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Patient outcomes in GuideLiner facilitated percutaneous coronary intervention stratified by the SYNTAX score: A retrospective analysis

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Abstract

Objectives: To determine patient outcomes in GuideLiner facilitated percutaneous coronary intervention stratified by the SYNTAX score.

Design: Single centre retrospective cohort analysis.

Participants: A total of 540 consecutive cases facilitated by GuideLiner at a single center.

Main outcome measures: Successful stent delivery, in-hospital, 30 day and 1 year mortality rates stratified by SYNTAX score.

Results: The most common indication for GuideLiner was need for increased support for balloon or stent delivery (82%), 6% for non-coaxial guide, 9% for chronic total occlusion and 3% for selective vessel engagement. Successful stent delivery was achieved in 91% of all cases, with no complications occurred due to GuideLiner use. In-hospital, 30 day and 1 year mortality rates were 2.8%, 2.1% and 4.5%, respectively. The high SYNTAX group was associated with higher rates of initial TIMI score of 0–1; however, the final TIMI score rate of successful delivery and complications did not differ between groups. In-hospital and 1 year mortality rates were higher in the higher SYNTAX groups.

Conclusions: The GuideLiner is an easy to use guide catheter extension system with high rates of success and low rates of complications, across all SYNTAX groups.

Keywords

Acute myocardial infarction, catheter-based coronary interventions, complex coronary intervention

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Introduction

Coronary artery disease (CAD) is one of the most prevalent causes for death in the world, leading to over 65% of all cardiovascular-related deaths[1] and accounting for an estimated 7.4 million global deaths in 2012 alone.[2] With the expansion of percutaneous coronary intervention (PCI) to high risk patients with complex coronary lesions, new techniques and equipment are needed to perform successful procedures. The GuideLiner (Vascular Solutions) is a rapid exchange "child in mother" catheter that aids stent delivery through complex coronary segments with extreme tortuosity, severe calcification and offers better support in situations with poor coaxial alignment.[3]

The SYNTAX score is a semi-quantitative anatomical method to assess CAD complexity.[4] It was initially developed to help risk stratify based on CAD burden and optimize the method of revascularization.[5] Despite

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having a high SYNTAX score, many patients are not suited for surgery due to comorbidities. As a result, the number of coronary artery bypass grafting (CABG) surgeries performed in the United States has decreased nearly 30% in the last decade, and the number of complex PCI cases has increased significantly.[6] New technologies like the GuideLiner can facilitate successful revascularization despite complex anatomy with high SYNTAX score.

The ACC/AHA lesion classification groups lesions into three categories based on individual characteristics such as length, calcification, tortuosity, chronic total occlusion, etc. This classification was originally published in 1988 and has remained a standard method to assess rate of success and risk of procedure.[7]

The objective of this study is to evaluate the indications, procedural success and safety outcomes of the GuideLiner for PCI, as stratified by SYNTAX groups.

Methods

We performed a retrospective analysis of all patients who underwent PCI at St. Boniface Hospital from 1 January 2013 to 31 December 2014. All cases that used the GuideLiner were included in the study. There were no exclusion criteria. All PCI procedures were performed by experienced interventional cardiologists. Decisions regarding transradial or transfemoral approach, techniques and devices were at the discretion of the operator. The study was approved by the local university (University of Manitoba Research Ethics Board) and hospital (St. Boniface Hospital Research Review Committee).

Patient demographics were recorded, and each case was reviewed for angiographic and procedural characteristics, including indication for GuideLiner, approach, culprit vessel, total fluoroscopy time, total contrast amount, lesion complexity and initial Thrombolyis in Myocardial Infarction (TIMI) score. The coronary vessel that required GuideLiner was assessed using the ACC/AHA lesion classification score. To measure the left ventricular end-diastolic pressure, a catheter was placed into the left ventricle (LV). LV ejection fraction was measured through a ventriculography at the time of the procedure. Procedural outcomes were also assessed including final TIMI grade flow, procedural success and complications related to GuideLiner use. Two co-authors (CP and HZ) were trained in SYNTAX score and calculated scores for each patient; with severity defined as low risk ($\leq$22), intermediate risk (23–32) and high risk ($\geq$33). In-hospital, 30 day and 1 year all-cause mortality were obtained.

Statistical analysis

For descriptive statistics, continuous variables with normal distribution were expressed as mean and standard deviation, and non-normally distributed variables were presented as median and interquartile range. The Shapiro-Wilk test was used to assess for normality of distribution. The data were stratified by SYNTAX score category (low, intermediate and high risk). For comparison of continuous variables between the three categories, the ANOVA test was used for normally distributed variables and Kruskal-Wallis test was used for skewed variables. For categorical variables, the chi-square test was used. Analyses were performed using SAS, version 9.4.

Results

A total of 5033 PCIs between January 2013 to December 2014 were performed at St. Boniface Hospital; 10.7% of these procedures required a GuideLiner (n = 540), in 497 total patients. The median age was 70 (IQR 61–78) years, with 77% males (Table 1). Approximately 36% of the patients were diabetics. Up to half of the patients had prior myocardial infarction (45%) and 36% had previous PCI. The majority of the procedures were elective (36%), while 27% for non-ST elevation myocardial infarction (NSTEMI) and 21% for ST elevation myocardial infarction (STEMI). Approximately 12% of patients were diagnosed with cardiogenic shock at initial presentation with the radial approach utilized in 48% of cases. Approximately half the lesions (47%) were AHA/ACC class C. The SYNTAX score was calculated in 428 patients, with 110 patients excluded due to previous CABG. The mean SYNTAX score was 21 ± 11, with 61% in the low risk category ($\leq$22), 24% in the intermediate category (23–32) and 15% in the high-risk category ($\geq$33).

The most common indication for GuideLiner use was increased support for equipment delivery (91%) (with 9% of cases were chronic total occlusion (CTO) procedures), non-coaxial guide alignment (6%) and 3% for other indications such as selective coronary visualization (Table 2). A total of 210 lesions (49%) were ACC/AHA lesion classification Type C lesions. CTO represented 12% of the study population. The rate of successful stent delivery was 91%. There were

Table 1. Study characteristics of all patients.

Variable	n = 540
Age (years)	70 (61–78)
Male gender	415, 77%
BMI (kg/m^2)	29 (26, 33)
Medical history	
Hypertension	382, 71%
Dyslipidemia	305, 56%
Stroke	57, 11%
Diabetes	196, 36%
Smoking	94, 17%
PVD	51, 9.4%
CKD	73, 14%
CHF	57, 11%
Prev MI	242, 45%
Prev PCI	192, 36%
Prev CABG	110, 20%
Reason for angiography	
STEMI	113, 21%
NSTEMI	145, 27%
Elective	194, 36%
Other	88, 16%
At presentation	
VT/VF	17, 4%
Cardiogenic shock	57, 12%
Creatinine (μmol/L)	91 (75, 130)
LVEDP, (mmHg)	19 ± 8
LVEF (%)	51 ± 15
Syntax (n = 430)	21 ± 11
Access	
Femoral	250, 46%
Radial	261, 48%
Both	29, 5%
Fluoroscopy time (min)	23 (16, 35)
Total contrast (mL)	200 (155, 260)
GuideLiner used for	
Left main	14, 3%
LAD	109, 20%
Circumflex	95, 18%
RCA	282, 52%
Ramus	1, 1%
LIMA	4, 1%
SVG	35, 7%

Mean ± SD or Median ± IQR for continuous variables. Frequency, % for categorical variables. BMI: body mass index; CABG: coronary artery bypass grafting; CHF: congestive heart failure; CKD: chronic kidney disease; LAD: left anterior descending; LIMA: left internal mammary artery; LVEDP: left ventricular end diastolic pressure; LVEF: left ventricular ejection fraction; MI: myocardial infarction; NSTEMI: non-ST-segment myocardial infarction; PCI: percutaneous coronary intervention; PVD: peripheral vascular disease; RCA: right coronary artery; SS: syntax score; STEMI: ST-segment myocardial infarction; SVG: saphenous vein graft; TIMI: thrombolysis in myocardial infarction; VT: ventricular tachycardia; VF: ventricular fibrillation.

Table 2. Procedural characteristics and outcomes of all patients.

Variable	All patients n = 540
Indication	
Increased support	443, 82%
Non-coaxial guide	30, 6%
CTO	51, 9%
Other	15, 3%
Lesion length (mm)	10 (5, 18)
Bifurcation or trifurcation	77, 14%
CTO	63, 12%
Proximal lesion	207, 38%
Extreme tortuosity	130, 24%
Severe calcification	174, 32%
Thrombus	61, 11%
Anomalous takeoff	43, 8%
ACC/AHA lesion classification	
A	71 (13%)
B	214 (40%)
C	255 (47%)
Successful delivery	487, 91%
Final TIMI grade 3	491, 91%
Need for additional support	
None	479, 89%
Device (IABP, Impella, ECMO)	12, 2%
Vasopressors	48, 9%
Cath complications	
None	540, 100%
In-hospital mortality	15 (2.7%)
30 day mortality	11 (2.1%)
1 year mortality	23 (4.5%)
30 day repeat MI	18 (3.4%)
1 year repeat MI	19 (3.7%)
In-hospital CABG	10 (1.9%)
30 day revascularization	26 (5.0%)
1 year revascularization	74 (14%)
30 day CHF	12 (2.3%)
1 year CHF	14 (2.6%)

Mean ± SD or Median ± IQR for continuous variables. Frequency, % for categorical variables. ACC: American College of Cardiology; AHA: American Heart Association; CABG: coronary artery bypass grafting; CHF: congestive heart failure; CTO: chronic total occlusion; ECMO: extracorporeal membrane oxygenation; IABP: intraortic balloon pump; MI: myocardial infarction; TIMI: thrombolysis in myocardial infarction.

no procedural complications from GuideLiner use. In-hospital, 30-day and 1 year all-cause mortality was 2.7%, 2.1% and 4.5%, respectively. Repeat PCI was 5% at 30 days and 14% at 1 year.

Baseline characteristics, angiographic characteristics, procedural and clinical outcomes were stratified

by SYNTAX score and compared (Tables 3 and 4). The high SYNTAX group was older (73 years, IQR 62–83) compared to the lower and intermediate SYNTAX groups (68 years, IQR 61–80; 68 years, IQR 60–73, respectively, $p = 0.005$). Rates of prior cerebrovascular accidents (19% for high SYNTAX, 9.7% for intermediate SYNTAX, 8% for low SYNTAX, $p = 0.004$), peripheral vascular disease (21% for high SYNTAX, 12% for intermediate SYNTAX, 5% for low SYNTAX, $p < 0.001$) were higher in the high SYNTAX group. Chronic kidney disease was higher in the high (18%) and intermediate (21%) SYNTAX groups than the low SYNTAX group (8.7%, $p < 0.0001$). Previous PCI rates were lower in the high SYNTAX group (11%) in comparison with the intermediate (39%) and low (40%) SYNTAX

Table 3. Study characteristics stratified by SYNTAX score.

Variable	SS $\leq$ 22 n = 263	SS = 23–32 n = 103	SS $\geq$ 33 n = 62	p-Value[a]
Age (years)	68 (60–75)	68 (61–80)	73 (62–83)	0.005
Male gender	69 (26%)	24 (23%)	12 (19%)	0.498
BMI (kg/m^2)	29.7 (26.4–33.4)	28.0 (25.3–32.4)	27.2 (25.0–30.3)	0.003
Medical history				
Hypertension	176, 67%	76, 74%	44, 71%	0.28
Dyslipidemia	151, 57%	54, 52%	32, 52%	0.96
Stroke	21, 8.0%	10, 9.7%	12, 19%	0.004
Diabetes	84, 32%	38, 37%	26, 42%	0.17
Smoking	59, 22%	14, 14%	13, 21%	0.24
PVD	13, 5%	12, 12%	13, 21%	<0.001
CKD	23, 8.7%	22, 21%	11, 18%	<0.001
CHF	23, 8.7%	8, 7.8%	9, 15%	0.20
Prev MI	108, 41%	38, 37%	19, 31%	0.45
Prev PCI	106, 40%	40, 39%	7, 11%	<0.001
Reason for angio				
STEMI	54, 21%	28, 27%	26, 42%	0.003
NSTEMI	81, 31%	25, 24%	16, 26%	
Elective	106, 40%	36, 35%	17, 27%	
Other	22, 8.4%	14, 14%	3, 5%	
At presentation				
VT/VF	11, 5%	1, 1%	3, 6%	0.25
Cardiogenic shock	19, 8%	16, 18%	13, 24%	<0.001
Creatinine (μmol/L)	86 (72–119)	99 (73–205)	103 (79–137)	0.036
LVEDP (mmHg)	19 ± 8	19 ± 8	22 ± 9	0.01
LVEF (%)	55 ± 14	48 ± 16	48 ± 15	<0.001
Access				
Femoral	81, 31%	53, 52%	31, 49%	0.003
Radial	165, 63%	44, 31%	29, 46%	
Both	16, 6%	5, 5%	3, 5%	
Fluoroscopy time (min)	21 (14, 32)	23 (18, 35)	26 (21, 34)	0.008
Total contrast (mL)	200 (150, 250)	208 (160, 260)	230 (160, 280)	0.05
GuideLiner used for				
Left main	3, 1%	2, 2%	4, 6%	0.05
LAD	44, 17%	31, 30%	17, 25%	
Circumflex	42, 16%	16, 15%	15, 24%	
RCA	172, 66%	55, 52%	28, 45%	
Ramus	1, 0%	1, 1%	0	
LIMA	0	0	0	
SVG	0	0	0	

Mean ± SD or Median ± IQR for continuous variables. Frequency, % for categorical variables. BMI: body mass index; CABG: coronary artery bypass grafting; CHF: congestive heart failure; CKD: chronic kidney disease; LAD: left anterior descending; LIMA: left internal mammary artery; LVEDP: left ventricular end diastolic pressure; LVEF: left ventricular ejection fraction; MI: myocardial infarction; NSTEMI: non-ST-segment myocardial infarction; PCI: percutaneous coronary intervention; PVD: peripheral vascular disease; RCA: right coronary artery; SS: syntax score; STEMI: ST-segment myocardial infarction; SVG: saphenous vein graft; TIMI: thrombolysis in myocardial infarction; VT: ventricular tachycardia; VF: ventricular fibrillation.
[a]Comparing SS < 22, SS = 23–32 and SS >33 groups.

Table 4. Procedural characteristics and outcomes of patients stratified by SYNTAX score.

Variable	SS ≤ 22 n = 263	SS = 23–32 n = 103	SS ≥ 33 n = 62	p-Value[a]
Indication				
Increased support	184, 81%	86, 83%	53, 85%	0.85
Non-coaxial guide	26, 9.8%	6, 6%	5, 8%	
CTO	41, 16%	10, 10%	3, 5%	
Other	10, 3.8%	1, 1%	1, 2%	
Lesion length (mm)	8 (5–15)	10 (6–20)	14 (10–20)	<0.001
Bifurcation or trifurcation	31 (11.8%)	20 (19.4%)	15 (24.2%)	0.023
CTO	35 (13.3%)	15 (14.7%)	3 (4.8%)	0.138
Proximal lesion	95 (36.1%)	45 (43.7%)	30 (48.4%)	0.132
Extreme tortuosity	66 (25.1%)	30 (29.1%)	17 (27.4%)	0.720
Severe calcification	67 (25.5%)	46 (44.7%)	34 (54.8%)	<0.001
Thrombus	32 (12.2%)	10 (9.7%)	13 (21.0%)	0.097
Anomalous takeoff	22 (8.4%)	7 (6.8%)	6 (9.7%)	0.795
ACC/AHA lesion classification				
A	36 (14%)	9 (9%)	8 (13%)	0.43
B	104 (39%)	41 (39%)	20 (32%)	
C	123 (47%)	53 (52%)	34 (55%)	
Successful delivery	239 (90.9%)	91 (90.1%)	56 (90.3%)	0.971
Final TIMI grade flow 3	251 (95.4%)	89 (86.4%)	49 (79.0%)	<0.001
Need for additional support				
None	239, 91%	93, 90%	49, 79%	0.03
Device (IABP, Impella, ECMO)	2, 1%	1, 1%	4, 2%	
Vasopressors	22, 8%	9, 9%	9, 14%	
Cath complications				
None	262, 100%	105, 100%	63, 100%	–
In-hospital mortality	4 (1.5%)	3 (2.9%)	5 (8.1%)	0.025
30 day mortality	5 (1.9%)	4 (4.0%)	2 (3.5%)	0.408
1 year mortality	9 (3.6%)	7 (7.3%)	1 (1.8%)	0.237
30 day repeat MI	8 (3.1%)	4 (3.9%)	2 (3.2%)	0.925
1 year repeat MI	9 (3.5%)	2 (2.0%)	4 (6.7%)	0.353
In-hospital CABG	4 (1.5%)	4 (3.9%)	0 (0.0%)	0.244
30 day revasculatization	11 (4.3%)	6 (5.9%)	6 (9.8%)	0.228
1 year revascularization	33 (12.6%)	8 (7.8%)	15 (24.2%)	0.010
30 day CHF	3 (1.2%)	1 (1.0%)	1 (1.8%)	0.820
1 year CHF	3 (1.2%)	3 (3.0%)	3 (4.8%)	0.116

Mean ± SD or Median ± IQR for continuous variables. Frequency, % for categorical variables. ACC: American College of Cardiology; AHA: American Heart Association; CABG: coronary artery bypass grafting; CHF: congestive heart failure; CTO: chronic total occlusion; ECMO: extracorporeal membrane oxygenation; IABP: intraortic balloon pump; MI: myocardial infarction; TIMI: thrombolysis in myocardial infarction.
[a]Comparing SS<22, SS = 23–32 and SS >33 groups.

groups ($p < 0.001$). Patients with high SYNTAX score were more likely to present with cardiogenic shock (24% vs. 18% and 8% in the intermediate and low SYNTAX groups, respectively, $p < 0.001$) and had higher LVEDP (22 ± 9 mmHg in high SYNTAX group vs 19 ± 8 mmHg in both intermediate and low SYNTAX groups, $p = 0.01$). LVEF was higher in the low SYNTAX patients ($55 \pm 14\%$) in comparison with the intermediate ($48 \pm 16\%$) and high SYNTAX groups ($48 \pm 15\%$, $p < 0.001$).

More patients in the low (95%) and intermediate (86%) SYNTAX group had final TIMI grade 3 compared to high SYNTAX patients (79%, $p < 0.001$). However, the rates of successful stent delivery were comparable despite the SYNTAX score (91% in low SYNTAX, 90% in both intermediate and high SYNTAX). In-hospital mortality was higher in the high SYNTAX group (8.1%) in our cohort compared with low (1.5%) and intermediate groups (2.9%, $p = 0.025$) but not 1 year mortality rates (3.6%, 7.3% and 1.8% for low, intermediate and high SYNTAX groups, respectively). Repeat revascularization at 1 year was highest in the high SYNTAX group (24%).

We stratified the data by clinical presentation (STEMI, NSTEMI or elective procedure, Table 5). The rate of cardiogenic shock (<0.0001) was higher in

Table 5. Lesion and patient characteristics and outcomes stratified by clinical presentation.

	STEMI n=113	NSTEMI n=145	Elective n=194	p-Value
Cardiogenic shock	47 (42%)	7 (4.8%)	3 (1.5%)	<0.0001
Bifurcation/trifurcation	14 (12%)	18 (12%)	26 (13%)	0.95
CTO	2 (1.8%)	5 (3.4%)	53 (27%)	<0.0001
Proximal	48 (42%)	60 (41%)	75 (39%)	0.78
Tortuosity	29 (26%)	37 (26%)	48 (25%)	0.98
Calcification	34 (30%)	49 (34%)	69 (36%)	0.62
Anomalous	8 (7%)	14 (9.7%)	16 (8.2%)	0.56
Type A	16 (14%)	19 (13%)	23 (12%)	0.35
Type B	55 (49%)	66 (46%)	49 (25%)	<0.0001
Type C	42 (37%)	60 (41%)	122 (63%)	<0.0001
Indication for GuideLiner				
Increase support	100 (88%)	131 (90%)	132 (68%)	<0.0001
Not coaxial	7 (6.2%)	9 (6.2%)	11 (5.7%)	
CTO	1 (0.9%)	1 (0.7%)	46 (24%)	
Other	4 (3.5%)	4 (2.8%)	5 (2.6%)	
Final TIMI 3	93 (82%)	115 (79%)	173 (89%)	0.038
Successful delivery	104 (92%)	127 (88%)	176 (91%)	0.45
In-hospital mortality	11 (9.7%)	2 (1.4%)	0 (0%)	0.0012
30 day mortality	1 (0.9%)	4 (2.8%)	3 (1.5%)	0.5
1 year mortality	4 (3.5%)	6 (4.1%)	4 (2.1%)	0.52
30 day repeat MI	5 (4.4%)	8 (5.5%)	5 (2.6%)	0.38
1 year repeat MI	5 (4.4%)	4 (2.8%)	5 (2.6%)	0.18
In-hospital CABG	5 (4.4%)	2 (1.4%)	3 (1.5%)	0.18
30 day revascularization	7 (6.2%)	6 (4.1%)	13 (6.7%)	0.59
1 year revascularization	11 (9.7%)	20 (14%)	23 (12%)	0.61
30 day CHF	1 (0.9%)	2 (1.4%)	4 (2.1%)	0.71
1 year CHF	4 (3.5%)	4 (2.8%)	1 (0.5%)	0.14

STEMI patients (42%) compared to NSTEMI (4.8%) and elective procedures (1.5%). The distribution of ACC/AHA lesion classification is different, with more Type C lesions requiring GuideLiner in elective cases (63% vs. 37% in STEMI, 41% in NSTEMI, $p < 0.0001$). The final TIMI grade 3 flow was lower in ACS patients (82% in STEMI, 79% in NSTEMI, 89% in elective, $p = 0.038$); however, the rate of successful stent delivery was similar. Unsurprisingly, STEMI patients had the highest in-hospital mortality (9.7%, vs 1.4% in NSTEMI, 0% in elective, $p = 0.0012$).

CTO cases ($n = 63$) are presented separately in Table 6. The majority of vessels with GuideLiner use was the right coronary artery (RCA, 89%). The rate of successful stent delivery was 89%, and 78% of cases had final TIMI flow grade 3.

Discussion

Interventional cardiology continues to improve through development of new technologies, methods and equipment for complex PCI. The main findings of our study are (1) GuideLiner is a safe and easy to use guide catheter extension system in this all comer study population; (2) GuideLiner leads to similar rates of successfully stent delivery regardless of patient presentation, lesion classification or SYNTAX score.

We demonstrated that use of the GuideLiner was associated with a high rate of successful delivery (91%). This success rate was similar regardless of SYNTAX score or clinical presentation (STEMI, NSTEMI or elective case). This high success rate is comparable to previous studies where procedural success rates range from 80.2 to 98.7%.[8,9] The wide range of procedural success rate could be related to differences in the patient population as well as lesion specific characteristics. Our study population had a final TIMI score of 3 in 91% of the cases and this is comparable to the 96% in a previous study.[9] Our slightly lower final TIMI score could be due to the higher rate of STEMI (25%) and NSTEMI (29%) patients in our study. Overall, complication rate from GuideLiner use is often quite low (1.6% in a previous study)[9] and we found no complications related to GuideLiner use. One reason for this could be the use of the second generation GuideLiner in our study as compared to first generation GuideLiner in a previous study.[9]

Table 6. CTO cases requiring GuideLiner support.

Variable	n= 63
Age (years)	68 (60–75)
Male gender	49, 78%
BMI (kg/m^2)	30 (27, 34)
Medical history	
Hypertension	47 (75%)
Dyslipidemia	47 (75%)
Stroke	7 (11%)
Diabetes	20 (32%)
Smoking	22 (14%)
PVD	6 (9.5%)
CKD	3 (4.8%)
CHF	4 (6.3%)
Prev MI	34 (54%)
Prev PCI	34 (54%)
Prev CABG	10 (16%)
Creatinine (μmol/L)	106.5 (85, 127)
Syntax	19 (12, 24)
Access	
Femoral	19 (30%)
Radial	18 (29%)
Both	26 (41%)
Fluoroscopy time, (min)	56 (39, 77)
Total contrast (mL)	250 (190, 300)
GuideLiner used for	
Left main	1 (2%)
LAD	4 (6%)
Circumflex	2 (3%)
RCA	56 (89%)
Lesion length (mm)	11 (10, 20)
Bifurcation or trifurcation	4 (6%)
Proximal lesion	31 (49%)
Extreme tortuosity	11 (17%)
Severe calcification	17 (27%)
Thrombus	1 (2%)
Anomalous takeoff	4 (6%)
Type C lesion	63 (100%)
Successful delivery	56 (89%)
Final TIMI grade 3	49 (78%)

Our all-comers patient populations allowed inclusion of ACS cases, including a significant number of STEMI patients. It is interesting to note that the majority of STEMI cases that required GuideLiner use was not considered a "difficult" lesion. Only 37% of these cases were Type C ACC/AHA lesions. However, during these emergencies, the key aim of treatment is to restore perfusion to the infarct artery. Using the GuideLiner may facilitate quicker balloon and stent delivery (the main indication for GuideLiner use in this group). Due to local expertise with the GuideLiner, we tend to use this technique with difficult lesions rather than trying other "buddy wire" methods as at other centers.[8] We had a high rate of successful stent delivery (92%) with final TIMI 3 flow rate of 82%. As interventionalists encounter more complex cases, especially calcific tortuous or previously stented vessels during STEMI, it is important to be aware of tools that can help facilitate PCI and lead to improved patient outcome.

Overall, the rates of adverse clinical outcomes in our patient population were low; however, this varied depending on the clinical presentation. In-hospital mortality was 3%, 30-day mortality was 2% and 1 year mortality was 10%. This is comparable to previous studies, such as Waterbury et al.[9] where in-hospital death in 2.9%, 30-day mortality in 4% and 1-year mortality in 14% of the patients. When the data were analyzed by presentation, in-hospital mortality was 10% for STEMI's compared to 1.4% for NSTEMI and 0% for elective cases. The high rate of in-hospital mortality for STEMI's can be accounted for by approximately half of the patients in this group presented with cardiogenic shock.

CTO is often considered the final frontier of percutaneous coronary intervention. A well-established use for GuideLiner support is during chronic total occlusion revascularization. Interventional cardiologists often require both passive (larger guiding catheter, different shaped guide catheter with support from the aortic sinuses or contralateral aortic wall) and active (super stiff wires, buddy wires, anchoring balloons, deep intubation of guide catheter) to achieve successful revascularization. The use of a GuideLiner can provide improved support and deeper intubation of the target vessel, and therefore improve the rate of success.

Previous studies had reported ACC/AHA lesion complexity; however, this does not allow a full assessment of the burden of coronary artery disease. This is the first study to stratify the use of GuideLiner and associated safety and outcomes by SYNTAX score. We found that the higher SYNTAX patients tended to be older and have more cardiovascular risk factors (cerebrovascular accidents, peripheral vascular disease, chronic kidney disease) as well as present more often with cardiogenic shock. They also had higher peak cardiac enzymes, LVEDP and lower LVEF. Hence, it is not surprising that mortality was higher in-hospital as well as at 1 year. However, despite the above, the rates of successful stent delivery and final TIMI flow were similar.

There are limitations to our study. This is a single center retrospective study and results and practice patterns may not be generalizable. As well, there is no non-GuideLiner comparison group which makes it difficult to determine the role GuideLiner played in the high rate of successful delivery.

Conclusions

This is the first study to stratify the use of GuideLiner and associated safety and outcomes by SYNTAX

score. We found that the GuideLiner is an easy to use guide catheter extension system with high rates of success and low rates of complications, across all SYNTAX groups.

Contributorship

All authors made a substantial contribution to: (1) the concept or design of the work; or acquisition, analysis or interpretation of data; (2) drafting or revising the article; (3) approved the version to be published; and (4) participated sufficiently in the work to take public responsibility for appropriate portions of the content.

Declaration of conflicting interests

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