BALLOON MITRAL VALVOTOMY FACILITATING WEANING OFF MECHANICAL VENTILATORY SUPPORT

Hatem Abbadi, MD, JBIM, JBC*

ABSTRACT

Balloon mitral valvotomy is a proven modality in the treatment of mitral valve stenosis. In patients presenting with acute heart decompensation due to severe mitral stenosis, initial medical therapy is attempted until more definitive therapy is planned and performed. We present a patient with severe mitral stenosis presenting with acute pulmonary edema. Despite the resolution of radiological pulmonary congestion under medical therapy, repeated attempts to wean the patient off mechanical ventilation support failed. The weaning was successful only after balloon mitral valvotomy was performed.

JRMS Dec 2006; 13(2):46-48

Case Report

A 67 year-old female patient with past history of severe mitral stenosis, atrial fibrillation, diabetes mellitus and hypertension, presented with acute pulmonary edema necessitating immediate mechanical ventilatory support.

Eight years earlier, she was detected to have severe mitral stenosis with mitral valve area of 1.1cm^2 by 2-dimensional Doppler echocardiography. Balloon mitral valvotomy (BMV) using double- balloon technique [(1)] was unsuccessful because the balloon failed to cross the mitral valve, presumably due to inappropriate transseptal puncture site (too cephalid). The patient declined the offer of elective surgical open mitral valvotomy.

On examination, blood pressure was 130/80 mmHg, ventricular rate was 85/min and irregularly irregular, jugular venous pressure was elevated. Cardiac examination was consistent with severe mitral stenosis, and there were moist rales in both lungs.

Surface electrocardiogram showed evidence of atrial fibrillation with controlled ventricular rate, right axis deviation, and right ventricular hypertrophy. Chest X-ray showed bilateral fluffy alveolar pulmonary edema.

Transthoracic echocardiographic examination revealed mitral valve area of 0.8 cm^2 by planimetry, left atrium size of 6.1cm, estimated pulmonary arterial systolic pressure of 90 mmHg and grade II mitral regurgitation. Mitral valve score was 8 by Wilkin's criteria.

Initial treatment including intravenous diuretics usage resulted in improvement of arterial hypoxemia and resolution of radiological signs of pulmonary edema in few days. However, several attempts to wean off mechanical ventilation failed as arterial blood gases profiles deteriorated and respiratory fatigue ensued. After having obtained informed consent from the families, urgent double- balloon BMV was performed using the double-balloon technique after the patient had been under mechanical ventilatory support for 16 days. After the procedure, left atrial pressure decreased from 30 to 10 mmHg, transmitral gradient from 30 to 10 mmHg, and pulmonary artery systolic pressure from 90 to 60mmHg, Mitral valve area increased from 0.8 to 1.5 cm^2, and left ventricular end-diastolic pressure remained unchanged at 10 mmHg. Coronary angiograms were normal with no increase in the mitral regurgitation. Her arterial blood gases profiles improved drastically and extubation was successful in 36 hours. The patient was discharged a week later on digitalis, low doses of loop diuretic and warfarin. Her cardiac status remained stable at six months follow-up visit.

Discussion

Rheumatic mitral stenosis is a chronic cardiac disease that results in considerable anatomical and functional alterations [(2)] in the form of an increase of left atrial pressure and subsequently the pulmonary venous pressure leading to chronic water deposition in the lung interstitium and pulmonary alveolar edema.

*From the Department of Cardiology, Queen Alia Heart Institute (QAHI), King Hussein Medical Center, (KHMC), Amman-Jordan.
Correspondence should be addressed to Dr. H. Abbadi, (KHMC)
Manuscript received June 16, 2004. Accepted September 16, 2004.

There are three phases of impairment of lung structure and function [3] in severe chronic mitral stenosis. Phase I consists of elevation of left atrial pressure resulting in an increase in pulmonary venous pressure, capillary blood volume and diffusion capacity (DLCO). Phase II as a result of persistence of high pulmonary venous pressure, deposition of water in the interstitium and diffusing membrane enlargement [4] occur and subsequently a decrease in lung distensibility and peripheral airway flow. In phase III, progressive deposition of protein, proteoglycan, collagen fibers in lung tissue occurs and results in interstitial fibrosis [5], decrease in lung compliance and restrictive pattern on pulmonary function test.

Percutaneous balloon mitral valvotomy is a palliative and relatively safe procedure in experienced hands and properly selected cases [6]. The procedures success rate is as high as 90%. On occasions, BMV is performed in elderly patients, despite a high mitral score, and in whom surgery carries a high risk due to coexistent impaired general condition and co-morbidities [7,8]. The risk of procedure-related death is less than 1%. Procedure-induced or aggravation of preexistent mitral regurgitation is the most common complication that necessitates surgery, occurring in less than 5%.

The procedure outcome depends on case selection. Mitral valve scoring proposed by Wilkin's is the most commonly adopted and depends on valve thickness, rigidity, calcification, and subvalvular apparatus [9].

Balloon mitral valvotomy is performed either by Double-balloon or by Inoue technique. The results of both techniques are comparable, though some studies showed a greater increment in the valve area using the former [10].

Several groups of investigators have drawn the attention to cardiovascular response in mechanical ventilation- dependent patients [11] and have emphasized the susceptibility to ischemia or heart failure in patients with limited cardiac reserve. There are several cardiac pathophysiologic changes that result from mechanical ventilation. First, increase metabolic demand; hence increase circulatory demand especially in patients with limited cardiac reserve. Second, increase in venous return as the contracting diaphragm displaces blood from the abdomen to the thorax. And last, increase in LV afterload that is imposed by negative pleural pressure swings.

Several investigators emphasized the improvement of all hemodynamic measures after balloon mitral valvotomy (BMV). Umesan M [12], showed improvement of all hemodynamic parameters in 315 patients after BMV in patients with coexisting severe pulmonary hypertension.

Joan A [13] reported improvement of pulmonary function test indices, after successful percutaneous BMV in 23 consecutive patients, with resultant significant increase in FVC, and FEVI, decrease in DLCO, improvement in small airway flow and relief of pulmonary congestion

Gortese D [14,15] suggested inverse relationship between severe mitral stenosis and observed diffusion capacity with decrease in pulmonary congestion after balloon valvotomy and concluded that congestion had caused limitation in vital capacity because of decrease lung compliance.

Yoshioka [16] noticed 6% and 5% increase in FVC and FEV1 respectively after successful BMV and 14% decrease in parameters of lung diffusion capacity.

In a study on 120 patients, Simkova I and Urbanova J after balloon mitral valvotomy noticed improvement of static and dynamic lung volumes and peripheral airway obstruction with substantial improvement of all ventilation parameters [3].

Short-term follow up after BMV detected immediate improvement in peripheral and central airway obstruction, determined not only by congestion but also by presence of bronchial hyperreactivity [17] as well as chronic organic changes like peripheral airways and alveoli.

Finally, some investigators like Lauk *et al* [18] recommend doing pulmonary function test that could help to decide on the best time to perform balloon mitral valvotomy in patients with moderate to severe mitral stenosis.

Conclusion

Patients with severe mitral stenosis may already have irreversible lung structural changes that may pose difficulties in weaning off mechanical ventilation support whenever it is needed in acute heart decompensation or surgery. Stenosis relief needs to be timed prior to the occurrence of significant lung changes. BMV is of help in mechanically ventilated -dependent patients and facilitates weaning and avoids the aggravation of chest wall mechanics inflicted by the chest surgical wound.

References

1. **Lock JE, Khalilullah M, Shrvastava S, *et al*.** Percutaneous catheter commissurotomy in rheumatic mitral stenosis. *N Engl J Med* 1985; 313: 1515-1518.
2. Hurst's the heart textbook, 9th edition. mitral valve disease chapter 1998; 64: 1789-1799.
3. **Simkova I, Urbanova J.** Pulmonary function alteration after correction of mitral stenosis. *Bratisl Lek Listy* 2001; 102(6): 278-281.
4. **Puri S, Baker L, Dukta D.** Reduced alveolar membrane diffusing capacity in chronic heart failure. *Circulation* 1995; 91: 2769-2774.
5. **Prockop D.** Collagen, elastin, and proteoglycan matrix for fluid accumulation in the lung in pulmonary edema. *American Physiological Society* 1979; 225-227.

6. **Inoue K, Owaki T, Nakanura T, *et al*.** Clinical application of transvenous mitral commissurotomy by new balloon catheter. *J Thoracic Cardiovascular Surgery* 1984; 394-402.
7. **Hildick-Smith DJR, Shaprio LM.** Balloon mitral valvuloplasty in elderly. *Heart* 2000; 83(4): 347-375.
8. **Sutaria N, Elder AT.** Long term outcome of percutaneous balloon mitral valvotomy in patient age 70 years and over. *Heart* 2000; 83: 433-438.
9. **Wilkins GT.** Percutaneous mitral valvotomy, analysis of echocardiography variable related to outcome and mechanism of dilatation. *Br Heart J* 1988; 60: 299-380.
10. **Ruiz CE, Zhang HP, Macaya C.** Comparison of inoue versus double balloon technique for commissural splitting after percutaneous valvotomy. *Am J Cardio* 1992; (69): 1100-1102.
11. **MacIntyre NR.** Evidence based guidelines for weaning and discontinuation of respirators. *Chest* 2001; 120(6): 375-396.
12. **Umesan M.** Effect of inoue balloon mitral valvotomy on reverse of pulmonary hypertension in 315 patients with mitral stenosis. *J Heart Valve Dis* 2000; 9: 609-615.
13. **Joan A.** Partial improvement of pulmonary functions. after balloon mitral valvotomy. *Chest* 2000; 117: 643-648.
14. **Gortese D.** Pulmonary function in mitral stenosis. *Mayo Clinic Proc* 1978; 5: 321-326.
15. **Ray S, Dodds P, Wilson G, *et al*.** Effect of balloon mitral commissurotomy on the alveolar capillary membrane and pulmonary capillary volume in-patient with mitral stenosis. *Am J Cardio* 1994; 74:1068-1070.
16. **Yoshioka M.** Improvement in pulmonary function in mitral stenosis after percutaneous valvotomy. *Chest* 1990; 89: 290-294.
17. **Nishmura Y.** Effect of bronchial hyperreactivity in-patient with mitral valve disease. *Chest* 1990; 98: 1085-1090.
18. **Lauk KW, Hung JS, Ding ZP, Joan A.** Controversies in balloon mitral valve commissurotomy, timing of intervention, selection technique. *Cathet Cardiovasc Diagn* 1995; 35: 91-100.