

Research Article

Atherectomy-Assisted PCI in CABG-Ineligible Patients: Outcomes and Clinical Resource Utilization Following Surgical Turndown

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Abstract

Patients with coronary artery disease turned down for coronary artery bypass surgery (CABG) often have high-risk features and anatomy that necessitates atherectomy, but clinical outcomes and procedural resource demands in this group are poorly characterized.

We retrospectively analyzed all patients undergoing percutaneous coronary interventions (PCI) utilizing orbital atherectomy (OA) or rotational atherectomy (RA) at our institution from January 1, 2021, and December 31, 2024. Patients were categorized as either surgical turndown patients undergoing atherectomy-assisted PCI (n=74) or patients undergoing atherectomy-assisted PCI without surgical evaluation (n=398). Baseline characteristics, procedural metrics, adjunctive device use, and outcomes were compared.

Surgical turndown patients were younger and had higher rates of chronic kidney disease and heart failure. Surgical turndown patients required significantly longer procedural times, larger guide catheters, more stents and balloons, had greater use of femoral access and significantly higher rates of mechanical circulatory support use (52.6% vs 13.3% p<0.001). Despite similar procedural complication rates, the surgical turndown patients had significantly higher major adverse cardiac events starting at hospital discharge (18.9% vs 1.3%), 30 days (20.3% vs 3.0%) and one year (29.1% vs 11.2%, all p<0.001).

Surgical turndown patients undergoing atherectomy-assisted PCI represent a high-risk cohort with increased procedural complexity and significantly worse outcomes. Despite similar procedural success and complication rates, in-hospital adverse events were significantly higher in the turndown group, highlighting the need for tailored strategies and closer post procedural surveillance in this population.

Keywords

Coronary calcification, complex coronary artery disease, side branch, orbital atherectomy, CABG turndown

Background

Coronary artery bypass grafting (CABG) is often the preferred revascularization strategy for patients with multivessel coronary artery disease, particularly in patients with diabetes or depressed left ventricle ejection fraction (LVEF)^{1,2} However, a subset of patients is deemed ineligible for surgical revascularization due to factors such as poor distal targets, advanced age, renal insufficiency, along with objective and perceived prohibitive surgical risk.^{3–6} These surgically ineligible patients frequently have complex coronary anatomy, including severe calcification, making percutaneous coronary intervention (PCI) both challenging and technically In such cases, plaque modification techniques are often necessary to achieve procedural success. While existing data suggest functional improvement and acceptable in-hospital risk, mortality remains high with 30 day- and one-year mortalities reported as 6% and 14.8% respectively.^{6–9}

As the population ages, an increasing number of patients will present with heavily calcified coronary lesions.^{10,11} In the context of advanced age, frailty, and multiple comorbidities, many of these individuals may be considered unsuitable for CABG and referred for PCI. In parallel, the expanding use of orbital and rotational atherectomy, positions these devices as valuable tools for managing surgically ineligible patients with heavily calcified lesions.¹² However, these procedures add complexity, require greater resource utilization and technical expertise. Despite this, the clinical outcomes and resource utilization in surgical turndown undergoing atherectomy assisted PCI patients remain poorly characterized.¹³

Therefore, we conducted a single-center analysis of all patients deemed ineligible for surgical revascularization who underwent atherectomy assisted PCI, evaluating procedural outcomes, MACE (Major Adverse Cardiac Events) up to one year and healthcare resource utilization.

Methods

Study Design

We conducted a retrospective, single-center study at a quaternary care institution, including all patients 18 years or older, who had been referred for surgical revascularization but deemed inoperable for any reason who then underwent PCI with rotational or orbital atherectomy between January 1, 2021 and December 1, 2024. As a reference, all patients who underwent atherectomy were evaluated and were placed into two groups, surgical turndown patients undergoing atherectomy-assisted PCI (n=74) or patients undergoing atherectomy-assisted PCI without surgical evaluation (398). Patients who were offered but declined coronary artery bypass surgery were excluded from the study. IRB (Institutional Review Board) approval was obtained prior to the initiation of the study.

Data Collection and Definitions

Baseline demographics, comorbidities and procedural characteristics were collected. Procedural success was defined as less than 20% residual stenosis with TIMI 3 flow without procedural complications or need for emergency surgery. MACE (cardiac death, myocardial infarction, stroke, or target vessel revascularization) was assessed at discharge, 30 days and 1 year.

Statistical analysis

Continuous variables were assessed for normality using the Shapiro-Wilk test. Normally distributed variables were compared using independent t-test and are presented as mean \pm standard deviation (*SD*). Non-normally distributed variables are shown as median [Interquartile Range] and compared with Mann-Whitney U tests. Categorical variables are compared using *Chi-square* Tests. A p-value <0.05 was considered statistically significant. All statistical analysis was performed using IBM SPSS Statistics (version 30.0.0.0 (172)).

Results

A total of 74 patients were evaluated for CABG but deemed ineligible and underwent atherectomy assisted PCI. In the same time frame, there were 398 patients who underwent atherectomy assisted PCI but had not been referred for CABG. (Figure 1)

Of the surgical turndown patients, 71.6% were male compared to 67.8% in the standard atherectomy group. The Median age in the turndown group was 69 compared to 72 in the standard atherectomy group ($p=0.030$). In the turndown group median body mass index (BMI) was 28.52 kg/m, 84.2% were Caucasian, 55.4% had diabetes, 60.8% had heart failure, 13.5% had prior stroke and 12.2% had prior CABG similar values were seen in the standard atherectomy group. In the turndown group, median LVEF was 45% and median GFR was 54 ml/min/1.73 m² while in the standard atherectomy median LVEF and GFR were 55% and 67 ml/min/1.73 m² respectively which were significantly different. The turndown group was also more likely to have presented with an acute myocardial infarction at their index coronary angiogram (Table 1).

Figure 1. Study Outcomes

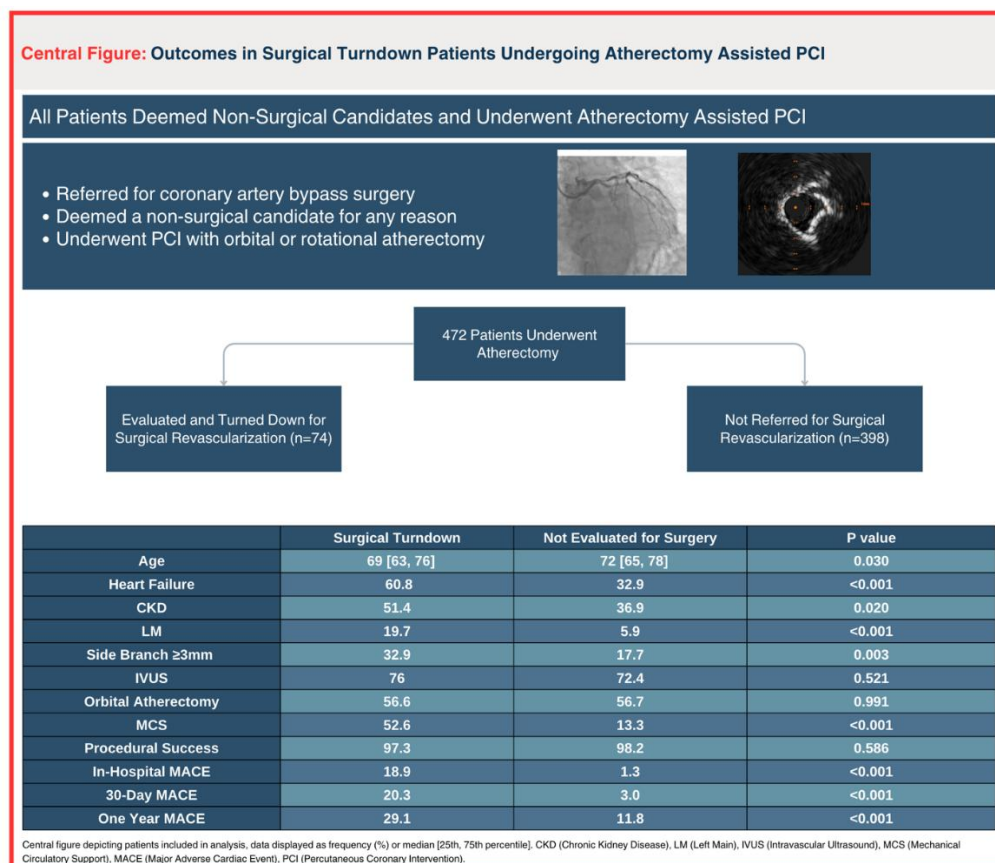


Table 1. Baseline Characteristics

	Surgical Turndown (n=74)	Not Referred for Surgery (n=398)	P value
Age	69 [63, 76]	72 [65, 78]	0.030
Male (%)	71.6	67.8	0.520
Caucasian (%)	84.2	82.6	0.757
BMI	28.52 [24.12, 33.32]	28.67 [24.73, 32.92]	0.522
Prior CABG (%)	12.2	13.8	0.702
Diabetes (%)	55.4	48.5	0.275
GFR ml/min/1.73 m ²	54 [31.5, 76]	67 [48, 84]	0.024
≥60 (%)	48.6	63.1	0.020
45-59 (%)	10.8	13.6	0.519
30-44 (%)	18.9	11.1	0.058
15-29 (%)	10.8	4.5	0.029
<15 (%)	10.8	7.8	0.386
Any CKD (%)	51.4	36.9	0.020
Hypertension (%)	93.2	90.7	0.481

Dyslipidemia (%)	85.1	87.4	0.588
Heart Failure (%)	60.8	32.9	<0.001
LVEF	45% [30%, 55%]	55% [40%, 60%]	<0.001
Prior Stroke (%)	13.5	8.6	0.182
Never smoker (%)	33.8	41.2	0.234
Index Presentation			
SIHD	31 (40.5)	207 (52)	0.110
UA	13 (17.6)	106 (26.6)	0.099
STEMI/NSTEMI	30 (41.9)	85 (21.4)	<0.001

Data expressed as percentage when (%), otherwise expressed as median [25th, 75th percentile]. BMI, (Body Mass Index), CABG (Coronary Artery Bypass Grafting), GFR, (Glomerular filtration rate), LVEF, (Left Ventricular Ejection Fraction), SIHD (Stable Ischemic Heart Disease), UA (Unstable Angina), STEMI (ST Elevation Myocardial Infarction), NSTEMI (Non-ST Elevation Myocardial Infarction).

In surgical turndown patients, femoral approach was used in 96.1% of patients compared to 85.2% of standard atherectomy patients (p=0.010). Median lesion length was 42 mm in the turndown group and 38.5 mm.

Table 2. Procedural characteristics

	Surgical Turndown (n=74)	Not Referred for Surgery (n=398)	P value
Guide Size (French)	7 [7, 7]	7 [7, 7]	0.021
Femoral access (%)	96.1	85.2	0.010
Pre-intervention luminal stenosis	90% [80%, 90%]	90% [80%, 90%]	0.080
Lesion length (mm)	42 [30, 72]	38.5 [30, 60]	0.243
Length mean	50.5	46.2	0.083
Number of stents	2 [1, 3]	2 [1, 2]	0.002
Stents mean	2.0	1.6	0.004
Number of balloons	3 [3, 5]	3 [2, 4]	0.001
Pre-dilation balloon diameter (mm)	3 [2.5, 3.25]	3 [2.75, 3.5]	0.056
Stent diameter (mm)	3.5 [3.5, 4]	3.5 [3.25, 4]	0.192
Post-dilation balloon diameter (mm)	4 [3.5, 4.5]	4 [3.5, 4.5]	0.235
Pre-Procedure TIMI 3 Flow (%)	90.7	94.3	0.227
Post-Procedure TIMI 3 Flow (%)	98.7	99.8	0.179
Vessel (%)			
Left main	19.7	5.9	<0.001
LAD	47.5	58.6	0.069
Circumflex	10.5	9.4	0.751
RCA	22.4	25.6	0.549
Ramus	0	0.2	0.665
PDA	0	0.2	0.665
Side branch ≥2mm present (%)	68.4	59.9	0.174
Side branch ≥3mm present (%)	32.9	17.7	0.003
Fluoroscopy time (minutes)	34.09 [27:02,48.59]	29.08 [23, 39.02]	<0.001
Procedural time (minutes)	132 [100, 163]	102 [85, 132]	<0.001
Contrast use (mL)	150 [117.5, 205]	150 [110, 200]	0.394
IVUS (%)	76.0	72.4	0.521

TVP (%)	23.7	16	0.104
MCS (%)	52.6	13.3	<0.001
Guide extension (%)	11.8	9.6	0.550
Cutting balloon (%)	15.8	13.8	0.646
Buddy wire (%)	6.8	6.0	0.811
Orbital Atherectomy (%)	56.6	56.7	0.991

Data expressed as percentage when (%), otherwise expressed as median [25th, 75th percentile], or mean. TIMI (Thrombolysis in Myocardial Infarction), LAD, (Left Anterior Descending Artery), RCA, (Right Coronary Artery), PDA, (Posterior Descending Artery), IVUS, (Intravascular Ultrasound), TVP, (Temporary Transvenous Pacemaker), MCS, (Mechanical Circulatory Support).

Median pre-stenosis was 90% in both groups, the surgical turndown group used significantly more balloons and stents 4.2 and 2.0 compared to the standard atherectomy group 3.3 and 1.6 respectively. Stent size, post dilation balloon size, and pre and post procedure TIMI 3 flow were similar. The turndown group had significantly more left main lesions 19.7% compared to 5.9% ($p<0.001$) and more side branches ≥ 3 mm 32.9% compared to 17.7% ($p=0.003$). The use of intravascular ultrasound (IVUS), guideliners, buddy wires, cutting balloons and temporary transvenous pacemakers (TVP) were similar between the groups. The use of mechanical circulatory support was significantly more in the turndown group 52.6% compared to 13.3% ($p<0.001$). Fluoroscopy and procedural time was significantly longer in the turndown group while contrast use was the same (Table 2).

The rate of procedural complications were similar between the groups, although perforations were significantly more in the turndown group 1.3% compared to 0% ($p=0.021$). MACE from hospital discharge to one year was significantly higher in the turndown group, in hospital MACE 18.9% compared to 1.3 ($p<0.001$), 30-day MACE 20.3% compared to 3.0 ($p<0.001$) and at one year 29.1% compared to 11.8% ($p<0.001$). Notably one year target lesion revascularization, myocardial infarction, cardiac death and all cause death were significantly more in the turndown group (Table 3). Stent thrombosis at one year was similar between the groups (Table 3).

Table 3. Procedural and Long-Term Outcomes

	Surgical Turndown (n=74)	Not Evaluated for Surgery (n=398)	P value
Dissection	0	1.7	0.249
Peroration	1.3	0	0.021
No Reflow	0	1	0.385
Emergency Surgery	0	0.2	0.665
Procedural Success	97.3	98.2	0.586
In Hospital MACE	18.9	1.3	<0.001
30 Day MACE	20.3	3.0	<0.001
1 Year TLR	9.1	1.7	0.002
1 Year MACE	29.1	11.8	<0.001
1 Year MI	12.7	2.1	<0.001
1 Year Cardiac Death	21.8	2.4	<0.001
1 Year All Death 2	29.1	7.7	<0.001
Stent Thrombosis			
Possible	3.6	1.7	0.414
Confirmed	0	1.7	

All data expressed as percentage. MACE, (Major Adverse Cardiac Events), TLR (Target Lesion Revascularization), MI, (Myocardial Infarction). For 30-day events, patients with available follow up in the turndown group was 74 and 398 in the other group, at one-year numbers were 55 and 288 respectively.

Among surgical turnaround patients, those who required mechanical circulatory support (MCS) experienced significantly worse outcomes compared to those who did not. Although procedural success rates were similar 95% compared to 100% ($p=0.186$), the MCS group had significantly higher in-hospital MACE 27.5% compared to 8.8%, ($p=0.041$) and one-year MACE 41.4% compared to 15.4%, ($p=0.034$). One-year cardiac mortality 34.5% compared to 7.7% ($p=0.016$) and all-cause mortality 44.8% compared to 11.5% ($p=0.007$) were also markedly higher among patients who required MCS. Rates of target lesion revascularization 10.3% compared to 7.7% ($p=0.360$), myocardial infarction 13.8% compared to 11.5% ($p=0.371$), and stent thrombosis were not significantly different. These findings, that despite similar procedural success and complication rates, surgical turnaround patients undergoing atherectomy-assisted PCI with MCS may identify a particularly high-risk subgroup with elevated long-term adverse event rates (Table 4).

Table 4. Outcomes in Surgical Turnaround Patients by Mechanical Circulatory Support.

	Surgical Turnaround Impella Used (n=40)	Surgical Turnaround no Impella Used (n=34)	P value
Dissection	0	0	
Perforation	2.5	0	0.353
No Reflow	0	0	
Emergency Surgery	0	0	
Procedural Success	95	100	0.186
In Hospital MACE	27.5	8.8	0.041
30 Day MACE	27.5	11.8	0.149
1 Year TLR	10.3	7.7	0.360
1 Year MACE	41.4	15.4	0.034
1 Year MI	13.8	11.5	0.371
1 Year Cardiac Death	34.5	7.7	0.016
1 Year All Death	44.8	11.5	0.007
Stent Thrombosis Possible Confirmed	3.4 0	3.8 0	0.937

All data expressed as percentage. MACE, (Major Adverse Cardiac Events), TLR (Target Lesion Revascularization), MI, (Myocardial Infarction). For 30-day events, patients with available follow up in the turnaround group was 40 and in the other group 34, at one-year numbers were 29 and 26 respectively.

Discussion

In this retrospective, single-center analysis of patients undergoing atherectomy-assisted PCI, we found that individuals deemed ineligible for CABG represent a uniquely high-risk population with significantly increased procedural complexity, resource utilization, and worse clinical outcomes. Compared with patients who were not referred to for surgical revascularization prior to undergoing atherectomy, the surgical turnaround group had similar rates of procedural success and periprocedural complications, yet significantly higher rates of adverse events beginning at hospital discharge and extending through one year. Notably the patients in the turnaround group were younger, this likely reflects decisions by interventional cardiologists not to refer older patients to surgery hence increasing the median age of the group that was not referred for bypass.

These findings align with prior studies which have demonstrated an elevated morbidity and mortality in patients with coronary artery disease who are referred for surgical revascularization and deemed ineligible⁶⁻⁸. However, existing literature has largely focused on CABG turnaround patients undergoing general PCI and have not reported on patients who underwent atherectomy. Our study adds granularity by specifically evaluating outcomes in patients who were deemed ineligible for surgical revascularization and were treated with either orbital or

rotational atherectomy. The elevated rate of MACE we observed in our study, highlights the vulnerability of these patients even when procedural success is obtained. Notably the one-year mortality was higher in our study population compared to published reports on surgical turn-down patients undergoing PCI, with reported rates of 14.8% compared to our observed rate of 29.1%. These findings also likely reflect patient selection as our cohort had higher rates of CKD, dialysis dependence, diabetes, and heart failure compared to large heart team studies.¹⁴

The increased procedural complexity observed in the turn-down cohort reflects a combination of complex anatomy and lack of surgical options, which often compels intervention on higher risk lesions including left main, bifurcation, and long lesions in addition to severe calcification. The significantly greater use of large-bore femoral access, more frequent use of multiple balloons and stents and over fourfold increase in mechanical circulatory support underscores the resource-intensive nature of these cases. Importantly, these procedures were not associated with increased periprocedural complications; however, the long-term event rates suggest that lesion complexity and patient-level comorbidities outweigh procedural success in determining outcomes.

Despite the increased complexity and intensity of intervention, rates of periprocedural complications—including perforation and emergency surgery—were not meaningfully different between groups, indicating that contemporary PCI techniques, including orbital and rotational atherectomy, can be performed safely in appropriately selected high-risk patients. However, the persistently higher adverse event rates post-procedure suggest that lesion and patient complexity may have a higher influence on long-term outcomes than procedural success.

These results underscore the importance of a tailored, multidisciplinary approach when managing patients turned down for CABG. Procedural planning should involve a heart team ideally with multiple operators, and thoughtful lesion planning, particularly in cases involving left main or long segment disease. Moreover, post-procedural care must be proactive, with close follow-up. Given the disproportionate burden of adverse outcomes in this group, further prospective studies are needed to define the optimal interventional approach, role of emerging calcium modification technologies, and the impact of structured follow-up care on outcomes. There are several limitations to this study. This was a single center, retrospective analysis and although the sample size is the among the largest focused on this population, it may not capture the full spectrum of practice patterns or outcomes at other institutions. While we used standard criteria for procedural success and MACE, unmeasured confounders such as frailty, anatomic subtleties and post-procedure care may have influenced outcomes. In addition, we did not assess functional improvement which is especially relevant in highly symptomatic patients with limited life expectancy.

Limitations

This study has several limitations. First, it is a retrospective, single-center analysis and may not reflect broader practice patterns or generalize to other populations. Second, surgical ineligibility was determined through documentation of cardiothoracic surgery consultation, which may vary between institutions and operators. Additionally, we did not capture frailty indices, symptom burden, or quality-of-life outcomes. Finally, while the two groups had similar characteristics, unmeasured confounders may still have influenced our results.

Conclusions

Patients turned down for CABG who undergo atherectomy-assisted PCI represent a high-risk, resource-intensive population with significantly worse clinical outcomes despite comparable procedural success. These findings underscore the need for tailored interventional strategies, enhanced post-procedural follow up and prospective research to guide optimal care in this vulnerable cohort.

Conflict of Interest

This author declares no conflict of interest by publishing this paper.

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