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Original Article

Clinical effectiveness of thrombus aspiration during percutaneous coronary intervention for stent thrombosis in a contemporary setting

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ABSTRACT

Objective: The impact of adjunctive manual thrombus aspiration (TA) in patients with stent thrombosis (ST) treated with percutaneous intervention has not been evaluated in the current era of potent P2Y12 agents and new-generation drug-eluting stents. We sought to assess the effect of TA using data from a large contemporary registry.

Methods: The study population was derived from the Essex ST Investigation Registry (ESTHIR), which contains all consecutive cases of angiographically determined definite ST undergoing interventional treatment in a tertiary cardiac centre between November 2015 and June 2018. Propensity score matching was performed to match patients who underwent TA (TA group) to those who did not (n-TA group). The study endpoints were final TIMI flow and survival free of cardiovascular death (CD) or target lesion revascularisation (TLR).

Results: A total of 128 ST patients were included in the present analysis. The mean age was 65 ± 11 years, and 84% were male. About 90% of the patients presented with STEMI, and 85% had very late ST. Seventy-two patients (56%) underwent TA. After propensity score matching, 30 patients were included in each study group. A higher rate of final TIMI III flow was observed in the TA group (TA vs n-TA group, 100% vs 83%), but this difference did not reach statistical significance ($p = 0.052$). At 1000 days of follow-up, survival free of CD or TLR was not different between the two groups ($p = 0.8$).

Conclusion: In a propensity-matched population of ST patients undergoing PCI in a contemporary setting, TA was not associated with improved final TIMI flow or long-term cardiovascular outcomes.

1. Introduction

Stent thrombosis (ST) is an uncommon but serious complication of percutaneous coronary intervention (PCI) with mortality rates that can be as high as 20-40%.[1,2] Its clinical presentation is with acute myocardial infarction (AMI) with ST being one of the causes of ST-segment elevation MI (STEMI) after coronary stent implantation.[3] Compared with AMI because of de novo coronary artery disease, AMI because of stent thrombosis has a different pathophysiology. An underlying ruptured or eroded atheromatic plaque can be the cause in the presence of neo-atherosclerosis within the stented segment. However, thrombus formation and ST without underlying plaque pathology can occur because of thrombogenicity of uncovered stent struts and polymer materials or disturbance of blood flow (e.g., in the presence of stent malapposition or under-expansion).[4] Furthermore, ST is associated with a larger thrombus burden and an increased risk of distal embolization and microvascular obstruction.[5] Despite these distinct features, no specific guidance exists regarding the best interventional treatment strategy for AMI because of ST. The management of this

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high-risk entity remains empirical, whereas registries of ST report that balloon angioplasty and thrombus aspiration are frequently used as destination therapy.[6-8]

Routine TA in the management of patients with STEMI was not associated with improved outcomes in recent large randomised controlled trials.[9,10] In this setting, a subgroup analysis of patients with a high thrombus burden demonstrated a trend towards fewer cardiovascular deaths.[11] In the past, small observational studies of patients undergoing PCI for ST have shown an association between TA and improved angiographic outcomes but had conflicting results regarding clinical outcomes.[12-15] These studies were conducted in non-contemporary settings, with most patients receiving bare metal and first-generation stents. No study has assessed the clinical effectiveness of TA in cases of ST in the contemporary era of potent P2Y12 agents and new-generation drug-eluting stents (DES). In this study, we aimed to investigate whether adjunctive manual TA for patients with ST treated in a contemporary setting was associated with improved myocardial perfusion and long-term clinical outcomes.

2. Methods

2.1. Patient population

The study population was derived from the Essex Stent Thrombosis Investigation Registry (ESTHIR), which contains all consecutive cases of angiographically determined definite ST undergoing interventional management at the Essex Cardiothoracic Centre (Basildon, United Kingdom) since November 2015. The registry has been described in detail before.[6] Essex Cardiothoracic Centre (CTC) is a large, tertiary cardiac centre providing PCI services in a 24/7 fashion for a catchment area of 2 million people, as the sole National Health Service (NHS) provider of this service for the specific population.

The mode of management in the registry was classified as either new stent implantation or non-stent treatment. Non-stent treatment includes medical management only (combination of antiplatelet and/or antithrombotic therapy), TA, plain old balloon angioplasty (POBA), and drug-coated balloon angioplasty (DCB). Unfractionated heparin was used for periprocedural anticoagulation in all patients, and the default mode of IIb/IIIa administration was IV via a peripheral line. For the current study, the initial population was formed from the registry's patients by applying the following inclusion criteria: ST of either a bare metal or a drug-eluting stent implanted in a native coronary artery, eGFR at presentation >30 ml/min, and in case of stent treatment, implantation of a new-generation DES. Two patient groups were formed: patients who had TA performed during PCI (TA group) and patients who had PCI without TA (n-TA group). All TA procedures were performed manually using 6F catheters [Export Advance™ Aspiration Catheter, Medtronic (USA) or Hunter® ST, IHT (Spain)]. After the application of propensity score matching, the adjusted population was formed consisting of 30 patients in each group.

2.2. Study outcomes

The angiograms of the study's patients were reviewed and adjudicated with regards to initial and final TIMI flow by an experienced cardiologist, member of the authors uninvolved in the management of the patients, and blinded to the outcome of the study. Follow-up was performed by means of in-hospital records review and General Register Office data to document all-cause death (ACD), cardiovascular death (CD), and target lesion revascularization (TLR). Target lesion revascularisation was defined as symptom or ischaemia-driven percutaneous or surgical revascularisation of the stent thrombosis-related lesion. Final TIMI flow grade and survival free of TLR or CD were the study's endpoints.

2.3. Statistical analysis

Continuous and normally distributed variables are presented as mean ± standard deviation, and continuous variables with asymmetric distribution are presented as median with range values. The normality assumption for continuous variables was evaluated using the Kolmogorov-Smirnov test. Categorical data are presented as counts and percentages. Between-group differences in variables were examined by the Pearson chi-square/Fisher's exact test and the Mood's median test for independent samples as appropriate. Propensity score matching (1:1), using a nearest neighbour algorithm and no replacement, was performed to match patients between the TA and n-TA groups. Matching was implemented by applying a “greedy” algorithm on the logit of the propensity score within a caliper equal to 0.01 times the pooled standard deviation of the logit. Patients were matched on the following characteristics: type of ST (acute + subacute vs. late + very late), type of ACS (STEMI vs. NSTEMI), type of treatment received (stent vs. non-stent), initial TIMI flow, cardiogenic shock or mechanical ventilation, diabetes mellitus, and use of IIb/IIIa antagonists. The effectiveness of matching to alleviate covariate imbalance was evaluated by the standardized difference “d” of the covariates between treatment groups, with a $d \leq 10\%$ being considered as an indication of negligible differences in the mean or prevalence of covariates between groups. The Kaplan-Meier analysis was used to compare outcomes between the two groups. Analyses were performed using the PASW version 22 (SPSS, Inc., Chicago, Illinois) software and the “IPWsurvival” package of the R software version 3.5.1 (R Foundation for Statistical Computing, Vienna, Austria). All tests were 2-tailed, and a p value < 0.05 was considered statistically significant.

3. Results

Between November 2015 and June 2018, 138 consecutive patients underwent PCI for ST and were, therefore, included in the ESTHIR registry (a case example is illustrated in the Appendix Fig. 1). After the application of the inclusion criteria of the study, 128 patients were used in the present analysis. The mean age was 65 ± 11 years, and 84% of study subjects were male. About 90% of the patients presented with STEMI, and 85% had VLST. Seventy-two patients (56%) underwent TA during PCI for ST. Patients in the n-TA group were more likely to have chronic kidney disease and be on mechanical ventilation at presentation. The discontinuation of antiplatelet therapy before the admission with ST was more common in patients who had TA. In these patients, the incidence of TIMI 0 flow at presentation and the subsequent use of IIb/IIa and intravascular imaging was higher. Finally, it was more common for this group of patients to receive a “non-stent” treatment. No patient had a TIA or stroke peri-procedurally or during in-hospital stay. The full baseline and peri-procedural characteristics of the total (unmatched) study population are listed in Tables 1 and 2.

Table 1
Baseline and presentation characteristics of the overall and matched populations

		Overall population (n = 128)		p	Matched population (n = 60)		p
		No thromboaspiration	Thromboaspiration		No thromboaspiration	Thromboaspiration	
		n (%)	n (%)		n (%)	n (%)	
Number		56 (100)	72 (100)	na	30 (100)	30 (100)	na
Age (years)		66 (43-92)	64 (43-91)	0.4	63 (48-89)	66 (44-84)	0.6
Male gender		47 (83.9)	61 (84.7)	0.9	26 (86.7)	27 (90.0)	1
Smoking		19 (33.9)	25 (34.7)	0.9	11 (36.7)	12 (40.0)	0.8
Dyslipidaemia		32 (57.1)	48 (66.7)	0.3	19 (63.3)	18 (60.0)	0.8
Hypertension		41 (73.2)	44 (61.1)	0.1	24 (80.0)	17 (56.7)	0.052
Diabetes		11 (19.6)	20 (27.8)	0.3	6 (20.0)	6 (20.0)	1
Family history		13 (23.2)	19 (26.4)	0.7	8 (26.7)	6 (20.0)	0.5
Renal insufficiency		12 (21.4)	6 (8.3)	0.03	3 (10.0)	3 (10.0)	1
Previous MI		48 (85.7)	57 (79.2)	0.3	26 (86.7)	26 (86.7)	1
Previous CABG		4 (7.1)	5 (6.9)	1	1 (3.3)	2 (6.7)	1
Diseased vessels	1	39 (69.6)	50 (69.4)	0.9	24 (80.0)	22 (73.3)	0.8
	2	12 (21.4)	17 (23.6)		5 (16.7)	6 (20.0)	
	3	4 (7.1)	5 (6.9)		1 (3.3)	2 (6.7)	
Presentation mode—clinical							
STEMI		48 (85.7)	67 (93.1)	0.2	29 (96.7)	29 (96.7)	1
NSTEMI		8 (14.3)	5 (6.9)		1 (3.3)	1 (3.3)	
Cardiogenic shock		5 (8.9)	6 (8.3)	1	2 (6.7)	2 (6.7)	1
Mechanical ventilation		7 (12.5)	2 (2.8)	0.04	2 (6.7)	0 (0.0)	0.5
Cardiac arrest		10 (17.9)	6 (8.3)	0.1	3 (10.0)	2 (6.7)	1
Presentation mode—stent-related							
Acute ST		2 (3.6)	7 (9.7)	0.4	0 (0.0)	1 (3.3)	0.4
Sub-acute ST		4 (7.1)	3 (4.2)		2 (6.7)	0 (0.0)	
Late ST		2 (3.6)	1 (1.4)		1 (3.3)	0 (0.0)	
Very late ST		48 (85.7)	61 (84.7)		27 (90.0)	29 (96.7)	
Antiplatelet therapy adherence							
No APT on presentation		9 (16.1)	17 (23.6)	0.3	5 (16.7)	7 (23.3)	0.5
Any APT discontinuation before ST		9 (16.1)	25 (34.7)	0.02	5 (16.7)	13 (43.3)	0.02
LV function status							
LVEF (%)		44 (15-60)	45 (15-55)	0.4	44 (25-55)	45 (20-55)	0.8
LVEF: normal		18 (32.1)	18 (25.0)	0.6	9 (30.0)	10 (33.3)	1
LVEF:30-50%		31 (55.4)	45 (62.5)		18 (60.0)	17 (56.7)	
LVEF: < 30%		7 (12.5)	9 (12.5)		3 (10.0)	3 (10.0)	

BMI = body mass index, CAD = coronary artery disease, MI = myocardial infarction, CABG = coronary artery bypass grafting, LVEF = left ventricular ejection fraction, STEMI = ST-elevation myocardial infarction, NSTEMI = non-ST-elevation myocardial infarction, UA = unstable angina, ST = stent thrombosis, APT = antiplatelet therapy.

Table 2
Peri-procedural characteristics of the of the overall and matched populations

	Overall population (n = 128)		P	Matched population (n = 60)		P
	No thromboaspiration	Thromboaspiration		No thromboaspiration	Thromboaspiration	
	n (%)	n (%)		n (%)	n (%)	
Number	56 (100.0)	72 (100)	na	30 (100)	30 (100)	na
Culprit stent localization						
Non-LAD	31 (55.4)	41 (56.9)	0.8	14 (46.7)	18 (60.0)	0.3
LAD	25 (44.6)	31 (43.1)	0.7	16 (53.3)	12 (40.0)	0.5
Circumflex	9 (16.1)	8 (11.1)		4 (13.3)	2 (6.7)	
RCA	20 (35.7)	31 (43.1)		9 (30.0)	14 (46.7)	
Diagonal	2 (3.6)	1 (1.4)		1 (3.3)	1 (3.3)	
Intermediate	0 (0.0)	1 (1.4)		0	1 (3.3)	
				0.0%		
Bifurcation lesion	2 (3.6)	1 (1.4)	0.6	1 (3.3)	1 (3.3)	1
Culprit stent type						
BMS	19 (33.9)	23 (31.9)	0.9	10 (33.3)	13 (43.3)	0.2
1st DES	9 (16.1)	11 (15.3)		4 (13.3)	8 (26.7)	
2nd DES	28 (50.0)	38 (52.8)		16 (53.3)	9 (30.0)	
Initial TIMI flow						
Initial TIMI flow = 0	31 (55.4)	59 (81.9)	0.001	21 (70.0)	21 (70.0)	1
Initial TIMI flow >0	25 (44.6)	13 (18.1)		9 (30.0)	9 (30.0)	
Intravascular imaging						
OCT	8 (14.3)	20 (27.8)	0.06	3 (10.0)	8 (26.7)	0.1
IVUS	4 (7.1)	10 (13.9)	0.2	2 (6.7)	3 (10.0)	1
Overall	12 (21.4)	30 (41.7)	0.008	5 (16.7)	11 (36.7)	0.08
IIb/IIIa	22 (39.3)	53 (73.6)	<0.001	16 (53.3)	16 (53.3)	1

(*continued on next page*)

Table 2 (*continued*)

	Overall population (n = 128)		P	Matched population (n = 60)		P
	No thromboaspiration	Thromboaspiration		No thromboaspiration	Thromboaspiration	
	n (%)	n (%)		n (%)	n (%)	
Type of treatment						
Thromboaspiration	0 (0.0)	2 (2.8)	0.01	0 (0.0)	1 (3.3)	0.3
DCB	10 (17.9)	4 (5.6)		4 (13.3)	1 (3.3)	
DES	36 (64.3)	43 (59.7)		21 (70.0)	21 (70.0)	
Balloon angioplasty	8 (14.3)	23 (31.9)		4 (13.3)	7 (23.3)	
Other*	2 (3.6)	0 (0.0)		1 (3.3)	0 (0.0)	
Number of stents used						
0	20 (35.7)	29 (40.3)	0.8	9 (30.0)	9 (30.0)	1
1	26 (46.4)	33 (45.8)		16 (53.3)	16 (53.3)	
2	9 (16.1)	8 (11.1)		4 (13.3)	3 (10.0)	
3	1 (1.8)	2 (2.8)		1 (3.3)	2 (6.7)	
>1	10 (17.9)	10 (13.9)	0.5	5 (16.7)	5 (16.7)	1
End TIMI flow						
3	47 (83.9)	64 (88.9)	0.2	25 (83.3)	30 (100.0)	0.052
2	6 (10.7)	8 (11.1)		4 (13.3)	0 (0.0)	
1	3 (5.4)	0 (0.0)		1 (3.3)	0 (0.0)	
Antiplatelet therapy on discharge						
ASA + clopidogrel	7 (12.5)	22 (30.6)	0.047	4 (13.3)	11 (36.7)	0.06
ASA + prasugrel	3 (5.4)	4 (5.6)		1 (3.3)	2 (6.7)	
ASA + ticagrelor	46 (82.1)	46 (63.9)		25 (83.3)	17 (56.7)	

LAD = left anterior descending, RCA = right coronary artery, BMS = bare metal stent, DES = drug-eluting stent, OCT = optical coherence tomography, IVUS = intravascular ultrasound, DCB = drug-coated balloon, ASA = aspirin.

* Includes one patient referred for in-hospital CABG, and one patient who was managed with triple antithrombotic therapy for 72 hrs and repeat angiogram showing resolution of thrombus.

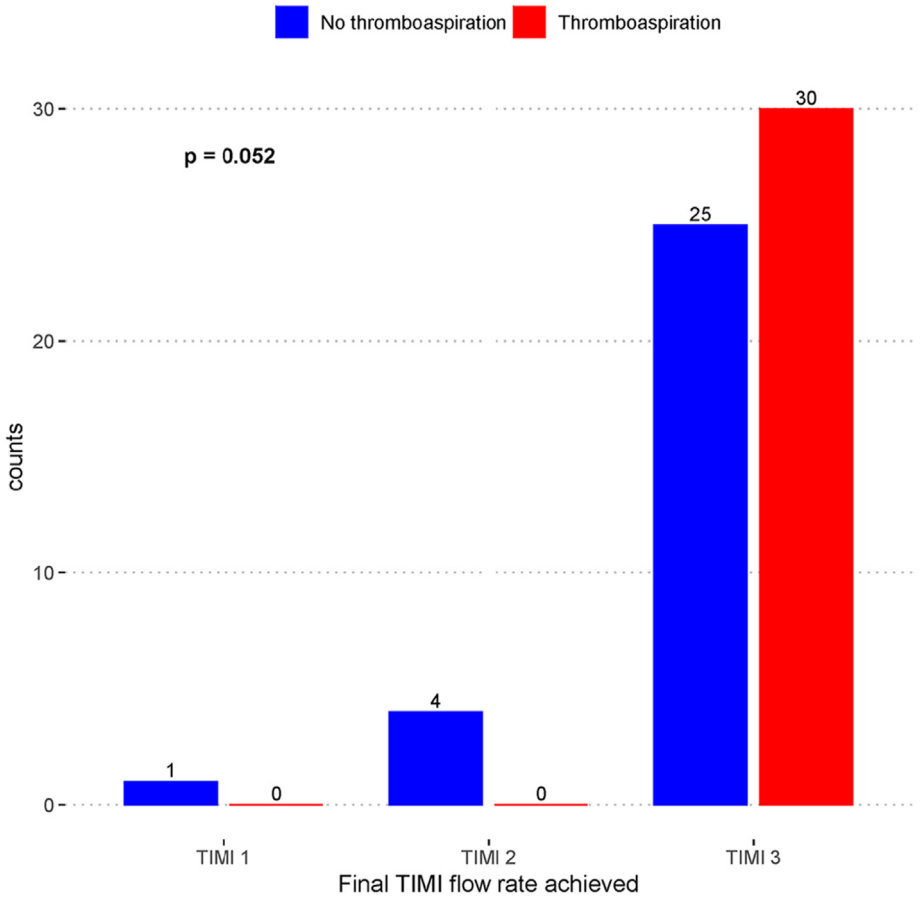

Figure 1. Differences in final TIMI flow rate between thrombo-aspiration (TA) and no thrombo-aspiration (n-TA) groups.

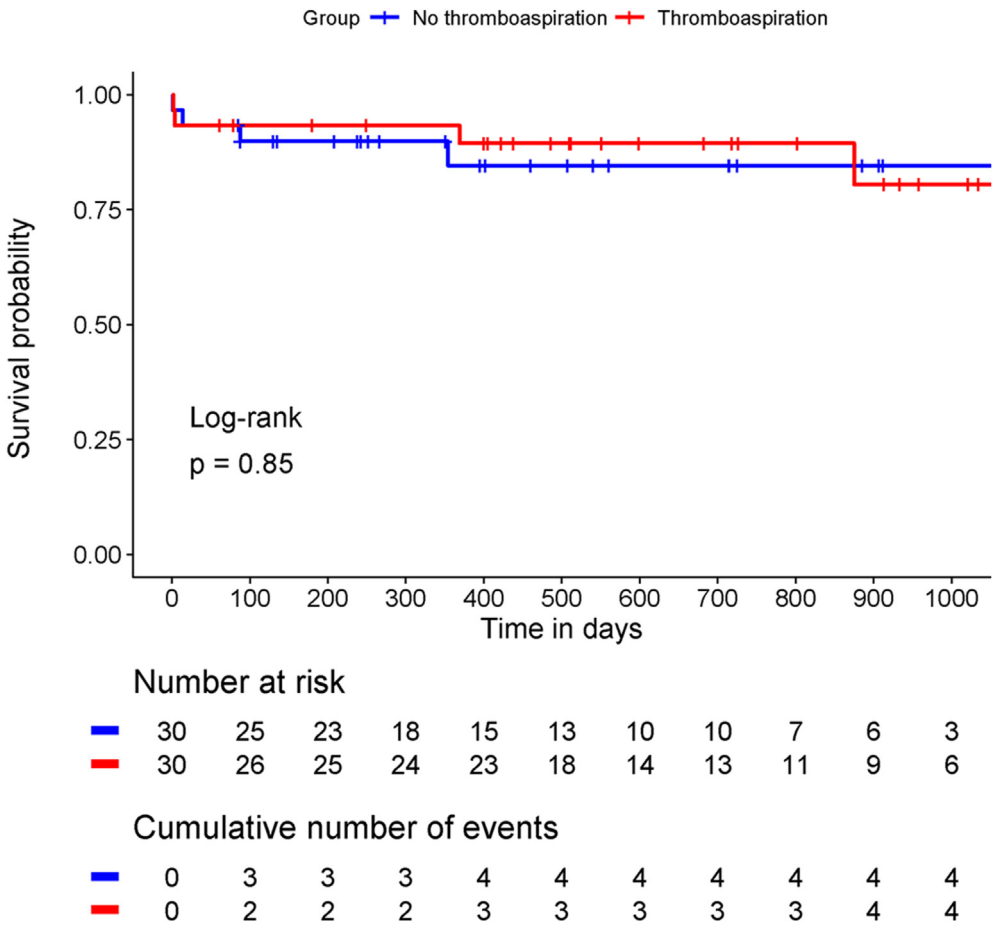

Figure 2. Kaplan-Meier survival analysis for the cardiac death (CD) or target lesion revascularisation (TLR) composite endpoint.

3.1. Adjusted population after propensity score matching

Baseline and peri-procedural characteristics of the adjusted sample (after matching) are presented in Tables 1 and 2. The overall performance of the matching process is demonstrated graphically in the Appendix (Fig. 2). All characteristics that were used for matching demonstrated SMDs below 1% with p values < 0.01 in comparisons between TA and n-TA groups (Tables 1 and 2). All other characteristics demonstrated non-significant differences between TA and n-TA groups (Tables 1 and 2).

3.2. Management in the adjusted population

The breakdown of the exact treatments received by the patients in the adjusted population (n = 60) is shown in Table 2. Considering the overall treatment group classification, 21 patients received stent treatment (70%), and 9 patients received non-stent treatment (30%) in both the TA and the n-TA group (p = 1). Focusing on the 42 patients who received stent treatment, a total number of 55 new-generation DES were implanted with a mean number of stents used per cases being 1 ± 0.8. There were no significant differences in the rate of intravascular imaging use to guide treatment. Adjunctive antiplatelet therapy was similar between the TA and n-TA groups, with regards to both the rates of peri-procedural IIb/IIIa use and the type of oral antiplatelets used for post-procedural management. The recommended antiplatelet therapy on discharge included a combination of aspirin and thienopyridine for at least 12 months.

3.3. Outcomes in the adjusted population

At the end of the intervention, all patients in the TA group achieved the TIMI 3 flow rate. In the n-TA group, the TIMI 3 flow rate was achieved in 25 of the 30 patients (4 patients had TIMI 2 flow, and 1 patient had TIMI 1 flow). Thus, the TA group achieved numerically higher overall TIMI 3 flow rates compared with the n-TA group (100% vs 83%), but this difference was borderline non-statistically significant (p = 0.052) (Fig. 1).

After a mean follow-up duration of 965 ± 45 days, 8 ACDs, 3 CDs, and 5 TLRs were observed. No cases of recurrent definite ST were documented. There were 2 in-hospital deaths, all cardiac in nature. Three of the TLRs were performed by means of CABG and 2 by repeat PCI. At 1000 days of follow-up, survival free of CD or TLR was not different between the TA and non-TA group (p = 0.8), as seen in Fig. 2.

4. Discussion

In the present propensity-matched study of patients with ST treated in a contemporary setting, the adjunctive use of manual TA

during interventional management did not result in better final TIMI flow rates or survival benefit regarding the combined clinical endpoint of cardiac death (CD) or target lesion revascularisation (TLR).

Early studies suggested that there could be benefits from routine manual thrombus aspiration for patient presenting with STEMI.[16] However, two subsequent large randomised controlled trials, involving thousands of patients, did not confirm the association between TA and improved clinical outcomes.[9,10] Hence, currently, routine TA during primary PCI is not recommended.[17] Nevertheless, patients included in the above studies had STEMI caused by de novo coronary artery disease.

To the best of our knowledge, our study is the first to evaluate the effect of TA during interventional management of patients with ST, adjusting for potential confounders with propensity score matching and being performed in a contemporary setting. There are no randomised studies investigating the clinical effectiveness of TA in ST patients undergoing PCI for ACS, but four observational studies have studied this association in the past.[12-15] In these studies, which collectively included 437 ST cases, TA was shown to improve angiographic outcomes, but there was no consistent conclusion regarding clinical outcomes. A study of 91 patients, which recruited cases between 2003 and 2008, demonstrated that the use of TA was associated with a reduction in the incidence of the composite endpoint of death, recurrent MI, and recurrent ST at 30 days.[13] However, a larger study, which included 205 cases, did not show any significant difference in the long-term clinical outcomes of patients treated with adjunctive TA or conventional PCI alone.[15] All four studies were conducted in a non-contemporary clinical setting, before more potent antiplatelet agents and new-generation drug-eluting stents become available. Moreover, these studies did not exclude important confounding factors, which could have affected the favourable results observed. For example, in the largest published study to date[15], showing improved post-procedural coronary blood flow with TA, the TA group had a significantly higher frequency of GpIIb/IIIa inhibitor use compared with the n-TA group. GpIIb/IIIa antagonists use has been shown to be associated with an improvement in epicardial coronary flow in patients undergoing PCI for acute myocardial infarction.[18] Unlike these previous studies, the improvement in the TIMI flow rate observed in our study did not reach statistical significance. Several factors might have contributed to this discordance with the increased proportion of patients with very late ST included in our study being one of them. Recent intracoronary imaging studies have provided insight into the pathophysiology of ST, suggesting that epicardial thrombus burden is lower in VLST compared with acute or early events[7]. Pre-procedural thrombus burden is thought to influence the efficacy of thrombus aspiration, with the latter being more effective in patients with a large thrombus burden.[19] It is, therefore, possible that TA is most beneficial in the subset of early ST and that this beneficial effect was lost in our study because of the small percentage of early ST cases included. Furthermore, given its contemporary nature, 75% of the patients studied were treated with a novel antiplatelet agent (mainly ticagrelor), with only a minority of patients receiving clopidogrel as part of their dual antiplatelet therapy regimen. At an epicardial level, ticagrelor use appears to be associated with a significant improvement in post-procedural TIMI flow in patients undergoing primary PCI for STEMI compared with clopidogrel.[20] It is, therefore, possible that the benefits of thrombus aspiration that were seen in studies conducted in a non-contemporary setting have been attenuated by the more potent antiplatelet regimen and 2nd-generation stents used to treat our cohort of patients. However, it must be noted that in the unadjusted overall population, more patients in the TA arm had clopidogrel as a P2Y12 antiplatelet agent. This could be explained by the fact that more patients in the TA arm were treated without a new stent placement, and therefore, the operators might opt for a less patent antiplatelet agent. Furthermore, there were more patients with the discontinuation of APT in the TA arm. This might suggest a degree of antiplatelet intolerance (i.e., tendency for bleeding, dyspnoea when on Ticagrelor, etc.). Hence, the operators might have preferred less “aggressive” platelet inhibition.

Given the rarity of ST, it is highly unlikely that appropriately powered randomized controlled studies will ever be conducted in this group of patients. Hence, the significance of the present study regarding the invasive management of ST. The results of our study are discouraging regarding the potential for a long-term clinical benefit with current TA devices. This is not an unexpected finding, given that current TA technology has several limitations, including thrombus embolization downstream because of wire crossing, limited ability of current aspiration catheters to deal with large, organised thrombi, and embolization of thrombus to other vascular territories during the removal of the aspiration catheter.[11] The results of our study, although not statistically significant, showed a favourable trend with regards to TIMI flow, highlighting the potential of improved thrombus aspiration technologies used in larger cohorts of ST patients, to conclusively establish the role of adjunctive TA in the management of patients with ST. Finally, a practical aspect of TA in ST cases should be noted because TA can facilitate subsequent intracoronary imaging, a useful tool for further management.[21]

5. Limitations

The results of the current study should be interpreted in the context of several limitations. The observational design of this study is the first one. We used propensity score matching to eliminate the effect of confounders, but it is possible that there were unmeasured variables that could have confounded our results. Additionally, the sample size of our study was modest, and a larger sample size might have led to different results like a significant difference in final TIMI flow. Finally, all TA procedures involved manual thrombectomy using currently available 6F catheters. The limitations of current manual TA technology, including distal embolization, limited ability to deal with large, organized thrombi, and embolization of thrombus to other vascular territories during catheter removal, have been suggested in several large trials[11]. Potentially, novel devices with advanced features could improve safety and clinical efficiency of TA.

6. Conclusion

In the first study conducted in the contemporary era of patent P2Y12 agents and new-generation drug-eluting stents, using propensity score matching to eliminate the effect of confounders, TA was not associated with improved post-procedural coronary flow or long-term cardiovascular outcomes in a matched population of ST patients.

Conflict of interest

None declared.

Appendix

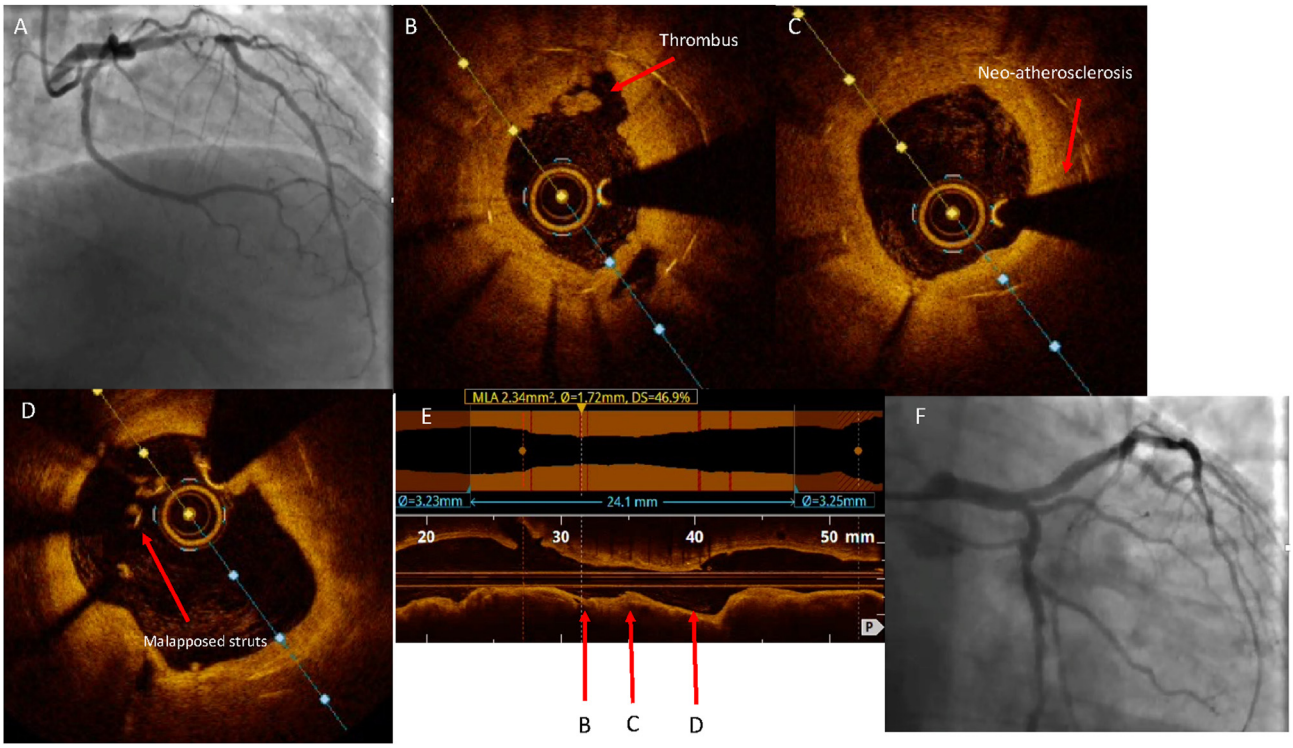

Figure 1. A case of very late stent thrombosis from ESTHIR where OCT imaging revealed multiple underlying pathologies. 67 years old presented with NSTEMI. ECG showed anterior TWI. History of previous PCI to proximal LAD 3 years earlier (3.00 × 16 mm DES). A. Coronary angiography revealed a subtotal thrombotic occlusion within the previously implanted LAD stent. B-E. OCT findings (OCT was performed after pre-dilatation with small semi-compliant balloon): B. Presence of thrombus with the old stent. C. Presence of neo-atherosclerosis. D. Major proximal stent struts malapposition. E. OCT longitudinal view reveals stent under-expansion. F. Final angiography after a Synergy 3.5 × 24 mm DES was deployed. ESTHIR = Essex Stent Thrombosis Investigation Registry, OCT = optical coherence tomography, NSTEMI = non-ST-elevation myocardial infarction, TWI = T-wave inversion, LAD = left anterior descending, DES = drug-eluting stent.

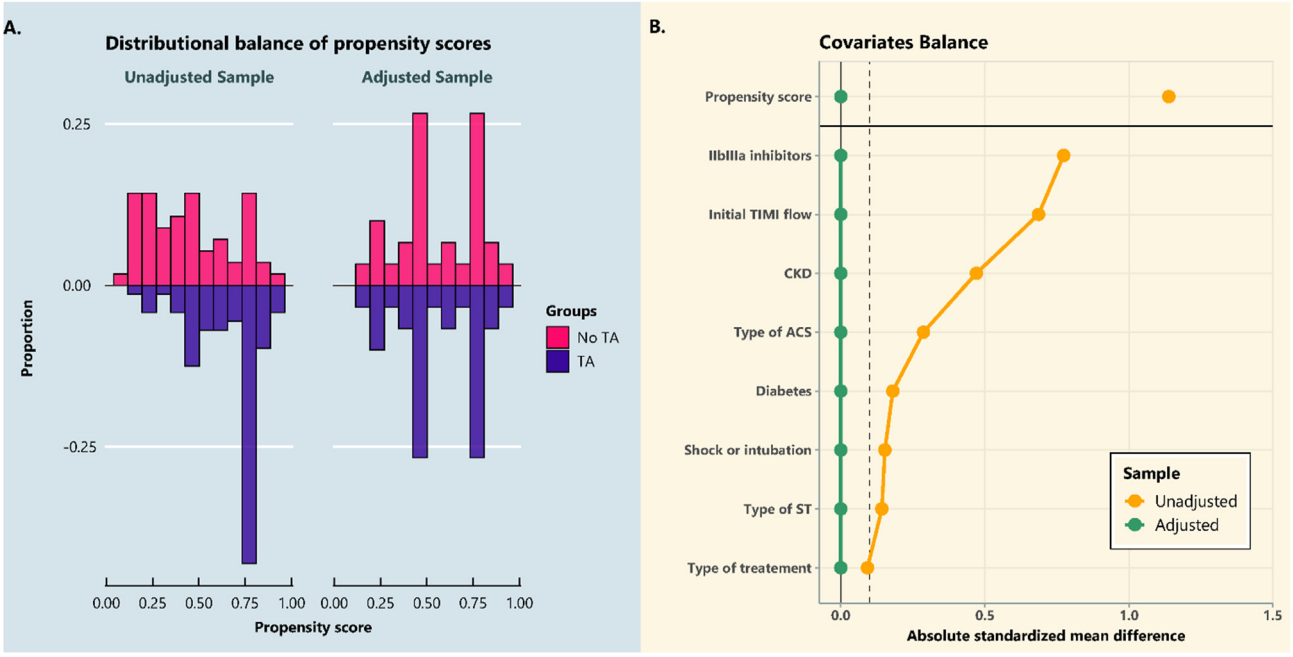

Figure 2. Graphical demonstration of the propensity score matching performance.

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