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SHORT REPORT

Predictors of Patency Following Infrainguinal Arterial Interventions Under Intravascular Ultrasound Guidance: Analysis from the iDissection Studies

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Background: Intravascular Ultrasound (IVUS) has been shown in smaller studies to improve outcomes when used to guide infrainguinal peripheral arterial interventions. The iDissection series of studies were conducted to determine the presence of dissections with various prepping devices in femoropopliteal and infrapopliteal arteries. The impact of IVUS-directed treatment on the long-term outcomes in these patients remains unclear.

Methods: All patients were enrolled at a single center with the exception of the Auryon BTK study (at 4 US centers). Seven prospective iDissection studies had been previously conducted with IVUS and the data was core lab adjudicated. We retrospectively analyzed major adverse limb events, freedom from target lesion revascularization (freedom from TLR) and patency at 1 year in these patients using medical records. The study was approved by a central ethics committee. Proportional and Kaplan–Meier survival analysis were performed. Logistic regression analysis to determine independent predictors of patency was performed.

Results: A total of 102 patients (n=135 encounters) were included. The median age was 72 years. 49.0% were diabetics and 50.0% had chronic limb-threatening ischemia (CLTI). 69.6% of lesions are de novo, 32.6% chronic total occlusion, 60.7% with moderate or severe calcium, and 72.6% femoropopliteal. Stent use was 38.5% (of which 53.8% drug eluting and 73.1% primary stenting), and drug-coated balloons 55.6%. Vessel prepping included atherectomy (66.7%), angioplasty (14.8%) and Flex VP (18.5%). Proportional Freedom from TLR at 1 year was 89.4%, and patency 89.4%. There was one major amputation. Mortality was 7.8% (95% CI; 3.49, 14.87). Logistic regression analysis showed that post balloon stenosis (odds ratio (OR) 1.07, p=0.015), tobacco use (OR 0.20, p= −0.007), presence of CTO (OR 3.59, p=0.019), and male sex (OR 3.85, p=0.035) were predictors of patency loss.

Conclusion: Infrainguinal arteries treated with IVUS guidance appears to have good patency and freedom from TLR. The presence of adventitial dissections does not appear to be predictive of patency likely confounded with the high use of drug-coated balloons and drug-eluting stents.

Keywords: dissection, intravascular ultrasound, patency, target lesion revascularization, vessel prepping, drug coated balloons, drug eluting stents

Background

The use of precision imaging with intravascular ultrasound (IVUS) was shown to improve outcomes of patients undergoing coronary interventions.[1–5] In peripheral arterial interventions, IVUS has been shown to be more accurate than angiography in defining plaque morphology, the presence of calcium and its severity, the number and extent of dissections, vessel size and lesion severity.[6–9] Smaller studies also indicated the positive role of IVUS in peripheral arterial interventions in reducing target lesion revascularization (TLR), improving patency and resulting in fewer complications.[10–16] Furthermore, operators quite often change their intraprocedural strategy of treatment based on

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IVUS findings. In the ADAPT-DES study IVUS changed PCI strategy in 74% of the time with operators using larger stents, higher balloon inflation and the need for additional post dilation.[17]

The core lab adjudicated iDissection series of prospective studies (n=7) were performed to determine the presence and extent of dissections and vessel sizing with IVUS when compared with angiography and using various atherectomy and vessel prepping devices. In this study we evaluate the long-term outcome of patients treated in the iDissection studies.

Methods

All patients in the seven prospective iDissection studies were included in this analysis.[7–9,18–20] Angiographic analysis in these patients was conducted by the QVA and IVUS Core Laboratory at the Midwest Cardiovascular Research Foundation (MCRF), Davenport, IA, USA. IVUS analysis was also done by the core laboratory at MCRF and St John Providence Health System, Detroit, MI, USA. All inclusion and exclusion criteria, procedural details and 30-day outcomes in each study have also been published. The 1-year data was retrospectively collected from medical records. The study was approved by WCG, a central Ethics Committee, Princeton, NJ. A waiver of informed consent was granted by the Ethics Committee given the retrospective nature of the data collection and no risks to subjects. The study complies with the Declaration of Helsinki. Demographics, clinical, angiographic and procedural outcomes were pooled from all the studies. The primary endpoints were target lesion revascularization (TLR) (defined as the retreatment of the index lesion) and clinical patency (defined as PSVR ≤2.4 and no TLR) at 30 days, 6 months and 12 months. During the follow-up analysis, the TLR, target vessel revascularization (TVR), mortality and patency rates were cumulative, and the denominator (N) was based on the follow-up visit, not the actual days from the index procedure.

Statistical Analysis

Descriptive analysis on all variables was done. Analysis was performed per patient and per encounter treated for each study arm. Continuous data was presented as mean ± standard deviation [median]; Categorical data was given as count/sample (percentage). Pearson's Chi-Square Exact Test, Fisher's Exact Test, Sign test and Student's *t*-test were used where appropriate. Normality and outlier tests were done with Anderson–Darling test and Grubbs test, respectively. Median confidence intervals were used when data was not normally distributed. The proportion confidence interval was calculated using the Adjusted Blaker's exact method.

Logistic regression analysis for patency was done. In addition, TLR and patency rates were analyzed for significance with drug-coated balloon or drug-coated stent. Logistic regression analysis was evaluated for significance with the Wald Test, area under ROC curve and Goodness of Fit tests, Pearson and Hosmer-Lemeshow. Predicted probability was evaluated for various hypothetical post-balloon stenosis (Core Lab verified), presence of chronic total occlusion, and tobacco use. Several multiple logistic regression analysis models were conducted to determine if drug elution had an impact on the overall outcome of TLR in the overall cohort. These models included below versus above the knee treatment, presence of C dissections on IVUS (adventitial dissections), and the use of DCB and DES. Survival analysis for freedom from TLR, patency and freedom from TLR for femoropopliteal versus infrapopliteal interventions were plotted. Procedures with patients who died, lost to follow-up or had missing information were censored. Statistical significance was determined by a p-value < 0.05. Software used was Minitab 21 (State College Pennsylvania, USA) and Cytel Studio 12 (Cambridge, Massachusetts, USA).

Results

A total of 102 patients (n=135 encounters) were included. The median age was 72 years. 49.0% were diabetics and 50.0% had chronic limb-threatening ischemia (CLTI). 69.6% of lesions are de novo, 32.6% chronic total occlusion, 60.7% with moderate or severe calcium, and 72.6% femoropopliteal. Stent use was 38.5% (of which 53.8% drug eluting and 73.1% primary stenting), and drug-coated balloons 55.6%. Vessel prepping included atherectomy (66.7%), angioplasty (14.8%) and Flex VP (18.5%) (Tables 1 and 2). NHLBI and IVUS dissections are listed in

Table 1 Demographics and Clinical Variables

	n	Mean	Median
Age (years)	102	72.0 ± 11.0	72.0
Body Mass Index (kg/m2)	102	29.2 ± 7.5	27.8
Ankle Brachial Index (culprit leg)	60	0.77± 0.36	0.74
Glomerular Filtration Rate (GFR	94	55.8 ± 16.1	59.0
		n′	%
Male	102	62	60.8
Coronary artery disease (CAD)	102	59	57.8
Chronic Kidney Disease	102	46	45.1
History of major amputation	102	5	4.9
Hypertension	102	93	91.2
Hyperlipidemia	102	93	91.2
Current or prior smoker	102	74	72.5
Diabetes Mellitus	102	50	49.0
Aspirin	102	86	84.3
ADP receptor antagonists	102	52	51.0
Cilostazol	102	17	16.7
Race			
White	102	93	91.2
Black/African American	102	8	7.8
Hispanic	102	1	1.0
Rutherford Becker (RB) Category			
Missing	102	3	2.9
RB 0	102	0	0
RB I	102	0	0
RB II	102	4	3.9
RB III	102	44	43.1
RB IV	102	22	21.6
RB V	102	28	27.5
RB VI	102	1	1.0

Notes: n′=number of events.

Table 3. There was one in-hospital mortality secondary to a retroperitoneal bleed and deemed to be procedure- but not device-related (Table 4). Individual outcomes are listed in Table 5.

On follow-up 7 patients died, 8 lost to follow-up and 3 had missing information. Proportional Freedom from TLR at 1 year was 89.4% (Figure 1) and patency 89.4% (Figure 2). There was one major amputation. Mortality was 7.8%. The

Table 2 Procedural and Angiographic Variables

	n	Mean ± SD	Median
Target lesion length (mm)	83	113.5 ± 87.5	100
Vessel diameter by angiography (mm)	113	5.3± 1.6	5.7
Baseline Stenosis %*	132	76.6 ± 20.3	74.0
Post vessel prepping percent stenosis %*	107	43.0 ± 19.2	42.0
Post adjunctive balloon MLD (mm)*	129	18.9 ± 10.4	19.0
Baseline Minimal Luminal Diameter (MLD) (mm)*	72	1.3 ± 1.2	1.1
Post vessel prepping MLD (mm)*	61	2.2 ± 1.1	2.4
Post adjunctive balloon MLD (mm)*	69	3.7 ± 1.2	3.9
Calcium Arc by IVUS*	40	214.9 ± 42.0	218.8
Diameter of vessel by IVUS*	87	6.0 ± 1.6	6.2
		n"	%
Number of Runoffs, Number of Procedures (n=135)	0 Runoffs	22	16.3
	1 Runoff	41	30.4
	2 Runoffs	33	24.4
	3 Runoffs	28	20.7
	Missing	11	8.1
Lesion Type, Number of Lesions (n=135)	Denovo	94	69.6
	Restenosis	35	25.9
	Mixed	6	4.4
Presence of thrombus (n=125)	Missing	18	13.3
	No	111	82.2
	Yes	6	4.4
Chronic total occlusion (n=135)	Yes	44	32.6
Stent use (n=135)	Yes	52	38.5
Calcium severity per PACSS classification*			
	Missing	5	3.7
	Grade 0	7	5.2
	Grade I	28	20.7
	Grade II	27	20.0
	Grade III or IV	55	40.7
Reason for stenting (n=52)	30% or higher residual	10	19.2
	Type D dissection	2	3.8

(*Continued*)

Table 2 (Continued).

	n	Mean ± SD	Median
	Perforation	2	3.8
	Primary stenting	38	73.1
Drug-eluting stents (52)	Yes	28	53.8
Drug-coated balloon (135)	Yes	75	55.6
Target Lesions (n=135)	Femoropopliteal	98	72.6
	Infrapopliteal	37	27.4

Notes: *core lab measurement; n = number of events, SD = standard deviation.

Table 3 Angiographic and IVUS Dissections

		n	%
Vessel Prepping devices			
	Angioplasty (PTA)	20	14.8
	Jetstream + adjunctive PTA	12	8.9
	Laser 355 nm + adjunctive PTA	49	36.3
	Flex VP + adjunctive PTA	25	18.5
	Rotarex + adjunctive PTA	20	14.8
	Orbital atherectomy + adjunctive PTA	9	6.7
Angiographic. NHLBI classification			
Baseline dissection (n=*135*)	Missing	2	1.5
	None	130	96.3
	A	2	1.5
	B	1	0.7
Post Vessel Prepping (n=135)	Missing	23	17.0
	None	96	71.1
	A	4	3.0
	B	4	3.0
	C	5	3.7
	D	2	1.5
	E	1	0.7
	F	0	0.0
Post balloon angioplasty (n=135)	Missing	4	3.0
	None	88	65.2
	A	9	6.7

(*Continued*)

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Table 3 (Continued).

		n	%
	B	11	8.1
	C	17	12.6
	D	5	3.7
	E	1	0.7
	F	0	0.0
IVUS. iDissection classification			
Baseline (n=135)	No	115	85.2
	A and B	13	9.6
	C	7	5.2
Post vessel prepping (n=135)	Missing	21	15.6
	No	50	37.0
	A and B	45	33.3
	C	19	14.1
Post balloon angioplasty	Missing	0	0.0
	No	20	14.8
	A and B	79	58.5
	C	36	26.7

Notes: n = number of events.

Table 4 In-Hospital Complications

	n	n	%	% 95% CI
Major bleed	135	3	2.2	(0.61, 6.36)
Pseudoaneurysm/AV fistula	135	0	0.0	(0.00, 2.63)
Distal embolization	135	3	2.2	(0.61, 6.36)
Target vessel revascularization	135	0	0.0	(0.00, 2.63)
Target lesion revascularization	135	0	0.0	(0.00, 2.63)
Unplanned major amputation	135	0	0.0	(0.00, 2.63)
Mortality*	135	1	0.7	(0.04, 3.80)
Perforation	135	3	2.2	(0.61, 6.36)

Notes: *retroperitoneal bleed.
Abbreviation: CI, Confidence interval.

Table 5 Outcomes

	n	Mean ± SD	Median	Median 95% CI
Ankle-Brachial index – target limb				
30-day	42	0.91 ± 0.25	0.91	(0.84, 0.99)
6-month	40	0.87 ± 0.27	0.91	(0.78, 0.95)
1-year	37	0.92 ± 0.29	0.93	(0.85, 1.00)
		n″	**%**	**% 95% CI**
Patency (PSVR ≤ 2.4)				
30-day	35	30	85.7	(70.50, 94.20)
6-month	48	44	75.8	(80.73, 97.10)
1-year	44	38	86.4	(73.18, 93.39)
Target lesion revascularization (Cumulative)				
30-day	134	0	0.0	(0.00, 2.63)
6-month	125	4	3.2	(1.10, 7.72)
1-year	119	13	10.9	(5.97, 17.82)
Target vessel revascularization (Cumulative)				
30-day	134	0	0.0	(0.00, 2.63)
6-month	125	4	3.2	(1.1, 7.720)
1-year	119	11	9.2	(4.89, 15.72)
Major amputation				
30-day	134	0	0.0	(0.00, 2.63)
6-month	124	1	0.8	(0.041, 4.14)
1-year	119	0	0.0	(0.00, 2.99)
Total mortality (Cumulative)				
In-hospital	102	1	1.0	(0.05, 5.34)
30-day	102	1	1.0	(0.05, 5.34)
6-month	102	8	7.8	(3.49, 14.87)
1-year	102	8	7.8	(3.49, 14.87)

probability of patency was higher in the femoropopliteal arteries versus infrapopliteal arteries (88.1% vs 71.9% respectively, p=0.023) (Figure 3) but probability of freedom from TLR was statistically similar (88.1% vs 93.6%, p=0.424). The Rutherford Becker category at 30-day remained unchanged at 1-year follow-up (Table 6).

Logistic regression analysis showed that post-balloon stenosis (odds ratio (OR) 1.07, p=0.015), tobacco use (OR 0.2, p=−0.007), presence of CTO (OR 3.6, p=0.019), and male sex (OR 3.85, p=0.035) were predictors of patency loss. Multiple regression models that included the presence of deep dissections on IVUS (p=0.597), above versus below the knee treatment (p=0.289), and use of drug-coated balloons (p=0.209) or drug-eluting stents (p=0.141) did not appear to predict target lesion revascularization.

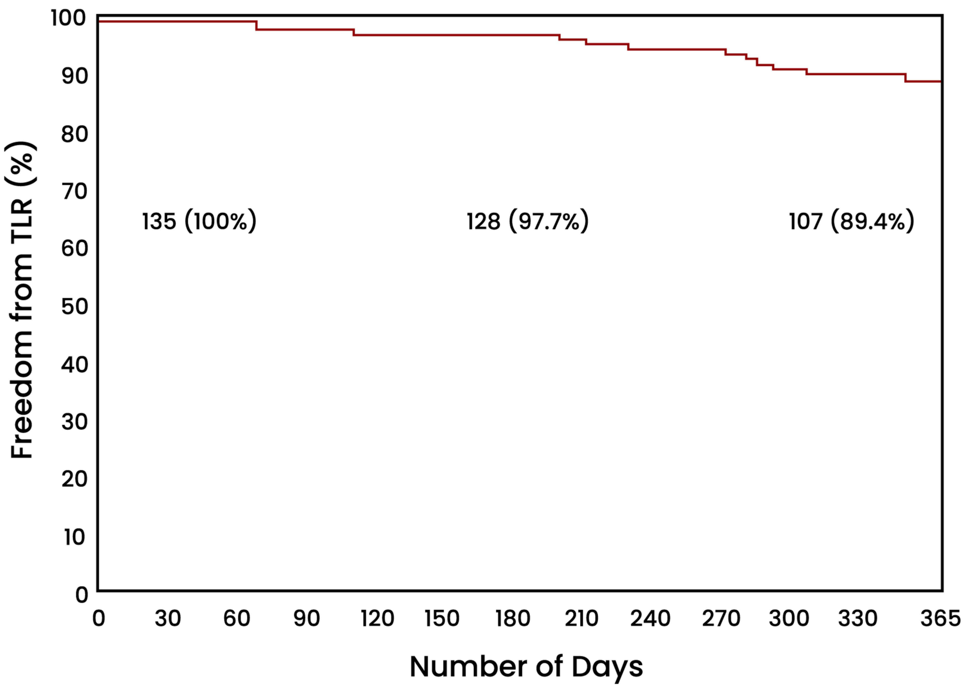

Figure 1 Freedom from target lesion revascularization at 1-year (n (%) number of patients at risk, percent of freedom from TLR). Encounters were censored for death, lost to follow-up or missing data. The 95% CI at 180 days was 97.7% (95.2,100.0) and at 365 days was 89.4% (84.0,94.9).

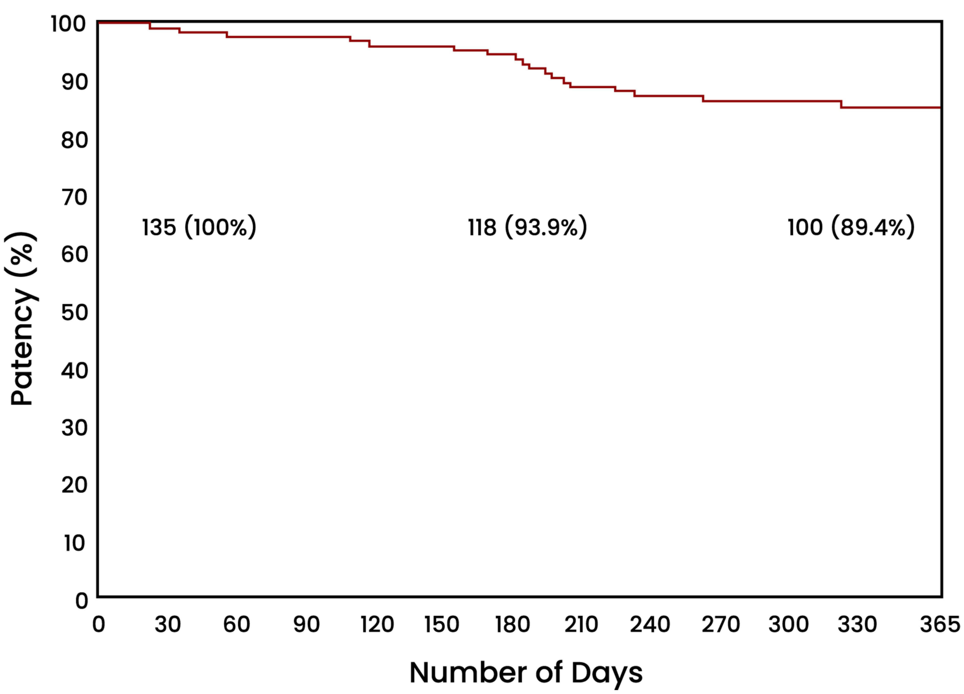

Figure 2 Freedom from patency at 1-year (n (%) number of patients at risk, percent of freedom with patency). Encounters were censored for death, lost to follow-up or missing data. The 95% CI were calculated for median patency at 180 days 75.8% (80.73, 97.10) and 1 year 86.4% (73.18, 93.39).

Discussion

IVUS is a precision imaging modality that offers significantly more accurate information to vessel wall morphology and size, lesion extent and severity, and degree of calcification. IVUS guidance quite often alters the intraprocedural strategy

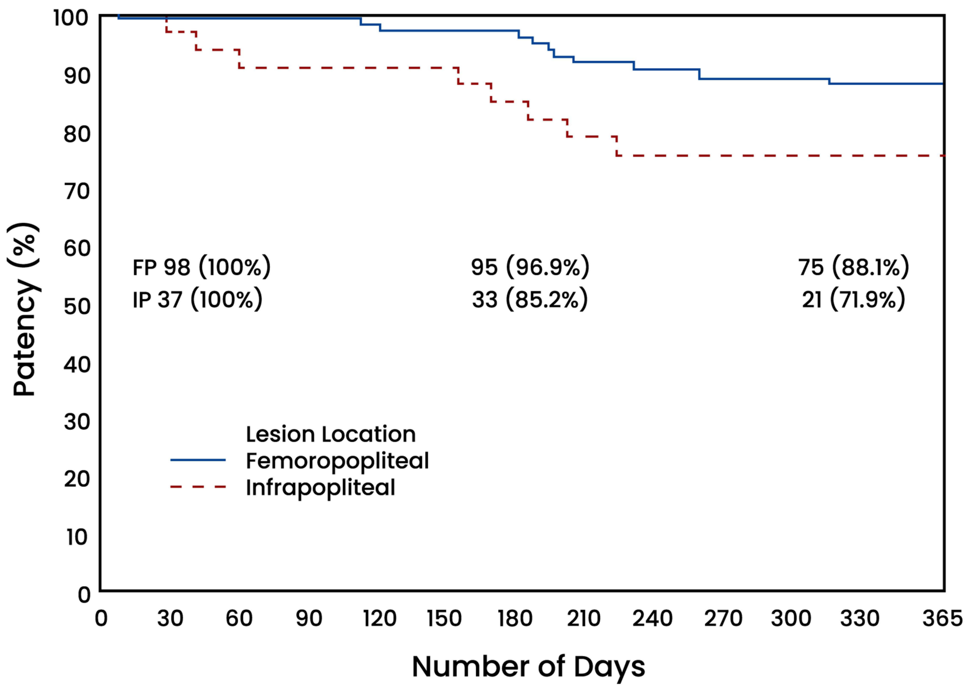

Figure 3 Freedom from patency between femoropopliteal and infrapopliteal arteries at 1-year (n (%) number of patients at risk, percent of freedom with patency), FP=femoropopliteal, IP=infrapopliteal. Encounters were censored for death, lost to follow-up or missing data. At 1 year, median patency in the femoropopliteal cohort was 88.1% (95% CI; 81.5, 94.7) and in the infrapopliteal cohort was 71.9% (95% CI; 56.3, 87.6).

of the operator in treating peripheral arterial disease (see typical cases 1 to 3 below; Figure 4–6). In this study, we have observed a high rate of freedom from TLR and patency in a cohort of patients with complex disease with 49.0% of patients being diabetics and just half the patients have chronic threatening limb ischemia. CKD was present in 45.1% of patients, CTO in 32.6% and severe calcium in 40.7% of patients.

Table 6 Rutherford Becker Category

		n″	%	% 95% CI
30-day (n=132)	Not Recorded or Done	21	15.9	(10.35, 23.06)
	RB=0	46	34.8	(27.10, 43.52)
	RB I	20	15.2	(9.56, 22.17)
	RB II	9	6.8	(3.46, 12.26)
	RB III	9	6.8	(3.46, 12.26)
	RB IV	3	2.3	(0.62, 6.26)
	RB V	23	17.4	(11.48, 24.83)
	RB VI	1	0.8	(0.04, 3.89)
6-month (124)	Not Recorded or Done	48	38.7	(30.26, 47.56)
	RB=0	40	32.3	(24.42, 41.06)
	RB I	14	11.3	(6.58, 17.92)
	RB II	0	0.0	(0.00, 2.87)

(*Continued*)

Table 6 (Continued).

		n"	%	% 95% CI
	RB III	10	8.1	(4.19, 14.25)
	RB IV	5	4.0	(1.60, 8.98)
	RB V	7	5.6	(2.55, 11.02)
	RB VI	0	0.0	(0.00, 2.87)
1-year (117)	Not Recorded or Done	52	44.4	(35.35, 53.88)
	RB=0	28	23.9	(16.86, 32.35)
	RB I	15	12.8	(7.48, 20.00)
	RB II	3	2.6	(0.70, 6.97)
	RB III	8	6.8	(3.02, 12.95)
	RB IV	2	1.7	(0.30, 5.75)
	RB V	9	7.7	(3.91, 13.84)
	RB VI	0	0.0	(0.00, 3.04)

A recent metanalysis evaluating the risk of restenosis post lower extremity arterial interventions showed Trans-Atlantic Inter-Society Consensus II classification, age, hypertension, diabetes, high-sensitivity C-reactive protein, and surgical approach were independent predictors of restenosis.[21] In our cohort and under IVUS guidance predictors of loss of patency were residual narrowing, CTO and male sex. This is consistent with data published by Horie et al[22] that reported a primary patency rate of 80.0% at 1-year after drug-coated balloon treatment of femoropopliteal lesions. In their study, predictors of restenosis were CTO ($p < 0.001$), circumferential calcification ($p = 0.023$), and smaller post-procedural minimum lumen area ($p=0.036$). Similarly, in a cohort of patients where 73.4% of patients had femoropopliteal arteries treated with DCB under IVUS guidance, predictors of restenosis were history of revascularization, CTO, residual stenosis, smaller distal reference vessel diameter, severe calcification and low-dose DCB.[23] CTO and residual narrowing appear to be consistent predictors of restenosis among published studies of femoropopliteal interventions performed with IVUS guidance.

Deeper dissections into the adventitia by IVUS did not appear to predict a higher rate of restenosis, likely related to the higher use of drug-eluting balloons and stents in the femoropopliteal arteries. Deeper dissections with adventitial injuries have been reported to predict loss of patency[24] but the use of drug elution has also been shown to mitigate the risk of deeper dissections.[25] Despite the use of drug elution, a recent randomized trial has shown that the addition of IVUS significantly improves outcome when compared with angiography-guided drug-coated balloon use in femoropopliteal arteries, particularly in complex lesions.[26]

Adventitial injury is more likely to impact long-term outcome when no drug elution is used. In the infrapopliteal arteries, the rate of deep dissections was very small with vessel prepping. Despite no drug elution use, the overall freedom from TLR appears to be superior to historic controls in the infrapopliteal arteries where no IVUS was used routinely.[27,28] This suggests that IVUS guidance in the infrapopliteal arteries is likely to improve outcomes despite no use of drug elution. This needs to be confirmed in randomized trials in infrapopliteal interventions.

The rate of patency was higher at 1 year following treatment of femoropopliteal arteries when compared to infrapopliteal ones despite the use of IVUS. Despite this difference, patency rate in the infrapopliteal arteries was high at 71.9% with very low rate of amputation, mortality and overall procedural complications. This is in contrast to the overall 1-year historic primary patency of 63.1%, repeat revascularization 18.2%, major amputation 14.9% and all-cause

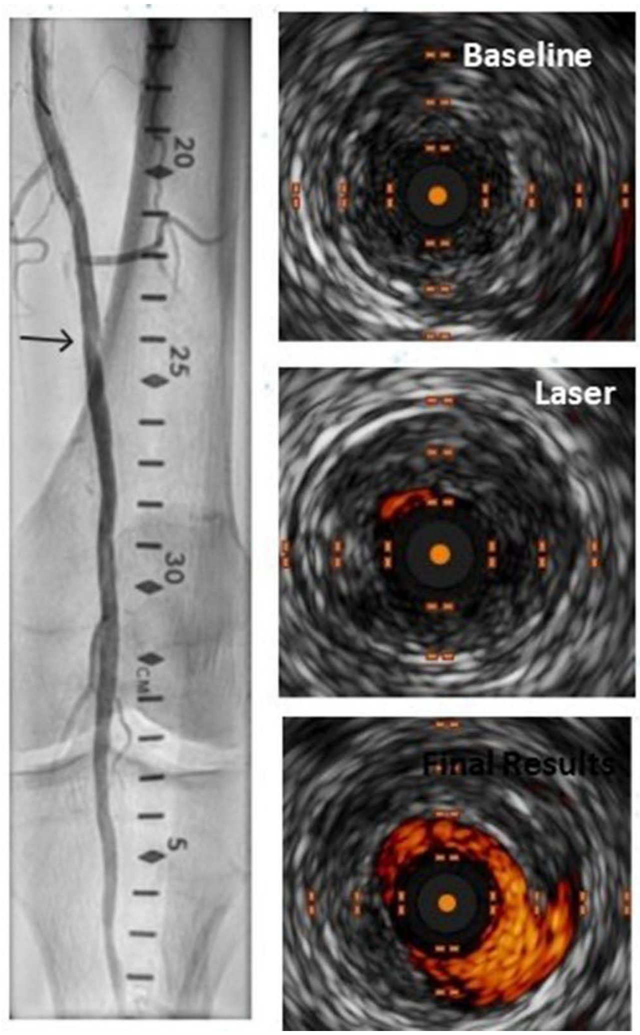

Figure 4 Case 1. Right panel. Baseline IVUS image showing total occlusion of the superficial femoral artery with intraluminal crossing. After laser, there was some flow seen by ChromaFlo (Philips). The final IVUS image post angioplasty showed good flow and a limited insignificant dissection (A1 based on iDissection classification; involving intima and less than 180 degrees). This matched with mark 24 (arrow) on the ruler in the final cine angiogram (left panel).

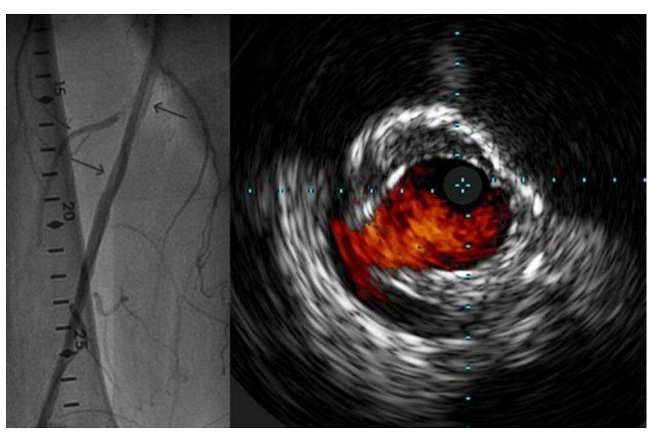

Figure 5 Case 2. Post atherectomy of the right superficial femoral artery. Left panel angiogram raises suspicion of spiral dissection (black arrows). IVUS (right panel) showed a type B1 dissection per iDissection classification (Involving media and less than 180 degrees). Flow was good by ChromaFlo (philips).

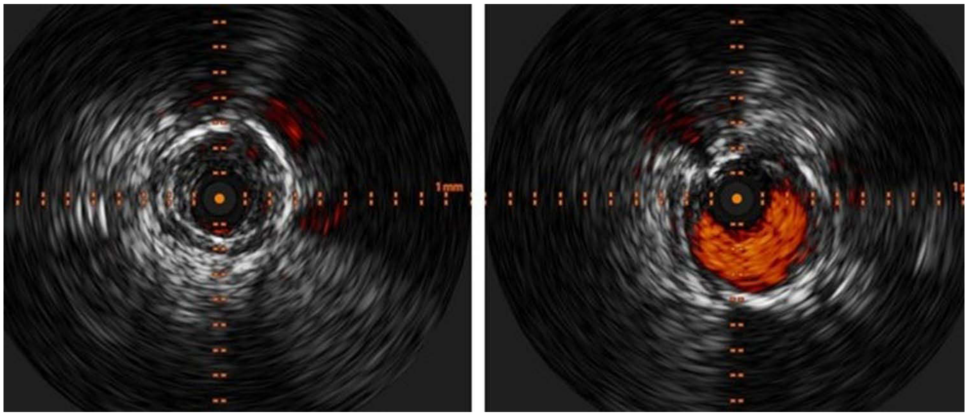

Figure 6 Case 3. Left panel: total occlusion of the tibioperoneal trunk. Intraluminal crossing noted. Post laser and low pressure balloon angioplasty with balloon sized using IVUS measurements, yielded optimal results with no dissection (right panel).

mortality 15.1%.[27,28] Multiple logistic regression analysis including above versus below the knee interventions, and use of drug elution vs no drug elution has shown no differences in TLR in this IVUS-treated cohort.

Example of Cases of Intravascular Ultrasound Applications

Case 1 (Figure 4). Patient presents with claudication Rutherford Becker category III after failed home exercise program. Ankle Brachial Index on the left was 0.6. Angiography revealed a total occlusion (CTO) of the left mid and distal superficial artery with collaterals to the left popliteal and left tibial arteries. CTO was crossed successfully using a crossing catheter and a 0.014″ 25 gm-tip wire. IVUS was then done and confirmed the intraluminal crossing of the wire and a vessel diameter of 5 to 5.5 mm. Laser atherectomy was then performed with the 2.35 mm of the 355-nm laser catheter followed by a 5 mm angioplasty balloon at 6 atmospheres. Angiographically, there was good flow in the vessel. One area of the vessel (arrow pointing on mark 24 of the ruler on the angiographic panel) appeared to have some haziness and had about 30–35% narrowing. Repeat IVUS showed a small intimal dissection of no clinical significance. There was residual plaque noted but good flow. No stenting was needed. IVUS in this case determined the intraluminal crossing of a CTO allowing us to use atherectomy safely. Also it guided the size of the balloon post atherectomy. In addition, it identified an insignificant dissection that did not need to be stented despite the appearance of haziness on the angiogram.

Case 2 (Figure 5). Patient presents with claudication Rutherford Becker category III and Ankle Brachial Index of 0.5. Angiography showed a severe 90% lesion in the mid to distal right superficial femoral artery. IVUS was performed. Fibrocalcific plaque was noted. Rotational atherectomy was performed followed by drug-coated balloon with size guided by the IVUS. Angiography showed the possibility of a type D spiral dissection (see 15 and 18 on the ruler marker). IVUS was then performed and showed a dissection (less than 180-degree arc and involving the intima and media. No injury to the adventitia is seen). The flow was good. We decided given the IVUS findings not to stent this vessel. IVUS did guide the extent of dissection, the size of the vessel and the nature of the plaque; none were adequately visualized by angiography.

Case 3 (Figure 6). Patient presents with chronic-threatening limb ischemia and an ulcer on the dorsal aspect of the first big toe. Angiography revealed severe disease in the tibial arteries with total occlusion of the anterior tibial artery (AT) and the tibioperoneal (TP) trunk. The peroneal, dorsalis pedis (DP) and distal AT were faintly filling with collaterals. Angiographically, the vessel was estimated to be 3.5 mm. An intravascular ultrasound (IVUS) showed the vessel size to be approximately 4.5 mm. This changed our original plan to use a 1.5 mm laser to 2 mm laser catheter. Post laser treatment, followed by a 4 mm low pressure balloon angioplasty (5 atmospheres), less than 10% residual narrowing is noted with no dissections. IVUS in this case was critical to provide the appropriate size of the vessel that led to the choice of the appropriate laser catheter size and balloon size. Also it verified the optimal final results with no dissections and good minimal luminal area gain.

Limitation of the Study

The study is limited by its smaller size and no control group (all patients had IVUS). The data however was acquired prospectively up to 1-month follow-up and was adjudicated by core lab. IVUS based multicenter and randomized studies are needed to determine the impact of IVUS on long-term outcomes of infrainguinal arterial endovascular intervention with prespecified subgroup analysis of patients with adventitial injury and drug elution. A basic knowledge of IVUS image interpretation is needed. Several aspects to IVUS need to be learned including vessel sizing, different plaque morphology, presence and severity of calcium, presence and extent of dissection, and assessment of lesion severity before and after treatments. Operators with less experience in IVUS may not be able to adequately utilize IVUS to its full potential in guiding peripheral arterial interventions. We believe IVUS training is critical for endovascular operators.

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Disclosure

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