

Mitral Valve Commissurotomy: Which One between the Three Techniques Gives a Better Long-Term Outcome?

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Abstract

Objective: we sought to compare long-term results of three techniques: CMC, OMC and PMC in patients with rheumatic mitral stenosis. **Patients and Method:** Between January 1994 and December 2015, 183 patients underwent mitral valve surgery for rheumatic mitral restenosis. All patients were investigated by echocardiography-Doppler performed by a senior cardiologist. The patients were divided into 3 groups: patients who have previously closed mitral commissurotomy (CMC n = 101), patients with previously open mitral commissurotomy (OMC n = 28) and those treated by Balloon mitral valvuloplasty (PMC = 54). **Results:** The three groups were comparable in term of major demographic data. Mitral restenosis occurred precociously in groups treated by PMC (7 ± 4 years), followed by group with OMC 11.4 ± 4 years and CMC group but it occurred later CMC 16.8 ± 7.8 years ($p < 0.01$). No statistical difference was found in perioperative and postoperative data. **Conclusion:** CMC produces better long-term outcome than OMC and PMC. However, it would be premature to conclude to its superiority.

Keywords

Rheumatic Mitral Stenosis, Closed Mitral Commissurotomy, Open Mitral Commissurotomy, Balloon Mitral Valvuloplasty

1. Introduction

Rheumatic mitral stenosis (RMS) is a frequent cause of valve disease in developing countries. Its prevalence is at least 10 times higher than in western countries [1].

Treatment of RMS has dramatically changed during the last few decades. Depending upon the severity of the disease and the socio-economic level, the treatment modality varies and the choice may be either conservative technique or mitral valve replacement procedure.

There are three conservative measures to treat RMS: closed mitral commissurotomy (CMC), open mitral commissurotomy (OMC) or percutaneous mitral commissurotomy (PMC). It is estimated that about 10% to 30% of patients have developed restenosis 5 - 10 years after initial successful surgical commissurotomy [2].

There is a paucity of data comparing long-term results of three conservative techniques. Many questions are still open about which technique allows the excellent long-term outcome and avoids precocious mitral restenosis. This retrospective study was designed to compare the long-term results of the three conservative procedures.

2. Patients and Methods

Among 1535 Consecutive patients who underwent mitral valve surgery at our institution between January 1994 and December 2015, we identified 183 patients (11.9%) who had previously received mitral commissurotomy.

Patients are divided into three groups: Patients who had closed mitral commissurotomy (CMC, n = 101), patients with previous open commissurotomy (OMC, n = 28) and patients who underwent percutaneous mitral commissurotomy (PMC, n = 54).

All patients were discussed at heart-team by both the cardiologist and the cardiac surgeons.

All patients were investigated by 2 dimensional and color Doppler echocardiography performed by a senior cardiologist before surgery.

The mitral valve area (MVA) was calculated from the Doppler study using the pressure half-time method and by planimetry using the parasternal short axis, and the continuous wave Doppler technique was used to calculate the mitral gradient and systolic pulmonary artery pressure (SPAP). Left ventricular dimension and function and left atrium (LA) diameter were measured as recommended by the American society of Echocardiography [3]. Color Doppler flow imaging was performed for diagnosis and quantification of mitral regurgitation (MR).

The study included symptomatic patients with mitral restenosis, with MVA \leq 1.5 cm², isolated MRS or with \leq grade II MR. Were excluded from the study, patients with MR > grade II and those with evidence of coronary artery disease.

Clinical data including, NYHA functional class, comorbidities, echocardiographic data and surgical data are reported.

2.1. Surgical Protocol

Patients were operated on under general anesthesia and cardiopulmonary bypass (CPB). In redo cardiac surgery, redo sternotomy was performed carefully. Limiting mediastinal dissection to only those structures for cannulation and exposure may reduce mortality and risk of cardiac injury. After initiation of CPB,

myocardial protection was maintained by antegrade intermittent infusion of cold crystalloid cardioplegia before 2000, and cold blood cardioplegia was used for all patients after 2000.

The judgment criteria of long term result were the interval between the initial mitral commissurotomy and mitral restenosis.

2.2. Definitions of Complications

Complications were defined in accordance with the published guidelines for reporting valve related morbidity and mortality after cardiac valve surgery [4].

2.3. Statistical Analysis

Statistical analysis was performed with SPSS (Statistical Package for social science: SPSS Chicago, IL 19.0).

Data were reported as the mean SD or median with IQ.

3. Results

As shown in **Table 1**, the three groups were comparable in terms of major demographic data. The patients in the three groups were young and there were more female than male. Women's were predominantly corresponding to 71% of the patients in this study.

All patients were symptomatic with more than 60% being in NYHA functional class III-IV. Incidence of preoperative atrial fibrillation was higher in patients with previous CMC (72.3%) vs. 61% in patients with PMC and 57% in those with OMC ($p = 0.19$). But the low incidence of preoperative cerebrovascular accident was found in CMC group.

Echocardiographic data showed that patients with mitral restenosis after OMC had large left atrium diameter than other groups (OMC: 58 ± 12.5 mm vs. CMC: 53.9 ± 8.3 vs. 52 ± 9.2 mm in PMC with $p = 0.032$).

The mean MVA was also statistically different in the three groups: CMC: 1.05 ± 0.3 cm² vs. 1.05 ± 0.2 cm² in PMC group and 1.26 ± 0.4 cm² OMC group ($p = 0.01$).

But not differences were found between groups in regard to other echographic parameters (LV diameters, LV ejection function, pulmonary artery pressure). Mitral restenosis occurred precociously in patients who underwent PMC than other groups: mean time interval between initial mitral commissurotomy and restenosis was: 7 ± 4 years in PMC group vs. 11.4 ± 4 years in OMC group and 16.8 ± 7.8 years in CMC group ($p = 0.001$).

Comorbidities expressed by Euroscore were frequent in patients with CMC or OMC than those treated by PMC ($p = 0.001$).

The 30-day mortality was similar between all groups ($p = 0.98$). There was no significant difference in the postoperative complications. But patients with CMC and those with OMC required more RBC transfusion compared with group treated previously by BMC (CMC: 41.4% vs. OMC: 32.1% and PMC: 13.5%, $p = 0.002$) (**Table 2**).

Left atrial thrombosis was found only in 2 cases in group with OMC.

Table 1. Patient's baseline characteristics.

Variable	CMC (n = 101)	OMC (n = 28)	PMC (n = 54)	P
Age (years)	43.5 ± 9.7	38.7 ± 10.4	43.1 ± 9.8	0.071
Sex F/M	73/28	16/12	44/10	0.063
BMI kg/m ²	24.2 ± 3.9	23.3 ± 3	23.9 ± 3	0.48
NYHA class III - IV	59 (58.4%)	18 (64.3%)	34 (63%)	0.78
CTI	0.57 ± 0.06	0.58 ± 0.08	0.56 ± 0.05	0.31
AF n (%)	73 (72.3%)	16 (57%)	33 (61%)	0.19
Preop CVA n (%)	2 (2%)	3 (10.7%)	3 (5.6%)	0.11
Renal dysfunction	3 (3%)	0 (0%)	2 (3.7%)	0.6
CPOD (%)	6 (5.9%)	1 (3.6%)	1 (1.9%)	0.48
LA diameter mm	53.9 ± 8.3	58 ± 12.5	52 ± 9.2	0.032
LV ESD mm	33.9 ± 6	34.5 ± 7.5	34.4 ± 7.5	0.89
LV EDD mm	50.5 ± 7.2	53.2 ± 7.6	50.7 ± 8.8	0.3
RF (%)	32 ± 6.9	32.7 ± 6.8	31.9 ± 7.8	0.89
LV EF (%)	60.8 ± 9.4	61.5 ± 9.1	60 ± 9	0.77
SPAP mmHg	50.8 ± 20.5	53.4 ± 20.8	51.6 ± 15.7	0.83
MVA (cm ²)	1.05 ± 0.3	1.26 ± 0.4	1.05 ± 0.2	<0.01
Mitral valve gradient (mmHg)	10.8 ± 4.3	9.3 ± 2.6	12.2 ± 4	0.2
Time years Follow-up period	16.8 ± 7.8	11.4 ± 4	7 ± 4	<0.01
LV EF <40%	3 (3%)	1 (3.6%)	2 (3.7%)	0.96
Euroscore	4.84 ± 2	4.96 ± 2	1.73 ± 2.2	<0.01

AF: atrial fibrillation, BMI: body mass index, CPOD: Chronic obstructive pulmonary disease, CTI: cardiothoracic index, LA: left atrium, LVEDD: left ventricular end diastolic diameter, LVEF: left ventricular ejection fraction, LVESD: left ventricular end systolic diameter, MVA: mitral valve area, RF: racourissement fraction, SPAP: systolic pulmonary artery pressure.

Table 2. Early surgical results.

Variable	CMC (n = 101)	OMC (n = 28)	PMC (n = 54)	P
No elective surgery n (%)	1 (1%)	0 (0%)	1 (1.9%)	0.73
Mean CPB time (min)	102.5 ± 41	114.6 ± 43.8	109 ± 48	0.37
Mean Aortic Cross Clamp time (min)	69.4 ± 34.2	78.9 ± 32	74.3 ± 42	0.42
Mean surgical procedure time (min)	205.6 ± 56.3	234 ± 68	204.8 ± 51.3	0.054
Mean MV support-time (H)	9 (6 - 18)	10 (6 - 18)	5 (4 - 7)	0.19
ICU stay	24 (22 - 48)	44 (24 - 60)	38 (24 - 48)	0.67
Postoperative stay	12.8 ± 9	14.9 ± 9.6	11.6 ± 4.6	0.27
LOS n (%)	11 (10.9%)	4 (14.3%)	3 (5.6%)	0.39
Reexploration for bleeding n (%)	4 (4%)	1 (3.6%)	2 (3.8%)	0.99
Postoperative RI n (%)	4 (4%)	2 (7.2%)	4 (7.4%)	0.62
RBC transfusion n (%)	41 (41.4%)	9 (32.1%)	7 (13.5%)	<0.01
In hospital mortality rate n (%)	8 (7.9%)	2 (7.1%)	4 (7.4%)	0.98
MOF (%)	7 (7.1%)	2 (7.1%)	2 (3.9%)	0.73

CPB: cardio pulmonary bypass, ICU: intensive care unit, LOS: low out pout syndrome, RBC: red blood cell, MOF: multivisceral organe failure.

4. Discussion

Our study compared long-term results obtained after mitral commissurotomy for RMS performed with three techniques: CMC, OMC and PMC. The main criteria were mitral restenosis. The study showed that mitral restenosis occurred precociously in patients treated by PMC 7 ± 4 years followed by those treated by OMC 11.4 ± 4 years, However mitral restenosis occurred later in patients who had previous CMC 16.8 ± 7.8 years ($p = 0.001$).

Rheumatic mitral stenosis (RMS) is a frequent cause of valve disease in developing countries [5]. Its prevalence is at least 10 times higher than in developed countries [1]. Treatment of RMS has dramatically changed during the last few decades. Depending upon the severity of the disease, the treatment modality varies and the choice may be either conservative techniques: Closed mitral commissurotomy (CMC), open mitral commissurotomy (OMC), percutaneous mitral commissurotomy (PMC) or straight way mitral valve replacement (MVR). In most cardiac centers, in developing countries CMC has been the favored technique for the treatment of RMS for several reasons. Became the affected poor patients cannot afford the cost of replacement by mechanical or bio-prosthetic valve and CMC remains an alternative saving therapy for them. CMC was widely done with good results in major cities as early as the 1960. However some disadvantages of CMC are real and must be appreciated. Since 1970, numerous surgeons have abandoned CMC in such patients and do an OMC. This technique, allowing direct inspection and treatment of the valve and its subvalvular apparatus, gradually replaced closed technique. But CMC in expert hand is a safe alternative to OMC and PMC [6]. In 1984, the introduction of PMC once again modified the therapeutic strategy of RMS [7]. PMC not only avoids all the complications associated with a surgical operation, open or closed, but also is cost effective [8] [9]. Many comparative studies [10] [11] were performed between series of patients treated with different techniques trying to establish the superiority of the latest technique over the others. Until today, there are still controversies about the long term results when comparing the three conservative techniques. It is known that conservative procedure is not a definitive therapy for mitral stenosis but rather a temporary palliative measure.

Also, it is interesting to remember that mitral valve disease is a continuously progressive disease. Often, repeat intervention is necessary after a certain period of time. Few studies are performed on randomized series and had a relatively short follow-up [12]. There is one randomized and prospective study comparing the long term (7 years) clinical and echocardiographic follow-up of the three conservative procedures [13]. This study concluded that PMC and OMC produce excellent and comparable hemodynamic improvement and associated with a lower rate of restenosis and need for re-intervention when compared to CMC.

Despite its retrospective design, our study was performed in order to compare to three conservative techniques. We found that the three groups were homogeneous for preoperative clinical variables echocardiographic data.

Prolonged follow-up revealed that the incidence of restenosis was as high as

30% - 40% after 10 years, which resulted in an increasing number of patients needing reoperation. According to the large group case reports in china, Liu *et al* reported that the average time interval between the initial mitral commissurotomy and the reoperation was 13 ± 6.8 years. Our results showed that recurrence of mitral stenosis occurred later after CMC compared to reports published in the literature 16.8 ± 7.8 years. Older studies found that reoperation is required due to restenosis is usually after about 10 years [14] [15] [16]. With the progress in CPB and myocardial protection, CMC gradually gave way to open mitral commissurotomy. Choudhary *et al.* found that outcome of OMC is better than CMC and it provides excellent early and long term results in a selected group of patients [17].

Since mitral balloon valvuloplasty (PMC) was introduced in 1984 by Inoue [7] and its widespread application, it's an effective treatment option for significant RMS. The efficacy of BMV has been well documented and accompanied by similar outcome as other methods [18]. (Today a similar area can be obtained after PMC) [5] [19]. The immediate and long term results of BMV are similar to those of closed and open surgical commissurotomy in comparable groups of patients [19] [20] [21]. Moreover, some authors have shown PMC to be comparable or superior to CMC [22]. After PMC, approximately 7% to 21% of patients develop recurrent heart failure due to mitral restenosis [23] [24]. In our study, mitral restenosis occurred more frequently in patients who had PMC (7 ± 4 years). In one study, symptomatic mitral restenosis occurred 11 ± 4 years after PMC [25].

In the literature we have observed different restenosis frequency among the studies, ranging from 3 to 7 years. In recent report [26], mitral restenosis occurred in 44.1% of patients in a mean 49 ± 31 months follow-up. In the other hand, not all patients were found to have an optimal mitral valve area, and it suggested that the mechanism of successful PMC may be more complex than reported previously [27] [28].

Wang *et al.* [29] observed gradual and progressive loss of the mitral valve area, after PMC and absence of correlation Between MVA and restenosis, suggesting that it is a part of an ongoing biological process rather than mechanical or retraction process.

Numerous studies identified some factors that favor a more successful outcome as: young age, satisfactory valvular anatomy, echocardiographic score ≤ 8 , presence of sinus rhythm, absence of mitral regurgitation before the procedure, and absence of surgical mitral commissurotomy before the procedure [26] [30] [31].

Study Limitations

This study has several limits inherent to its retrospective design. Despite restenosis of mitral area occurred later after CMC, it is difficult to conclude its superiority than other techniques.

The three techniques were performed in different centers by different practitioners; hence, it is difficult to establish direct comparison among the three tech-

niques. The lack of data concerning mitral valve anatomy before BMV may not help to separate favorable cases (score >8).

5. Conclusion

This study showed that CMC and OMC produce excellent long-term results and have low rate mitral restenosis. However, it would be premature to come to a definitive conclusion inherent to study limitations.

References

- [1] Enio, E., Guerios, R.B., *et al.* (2005) Mitral Stenosis and Percutaneous mitral valvuloplasty (Part 1). *The Journal of Invasive Cardiology*, **17**, 382-386.
- [2] John, S., Perianayagam, W.J., Abraham, K.A., *et al.* (1978) Restenosis of Mitral Valve: Surgical Consideration and Result of Operation. *The Annals of Thoracic Surgery*, **25**, 316-321. [https://doi.org/10.1016/S0003-4975\(10\)63548-5](https://doi.org/10.1016/S0003-4975(10)63548-5)
- [3] Schiller, N., Shah, P., Crawford, M., De Maria, A., Devereux, R., Feigenbaum, H., Gutgesell, H., Reichek, N., Sahn, D., Schnittger, I. and Tajik, A., American Society of Echocardiography Committee on Standards, Subcommittee on Quantitation of Two-Dimensional Echocardiograms (1989) Recommendations for Quantitation of the Left Ventricle by Two-Dimensional Echocardiography. *Journal of the American Society of Echocardiography*, **2**, 358-367. [https://doi.org/10.1016/S0894-7317\(89\)80014-8](https://doi.org/10.1016/S0894-7317(89)80014-8)
- [4] Edmunds, L.H., Clark, L.H., Miller, D.C. and Weisel, R.D. (1988) Guidelines for Reporting Morbidity and Mortality after Cardiac Valvular Operations. *The Journal of Thoracic and Cardiovascular Surgery*, **86**, 351-353.
- [5] Farhat, M.B., Ayari, M., Maatouk, F., *et al.* (1998) Percutaneous Balloon Versus Surgical Closed and Open Mitral Commissurotomy: Seven-Year Follow-Up Results of a Randomized Trial. *Circulation*, **97**, 245-250. <https://doi.org/10.1161/01.CIR.97.3.245>
- [6] Ates, A., Unlu, Y., Yekeler, I., Erkut, B., Balci, A.Y., Ozyazicioglu, A. and Kocak, H. (2005) Role of Closed Mitral Commissurotomy for Mitral Stenosis: Mid- and Long-Term Surgical Outcome of 36 Patients. *The Heart Surgery Forum*, **8**, E55-E59.
- [7] Inoue, K., Owaki, T., Nakamura, T., Kitamura, F. and Miyamoto, N. (1984) Clinical Application of Transvenous Mitral Commissurotomy by a New Balloncatheter. *The Journal of Thoracic and Cardiovascular Surgery*, **87**, 394-402.
- [8] Rifaie, O., Abdel-Dayem, M.K., Ramzy, A., Ezz-El-Din, H., El-Ziady, G., El-Itriby, A., El-Sayed, H., Wagdy, H., Awadallah, H. and Nammas, W. (2009) Percutaneous Mitral Valvotomy versus Closed Surgical Commissurotomy. Up to 15 Years of Follow-Up of a Prospective Randomized Study. *Journal of Cardiology*, **53**, 28-34. <https://doi.org/10.1016/j.jcc.2008.08.003>
- [9] Cheng, T.O. (2003) No More Comparative Studies of Percutaneous Balloon Valvuloplasty versus Open Surgical Commissurotomy for Mitral Stenosis. *Cardiology*, **99**, 216. <https://doi.org/10.1159/000071253>
- [10] Hickey, M.S.J., Blackstone, E.H., Kirklin, J.W. and Dean, L.S. (1991) Outcome Probabilities and Life History after Surgical Mitral Commissurotomy: Implications for Ballon Commissurotomy. *Journal of the American College of Cardiology*, **17**, 29-42.
- [11] Raju, B.S., Turi, Z. and Raju, R. (1993) Three and One-Half Year Follow-Up of a Randomized Trial Comparing Percutaneous Balloon and Surgical Closed Mitral

Commissurotomy. *Journal of the American College of Cardiology*, **21**, 818.

- [12] Arora, R., Nair, M., Kalra, G.S., Nigam, M. and Khalilullah, M. (1993) Immediate and Long-Term Results of Balloon and Surgical Closed Mitral Valvotomy: A Randomized Comparative Study. *American Heart Journal*, **125**, 1091-1094.
- [13] Farhat, M.B., Ayari, M., Maatouk, F., Betbout, F., Gamra, H., Jarrar, M., Tiss, M., Hammami, S., Thaalbi, R. and Addad, F. (1998) Percutaneous Balloon versus Surgical Closed and Open Mitral Commissurotomy Seven-Year Follow-Up Results of a Randomized Trial. *American Heart Association*, **97**, 245-250.
<https://doi.org/10.1161/01.cir.97.3.245>
- [14] Nathaniels, E.K., Moncure, A.C. and Scannell, J.G. (1970) A Fifteen-Year Follow-Up Study of Closed Mitral Valvuloplasty. *The Annals of Thoracic Surgery*, **10**, 27-36. [https://doi.org/10.1016/S0003-4975\(10\)65561-0](https://doi.org/10.1016/S0003-4975(10)65561-0)
- [15] Fraser, K. and Sugden, B.A. (1977) Second Closed Mitral Valvotomy for Recurrent Mitral Stenosis. *Thorax*, **32**, 759-762.
- [16] John, S., Bashi, W., Jairaj, P.S., *et al.* (1983) Closed Mitral Valvotomy: Early Results and Long-Term Follow-Up of 3724 Consecutive Patients. *Circulation*, **68**, 891-896.
<https://doi.org/10.1161/01.CIR.68.5.891>
- [17] Choudhary, S.K., Dhareshwar, J., Govil, A., Airan, B. and Kumar, A.S. (2003) Open Mitral Commissurotomy in the Current Era: Indications, Technique, and Results. *The Annals of Thoracic Surgery*, **75**, 41-46.
[https://doi.org/10.1016/S0003-4975\(02\)04276-5](https://doi.org/10.1016/S0003-4975(02)04276-5)
- [18] De Souza, J.A.M., Martinez Jr, E.E., Ambrose, J.A., Alves, C.M.R., Born, D., Buffolo, E. and Carvalho, A.C.C. (2001) Percutaneous Balloon Mitral Valvuloplasty in Comparison with Open Mitral Valve Commissurotomy for Mitral Stenosis during Pregnancy. *Journal of the American College of Cardiology*, **37**, 900-903.
[https://doi.org/10.1016/S0735-1097\(00\)01184-0](https://doi.org/10.1016/S0735-1097(00)01184-0)
- [19] Turi, Z.G., Reyes, V.P., Raju, B.S., *et al.* (1991) Percutaneous Balloon versus Surgical Closed Commissurotomy for Mitral Stenosis: A Prospective, Randomized Trial. *Circulation*, **83**, 1179-1185. <https://doi.org/10.1161/01.CIR.83.4.1179>
- [20] Reyes, V.P., Raju, B.S., Wynne, J., *et al.* (1994) Percutaneous Balloon Valvuloplasty Compared with Open Surgical Commissurotomy for Mitral Stenosis. *The New England Journal of Medicine*, **331**, 961-967.
<https://doi.org/10.1056/NEJM199410133311501>
- [21] Pathan, A.Z., Mahdi, N.A., Leon, M.N., Lopez-Cuellar, J., Simosa, H., Block, P.C., Harrell, L. and Palacios, I.F. (1999) Is Redo Percutaneous Mitral Balloon Valvuloplasty (PMV) Indicated in Patients with Post-PMV Mitral Restenosis? *Journal of the American College of Cardiology*, **34**, 49-54.
- [22] Essop, R., Rothlisberger, C., Dullabh, A. and Sareli, P. (1995) Can the Long Term Outcomes of Percutaneous Balloon Mitral Valvotomy and Surgical Commissurotomy be Expected to Be Similar? *The Journal of Heart Valve Disease*, **4**, 446-452.
- [23] Cohen, D.J., Kuntz, R.E., Gordon, S.P.F., *et al.* (1992) Predictors of Long-Term Outcome after Percutaneous Mitral Valvuloplasty. *The New England Journal of Medicine*, **327**, 1329-1335. <https://doi.org/10.1056/NEJM199211053271901>
- [24] Iung, B., Cormier, B., Ducimetiere, P., *et al.* (1996) Functional Results 5 Years after Successful Percutaneous Mitral Commissurotomy in a Series of 528 Patients and Analysis of Predictive Factors. *Journal of the American College of Cardiology*, **27**, 407-414. [https://doi.org/10.1016/0735-1097\(95\)00481-5](https://doi.org/10.1016/0735-1097(95)00481-5)
- [25] EidFawzy, M., Hassan, W., Shoukri, M., Al Sanei, A., Hamadanchi, A., El Dali, A. and Al Amri, M. (2005) Immediate and Long-Term Results of Mitral Balloon Val-

valvotomy for Restenosis Following Previous Surgical or Balloon Mitral Commissurotomy. *American Journal of Cardiology*, **96**, 971-975.

<https://doi.org/10.1016/j.amjcard.2005.05.055>

- [26] Borges, I.P., Peixoto, E.C.S., Peixoto, R.T.S., de Oliveira, P.S., Netto, M.S., Labrunie, P., Labrunie, M., Peixoto, R.T.S. and de Amorim, V.R. (2005) Percutaneous Mitral Balloon Valvotomy. Long-Term Outcome and Assessment of Risk Factors for Death and Major Events. *Arquivos Brasileiros de Cardiologia*, **84**, 397-404.
- [27] Fatkin, D., Roy, P., Morgan, J.J. and Feneley, M.P. (1993) Percutaneous Balloon Mitralvalvotomy with the Inoue Single-Balloon Catheter: Commissural Morphology as a Determinant of Outcome. *Journal of the American College of Cardiology*, **21**, 390-397. [https://doi.org/10.1016/0735-1097\(93\)90680-Y](https://doi.org/10.1016/0735-1097(93)90680-Y)
- [28] Hasan-Ali, H., Shams-Eddin, H., Abd-Elsayed, A.A. and Maghraby, M.H. (2007) Echocardiographic Assessment of Mitral Valve Morphology after Percutaneous Transvenous Mitral Commissurotomy (PTMC). *Cardiovascular Ultrasound*, **5**, 48.
- [29] Wang, A., Krasuski, R.A., Warner, J.J., *et al.* (2002) Serial Echocardiographic Evaluation of Restenosis after Successful Percutaneous Mitral Commissurotomy. *Journal of the American College of Cardiology*, **39**, 328-334. [https://doi.org/10.1016/S0735-1097\(01\)01726-0](https://doi.org/10.1016/S0735-1097(01)01726-0)
- [30] Palacios, I.F., Tuzcu, M.E., Weyman, A.E., Newell, J.B. and Block, P.C. (1995) Clinical Follow-Up of Patients Undergoing Percutaneous Mitral Balloon Valvotomy. *Circulation*, **91**, 671-676. <https://doi.org/10.1161/01.CIR.91.3.671>
- [31] Hildick-Smith, D.J., Taylor, G.J. and Shapiro, L.M. (2000) Inoue Balloon Mitral Valvuloplasty: Long-Term Clinical and Echocardiographic Follow-Up of a Predominantly Unfavourable Population. *European Heart Journal*, **21**, 1690-1697. <https://doi.org/10.1053/euhj.2000.2241>



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