

Mitral Valve Plasty for Mitral Regurgitation after Blunt Chest Trauma

Hajime Kumagai, MD, Yoshiharu Hamanaka, MD, Shinji Hirai, MD, Norimasa Mitsui, MD, and Taira Kobayashi, MD

A 21 year-old woman was admitted to our hospital because of chest and back pain after blunt chest trauma. On admission, consciousness was clear and a physical examination showed labored breathing. Her vital signs were stable, but her breathing gradually worsened, and artificial respiration was started. The chest roentgenogram and a subsequent chest computed tomographic scan revealed contusions, hemothorax of the left lung and multiple rib fractures. A transthoracic echocardiography (TTE) revealed normal left ventricular wall motion and mild mitral regurgitation (MR). TTE was carried out repeatedly, and revealed gradually progressive MR and prolapse of the posterior medial leaflet, although there was no congestive heart failure. After her general condition had recovered, surgery was performed. Intraoperative transesophageal echocardiography (TEE) revealed torn chordae at the posterior medial leaflet. The leaflet where the chorda was torn was cut and plicated, and posterior mitral annuloplasty was performed using a prosthetic ring. One month later following discharge, the MR had disappeared on TTE. (Ann Thorac Cardiovasc Surg 2001; 7: 175-9)

Key words: mitral valve plasty, traumatic mitral regurgitation, transesophageal echocardiography (TEE)

Introduction

Recently, the incidence of blunt chest trauma has been increasing because of traffic accidents, and a few cases unfortunately lead to death without appropriate diagnosis and treatment in spite of improved diagnostic procedures and surgical techniques. Generally, myocardial injuries are not uncommon, but mitral valve injuries are very rare.^{1,2)} In cases of blunt chest trauma, it is clinically important to detect new systolic murmurs and any symptoms of heart failure which can lead to fatality, and to do the operation in a timely manner. Ordinarily, transthoracic echocardiography (TTE) and transesophageal echocardiography (TEE) are used as diagnostic tests for this injury. Then, we have to determine, whether to per-

form mitral valve plasty or mitral valve replacement, on the basis of intraoperative findings and the patient's background in each case. We report a case of mitral valve plasty performed for treatment of mitral valve rupture after blunt chest trauma and review all cases of traumatic mitral regurgitation (MR).

Case Report

A 21 year-old woman was admitted to our hospital because of chest and back pain after blunt contusion of the chest due to a traffic accident late at night on April 24, 2000. On admission, consciousness was clear and a physical examination showed labored breathing, in addition to a wound on the chin and the chest. Her blood pressure was 89/39 mmHg and her pulse rate was 73 beats/min. Laboratory data showed an abnormally elevated white blood cell count of 11,900/mm³, and elevated levels of transaminase (glutamate oxaloacetate transaminase 209 mU/mL, glutamate pyruvate transaminase 134 mU/mL), lactate dehydrogenase (1,457 mU/mL) and creatine phosphokinase (467 mU/mL). Results of initial arterial blood

From the Department of Thoracic Surgery, Hiroshima Prefectural Hospital, Hiroshima, Japan

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Address reprints requests to Hajime Kumagai, MD: Department of Thoracic Surgery, Hiroshima Prefectural Hospital, 1-5-54 Ujinakanda, Minami-ku, Hiroshima 734-8530, Japan.

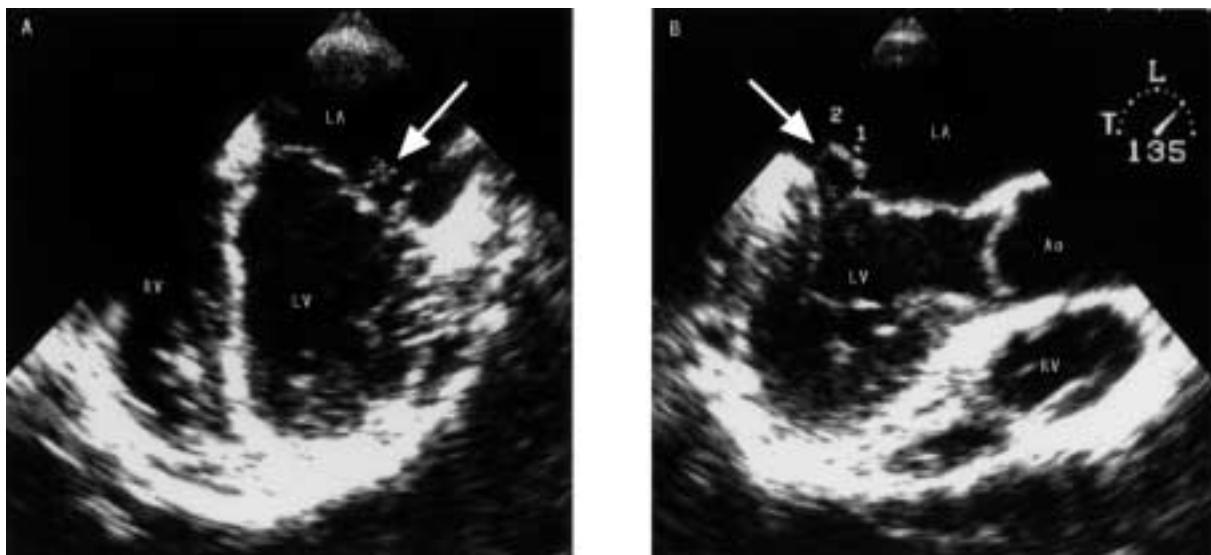


Fig. 1. A, B: Transesophageal echocardiography (four-chamber view) demonstrating prolapse of the posterior mitral leaflet (arrows). LV: left ventricle, LA: left atrium, Ao: aorta, RV: right ventricle.

gas analysis in a 10L breath mask were as follows: pH 7.347, carbon dioxide tension 43.3 mmHg, oxygen tension 83.0 mmHg, base excess of -2.0 mmol/L and oxygen saturation 94%. The left chest pain and dyspnea gradually worsened, and oxygen saturation was reduced to 84%. The patient was intubated and artificial respiration was started.

The chest roentgenogram and a subsequent chest computed tomographic scan revealed contusion, hemothorax of the left lung and multiple rib fractures. A chest drainage tube was inserted into the left lung cavity. The first TTE on April 25 revealed normal left ventricular wall motion, mild MR, and did not reveal any rupture of the papillary muscle. TTE was repeatedly performed, and ultimately TTE revealed a gradually progressing MR, slight pericardial effusion but no congestive heart failure. One month later, TTE and TEE revealed severe MR due to prolapse of the posterior medial leaflet (Figs. 1, 2A), suggesting torn chordae, although left ventricular function was normal. After her general condition had improved, and she had been weaned from ventilatory support, surgery was undertaken because of isolated rupture of the papillary muscle and because the patient's condition was not complicated by injuries to other major organs.

Intraoperative TEE was used to evaluate mitral regurgitation and left ventricular movement. Intraoperative findings revealed torn chordae at the posterior medial leaflet. Other chordae and the papillary muscles were not injured. The leaflet where the chorda was torn was cut and plicated. A prosthetic ring was attached as a pos-

terior mitral annuloplasty. After declamping, TEE showed that the MR had disappeared. After the operation, the patient recovered without marked complications. One month later, after discharge, TTE revealed trivial MR and an ejection fraction of 0.70 (Fig. 2B).

Discussion

The incidence of traumatic heart injury caused by traffic accidents has been increasing. Myocardial contusion is common but valve rupture is rare. Mitral regurgitation (MR) due to blunt chest trauma is a very rare event.^{1,2)} Rupture of the mitral valve causes sudden or gradually worsening MR, and progressive congestive heart failure. Trauma due to a traffic accident is often further complicated by multiple injuries. Therefore it is important to diagnose MR as quickly as possible, to assess the general condition of the patient and to determine the order of priority in treatment. It is necessary that damage of other organs be thoroughly assessed before surgery, because of risks associated with intraoperative heparinization.

Chest roentgenogram, TTE and TEE are performed for diagnosis of valve injury. TTE and TEE are useful modalities for diagnosis of rupture of the mitral valve, and can be done at the bed side. The buckling of one or both mitral leaflets into the left atrium during systole on two-dimensional echocardiography, or mid or late systolic posterior motion of the mitral valve on M-mode are specific signs of TTE which strongly suggest mitral valve prolapse.³⁾ TTE offers the advantage of being a non-invasive diagnostic test which

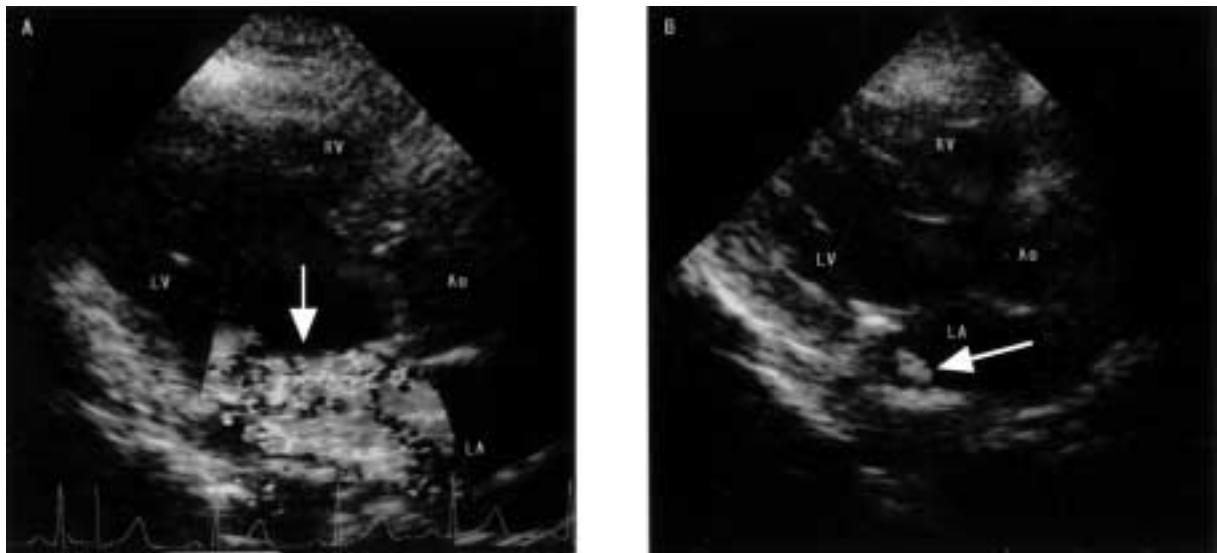


Fig. 2. A: Preoperative transthoracic echocardiography (long-axis view) demonstrating severe mitral regurgitant jet into the left atrium (arrow). B: Postoperative transthoracic echocardiography (long-axis view) demonstrating trivial mitral regurgitant jet into the left atrium (arrow). LV: left ventricle, LA: left atrium, Ao: aorta, RV: right ventricle.

can be used over and over again during a patient's course. The area around the mitral valve can be clearly visualized with TEE. Another advantageous feature of TEE is that real-time information is provided, which is especially important in cases involving mitral valve plasty, to evaluate the degree of MR and laceration of the valve leaflet. If TEE shows moderate or severe MR, after the cardiopulmonary bypass is off, the surgeon has to consider mitral valve replacement.

Rupture of the mitral valve is caused by a variety of mechanisms. The damage most likely occurs when pressure is applied at early systole during the isovolumic contraction between the closure of the mitral valve and the opening of the aortic valve.⁴⁾ Traumatic rupture of the mitral valve occurs at the papillary muscle, chordae tendineae and valve leaflet. Each papillary muscle is supplied by one or more of the long penetrating vessels, arising from one of the epicardial arteries, and, if damaged, the muscle and chordae may undergo progressive ischemia and subsequent infarction with elongation and paresis, resulting in delayed rupture.⁵⁾ Rupture of a papillary muscle in the left side of the heart with its relatively high pressure would not be as well tolerated as rupture of one of the tricuspid papillary muscles in the low pressure side of the heart.¹⁾ Severe MR and subsequent congestive heart failure may be present immediately or may be delayed, depending on the volume of regurgitation and the state of left ventricular function.⁶⁾ The posterior leaflet has much thinner chordae than the anterior leaflet, and the thinner chordae are weaker than

the corresponding chordae associated with the anterior leaflet and are more vulnerable to rupture.⁷⁾ In the present case, the patient injured her left side as a result of an accident while riding on the passenger seat of a motor-bike. Violent compression was applied directly to the left ventricle without cushioning by the right ventricle or tricuspid valve. The pathological findings showed that the papillary muscle was elongated and torn by high pressure, with subsequent ischemia and infarction. This primary damage resulted in the development of coagulation necrosis, resulting in subsequent rupture (Fig. 3).



Fig. 3. Microscopic findings (H.E. staining, $\times 80$). The papillary muscle developed coagulation necrosis and the nuclear of the muscle cell had disappeared.

A review of 40 reported operative cases of traumatic MR in the English and Japanese literature (Table 1), revealed 17 cases which were followed for over one month from time of injury to time of operation.^{6,8-10)} Congestive heart failure occurred in only 4 cases and all were operated on within 24 hours. In many cases, heart failure was delayed because of good left ventricular function and minimal regurgitation. In such cases, periodic TTE is necessary to detect delayed papillary muscle and chordal rupture and worsening of heart failure. The papillary muscle is the most vulnerable valvular structure and had

ruptured in 25 cases. Mitral valve replacement (MVR) was performed in 23 cases. Surgeons have to determine whether to perform mitral valve plasty or MVR on the basis of intraoperative findings in each individual case. MVR is a reliable and simple procedure. Moreover, recently valvuloplasty can also be performed with low operative mortality and is associated with superior late survival in patients with valve prolapse.¹¹⁾ Annuloplasty with a prosthetic ring reduces dilatation of the size of the annules and regurgitation, and improves leaflet coaptation. Preservation of the posterior leaflet chordal attach-

Table 1. Reported operative cases of traumatic mitral regurgitation in the English and Japanese literature

Author / Date	Sex	Age (y)	Operative interval	Valve pathology	Method of repair	Author / Date	Sex	Age (y)	Operative interval	Valve pathology	Method of repair
McLaughlin (1964)	M	7	8 months	Ruptured chordae, torn anterior leaflet	Annulus plication	Yanagi (1986)	M	22	6 months	Ruptured anterior chordae tendineae	Mitral annuloplasty, chordal repair
Bailey (1969)	M	55	24 years	Ruptured chordae, torn anterior leaflet	Autologous fascia lata graft	Al Kasab (1988)	M	27	3 weeks	Anterolateral papillary muscle necrosis	Mitral valve replacement
Bailey (1969)	M	59	2 months	Ruptured chordae tendineae	Autologous fascia lata graft	Katagiri (1988)	M	50	75 days	Ruptured posterior chordae tendineae	Mitral valve replacement
Bryant (1973)	M	36	40 hours	Ruptured anterolateral papillary muscle, torn chordae tendineae	Mitral valve replacement	Werne (1989)	M	36	4 days	Ruptured anterolateral papillary muscle	Mitral valve and tricuspid valve replacement
Takaba (1973)	F	48	4 months	Perforated anterior leaflet, torn chordae tendineae	Leaflet and chordal repair	Van Roye (1989)	M	35	5 months	Ruptured anterior and posterior chordae tendineae	Mitral valve replacement
Anyanwu (1976)	M	30	9 years	Ruptured posterior leaflet, perforated anterior leaflet	Mitral valve replacement	Chang (1989)	M	24	24 hours	Ruptured posteromedial papillary muscle	Reimplant muscle, mitral annuloplasty
Harada (1977)	F	30	30 days	Torn posterior leaflet	Primary repair with pledges	Okazaki (1989)	M	18	4 months	Papillary muscle necrosis	Mitral valve replacement
Rashid (1978)	M	29	33 days	Ruptured anterolateral papillary muscle	Mitral valve replacement	McCrory (1991)	M	6	12 weeks	Ruptured anterolateral papillary muscle	Mitral valve replacement
Natsuaki (1979)	M	38	4 months	Ruptured chordae tendineae	Mitral annuloplasty, chordal repair	Kawai (1991)	M	17	9 days	Ruptured anterolateral papillary muscle	Mitral valve replacement
Reginato (1980)	M	6	24 hours	Papillary muscle necrosis	Mitral valve replacement	Fiane (1993)	M	22	14 days	Ruptured anterolateral papillary muscle	Mitral valve replacement
Kratz (1980)	M	17	6 hours	Lacerated posterior leaflet	Primary repair with pledges	Spangenthal (1993)	F	35	19 days	Ruptured posteromedial papillary muscle	Mitral valve replacement
Araki (1980)	M	27	4 days	Ruptured posterior chordae	Mitral valve replacement	Take (1993)	F	13	3 months	Ruptured posteromedial papillary muscle	Fixation of papillary muscle
Katou (1982)	M	50	3 months	Ruptured anterior papillary muscle	Mitral valve replacement	Ichihara (1993)	M	27	14 hours	Ruptured anterolateral and posteromedial papillary muscle	Mitral valve replacement
Hamada (1982)	M	27	20 days	Prolapse of mitral leaflet	Mitral annuloplasty	Coleman (1994)	M	12	6 days	Valve tear, ruptured posteromedial papillary muscle	Mitral annuloplasty
Muzzucco (1983)	M	18	3 days	Ruptured anterolateral papillary muscle	Reimplant muscle, commissuroplasty	McDonald (1996)	M	42	1 day	Ruptured anterolateral papillary muscle	Mitral valve repair, annuloplasty, inserted two artificial chordae
Pillai (1983)	M	28	36 hours	Ruptured anterolateral papillary muscle	Mitral valve replacement	Shimokawa (1996)	M	64	32 months	Ruptured posterior chordae tendineae	Mitral annuloplasty, chordal repair
Devineni (1983)	M	41	48 hours	Ruptured anterolateral papillary muscle	Mitral valve replacement	Reardon (1998)	M	52	18 days	Ruptured posterior chordae tendineae	Mitral valve repair, annuloplasty
Yoshioka (1983)	M	45	5 months	Ruptured posterior papillary muscle	Mitral valve replacement	Guhathakurta (1999)	M	34	2 months	Ruptured posteromedial papillary muscle	Mitral valve replacement
Cuadros (1984)	F	25	9 days	Torn posterior papillary muscle	Mitral valve replacement	Kugai (2000)	M	28	6 days	Ruptured anterolateral papillary muscle	Mitral valve replacement
Pellegrini (1986)	M	23	72 hours	Ruptured anterolateral papillary muscle	Mitral valve and tricuspid valve replacement	Kumagai (2000)	F	21	43 days	Posteriorlateral papillary muscle necrosis	Mitral valve repair, annuloplasty

ments and papillary muscle is important because of the importance of papillary muscle-annular continuity to overall left ventricular function.⁶ In particular, like the present case, mitral valve plasty should be selected for young patients considering their tolerance for prosthetic valves, long-term outcome and preparation for childbirth.

As an overall strategy, we think it is best to use TTE and TEE for real-time monitoring in cases where this type of injury is suspected. In cases of blunt chest trauma, it is clinically important to detect any new systolic murmurs and any symptoms of heart failure which can potentially lead to fatality, and important to perform surgery in a timely fashion.

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