The Impact of CK-MB Elevation in Patients With Acute Type A Aortic Dissection With Coronary Artery Involvement

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Research article

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Abstract

Background

Acute coronary artery involvement (ACI) is a lethal complication of acute type A aortic dissection. Although ACI has been reported as one of the prognostic factors of acute type A aortic dissection, it does not always cause coronary ischemia. The extent of myocardial damage varies from case to case. Moreover, since the definition of ACI varies from paper to paper, it is unknown what the difference is between ACI with and without myocardial necrosis. In general, it can be assumed that cases with myocardial infarction have worse results. However, it is unknown how poor ACI is with myocardiac ischemia and how optimistic it is without it. This study compared the surgical results between the two groups of ACI with or without myocardiac ischemia.

Methods

Among 348 patients who underwent an emergency operation for acute type A aortic dissection, there were 28 (8.0%) patients complicated by ACI and underwent additional coronary artery bypass grafting. We divided 26 of those patients into two groups; the MI group (with CK-MB elevation) and the NMI group (without CK-MB elevation) and compared both groups.

Results

Of the 26, sixteen were in the MI group, and ten were in the NMI group. The average CK-MB in the MI group was 225.5 IU/L, and that in the NMI group was 13.5 IU/L. The mean time from onset to surgery was 248 minutes in the MI group, 250 minutes in the NMI group. There was statistical significance in mortality (69% vs. 13%, p=0.03). There was no significance in major complications (ICU days, reintubation, reoperation, pneumonia, sepsis).

Conclusions

Acute coronary artery involvement was associated with 8.0% of patients with ATAAD, and 62% of them had myocardial ischemia with CK-MB elevation. As expected, the MI group had significantly higher mortality than the NMI group. It is crucial for cases with suspected ACI to obtain coronary perfusion as soon as possible to prevent CK-MB from elevationg.

Introduction

Acute type A aortic dissection (ATAAD) is highly lethal and requires emergency intervention. Although recently the treatment of ATAAD has provided better outcomes than before, ACI is an independent predictor of mortality (1).

Although there were many articles about ACI, the definition of ACI differs because there were no criteria for diagnosis. It was reported that ACI did not necessarily cause myocardial ischemia because the degree of impairment varied from case to case. There was no paper focusing on the actual impact of myocardial damage on patients with ACI. Therefore, in this study, we retrospectively analyzed the surgical outcomes of ACI with or without myocardial damage.

Material And Methods

Patient population

Between October 2007 and August 2018, 348 consecutive patients underwent surgery for ATAAD in our institution. Twenty-eight patients suffered from ACI and underwent aortic surgery and additional coronary artery bypass grafting (CABG). Patients who had aortic dissection to the orifice of a coronary artery, and were repaired only by suture (n=4), underwent percutaneous coronary intervention (n=3) were excluded in this study.

Diagnosis

The diagnosis of ATAAD was confirmed with computed tomography (CT) in all cases. The diagnosis of ACI was defined as follows:

1. New ST change in the electrocardiogram
2. Abnormal wall motion of ventricle on echocardiogram
3. Direct observation of dissected coronary artery after circulatory arrest

We did not perform preoperative coronary angiography routinely, but it was performed in other hospitals for suspected acute coronary syndrome cases. In those cases, ATAAD was diagnosed during the percutaneous coronary intervention (PCI) procedure.

We analyzed laboratory data immediately before surgery and immediately after surgery. According to the results, we divided the patients into two groups:

MI group: with CK-MB > 22 IU/L

NMI group: with CK-MB<22 IU/L

CK-MB over 22IU/L was defined as the cutoff value in our facility.

Patient transportation and preparation

Our institute accepted any patients in any condition. Exclusion criteria for operation included patient's refusal and long cardiac arrest time (>20 minutes) before hospital arrival. Patients diagnosed with ATAAD at our hospital were transferred to the operation room directly from CT examination, and patients diagnosed before arrival were taken directly to surgery.

The operative procedure started with median sternotomy and standard extracorporeal circulation (2). Three arterial cannulation sites were used via a femoral artery, axillary artery, or the ascending aorta. The femoral vein and right atrium were used for venous drainage. Retrograde cardioplegia was performed via the coronary sinus. The circulatory arrest was achieved at a tympanic temperature of 25–27_C. Then the ascending aorta was incised. After opening the aorta, the first retrograde cardioplegia was injected. Basically, we performed ascending aorta replacement (AAR) was performed because it was less invasive. We did not use selective cerebral perfusion to shorten the operative time. After the circulatory arrest, distal anastomosis was made with 4-0 monofilament continuous sutures. Teflon (DuPont, Wilmington, DE) felt strip was used to reinforce the anastomosis of graft and native aorta. Then antegrade systemic circulation was started via the side branch of the graft, and the patient was rewarmed. Finally, proximal anastomosis was performed, and then coronary circulation started after de-airing. CABG was added after aortic repair or before coronary circulation restarted. If we considered intra-aortic balloon pumping (IABP) necessary, we inserted it after cardiopulmonary bypass weaning.

Statistical analysis

We analyzed all data with SPSS software version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive data are presented as counts (percentages), means, and standard deviations for normally distributed data, or medians (25th-75th quartile) for skewed data. The primary endpoint was in-hospital mortality, and the secondary endpoint was major complications. Major complications included reintubation, reoperation for bleeding, postoperative renal insufficiency, pneumonia, and sepsis.

Results

Baseline patient characteristics are shown in Table 1. Average CK-MB was 226.5 IU/L in the MI group, 13.5 IU/L in the NMI group. No significant difference was observed in most, but only heart failure was significantly more in the MI group.

Operative data are shown in Table 2. ACI was observed on both RCA and LCA without significance. Although there was no statistical significance, all patients with RCA and LCA involvement were in the MI group.

Total operative time was 209±84 minutes in the MI group, 207±40 minutes in the NMI group. Circulatory arrest time was 25±5 vs. 25±4 minutes, and the cardiopulmonary bypass time was 152±27 vs. 150±28 minutes, respectively.

In all cases, ascending aorta replacement was performed. Intra-aortic balloon pumping (IABP) was used in 7 (43.8%) in the MI group. It was not used for patients with a patent false lumen of descending aorta. Percutaneous cardiopulmonary support was used in 2cases in the MI group. IABP and percutaneous cardiopulmonary support were not used for patients in the NMI group. Sixteen (11 in the MI group, 5 in the NMI group) patients had other vessels' involvement. Cerebral artery involvement was the most; 8(50.0%) vs. 3 (30.0%) (p=0.31) respectively. Three patients were in a coma preoperatively. Artery involvement of mesenteric, renal, lower extremities area was seen only in the MI group. No intervention for the other artery's involvement was performed.

Table 3 shows the mortality and major complications. The mortality was significantly higher in the MI group than in the NMI group (69% vs. 13 % p=0.03). The mean ICU stay days were 4±5 days in the MI group and 3±3 days in the NMI group. There was no significant difference in other complications.

Discussion

Coronary artery involvement is a lethal complication, with high mortality rates (19.5-33%) (3–5). However, one of the most difficult aspects of ACI is a correct preoperative diagnosis and its evaluation. Firstly, the main symptom of ATAAD “masks” that of coronary ischemia (6), and secondly, there is no definitive diagnostic examination.

CK-MB is prevalently used as an absolute quantitative value, helpful in diagnosing myocardial infarction. Since the etiology of the ACI due to ATAAD is different from that of ordinary CAD, the ACI does not necessarily lead to myocardiac necrosis at the same speed. However, it was unknown that how many patients with ACI had a CK-MB elevation and the true impact of CK-MB elevation on the surgical outcome of ATAAD with ACI.

The present study showed that about 62% of patients with ACI had an increase in CK-MB. Moreover, the MI group had significantly higher mortality than the NMI group. As time is an essential factor when considering CK-MB, it should be noted that this study dealt with the data when surgery was performed about 4 hours after the onset. If it took more time to operate, the proportion of patients with a CK-MB elevation would increase, and as a result, the mortality was also expected to increase. Then, what kind of management should be done so as not to raise CK-MB?

Previous reports showed that time to operation was a predictive factor for patients with ATAAD (7, 8). However, in patients with ACI, time management to prevent CK-MB from rising is important. PCI would be able to revascularize fastest, and there is a possibility that it can prevent CK-MB elevation. However, as mentioned at the beginning, it is not easy to diagnose ACI preoperatively. Moreover, it would be difficult for both cardiologists and cardiac surgeons to treat every emergency case in actual clinical practice. On the other hand, although it would take more time than PCI, additional CABG can be performed safely only by cardiac surgeons, which is more practical. As for the timing of CABG, we performed CABG after aortic repair. We prioritized achieving cardiac arrest over revascularization of the coronary arteries because the progression of myocardial ischemia can be delayed by circulatory arrest. After all, it reduces myocardial oxygen demand by more than 90%.However, there is a situation where PCI first management is superior. In the most severe ACI cases, sudden occlusion of the coronary artery may result in death in tens of minutes. This study included only one case of such acute occlusion of the left main trunk (Figure1). In this case, preoperative PCI played an important role as a bridge to operation. Although the patient was in hemodynamically severe condition even after the PCI, he underwent operation successfully. He survived five years follow-up. Presumably, other similar cases have occurred. However, they died before reaching the hospital. Future studies are needed for better management.

According to the International Registry of Acute Aortic Dissection study, the number of organs with malperfusion is also an independent predictor of outcome; the more organs suffering malperfusion, the worse the prognosis. In this study, there was no significant difference in the rate of other organ's ischemia between the MI group and the NMI group. However, the CK value tended to be higher in the MI group because there were more patients with other artery involvement in the MI group. In particular, Mesenteric malperfusion has been reported to be an independent prognostic factor for ATAAD (9). Since there were few cases of mesenteric malperfusion with ACI in this study, it was not known how mesenteric malperfusion affects the prognosis in patients with ACI. More research is necessary.

Limitations

Our report described a retrospective and observational single-center non-randomized study. Secondary, the sample volume was small. However, ATAAD with ACI was rare, and the sample volume was not large even in past reports. Finaly we had no control group of patients with ACI not receiving CABG, or undertaking PCI only without CABG. Further studies are required to clarify the best treatment for life-saving patients.

Conclusion

Sixty-two percent of patients with ACI increased CK-MB in an average of 4 hours from onset to surgery. The mortality of patients with CK-MB elevation was significantly higher than that of those without CK-MB elevation.. It is important to treat patients with ATAAD complicated with ACI before they have an increase in CK-MB.

List Of Abbreviations

ACI: acute coronary artery involvement

ATAAD: acute type A aortic dissection

PCI: percutaneous coronary intervention

CABG:coronary artery bypass grafting

intra-aortic balloon pumping (IABP)

RCA:right coronary artery, LCA: left coronary artery

Declarations

Ethics approval and consent to participate: The ethics committee of our institute approved this study (REC number:R2019-209).

Consent for publication : Not applicable.

Availabiltity of data and materials

Data sharing not applicable to this article as no data sets were generated during the current study.

Competing interests: None declared

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Authors' contributions: Naoshi Minamidate analyzed and interpreted the data. Tomoaki Suzuki read and approved the manuscript.

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Tables

Table 1 Preoperative patient characteristics

Table 1.					
Variable	MI		NMI		p value
	16		10		
Age	62	±15	69	±10	0.63
Male	12	75.0%	6	60.0%	0.42
Height	166.7	±6.8	160.1	±13.2	0.22
Weight	66.8	±11.8	62.1	±16.5	0.61
Body mass index	23.9	±3.2	23.7	±4.2	0.71
Body surface area	1.7	±0.2	1.6	±0.3	0.56
ECG ST change	11	84.6%	5	50.0%	0.09
Hypertension	11	68.8%	7	70.0%	0.94
Smoking	6	37.5%	4	40.0%	0.89
CardioHistory	1	6.3%	0	0.0%	0.42
Diabetes mellitus	2	12.5%	1	10.0%	0.72
Hyperlipemia	1	6.3%	4	40.0%	0.03
Preoperative renal insufficiency	0	0.0%	2	20.0%	0.06
Shock	8	50.0%	1	10.0%	0.03
Resuscitation	2	12.5%	1	10.0%	0.72
Heart failure	10	62.5%	1	10.0%	0.01
Arrhythimia	2	12.5%	1	10.0%	0.72

ECG: electrocardiogram

Table 2 operative data

Table2					
	MI		NMI		p value
Ascending replacement+CABG					
RCA	7	43.8%	8	80.0%	0.07
LCA	5	31.3%	2	25.0%	0.52
RCA,LCA	4	25.0%	0	0.0%	0.09
IABP	7	43.8%	0	0.0%	0.01
PCPS	2	12.5%	0	0.0%	0.24
Operative time (min)	209	±84	207	±40	0.46
Circulatory arrest time	25	±5	25	±4	0.47
Cardiopulmonary bypass time	152	±27	150	±28	0.43
Onset to Operation	248	151-355	250	223-304	0.38
Other artery's involvement					
Cerebral	8	50.0%	3	30.0%	0.31
Mesenteric	3	18.8%	0	0.0%	0.14
Renal	3	18.8%	0	0.0%	0.14
Lower extremities	2	12.5%	0	0.0%	0.24

Table 3: Postoperative data

	MI		NMI		
Postoperative Max CK	2956		604.5		
Postoperative Max CK-MB（Average）	226.5		13.5		
ICU stay (days)	4	±5	3	±3	0.41
Total ventilator time(h)*	57	(1-689)	35	(22-440)	0.32
Reintubation	1	(6%)	1	(10%)	0.72
Reoperation for bleeding	0	(0%)	0	(0%)	NS
Postoperative renal insufficiency	0	(0%)	0	(0%)	NS
Pneumonia	0	(0%)	0	(0%)	NS
Sepsis	0	(0%)	0	(0%)	NS
Mortality(hospital)	9	(69%)	1	(13%)	0.03

*Median and interquartile range.

Figures

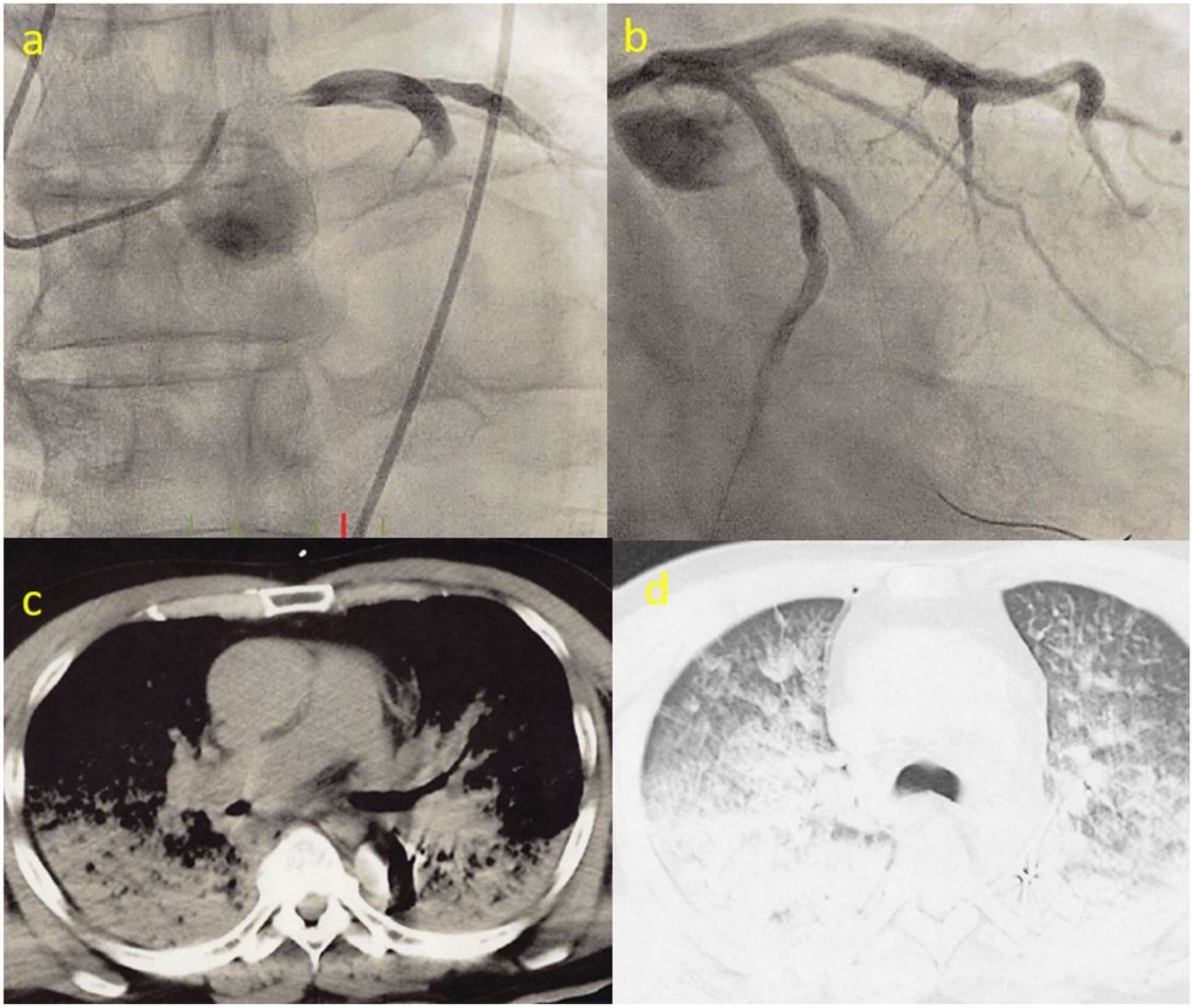

Figure 1

Severe ACI case with LMT obstruction a: The LMT was dissected, and coronary flow was very slow. b: PCI for LMT was performed, but the flow remained slow. c,d: the patient suffered acute heart failure. IABP was seen in the descending aorta. LMT: left main trunk, PCI:percutaneous coronary intervention, IABP: intra-aortic balloon pumping