OCT versus Angiography Guided PCI
ILUMIEN IV: OPTIMAL PCI

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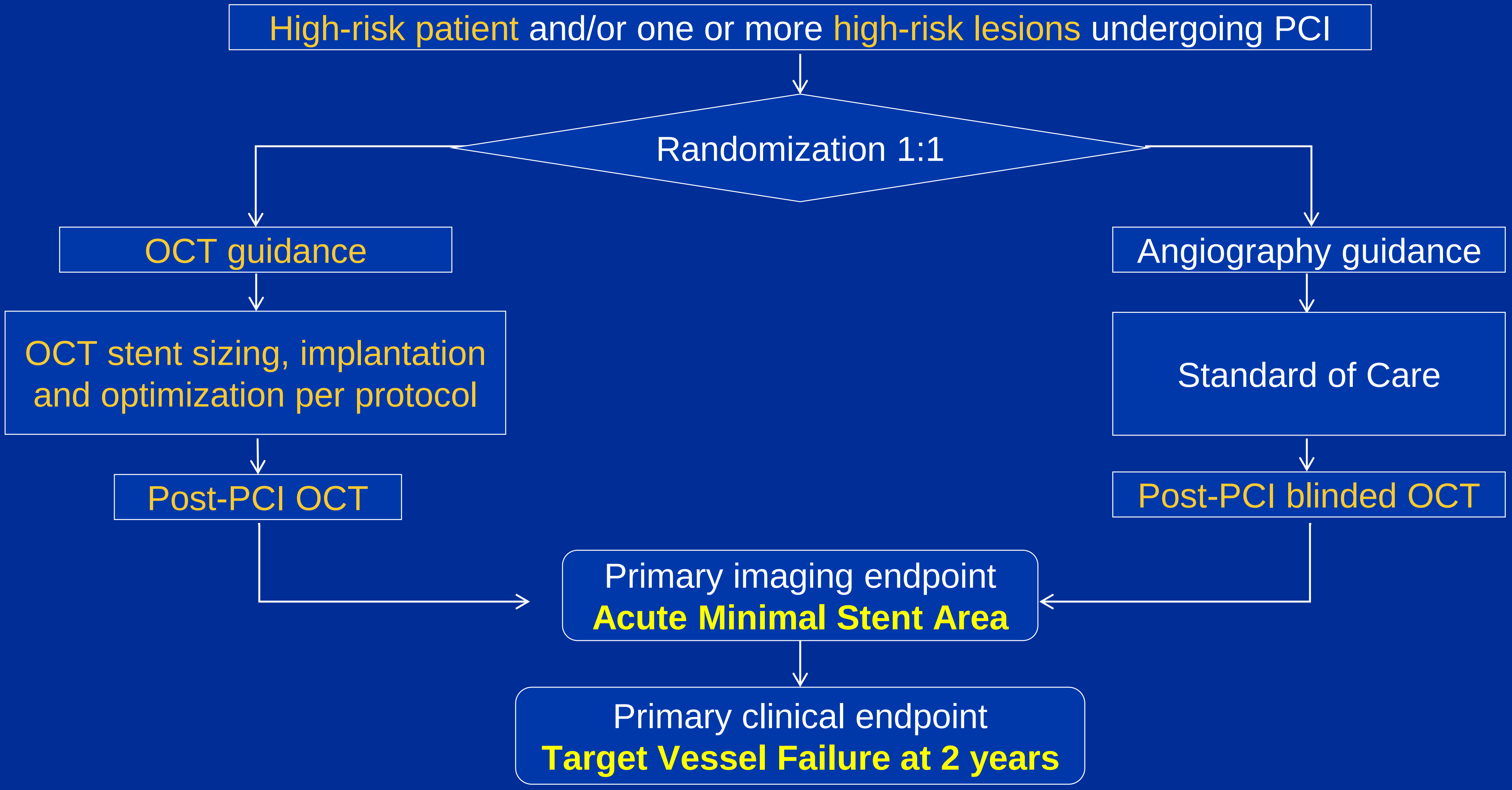
Background

- PCI is most commonly guided by angiography alone
- OCT is a high-resolution intravascular imaging modality that can be used to guide and optimize PCI
- In ILUMIEN III,[1] OCT guidance improved procedural success compared with angiography guidance
  - Greater stent expansion
  - Reduced major malapposition and major dissection
- Whether OCT can improve clinical outcomes is unknown

[1]Lancet. 2016 Nov 26;388:2618-2628.

Study Flow



ClinicalTrials.gov #NCT03507777

Qualifying High-risk Criteria

High-risk Patient

- Medication-treated diabetes mellitus

High-risk Lesion

- NSTEMI
- STEMI >24 hours from symptom onset
- Long or multiple lesions (planned total stent length ≥28 mm)
- Diffuse or multi-focal in-stent restenosis
- Angiographic severe calcification
- Chronic total occlusion
- Bifurcation, planned to be treated with 2 stents

Endpoints

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1. Primary Imaging Endpoint (powered)

Post-PCI MSA assessed by OCT

Superiority of OCT to angiography

Δ 0.4 mm^2, SD 2.2 mm^2, 1600 randomized patients = 95% power at one-sided α 0.025

2. Primary Clinical Endpoint (powered)

TVF during 2-year follow-up

Superiority of OCT to angiography

Control TVF 12.0%, HR 0.65, 1230 randomized patients = 90% power at one-sided α 0.025

3. Safety Endpoints (not powered)

Stent thrombosis and procedural complications

Randomization and Follow-up

2690 patients enrolled at 80 sites in 18 countries

203 roll-in patients

2487 patients randomized

1233 OCT-guided PCI

30 poor image qualify
33 no final OCT performed
19 OCT did not cross the lesion
3 no new stent placement
1 withdrew consent before PCI

1147 final OCT available for the primary imaging endpoint analysis

5 lost to follow-up **
9 withdrew consent, other
52 missed 2-year visit

1167 2-year follow-up completed (94.6%)

1233 primary clinical endpoint analysis

1254 angiography-guided PCI

26 poor image qualify
16 no final OCT performed
8 OCT did not cross the lesion
1 no new stent placement
2 withdrew consent before PCI

1201 final OCT available for the primary imaging endpoint analysis

7 lost to follow-up **
19 withdrew consent, other
53 missed 2-year visit

1175 2-year follow-up completed (93.7%)

1254 primary clinical endpoint analysis

Study Organization

- Principal Investigators: Ziad Ali, Ulf Landmesser
- Chairman: Gregg Stone
- Academic Research Organization: Cardiovascular Research Foundation
- Steering Committee: Gregg Stone, Ziad Ali, Ulf Landmesser, Takashi Akasaka, Hiram Bezerra, Giulio Guagliumi, Jonathan Hill, Francesco Prati, Matthew Price, Richard Shlofmitz, William Wijns
- Intravascular Imaging Core Lab: CRF - Akiko Maehara (Director)
- Angiographic Core Lab: CRF – Ivana Jankovic (Deputy Director)
- Data Safety Monitoring: CRF – John Hirshfeld (Director)
- Clinical Endpoints Committee: Ozgen Dogan (Chair)
- Site Monitoring & Data Management: Abbott Vascular
- Sponsor and Funding Source: Abbott Vascular

Highest Enrollers

Investigator	Institution	City, State, Country	N
Richard Shlofmitz	St. Francis Hospital	Roslyn, NY, USA	301
Franco Fabbiocchi	Centro Cardiologico Monzino	Milan, Italy	140
Fernando Alfonso	Hospital Universitario de la Princesa	Madrid, Spain	131
Paolo Canova	Ospedale Papa Giovanni XXIII	Bergamo, Italy	116
David Leistner	Universitatsmedizin Berlin	Berlin, Germany	113
Rohit Oemrawsingh	Albert Schweitzer Ziekenhuis	Dordrecht, Netherlands	82
Matthew Price	Scripps Health	La Jolla, CA, USA	72
Stephan Achenbach	Kliniken der Friedrich-Alexander	Erlangen, Germany	69
Carlo Trani	Policlinico Universitario A. Gemelli	Rome, Italy	68
Balbir Singh	Max Super Specialty Hospital	New Delhi, India	62

Baseline Characteristics

	OCT (n=1233)	Angio (n=1254)
Age, years	65.5 ± 10.5	65.7 ± 10.3
Male	78.5%	76.2%
Hypertension	71.4%	74.0%
Dyslipidemia	65.5%	68.6%
Diabetes mellitus	42.4%	41.5%
Current smoker	19.6%	19.7%
Serum creatinine, mg/dl	0.96 ± 0.23	0.96 ± 0.25
Silent ischemia	14.0%	15.4%
Stable angina	27.0%	28.5%
Acute coronary syndrome	59.0%	66.1%

Qualifying Characteristics

	OCT (n=1231)	Angio (n=1250)	Difference [95% CI]
Medication-treated diabetes mellitus	40.4%	39.8%	0.5% (-3.3, 4.4)
Long or multiple lesions	69.3%	65.9%	3.4% (-0.3, 7.0)
NSTEMI	24.5%	23.8%	0.6% (-2.8, 4.0)
Angiographic severe calcification	11.4%	11.7%	-0.3% (-2.8, 2.2)
In-stent restenosis (ISR)	10.6%	11.0%	-0.5% (-2.9, 2.0)
Chronic total occlusion (CTO)	7.6%	6.3%	1.3% (-0.7, 3.3)
STEMI (>24 hours from onset)	5.4%	5.6%	-0.2% (-2.1, 1.6)
Bifurcation with 2 planned stents	3.2%	3.4%	-0.2% (-1.6, 1.3)

Angiographic Characteristics

	OCT (L=1320)	Angio (L=1387)	Difference [95% CI]
LAD/LCx/RCA	53.3/ 19.0/ 27.7%	50.9/ 20.6/ 28.5%	--
Thrombus	6.8%	7.4%	-0.6% (-2.6, 1.4)
Calcification (severe)	32.0%	29.7%	2.3% (-1.2, 5.8)
Reference vessel diameter, mm	2.93 ± 0.43	2.90 ± 0.42	0.0 (-0.0, 0.01)
Minimum lumen diameter, mm	0.88 ± 0.43	0.88 ± 0.42	-0.0 (-0.0, 0.0)
Diameter stenosis, %	69.8 ± 13.9	69.6 ± 13.8	0.3 (-0.8, 1.3)
Lesion length, mm	32.9 ± 15.9	29.9 ± 16.1	3.0 (1.7, 4.2)
TIMI III flow	81.4%	79.3%	2.1% (-0.9, 5.2)

Procedural Characteristics

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	OCT (n=1233)	Angio (n=1254)	Difference [95% CI]
Stents per patient	1.7 ± 0.9	1.6 ± 0.8	0.1 (0.0, 0.2)
Stent length, mm	44.2 ± 23.8	40.5 ± 24.0	3.8 (1.9, 5.6)
Maximal stent diameter, mm	3.22 ± 0.48	3.11 ± 0.40	0.11 (0.07, 0.14)
Post-dilatation balloons used, n	1.6 ± 1.2	1.3 ± 1.2	0.3 (0.2, 0.4)
Maximum device size, mm	3.67 ± 0.56	3.37 ± 0.47	0.31 (0.27, 0.34)
Maximum inflation pressure, atm	19.8 ± 3.1	18.4 ± 3.3	1.4 (1.2, 1.7)
Procedure duration, min	68.3 ± 38.3	50.0 ± 35.4	18.3 (15.4, 21.2)
Fluoroscopy duration, min	20.9 ± 13.8	17.4 ± 11.8	3.6 (2.6, 4.6)
Radiation dose, Gy	2.01 ± 1.75	1.55 ± 1.36	0.46 (0.32, 0.60)
Contrast volume, mL	231.9 ± 88.2	198.3 ± 81.7	33.7 (27.0, 40.4)

Primary Imaging Endpoint

Final post-PCI MSA by OCT (mm^2)

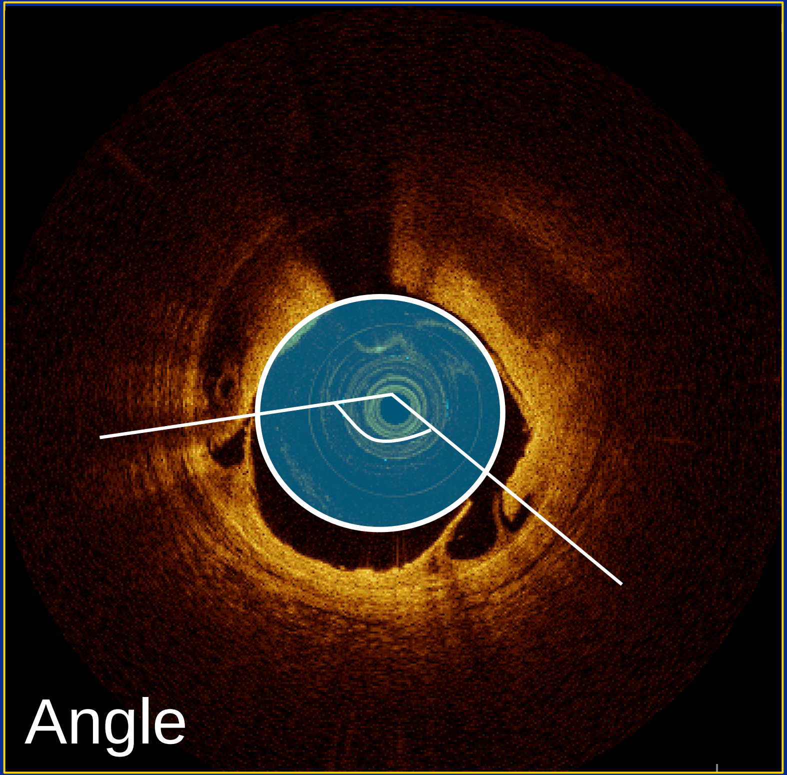
OCT L=1222	Angio L=1328	Difference [95% CI]	P-Value
5.72 ± 2.04	5.36 ± 1.87	0.36 (0.21, 0.51)	<0.001

Stent Expansion Endpoints

	OCT (L=1228)	Angio (L=1329)	Difference [95% CI]
Min stent expansion, %	80.8 ± 16.8	78.0 ± 16.7	2.9 (1.6, 4.2)
Mean stent expansion, %	111.3 ± 16.3	103.0 ± 17.2	8.2 (6.9, 9.5)
Stent expansion			
- Acceptable (≥90%)	40.5%	23.3%	17.2% (13.6, 20.8)

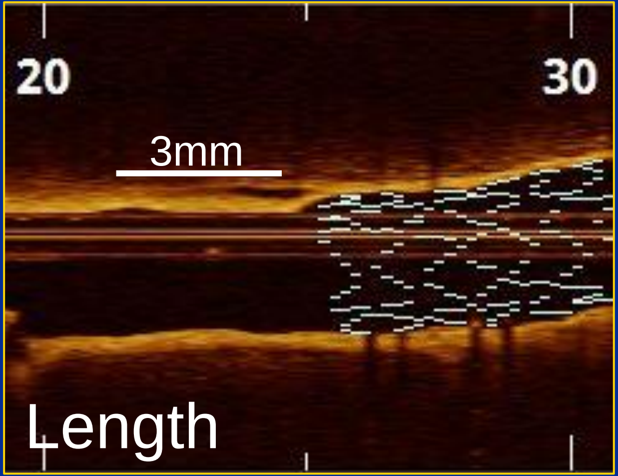
Post-procedure OCT Findings

	OCT (L=1228)	Angio (L=1329)	Difference [95% CI]
Dissection, any	32.0%	34.2%	-2.2% (-5.9, 1.4)
Major	2.9%	5.1%	-2.2% (-3.9, -0.6)
Minor	22.7%	19.4%	3.3% (-0.1, 6.6)



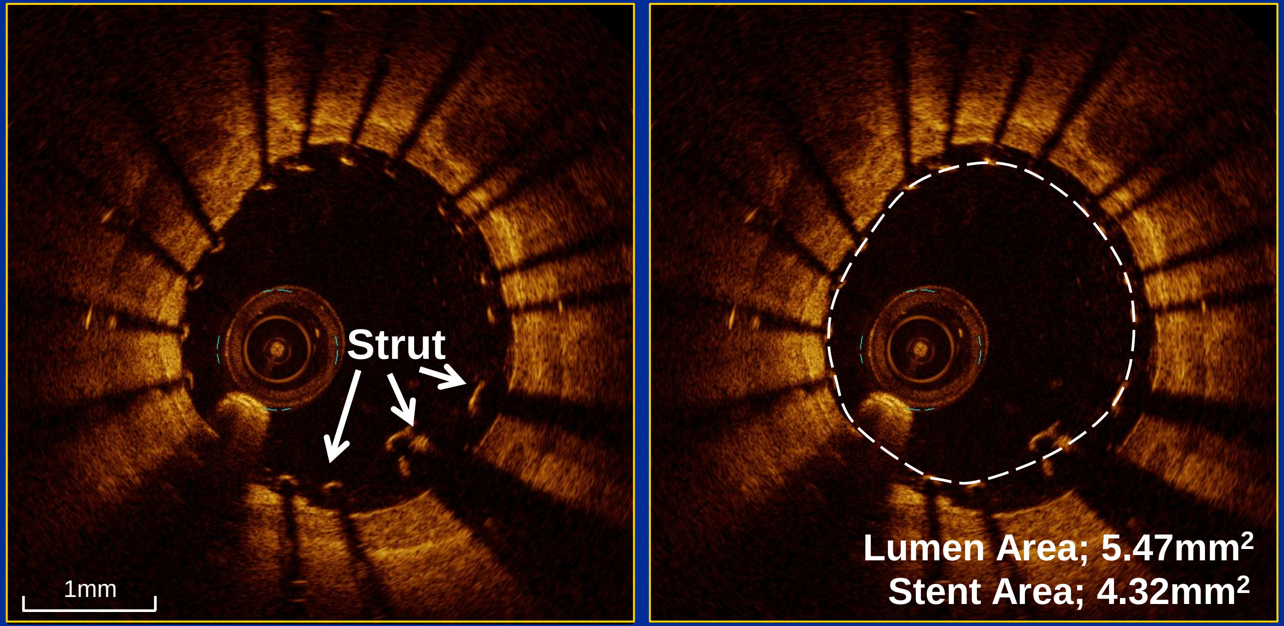
Major Dissection

1) Angle >60˚
2) Length >3 mm



Post-procedure OCT Findings

	OCT (L=1228)	Angio (L=1329)	Difference [95% CI]
Malapposition, any	55.3%	69.7%	-14.4% (-18.1, -10.6)
Major	15.8%	33.2%	-17.4% (-20.6, -14.1)
Minor	39.4%	36.5%	3.0% (-0.8, 6.7)

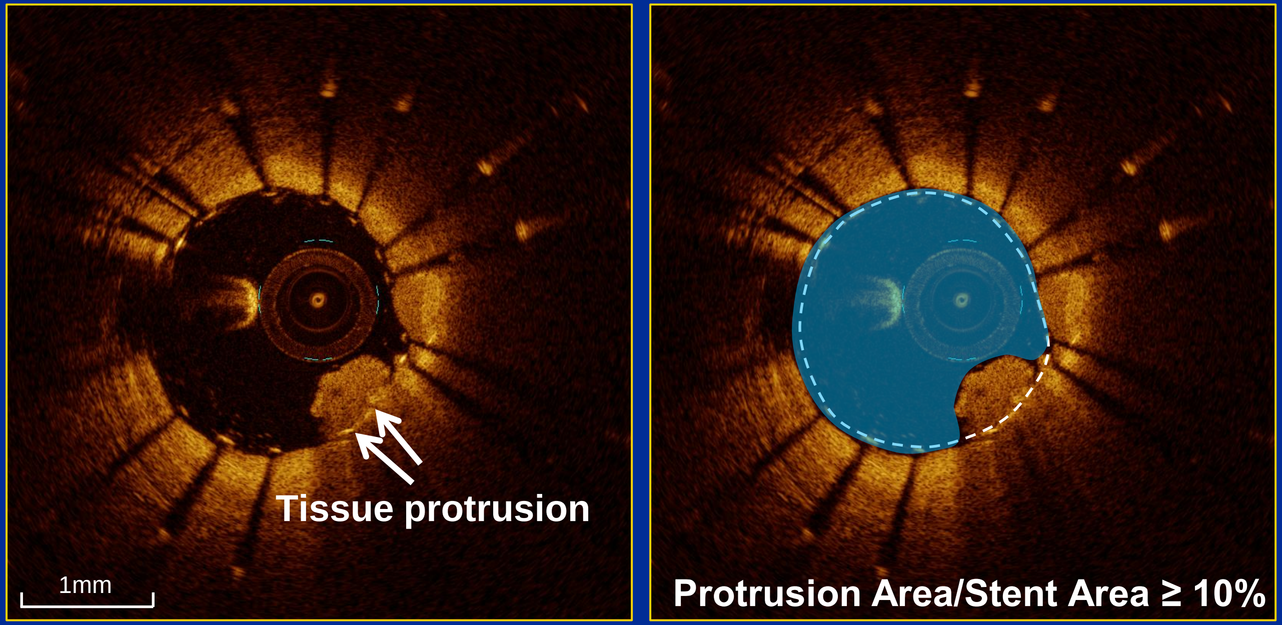


Major

Strut(s) >0.2 mm from vessel edge and stent underexpansion

Post-procedure OCT Findings

	OCT (L=1228)	Angio (L=1329)	Difference [95% CI]
Tissue Protrusion, any	55.9%	47.0%	8.9% (5.0, 12.8)
Major	5.3%	8.3%	-3.0% (-4.9, -1.0)
Minor	50.6%	38.7%	11.9% (8.1, 15.7)



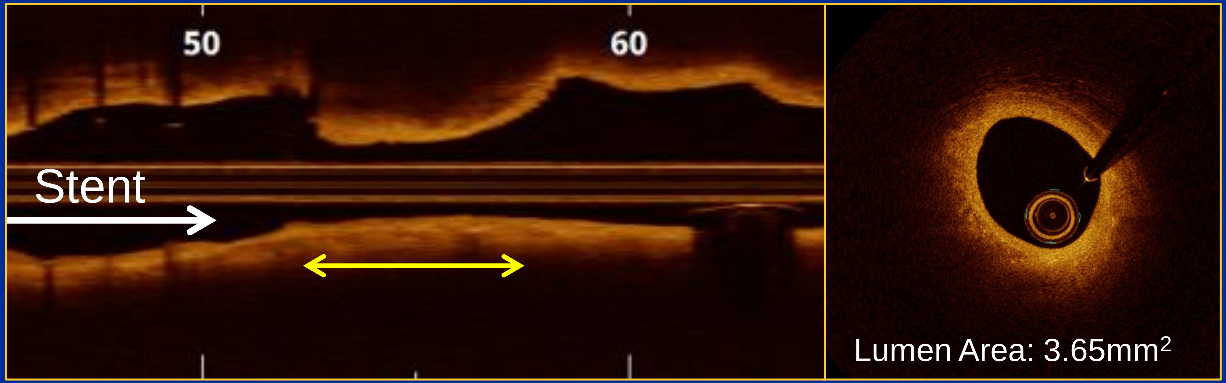
Major

Mass >0.2 mm from vessel edge and protrusion area/stent area ≥10%

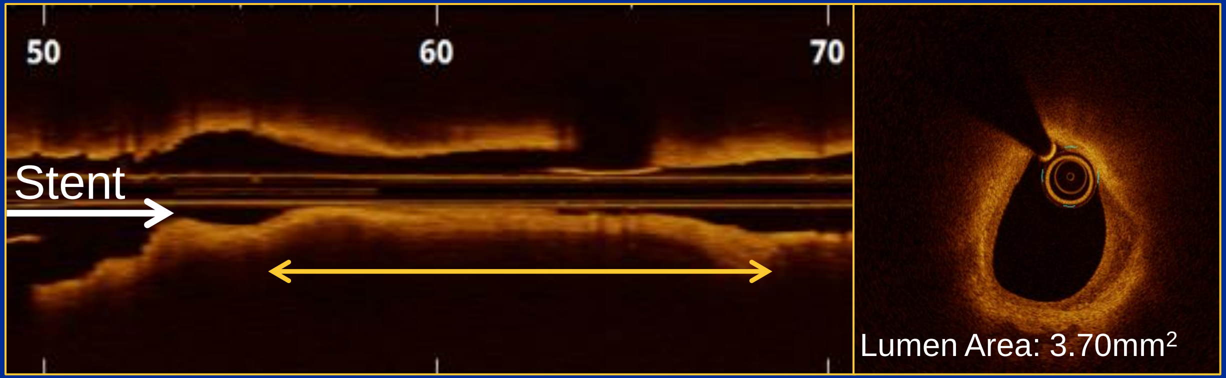
Post-procedure OCT Findings

	OCT (L=1228)	Angio (L=1329)	Difference [95% CI]
Reference Disease, any	17.3%	20.1%	-2.8% (-5.9, 0.3)
Focal	9.5%	12.1%	-2.7% (-5.1, -0.2)
Diffuse	7.8%	8.0%	-0.1% (-2.3, 2.0)

Focal



Diffuse



MLA in the reference segment <4.5mm^2

Angiographic Complications (Core Laboratory)

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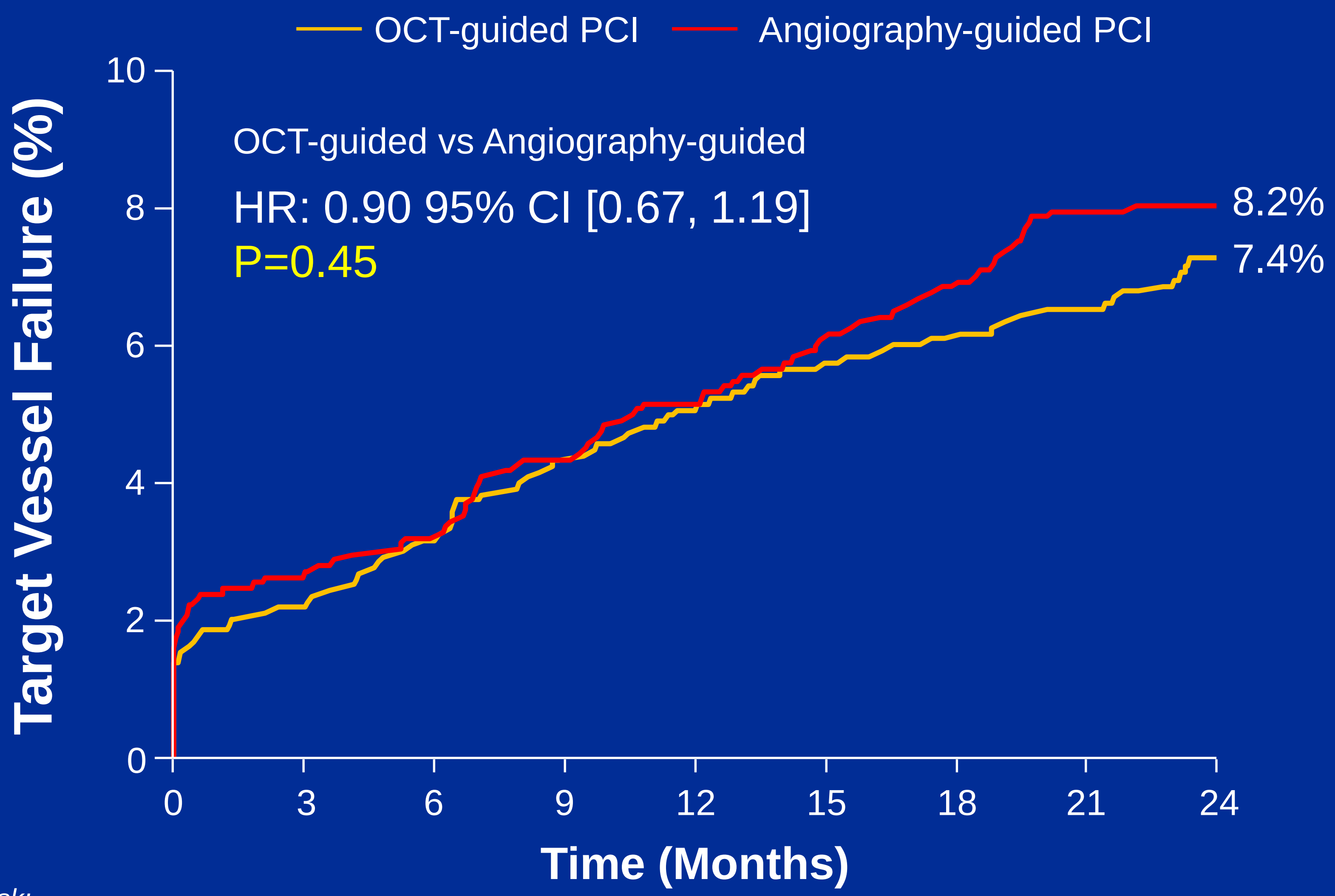
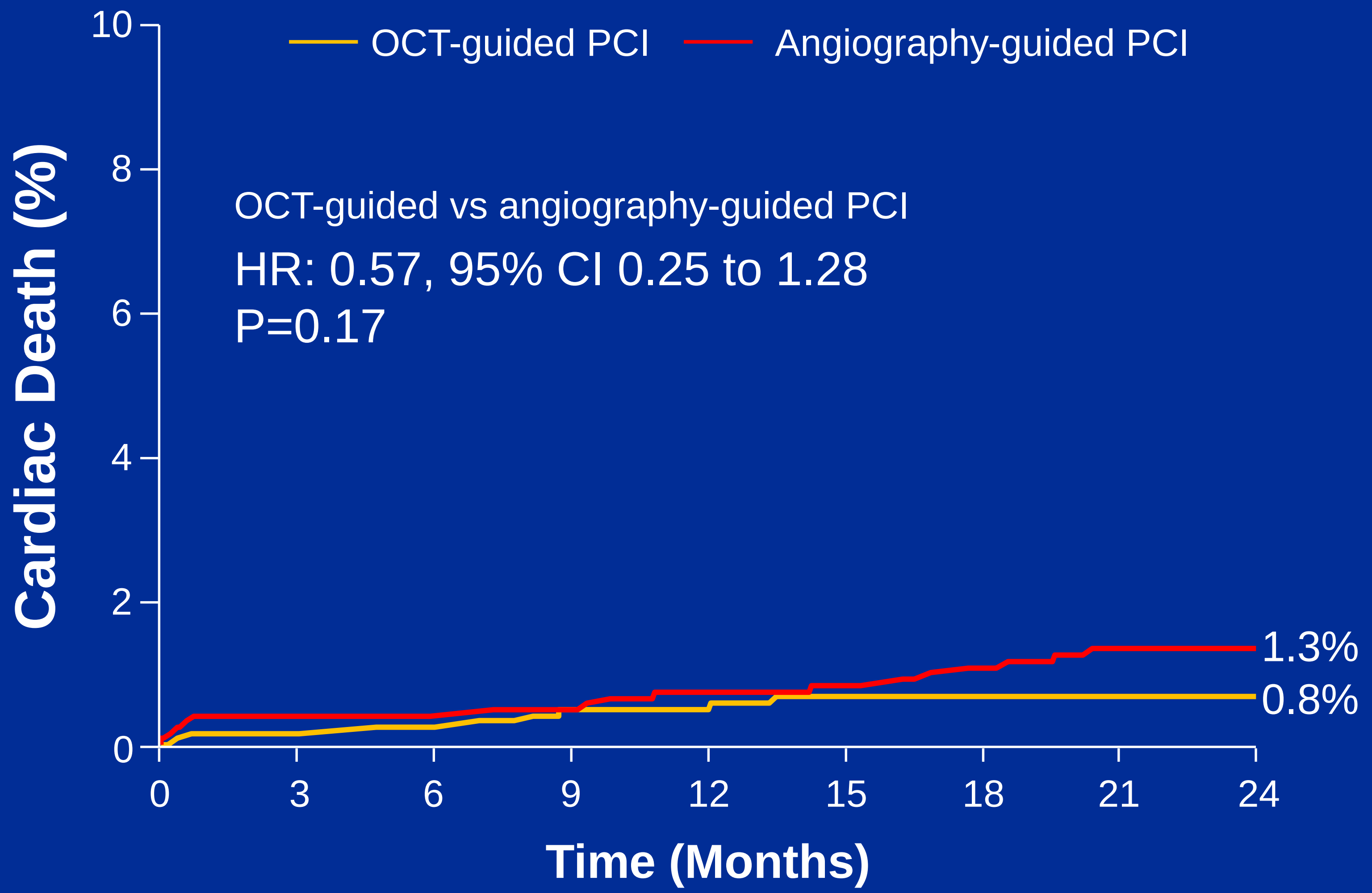
	OCT (I=1320)	Angio (I=1387)	Difference [95% CI]
Final angiographic complications	3.6%	5.3%	-1.7% (-3.3, -0.1)
Dissection ≥ type B	1.2%	1.5%	-0.3% (-1.2, 0.6)
Slow flow or no reflow	0.2%	0.5%	-0.3% (-0.8, 0.2)
Thrombus	0.3%	0.7%	-0.4% (-1.1, 0.2)
Abrupt closure	0.0%	0.0%	0.0% (-0.3, 0.3)
Perforation	0.2%	0.0%	0.2% (-0.1, 0.7)
Distal embolization	0.9%	1.3%	-0.4% (-1.2, 0.4)
Procedure-related stent thrombosis	0.0%	0.1%	-0.1% (-0.4, 0.2)
Procedure-related thrombotic events	2.3%	4.1%	-1.8% (-3.1, -0.4)
Catheter-related complications	0.1%	0.2%	-0.1% (-0.5, 0.3)

Primary Clinical Endpoint – Target Vessel Failure



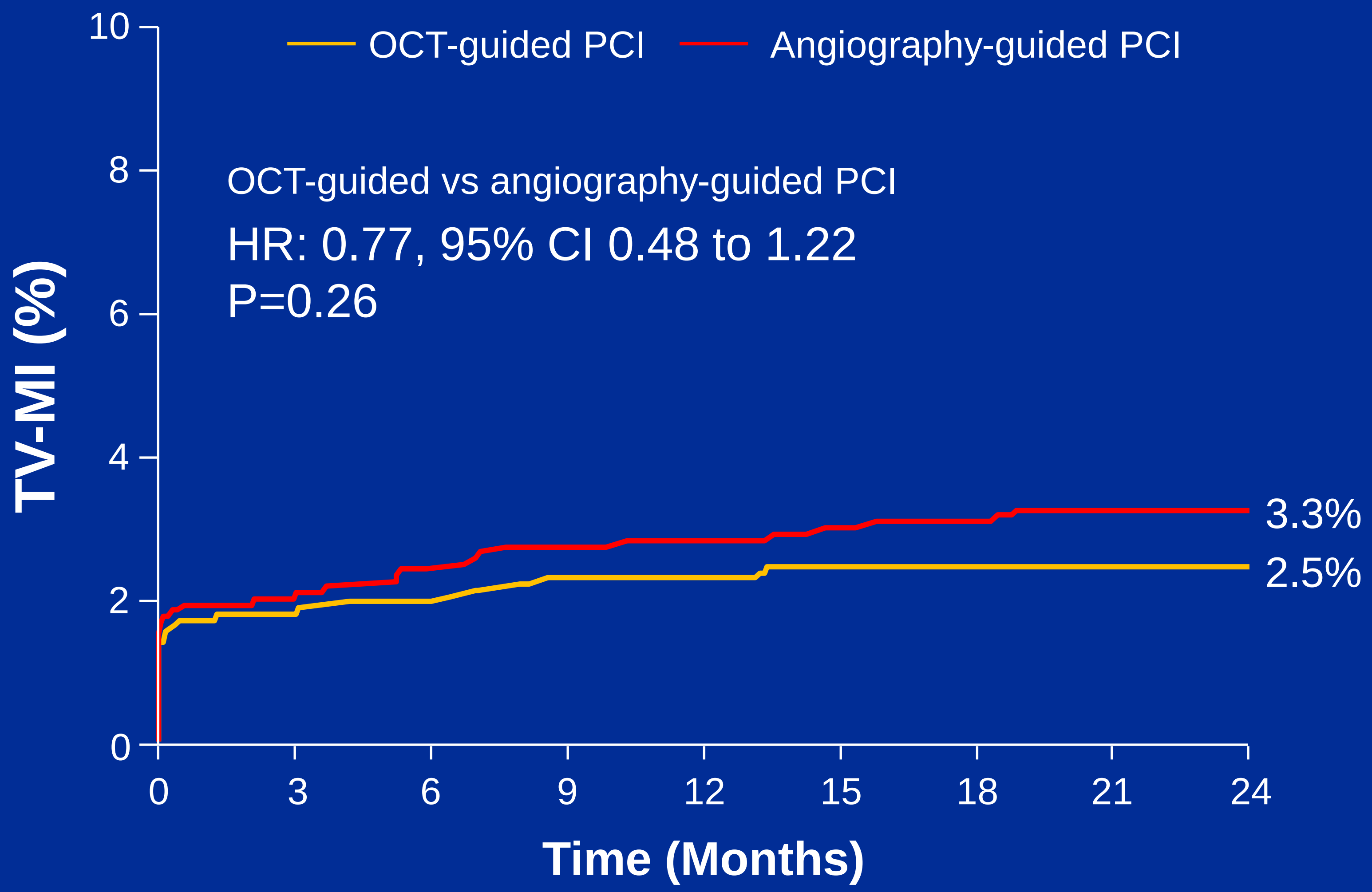
Number at risk:									
OCT-guided	1233	1187	1174	1157	1127	1096	1085	1077	560
Angiography-guided	1254	1195	1184	1168	1143	1108	1092	1070	573

Cardiac Death



Number at risk:									
OCT-guided	1233	1211	1208	1201	1180	1152	1146	1143	595
Angiography-guided	1254	1221	1217	1214	1195	1165	1156	1144	609

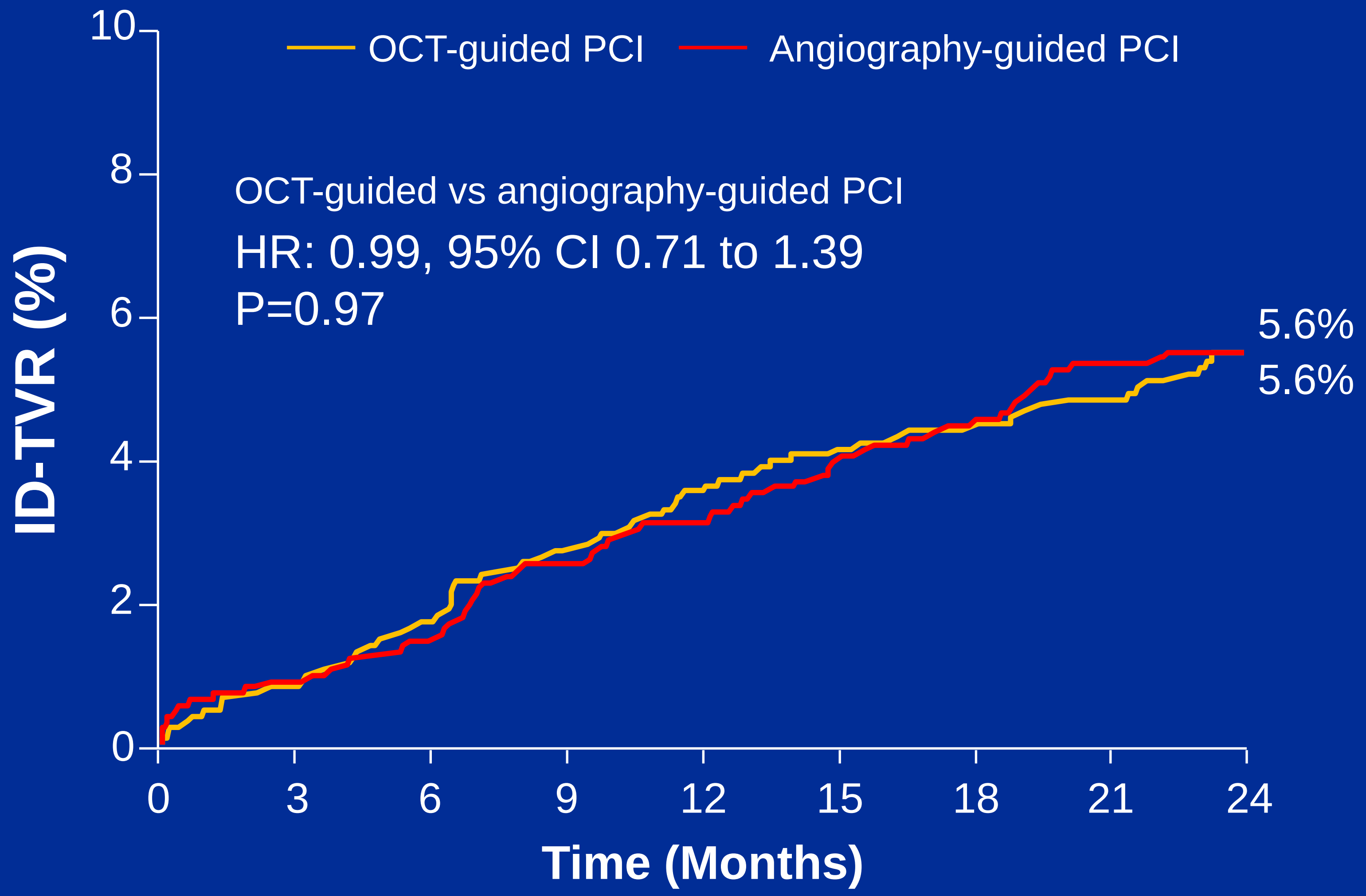
Target-Vessel MI



Number at risk:

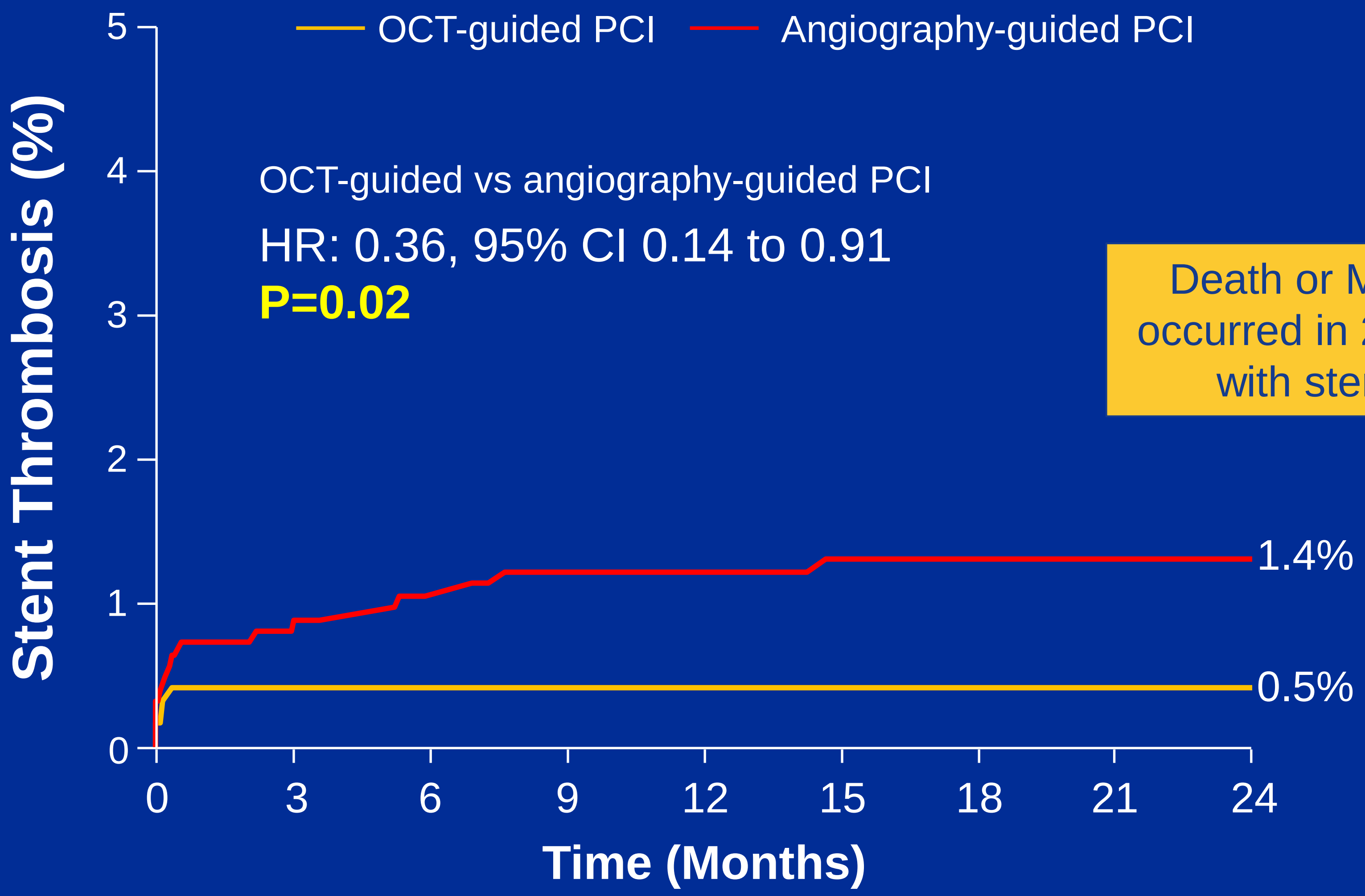
OCT-guided	1233	1191	1186	1177	1156	1127	1120	1117	581
Angiography-guided	1254	1201	1192	1186	1166	1136	1126	1112	590

Ischemia-Driven Target Vessel Revascularization



Number at risk:									
OCT-guided	1233	1202	1189	1172	1141	1110	1100	1092	569
Angiography-guided	1254	1211	1200	1184	1159	1124	1108	1087	585

Stent Thrombosis (Def/Prob)



Death or MI within 2 years occurred in 22/23 pts (95.7%) with stent thrombosis

Number at risk:

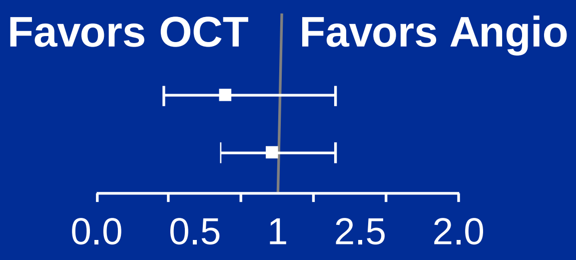
OCT-guided	1233	1207	1204	1197	1176	1149	1143	1140	593
Angiography-guided	1254	1216	1209	1204	1185	1156	1147	1135	607

2-Year Clinical Outcomes

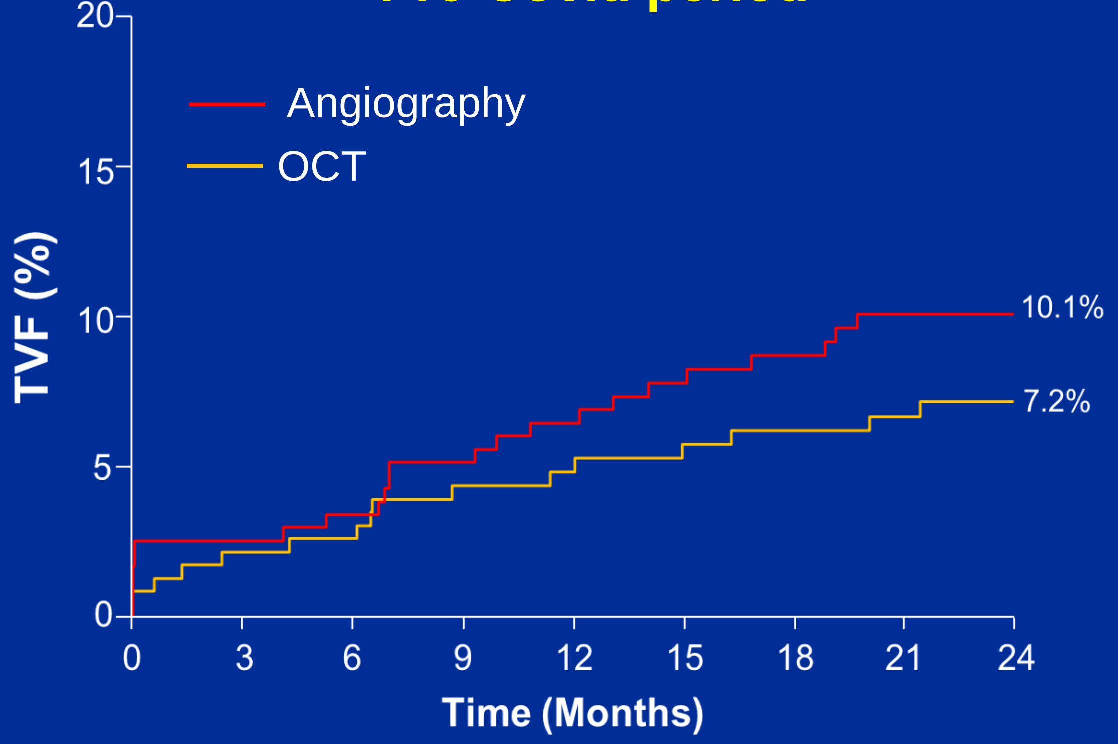
	OCT (n=1233)	Angio (n=1254)	Hazard Ratio (95% CI)
All-cause mortality	2.7%	3.6%	0.73 (0.47, 1.16)
-Cardiac	0.8%	1.3%	0.57 (0.25, 1.29)
-Vascular	0.3%	0.3%	0.76 (0.17, 3.38)
-Non-cardiovascular	1.7%	2.0%	0.84 (0.46, 1.52)
All MI	4.8%	6.0%	0.80 (0.56, 1.13)
-TV-MI	2.5%	3.3%	0.77 (0.48, 1.22)
-Periprocedural MI	1.4%	1.7%	0.82 (0.43, 1.56)
-Non-periprocedural MI	3.4%	4.4%	0.77 (0.51, 1.17)
All revascularization	9.4%	10.1%	0.94 (0.72, 1.21)
- ID-TVR	5.6%	5.6%	0.99 (0.71, 1.40)
- ID-TLR	4.5%	4.3%	1.05 (0.71, 1.54)
- ID-TVR/non-TLR	1.8%	2.4%	0.79 (0.45, 1.38)

Covid Impact

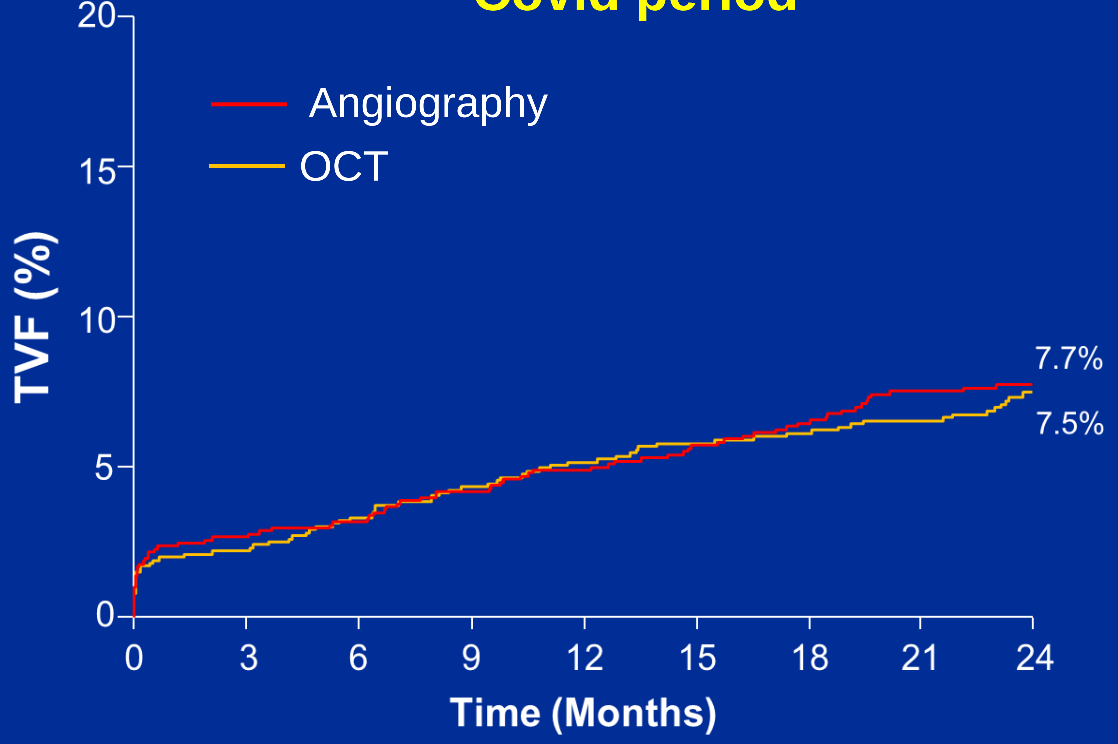
	OCT	Angiography	Hazard Ratio [95% CI]
Target Vessel Failure			
Pre-Covid (n=476)	7.2%	10.1%	0.70 [0.37, 1.32]
Covid (n=2020)	7.5%	7.7%	0.96 [0.69, 1.32]



Pre-Covid period



Covid period



Conclusions 1

- OCT-guidance resulted in a larger MSA than angiography guidance, with greater stent expansion

- OCT-guidance led to fewer major dissections, major malapposition, major tissue protrusion and untreated focal reference segment disease

- OCT-guidance reduced angiographic complications

Conclusions 2

- The 2-year rates of TVF were not statistically different between OCT-guided and angiography-guided PCI
- OCT-guided PCI significantly reduced stent thrombosis
- There were trends for fewer cardiac deaths and MI with OCT-guidance, consistent with prior intravascular-imaging studies
- Rates of TVR were lower than expected, a finding possibly impacted by the COVID pandemic

Simultaneous Publication

NEJM

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Optical Coherence Tomography–Guided versus Angiography-Guided PCI

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