A Case of Fatal Mechanical Mitral Valve Leaflet Fracture Embolization

- A Case Report -

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The fracture embolization of a mechanical valve is a very rare but potentially fatal event that can cause acute severe valve regurgitation and subsequent decompensated heart failure. Generally, the mechanical valve is durable and semi-permanent. If this is not the case, bacterial endocarditis can occur. However, leaflet fracture embolizations related to mechanical failure may occur in the specific mechanical valve brands associated with the subjects own structural fragilities. In this case, we dealt with a case of fatal Edward-Duromedics mechanical mitral valve leaflet fracture embolization that had been implanted 20 years ago. The patient presented with severe acute heart failure and shock. Severe transvalvular mitral regurgitation and only one valve leaflet was observed in echocardiography. Although the emergency mitral valve replacement was performed under the diagnosis with valve leaflet fracture embolization, the patient was not resuscitated from systolic pump failure and died.

Key Words: cardiogenic shock, heart valve prosthesis, mitral valve insufficiency, prosthesis failure.

Mechanical valve prostheses have better hemodynamic characteristics and durability than bioprosthetic valves. The major complications of mechanical valve are thromboembolism, infective endocarditis, and bleeding problems associated with long-term warfarin use, but structural complications are rare. We report a fatal leaflet fracture embolization case of the Edwards-Duromedics mitral valve (Baxter Healthcare Corp., Cleveland, MS, USA), which occurred 20 years after implantation.

CASE REPORT

A 60-year-old man visited our emergency department with abrupt onset severe dyspnea and diaphoresis for 5 hours. In the initial physical examination, patient was very acutely-ill looking and marked dyspnea and his vital signs were as follows; blood pressure 70/40 mmHg, pulse rate 140 beats/min, respiratory rate 42/min and body temperature 36.3°C. His jugular veins were engorged and crackle was remarkable in both whole lung field. Grade V/VI holosystolic murmur was audible in apical area. Electrocardiogram showed atrial fibrillation and a rapid ventricular response with 130–145 beats/min. Chest radiography revealed bilateral pulmonary edema. Complete blood count showed anemia with 10.6 g/dl of hemoglobin and white blood cell of 7,500/μl and platelet of 191,000/μl.

Arterial blood gas analysis showed severe hypoxia with an oxygen partial pressure of 44.3 mmHg (normal range, 80–100 mmHg), a carbon dioxide partial pressure of 35.8 mmHg (normal range, 35–45 mmHg), pH 7.413, and an oxygen saturation of 75.3% (normal range 92–100%). The cardiac specific troponin-T level was 0.170 ng/ml (normal range, up to 0.1 ng/ml), the creatine kinase-MB isoform level was 8.4 ng/ml (normal range, 0–4.94 ng/ml), and the N-terminal pro B-type natriuretic peptide level was 1,468 pg/ml (normal range, 0–264 pg/ml). His prothrombin time (International normalized ratio) was 1.59 (normal range, below 1.2). In the past medical history, he had undergone the mechanical mitral valve replacement for mitral stenosis on 20 years ago in other hospital. The last medical surveillance was performed in 6 months ago

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in the hospital where he underwent surgery. In that time, patient had not been shown any abnormality in echocardiographic and physical examination. Patient was prescribed digoxin and warfarin as like before and continued on the day of visiting us. We have confirmed the patient’s surgery history of the mechanical valve replacement with the 31 mm Edward Duromedics (Baxter Healthcare Corp., Cleveland, MS, USA) valve via telephone contact to medical doctor in the hospital where patient was undergone the operation.

The respiratory distress was worse, and thus, endotracheal intubation and mechanical ventilation was initiated in the emergency department. To find the cause of abrupt decompensated heart failure and systolic murmur on apical area, bedside portable echocardiography was performed under mechanical ventilation. In the transthoracic echocardiography, left ventricular dimension on end-diastole and end-systole were 45 mm and 33 mm each. Mildly depressed left ventricular systolic function was observed with 46 % of ejection fraction. Regional wall motion abnormality in left ventricle was not evident. Although the mitral transvalvular regurgitation was under suspicion (Fig. 1), it was very difficult to observe precisely the fine morphology and function of the mechanical mitral valve due to extreme tachycardia and dyspnea of patient even under the mechanical ventilation. We started dopamine and dobutamine 10 ug/kg/min each, and titration up to 30 ug/kg/min for dopamine and 20 ug/kg/min for dobutamine. In the intensive care unit, the blood pressure was about 80/50 mmHg and pressure via subclavian venous catheter was 9 cm H2O, the transesophageal echocardiography showed severe transvalvular mitral regurgitation with only one mobile valve leaflet (Fig. 2). Emergent mitral valve replacement was determined after consulting our cardiothoracic surgeon.

In the operation theater, a cardiopulmonary bypass was instituted via the femoral vessel, and only one mitral valve leaflet was presented (Fig. 3) but no thrombus or paravalvular leakage was observed, and the other fracture-embolized leaflet was not found within operation field. The damaged 31 mm Edwards-Duromedics valve was removed and replaced with a St. Jude 29 mm mechanical valve (St. Jude Medical Inc., St. Paul, MN, USA). However, after valve replacement, weaning off cardiopulmonary bypass was impossible due to intractable pump failure associated with low cardiac output. The intraoperative transesophageal echocardiography showed the myocardial contractility was very impaired. 5 hours after begin-

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**Fig. 1.** Transthoracic echocardiography in parasternal long axis view (angulation to medially) showing mitral transvalvular regurgitation and mildly depressed left ventricular systolic function, but difficult to observe the precise mitral valve morphology and function.

**Fig. 2.** Transesophageal echocardiography showing severe transvalvular mitral regurgitation and movement of only one valve leaflet.

**Fig. 3.** Photograph of the surgically removed mechanical valve showing the single retained leaflet.
months.9) Yamazaki et al. 9) reported one case of mechanical mitral valve embolization that was related with another leaflet motion abnormality detected by a cinefluoroscopic examination 5 months before embolization.

Medical intervention and emergency surgical repairment of the fractured valve is important. Unfortunately, we did not perform cinefluoroscopy at initial evaluation, and our patient was very rapid deteriorated, and so, we thought the best way is immediate surgical repairment. Fine hemodynamic monitoring like Swan-Ganz catheter, inotropic agent such as dobutamine, and intraaortic counter pulsation or percutaneous cardiopulmonary support (PCPS) must be considered to achieve patient’s hemodynamic stability.

In our case, the embolized leaflet was not found in the cardiac cavity and plain chest films, but embolized leaflets are usually found between the aorta and femoral artery.11) On the other hand, if a leaflet is fragmented to more than 2 pieces, it can be found in upper extremities, such as, in the brachiocephalic artery.9) Simple X-ray examination and ultrasonography can use to detect embolized leaflet, but computed tomography provides the best means of detecting the embolized leaflet,11) which is unlikely to cause an immediate serious problem,12) but can cause arterial wall damage or be progressively extruded.11)

In the 21th century, Bottio et al.10) reported a new bileaflet mechanical valve, TRI Technologies valve (TRI Technologies, Prosthetic Heart Valve, Ltda, Belo Horizonte, Brazil) occurred leaflet escape as a result of pivoting system fracture. This means leaflet escape is own structural fragility problem of Edward-Duromedics mechanical valve and other some kinds of mechanical valve brands, and can be occur at this time and future.

To the best of our knowledge, the described case had the longest time from operation to an fracture embolic event for an Edwards-Duromedic valve. After mechanical valve replacement, if sudden onset dyspnea, acute pulmonary edema, and abnormal valvular motion are observed at any time without another cause, the rare but fatal complication of leaflet embolization must be suspected and must perform appropriate medical and surgical treatment.

DISCUSSION

Thorombus, pannus and paravalvular leakage due to bacterial endocarditis cause mechanical valve dysfunction, but very rarely the mechanical valve structural problem causes the valve dysfunction. Different types of mechanical valve failures have been described for various mechanical valves, such as, the ball-cage, tilting disc, and the bileaflet valve since the 1960’s.1-3) The Edwards-Duromedics valve prosthesis is a bileaflet carbon valve that was introduced clinically in 1982. This valve is designed to have central flow characteristics and a self-irrigating hinge mechanism to avoid stasis and thrombosis in the critical articulation area. However, in May 1988 marketing and distribution of the valve was suspended because leaflet embolization had been observed in 12 patients after about 20,000 implantations in the aortic and mitral positions.4) In 1994 the Baxter clinical data report claimed a leaflet embolization incidence of 0.029% per patient-year, but other report issued in 1998, claimed an incidence of 0.08%.5) Furthermore, this incidence was higher for the mitral position.6) The five factors of leaflet embolization were summarized by Baudet et al.6) in 1995 as; 1) Clustered microporosity, 2) Cavitation bubbles (“microjets”), 3) Dimensional tolerances, 4) Insufficient compliance of the sewing ring, and 5) Surgical mishandling. Cavitation thresholds, which are related to cavitation bubble formation are much lower for the Edwards-Duromedics valve than for the other bileaflet valves, such as, the St. Jude and the Carbomedics valve (CarboMedics Inc., Austin, TX).7) The leaflet escape incidence is higher in mitral position than in aortic position about 2 times. This difference could be explained by higher stress through mitral position.8) Fracture escapes occurred within a variable period, 19 days8) to 202 months.9)

The clinical symptoms and signs of leaflet embolization are similar to those of acute valvular regurgitation, and include, sudden onset dyspnea, tachypnea, pulmonary congestion, and hypotension or shock. Leaflet embolization can be discriminat-ed from valve thrombosis with an abrupt symptom onset. Cinefluoroscopy provides a rapid and noninvasive means of detect leaflet embolization and other valve abnormalities.10) Yamazaki et al.9) reported one case of mechanical mitral valve leaflet embolization that was related with another leaflet motion abnormality detected by a cinefluoroscopic examination 5 months before embolization.

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