The Effect of Emergency Aortocoronary Bypass, Infarctectomy and Ventricular Aneurysmectomy on Arrhythmias in Patients with Acute and Chronic Myocardial Infarctions

NOBUYUKI TANAKA, JURO WADA, KENJI SUGIKI, SATORU KANEKO,
TERUHISA KAZUI AND SAKUZO KOMATSU

IN this communication, we presented the clinical results of 14 cases of emergency surgery for acute evolving myocardial infarctions developed outside our hospital^{1,2} and other two cases of infarctectomy and ventricular aneurysmectomy in subacute and chronic phase of myocardial infarction⁴ (MI). The effect of emergency surgical treatment for cardiac arrhythmias by means of aortocoronary bypass (AC-bypass) or infarctectomy were evaluated. In experimental study, we have demonstrated that the threshold to

cause atrial fibrillation (AF) and ventricular tachycardia (VT) or ventricular fibrillation (VF) were found to be reduced in the early phase of acute myocardial infarction (AMI). We discussed the validity of early surgical intervention for AMI complicated with cardiac arrhythmias.

1. The surgical effect on arrhythmias in patients with evolving acute myocardial infarction.

Materials and methods: The clinical results of 14 cases of emergency surgeries were listed in

TABLE I CLINICAL RESULTS OF EMERGENCY SURGERY FOR ACUTE MYOCARDIAL INFARCTION SAPPORO MEDICAL UNIVERSITY 8/11/'77

	Name	Age, Sex	Location	Shock	Arrhythmias	Onset-surgery	Results
1.	KE	55, M	INF. (POST)	+	AF, PVC, VF	6 HRS. SVG/RCA	S-3Y7M
2.	YS	72, F	INF. (ANT)	+	VF	4.5 LAD, RCA	S-2Y8M
3.	HS	59, M	ANT.	+	VT, VF	20 HRS, LAD, RCA	D. (Shock)
4.	IM	49, M	ANT.	—	PVC, VT	5 LAD	S-1Y4M
5.	KT	42, M	ANT. (INF)	+	NONE	5.5 LAD, RCA 25days-Infarctectomy	VT-Recurring S-1Y8M
6.	NT	44, M	POST.	—	AF	6 CX, LAD	S-1Y
7.	KS	72, M	ANT. LV-Rupture	+	VT, VF	5 Repaire/LV	S-6M
8.	HT	50, M	ANT.	—	AF, VT, VF	4.4 LAD	S-7M
9.	OT	51, M	ANT.	—	NONE	7 LAD	S-6M
10.	YS	54, M	INF.	—	A-V Block	5 RCA	S-4M
11.	NT	65, M	INF. (POST)	+	A-V Block	3 RCA	D. (Shock)
12.	EM	51, M	ANT. (INF)	++	PVC	6 LAD, RCA	D. (Shock)
13.	MK	63, M	POST	+	NONE	8 CX, LAD	S-3M
14.	AY	63, M	ANT. (POST)	—	PVC	6 LAD	S-3M
Total	14 cases			Shock: 8 cases		3 HRS TO 20	S-11 cases, D-3 cases

S-Survived, D-Died

*Department of Thoracic and Cardiovascular, Surgery,
The Sapporo Medical University Hospital, Sapporo, Japan*

Fig.1. Case 8. 50 years old male had an emergency AC-bypass to LAD 4.4 hours after the onset of AMI complicated with AF, VT and VF. He returned to normal sinus rhythm immediately after the operation.

Table I. In these, nine of 14 patients have shown a various kinds of arrhythmias: VT or VF in 6, AF in 3 and atrio-ventricular block in two in the early phase of AMI. Eight of 14 developed the typical picture of cardiogenic shock (low blood pressure less than 90 mmHg, mental confusion and perspiration with cold extremities) at the time of admission to our coronary care unit. All 14 patients underwent emergency left cardiac catheterization as well as selective coronary arteriography by spot film technique.³ These patients were directly transferred to the operating room. As soon as the patients were on cardio-pulmonary bypass, AC-bypass was done to the infarcted area as the first. When the chest was closed, myocardial pace-maker leads and left atrial tube for pressure study were in place for postoperative care.

Results: Twelve cases of emergency AC-bypass graftings could be carried out within 3 to 8 hours (5.5 hours as an average) after the onset of AMI. There was a case of successful ventricular repaire for acute rupture of the anterior wall resulted in cardiac tamponade with cardiac arrest developed 5 hours of AMI. In these 14 cases, we lost three patients in the early postoperative period.

As to the effect on arrhythmias, 5 of 6 patients who had the episodes of VT or VF prior to the surgery were able to survive the operation of AC-bypass in 4 and of ventricular repaire in one. Subsequently, VT and VF were completely disappeared in 4 of 5 patients. However, a 72 years old female with double AC-bypass graftings had developed two times of VTs in the first week of

Fig.2. Case 7. 72 years old male had a rupture of left ventricle complicated with the attack of VT and VF which were terminated by a repaire of the left ventricle resulted in excellent hemodynamic condition.

Fig.3. A 47 years old male had a postinfarction anterior ventricular aneurysm complicated with recurrent attack of VT which was terminated by ventricular aneurysmectomy.

Based on the findings during the attack of VT which showed CRBBB with left posterior hemiblock, re-entry mechanism was supposed to be the cause of VT.

operation for which 50 mg of intravenous administration of xylocain solution was effective to terminate the attack. There were 3 patients who developed AF prior to surgery which were eliminated by AC-bypass graftings without any recurrence in postoperative period. Two patients have shown complete atrio-ventricular block at the admission both with inferior MI. One of these patients was able to back to normal sinus rhythm immediately after AC-bypass to right coronary artery (RCA), however, the other developed postoperative cardiogenic shock even after AC-bypass to RCA, consequently, he died of irreversible shock with recurrent attack of VT and VF.

2. The effect of infarctectomy and left ventricular aneurysmectomy for recurrent ventricular tachycardias⁴

Infarctectomy: A 42 years old male with recent history of acute inferior myocardial infarction received AC-bypass to RCA and left anterior descending (LAD) coronary artery for acute anterior MI. However, anterior transmural MI gradually developed in the second week after the operation which complicated with recurrent attack of VT and VF even with massive dosis of antiarrhythmic drugs resulting in worsening his congestive heart failure. Infarctectomy was tried as a final procedure to terminate VT. Fortunately, since the operation he has been completely free from the attack of VT or VF. Postoperative

TABLE II STUDY OF ECHO ZONE IN EXPERIMENTAL ACUTE MYOCARDIAL INFARCTION

1. Atrial Echo zone: Atrial Extrastimulus Method (A_1-A_2)			
#	2	210-260 msec.	
#	3	100-170 msec.	
#	4	75-90 msec.	
#	5	145-230 msec.	
2. Ventricular Echo Zone: Ventricular Extrastimulus Method (V_1-V_2)			
#	2	355-370 msec.	
#	3	145-200 msec.	
#	4	100-165 msec.	
#	5	220-245 msec.	

His bundle EKG showed that only a latent A-H block at rate of 115 per minutes of regular atrial pacing was demonstrated, however, VT or VF could not be initiated by regular atrial pacing nor by extrastimulus methods⁵

Left ventricular aneurysmectomy: A 47 years old male who had a documented history of acute anterior MI 2 years ago had experienced four times of ventricular tachycardias. At the time of the last attack, he developed ventricular fibrillation needed cardioversion for resuscitation. He

Fig.4. Experiment No.4, atrial fibrillation was initiated by atrial extrastimulus method with A_1-A_2 interval of 90msec. AF could be identified that plunge electrode potentials showed relatively regular activation with minor change of configurations.

Fig.5. Experiment No.5, VT followed by VF was initiated by ventricular extrastimulus method with V_1 - V_2 interval of 210msec. VT was identified that relatively regular ventricular activation in all plunge electrodes were demonstrated, however, in VF which were totally changed to irregular potentials with completely disfigured pattern of ventricular activations.

was transferred to our department for further treatment. His left ventriculogram showed a large anterior aneurysm and the LAD coronary artery was totally occluded at the proximal part, however other coronary arterial branches were free from stenosis. Based on the EKG findings taken during the attack of VT showed complete RBBB with left posterior hemiblock⁸ (Fig. 3) which was supposed to be a re-entry mechanism as a cause of VT. His anterior aneurysm was successfully resected, subsequently, since the operation he never experienced any other episode of VT or VF. His bundle EKG at 6 months after the surgery did not show any sign of A-H block with regular atrial pacing and VT could not be initiated by the electrical stimulations. He has been without any antiarrhythmic drugs for 28 months and completely free from the attack of VT.

3. Experimental study on the mechanism for development of atrial fibrillation and ventricular tachycardia or ventricular fibrillation in the early phase of acute myocardial infarction.

Materials and methods: In order to study the electro-physiological basis for the development of AF and VT or VF in AMI, experimental anter-

ior MIs were made in 5 mongrel dogs by ligating the proximal part of the LAD coronary arteries. Beside standard surface EKG, His bundle EKG, plunge electrodes in endocardial and epicardial potentials both of the infarcted and non-infarcted areas were monitored. After the LADs were ligated for 3 hours, the above arrhythmias were tried to be initiated by means of regular atrial pacing and atrial or ventricular extrastimulus methods (8 regular pacing followed by single extrastimulus) using a electric stimulator. The electrical stimulations were repeated more than 5 times in each animals, all the arrhythmias induced were recorded with multichannel recorder with Mingogram of paper speed from 25 to 100 mm/sec.

Results: AF and VT or VF were constantly and repeatedly initiated by the above electrical stimulations in 4 of 5 animals. (Table II).

Atrial fibrillation: Before the ligation of the LADs there were no animals which have shown any kinds of arrhythmias, on contrary, AFs were easily initiated with a atrial extrastimulus method. The A_1 - A_2 intervals which could initiate AFs ranged from 75 to 260 msec. in four animals. The range of A_1 - A_2 intervals were varied in each animals but it was shown to be constant in

each cases. The above results showed that there may be a echo-zone to initiate AF in the heart with AMI.

Ventricular tachycardia and ventricular fibrillation: It was also demonstrated that before the LAD were ligated, there were no VT or VF initiated by the electrocal stimuli, however, 3 hours after the ligation of the LAD, VT and VF were easily and repeatedly induced by ventricular extrastimulus method. The V_1-V_2 intervals for initiation of VT or VF ranged from 100 to 370 msec. in 4 animals. The V_1-V_2 intervals in each cases were different which made us to consider that in the early phase of acute myocardial infarction there may be a certain state that is easy to develop VT or VF by the extrastimulus.

DISCUSSION

Acute myocardial infarction or myocardial ischemia that cause death of myocardium also cause arrhythmias at the same time. However, currently available drugs, electrical stimulations or cardioversion will not influence the final size of myocardial necrosis in AMI.⁶ Some arrhythmias are considered to be the results of muscle damage for example, atrial fibrillation tend to occur in acute development of ventricular power failure. Ischemic involvement of the interventricular septum in the infarct brings about the development of atrio-ventricular block in acute stage of large infarct.

If the development of ischemia results in death of some muscle, this damage may cause arrhythmias, on the other hand the arrhythmias itself may advance the extension of myocardial necrosis which leads to further cell death in vicious cycle.⁷ In other words, if the size of infarct is determined by the presence of arrhythmias, it may be valid that the operative procedures to reduce infarct size by means of AC-bypass may reduce the development of arrhythmias in turn.

We have demonstrated that even in early stage of AMI may provide a special heart condition which easily initiate atrial fibrillation or ventricular arrhythmias by extrastimuli using animal experiments that was quite different from normal states. Aortocoronary bypass or infarctectomy may supposed to be a effective procedure to remove abnormal focus which can initiate lethal arrhythmias.

CONCLUSION

We have demonstrated that emergency myocardial revascularization for acute evolving MI when done within 8 hours of the onset may be effective in most case to terminate arrhythmias as well as to prevent the extention of muscle necrosis. Infarctectomy or ventricular aneurysmectomy done both in early or chronic phase of MI seemed to be effective to eliminate ventricular tachycardia. We studied that the heart may be in a special state in myocardial infarction where the threshold for development of arrhythmias may be reduced. Therefore, ischemic focus which causes extrastimuli in the infarcted heart should be revascularized or removed by surgery.

REFERENCES

1. TANAKA, N., ASAI, Y., TODO, K., ADACHI, H., NAGAO, H., KITAYA, T., AJIKI, H., KAMATA, K., SUDA, Y., KOMATSU, S., WADA, J., MAHARA, F., YAMADA, H., & MURAKAMI, T.: A successful case of emergency aorta to right coronary saphenous vein bypass for acute myocardial infarction. *J. Japanese Association for Thoracic Surgery* 22: 1134, 1974 (in Japanese).
2. TANAKA, N., SUGIKI, K., KAZUI, T., SUDA, Y., KOMATSU, S., & WADA, J.: Three cases of successful emergency aorta to coronary bypass grafting for evolving acute myocardial infarction. *J. Japanese Surgical Society* 78: 13, 1977 (in Japanese).
3. ABE, H., MUTA, N., TANAKA, N., & WADA, J.: Selective coronary arteriography by spot film roentgenographic technique: Its feasibility and limitation. *Sapporo Medical Journal* 44: 153, 1975.
4. TANAKA, N., OHNO, T., MORIMOTO, K., SUGIKI, K., KAZUI, T., NISHIMURA, S., KOMATSU, S., & WADA, J.: Two successful cases of surgical treatment for life-threatening ventricular tachycardia in patients with myocardial infarction. *Japanese J. of Thoracic Surgery* 30: 1977 (in Japanese).
5. WELLENS, H. J., SCHUILENBRUG, R. M., & DURRER, D.: Electrical stimulation of the heart in patients with ventricular tachycardia. *Circulation* 46: 216, 1972.
6. COX, J. R. Jr., ROBERTS, R., AMBOS, H. D., OLIVER, G. C., & SOBEL, B. E.: Size and early ventricular dysarrhythmia. *Circulation* 53: (Supp. I) 150, 1976.
7. FOZZARD, H. A.: Discussion, Have we solve the arrhythmia problem? *Circulation*: 53 (Supp. I) 153, 1976.
8. ROSENBAUM, M. B., ELIZARI, M. V., & LAZZARI, J.: Los hemibloqueos. Buenos Aires, Ed Paidós, 1968.