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EFFECT AND LIMITATION OF INTRA-AORTIC BALLOON PUMPING FOLLOWING VALVE REPLACEMENT SURGERY

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INDEXING WORDS

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SYNOPSIS

To evaluate the effect and the limitation of intra-aortic balloon pumping (IABP) in patients with severe left ventricular failure (LVF) following valve replacement surgery, we assessed the results of 282 patients who underwent such surgery. Among 25 patients in whom IABP was used after valve replacement, 17 patients could be weaned from IABP, and 14 of them achieved long-term survival. The durations of IABP support for patients who were weaned from IABP were shortened and were mostly within 48 hours, whereas those in patients not weaned from IABP tended to be prolonged. Among 25 IABP patients, 8 had definite causes of LVF such as perioperative myocardial infarction, but the other 17 patients experienced LVF despite uneventful operation. In the latter group of patients, preoperatively depressed left ventricular function was observed in 10 patients. In the former group of patients, the duration of IABP was much longer, and the weaning rate, as well as survival rate, was significantly poorer. On the other hand, in the latter-group patients, the duration of IABP was shortened and the survival rate was excellent. In conclusion, IABP support for patients with postoperative LVF of unknown causes, which might include patients with preoperatively depressed left ventricular function, was sufficiently effective, whereas no significant effect of IABP was noted for patients experiencing LVF after definite and serious perioperative complications.

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INTRODUCTION

Intra-aortic balloon pumping (IABP) has been employed widely as a means of mechanical circulatory assistance in patients who had experienced serious left ventricular failure (LVF) after cardiac operation, and the effect of this device on the improvement of cardiac function is well documented [3, 7, 10, 13, 15, 19, 22]. However, it was also recognized that despite IABP support, there are some patients who cannot be saved from such postoperative LVF [1,5,11,21]. On the basis of this recognition, we assessed the results of valve replacement surgery in patients with valvular heart disease, to evaluate the effects and the limitations of IABP in patients with severe LVF following such surgery.

MATERIALS AND METHODS

Two hundred and eighty-two patients who had undergone valve replacement surgery in our institute between January 1980 and December 1990 were assessed. Patients with *redo* valve replacement surgery or concomitant coronary bypass surgery were excluded from this study. We also excluded patients in whom IABP had been initiated from the preoperative period due to intractable LVF. Among these 282 patients, 89 patients received aortic valve replacement mainly due to aortic stenosis or regurgitation (ranging in age from 25 to 73 years old with an average of 50 years), 148 patients with mitral valve replacement mainly due to mitral stenosis or regurgitation (from 26 to 73 years old with an average of 51 years), and 45 patients with double valve replacements due to combined aortic and mitral valve disease (from 33 to 71 years old with an average of 50 years).

The criteria for IABP application were as follows: profound LVF associated with low systolic blood pressure ($\leq$80 mmHg), high left atrial pressure ($\geq$ 20 mmHg), and low cardiac output ($\leq$2.0 l/min/m^2) in spite of the administration of a large amount of catecholamines with appropriate volume loading. According to these criteria, IABP was used in 25 patients after valve replacement, among them IABP was applied for the removal of the cardiopulmonary bypass in 23 patients. In the remaining 2 patients, IABP support was necessary due to recurrent LVF in the immediate postoperative period after the removal of the cardiopulmonary bypass. The IABP was inserted from the femoral artery in all patients by percutaneous femoral puncture or by femoral arteriotomy.

The parameters examined were as follows: preoperative cardiac status

determined by the old New York Heart Association (NYHA) functional classification, preoperative hemodynamic parameters derived from cardiac catheterization (cardiac index, pulmonary wedge pressure, left ventricular ejection fraction and left ventricular end-diastolic pressure) and from echocardiogram (% fractional shortening), perfusion time of extracorporeal circulation and the time of aortic cross clamping during the operation, causes of LVF, duration and result of IABP support, and patient's outcome.

The values were expressed as a mean±standard deviation of the mean. Student's *t*- test was used for statistical analysis, and p values less than 0.05 were considered to be significant.

RESULTS

The result of IABP support in each disease group is shown in **Table I.** Among 25 patients in whom IABP support was necessary, 17 patients (68%) could be weaned from IABP, and 14 of them achieved long-term survival. The other 3 patients weaned from IABP died of multiple organ failure or renal failure following recurrent or prolonged LVF.

There were no statistical differences in the preoperative data between patients who did not have (n=257) / and those who had (n=25) IABP support, i.e., NYHA functional class (3.0±0.7 in the former group; 3.2±0.8 in the latter group), cardiac index (2.72±0.63 l/min/m^2 ; 2.50±0.44 l/min/m^2), pulmonary wedge pressure (17.3±6.4 mmHg;15.4±4.1mmHg), left ventricular ejection fraction (57.7±11.0 %; 54.6±8.5 %), % fractional shortening (32.5± 5.8 %; 29.5± 8.4 %), or left ventricular end-diastolic pressure (14.8±6.0 mmHg ; 12.8±5.7 mmHg) . Moreover, no statistically significant differences were found in the values of perfusion time (152±45 min; 190±59 min) or aortic cross clamping

disease	no. of patients	postop. IABP use		
		patients	weaned	survived
AS	25	3	2	2
AR	64	3	2	2
MS	96	13	10	7
MR	52	2	1	1
A + M	45	4	2	2
total	282	25	17	14

Table I Results of postoperative IABP support in each disease group. AS: aortic stenosis, AR: aortic regurgitation, MS: mitral stenosis, MR: mitral regurgitation, A+M: combined.

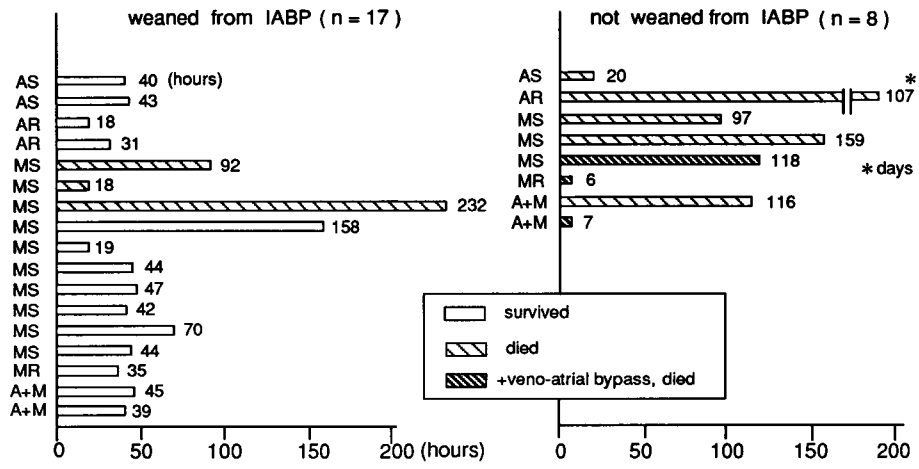

Fig. 1 Duration of IABP support in patients who could (left) or could not (right) be weaned from IABP. Among patients who could be weaned from IABP, 14 of them achieved long-term survival, in whom the duration of IABP support was significantly shortened.

time (105±30 min ; 110±24 min) between these two groups of patients. **Figure 1** shows the duration of IABP support in patients who could (n=17) / or could not (n=8) be weaned from IABP. In the former group of patients, long-term survival was achieved in 14 patients, as descrived in **Table I**, in whom the duration of IABP support was shortened and was mostly within 48 hours. On the other hand, not only in patients who could not be weaned from IABP but also in patients who weaned from IABP but finally died, the duration of IABP support tended to be prolonged and most times exceeded 96 hours, with the exception of a few patients who experienced serious LVF and died within several hours after the initiation of IABP with veno-atrial bypass. In addition, 107 days of IABP support was given to one AVR patient of this group because

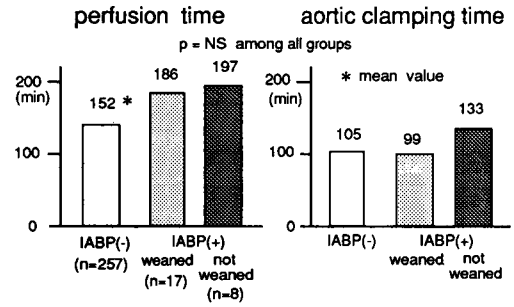

Fig. 2 Mean value of perfusion time (left) and aortic cross clamping time (right) in patients who did not and who did use the IABP postoperatively, or in patients who could or could not be weaned from IABP.

he had worsened to so-called "IABP dependent"[4] LVF in the late postoperative period. **Figure 2** shows the mean value of perfusion time and aortic cross clamping time of patients who could or could not be weaned from IABP. The value of perfusion time was almost the same between the two groups of patients, but the value of aortic cross clamping time in patients who could not be weaned from IABP tended to be longer than that of patients who could be weaned from IABP, but these values were statistically insignificant.

Among the 25 patients who had received IABP, 8 patients had definite causes of LVF, such as perioperative myocardial infarction, but the other 17 patients experienced LVF despite uneventful operation (**Table II**). In the latter group of patients, it was specu-

disease	cause detected		cause unknown
AS	0		3 (0)
AR	1	(PMI)	2 (2)
MS	6	PMI : 2 LV rupture : 2 stuck valve : 1 bleeding : 1	7 (5)
MR	0		2 (1)
A+M	1	(PMI)	3 (2)
total	8		17 (10)

( ) No. of patients who showed depressed left ventricular function preoperatively.

Table II Patient distribution in each disease group according to the cause of postoperative left ventricular (LV) failure. PMI: perioperative myocardial infarction.

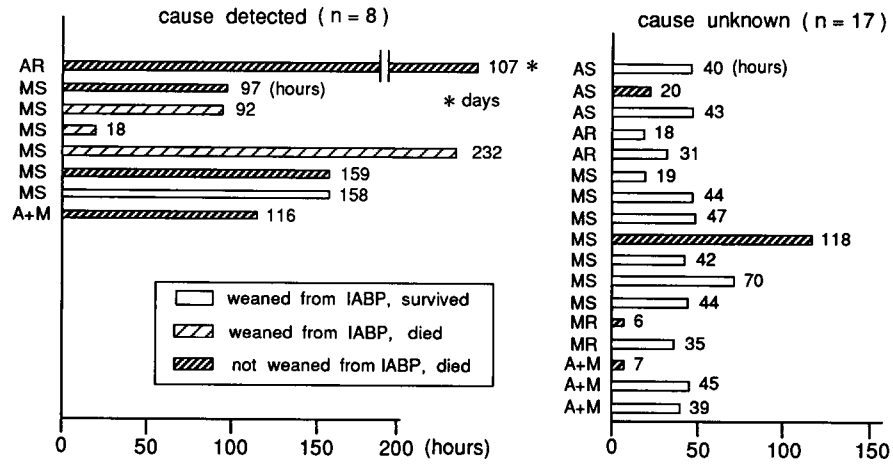

Fig. 3 Duration of IABP support in patients who had (left) or did not have (right) definite causes of postoperative left ventricular failure (LVF). These values were much longer in patients who had definite causes of LVF, and long-term survival was achieved only in one of them. On the other hand, in "cause unknown" patients, these values were not long, and their outcome was mostly excellent.

lated that postoperative LVF in 10 patients was induced by significantly reduced preoperative left ventricular function [16, 17], which was revealed by the depressed left ventricular ejection fraction (<45 %) and % fractional shortening (<27%) and/or cardiac index (<2.0 l/min/m^2). **Figure 3** shows the duration of IABP support in patients who had (n=8) / or did not have (n=17) definite causes of LVF. In the former group of patients, the duration of IABP support was much longer and exceeded 90 hours, except for one patient, and long-term survival was achieved only by one patient. On the other hand, in the latter group of patients, the duration of IABP support was not so long, and most of them were within 48 hours. The patient's outcome was also excellent in this group of patients, where 13 out of 17 patients survived longer postoperatively.

DISCUSSION

With the development of operative techniques and myocardial protection, the results of surgery not only for ischemic heart disease but also for valvular heart disease have been much improved [15, 22]. However, even with these developments, there are still some patients who cannot do without IABP support to maintain postoperative hemodynamics [15]. Such a condition was reported in several articles, where 2.4% to 15% of surgical patients with cardiac disease needed IABP support during the peri- or immediate postoperative period [2, 8, 9, 12, 14, 18, 20]. In addition, it was also reported that this rate of incidence was greater in valvular heart disease compared with ischemic heart disease [5, 20]. Regarding this higher rate of incidence, Downing et al.[5] deduced that patients with valvular lesions and left ventricular impairment might not respond to valve replacement with immediate improvement in pump function, unlike patients with ischemic heart disease who might directly and immediately benefit from increased coronary perfusion and revarsal of myocardial ischemia as a result of coronary artery bypass grafting.

As regards the survival rate after removal of IABP support, it was reported that 27% - 58% of the series of IABP patients who underwent cardiac surgery could achieve long-term survival [2, 3, 9, 13, 18, 21]. In only patients with valve replacement surgery, this survival rate ranged from 34% to 56% in the reviewed articles [5, 10, 14]. These incidence rates were similar to our results, where 56% of patients (14 out of 25 patients) who had experienced severe peri- or immediate postoperative LVF could be saved from LVF with the aid of IABP and survived

for a long time. Furthermore, these articles presented the various factors such as preoperative left ventricular dysfunction [3, 6, 11], NYHA IV cardiac function [1, 13, 14], combined valve procedures and aortocoronary bypass [1, 5, 20], or age of patients [6, 14], which influence the survival rate after IABP support. However, it was also reported that the use of IABP should improve survival in patients with reversible left ventricular dysfunction due to the beneficial effect on myocardial performance[7, 9]. This consideration might be supported by our results, that is, even though the incidence of IABP was certainly increased in patients with LVF due to depressed left ventricular function, the effect of IABP on them or their survival rates were significantly improved. In addition, only a short duration of IABP support was necessary in these patients, thus most could be weaned from IABP within 2 days after IABP initiation.

This study also clarified the limitations of IABP as circulatory assistance in patients with severe LVF following valve replacement surgery. Particularly in those patients with LVF which was caused by definite perioperative complications such as myocardial infarction, no significant effect of IABP can be expected on the patient's outcome, i. e., when LVF occurred due to serious surgical complications, the patient's outcome was significantly poor, even if he could be weaned from much longer IABP support (generally more than 4 days). Therefore, in this category of patients, more advanced mechanical support such as a left ventricular assist device would be necessary to obtain a more improved outcome[15].

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