workstation for further offline analysis (EchoPAC 6.1; GE Vingmed Ultrasound AS).

Conventional echocardiographic parameters were measured according to the guidelines of the American Society of Echocardiography [13]. Left ventricular ejection fraction was calculated using biplane Simpson's method. The LV enddiastolic and endsystolic diameter (LVED and LVES), LA diameter, LAVI, mitral inflow early (E wave) and late (A wave) diastolic velocities, early diastolic annular velocity (E′), and the E/E′ ratio were measured.

Multidirectional LV strain analysis was performed using 2D speckle-tracking imaging as previously described [14,15]. Images were recorded with a frame-rate of at least 50 frames per second to allow for reliable operation of the software (EchoPac6.1; GE Vingmed Ultrasound AS, Horton Norway). The speckles can be detected and tracked on the standard grayscale 2D images. Myocardial strain can be calculated by measuring the change of the position of the speckles within a myocardial segment along the cardiac cycle. End-systolic regions of interest (ROI) were traced on the endocardial cavity using a point-and-click approach with special care taken to adjust the tracking of all endocardial segments. A second larger concentric circle was then automatically generated and manually adjusted near the epicardium. Speckle tracking automatically analysed frame-by-frame the movement of the speckles over the cardiac cycle. Each image was divided into six standard segments, corresponding strain curves were obtained. Mean strain values were calculated for each parasternal short-axis view, apical long axis, apical four- and two-chamber views, as the sum of peak systolic strain values in six segments, divided by six. Global longitudinal strain (GLS) was derived from the average of longitudinal strain values in the apical four-chamber, two-chamber and long axis views. The assessment of global radial strain (GRS) and global