Different Outcomes in Two Cases of Papillary Muscle Rupture with Different Timings of Coronary Revascularization, Mechanical Circulatory Support, and Surgery

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Papillary muscle rupture is a rare but devastating complication following acute myocardial infarction (AMI). It should be treated with early stabilization of the circulation and early surgery. Here, we report two cases of papillary muscle rupture following AMI with different outcomes. In patient 1, a 78-year-old man was diagnosed with AMI. He presented with hypotension and hypoventilation. Transthoracic echocardiography (TTE) showed moderate mitral regurgitation (MR). Emergency coronary angiography (CAG) demonstrated 90% stenosis of the right coronary artery (RCA) and 100% obstruction of the left circumflex artery. Coronary revascularization was performed before the surgical procedure. The patient died 49 days after cardiac surgery. In patient 2, a 65-year-old man was transferred to our hospital with dyspnea and shock. TTE showed severe MR. CAG showed a dominant RCA without stenosis, left ascending artery with 90% stenosis, and left circumflex artery with 100% obstruction. Veno-arterial extracorporeal membrane oxygenation (V-A ECMO) was established, and emergent surgery was performed without coronary revascularization. The patient was discharged 12 weeks after surgery. Thus, early introduction of mechanical circulatory support and early surgery could be significant in achieving a better outcome.

KEY WORDS: extracorporeal membrane oxygenation, myocardial infarction, papillary muscle rupture

Case reports

Patient 1

A 78-year-old man was admitted to our hospital with the complaint of dyspnea following a 1-day history of chest pain. An electrocardiogram showed significant ST depression in leads II, III, aVF, and V1−4. A roentgenogram revealed severe pulmonary vascular congestion. Transthoracic echocardiography (TTE) showed moderate mitral regurgitation (MR) resulting from prolapse of the anterior leaflet of the mitral valve. The partial pressures of arterial oxygen and carbon dioxide were 60 Torr and 32 Torr, respectively, with 80% oxygen saturation. Consequently, the patient was intubated and immediately started on mechanical ventilatory support. Emergency coronary angiography (CAG) performed one hour after admission revealed 90% stenosis of the right coronary artery (RCA) and 100% obstruction of the left circumflex artery (Fig. 1a, b). Intra-aortic balloon pumping (IABP) was subsequently initiated. Three hours after admission, percutaneous coronary intervention (PCI) in the left circumflex artery was performed; however, the patient’s circulation did not improve. A repeat TTE revealed severe MR and a reduced ejection fraction. Six hours post-admission, veno-arterial extracorpo-
real membrane oxygenation (V-A ECMO) was established and emergency surgery was performed. The posteromedial papillary muscle had ruptured completely at the base (Fig. 1c). Mitral valve replacement was performed with the 27-mm Carpentier-Edwards PERIMOUNT Magna Mitral Ease Heart Valve® (Edwards Life science Ltd, Tokyo, Japan) and concomitant coronary artery bypass grafting (CABG) to the RCA was performed with a saphenous vein graft. Failure to wean off cardiopulmonary bypass necessitated V-A ECMO and IABP support. V-A ECMO and IABP support were withdrawn on postoperative day 14, and the patient was switched to veno-venous ECMO (V-V ECMO) due to his poor respiratory condition. The patient was then weaned from V-V ECMO and tracheostomy was performed on postoperative day 28. Echocardiography showed poor left ventricular function with an ejection fraction of 38%. The patient developed hemorrhagic shock due to a rectal ulcer 30 days postoperatively. Although total colorectal resection and ileostomy were performed, he died 49 days after the cardiac surgery.

Patient 2
A 65-year-old man was admitted to our hospital after being intubated in the ambulance due to a complaint of dyspnea and shock. TTE showed severe MR resulting from prolapse of the posterior papillary muscle. CAG revealed a dominant RCA without stenosis, a left ascending artery (LAD) with 90% stenosis, and a left circumflex artery with 100% obstruction (Fig. 2a, b). One hour after admission, IABP and V-A ECMO were established due to worsening respiratory and circulatory status after which emergency surgery was performed. The posteromeral papillary muscle had ruptured completely at the base (Fig. 2c). Mitral valve replacement was performed with a 29-mm St. Jude Mechanical valve (St. Jude Medical Inc., St. Paul, MN, USA). Circulatory hemodynamics were maintained by IABP, but V-V ECMO was required due to his poor respiratory condition. Post-perfusion lung syndrome occurred because of the inadequate preoperative reduction of left ventricular end-diastolic pressure (LVEDP). The patient was weaned from V-V ECMO on postoperative day 2, and PCI in the LAD and the first diagonal branch was performed on day 8. The IABP was removed at 12 days postoperatively. Two weeks after the surgery, the patient went into septic shock due to *Pseudomonas aeruginosa* infection and subsequently developed intracranial hemorrhage. Although the patient required tracheotomy and intensive care for another 7 weeks, he was discharged 12 weeks after the surgery.

The patients’ clinicopathological findings on admission are presented in Table 1.

**Discussion**

Acute MR due to rupture of the papillary muscle is reportedly associated with high in-hospital mortality, and the early mortality rate after mitral valve surgery is 23–39%. The two cases presented herein highlight two important perioperative treatments.

The first important consideration is whether preoperative mechanical circulatory support may affect postoperative mortality.
A recent study has reported that preoperative mechanical support does not worsen the outcome\(^1\). In patient 1, the preoperative PCI involved intraprocedural disruption of hemodynamic circulation. Delayed initiation of V-A ECMO could lead to preoperative pulmonary congestion and poor respiratory condition and preoperative initiation could be life-saving, as observed in patient 2. The two cases reported here emphasize that physicians should not hesitate to institute mechanical circulatory support initiation when hemodynamic circulation is disrupted or when further deterioration is expected. However, patient 2 required postoperative V-V ECMO due to inadequate preoperative venting of the left ventricular system, resulting in pulmonary congestion. V-A ECMO can cause the unoxygenated blood to flow into the coronary arteries due to mixing if the auto cardiac output continues.

Peripheral V-A ECMO is widely used in cardiogenic shock and provides systemic perfusion in papillary muscle rupture, but if left ventricular unloading is suboptimal, left ventricular overload and pulmonary edema occur\(^5\). The Impella (Abiomed, Danvers, MA, USA) helps reduce LVEDP and may thus be a suitable option to help avoid pulmonary congestion\(^6\).

The second important consideration is whether revascularization should be performed concomitantly during the mitral valve replacement. One study reported that operative mortality could be improved by adding concomitant CABG to valve surgery\(^3\). However, other studies have reported no differences in operative mortality rates with concomitant CABG\(^1,2,7\). It is unclear whether preoperative and intraoperative revascularizations are mandatory in this clinical context. In patient 1, preoperative PCI and

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**Table 1** Preoperative clinical data of patients

| Patient | BP (mmHg) | HR (bpm) | NE (µg/kg/min) | CK/CK-MB (U/L) | V-A ECMO (after admission) | Surgery (after admission) | EF (%) | STS/Japan/Euro score (%) |
|---------|-----------|----------|----------------|----------------|---------------------------|--------------------------|-------|-------------------------|
| Patient 1 | 80/40, 111 | 0.4 | 593/29 | 6h | 6h | 40 | 58.3/36.4/38.9 |
| Patient 2 | 102/77, 146 | 0.7 | 348/37 | 1h | 3h | 50 | 47.7/37.0/30.7 |

BP: blood pressure, CK: creatine kinase, EF: ejection fraction, HR: heart rate, NE: norepinephrine, V-A ECMO: veno-arterial extracorporeal membrane oxygenation

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**Fig. 2**

a, b: Coronary angiography showing 90% stenosis of the left ascending artery (arrow) and 100% obstruction of the left circumflex artery (arrowhead).

c: A specimen of the ruptured posteromedial papillary muscle base with the anterior mitral leaflet.
intraoperative CABG were performed, while in patient 2, preoperative CAG was performed to identify the responsible ischemic lesion rather than for revascularization. As was observed in patient 2, once a patient’s general condition is stabilized, they can undergo elective postoperative PCI postoperatively for improvement of circulatory hemodynamics. Although we could not determine whether the different outcomes in the two cases were due to the differing revascularization plans, concomitant CABG during mitral valve replacement (MVR) does not appear to be an absolute necessity. In addition, early revascularization of lesions other than those culprit for AMI could help in earlier hemodynamic recovery.

In summary, we instituted mechanical circulatory support prior to comprehensive evaluation of the coronary lesion. This approach allows for subsequent urgent MVR after choosing a suitable revascularization plan, such as CABG or PCI.

Conclusion

Our experience with these two patients suggests that early institution of mechanical support is important after detecting papillary muscle rupture and hemodynamic deterioration subsequent to AMI. Concomitant coronary artery revascularization might not always be necessary.

Conflicts of interest

All authors declare that they have no conflicts of interest.

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