

Indication and timing of percutaneous mitral balloon valvotomy and the role of atrial fibrillation

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Percutaneous transvenous mitral balloon valvotomy (PTMV) has been proven to be an effective and safe method for treatment of patients with severe mitral valve stenosis. This technique has become an accepted alternative for surgical commissurotomy, not only in young patients with pliable valves, but also in selected older patients with extensive valvular pathology. This review highlights the significance of coexisting atrial fibrillation, patient selection and timing of PTMV in patients with mitral valve stenosis. (*Neth Heart J* 2005;13:4-10.)

Key words: mitral valve stenosis, valvotomy, atrial fibrillation

Short- and long-term results of percutaneous mitral balloon valvotomy (PTMV) demonstrate the efficacy of PTMV and confirm that PTMV is a safe procedure.¹⁻⁸ In this review we highlight the significance of coexisting atrial fibrillation, patient selection and timing of PTMV in patients with mitral valve stenosis.

Atrial fibrillation

Atrial fibrillation (AF) is a common but often late complication of mitral stenosis.^{9,10} We have already reported that AF is an important predictor for unfavourable clinical outcome (death, reintervention or mitral valve replacement) and restenosis after PTMV.¹ Chronic AF was the only factor with predictive value for these events before intervention. The duration of

chronic AF was also important for its predictive value: if chronic AF at the time of PTMV had been present for more than one year, the risk of an event or restenosis during follow-up increased sevenfold.¹¹ The presence of AF was of predictive value for severe mitral regurgitation immediately following PTMV,¹¹ but this finding was seen in a small study group (n=140). In a larger group of patients (n=298) chronic AF was not predictive for this event.⁸

Factors such as age, NYHA class, left atrial dimension, averaged maximal and mean transmitral gradient as well as right atrial pressure were all found to be related to chronic AF in patients with mitral valve stenosis.¹¹ In our experience, all of the above-mentioned factors were of no predictive value for events during follow-up, except chronic AF.¹ This was comparable with the results of follow-up studies in small patient groups.^{12,13} In larger studies, however, factors related to chronic AF, became independent predictors in themselves.¹⁴⁻¹⁶ From these conflicting results it can be concluded that chronic AF as such does not increase the risk for adverse results immediately following PTMV or an event during follow-up, but all factors are associated with this arrhythmia. Chronic AF is related to progression of mitral valve stenosis and therefore reflects more severe morphological and haemodynamic abnormalities.¹¹

On the other hand, the rhythm disturbance itself will influence the event rate during follow-up after PTMV. It is known that AF in patients with mitral valve stenosis will reduce the cardiac output.¹⁷⁻¹⁹ Previous reports suggest that the conversion to sinus rhythm after PTMV will favour the exercise capacity of patients and contribute to improvement of NYHA class.^{17,20,21} Patients with mitral valve stenosis and chronic AF have a higher incidence of thromboembolic events compared with patients in sinus rhythm.²² Cardioversion of chronic AF to sinus rhythm may reduce the incidence of thromboembolic events because restoration of sinus rhythm reverts the process of left and right atrial enlargement in patients with chronic AF and mitral valve disease.²³ A large number of patients in chronic AF are on anticoagulant therapy, causing bleeding complications, compared with patients in or converted to sinus rhythm.

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Identification of AF as a predictor of poor prognosis and outcome pleads in favour of earlier PTMV in patients with tight mitral stenosis, to prevent this complication from occurring. In addition, these findings provide support for the strategy of restoring and maintaining sinus rhythm in patients with AF after PTMV.

Rhythm intervention after PTMV

When no action is undertaken to restore sinus rhythm following PTMV, chronic AF will persist.²⁴ However, because the electrophysiological basis for atrial fibrillation is reduced by PTMV,²⁵ it is presumed that the probability to restore sinus rhythm is increased following PTMV. Therefore we offered a flowchart for the selection of patients for cardioversion after PTMV (figure 1).²⁴ Cardioversion seems to be most successful in patients with a decrease in the maximal gradient ≤ 13 mmHg following PTMV and in younger patients when AF existed for more than one year.

The left atrial dimension is believed to be a factor influencing the results of cardioversion in patients with AF following closed mitral valvotomy.²⁶ However, in our limited study group this relation was not found

for PTMV.²⁴ Further studies are needed to determine patient subgroups after successful PTMV who should be selected for cardioversion and the criteria for this selection.

Selection of patients for PTMV

Symptoms

Truly asymptomatic patients with moderate to severe mitral stenosis (mitral valve area (MVA) < 1.5 cm²) are usually not candidates for PTMV, except in cases requiring urgent noncardiac surgery, patients planning pregnancy, or patients with an increased risk of embolism, such as those with recurrent atrial arrhythmias.

Mitral valve area

Moderate or severe mitral valve stenosis with MVA less than 1.5 cm² should be present. In many studies MVA is assessed by Doppler echocardiography, using the pressure half time (PHT) method.^{1,27,28} This measurement is easy to perform and can be reliably obtained for most patients with mitral valve stenosis.^{27,29} The PHT method is, however, an indirect measure-

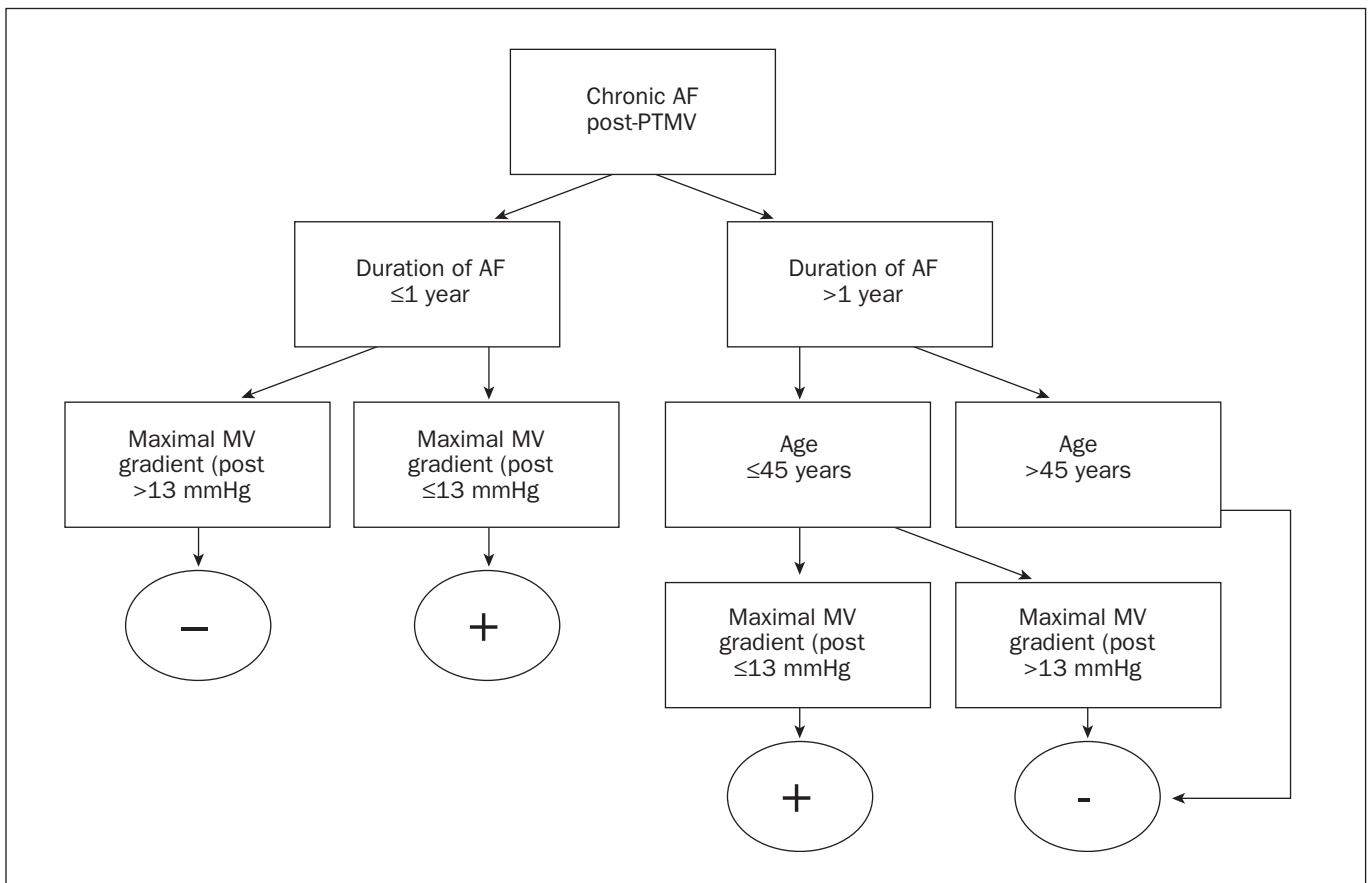


Figure 1. Flowchart for selection of patients with pre-existing chronic atrial fibrillation for cardioversion following PTMV. + candidate for cardioversion; - not a candidate for cardioversion. AF=atrial fibrillation, MV=mitral valve gradient, PTMV=percutaneous transvenous mitral balloon valvotomy, post=post-PTMV.

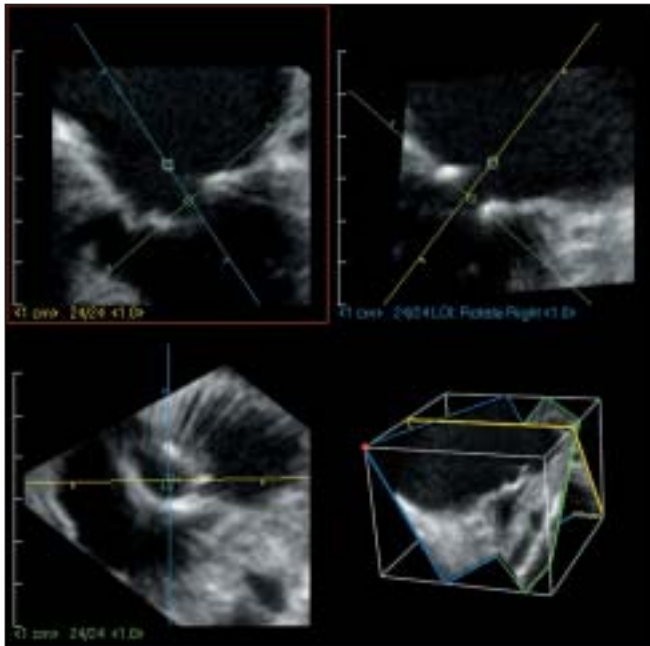


Figure 2. Mitral valve area measurement by planimetry using anyplane echocardiography. Two long-axis cut planes perpendicular to each other (A and B). By guidance of line of intersection, optimal short-axis cut plane was selected: the image that cut the mitral valve just at the cusp tips (C). 3D dataset and spatial alignment of 3 cut planes (D). (From: Langerveld J, Valocik G, et al. Additional value of three-dimensional transesophageal echocardiography for patients with mitral valve stenosis undergoing balloon valvuloplasty. *J Am Soc Echocardiogr* 2003;16:841-9.)

ment and can be influenced by haemodynamic variables, such as left atrial and ventricular compliance,³⁰ initial atrioventricular pressure gradient,³⁰ atrial septal defect³¹ and aortic regurgitation.^{32,33} In our experience

the MVA could be assessed in almost all patients by two-dimensional (2D) transthoracic (TTE) or transoesophageal echocardiography (TOE). However, in patients with a poor acoustic window or if the PHT method was not reliable, MVA assessed by three-dimensional (3D) TOE could be a valuable alternative (figure 2).³⁴

Mitral valve anatomy and morphological characteristics

The assessment of mitral valve anatomy has several aims when establishing the indications and prognostic factors for PTMV. It is important to ensure by 2D TTE or TOE that there are no contraindications for the technique, such as left atrial thrombus, mitral regurgitation more than grade II/IV, and extensive calcification of leaflet or subvalvular apparatus. With atrial thrombus, anticoagulation therapy should be started, and after six weeks TOE is required to check whether the thrombus is dissolving. In case of severe mitral regurgitation or extensive calcification, mitral valve replacement is indicated instead of PTMV.

Echocardiographic assessment allows the classification of patients into different prognostic groups with a view to predicting the results of PTMV. In our institution, like most investigators, we used the echocardiographic Wilkins score³⁵ (table 1), although some investigators do use a more general assessment of valve anatomy.^{4,36} In many studies the Wilkins score has been a significant predictor for outcome of PTMV in the short-^{2,12,36,37} as well as the long term.^{38,39} We found the Wilkins score to be of predictive value for a successful PTMV procedure;⁸ however, it was not of predictive value for the occurrence of severe mitral valve regurgitation following PTMV or for the occurrence of major cardiac events or restenosis during follow-up.¹ This is probably related to selection bias: our study

Table 1. Grading of mitral valve characteristics from the echocardiographic examination (Wilkins score).³⁵

Grade	Mobility	Subvalvular thickening
1	Highly mobile valve with only leaflet tips restricted	Minimal thickening just below the mitral leaflets
2	Leaflet mid and base portions have normal mobility	Thickening of chordal structures up to one third of the chordal length
3	Valve continues to move forward in diastole, mainly from the base	Thickening extending to the distal third of the chords
4	No or minimal forward movement of the leaflets in diastole	Extensive thickening and shortening of all chordal structures extending down to the papillary muscles
Grade	Thickening	Calcification
1	Leaflets near normal in thickness (4-5 mm)	A single area of increased echo brightness
2	Mid-leaflets normal, considerable thickening of margins (5-8 mm)	Scattered areas of brightness confined to leaflet margins
3	Thickening extending through the entire leaflet (5-8 mm)	Brightness extending into the mid-portion of the leaflets
4	Considerable thickening of all leaflet tissue (>8-10 mm)	Extensive brightness throughout much of the leaflet tissue

The total echocardiographic score was derived from an analysis of mitral leaflet mobility, valvular and subvalvular thickening, and calcification which were graded from 0 to 4 according to the above criteria. This gave a total score of 0 to 16.

Table 2. Echocardiographic score for severe mitral regurgitation after percutaneous mitral balloon valvotomy.⁴¹**II. Valvular thickening (score each leaflet separately)**

- 1 Leaflet near normal (4-5 mm) or with only a thick segment
- 2 Leaflet fibrotic and/or calcified evenly; no thin areas
- 3 Leaflet fibrotic and/or calcified with uneven distribution; thinner segments are mildly thickened (5-8 mm)
- 4 Leaflet fibrotic and/or calcified with uneven distribution; thinner segments are near normal (4-5 mm)

III. Commissural calcification

- 1 Fibrosis and/or calcium in only one commissure
- 2 Both commissures mildly affected
- 3 Calcium in both commissures, one markedly affected
- 4 Calcium in both commissures, both markedly affected

IV. Subvalvular disease

- 1 Minimal thickening of chordal structures just below the valve
- 2 Thickening of chordae extending up to one-third of chordal length
- 3 Thickening to the distal third of the chordae
- 4 Extensive thickening and shortening of all chordae extending down to the papillary muscle

The total score is the sum of these echocardiographic features (maximum 16).

patients were selected by their Wilkins score, a score of 8 or less was preferred for PTMV, and with a score >8 mitral valve replacement was preferred. We are convinced that the Wilkins score is a useful tool for the selection of patients for PTMV, considering the acceptable results during follow-up using this selection criterion. However, all echocardiographic classifications have the same limitations: 1. reproducibility is difficult, as the scores are only semiquantitative; 2. lesions may be underestimated, especially with regard to the assessment of subvalvular disease; and 3. the use of scores describing the degree of overall valve deformity may not identify localised changes in specific portions of the valve apparatus (leaflets, commissures), which may increase the risk of severe mitral regurgitation.⁴⁰ Therefore, we can only recommend that the user adopts the system he is most familiar and at ease with.

Probably other echocardiographic characteristics should be scored as well for the prediction of severe mitral regurgitation, as suggested by Padial et al.,^{41,42} who proposed a new echocardiographic score based on distribution of leaflet thickening and calcification (table 2). Further studies are required to determine the exact value of this score.

A new predictive factor for a successful PTMV procedure has been introduced, which can be assessed by 3D TOE: the mitral valve volume (MVV)

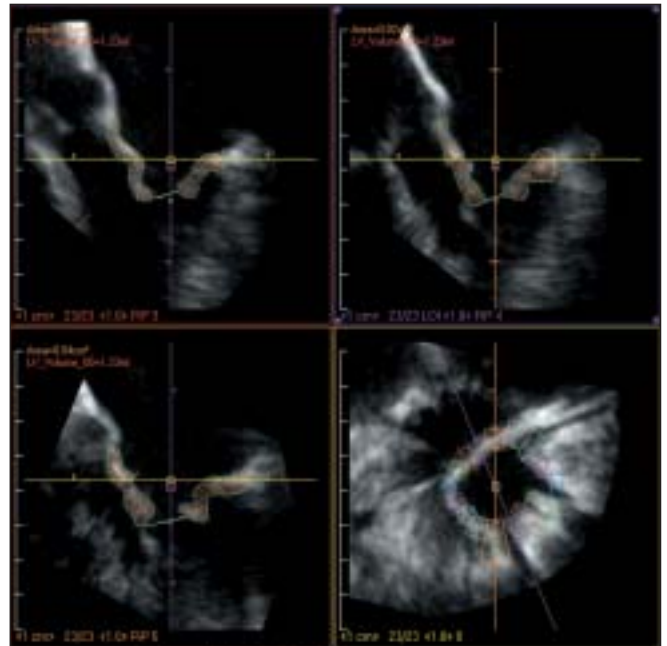


Figure 3. Volume measurement of mitral valve leaflets by anyplane echocardiography. Three long-axis cut planes constructed around centre axis of mitral apparatus (A, B and C). In these views, boundaries of mitral valve subvolumes were traced and their corresponding short-axis views are presented in short-axis cut plane (D). In all, 8 slices were used for volume computation. After the volume of each slice had been calculated, the system summed the corresponding subvolumes and finally calculated the volume of the whole mitral valve. (From: Langerveld J, Valocik G, et al. Additional value of three-dimensional transesophageal echocardiography for patients with mitral valve stenosis undergoing balloon valvuloplasty. *J Am Soc Echocardiogr* 2003;16:841-9.)

(figure 3).³⁴ We feel that the 3D MVV assessment can be used for the selection of patients for PTMV. However, a more standardised procedure of MVV measurement and further studies with a larger number of patients are required to define the relevance of MVV assessment by 3D echocardiography in clinical practice.

Elderly patients with more extensive mitral valvular disease

In selected elderly patients with more extensive valvular pathology, PTMV has become an accepted alternative for surgical commissurotomy.⁴³⁻⁴⁸ In this less favourable group the decision must be made for each case individually. Surgery is the preferred option in a patient with unfavourable echocardiographic characteristics, whereas balloon dilatation is a better option in patients at high surgical risk. Patients who refuse surgery or who cannot undergo surgery because of other serious comorbidity can be candidates for PTMV despite a Wilkins score >8. We confirmed that PTMV can be safely performed in selected patients with a suboptimal morphology with acceptable short-term results.⁸

However, care should be taken to adjust the balloon size in these patients.

Experience of the intervention team

The choice of therapy depends on the experience of the intervention team. In the course of time, experience with PTMV increased and hence more patients with a Wilkins score >8 were accepted for PTMV instead of surgical intervention. A learning curve of the intervention team is suggested in the literature.^{4,49-51} Jung et al. found in a study with 1514 patients that most failures of PTMV occur early in the investigator's experience.⁴ In multicentre studies⁴⁹ the mortality rate and the incidence of haemopericardium are higher compared with those from single large-volume centres.⁴ These findings reflect the importance of training.

Restenosis

Mitral valve stenosis is a lifelong progressive process which cannot be terminated by PTMV. Therefore, restenosis is expected during follow-up. The restenosis rate after PTMV ranges from 4 to 40%, depending on patient selection, duration and method of follow-up.^{12,36,52-54} In our long-term study, we found a restenosis rate of 28.3% after four years of follow-up.¹ Several studies suggest that repeat balloon commissurotomy is a valid option for symptomatic restenosis after a first successful procedure.^{55,56} Repeat PTMV can be performed safely and provides sustained mid-term functional improvement.

Most reports of repeat PTMV are in selected patients of young age with favourable valve anatomy.^{55,56} Therefore, re-PTMV is certainly the treatment of choice in these patients. In elderly patients with more calcified mitral valves showing restenosis following PTMV, the therapy of choice is not yet clear. The indications for this should be investigated in a randomised study, comparing re-PTMV and mitral valve replacement. Regarding the acceptable results of PTMV in patients with a more unfavourable anatomy of the mitral valve, we can assume that repeat PTMV can be performed, with acceptable risks and results.

Timing of PTMV

It is generally accepted that PTMV should be performed in patients with severe to moderate mitral valve stenosis ($MVA < 1.5 \text{ cm}^2$) who are symptomatic. However, when an asymptomatic patient with moderate to severe mitral valve stenosis and a low echocardiographic score (Wilkins score ≤ 8) develops an increased risk for an embolic event, for instance by developing atrial fibrillation, PTMV is advisable in order to prevent embolic complications and preserve sinus rhythm.

Patients with moderate to severe mitral stenosis, and moderate or severe pulmonary hypertension at rest (pulmonary artery systolic pressure $>50 \text{ mmHg}$) should be considered for PTMV, even if they have no (or deny) symptoms. When the haemodynamic exercise

test with Doppler echocardiography shows a rise in transmitral gradient $>15 \text{ mmHg}$ and a systolic pulmonary artery pressure $>60 \text{ mmHg}$, PTMV should be considered.⁵⁷

In patients with only mild symptoms and moderate to severe mitral valve stenosis, PTMV should be considered, especially if the patient develops atrial fibrillation and the echocardiographic score is low.

In patients with moderate to severe symptoms and moderate to severe mitral valve stenosis, PTMV is indicated. In this group a higher echocardiographic score can be accepted, especially if the risk for surgery is increased.

In pregnant patients with symptomatic mitral valve stenosis, medical treatment should be the first line of management. However, after failure of medical treatment PTMV is indicated. PTMV should not be attempted in the first trimester of pregnancy to prevent radiation damage during organogenesis.⁵⁸ Whether or not the valve anatomy (Wilkins score) should be taken into consideration in this condition, is debatable. A small increase in mitral valve area may be adequate to get the patient safely through pregnancy. Patients with severe mitral valve stenosis, who are symptomatic prior to conception, will not predictably tolerate the haemodynamic burden of pregnancy and should be considered for PTMV in advance.

Perspectives

Although the incidence of mitral valve stenosis is relatively low in Western countries, one should be aware of this disease. Especially nowadays with an immigration pattern from countries with a high prevalence of rheumatic fever in Western countries, incidence of mitral valve stenosis is expected to increase.⁵⁹

A severe complication of PTMV is tamponade or severe mitral valve regurgitation. In our experience 4.0% of patients required an acute intervention because of tamponade ($n=10$) or severe mitral valve regurgitation ($n=2$). Having seen these risks for complications and in view of the relatively small number of patients in almost 15 years of experience with PTMV in the Netherlands, it is advisable to continue performing this procedure in a limited number of centres with surgical back-up. PTMV should be performed by specialised interventional cardiologists. This will guarantee an experienced team and will provide the conditions needed for PTMV to be a relatively low-risk procedure.

If atrial fibrillation develops in patients with mitral valve stenosis, PTMV should no longer be postponed. Although increased frequency of complications immediately following PTMV and during follow-up can be expected, the presence of chronic atrial fibrillation existing for more than one year should not be seen as a contraindication for PTMV. In these patients the stepwise dilatation technique should be carried out with special care, and one should not be too eager to enlarge the mitral valve area, especially if the transmitral

gradient does not decrease after several balloon inflations. These recommendations should be evaluated in a prospective study. To evaluate the benefit of cardioversion following PTMV in patients with chronic atrial fibrillation a prospective study is needed as well, preferably combined with an electrophysiological study pre- and post-PTMV and during follow-up.

In the future there will probably be a role for 3D echocardiography in clinical practice for the management of mitral valve stenosis, especially for patient selection. More studies with larger patient populations are needed to underline this statement. Our findings about the mitral valve volume are promising.³⁴ ■

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