

## Inoue풍선을 이용한 경피적 승모판막성형술후 추적관찰

고영엽 · 현민수 · 김정경

## Follow-Up Assessment after Percutaneous Mitral Valvuloplasty (PMV) with Inoue Balloon

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## ABSTRACT

**Background :** Percutaneous Mitral Valvuloplasty (PMV) is the first-line treatment modality in selected patients with symptomatic mitral stenosis and more recently available Inoue single-balloon catheter technique produces good results with low incidence of complications. The purpose of this study was to evaluate the immediate and over 6 months follow-up results after successful PMV with an Inoue balloon and to identify the predictive factors for the results. **Methods :** From May 1995 to February 1997, a PMV with an Inoue balloon was technically successful in 114 (95%) of the 119 patients treated at the Sejong General Hospital. In this study, a series of echocardiographic follow-up were performed in 54 patients with rheumatic mitral stenosis, at least 6 months after their successful PMV. In PMV, the inflation was conducted in steps, starting with a recommended maximum size of balloon by the Inoue criteria. After each inflation, the mitral valve opening and competence were evaluated by Transesophageal echocardiography (TEE) and continuing increase balloon size. **Results :** Echocardiographic follow-up assessment was performed in 54 patients serially in a interval of 3 months or 6 months. Their mean age was  $46 \pm 11$  years (24 to 66 years) and the mean total echocardiographic score was  $7.1 \pm 1.6$ . A optimal result was obtained in 95% of the cases (51/54). The post-PMV mitral valve area increased to  $1.95 \pm 0.37$  cm<sup>2</sup> and  $1.79 \pm 0.28$  cm<sup>2</sup> by 2-D and Doppler method, the average transmitral mean diastolic pressure gradient decreased to  $5.16 \pm 2.8$  mmHg and LA pressure was decreased to  $11.28 \pm 8.2$  mmHg. The newly developed and aggravated mitral regurgitation was observed in 17 patients (31.5%). The restenosis was noted in 2 cases (3.7%) after 1 year follow-up. The pre-procedural echocardiographic score for leaflet mobility, thickening and calcification was more higher in patients with restenosis. There was significant tendency of decrement in the mitral valve area in patients with a echocardiographic score  $\geq 8$  compared with those  $\leq 8$  over 6 months after the PMV. **Conclusion :** PMV with the Inoue balloon under TEE guide as a combined treatment modality of patient with symptomatic mitral stenosis is relatively safe and achieves good immediate and midterm follow-up results. The echocardiographic score is considered as useful predictor of midterm results and restenosis after PMV with Inoue balloon. (Korean Circulation J 1998;28(11):1841-1851)

**KEY WORDS :** Percutaneous mitral valvuloplasty (PMV) · Inoue balloon.

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PMV , 2 , 3 , 6 , 1 , 1 11.6±5.6 48 2D (Echo - Score) 가 (Wilkins GT et al., 1988) Parasternal Short Axis View 가 Planimetry Apical 4 - Chamber View Co - ntinuous Wave Doppler Pressure Half Time 2 - D 가 Pulsed Wave Doppler Color Doppler Flow Mapping +1 +4 4 가

PMV 6 PMV 가 50% (Restenosis) PMV , Paired t - test SPSS/PC + P 0.05 가

## 결 과

PMV시술의 성공률 119 114 95.8% 가 Grade II PMV 가 5 가 PMV 54 51 (94.4%) (Optimal res - ults) 3 (5.6%) (Subopti - mal results)

PMV ( GIII) 1.5 cm<sup>2</sup> 가 25% 가 PMV 가 (Optimal group) , 가 (Suboptimal group)

승모판구면적 및 좌심방과 좌심실의 변화 2 - D Pressure Half Time 1.00±0.24 cm<sup>2</sup> 0.93±0.17 cm<sup>2</sup> 1.95±0.37 cm<sup>2</sup>(p<0.001), 1.79±0.28 cm<sup>2</sup>(p<0.001) 가 3 1 1.5 cm<sup>2</sup> 57.61±9.3% 60.1±7.3%, 3 63.1±7.1% 가 가 6 63.0±8. , 1

**Table 2.** Changes of echocardiographic variables before, after PMV, at 3months, at 6 months and further longterm follow-up for 54 patients with underwent PMV

|                              | pre-PMV     | post-PMV    | 3mo FU      | 6mo FU      | 12mo FU     | Last FU     |
|------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|
| MVA : 2D (cm <sup>2</sup> )  | 1.00 ± 0.24 | 1.95 ± 0.37 | 1.72 ± 0.33 | 1.72 ± 0.30 | 1.77 ± 0.32 | 1.81 ± 0.21 |
| MVA : PHT (cm <sup>2</sup> ) | 0.93 ± 0.17 | 1.79 ± 0.28 | 1.55 ± 0.21 | 1.61 ± 0.29 | 1.56 ± 0.20 | 1.63 ± 0.25 |
| TMG (mmHg)                   | 12.3 ± 5.2  | 5.16 ± 2.8  | 5.29 ± 2.3  | 5.38 ± 1.7  | 4.95 ± 1.17 | 5.06 ± 2.74 |
| LAD (mm)                     | 57.5 ± 6.3  | 48.7 ± 7.5  | 50.1 ± 7.1  | 49.7 ± 8.4  | 47.6 ± 7.1  | 49.4 ± 6.3  |
| EF (%)                       | 57.5 ± 9.3  | 60.1 ± 7.3  | 63.1 ± 7.1  | 63.0 ± 8.1  | 61.0 ± 6.6  | 59.0 ± 7.2  |

MVA : Mitral valve area, TMG : Transmitral mean pressure gradient  
LAD : Left atrial dimension, EF : Left ventricular ejection fraction

1%, 61.0 ± 6.6% 59.0 ± 7.2%

57.5 ± 6.3 mm 48.7 ± 7.5 mm (p=0.031)

(Table 2).

혈역학적 소견의 변화

12.3 ± 5.2 mmHg 5.16 ± 2.8 mmHg (p<0.001)

3, 6, 1

5.29 ± 2.3 mmHg, 5.38 ± 1.7 mmHg, 4.95 ± 1.17 mmHg 5.06 ± 2.74 mmHg  
가 .

21.74 ± 9.28 mmHg 11. 28 ± 8.20 mmHg (p<0.001)

시술후 승모판폐쇄부전

54 50

4 Grade I

54

(16 ) 가 가

(1 )가 17 (31.5%) Grade 1 가 가

16 (94%), Grade 2가 가 가 1 (6%) .

Grade III

Grade II

2 1

(Table 3).

합병증의 발생

119 PMV Grade III 4 (3.4%)

**Table 3.** Mitral regurgitation(MR) after PMV by PW Doppler and color doppler mapping

|                                       |    |
|---------------------------------------|----|
| Previous No MR                        | 50 |
| New MR occurred                       | 16 |
| Previous MR( GII)                     | 4  |
| No change of grade                    | 3  |
| Increased grade                       | 1  |
| MR developed or increased in severity |    |
| Increment of Grade 1                  | 16 |
| Increment of Grade 2                  | 1  |
| Final MR                              |    |
| Grade I                               | 15 |
| Grade II                              | 2  |

MR developed or increased in severity after PMV in 17(31.5%) patients.

가 1 ,

가 1

1

2

(Chordal Rupture)

(0.9%)

Pigtail

PMV (Table 4).

경피적 승모판막성형술 직후 초기결과에 따른 비교

Optimal Suboptimal

, , ,

Suboptimal

34 Optimal 46.5  
가 67%

**Table 4.** Complications after PMV

| Complication               | No.         |
|----------------------------|-------------|
| Mitral regurgitation( 3)   | 4/119(3.4%) |
| MV tearing with PM rupture | 1/119(0.9%) |
| PM rupture                 | 1/119(0.9%) |
| Chordal rupture, only      | 2/119(1.7%) |
| MVR or MVP                 | 2/119(1.7%) |
| Cardiac tamponade          | 1/119(0.9%) |
| Significant ASD            | 0/119       |
| Bleeding(requiring BTF)    | 0/119       |
| Thromboembolism            | 0/119       |
| Death                      | 0/119       |

PM : Papillary muscle, MVR : Mitral valve replacement  
MVP : Mitral valvuloplasty, ASD : Atrial septal defect  
BTF : Blood transfusion

**Table 5.** Predictors for the immediate outcomes after PMV

| Baseline Variables                        | Outcomes      |                 |
|-------------------------------------------|---------------|-----------------|
|                                           | Optimal(n=51) | Suboptimal(n=3) |
| Age*(yr)                                  | 46.5 ± 11.3   | 34.0            |
| Male/Female                               | 10/41         | 1/2             |
| NSR/AF                                    | 25/26         | 0/3             |
| Total echo score                          | 7.11 ± 1.6    | 7.00 ± 1.4      |
| Mitral valve area (cm <sup>2</sup> )      |               |                 |
| Pre-PMV                                   | 0.93 ± 0.17   | 0.90 ± 0.10     |
| Post-PMV                                  | 1.82 ± 0.25   | 1.37 ± 0.38     |
| LA dimension (mm)                         | 52.8 ± 6.5    | 52.0 ± 3.6      |
| LA pressure (mmHg)                        | 21.8 ± 9.6    | 20.0 ± 1.0      |
| Transmitral mean pressure gradient (mmHg) | 12.2 ± 5.3    | 13.7 ± 3.3      |
| MR increment                              | 15/51(29%)    | 2/3( 67%)       |
| 2nd stage ballooning                      | 43/51(84%)    | 3/3(100%)       |

\*p<0.05

Optimal 29% (Table 5).

장기간 추적관찰시 비재협착군과 재협착군의 비교

11.6 ± 5.6

, Event가  
50% 2  
, PMV  
가  
가  
가

**Table 6.** Pre & post-PMV clinical, echocardiographic & procedural variables in 54 patients between group without restenosis & with restenosis

| Variables                                 | Without Estenosis (n=52) | With Restenosis (n=2) |
|-------------------------------------------|--------------------------|-----------------------|
| Age(yr)                                   | 45.5 ± 11.4              | 52 ± 8.5              |
| Male/Female                               | 11/41                    | 0/2                   |
| NSR/AF                                    | 24/28                    | 1/1                   |
| LVEF(%)                                   |                          |                       |
| Pre-PMV                                   | 57.4 ± 9.5               | 60 ± 1.4              |
| Post-PMV                                  | 60.2 ± 7.5               | 58.5 ± 1.4            |
| Total echo score                          | 7.03 ± 1.55              | 8.25 ± 2.48           |
| Mobility*                                 | 1.69 ± 0.45              | 2.0 ± 1.41            |
| Thickness*                                | 1.75 ± 0.65              | 2.0 ± 0.0             |
| Calcification*                            | 1.6 ± 0.65               | 2.0 ± 0.0             |
| Subvalvular thickening                    | 1.96 ± 0.58              | 2.25 ± 1.06           |
| Mitral valve area(cm <sup>2</sup> )       |                          |                       |
| Pre-PMV                                   | 0.93 ± 0.2               | 0.95 ± 0.1            |
| Post-PMV                                  | 1.78 ± 0.3               | 1.80 ± 0.1            |
| LA dimension(mm)                          |                          |                       |
| Pre-PMV                                   | 52.8 ± 6.2               | 52.0 ± 12.7           |
| Post-PMV                                  | 48.5 ± 7.5               | 50.5 ± 9.9            |
| LA pressure(mmHg)                         |                          |                       |
| Pre-PMV                                   | 21.6 ± 9.4               | 24.5 ± 4.9            |
| Post-PMV                                  | 11.4 ± 8.2               | 12 ± 7.9              |
| Transmitral mean pressure gradient (mmHg) |                          |                       |
| Pre-PMV                                   | 12.4 ± 5.2               | 10.5 ± 6.4            |
| Post-PMV                                  | 5.2 ± 2.8                | 5.0 ± 1.4             |
| MR increment                              | 17/52(33%)               | 0                     |
| 2nd stage ballooning                      | 44/52(85%)               | 2/2(100%)             |

\* p<0.05

, 가

17

(Table 6).

심초음파점수 8이하군과 8초과군의 비교

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가 6

**Table 7.** Comparison of clinical and echocardiographic variables before and after PMV, above 6 months and further long term follow-up between group with echocardiographic score of 8 or less and more than 8

| Variables                                 | Echo score > 8<br>(n=8) | Echo score ≤ 8<br>(n=46) |
|-------------------------------------------|-------------------------|--------------------------|
| Age(yr)                                   | 50.8 ± 9.7              | 45.3 ± 11.6              |
| Male/Female                               | 1/7                     | 10/36                    |
| NSR/AF                                    | 3/5                     | 22/24                    |
| Mitral valve area(cm <sup>2</sup> )       |                         |                          |
| Pre-PMV                                   | 0.89 ± 0.20             | 0.93 ± 0.16              |
| Post-PMV                                  | 1.86 ± 0.25             | 1.79 ± 0.30              |
| 6mo F/U*                                  | 1.50 ± 0.25             | 1.65 ± 0.27              |
| Long term F/U*                            | 1.47 ± 0.23             | 1.60 ± 0.16              |
| LA dimension(mm)                          |                         |                          |
| Pre-PMV                                   | 56.3 ± 6.7              | 52.2 ± 6.3               |
| Post-PMV                                  | 48.0 ± 8.6              | 48.9 ± 7.5               |
| LA pressure(mmHg)                         |                         |                          |
| Pre-PMV                                   | 19.3 ± 8.7              | 22.5 ± 9.7               |
| Post-PMV                                  | 12.4 ± 5.9              | 11.4 ± 9.1               |
| Transmitral mean pressure gradient (mmHg) |                         |                          |
| Pre-PMV                                   | 11.1 ± 4.3              | 12.5 ± 5.6               |
| Post-PMV                                  | 5.1 ± 3.5               | 5.1 ± 2.7                |
| MR increment                              | 5/8 (63%)               | 12/46 (26%)              |
| 2nd stage ballooning                      | 7/8 (88%)               | 39/46 (85%)              |

\* P<0.05

| Planimetry | Doppler Method                                          |
|------------|---------------------------------------------------------|
| 8          | 1.50 ± 0.25 cm <sup>2</sup> 1.47 ± 0.23 cm <sup>2</sup> |
| 8          | 1.65 ± 0.27 cm <sup>2</sup> 1.60 ± 0.16 cm <sup>2</sup> |
| 8          | 63% (5/8) 26% (12/46)                                   |
|            | (Table 7).                                              |

## 고 안

Inoue 가  
(Commissural Splitting) Inoue  
PMV

3)9)19 - 21)28) 가  
Inoue ,  
3 가 가  
가  
22 - 25)27)  
6)  
가  
29 - 34)  
PMV  
가  
가  
가  
1  
가  
PMV  
가  
29 - 34)  
Inoue Inoue  
3 6

PMV, 160 cm, 175 cm, 28 mm, 175 cm, 30 mm, Feldman<sup>26)</sup>, 180 cm, 30 mm, Inoue.

PMV Inoue

Doppler

2-D Planimetry 1, Gorlin 2-D

가

가가 PMV 1 2 mm 가

(Co - 24 . 가

48 가

28)35 - 36) 가

1.8 cm<sup>2</sup> 2.4 cm<sup>2</sup> . In - , Nobuyoshi<sup>7)</sup> 1.4 ± 0.4 cm<sup>2</sup> 2.0 ± 0.5 cm<sup>2</sup> 가 , Chen<sup>17)</sup> Feldman<sup>26)</sup> 1.1 ± 0.4 cm<sup>2</sup> 2.0 ± 0.4 cm<sup>2</sup> 가 가, 1.0 cm<sup>2</sup> 1.8 cm<sup>2</sup> 가 가 60 82% . PMV Planimetry 1.00 ± 0.24 1.95 ± 0.37 가 cm<sup>2</sup> , - 0.93 ± 1.7 cm<sup>2</sup> 1.79 ± 0.28 cm<sup>2</sup> 가 92 95% . Abascal<sup>37)</sup> 가 96% , Abdullah<sup>24)</sup> 97%, Chen<sup>17)</sup> 96% 가 50% 가 38 - 39) Hung<sup>14)</sup> 81. 8% . ( , , Total Echo Score가 PMV , PMV 가 )가 . Vahanian<sup>27)</sup> 4%

Trefoil PMV

Suboptimal Optimal 46.5 . (Paracommissural Tear) Chordae 가가 PMV Chordae 가 Inoue Chordae 가 Chen<sup>17)</sup> 가 4 cm<sup>2</sup>/m<sup>2</sup> . PMV 26.7 ± 1.6 mm Hung 가 14) 10 10 Crescent Inoue 23) 10 Bassand 160 cm 26 mm,

가 Bassand <sup>23)</sup> PMV ,  
가 가 PMV  
가  
가 , 8 , 8 8  
Technique PMV 6 8  
8 20% 40 - 41) PMV 가 26% 31.5%, 8  
가 가 63%  
4.3% 53% PMV  
30% 가 가  
5)9)23)27)37 - 38) Inoue 5.6  
33% 7)13)18)24)37)  
54 17 (31.5%) 가 ,  
가 1 가 PMV  
Grade I  
가 가 17 PMV  
Belcher<sup>42)</sup> Heger <sup>43)</sup> 11 14 , PMV  
28%, Lyons <sup>44)</sup> Ravkilde <sup>45)</sup> 5 119 PMV 가  
25% , Higgs <sup>46)</sup> 6 9 54  
11% 11.6 ± 6 가  
Pala -  
cio <sup>5)</sup> 1  
22% , Al Zaibag <sup>4)</sup> 1 가  
가 Inoue 6  
27 ± 11 1. 4% 가  
Chen <sup>47)</sup> 5 ± 1  
6.8% Inoue  
Sim <sup>48)</sup>  
가 1  
13 ± 4 가 50% Inoue  
Inoue  
47% 18% (Midterm Results)  
1 가  
, 3.7%  
PMV 요 약  
PMV PMV  
PMV NYHA , , 연구배경 :  
, 15)17 - 18) Inoue



목 적 :

Inoue

가

중심 단어 :

Inoue

방 법 :

1995 5 1997 2

Inoue

, 3

, 6 , 12

성 적 :

1997 8 , 6 가

54 ( 11 , 43 ) ,

46 ± 11 11.56 ± 5.6

가 25 (46%),

29 (54%) 54

51 95%

. 2 - D Pressure Half Time

1.00 ± 0.24 cm<sup>2</sup> 0.93

± 0.17 cm<sup>2</sup> 1.95 ± 0.37 cm<sup>2</sup> (p < 0.001), 1.7

9 ± 0.28 cm<sup>2</sup> (p < 0.001) 가 1

1.5 cm<sup>2</sup> 13.3

± 5.2 mmHg 5.16 ± 2.8 mmHg (P < 0.05)

가

57.61 ± 9.3%

60.1 ± 7.3%, 3 63.21 ± 7.48%

가 .

17 (31.5%) ,

(3.7%) .

, , 가

6 8

8

결 론 :

Inoue

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