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Angiographically Based Direct Implantation of the Bioresorbable Vascular Scaffold in Non-ST Segment Elevation Acute Coronary Syndrome: Feasibility and Outcome

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Abstract

BACKGROUND: Direct implantation of metallic drug-eluting stents is recommended for lesions with high thrombotic burden; however, this can't be applied to bioresorbable scaffold for which adequate lesion preparation is recommended.

AIM: We aimed at assessing the feasibility and safety of direct scaffold implantation based only on angiographic assessment in patients presented with non-ST segment elevation acute coronary syndrome.

METHODS: The study was a retrospective two-centre study conducted over patients diagnosed with NSTE-ACS presented to cardiology department at Juan Ramon Hospital, Spain and critical care department, Cairo University in the period between February 2016 to May 2017. We included patients for whom we depend only on angiographic assessment for decision making whether to directly implant the scaffold or predilate the lesion and we excluded patients for whom intracoronary imaging was used at the index procedure either for pre or post-implantation. The primary outcome of interest was the device-oriented composite endpoints (DOCE) including cardiac death, and MI attributed to the target vessel and TLR. The secondary endpoints were the broader patient-oriented composite outcome (POCE) and scaffold/stent thrombosis. POCE includes all-cause mortality, any MI and any revascularisation (including TLR, TVR and revascularisation of non- target vessel)

RESULTS: Among 46 patients with NSTE-ACS treated with BVS, we did direct implantation in 20 patients (group A), and we used pre dilatation in 26 patients (group B). The two groups have similar demographics and clinical criteria. Procedural success was obtained in all study population. Mean follow up duration was 12 months. We have total of 10% device-oriented composite endpoints in group A versus 15% in group B (p-value = 0.684). We didn't document any cardiac death in both groups. In group B we had one (3.8%) non-fatal MI while there was no MI in group A (P-value = 1). In group A we had 2 cases (10%) of TLR while in group B there were 3 cases (11.5%) TLR (P-value = 1). We have two cases (7.7%) of TVR in group B and one in group A p-value = 1. All cases were planned staged PCI. Scaffold thrombosis occurred in one case in group A (5%) and two cases in group B (7.7%) p-value = 1.

CONCLUSION: With proper lesion selection, direct BVS implantation in all-comers NSTE-ACS patients is feasible and safe even without the aid of intracoronary imaging.

Introduction

Despite that drug-eluting stents (DES) with biocompatible or biodegradable polymers have a considerably improved safety profile and considered a standard of care for patients with coronary artery disease [1], [2], bioresorbable stents, commonly referred to as scaffolds, can provide support to the vessel wall for a defined period after angioplasty but are subsequently resorbed [3].

Current recommendation for the bioresorbable vascular scaffold (BRS) implantation is plaque preparation with adequate pre dilatation [4], [5] however in the setting of large thrombus burden like patients with acute coronary syndrome (ACS), aggressive pre dilatation may result in an increased risk of distal embolization and subsequent flow

deterioration [6].

Moreover, the culprit lesion in both groups has different morphologic patterns. Lesions in ST-segment elevation myocardial infarction (STEMI) tends to be softer, more lipid-rich, with thinner cap with more thrombotic burden mainly red thrombus [7] making them an ideal substrate for the BRS which is not the case for the non-ST segment elevation ACS (NSTE-ACS). NSTE-ACS represents a challenging subset in which BRS is under-investigated.

On the other hand, precise vessel/scaffold sizing should be performed, preferably with optical coherence tomography (OCT), which also allows accurate assessment of scaffold apposition [8]. However, in the setting of all-comers ACS patients intracoronary imaging may not be available especially in low- and middle-income countries. We aimed at assessing the feasibility and safety of direct scaffold implantation based only on angiographic assessment in a high-risk group of patients (NSTE-ACS).

Methods

The current study was a retrospective two-centre study conducted over patients diagnosed with NSTE-ACS presented to cardiology department at Juan Ramon Hospital, Spain and critical care department, Cairo University in the period between February 2016 to May 2017.

We included patients for whom we depend only on angiographic assessment for decision making whether to directly implant the scaffold or predilate the lesion and we excluded patients for whom intracoronary imaging whether intravascular ultrasound (IVUS) or OCT were used at the index procedure either for pre or post-implantation.

We used the ABSORB (Abbott Vascular, Santa Clara, CA, USA), the second-generation device, BVS 1.1 which is an everolimus-eluting BRS composed of Poly-L-lactic acid (PLLA) and Poly-D, L-lactic acid (PDLLA), designed in in-phase zigzag hoops linked by bridges

When pre dilatation was attempted it was done with balloon 0.5 mm smaller or equal to scaffold device recommended. In the second group direct scaffold implantation was done. Deployment of the scaffold was done with slow increase of two atmospheres every five seconds until the scaffold is completely expanded. The pressure is maintained for 30 seconds. Post-dilatation, when attempted, was done with non-compliant balloon at high pressure (> 16 atm) and the dilatation limit was 0.5 mm above the nominal diameter.

Clinical follow-up was obtained by the clinical visit and/or through telephone contact, according to a schedule specific for each site. Major adverse cardiac events were collected at discharge and the end of the follow-up period. The primary outcome of interest was the device-oriented composite endpoints (DOCE) including cardiac death; MI attributed to the target vessel and TLR [9]. The secondary endpoints were the broader patient-oriented composite outcome (POCE) and scaffold/stent thrombosis. POCE includes all-cause mortality, any MI and any revascularisation (including TLR, TVR and revascularisation of non- target vessel) [9]. MI definitions were based on the most recent universal definition of MI [10]. All deaths were considered cardiac unless proven otherwise. Stent/scaffold thrombosis definitions were based on the Academic Research Consortium (ARC) criteria [9].

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Data were summarised using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were made using the non-parametric Mann-Whitney test [11]. For comparing categorical data, Chi-square ($\chi 2$) test was performed. Exact test was used instead when the expected frequency is less than 5 [12]. P-values less than 0.05 were considered as statistically significant.

Results

From whole patients who received at least one BVS during the mentioned period, forty-six patient were enrolled in our study. Those patients received at least one BVS depending on visual assessment of the angiography without the aid of any intracoronary imaging modality during the index procedure.

Table 1: Clinical characteristics

		Direct (20)	Predilatation (26)	P value
Patient Characteristics				
Age		49.85 ± 9.16	52.50 ± 7.40	0.602
Male sex		16 (80.0%)	17(65.4%)	0.275
Smoking		15 (75.0%)	20 (76.9%)	1
Obesity		2 (10.0%)	3 (11.5%)	1
Dyslipidemia		6 (30.0%)	9 (34.6%)	0.741
Hyperuricemia		1 (5.0%)	1 (3.8%)	1
Hypertension		5 (25.0%)0	9 (34.6%)	0.482
DM		3 (15.0%)	3 (11.5%)	1
Family history of IHD		0	1 (3.8%)	1
Clinical Presentation and management				
TIMI risk score		1.9 ± 0.91	2.0 ± 0.85	0.885
Admission diagnosis	Unstable angina	9 (45.0%)	13 (50.0%)	0.736
	NSTEMI	11 (55.0%)	13 (50.0%)	
Early invasive strategy		15 (75.0%)	21 (80.8%)	0.726
Elective strategy		5 (25.0%)	5 (19.2%)	
Single vessel disease		17 (85.0%)	20 (76.9%)	0.711
MVD		3(15.0%)	6 (23.1%)	

The enrolled patients were divided into two groups. Group A included 20 patients who received direct scaffold implantation and group B included 26

patients in which pre dilatation was done. Patients' demographics, clinical data and risk factors were nearly similar in both groups as shown in Table 1. In group A 11 patients (55%) had NSTEMI and 9 patients (45%) had unstable angina, while in group B NSTEMI represent 50% (13 patients) and UA represent 50% (13 patients), P = value 0.736. Group A has TIMI risk score of 1.9 ± 0.91 as compared to group B 2.0 ± 0.85, P-value = 0.885. Post-dilatation was done in 90% of patients in group A and 88% of group B, p-value = 1. Angiographic and procedural data are presented in Table 2.

Table 2: Angiographic and procedural data

Target vessel	LAD	16 (69.6%)	19 (57.6%)	0.453
	LCX	4 (17.4%)	6 (18.2%)	
	RCA	3 (13.0%)	8 (24.2%)	
Post-dilatation		18 (90.0%)	23 (88.5%)	1
Scaffold size, mm		3.23 ± 0.25	3.04 ± 0.33	0.018
Scaffold length, mm		18.15 ± 6.06	20.45 ± 6.25	0.140
Dissection		1 (5.0%)	4 (15.4%)	0.369
Slow flow		1 (5.0%)	0 (0.0%)	0.435
No re-flow		1 (5.0%)	0 (0.0%)	0.435
Stent thrombosis		0 (0%)	0 (0%)	----
Side-branch compromise		3 (15%)	6 (23.1%)	0.711

Procedural success was obtained in all study population. Offline QCA analysis was done for all patients and data are presented in Table 3. Immediate clinical success was achieved in all cases. There was no significant difference between procedural complications in both groups.

Table 3: QCA data

	QCA		
	Direct	Predilatation	P-value
MLD	1.15 ± 0.31	0.94 ± 0.29	0.008
RVD	3.02 ± 0.44	2.83 ± 0.46	0.171
DS %	61.74 ± 11.41	65.47 ± 10.99	0.170
Acute gain	1.25 ± 0.38	1.17 ± 0.48	0.880
Late loss	0.52 ± 0.53	-0.65 ± 3.46	0.210
Late loss index	36.57 ± 24.59	39.43 ± 48.47	0.607

Edge dissection occurred in one patient (5%) in group A and 4 patients (15.4%) in group B, p-value 0.369. Slow flow and no-reflow occurred in 2 patients in group A yet this was statistically insignificant, p-value = 0.435. Side branch compromise occurred in 3 patients (15%) in group A and in 6 patients (23%) in group B p-value = 0.945. Those who had chest pain or impaired TIMI flow were treated with either balloon dilatation in side-branch ostium or final kissing inflation. We didn't document any in-hospital major adverse events. Mean FU duration of this group was 12 months. Angiographic follow up was done in 7 patients in group A (35%) while in group B angiographic follow up was done in 14 patients (53%) P-value = 0.451. During the whole FU period, there was a lower incidence of both device-oriented and patient-oriented composite endpoints in the direct implantation group (group A), yet this was statistically insignificant (Table 4). DOCE occurred in 10% in group A and in 15% in group B (p-value = 0.684). POCE occurred in 15% in group A and 23% in group B (p-value = 0.711). We didn't document any cardiac death in both groups. In group B we had one (3.8%) non-fatal MI while there was no MI in group A (P-value = 1). In group A we had 2 cases (10%) of TLR while in group B there were 3 cases (11.5%) TLR (P-value = 1). One case of TLR in group A was due to very late definite scaffold thrombosis and was treated with DES. The other case underwent an OCT which revealed ISR with neoatherosclerosis and was treated with another scaffold. In group B one case of TLR was also due to late thrombosis and was treated with DES. OCT of the second case revealed diffuse intimal hyperplasia and was treated with scoring balloon followed by a drug coating balloon (DCB) angioplasty, and the third case has neoatherosclerosis and was treated with DES. We have two cases (7.7%) of TVR in group B and one in group A p-value = 1. All cases were planned staged PCI.

Scaffold thrombosis occurred in one case in group A (5%) and two cases in group B (7.7%) p value = 1. In group A the patient presented with UA, OCT under expanded struts which treated with aggressive post dilatation, intracoronary GPIIb-IIIa inhibitor and DES. In group B one patients with late scaffold thrombosis presented with STEMI three days after discontinuation of the Aspirin. Primary PCI was done with implantation of a DES. The other patient presented with recurrent chest pain and his OCT revealed proximal edge dissection that was treated with implantation of another scaffold.

Table 4: Outcome

	Composite end points		
	Direct	Predilatation	P value
Death	0	0	---
MI	0	1 (3.8%)	1
TLR	2 (10%)	3 (11.5%)	1
TVR	1 (5%)	2 (7.7%)	1
ST	1(5%)	2 (7.7%)	1

Discussion

In the setting of emergency PCI to an ACS patient using the BVS the operators will be faced with too difficult decisions. First, whether to predilate the lesion as recommended for this specific device or to directly implant the scaffold as preferred in lesions with high thrombotic burden. The second difficult scenario is about the appropriate sizing of the scaffold and sizing of the balloons for pre and post dilatation if intracoronary imaging is not available which is a common scenario in all-comers ACS patients due to high cost or limited availability.

There is no solid data to support decision making in this difficult scenario. Several studies showed that direct implantation of metallic DES is associated with the reduction of flow disturbances after primary PCI, better ST-segment resolution as well as better survival at 30 days and one year [13], [14], [15], [16].

However, in the BVS where pre dilatation is highly recommended, data about feasibility and safety of direct scaffold implantation is so limited to give strong evidence for decision making.

Adding to the difficulty, the spectrum of ACS is not homogenous. The culprit lesion in STEMI versus NSTE-ACS has different morphologic patterns. Lesions in STEMI tends to be softer, more lipid-rich, with thinner cap with more thrombotic burden mainly red thrombus [7] making them an ideal substrate for BVS which is not the case for the NSTE-ACS.

To the best of our knowledge, our study is the first one to evaluate the immediate and one-year outcome of direct BVS implantation in a cohort of patient with NSTE-ACS based only on angiographic assessment without use of intracoronary imaging. We achieved procedural and clinical success in all patients. We didn't report any in-hospital adverse events. At 12 months follow up there was no significant difference between direct implantation group and pre dilatation group as regard composite endpoints or scaffold thrombosis.

Rzeszutko et al., [17] reported the in-hospital outcome of 50 ACS patients who received direct scaffold implantation. NSTEMI represent 62 % of their study population. They also didn't use OCT for sizing. They didn't report any in-hospital MI, scaffold thrombosis or TLR but long-term data were not reported.

Suarez de Lezo et al., [18] studied the outcome of direct scaffold implantation and reported a 5.9% MACE rate 12 months. They reported 0.6% death due scaffold thrombosis and 4% TLR however there was no significant difference between direct implantation group and pre dilatation group. Importantly they use intracoronary Imaging (IVUS or OCT) in nearly 86%of lesions which allow better sizing and ensure good scaffold apposition.

In the BVS-STEMI-STRATEGY-IT study, Alfonso Ielasi et al., [19] evaluate the 30-day outcome of BVS in STEMI patients using pre-specified strategy. The strategy involved using direct implantation only when there is TIMI 2-3 flow after wiring the culprit lesion and/or after thrombus aspiration and only when the residual stenosis is less than 30%. Otherwise, pre-dilatation was done. They reported DOCE 0.6% (0.4% death and 0.2% TLR) and scaffold thrombosis in 0.2%. The used intracoronary imaging before implantation in 26% of cases and at least after implantation in 52% of cases.

The most important finding of our study is the feasibility and good midterm outcome of direct BVS deployment in patients with NSTE-ACS. The value of an angiographic assessment of a scaffold invisible for fluoroscopy was supposed to be limited and does not provide information about the scaffold apposition. However, this was disproven by our results. However, it is not a randomised study, the study sample size is relatively small, and the results only allow for raising a new principle that needs larger randomised studies to prove.

In conclusion, with proper lesion selection, direct BVS implantation in all-comers NSTE-ACS patients is feasible and safe even without the aid of intracoronary imaging.

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