

# ULTIMATE

**A Multicenter, Prospective, Randomized Trial  
Comparing Intravascular Ultrasound-guided  
versus Angiography-guided Implantation of  
Drug-Eluting Stent in All-comers**

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# Disclosure Statement of Financial Interest

I, (**Jun-Jie Zhang**) DO NOT have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.

# Background

- Both randomized and observational studies have reported the clinical advantages of IVUS-guided PCI in patients who have complex lesions.
- The benefits of IVUS guidance over angiography guidance in all-comers who receive 2<sup>nd</sup> generation DES implantation still remain understudied.

# Study Design

1448 all-comer patients

1:1 Randomization

IVUS guidance  
(n=724)

Angiography guidance  
(n=724)

Primary endpoint: TVF at 12 months

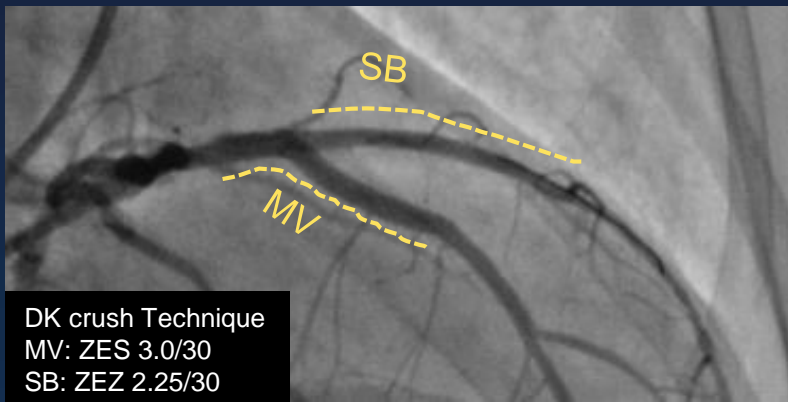
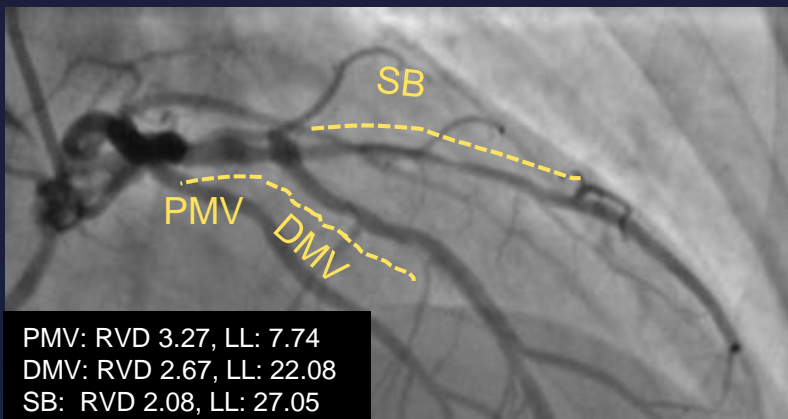
# Major Inclusion Criteria

- **Silent ischemia, Stable angina or unstable angina**
- **Acute myocardial infarction >24 h**
- ***De novo* lesion**

# Major Exclusion Criteria

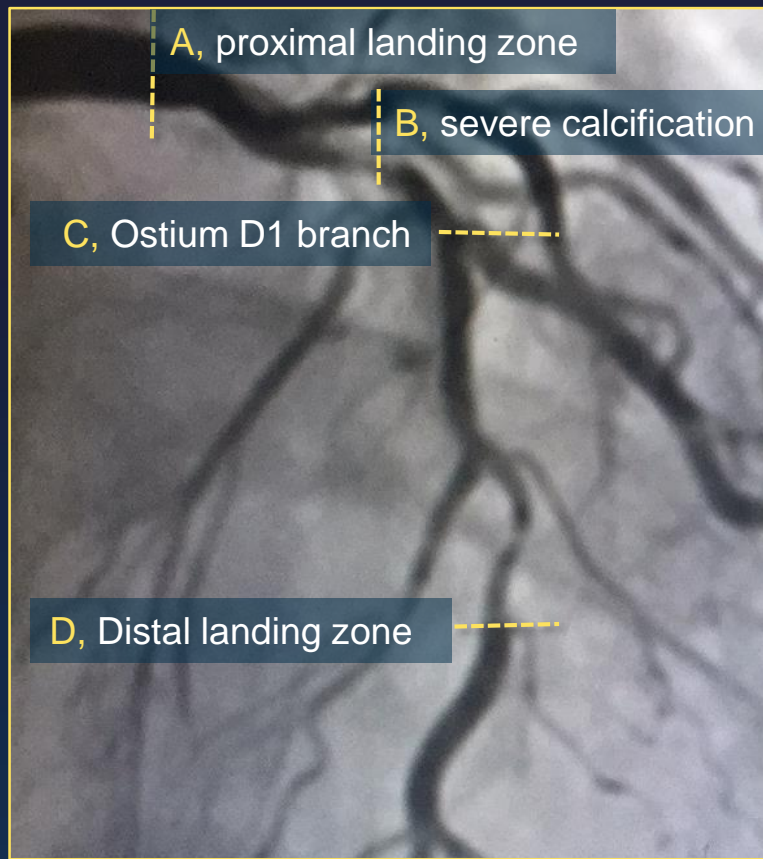
- Life expectancy <12 months
- Intolerant of DAPT
- CTO not re-canalized
- Severe calcification needing rotational atherectomy

# Angiography-guided PCI



- Stent size by visual estimation
- Routine post-dilation
- Angiographic success
  - ✓ TIMI 3 flow
  - ✓ Residual stenosis <20%
  - ✓ Dissection <Type B

# IVUS-guided PCI



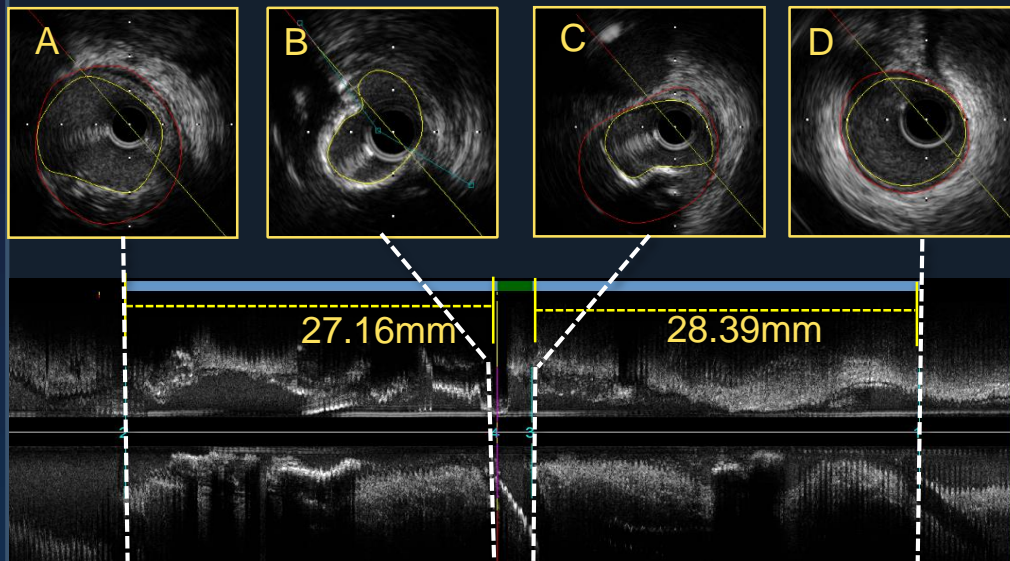
## Pre-stenting IVUS assessment

LD: 3.3 mm  
VD: 4.4 mm  
PB: 40.9%

LD: 2.1 mm  
VD: 3.9 mm  
MLA: 3.85 mm<sup>2</sup>

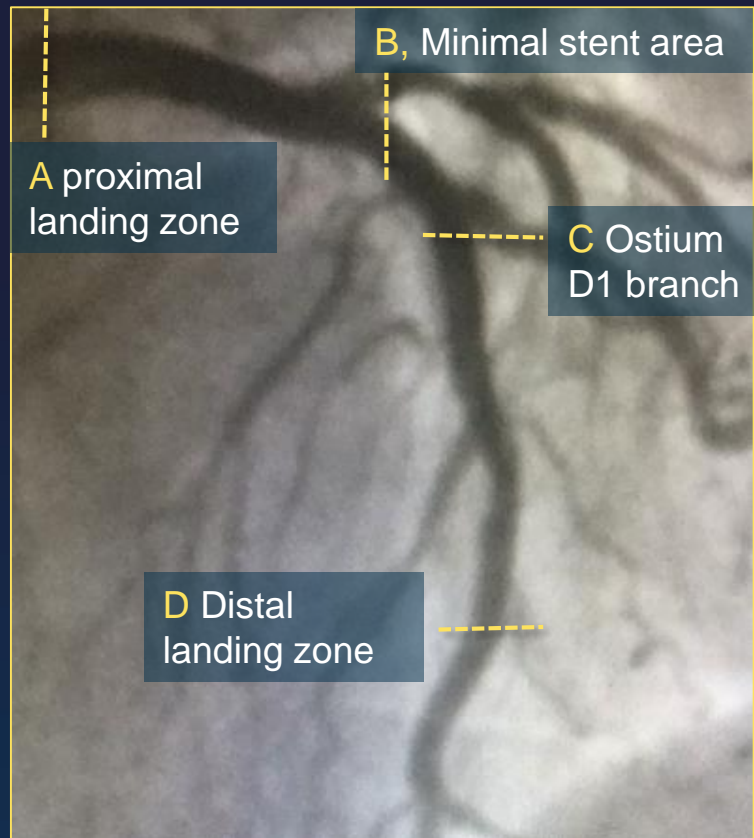
LD: 2.5 mm  
VD: 3.9 mm  
PB: 55.9%

LD: 2.8 mm  
VD: 3.1 mm  
PB: 19.6%





# IVUS-guided PCI



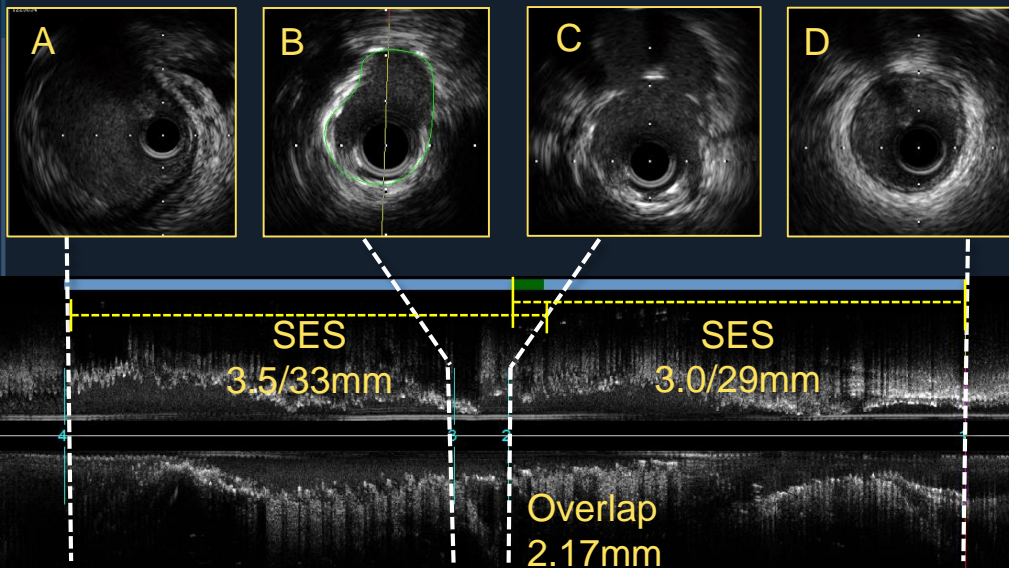
## Post-stenting IVUS Assessment

LA: 10.95 mm<sup>2</sup>  
 VA: 15.14 mm<sup>2</sup>  
**PB: 27.7%**

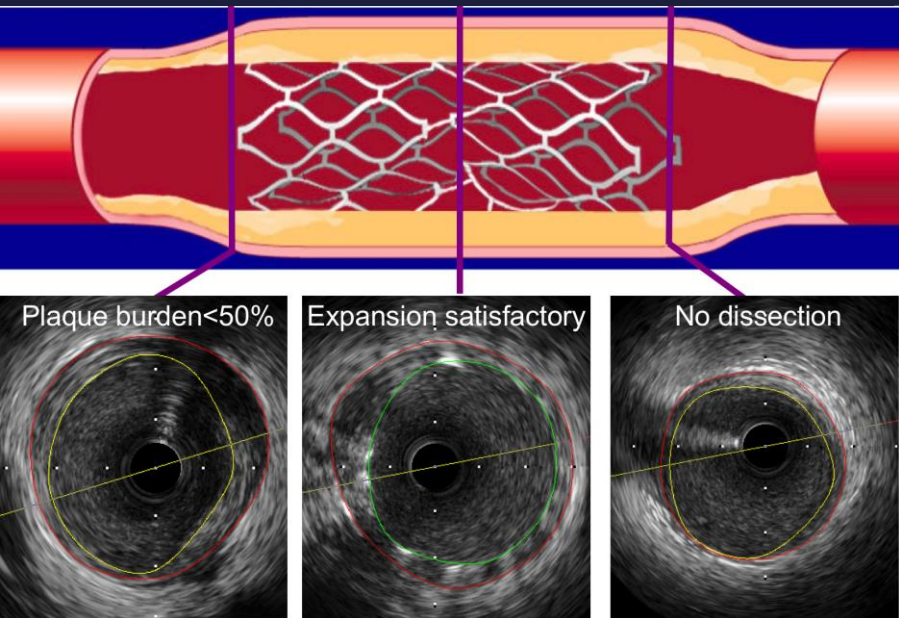
**MSA: 5.23 mm<sup>2</sup>**

LA: 5.44 mm<sup>2</sup>  
 VA: 12.33 mm<sup>2</sup>  
 PB: 55.9%

LA: 6.05 mm<sup>2</sup>  
 VA: 7.53 mm<sup>2</sup>  
**PB: 19.6%**



# IVUS-defined Criteria for The Optimal Stent Deployment



1. Minimal lumen CSA in stented segment **>5.0 mm<sup>2</sup>**, or 90% of distal reference lumen CSA;
2. Plaque burden at the 5-mm proximal or distal to the stent edge **<50%**;
3. no edge dissection involving media with length **>3mm**.

# Sample Size Calculation

*IVUS guidance*

*Angiography guidance*

2.8-3.1%

**1-year TVF**

*Prior studies*

6.0-6.5%

Conservative  
assumption

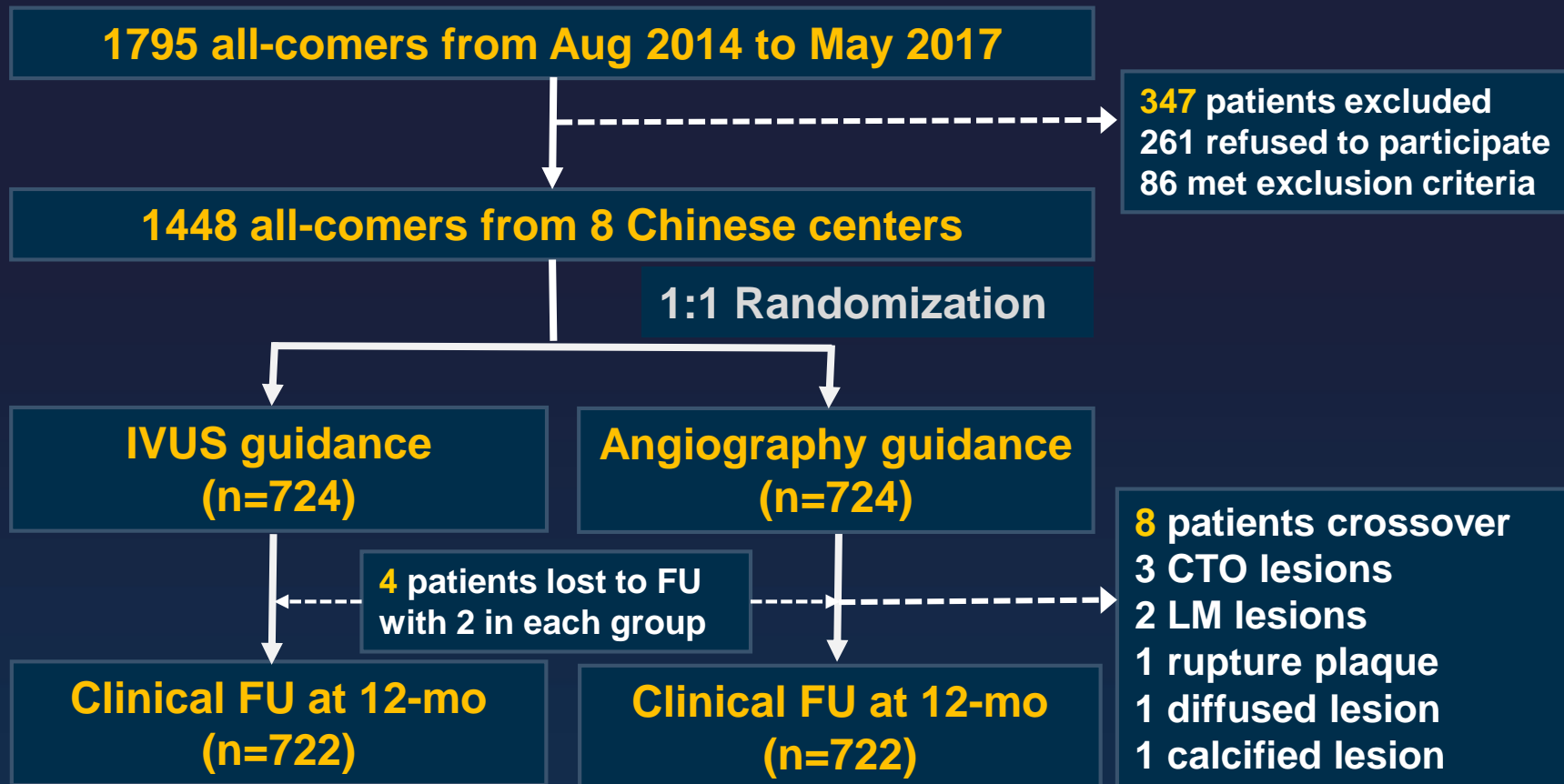
**2.9%**

**6.1%**

*80% power with a 2-sided alpha of 0.05*

*N=658 pts/group, 10% lost = total **1448 pts***

# Enrollment



# Baseline Clinical Data

	<b>IVUS guidance (n=724)</b>	<b>Angiography guidance (n=724)</b>	<b><i>P</i></b>
Age	65.2 ± 10.9	65.9 ± 9.8	0.19
Male	73.9%	73.2%	0.77
Hypertension	70.7%	72.0%	0.60
Diabetes	30.0%	31.2%	0.61
Current smoker	34.9%	31.5%	0.16
UAP	67.4%	64.4%	0.22
AMI	11.2%	14.0%	0.11
LVEF, %	60.9 ± 7.9	60.3 ± 9.3	0.19

# Core Lab Lesions Data (I)

	<b>IVUS guidance (n=962)</b>	<b>Angiography guidance (n=1016)</b>	<b><i>P</i></b>
Lesion location			0.51
LM	9.9%	8.6%	
LAD	47.5%	46.7%	
LCX	17.3%	16.8%	
RCA	25.4%	28.0%	

# Core Lab Lesions Data (II)

	<b>IVUS guidance (n=962)</b>	<b>Angiography guidance (n=1016)</b>	<b><i>P</i></b>
Multi-vessel disease	52.6%	57.2%	0.08
B2/C	66.1%	67.7%	0.45
Bifurcation	23.5%	26.5%	0.13
CTO	8.8%	9.0%	0.93
Moderate to severe calcification	25.3%	24.2%	0.59

# Procedural Data (I)

	IVUS guidance (n=724)	Angiography guidance (n=724)	<i>P</i>
<b>Per patient, n (%)</b>			
Stent number	2.40±1.55	2.47±1.56	0.39
Mean stent length, mm	66.42±46.17	66.49±44.36	0.98
Mean stent diameter, mm	3.15±0.42	2.99±0.38	<0.001
Max balloon diameter, mm	3.84±0.52	3.62±0.51	<0.001
Max Post-dilation pressure, atm	19.8±3.7	19.2±3.6	0.003



# Procedural Data (II)

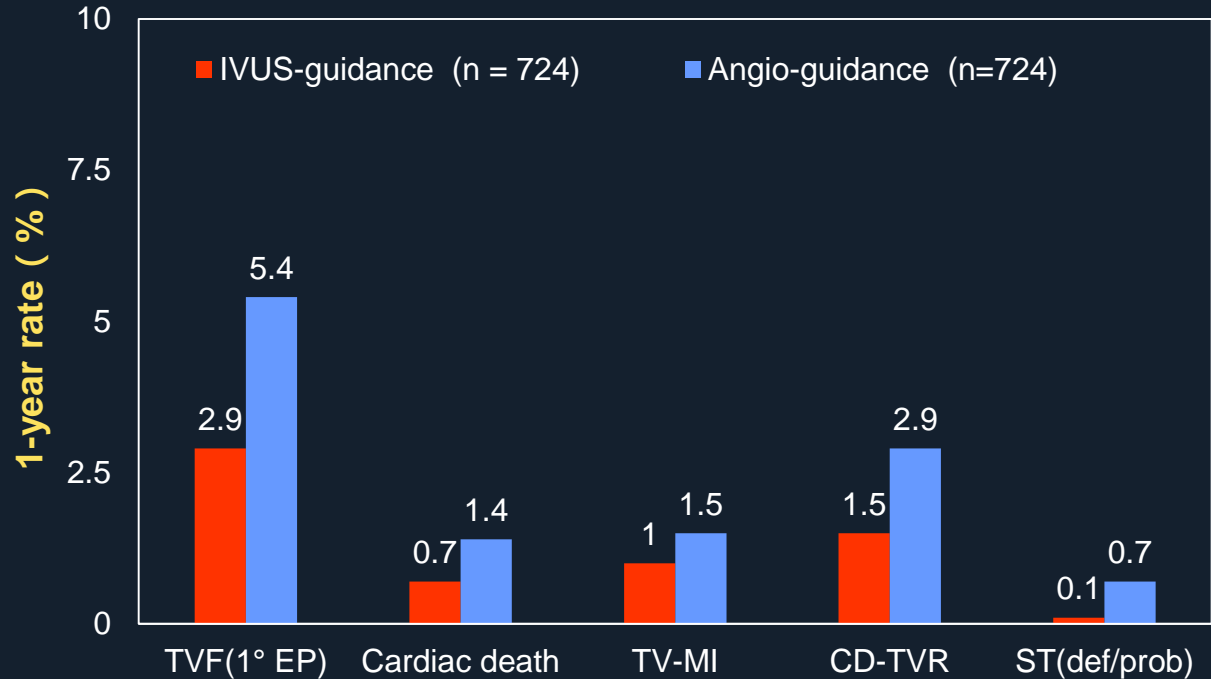
	<b>IVUS guidance (n=962)</b>	<b>Angiography guidance (n=1016)</b>	<b><i>P</i></b>
<b>Per lesion, n (%)</b>			
Stent number	1.81±0.80	1.76±0.77	0.16
Mean stent length, mm	49.99±25.10	47.38±22.42	0.02
Mean stent diameter, mm	3.14±0.51	2.97±0.48	<0.001
Max balloon diameter, mm	3.73±0.56	3.51±0.53	<0.001
Max post-dilation pressure, atm	19.7±3.7	19.0±3.7	<0.001

# Procedural Data (III)

	<b>IVUS guidance (n=724)</b>	<b>Angiography guidance (n=724)</b>	<b>P</b>
Radial access	94.8	96.8	0.07
2 <sup>nd</sup> generation DES	99.2%	98.8%	0.44
Post-dilation	96.6%	94.9%	0.11
Procedural time, min	60.88	45.49	<0.001
Contrast volume, ml	178.29	161.96	<0.001
CIN*	7.9%	5.8%	0.12
Complete revas.	73.3%	75.0%	0.47
Angiographic success	98.0%	97.8%	0.77

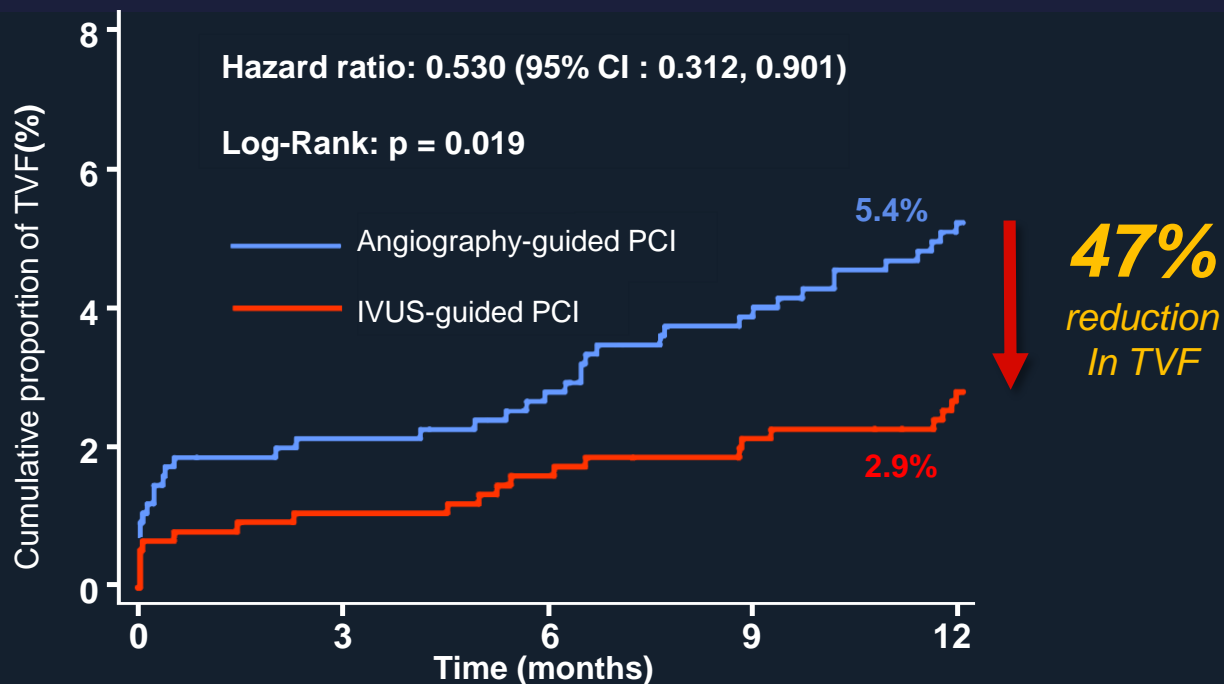
\*, contrast induced nephropathy

# Clinical Outcome



# Primary Endpoint

## TVF at 12 months

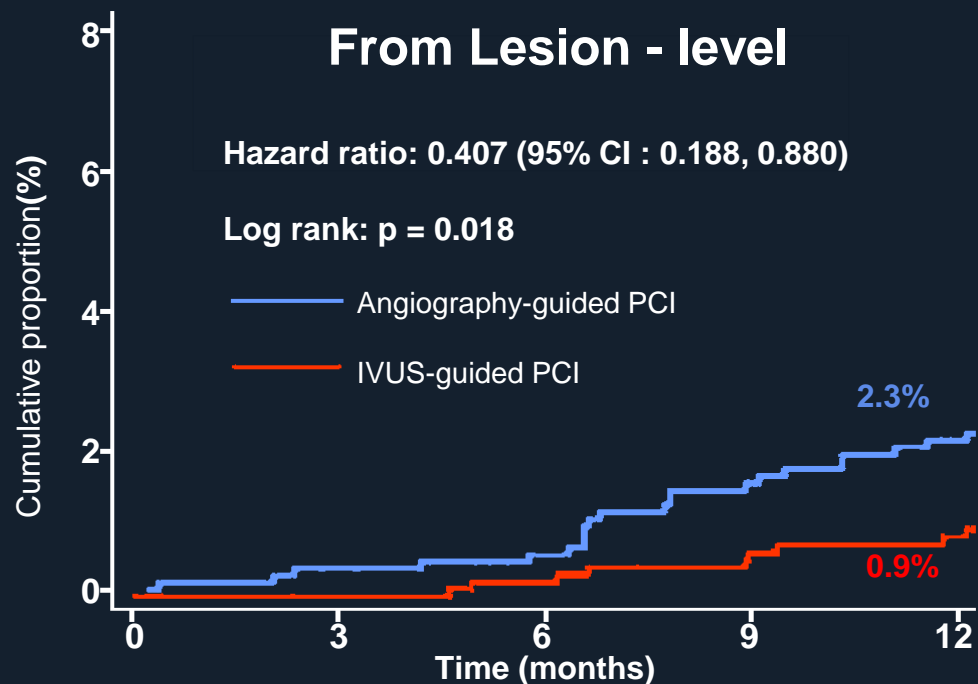


Number at risk

Angiography	724	706	698	685	676
IVUS	724	715	710	704	696

# Secondary Endpoint

## CD-TLR or Definite ST at 12 months

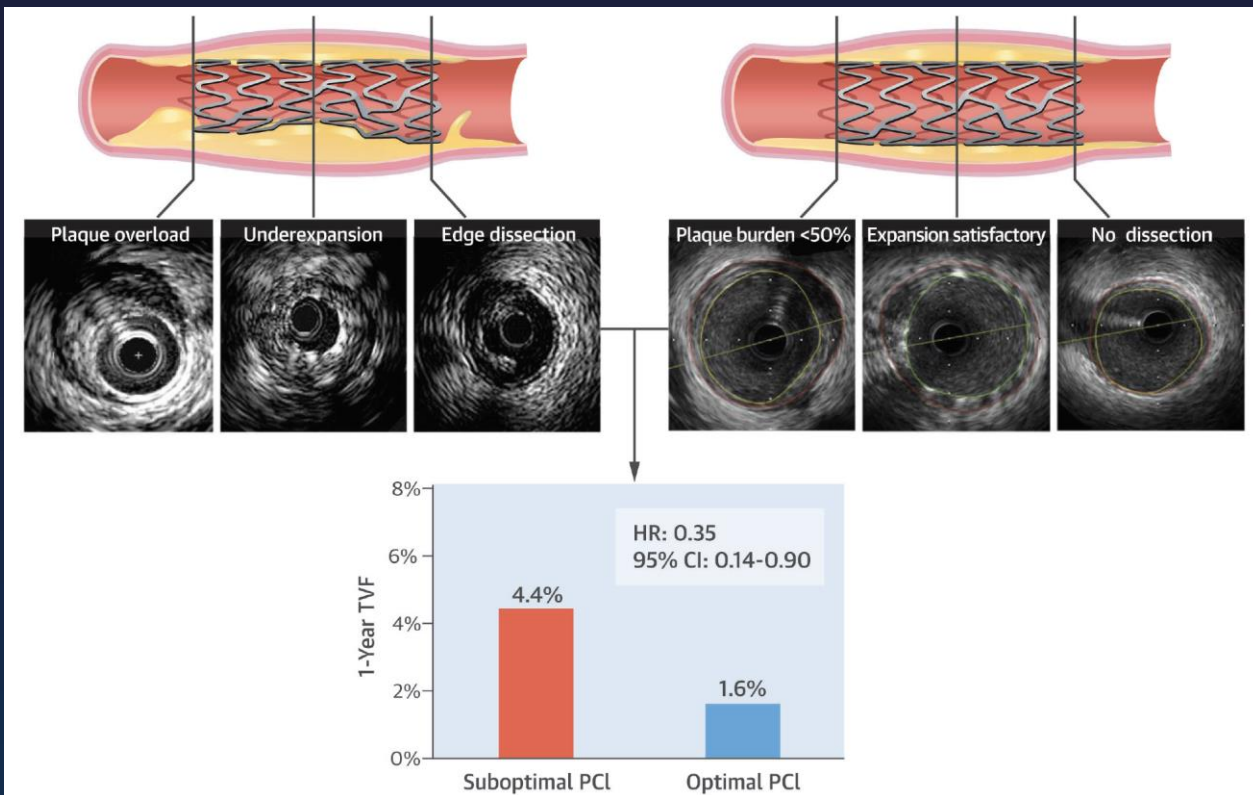
**Number at risk**

Angiography	1016	1003	995	979	969
IVUS	963	957	953	946	938

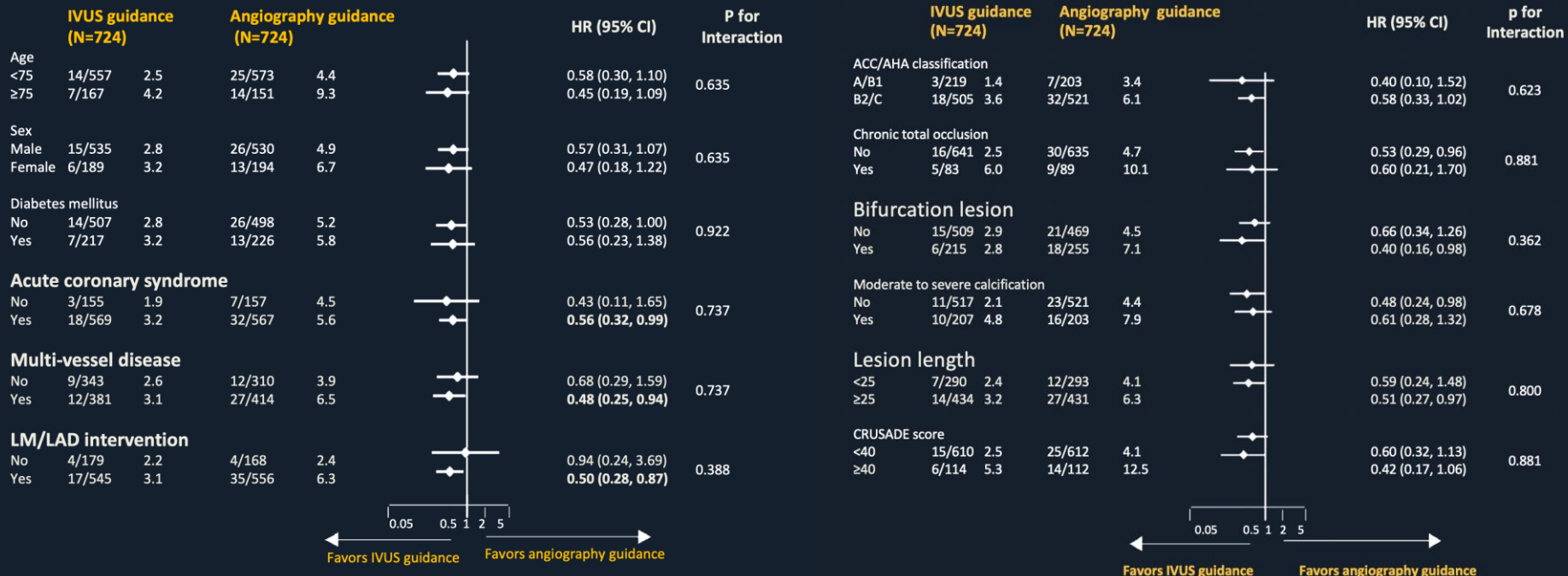
# On-site Post-procedure IVUS Assessment

	Optimal group	Suboptimal group	<i>P</i>
Number of patients, n (%)	384 (53.0)	340 (47.0)	
Number of lesions, n (%)	578 (60.1)	384 (39.9)	
MSA, mm <sup>2</sup>	6.09	5.45	<0.001
Prox. edge plaque burden	37.2%	51.2%	<0.001
Dist. edge plaque burden	24.2%	35.1%	<0.001

# Suboptimal vs. optimal IVUS-guided PCI

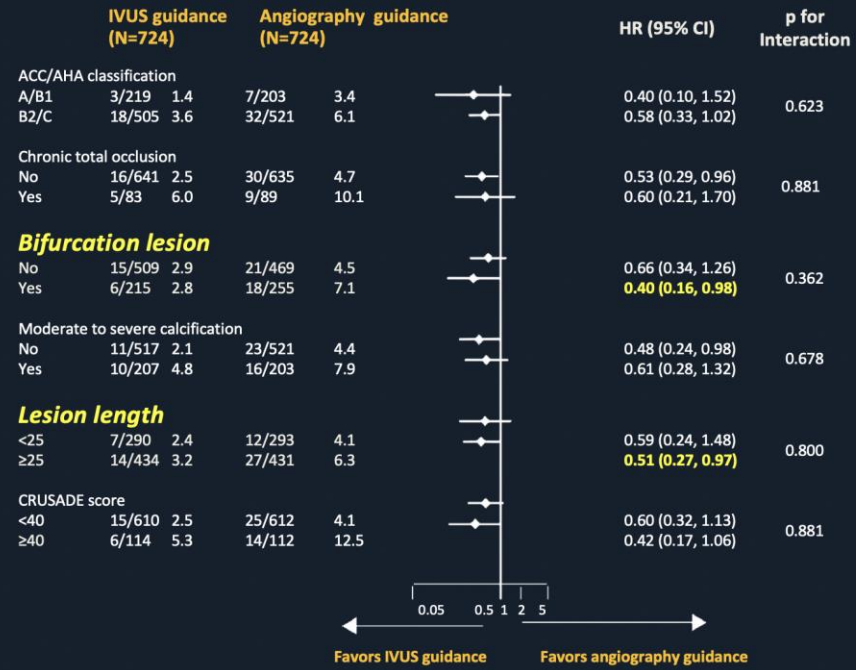
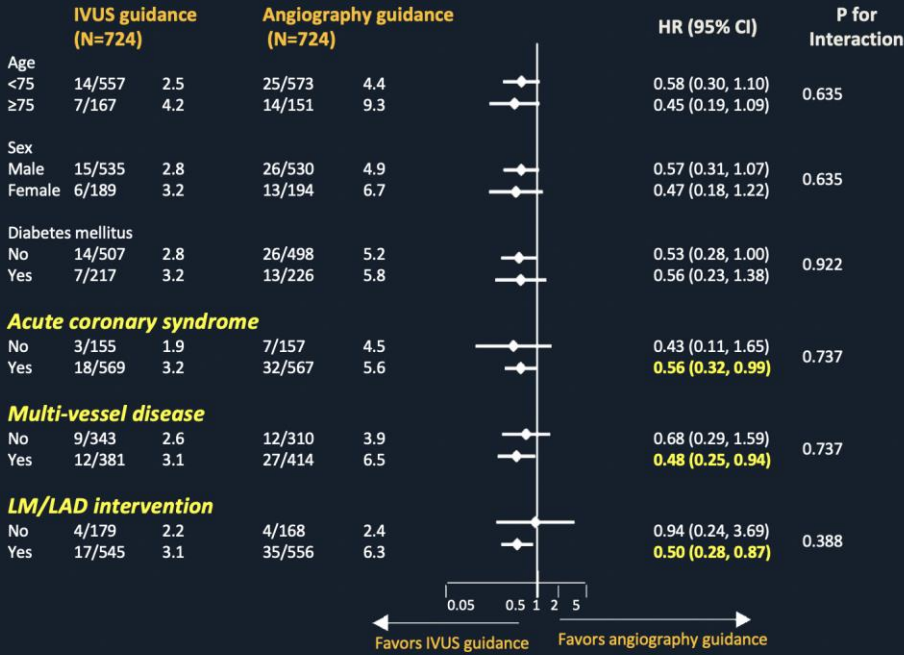


# Pre-specified Subgroup Analysis





# Pre-specified Subgroup Analysis





# Intravascular ultrasound guidance reduces cardiac death and coronary revascularization in patients undergoing drug-eluting stent implantation: results from a meta-analysis of 9 randomized trials and 4724 patients

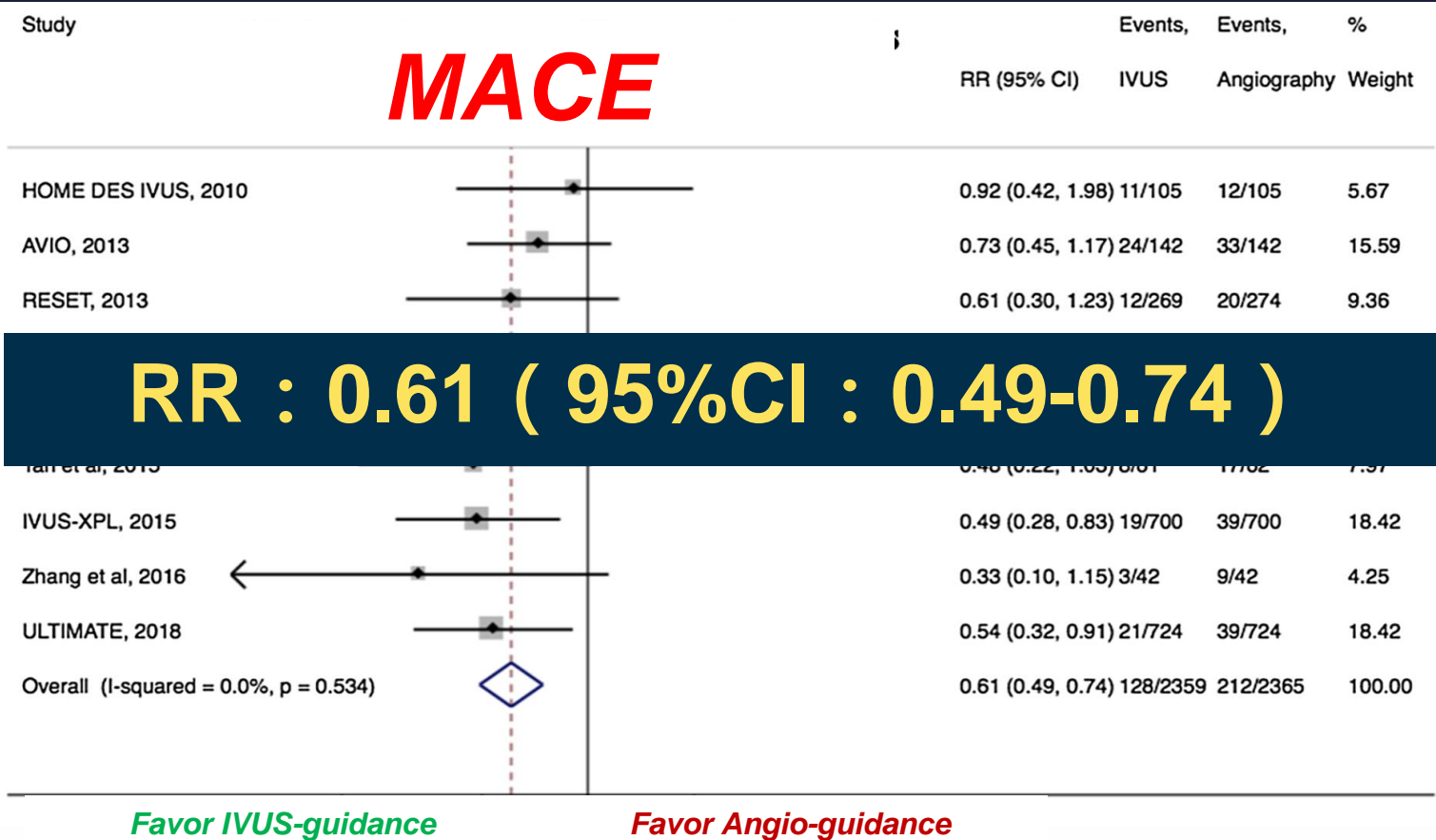
Xiao-Fei Gao<sup>1,2</sup> · Zhi-Mei Wang<sup>1</sup> · Feng Wang<sup>1</sup> · Yue Gu<sup>1</sup> · Zhen Ge<sup>1</sup> · Xiang-Quan Kong<sup>1</sup> · Guang-Feng Zuo<sup>1</sup> · Jun-Jie Zhang<sup>1,2</sup> · Shao-Liang Chen<sup>1,2</sup>

**9 randomized studies with 4724 patients  
IVUS- vs. Angio-guided DES implantation**

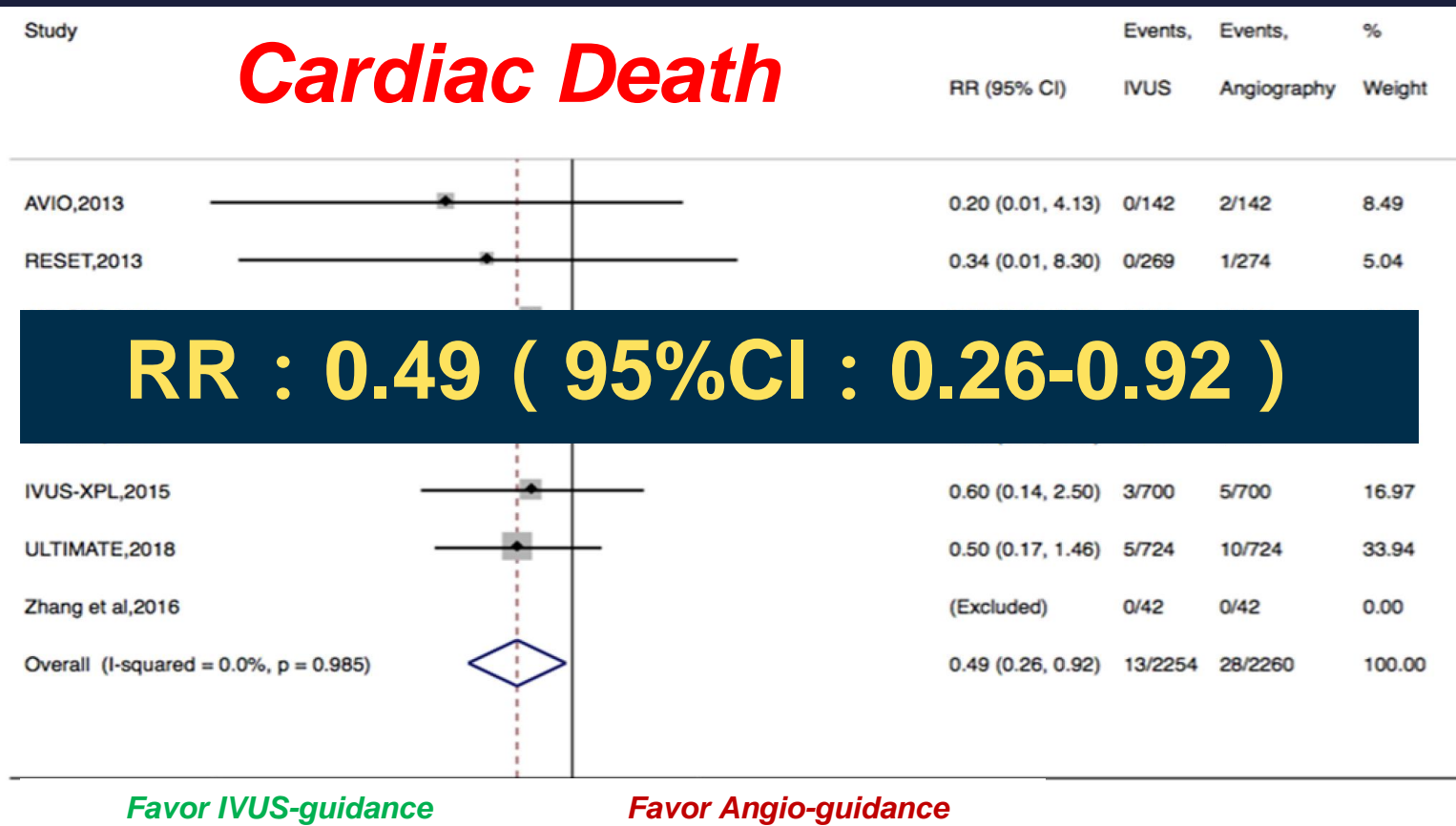
# Study Design of 9 RCT

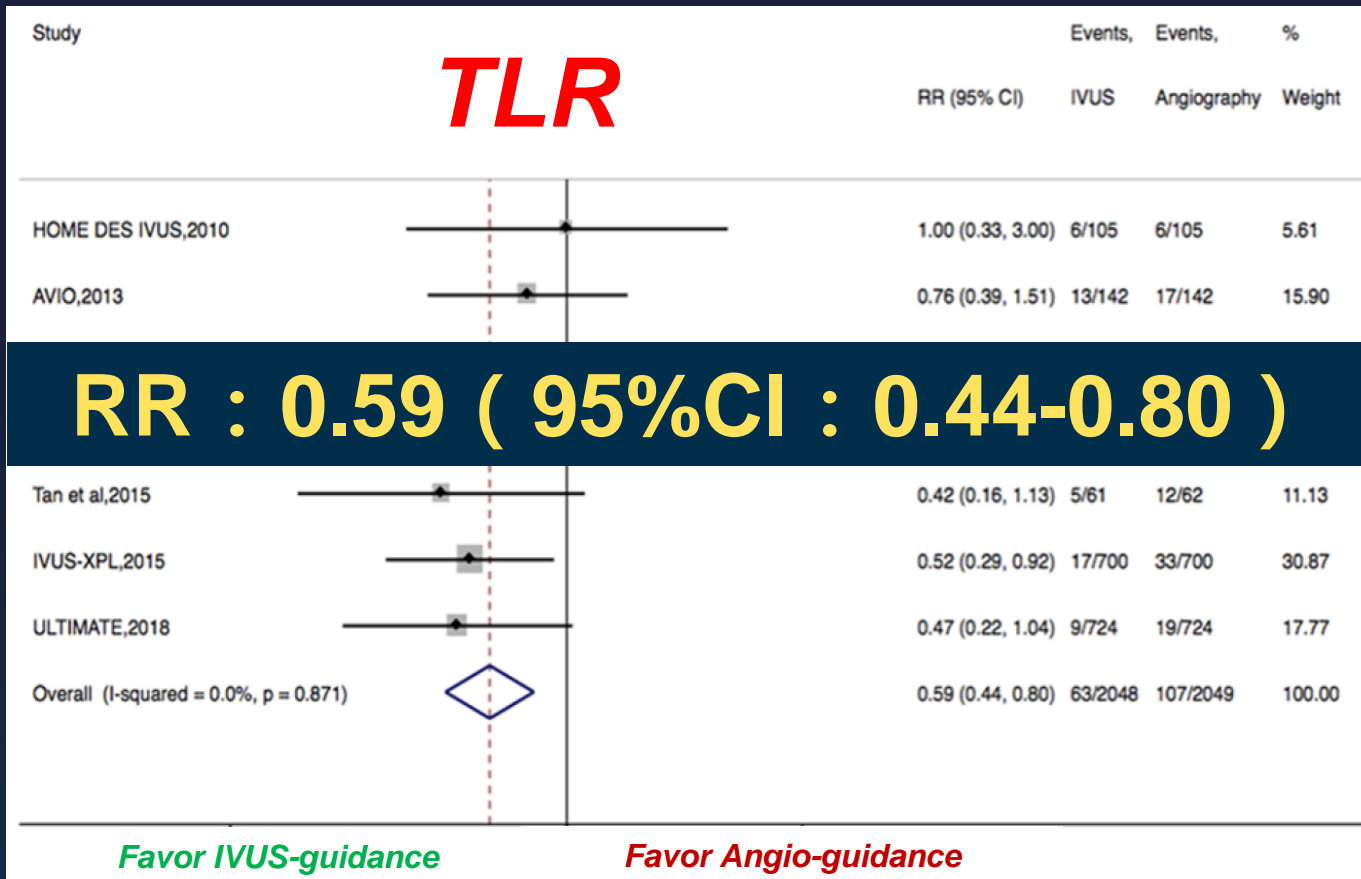
	Year	Sample size (n)	Center	Key inclusion criteria	DES type	FU (mo)	Primary endpoint	MACE
HOME DES IVUS	2010	105/105	Single center	AHA defined lesion type B2/C, proximal LAD, LM, RVD < 2.5 mm, lesion length > 20 mm, ISR, insulin dependent DM and ACS	First generation	18	MACE	Death, MI, TLR
AVIO	2013	142/142	Multicenter	Long lesions (> 28 mm), CTO, bifurcation lesions, small vessels ( $\leq 2.5$ mm), patients requiring 4 or more stents	First generation	24	Post-PCI MLD	Cardiac death, MI, or TVR
RESET	2013	269/274	Multicenter	De novo lesion requiring a stent length $\geq 28$ mm (RVD $\geq 2.5$ mm)	Second generation	12	MACE	Cardiac death, MI, TVR or ST
AIR-CTO	2015	115/115	Multicenter	CTO	First/second generation	24	In-stent late lumen loss	Death, MI, TLR, ST
CTO-IVUS	2015	201/201	Multicenter	CTO	Second generation	12	Cardiac death	Cardiac death, MI, or TVR
Tan et al.	2015	61/62	Single center	Unprotected LM	First generation	24	MACE	Cardiac death, MI, or TLR
IVUS-XPL	2015	700/700	Multicenter	Long lesions requiring stent length $\geq 28$ mm (RVD 2.5–4 mm)	Second generation	12	MACE	Cardiac death, target lesion MI, or TLR
Zhang et al.	2016	42/42	Single center	De novo lesion in a small vessel (diameter 2.25–2.75 mm)	NR	12	Post-PCI MLD	Cardiac death, MI, or TVR
ULTIMATE	2018	724/724	Multicenter	All comers	Second generation	12	TVF (cardiac death, TVMI or TVR)	Cardiac death, TVMI or TVR

# MACE

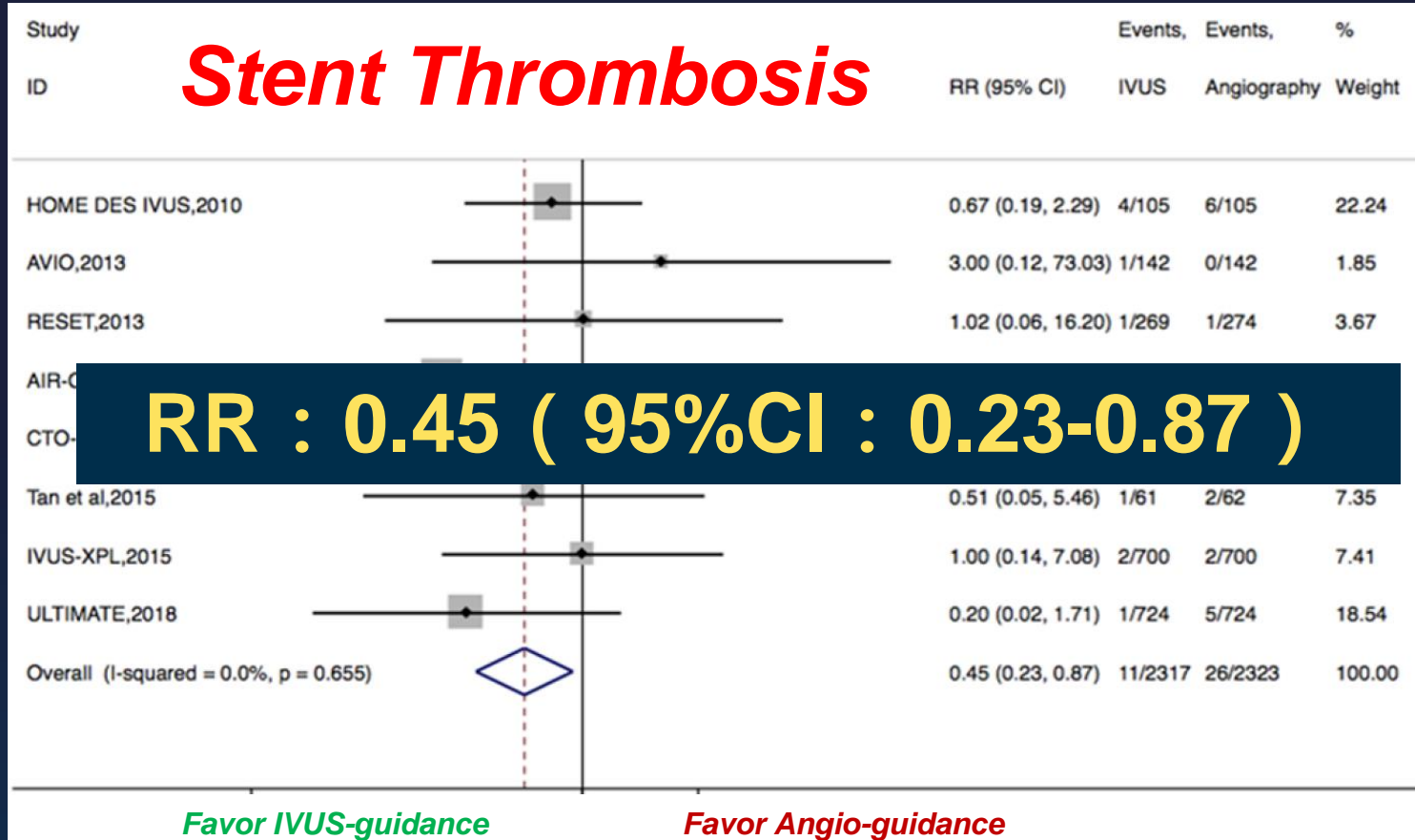


# Cardiac Death





# Stent Thrombosis



# Conclusion

- The randomized ULTIMATE trial demonstrated that IVUS-guided DES implantation in all-comers resulted in lower incidence of TVF at 12 months, compared with angiography guidance, particularly for patients who had an IVUS-defined optimal procedure.
- The present meta-analysis, including 9 RCTs and 4724 patients, demonstrated that IVUS-guided DES implantation were associated with a significant lower risk of MACE, cardiac death, TVR, TLR, and ST.



*Thanks for Your  
Attention*