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This is a meeting paper, and the video was accepted for presentation on the “Mitral Conclave 2023”.

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Abbreviations

papillary muscle rupture = PMR
Intra-aortic ballon pump = IABP
Extracorporeal membrane oxygenation = ECMO
mitral valvuloplasty = MVP
mitral valve replacement = MVR

Central Message: Totally endoscopic minimally invasive mitral valvuloplasty with beating heart in the papillary muscle rupture accompanied with severe heart failure is effective and reliable.

Perspective Statement: Beating heart technique is helpful to achieve excellent myocardial protection, especially in patients with poor left ventricular function. Totally endoscopic minimally invasive mitral valvuloplasty could improve surgery outcomes of patients with papillary muscle rupture caused by acute myocardial infarction.

Central Picture Legend: Papillary muscle rupture under totally endoscopic minimally invasive approach.

Keywords. Papillary muscle rupture, Beating heart, Mitral valvuloplasty, Minimally invasive
A 64-year-old man who presented with papillary muscle rupture (PMR) after acute myocardial infarction and cardiogenic shock was emergency transferred to our institution with the support of intra-aortic ballon pump (IABP) and extracorporeal membrane oxygenation (ECMO). The patient underwent percutaneous coronary intervention 3 days ago for acute right coronary artery occlusion. Electrocardiogram on admission revealed acute inferior myocardial infarction. Chest radiograph revealed acute pulmonary edema (Figure 1, A). Echocardiography demonstrated severe mitral regurgitation with posterior leaflet flail caused by PMR (Figure 1, B, C).

Besides, the patient had acute liver injury and acute kidney injury requiring dialysis. STS score predicted the risk of operative mortality was high to 39.795%.

Emergency totally endoscopic minimally invasive mitral valvuloplasty (MVP) on beating heart was performed (Video 1). Patient was intubated with a single-lumen endotracheal tube. Normothermic cardiopulmonary bypass was established via the femoral artery and vein, while the ECMO maintained a self-circulation. A limited right anterolateral thoracotomy was then performed through the fourth and fifth intercostal space, and thoracic cavity was insufflated with carbon dioxide to reduce intracardiac air. Intraoperatively, mitral valvuloplasty was performed via ruptured papillary muscle heads resection (Figure 2, A), artificial chordae tendinae implantation (Figure 2, B), commisuroplasty between A3 and P3 (Figure 2, C), and annuloplasty with a 28-mm Physio II Edwards semirigid complete ring (Figure 2, D).

Keep the mitral valve open before the closure of left atrium filled with blood to avoid
potential risk of air embolism. Cardiopulmonary bypass was weaned off smoothly,
and the cannulations of femoral artery and vein were reconnected to ECMO.

Postoperative transesophageal echocardiography showed trivial mitral regurgitation
(Figure 1, D). The patient recovered stably, in who was conscious on postoperative
day 2, weaned from ECMO, IABP, and ventilator on postoperative day 5, 7, 21,
respectively. Sadly, the patient died for sepsis caused by biliary tract infection 32 days
after surgery.

Discussion. Papillary muscle rupture (PMR) after acute myocardial infarction is a
life-threatening complication (30-day mortality up to 39.3%). It results in severe
mitral valve regurgitation, often accompanied by pulmonary edema and cardiogenic
shock, requiring both medical treatment and emergent surgical intervention(1).
Mechanical circulatory assistance including IABP and ECMO, are often needed. MVP
appears to be a viable alternative to mitral valve replacement (MVR) for PMR, given
that it has lower operative mortality, shorter hospital stays and similar incidence of
short-term postoperative complications (2). However, MVR is still the preferred
strategy for most surgeons in cases of PMR (about 80%), may due to the complexity
and difficulty of MVP in PMR, prolonged operation time, and controversial valve
reintervention(3).
Conventional cardiac arrest carried a high burden of associated potential morbidity
and mortality in poor left ventricular function, especially in our case. Considering
better myocardial protection, high risk of valve prosthesis thrombosis under ECMO
support, and accumulated extensive experience of MVP, we finally chose to perform
empty beating heart MVP via totally endoscopic minimally invasive approach.
Continuous myocardial perfusion throughout the operation could alleviate myocardial damage caused by hypothermia, edema and ischemia-reperfusion injury. The alternative to the beating heart technique is a ventricular fibrillation arrest. However, fibrillation arrest may reduce oxygen delivery to the subendocardium and thus provides suboptimal myocardial protection(4). These were reasonable explanations for the lower postoperative morbidity and mortality in the minimally invasive beating heart group.

Though excellent mitral valve exposure could be obtained through the incision of the interatrial groove combined with continuous drainage, the beating heart technique more or less increased returned blood volume disturbing the operation, and risk of blood damage augment. Measures (such as esmolol) to lower heart rate and avoiding excessive negative pressure would be helpful.

A particular concern is air embolism, however, there is controversy whether open mitral valve surgery with a beating heart increased the risk of stroke(5). Generally, the aortic valve could not open easily during diastolic or systolic periods in an empty beating heart, for the aortic root pressure is much higher than atmospheric pressure. Besides, beating heart technique might reduce the risk of systemic embolism by avoiding aortic cross-clamp. Carbon dioxide insufflation to displace intracardiac air, continuous drainage in the ascending aorta and adequate head-down position may also contribute to reduce the risk of embolism.

In conclusion, beating heart technique was helpful to achieve excellent myocardial protection, especially in patients with poor left ventricular function. Totally endoscopic minimally invasive MVP could improve surgery outcomes of patients with PMR caused by acute myocardial infarction.

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REFERENCES


Figure 1. A, Acute pulmonary edema. B, Ruptured posteromedial papillary muscle. C, Preoperative mitral regurgitation. D, Postoperative mitral regurgitation. PMR, papillary muscle rupture.

Figure 2. A, Ruptured papillary muscle. B, Artificial chordae tendinae implantation. C, Commisuroplasty between A3 and P3. D, Annuloplasty with semirigid complete ring.
Video 1. Video depicting pre- and post-operative echocardiography, operative procedures.