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Impact of Thrombus Aspiration on Clinical Outcomes in Korean Patients with ST Elevation Myocardial Infarction

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We evaluated whether thrombus aspiration (TA) during primary percutaneous coronary intervention (PCI) reduces adverse clinical outcomes within 30-days and 1-year periods. There is no well-designed, Korean data about the clinical impact of intracoronary TA during primary PCI in patients with ST-segment elevation myocardial infarction (STEMI). From the Korea Acute Myocardial Infarction Registry-National Institute of Health, 3749 patients with STEMI undergoing primary PCI within 12 hours (60.8±12.9 years, 18.7% women) with pre-procedural Thrombolysis in Myocardial Infarction (TIMI) flow 0, 1 in coronary angiography were enrolled between November 2011 and December 2015. The patients were divided into two groups: PCI with TA (n=1630) and PCI alone (n=2119). The primary end-point was major adverse cardiac event (MACE), defined as the composite of cardiovascular death (CVD), recurrent MI and stroke for 30-days and 1-year. TA did not diminish the risk of MACE, all-cause mortality and CVD in all patients during 30-days or 1-year. After performing the propensity score matching, TA also did not reduce the risk of MACE (Hazard ratio (HR) with 95% Confidence Interval (CI):1.187 [0.863-1.633], p value=0.291), all-cause mortality (HR with 95% CI: 1.130 [0.776-1.647], p value=0.523) and CVD (HR with 95% CI: 1.222 [0.778-1.920], p value=0.384) during the 1-year period. In subgroup analysis, there was no benefit of clinical outcomes favoring PCI with TA. In conclusion, primary PCI with TA did not reduce MACE, all-cause mortality or CVD among the Korean patients with STEMI and pre-procedural TIMI flow 0, 1 during the 30-day and 1-year follow ups.

Key Words: *Myocardial Infarction; Percutaneous Coronary Intervention; Thrombectomy*

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INTRODUCTION

Manual thrombus aspiration (TA) during primary percutaneous coronary intervention (PCI) reduces thrombus burden and improves markers of myocardial reperfusion in patients with acute ST-elevation myocardial infarction (STEMI).[1,2] However, its clinical benefits have been a controversial issue of debate. Thrombus Aspiration during Percutaneous coronary intervention in acute myocardial infarction Study (TAPAS) trial[3] and other several studies[4-6] showed a mortality reduction with TA. In contrast, in 2 recent multi-center randomized trials, the Trial of Routine Aspiration Thrombectomy with PCI versus PCI Alone in Patients with STEMI (TOTAL)[7] and the Thrombus Aspiration in ST-Elevation myocardial infarction in Scandinavia (TASTE)[8,9] failed to show a significant reduction in clinical events including mortality. As a result, the recent guidelines did not recommend routine TA.[10,11]

There is no well-designed Korean data about the clinical impact of intracoronary TA during primary PCI in patients with STEMI. In this study, we sought to evaluate the

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clinical impact of TA during primary PCI in STEMI patients with pre-procedural Thrombolysis in Myocardial Infarction (TIMI) flow 0, 1.

MATERIALS AND METHODS

1. Study design and population

The study population was derived from the Korea Acute Myocardial Infarction Registry-National Institutes of Health (KAMIR-NIH) from November 2011 to December 2015. The KAMIR-NIH is a prospective, multicenter, web-based observational cohort study to develop the prognostic and surveillance index of Korean patients with acute myocardial infarction (AMI) from 20 centers in Korea and has been supported by a grant from Korea Centers for Disease Control and Prevention since November 2011.

We analyzed a total of 13,516 patients with AMI undergoing primary PCI. The inclusion criteria for the current study were as follows.

(1) Patients with STEMI
(2) Patients who underwent coronary angiography and PCI within 12 hours of the onset of symptoms
(3) Pre-procedural TIMI flow 0, 1

We, therefore, enrolled patients in the current study. The study flow diagram is shown in Fig. 1. All patients submitted the written informed consent forms for participating in the registry. Trained study coordinators at each of the participating institutions collected the data using a standardized format. Standardized definitions of all variables were determined by the steering committee board of KAMIR-NIH. The present study was conducted according to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a prior approval by the institution's human research committee.

2. Classification of coronary angiographic findings and interventional procedures

Coronary angiography findings were graded based on the ACC/AHA (American College of Cardiology/American Heart Association) classification system.[12] This is also associated with the complexity of the lesions. Blood flow on coronary angiography was evaluated based on the TIMI flow.[13] Primary PCI was performed according to the standard guideline.[14,15]

3. Study endpoints

The primary efficacy end-points were major adverse cardiac event (MACE), defined as a composite of the cardiovascular death (CVD), myocardial infarction (MI) or stroke at 30-day and 1-year. The secondary efficacy end-points were all-cause mortality and CVD during 30-days and 1-year.

4. Statistical analysis

Continuous variables were expressed as mean±SD (SD: standard deviation) or the median and interquartile range, and they were compared using the independent *t* test or Mann-Whitney U test between the two groups. Categorical variables were compared with Pearson's Chi-square or Fisher's exact tests between the two groups. Due to the significant baseline differences between the PCI with TA group and the PCI only group, the propensity score matching method was used. Before using propensity score matching method, we performed multiple imputation procedures to fill in the missing data of several important variables such as the left ventricular ejection fraction, initial systolic blood pressure and initial heart rate. The propensity scores were estimated using a multiple logistic regression model that contained 32 covariates in Table 1. The matching ratio was 1 to 2. Model discrimination was measured using c-statistic, and calibration was assessed by the Hosmer-Lemeshow goodness-of-fit test (c-statistic: 0.647, Hosmer-Lemshow: p=0.169). The results of the multivariable models were verified using propensity score matching method. All statistical tests were 2-tailed, and a p value<0.05 was considered statistically significant. Statistical analysis was done using the SPSS version 21.0 (Statistical Package for Social Science, SPSS Inc., Chicago, IL, USA).

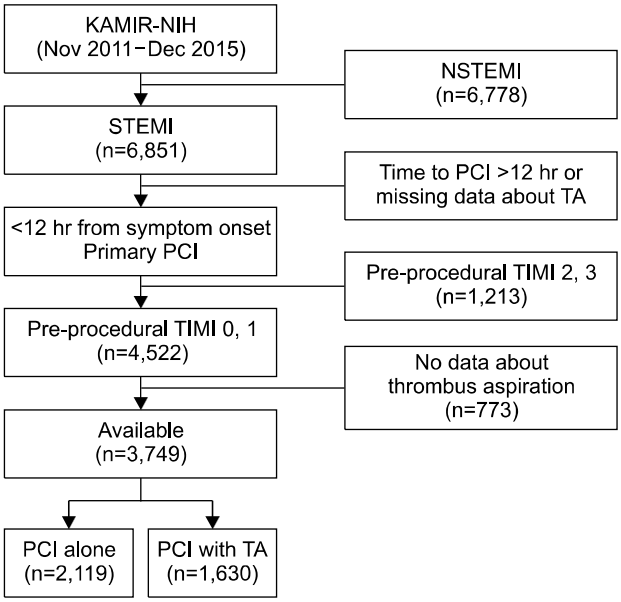

FIG. 1. Study population flow chart. From the Korean Acute Myocardial Infarction Registry - National Institute of Health (KAMIR-NIH), we analyzed a total of 13516 patients with acute myocardial infarction undergoing primary PCI. Inclusion criteria for the current study are the patients with STEMI who underwent coronary angiography and PCI within 12 hours of the onset of symptoms, pre-procedural TIMI flow 0, 1 and follow-up for 1-year. As a result, 2119 patients of PCI alone group and 1630 patients of PCI with TA group were enrolled, respectively.
NSTEMI: non ST-segment elevation myocardial infarction, STEMI: ST-segment elevation myocardial infarction, PCI: percutaneous coronary intervention, TIMI: Thrombolysis In Myocardial Infarction, TA: thrombus aspiration.

TABLE 1. Baseline clinical, procedural, medical characteristics between PCI alone and PCI with TA groups before and after propensity score matching

Variables	All patients			Propensity matched patients		
	PCI alone (n=2119)	PCI with TA (n=1630)	p value	PCI alone (n=2066)	PCI with TA (n=1528)	p value
Clinical variables						
Age, years	62.6±12.5	60.8±12.87	<0.001	61.2±12.5	60.4±12.8	0.151
Female gender (%)	442 (20.9)	304 (18.7)	0.101	429 (20.8)	293 (19.2)	0.240
BMI (kg/m^2)	24.2±3.2	24.4±3.2	0.014	24.3±3.2	24.5±3.2	0.388
Hypertension (%)	955 (45.1)	730 (44.8)	0.889	926 (44.8)	681 (44.6)	0.877
Dyslipidemia (%)	243 (11.5)	171 (10.5)	0.372	225 (10.9)	164 (10.7)	0.878
Diabetes mellitus (%)	496 (23.4)	379 (23.3)	0.942	481 (23.3)	355 (23.2)	0.982
Current smoking (%)	963 (45.4)	764 (46.9)	0.388	955 (46.2)	708 (46.3)	0.940
Family history of IHD (%)	132 (6.2)	107 (6.6)	0.727	129 (6.2)	100 (6.5)	0.725
Previous heart failure (%)	15 (0.7)	15 (0.9)	0.590	14 (0.7)	15 (1.0)	0.341
Previous angina (%)	128 (6.0)	103 (6.3)	0.777	125 (6.1)	98 (6.4)	0.662
Previous myocardial infarction (%)	129 (6.1)	97 (6.0)	0.916	126 (6.1)	91 (6.0)	0.875
Previous stroke (%)	107 (5.0)	78 (4.8)	0.101	106 (5.1)	75 (4.9)	0.763
Laboratory data						
Creatinine clearance (Ccr)	79.4±37.4	83.9±42.3	0.001	83.1±35.9	84.9±35.2	0.176
Hemoglobin (g/dL)	14.2±1.9	14.3±1.9	0.339	14.3±1.9	14.4±1.9	0.985
LDL (mg/dL)	115.8±38.1	116.6±39.2	0.531	116.6±38.4	117.2±39.8	0.803
HDL (mg/dL)	42.1±11.9	42.9±12.8	0.036	41.9±10.9	42.9±12.9	0.012
TG (mg/dL)	144.6±126.8	147.1±120.6	0.549	143.7±124.6	145.2±121.2	0.672
TC (mg/dL)	183.4±44.7	182.4±44.9	0.515	184.1±44.5	183.1±45.3	0.285
CK-MB (ng/mL)	172 (60-300)	150 (43-300)	0.006	154 (47-299)	167 (57-300)	0.024
LVEF (%)	50.4±10.3	50.3±9.6	0.811	50.4±9.9	505±9.6	0.959
Procedural data						
Killip class III-IV (%)	342 (16.1)	219 (13.4)	0.024	303 (14.7)	209 (13.7)	0.407
Symptom to balloon time (min)	185 (124.5-290)	178 (121-285)	0.165	180 (122-285)	177 (120-284)	0.202
Door to balloon time (min)	58 (45-73)	56 (45-70)	0.040	57 (44-72)	57 (45-70)	0.330
SBP at admission (mmHg)	124.6±32.1	125.8±31.8	0.283	125.1±30.3	127.1±30.3	0.377
HR at admission (beat per min)	75.9±20.2	74.1±19.8	0.007	74.8±19.0	74.7±19.3	0.443
Pre-Procedural TIMI flow 0	1755 (82.8)	1477 (90.6)	<0.001	1722 (83.3)	1377 (90.1)	<0.001
Post-Procedural TIMI flow 0-1	25 (0.7)	16 (0.4)	0.563	22 (1.1)	16 (1.0)	0.959
Infarct-related vessel (%)			<0.001			0.308
Left anterior descending artery	1101 (52.0)	702 (43.1)		977 (47.3)	688 (45)	
Left circumflex artery	223 (10.5)	140 (8.6)		195 (9.4)	136 (8.9)	
Right coronary artery	764 (36.1)	776 (47.6)		876 (42.4)	693 (45.4)	
Left main coronary artery	31 (1.5)	12 (0.7)		19 (0.9)	11 (0.7)	
Diseased vessel (%)			0.002			0.759
1	1107 (52.2)	947 (58.1)		1159 (56.1)	886 (58.0)	
2	612 (28.9)	442 (27.1)		574 (27.8)	417 (8.9)	
3	321 (15.1)	202 (12.4)		274 (13.3)	187 (12.2)	
Left main isolated	9 (0.4)	4 (0.2)		6.8 (0.3)	4.0 (0.3)	
Left main complex	70 (3.3)	35 (2.1)		53 (2.6)	34 (2.2)	
Anterior myocardial infarction (%)	1132 (53.4)	714 (43.8)	<0.001	996 (48.2)	699 (45.7)	0.136
Transfemoral vascular approach (%)	1732 (81.7)	1131 (69.4)	<0.001	1589 (76.9)	1109 (72.6)	0.001
ACC/AHA B2/C lesion (%)	1886 (89.0)	1508 (92.5)	<0.001	1878 (90.9)	1408 (92.1)	0.191
Index procedure (%)			0.002			
Culprit only PCI	1852 (87.4)	1479 (90.7)		1846 (90.3)	1385 (90.6)	0.197
Multi-vessel PCI	267 (12.6)	151 (9.3)		220 (10.7)	143 (9.4)	

RESULTS

1. Baseline characteristics

A total of 3749 patients were enrolled in this study. Enrolled patients were divided into 2 groups: PCI with TA group (n=1630) and PCI alone group (n=2119). The TA during PCI procedure was performed in 43.7 percent of the total patients.

TABLE 1. Continued

Variables	All patients			Propensity matched patients		
	PCI alone (n=2119)	PCI with TA (n=1630)	p value	PCI alone (n=2066)	PCI with TA (n=1528)	p value
In-hospital medication						
Aspirin	2106 (99.4)	1626 (99.8)	0.156	2059 (99.6)	1524 (99.7)	0.593
Clopidogrel	1510 (71.3)	1214 (74.5)	0.031	1512 (73.2)	1138 (74.5)	0.391
Prasugrel	333 (15.7)	236 (14.5)	0.317	307 (14.9)	219 (14.3)	0.662
Ticagrelor	524 (24.7)	427 (26.2)	0.324	519 (25.1)	393 (25.7)	0.682
Statin	1909 (90.1)	1507 (92.5)	0.014	1886 (91.3)	1408 (92.1)	0.357
ACEi or ARB	1643 (77.5)	1286 (78.9)	0.338	1619 (78.4)	1200 (78.5)	0.908
B-blocker	1776 (83.8)	1388 (85.2)	0.282	1747 (84.6)	1301 (85.1)	0.651
Calcium channel blocker	64 (3.0)	47 (2.9)	0.882	64.2 (3.1)	43 (2.8)	0.620
Glycoprotein IIb/IIIa inhibitor	427 (20.2)	478 (29.3)	<0.001	505 (24.4)	419 (27.4)	0.044

Dichotomous variables are expressed as n (%); continuous variables are expressed as mean±standard deviation or median with interquartile range.
BMI: body mass index, LDL: low density lipoprotein, HDL: high density lipoprotein, TG: triglyceride, TC: total cholesterol, CK-MB: creatine kinase-MB, LVEF: left ventricular ejection fraction, TIMI: thrombolysis in myocardial infarction, SBP: systolic blood pressure, HR: heart rate, PCI: percutaneous coronary intervention, ACEi: angiotensin converting enzyme inhibitor, ARB: angiotensin receptor blocker.

Baseline characteristics of patients before and after propensity score matching were shown in Table 1. Patients in the PCI with TA group were younger and had higher body mass indexes (BMI). In laboratory data, creatinine clearance and high-density lipoprotein (HDL) levels were significantly higher in the PCI with TA group. In hemodynamic and procedural characteristics analysis, patients in the PCI with TA group had lower Killip classes, heart rates and shorter door-to-balloon time at admission. More patients in the PCI with TA group had right coronary artery disease as the infarct-related vessel and many more cases of single vessel diseases. The higher number of transfemoral vascular approaches and culprit only PCI were found in the PCI with TA group. Glycoprotein IIb/IIIa inhibitor, statin and clopidogrel were used more often in the PCI with TA group than the PCI alone group.

After propensity-score matching, the differences in clinical variables between the PCI with TA group and the PCI alone group were less significant. Higher levels of HDL and creatine kinase-MB (CK-MB) were observed in the PCI with TA group. More cases of transfemoral vascular approaches were performed in the PCI alone group. In addition, glycoprotein IIb/IIIa inhibitors were used more often in the PCI with TA group than the PCI alone group.

2. Clinical outcomes

Clinical outcomes of the 30-day and 1-year follow-up before and after propensity matching are shown in Table 2. MACE and all-cause mortality were observed in 308 (8.2%) and 271 (7.2%) patients during the 1-year follow up respectively. With respect to the primary efficacy outcome, there was no significant difference in the incidence of MACE between the PCI alone and the PCI with TA groups at the 30-day and 1-year follow up in all patients. After propensity-score matching, there were also no significant differences in the incidence of MACE between the two groups at 30-days (5.3% vs. 5.3%, adjusted HR with 95% CI: 1.342 [0.826-2.179], p value=0.235 for TA use) and 1-year (8.2% vs. 8.2%, adjusted HR with 95% CI: 1.187 [0.863-1.633], p value=0.291 for TA use). Fig. 2 shows the Kaplan-Meier curves for 1-year MACE between the PCI alone and the PCI with TA groups in propensity-matched cohorts. There was no difference between the two groups in the rate of MACE at 1-year follow-up. Furthermore, the secondary efficacy outcomes, CVD and all-cause mortality were not different between the two groups at the 30-day and 1-year follow up before and after propensity-score matching.

Hazard ratios of various subgroups were analyzed in propensity score matched patients during a 1-year follow up. The frequency of MACE did not decrease in the PCI with TA group in all subgroup analyses (Fig. 3).

DISCUSSION

The major finding of our study is that PCI with TA in patients of STEMI who underwent primary PCI within 12 hours and pre-procedural TIMI flow 0, 1 did not reduce the risk of the adverse clinical outcomes at the 1-year follow up. Moreover, there was no improvement in clinical outcomes in the various subgroup analyses.

The result of our study corresponded well with several large-scale trials.[7-9,16,17] In the randomized clinical trial of TASTE, routine thrombus aspiration before PCI did not reduce 30-day mortality, rate of death from any cause or the composite of death from any cause, re-hospitalization for myocardial infarction, or stent thrombosis at 1-year.[8,9] The Trial of TOTAL also pointed out that thrombus

Table 2. Clinical outcomes of thrombus aspiration between PCI alone and PCI with TA groups before and after propensity score matching at 30-day and 1-year

	All patients					Propensity-matched patients				
	PCI alone N=2119, (%)	PCI with TA N=1630, (%)	p value	Unadjusted HR for TA (95% CI)	p value	PCI alone N=2066, (%)	PCI with TA N=1528, (%)	p value	Adjusted HR for TA (95% CI)	p value
30-day										
All-cause mortality	113 (5.3)	77 (4.7)	0.410	0.886 (0.663-1.184)	0.413	106 (5.1)	76 (5.0)	0.878	1.031 (0.599-1.773)	0.913
CVD	105 (5.0)	72 (4.4)	0.485	0.892 (0.661-1.204)	0.454	98 (4.7)	71 (4.6)	0.937	1.236 (0.696-2.194)	0.470
Stroke	19 (0.9)	16 (1.0)	0.864	1.096 (0.564-2.132)	0.786	12 (0.6)	12 (0.8)	0.536	1.133 (0.494-2.601)	0.768
Recurrent MI	13 (0.6)	13 (0.8)	0.554	1.301 (0.603-2.806)	0.502	17 (0.8)	15 (1.0)	0.720	1.446 (0.604-3.463)	0.408
Stent thrombosis	11 (0.5)	10 (0.6)	0.826	1.182 (0.502-2.784)	0.701	11 (0.5)	9 (0.6)	0.999	1.136 (0.428-3.017)	0.798
TVR/TLR	4 (0.2)	2 (0.1)	0.703	0.648 (0.119-3.537)	0.616	4 (0.2)	4 (0.3)	0.730	0.836 (0.146-4.788)	0.841
MACE	117 (5.5)	83 (5.1)	0.608	0.923 (0.697-1.223)	0.578	109 (5.3)	81 (5.3)	0.999	1.342 (0.826-2.179)	0.235
1-year										
All-cause mortality	160 (7.6)	111 (6.8)	0.408	0.898 (0.705-1.144)	0.383	150 (7.3)	108 (7.1)	0.825	1.130 (0.776-1.647)	0.523
CVD	131 (6.2)	90 (5.5)	0.402	0.893 (0.683-1.168)	0.408	123 (6.0)	88 (5.8)	0.806	1.222 (0.778-1.920)	0.384
Stroke	28 (1.3)	30 (1.8)	0.505	1.195 (0.714-2.002)	0.498	27 (1.3)	27 (1.8)	0.262	1.379 (0.747-2.544)	0.304
Recurrent MI	34 (1.6)	24 (1.5)	0.791	0.897 (0.531-1.513)	0.683	33 (1.6)	23 (1.5)	0.826	1.028 (0.582-1.816)	0.925
TVR and TLR	47 (2.2)	22 (1.3)	0.051	0.591 (0.356-0.982)	0.042	46 (2.2)	22 (1.4)	0.087	0.603 (0.350-1.039)	0.069
Stent thrombosis	16 (0.8)	13 (0.8)	0.999	1.029 (0.494-2.143)	0.939	16 (0.8)	12 (0.8)	0.971	0.970 (0.426-2.208)	0.970
MACE	179 (8.4)	129 (7.9)	0.589	0.925 (0.737-1.160)	0.499	170 (8.2)	125 (8.2)	0.959	1.187 (0.863-1.633)	0.291

PCI: percutaneous coronary intervention, TA: thrombus aspiration, CVD: cardiovascular death, MI: myocardial infarction.
Adjust included various clinical variables including age, sex, BMI, heart rate at admission, SBP at admission, HDL, Creatine clearance, Hemoglobin, symptom balloon time (min), index procedure (culprit only PCI vs. Multi-vessel PCI), use of statin, beta-blocker, RAS blocker, Glycoprotein IIb/IIIa inhibitor, LVEF.

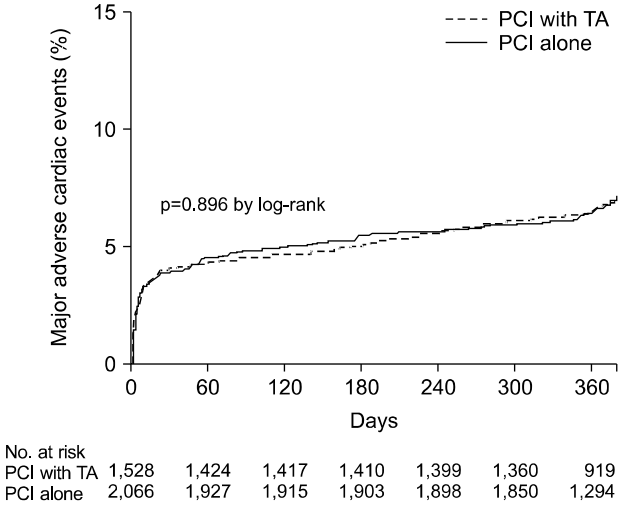

FIG. 2. Kaplan-Meier curve of MACE at 1-year between PCI alone and PCI with TA in propensity-matched cohort. The rate of MACE at 1-year follow-up was no significant difference between the two groups.
MACE: major adverse cardiac events, PCI: percutaneous coronary intervention, TA: thrombus aspiration.

aspiration did not significantly improve cardiovascular mortality at 180 days. Rather, the investigators of the TOTAL trial found that the risk of stroke in the patients treated with thrombus aspiration was significantly higher within 30 days.[7]

However, several previous reports disagreed with our findings. In the TAPAS trial,[3] 1-year cardiac death was reduced in the TA group (HR: 1.93; 95% CI [1.11-3.37], p=0.020). Burzotta et al.[6] showed individual patients-data pooled analysis of randomized studies, in which thrombectomy significantly improved the clinical outcomes in patients with STEMI undergoing mechanical reperfusion. Also, Costopoulos et al.[2] documented that the use of manual thrombectomy devices was associated with significant improvements in ST-segment resolution, Myocardial Blush Grade (MBG) 3, TIMI grade 3 flow as well as clinical parameters (43% reduction in mortality, p=0.04) in patients undergoing primary PCI.

Some KAMIR data demonstrated that TA showed clinical benefits only in special subgroups. Hachinohe et al.[18] compared clinical outcomes between the PCI with TA and the PCI alone groups. Although TA did not improve the

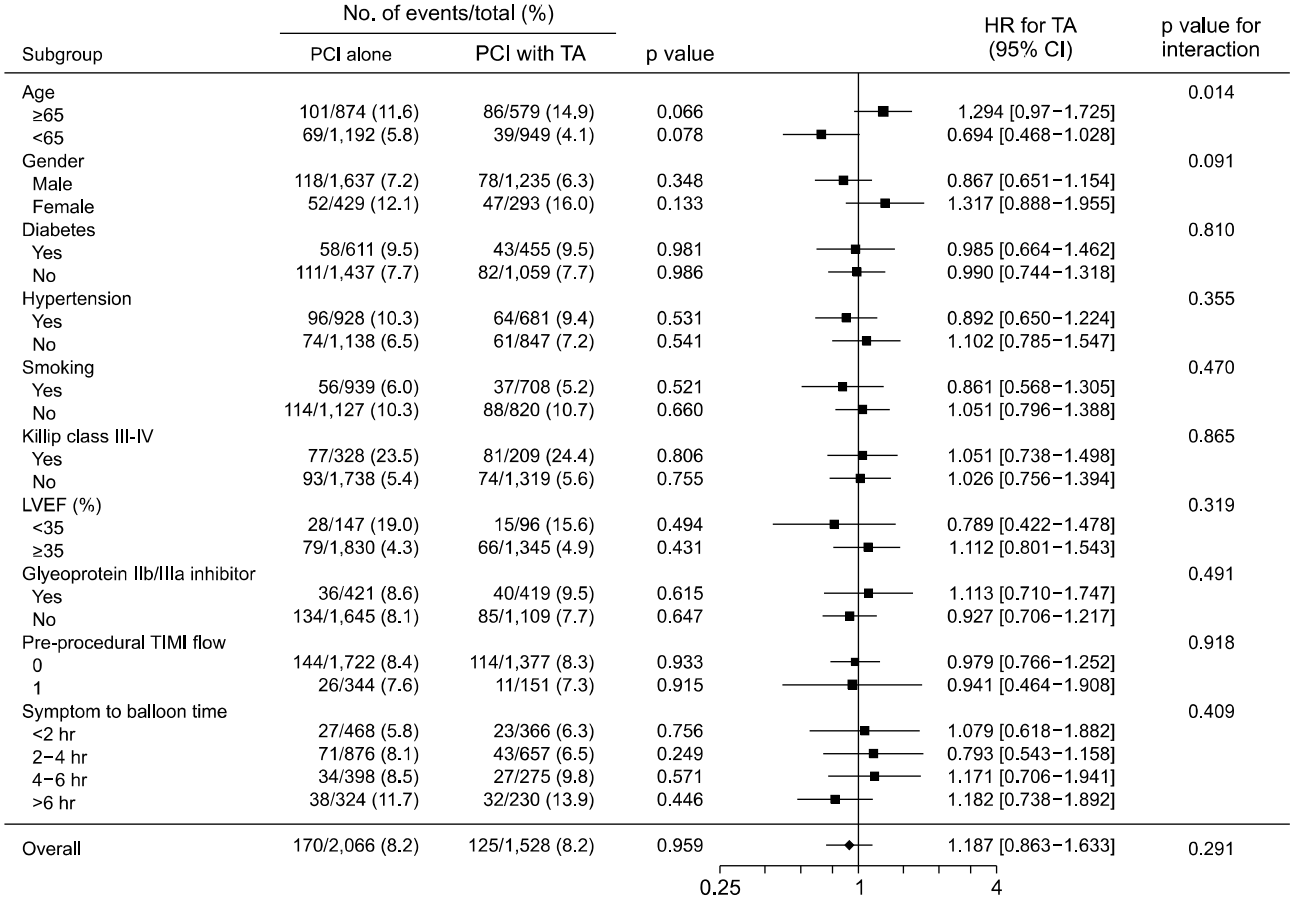

FIG. 3. Subgroup analysis: unadjusted hazard ratio (HR) for 1-year MACE in propensity score matched patients. HR of various subgroup were analyzed in propensity score matched patients during 1-year follow up. MACE was not reduced in PCI with TA group in any subgroups. HR of overall patients was adjusted result. MACE was not also reduced in PCI with TA group in overall patients.
PCI: percutaneous coronary intervention, TA: thrombus aspiration, CVD: cardiovascular death, MI: myocardial infarction, MACE: major adverse cardiovascular event, HR: hazard ratio, TIMI: Thrombolysis in Myocardial infarction.

clinical outcomes in all patients, TA for LAD occlusion and the use of GP IIb/IIIa inhibitors with TA showed an improvement in 12-month MACE. Sim et al.[19] also reported that manual TA during primary PCI did not improve the clinical outcomes at 12-months; manual TA was associated with a higher risk-adjusted MACE rate compared to PCI alone in patients with longer total ischemic times.

The use of glycoprotein IIb/IIIa inhibitors and manual thrombectomy has been debated in previous studies.[6,18,20,21] In the Intracoronary Abciximab and Aspiration Thrombectomy in Patients With Large Anterior Myocardial Infarction (INFUSE-AMI) trial, an intracoronary bolus infection of the glycoprotein IIb/IIIa inhibitor abciximab was effective in reducing the infarct size, whereas thrombectomy through manual aspiration was not. Reduced embolization and improved myocardial perfusion may improve clinical outcomes. A similar result was also reported in a study published in Korean, in which manual TA was not associated with reduced infarct size assessed by cardiac computed tomography.[22] TA may not be a safe procedure and distal embolization including cerebral embolization can occur.[7,17] Coronary thrombus material triggers thrombotic, inflammatory, vasoconstrictor, and other pathways. Evacuating a portion of the thrombus and plaque material resolves only a part of the pathophysiological problem. Disrupting thrombus formation pharmacologically may be more effective.[8]

Based on the results of the INFUSE-AMI, TASTE and TOTAL trials, The 2015 ACC/AHA guidelines for management of STEMI patients has been recently revised to show that the effectiveness of selective and bailout aspiration thrombectomy in patients undergoing primary PCI is not well established (Class IIB, level of evidence C). Also, routine aspiration thrombectomy before primary PCI is not useful (Class III, level of evidence A).[11] Routine thrombus aspiration is not recommended (Class III, level of evidence A), but in cases of large residual thrombus burden after opening the vessel with a guide wire or a balloon, thrombus aspiration may be considered in the 2017 ESC guidelines.[10]

Our results didn't show any benefit of TA during PCI at the 30-days and 1-year follow-ups. In addition, TA with concomitant use of glycoprotein IIb/IIIa inhibitors did not improve the clinical outcomes. These results imply that TA might have been performed more often in patients with a larger burden of thrombus or in patients with higher risk, resulting in worse clinical outcomes. Types of thrombus can affect mortality during PCI. Some studies have focused on the macroscopic appearance of the aspirated material, subdivided into white (fibrin-rich) and red (erythrocyte-rich) thrombus. White thrombus was typically found in patients with a small thrombus burden and a short ischemic time. By contrast, red thrombus tends to be found in late-presenting patients with a higher risk of distal embolization and cardiac mortality.[23] In our study, we could not analyze the burden or the type of thrombus.

This study has several limitations. First, although it was conducted in the patients with MI registered with the KAMIR-NIH and although statistical adjustment including propensity score matching was performed, some confounding factors still existed. Second, we only used TIMI flow grading, which is a subjective categorical variable, and other predictive markers of myocardial perfusion such as corrected TIMI frame count and myocardial brush grade, were unavailable.[24,25] Third, as we analyzed the events limited within one year, the study might be underpowered to demonstrate the clinical usefulness of TA in STEMI patients.

In conclusion, our study showed that TA during primary PCI as compared to PCI alone did not reduce the incidence of MACE and all-cause mortality and CVD among the Korean patients with STEMI and pre-procedural TIMI flow 0, 1 at the 30-day and 1-year follow-ups.

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CONFLICT OF INTEREST STATEMENT

None declared.

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