Novel intraoperative evaluation for mitral valve regurgitation: retrograde cardioprotective beating test

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Abstract

In mitral valvuloplasty, the saline injection test is commonly employed. However, discrepancies in regurgitation between the naked eye findings during the saline injection test and the postoperative echocardiographical findings are noted. Here, we describe a technique that allows direct transatrial evaluation of the valve in the fully loaded, beating heart without the risks of air embolism. Physiological systolic mitral valve movement is reproduced under aortic cross-clamping. This novel evaluation enables a complete and safe mitral valve repair.

Keywords: Mitral valvuloplasty • Mitral valve regurgitation • Intraoperative evaluation • Leak • Beating heart • Retrograde cardioplegia

INTRODUCTION

Mitral valvuloplasty (MVP) is one of the standard surgical treatments for mitral regurgitation (MR) [1–4]. To improve the long-term outcome of MVP, the complete prevention of residual MR is important. Intraoperative assessment of the competency of the repaired mitral valve before closure of the atrium is an important step in accomplishing a successful mitral valve repair. Saline injection test to the left ventricle (LV) under pressure is the most popular and reliable method to evaluate the repaired mitral valve. However, discrepancies in regurgitation are sometimes noticed between the naked eye findings during the saline injection test and the postoperative echocardiographical findings. Thus, we have developed a novel intraoperative evaluation for MR after MVP, the retrograde cardioprotective beating test (RC-beating test). In this evaluation, systolic mitral valve movement under physiological conditions is reproduced under aortic cross-clamping; hence, a complete and safe MR repair is enabled.

TECHNIQUE

Operations were performed through a median sternotomy. After systemic heparinization, total cardiopulmonary bypass was established between the ascending aorta and both venae cava. The ascending aorta was cross-clamped, and the right atrium was incised parallel to the intraatrial sulcus in order to expose the ostium of the coronary sinus (CS). A 3-0 polyester purse string suture was made around the ostium of the CS. Subsequently, a three-way (main perfusion, intra-CS pressure measurement and balloon inflation lines) retrograde perfusion cannula was inserted into the CS. Initially, retrograde cold blood cardioplegia (RC-CBCP) was started with a roller pump and then continuously dripped by gravity. MVP was performed under cardiac arrest without interrupted procedures. After the procedures were finished, terminal warm blood was injected, and then warm oxygenated blood was retrogradely perfused instead of RC-CBCP. During retrograde perfusion of warm oxygenated blood, a line of the root vent needle was opened to deair the aorta. A few minutes later, the beating heart was re-established spontaneously. Retrograde CS perfusion flow was maintained at >200 ml/min, which produced an intra-CS mean pressure of approximately 40 mmHg. For adequate volume loading of the LV, no additional system was required because oxygenated blood was perfused from the CS through the coronary venous system, the besian vein and then of the LV. We were able to test the results of MVP under more physiological conditions than the saline injection test. The atrial view of the closed valve not only gave visual information pertaining to the presence or absence of minor regurgitation, but could also allow technical manipulation if necessary, which the saline injection test could not. The developed or systolic LV pressure information could be indirectly obtained via the aortic root pressure monitoring a port of the root vent needle (Fig. 1). In this case, an LV pressure ranging between 70 and 90 mmHg during the RC-beating test was employed. If a residual minor leakage was detected, RC-CBCP was reperfused and an additional procedure was performed under cardiac arrest. After confirming the complete absence of leakage, the aortic clamp was released, and the retrograde CS perfusion cannula was removed.

This novel intraoperative evaluation for MR has been applied in 50 cases so far. In 15 (30%) patients, minor leakages that were unremarkable in the saline injection test were detected during the RC-beating test. Almost all patients with the RC-beating test revealed no MR on intraoperative transesophageal...
echocardiography (TEE). No second pump run was required in this series. The results of the RC-beating test were satisfactory, and discrepancies were not recognized between the RC-beating test and the postoperative echocardiographical findings.

**COMMENT**

Determining the competence of the repaired mitral valve while the left atrium is still open is an imprecise matter. For simplicity, it is usually done by injecting saline solution into the LV through the mitral valve with a bulb syringe or through the root vent needle under artificial aortic insufficiency in the non-beating heart to avoid air embolism. However, proper evaluation of valve function requires a beating, fully loaded heart. In the cases of MVP, the three-dimensional architecture of the beating heart provides a good opportunity to examine the mitral valve under more physiological conditions than in a cardiac arrest state. In a previous report, a leakage test showed good competence (no leak), and MV replacement was performed in the second or third arrest after unexpected mild leakage was detected by TEE [5]. In 6–8% of cases, greater than moderate MR by post-pump echocardiography led to second pump runs for further surgery [6]. These discrepancies between the saline injection test and post-pump TEE must lead to second pump runs. Because RC-beating test allows the identification of the exact location and nature of the residual leaks, measures to correct them can be implemented, if necessary, before the left atrium is closed. A previous report showed that about 20% of patients were left with residual trivial or mild MR [6]. However, almost all patients with the RC-beating test revealed no MR on intraoperative TEE. To avoid the recurrence of regurgitation, a significantly high level of competence of the valve is essential in the repair of the mitral valve. This method enabled a more complete and safe MR repair.

**Conflict of interest:** none declared.

**REFERENCES**