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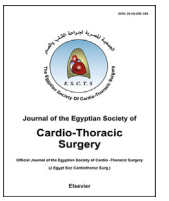

Echocardiographic study of functional tricuspid regurgitation and results of tricuspid valve repair

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ABSTRACT

Background: Functional tricuspid regurgitation (FTR) is often neglected. No clear consensus has been reached on superiority of preoperative transthoracic (TTE) or intraoperative transesophageal echocardiography (TEE) in assessment of tricuspid regurgitation (TR) in rheumatic heart disease. There is still debate when to consider for surgical repair of FTR and its benefits.

Methods: A total of 50 patients with rheumatic heart disease involving mitral, aortic or both valves with moderate and severe TR were included in the study. TR was assessed using preoperative TTE and intraoperative TEE. 36 out of 50 patients underwent tricuspid valve repair. Two patients died in postoperative period. Results of tricuspid valve repair were studied in 34 patients after six months of surgery.

Results: TTE was superior in assessing tricuspid annulus size, central jet area, vena contracta, right atrium size and right ventricle systolic pressure. Patients undergoing tricuspid valve repair had better quality of life with significant improvement in grade of dyspnea, angina, pedal edema and hepatomegaly. The annulus size, jet velocity and right ventricle systolic pressure were significantly lower in patients who underwent tricuspid valve repair. Tricuspid valve should be repaired in all cases of moderate to severe TR with significant annular dilation (>38 mm).

Conclusions: FTR is better assessed by TTE compared to intraoperative TEE. Concomitant TR correction (even in moderate degree of TR with tricuspid annulus $\geq$ 38 mm) should be strongly considered at the time of left side valve surgery resulting in better quality of life.

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1. Introduction

The tricuspid valve (TV) has not received as much attention as the aortic valve or mitral valve. It has been referred to as the "forgotten valve." Significant tricuspid regurgitation (TR) may be clinically silent for prolonged period of time during which progressive right ventricle dilatation and dysfunction may develop [1]. Functional tricuspid regurgitation (FTR) is often neglected. Only recently it has been considered worthy of attention by surgeons. Transesophageal Echocardiography (TEE) is an invaluable adjunct for preoperative and postoperative evaluation of cardiac pathophysiology in valvular heart disease and it should be routinely used in patients undergoing cardiac surgery [2,3]. In this study we compared the preoperative transthoracic echocardiography (TTE) and intraoperative TEE in the assessment of secondary TR in rheumatic heart disease patients. Nevertheless, no clear consensus has been reached in literature on when FTR should be corrected and how it should be corrected [1]. Originally, it was thought that in most patients with secondary TR, surgical treatment of the mitral valve disease would correct the problems of the right side. Hence, a conservative approach to TV was considered [2]. However recently the indications for surgery for TR have shifted towards progressively more interventional attitude. We studied the clinical profile and TTE variables of the patients after six months of TV repair for FTR.

2. Patients and methods

This was a comparative study conducted in the Department of Cardiothoracic and Vascular Surgery, Cardiology and Cardiac Anesthesia, Advanced Cardiac Center, Post Graduate Institute of Medical Education and Research, Chandigarh, India from 1st July 2016 to 31st December 2017. 50 adult patients were enrolled with rheumatic heart disease undergoing mitral, aortic or both valve surgery having TR. Inclusion criteria: all adult patients with rheumatic heart disease undergoing mitral, aortic or both valve surgery having TR operated by all surgeons, patients willing to give valid informed consent for TTE and TEE. Exclusion criteria: patients with history of previous cardiac surgeries, patients with infective endocarditis requiring valve replacement surgery, patients with congenital anomalies of mitral and tricuspid valves, patients with both tricuspid stenosis and TR, pregnant patients, patients undergoing urgent or emergency surgery, unwilling patients. Preoperative TTE was done by using M5S adult TTE probe of GE-vivid E9 Echo machine. It was performed and recorded by consultant cardiologist. The standard echocardiographic views for TV evaluation were apical four-chamber view, parasternal right ventricular inflow view, parasternal short-axis view at the great vessel level and subcostal four-chamber view. The following parameters were measured with TTE: (1) vena contracta width ($\geq$7 mm defines severe TR) [4]; (2) systolic hepatic flow reversal (presence of systolic hepatic flow reversal is specific to severe TR); (3) right ventricle dimensions, right atrium volume, inferior vena cava diameter and its respiratory kinetics and pulmonary arterial systolic pressure; (4) tricuspid annulus (considered enlarged if > 40 mm or 21 mm/m^2) [4]; (5) excursion and velocities: tricuspid annular plane systolic excursion (TAPSE < 15 mm) or the systolic myocardial velocities (<11 cm/s) to identify right ventricular (RV) dysfunction. TAPSE was evaluated by putting M-mode on lateral tricuspid annulus in apical four chamber view. Systolic myocardial velocity was measured in apical four chamber view by using tissue doppler over lateral tricuspid annulus [5]. Intraoperative TEE was done by using 6VT adult TEE probe of GE-vivid E9 Echo machine. TEE was done by consultant cardiac anasthesiologist. Intraoperative TEE was performed with transesophageal transducer according to standard published and accepted techniques. Initial imaging was performed after endotracheal intubation and induction of general anesthesia but before instituting cardiopulmonary bypass (CPB). Subsequent images were obtained during the operation as warranted and at the completion of surgical procedure after weaning from CPB support and stabilization of hemodynamics. The examination of TV was done using mid-esophageal four-chamber view [6], modified mid-esophageal bicaval view, transgastric (TG) short axis view, TG RV inflow view and deep transgastric RV inflow outflow view. Color flow doppler was used for rapid estimation of severity of TR (regurgitant jet area with mild TR area <5 cm^2, moderate TR 5–10 cm^2 and severe >10 cm^2 or based on jet area over right atrium area). Both the tricuspid and hepatic flow patterns in pulse wave Doppler were affected by respiration [7,8] Systolic hepatic flow reversal was specific for severe TR.

All patients underwent mitral or aortic valve replacement or double valve replacement through median sternotomy with the use of normothermic CPB and cold blood cardioplegic arrest. Right atrium (RA) was opened and TV inspected in all patients after mitral or aortic valve replacement or double valve replacement. The tricuspid annular diameter was measured from the anteroseptal commissure to the anteroposterior commissure using a supple ruler. Patients with a tricuspid annular dimension greater than or equal to 70 mm underwent tricuspid repair (ring annuloplasty or DeVegas annuloplasty repair). After repair saline jet test was performed to assess the degree of TR before closing RA.

In DeVegas annuloplasty, 3-0 prolene double-arm pledgetted sutures were used. The inner suture line was begun approximately 3 mm off of the tricuspid annulus. The bites were approximately 3 mm in depth and 5 mm in length, skipping 5 mm between bites. This inner suture line proceeded in a clockwise fashion around the annulus to the posteroseptal commissure. The outer suture line was 3 mm outside the first and placed in a similar fashion, in a clockwise direction to the posteroseptal commissure. A second Teflon pledget was passed onto the free ends of the suture. The suture was tightened down over a tricuspid ring sizer. A No. 29 sizer was generally adequate (Fig. 1).

We used the Carpentier-Edwards tricuspid annuloplasty ring, which was an incomplete ring leaving a gap in the area of the septal annulus adjacent to the conduction system (Fig. 2). Sizing of the annuloplasty ring was done by referencing the intercommissural distance (anterior leaflet length). This was done most accurately by distracting the chordae of the anterior

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