

Meta-analysis: Single-stent vs. Two-stent

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1 vs 2 stents metaanalysis

	Year	Studies/Patients N=	Randomized studies	Non- randomized	Clinical endpoints	Angio endpoints
Biondi-Zoccai	2008	5/1141	4	1	X	X
Brar	2009	6/1641	6	0	X	
Kastritsis	2009	6/1642	6	0	X	
Zhang	2009	5/1550	5	0	X	X
Hakeem	2009	6/1641	6	0	X	X
Athappan	2010	5/1145	3	2	X	X
Niccoli	2010	6/962	3	3	X	X
Zamani	2011	42/6825	6	36	X	
Behan	2011	2/913	2	0	X	
Zimarino	2013	12/7041	5	7	X	

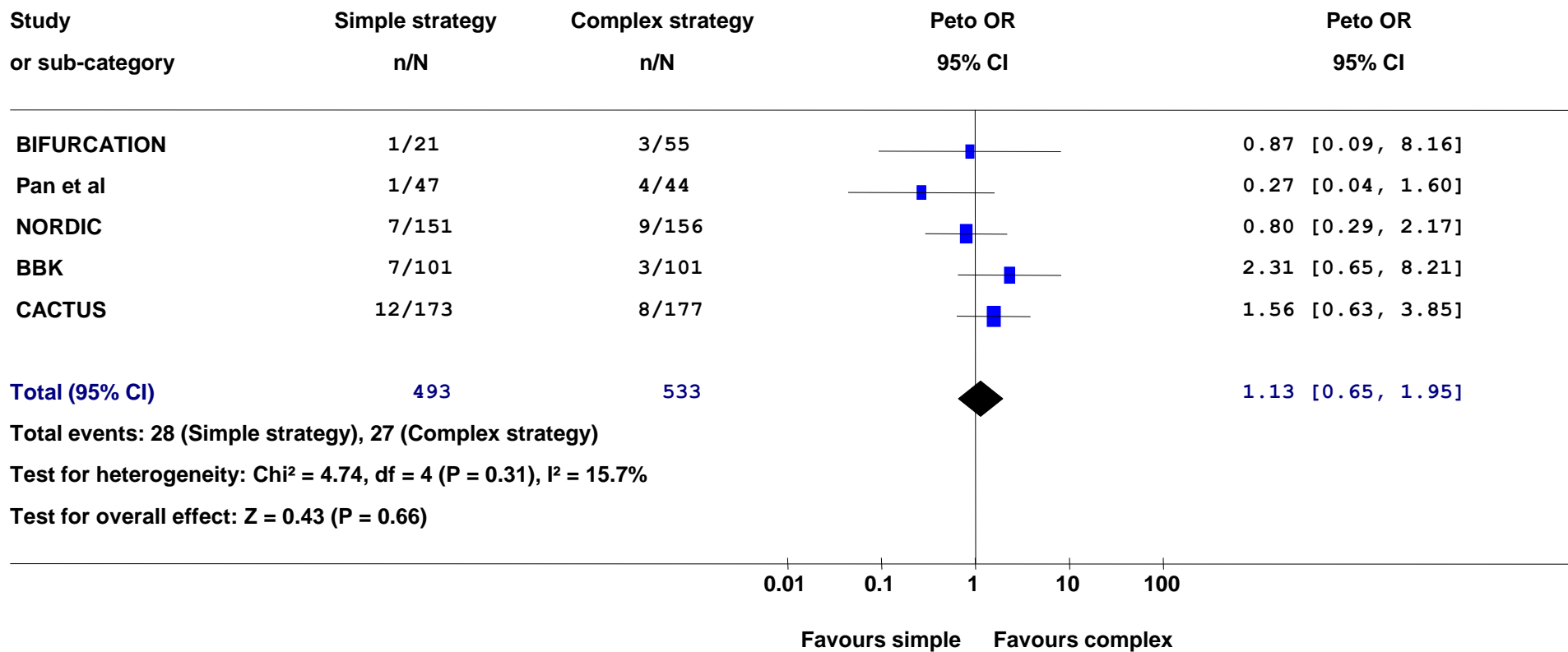
Superiority of A Simple Stenting Strategy For Coronary Bifurcation Lesions In The DES Era (Meta-Analysis Of 1141 Patients)

Included studies

<i>Study</i>	<i>Year</i>	<i>Pts on simple strategy</i>	<i>Pts on complex strategy</i>	<i>Specific strategy</i>
BBK	2007	101	101	T
Bifurcation Sirius	2004	22	63	Crushing
CACTUS	2008	173	177	Crushing
NORDIC	2004	207	206	T
Pan et al	2004	47	44	T

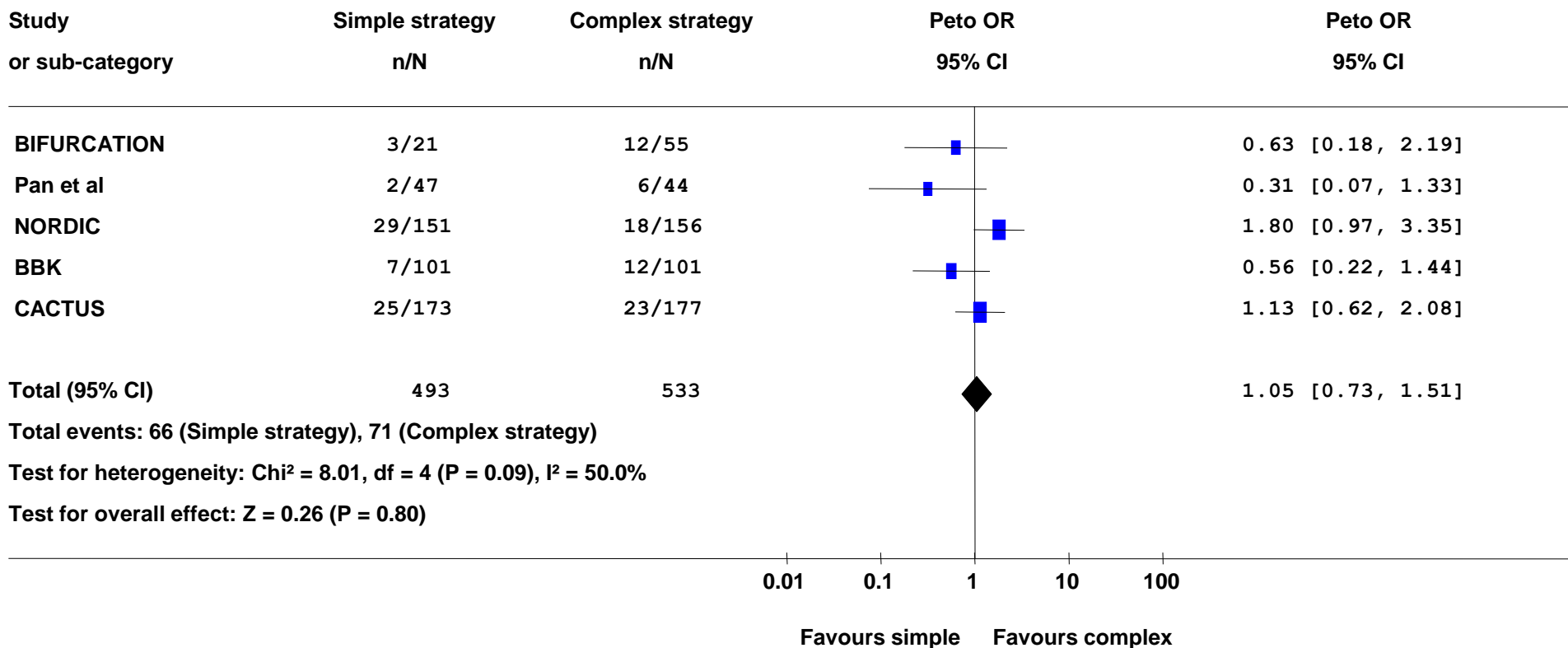
Superiority of A Simple Stenting Strategy For Coronary Bifurcation Lesions In The DES Era (Meta-Analysis Of 1141 Patients)

Risk of binary restenosis – main branch



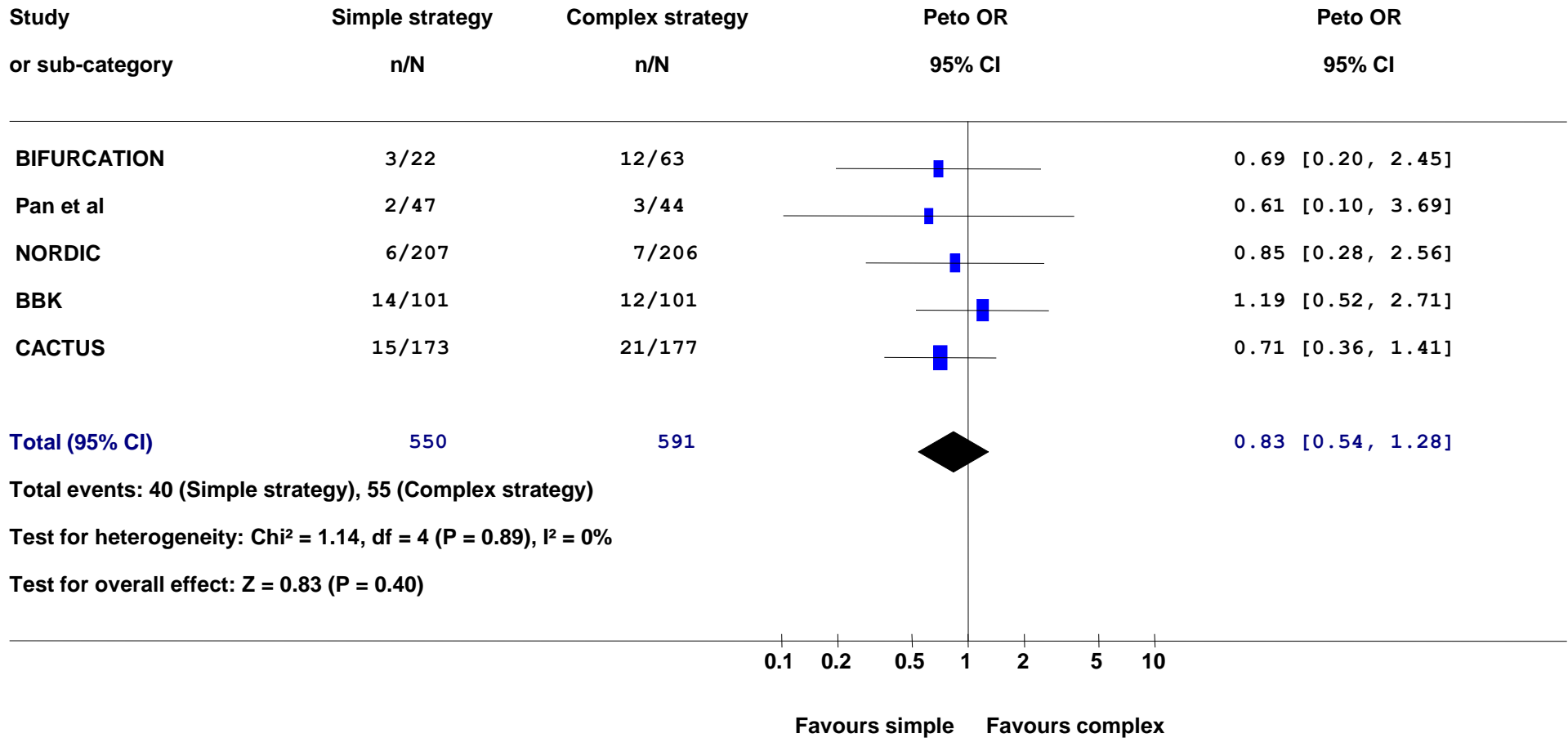
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Risk of binary restenosis – side branch



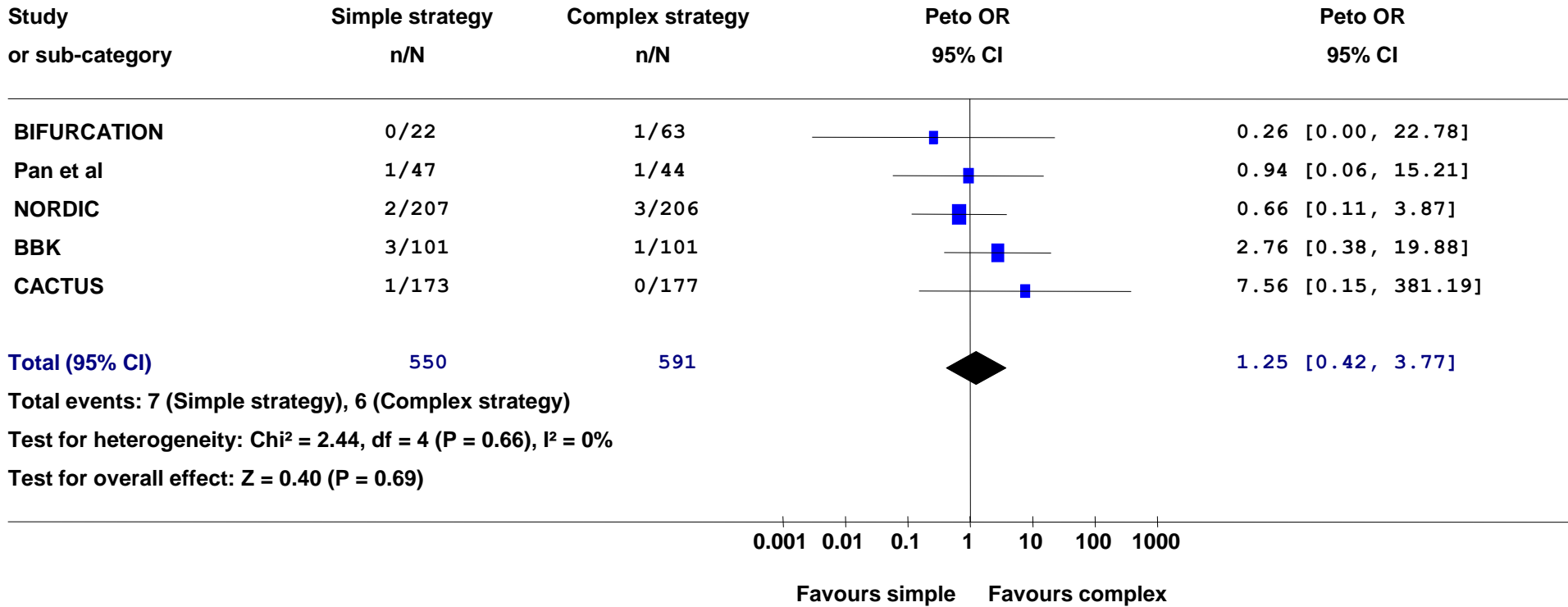
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Risk of MACE



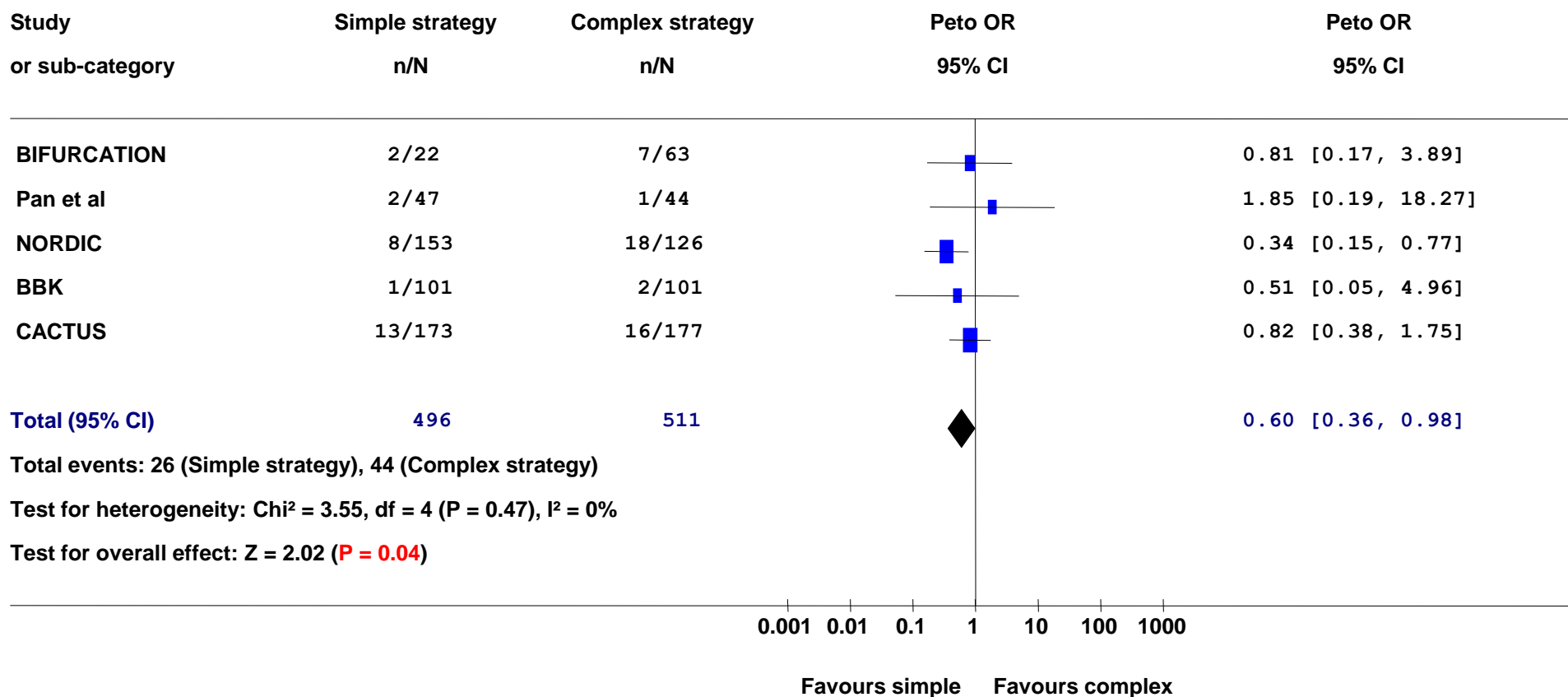
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Risk of death



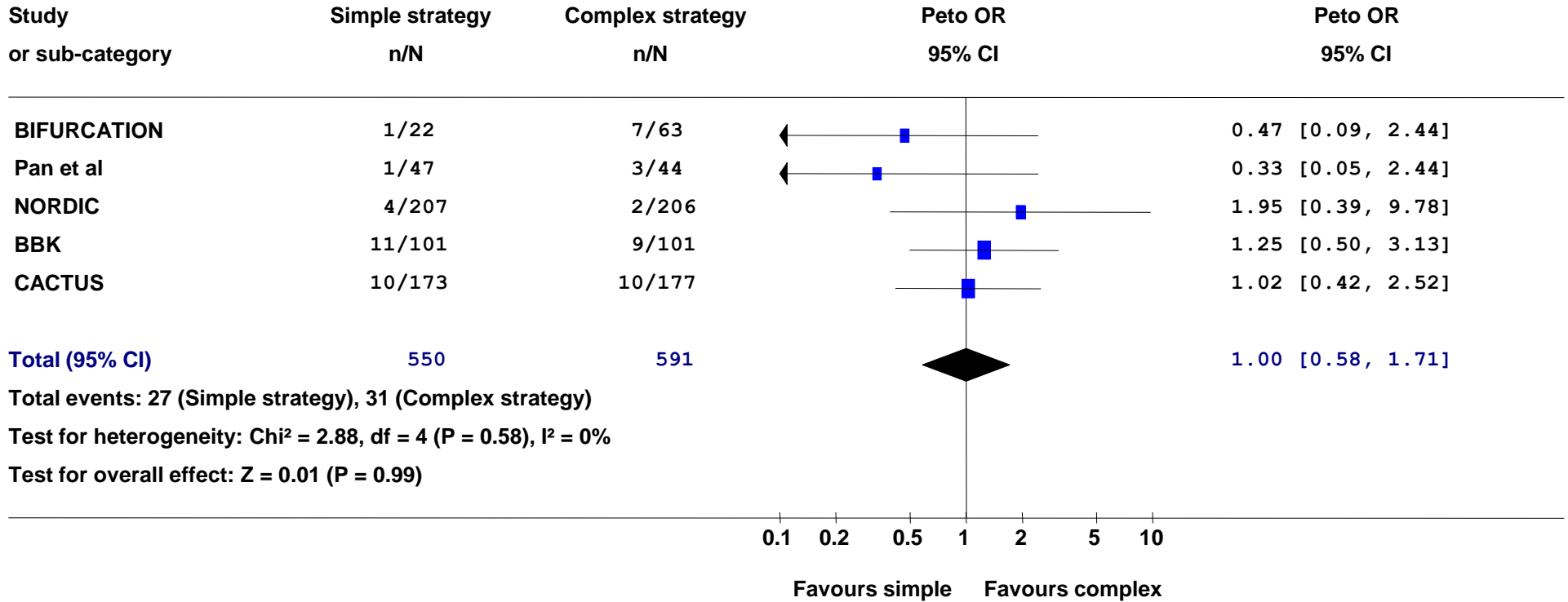
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Risk of MI



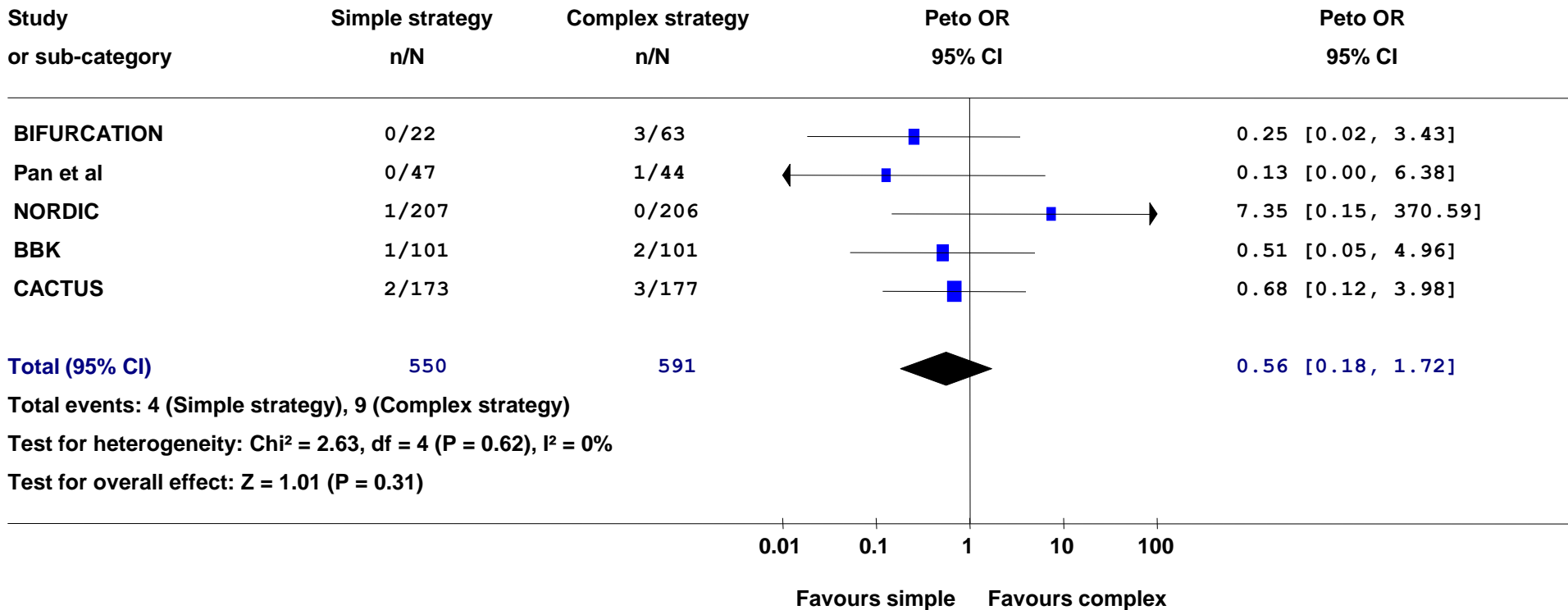
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Risk of TLR – any branch



Superiority of A Simple Stenting Strategy For Coronary Bifurcation Lesions In The DES Era (Meta-Analysis Of 1141 Patients)

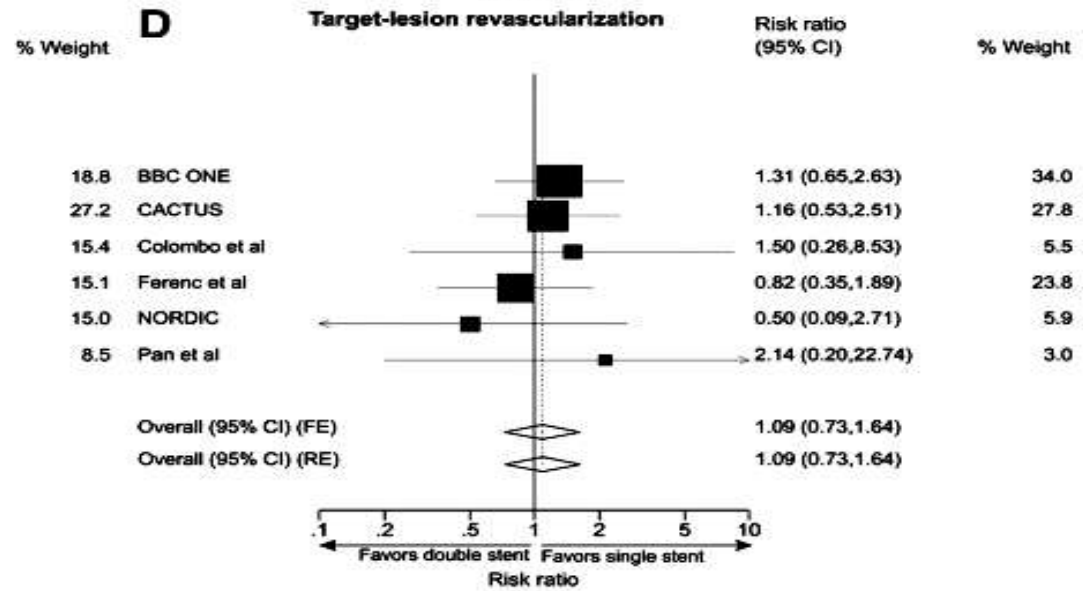
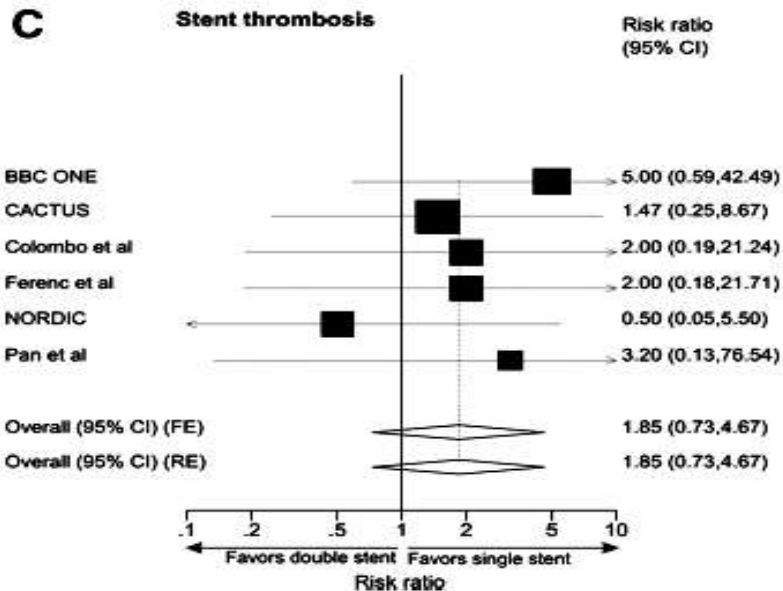
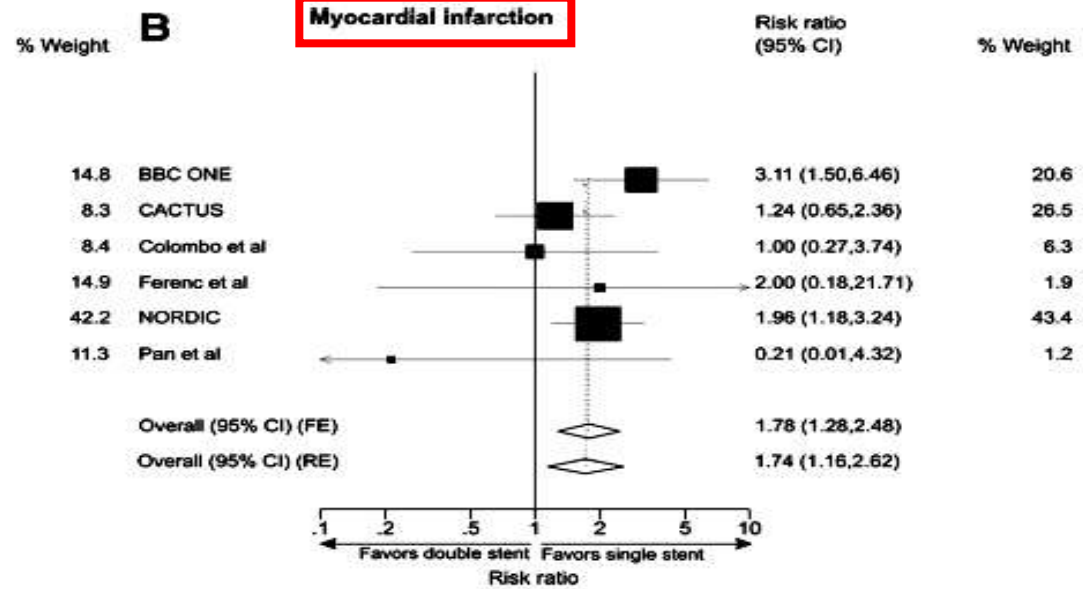
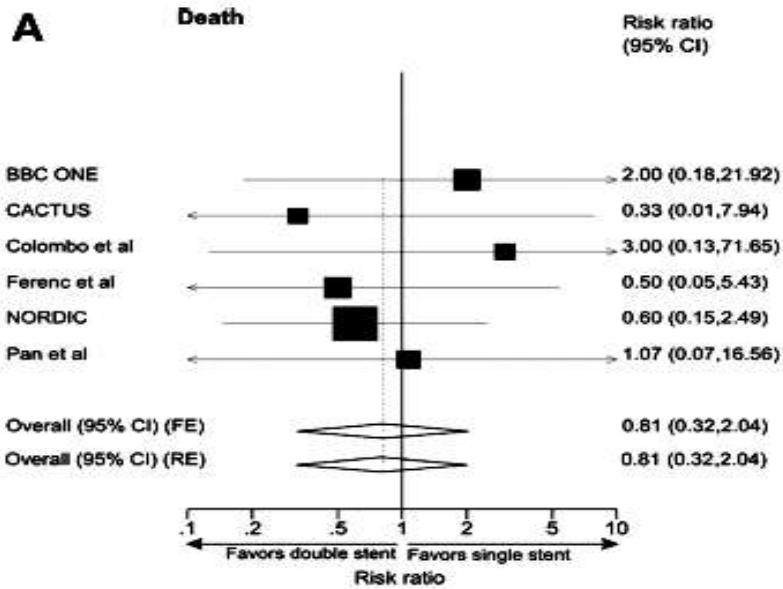
Risk of stent thrombosis



Double Vs Single Stenting for Coronary Bifurcation Lesions, a Meta-Analysis: Procedural Characteristics

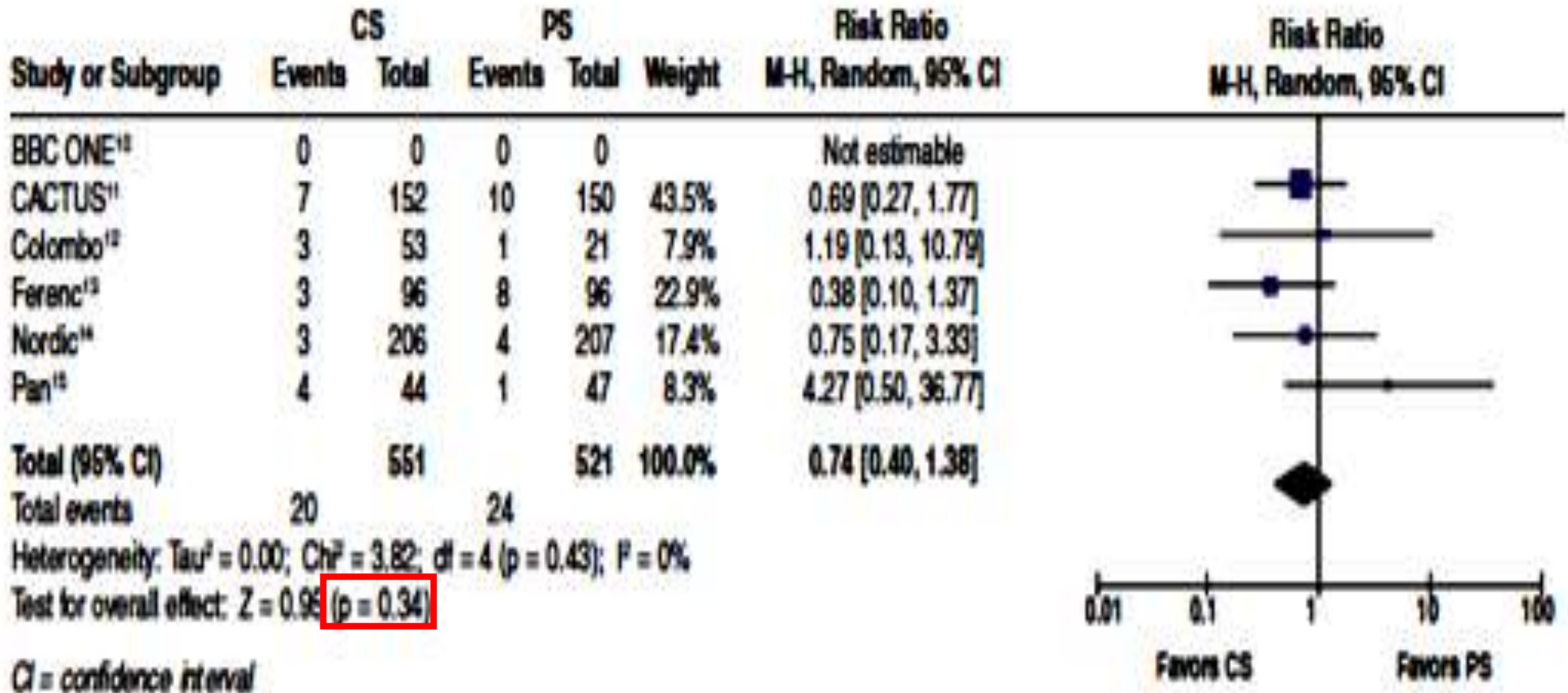
Study	No. Patients Crossed Over		True Bifurcation Lesions, n (%)	Stenting Technique* (MV+SB)	Type of DES	GP IIb/IIIa Inhibitors (MV; MV+SB)	Final "Kissing Balloon" Inflation, n (%) (MV; MV+SB)	Angiographic Follow-Up (MV; MV+SB)
	To Simple Strategy	To Complex Strategy						
BBC ONE	4	7	415 (83)	Crush technique (169), culotte technique (75), T-stenting (7), other (4)	PES	70; 110	73 (29); 189 (76)	ND
CACTUS	ND	54	328 (94)	Crush technique (231)	SES	30; 40	156 (90); 163 (92)	302 (150; 152)
Colombo et al	2	22	ND	T-stenting (60), V-stenting (1), Y-stenting (2)	SES	8; 27	19 (86); 60 (95)	ND
Ferenc et al	3	19	138 (68)	T-stenting (120)	SES	0; 0	101 (100); 101 (100)	192 (96; 96)
NORDIC	10	9	ND	Crush technique (103), culotte technique (43), other (69)	SES	106; 105	65 (31); 152 (74)	307 (151; 156)
Pan et al	4	1	78 (86)	T-stenting (45)	SES	29; 25	28 (56); 34 (77)	80

Double Vs Single Stenting for Coronary Bifurcation Lesions



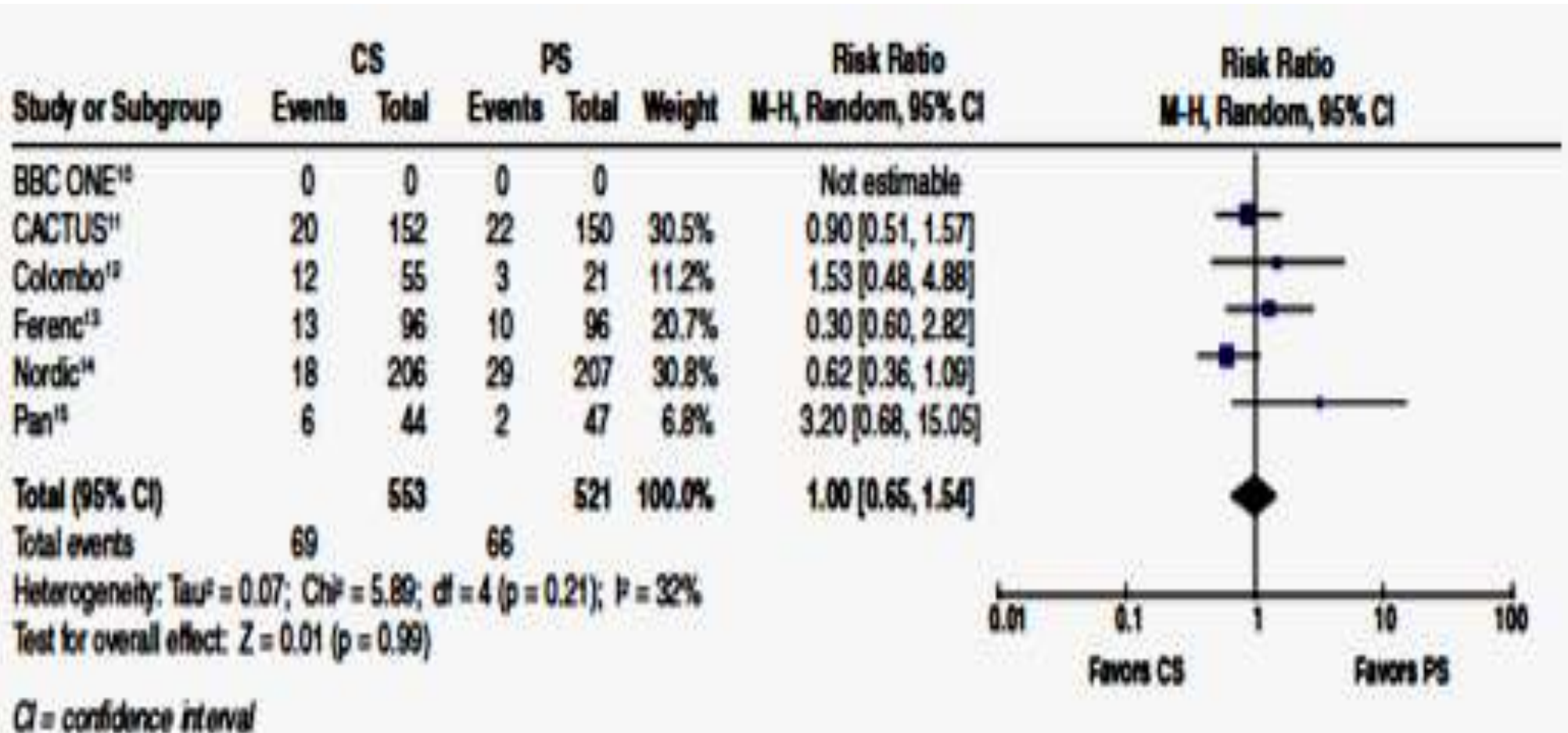
Provisional vs. complex stenting strategy for coronary bifurcation lesions: meta-analysis of randomized trials

Main Branch Restenosis



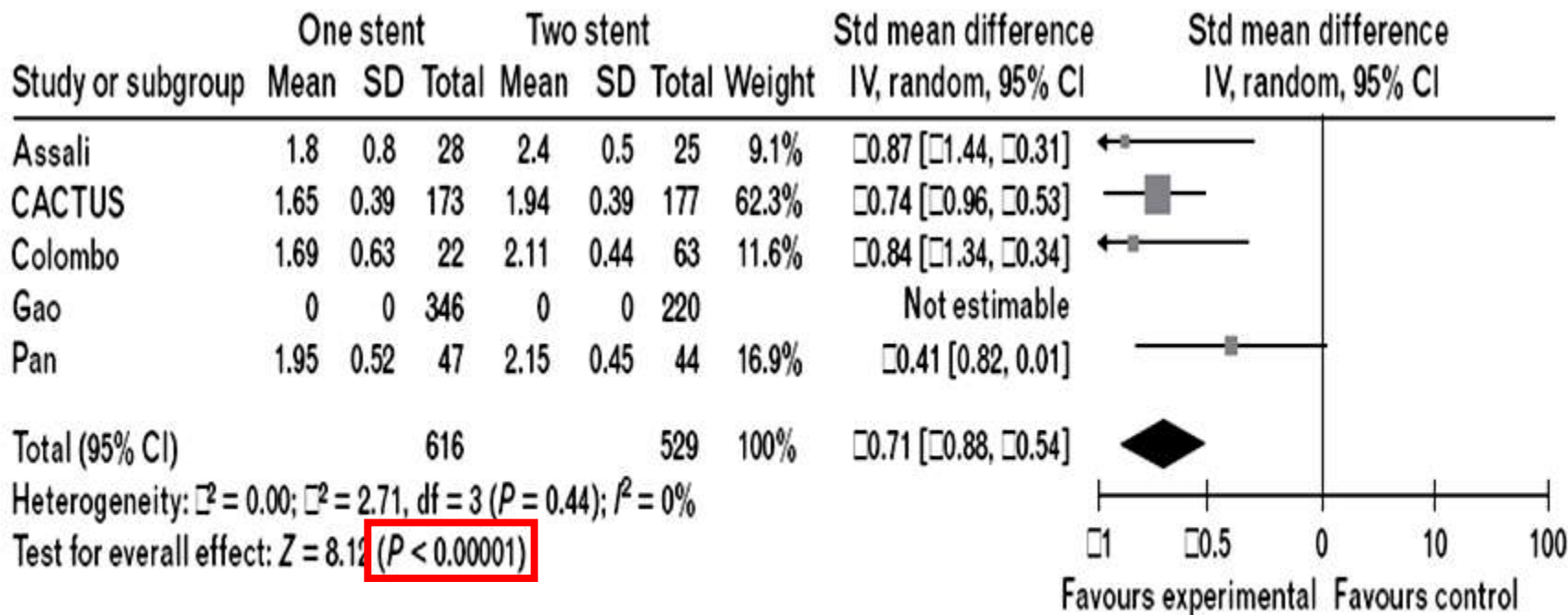
Provisional vs. complex stenting strategy for coronary bifurcation lesions: meta-analysis of randomized trials

Side Branch Restenosis



True coronary bifurcation lesions: meta-analysis and review of literature

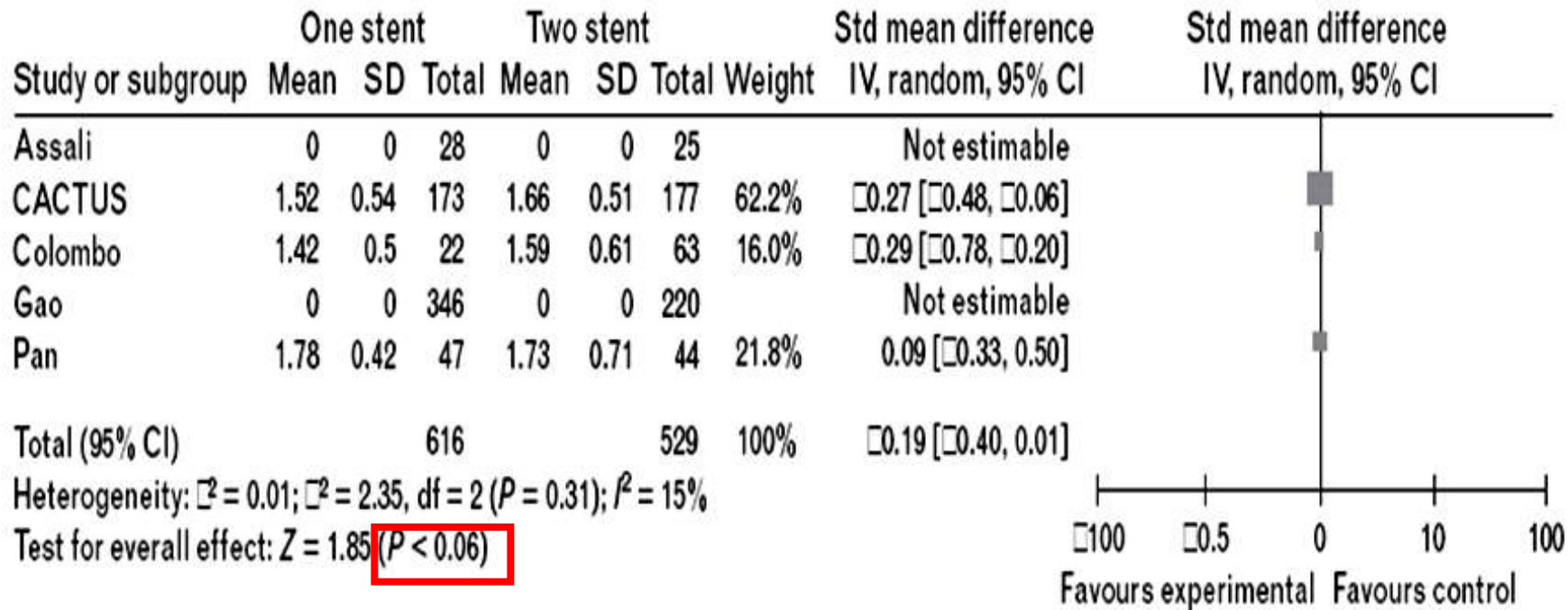
Postprocedural minimal luminal diameter of the side branch



Overall estimate of the postprocedural minimal luminal diameter of the side branch in patients treated with the single-stent strategy compared with patients receiving the two-stent strategy. IV, Inverse variance.

True coronary bifurcation lesions: meta-analysis and review of literature

Follow-up minimal luminal diameter of the side branch



Overall estimate of the follow-up minimal luminal diameter of the side branch in patients treated with the single-stent strategy compared with patients receiving the two-stent strategy. IV, Inverse variance.

**DES
Main Branch
Only**

Hildick Smith 2008
Pan 2004
Assali 2006
Vigna 2007
Ge 2005
Pan 2007
Ferenc 2008
Colombo 2004
Pan 2007
Palmerini 2008
Galassi 2009
DiMario 2007
Valgimigli 2006
VA MB DES No SB Stent
Pooled Estimate

**DES
With Side
Branch Stent**

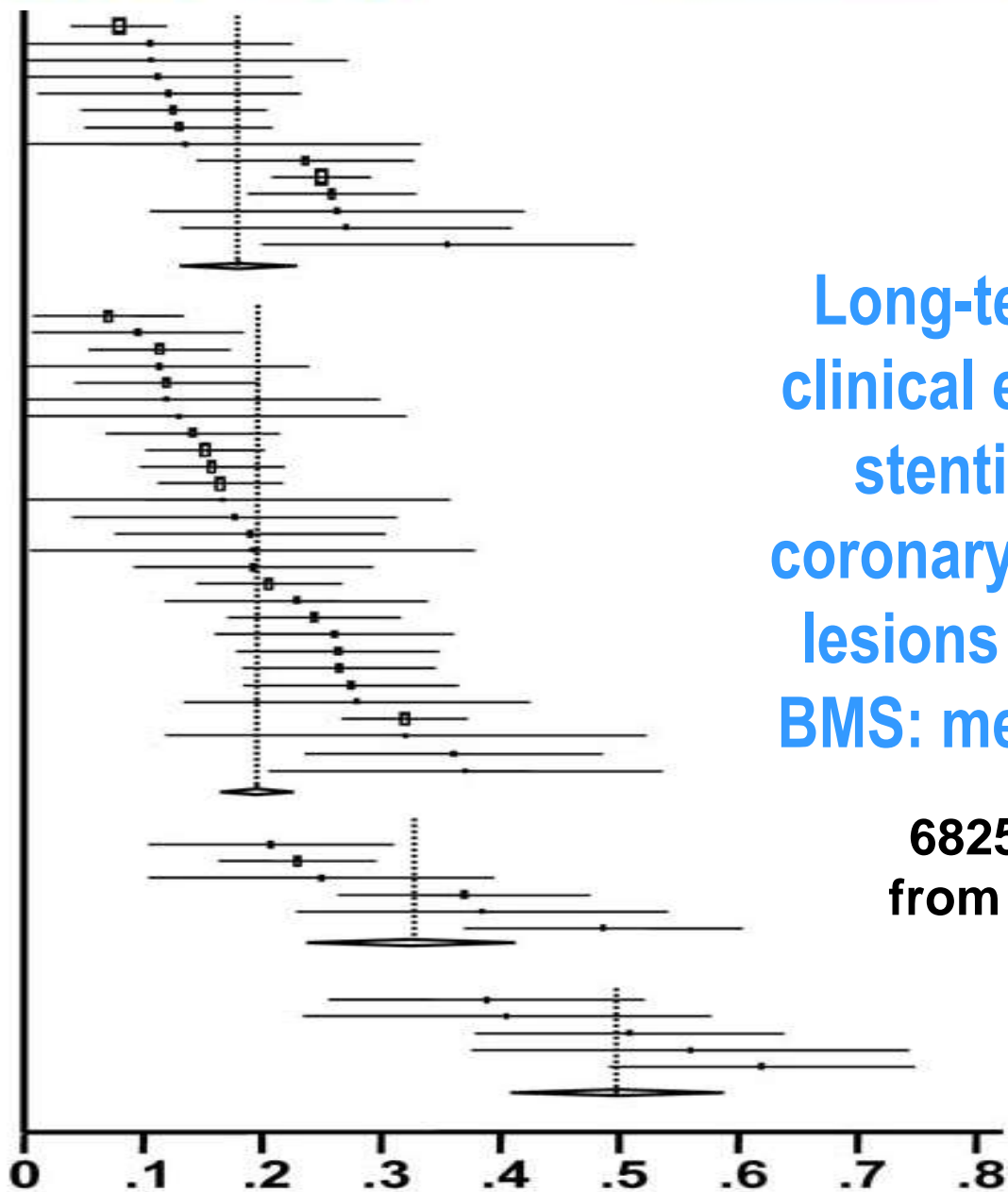
Chen 2007
Burzotta 2007
Chen 2008
Pan 2004
Ferenc 2008
Assali 2006
Hoye 2005
Moussa 2006
Hildick Smith 2008
Colombo 2009
Hoye 2006
Prasan 2004
Kaplan 2007
Colombo 2004
Rizik 2006
Diaz de la Liera 2006
Galassi 2009
Ge 2007
Chen 2008
Galassi 2009
Ge 2006
Adriaenssens 2008
DiMario 2007
Valgimigli 2006
Palmerini 2008
VA MB DES and SB Stent
Ge 2006
Kaplan 2007
Pooled Estimate

**BMS
Main Branch
Only**

Al Suwaidi 2000
Aliabadi 1997
Pan 1999
Finci 2000
Yamashita 2000
VA MB BMS No SB Stent
Pooled Estimate

**BMS
With Side
Branch Stent**

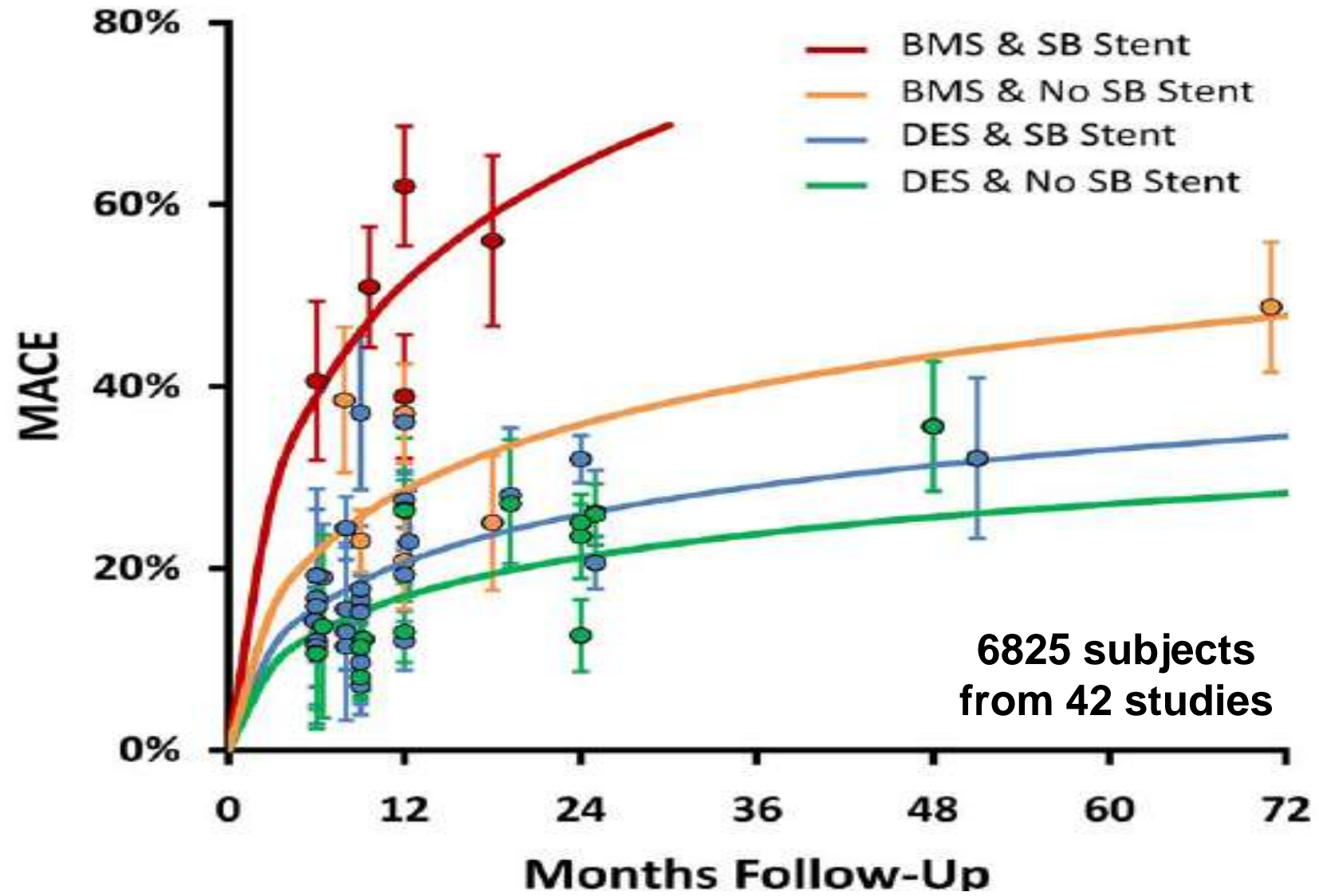
Al Suwaidi 2000
Assali 2004
Yamashita 2000
Pan 1999
Finci 2000
Pooled Estimate



Long-term risk of clinical events from stenting SB of coronary bifurcation lesions with DES / BMS: meta-analysis

6825 subjects from 42 studies

Long-term risk of clinical events from stenting SB of coronary bifurcation lesions with DES / BMS: meta-analysis



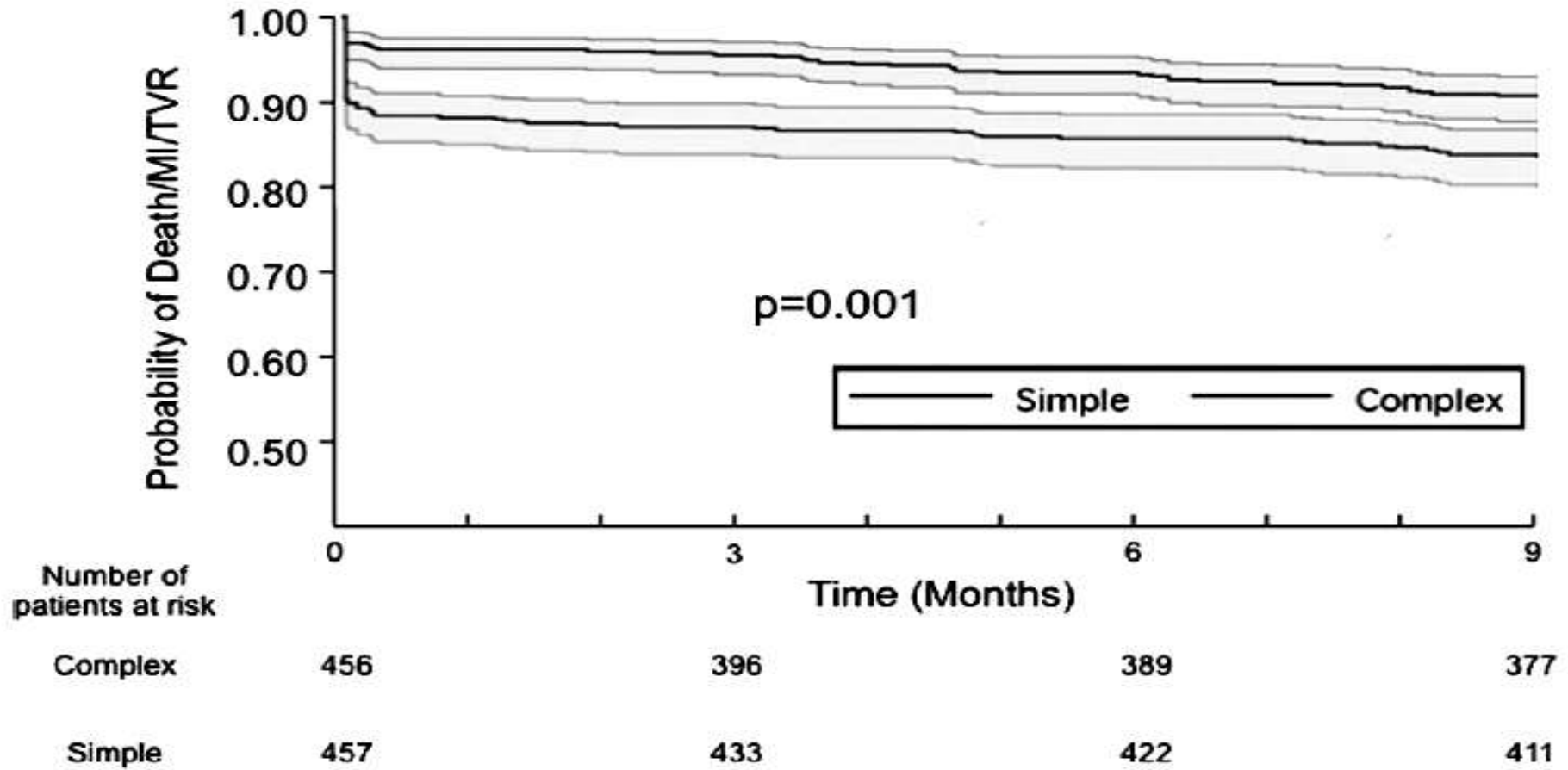
Simple or Complex Stenting for Bifurcation Coronary Lesions : A Patient-Level Pooled-Analysis of Nordic 1 and BBC

Trial End Points Simple vs Complex Total

	Simple (n=457)	Complex (n=456)	HR (95% CI)	P Value
All-cause death, myocardial infarction (periprocedural and subsequent) or target vessel revascularization at 9 months	46 (10.1%)	79 (17.3%)	1.84 (1.28–2.66)	P=0.001
All-cause death, myocardial infarction (subsequent alone) or target vessel revascularization at 9 months	32 (7.0%)	41 (9.0%)	1.38 (0.87–2.20)	0.168
All-cause death	5 (1.0%)	5 (1.0%)		0.99
Periprocedural	2 (0.4%)	3 (0.6%)		
Subsequent	3 (0.6%)	2 (0.4%)		
Myocardial infarction	22 (4.8%)	56 (12.3%)		<0.001
Periprocedural	16 (3.5%)	45 (9.9%)		<0.001
Subsequent	6 (1.3%)	11 (2.4%)		0.22
Target vessel revascularization	26 (5.7%)	33 (7.2%)		0.34
PCI	24 (5.3%)	20 (4.4%)		0.54
CABG	2 (0.4%)	13 (2.9%)		0.004
Stent thrombosis (ARC definite)	3 (0.7%)	6 (1.3%)		0.31
In-hospital				
Death	2 (0.4%)	3 (0.6%)		0.65
Myocardial infarction	17 (3.7%)	45 (9.9%)		<0.001
CABG	0 (0%)	4 (0.8%)		0.04

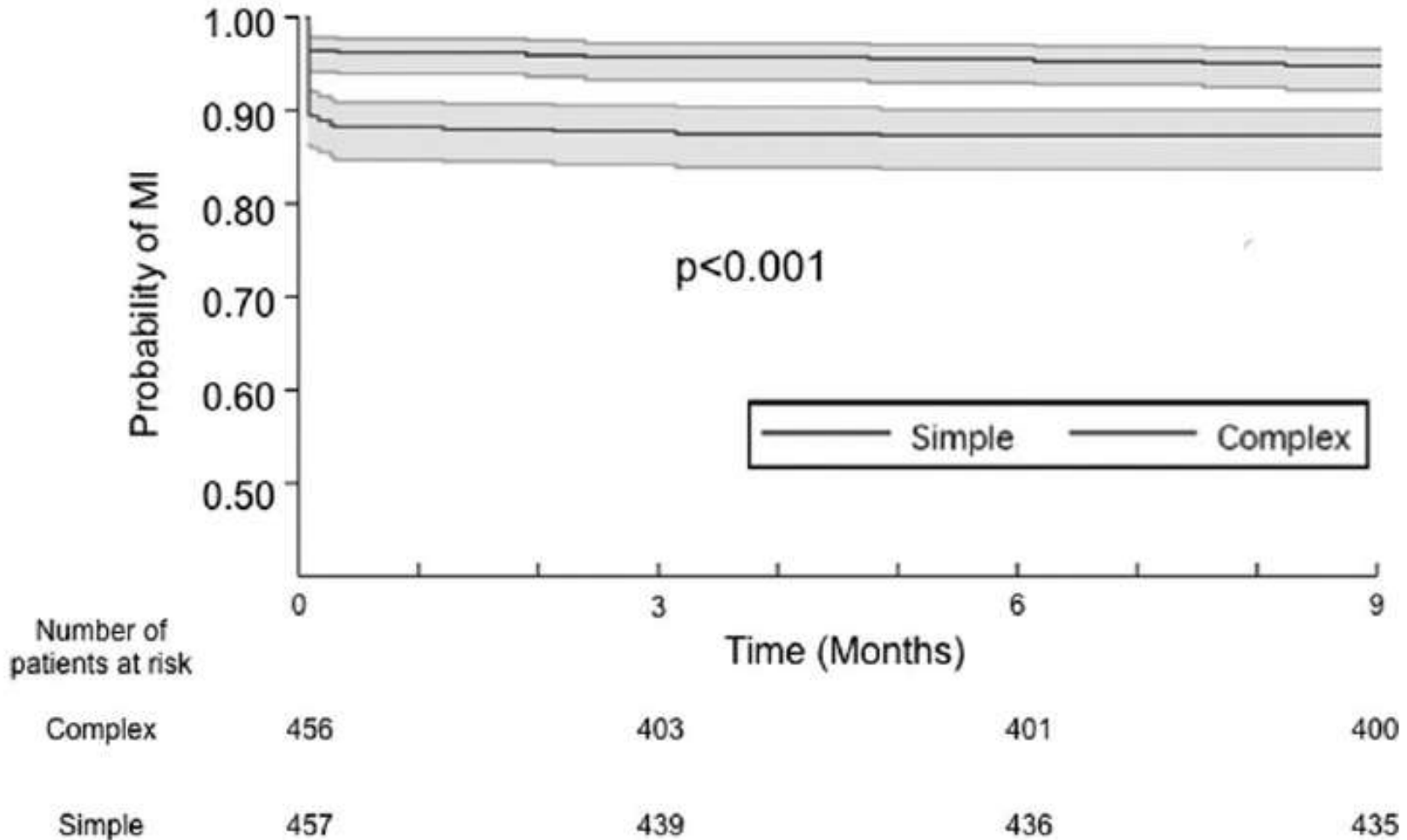
Simple or Complex Stenting for Bifurcation Coronary Lesions : A Patient-Level Pooled-Analysis of Nordic 1 and BBC

Kaplan-Meier freedom from the composite event



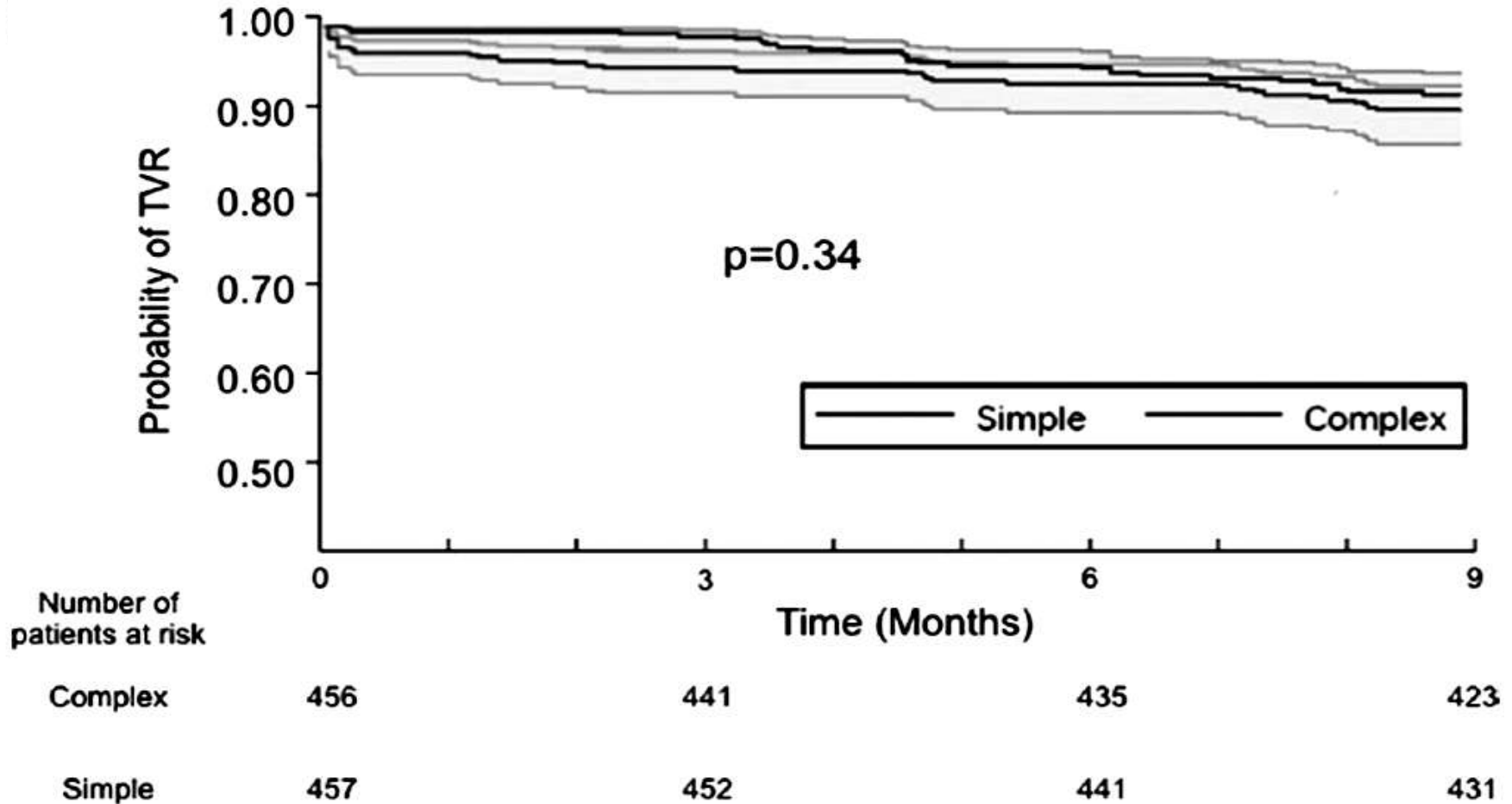
Simple or Complex Stenting for Bifurcation Coronary Lesions : A Patient-Level Pooled-Analysis of Nordic 1 and BBC

Kaplan-Meier freedom from MI



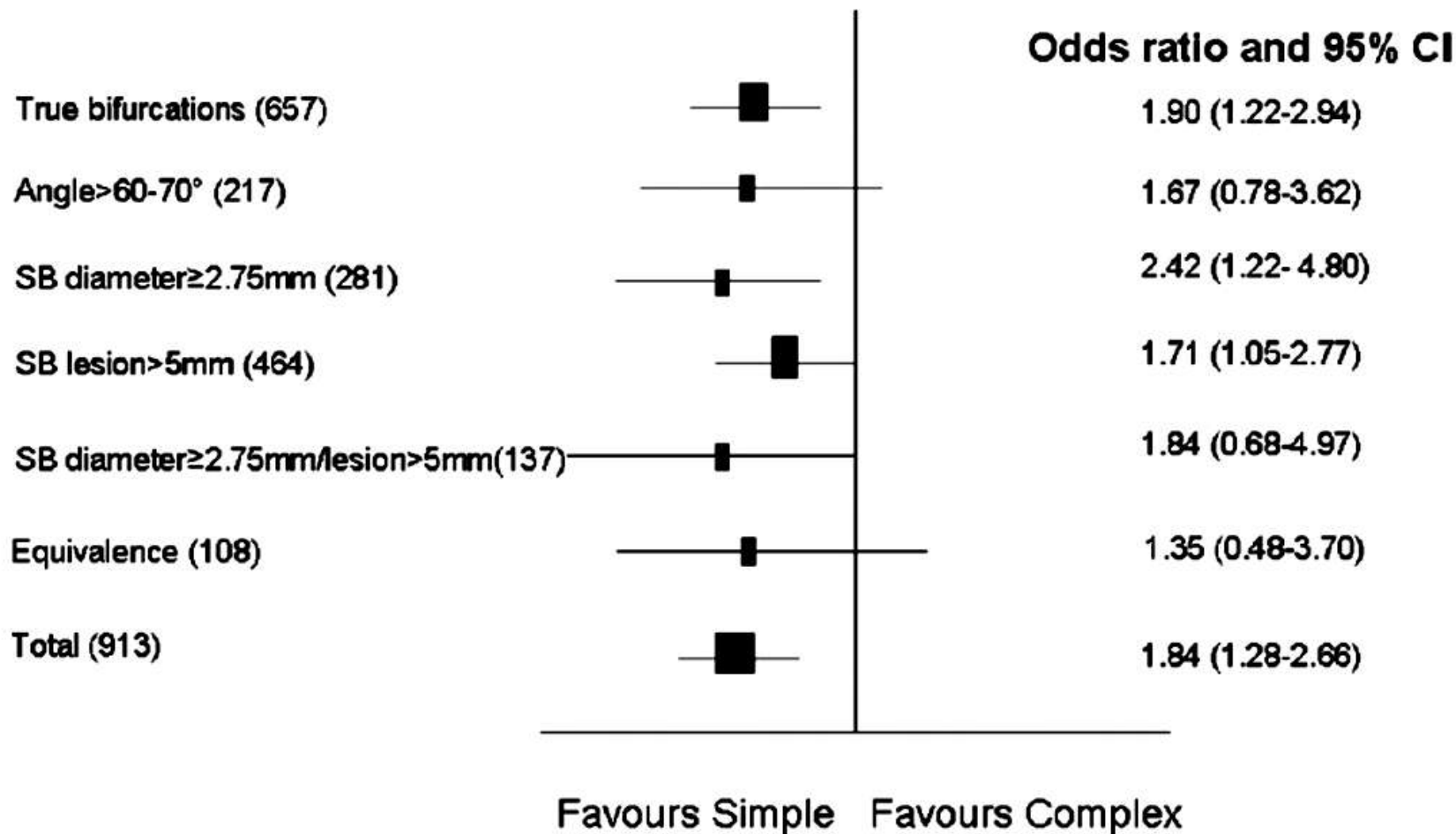
Simple or Complex Stenting for Bifurcation Coronary Lesions : A Patient-Level Pooled-Analysis of Nordic 1 and BBC

Kaplan-Meier freedom from TVR



Simple or Complex Stenting for Bifurcation Coronary Lesions : Patient-Level Pooled-Analysis of Nordic 1 and BBC

Primary outcome for individual subgroups



Simple or Complex Stenting for Bifurcation Coronary Lesions : A Patient-Level Pooled-Analysis of Nordic 1 and BBC

Procedure Characteristics

	Simple (n=457)	Complex (n=456)	P Value
Side branch stented, n (%)	16 (3.5%)	421 (92.3%)	<0.001
Crush technique, n (%)	...	272 (59.6%)	
Culotte technique, n (%)	...	118 (25.9%)	
Other complex technique n (%)	16 (3.5%)	59 (12.9%)	
Final kissing balloons, n (%)	129 (28.3%)	342 (75.3%)	<0.001
Procedural success, n (%)	435 (95.4%)	429 (94.5%)	0.430
Procedural time (min, SD)	57	78	0.001
Fluoroscopy time (min, SD)	15.1 (11.1)	21.5 (11.4)	<0.001
Contrast volume (mL, SD)	243.2 (108.1)	297.9 (129.3)	<0.001

Late thrombosis after 2 versus 1 DES in the treatment of coronary bifurcations. Meta-analysis of randomized and observational studies

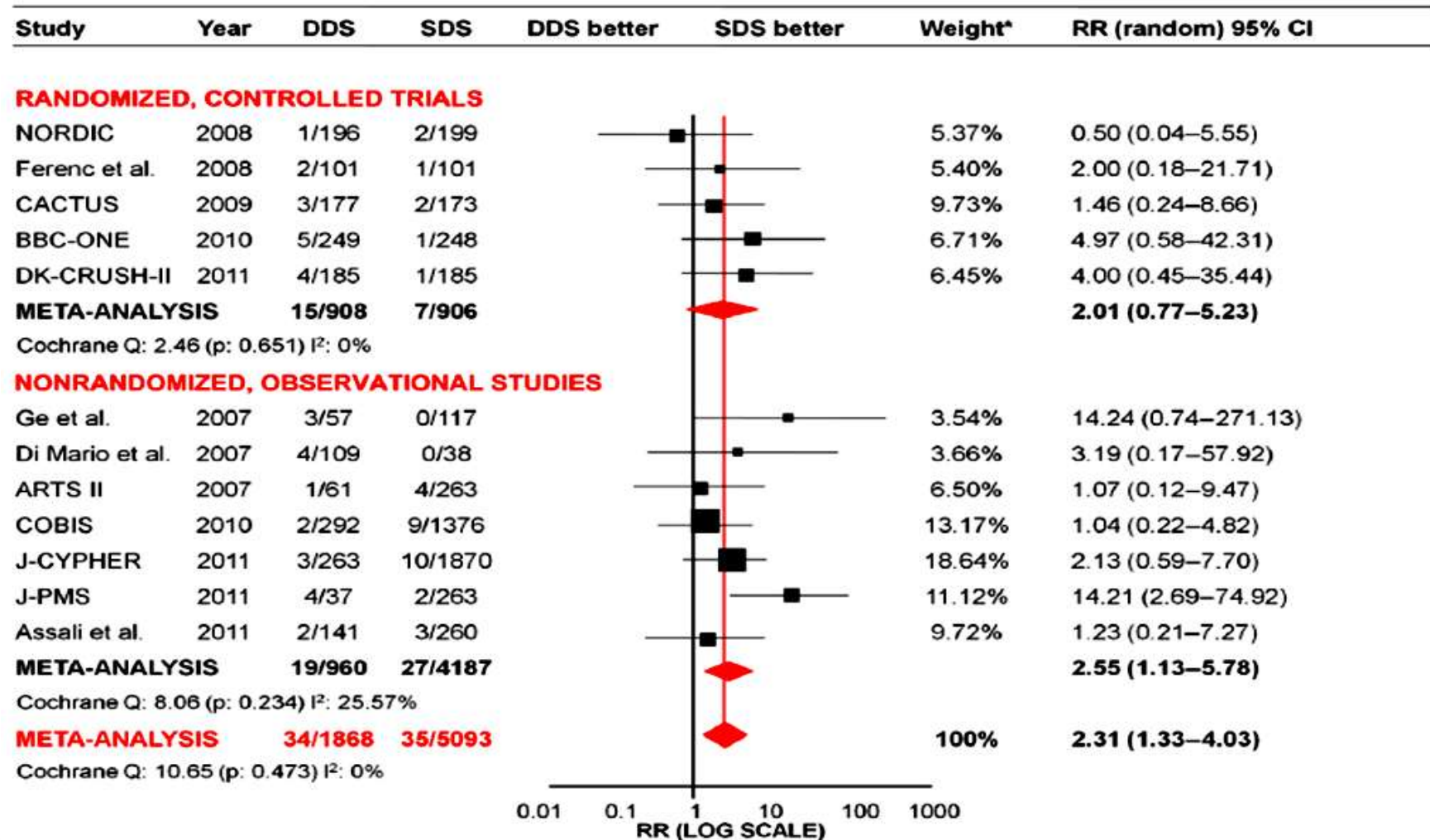
Summary of the Characteristics of the Included Studies

	Nordic	BBK	CACTUS	BBC-ONE	DK-CRUSH-II	Ge et al.	Di Mario et al.	ARTS-II	COBIS Registry	J CYPHER Registry	JPMS Registry	Assali et al.
Type of study	RCT	RCT	RCT	RCT	RCT	nROS	nROS	nROS	nROS	nROS	nROS	nROS
Year of publication	2006	2008	2009	2010	2011	2005	2007	2007	2010	2011	2011	2012
No. of patients	413	202	350	500	390	174	150	324	1,691	2,122	324	401
Patient treatment (SDS/DDS)	199/196	101/101	173/177	248/249	185/185	117/57	38/109	263/61	1,376/292	1,870/263	263/37	260/141
Follow-up, mo	14	9	6	6	12	9	12	12	22	36	36	24
Type of DES	Sirolimus	Sirolimus	Sirolimus	Paclitaxel	Sirolimus	Sirolimus	Paclitaxel	Sirolimus	Operator discretion	Sirolimus	Sirolimus	Operator discretion
DDS technique	Crush	T stenting	Crush	Crush	Crush	Crush	Crush	Crush	Crush	Crush	Crush	Mini-Crush
	Culotte			Culotte		V stenting	T stenting	V stenting	V stenting	T stenting	T stenting	T stenting
	Other			T stenting		T stenting	Culotte	T stenting	T stenting	Culotte	Culotte	V stenting
				Other		Culotte	Kissing stents	Culotte	Culotte	Kissing stents	Kissing stents	Culotte
True bifurcations*, no. (%)	NA	138 (68)	328 (94)	415 (83)	390 (100)	NA	NA	200 (62)	1,170 (69)	1,181 (56)	NA	NA
Use of glycoprotein IIb/IIIa, no. (%)	211 (51)	0	70 (20)	180 (36)	10 (3)	82 (47)	35 (23)	119 (37)	NA	NA	NA	235 (58)
Final kissing balloon, no. (%)	217 (52)	202 (100)	319 (91)	262 (52)	332 (85)	103 (59)	112 (75)	40 (12)	686 (41)	1,254 (59)	97 (30)	318 (79)
Duration of DAPT, mo	14	6	6	>9	>12	>3	>3	2	3-6 (recommended)	3 (recommended)	3 (recommended)	6 (recommended)
Crossover rate from provisional to double stenting %	430	19	31	—	—	—	—	—	—	—	—	—

Late thrombosis after 2 versus 1 DES in the treatment of coronary bifurcations. Meta-analysis of randomized and observational studies

A

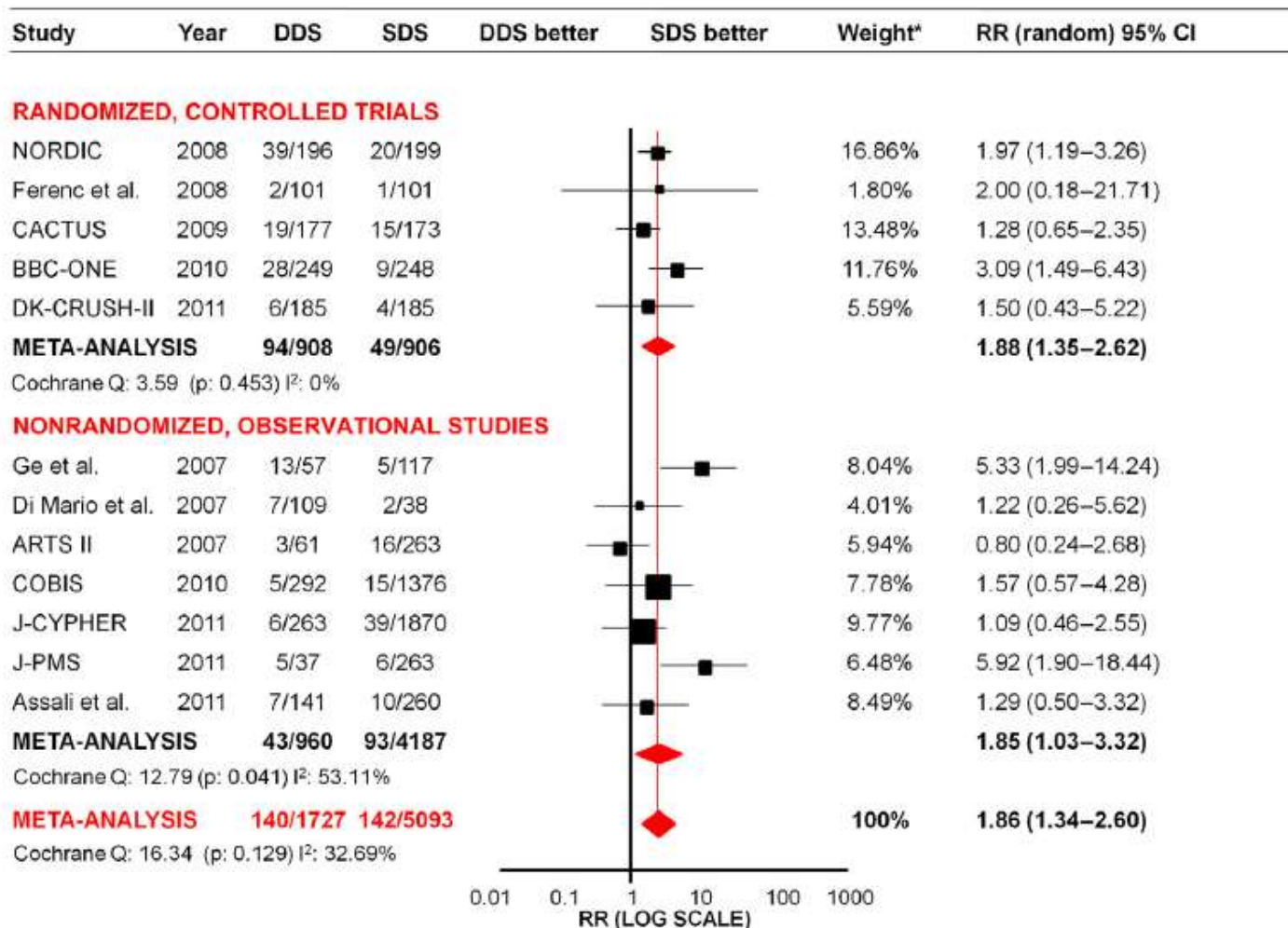
DES Thrombosis



Late thrombosis after 2 versus 1 DES in the treatment of coronary bifurcations. Meta-analysis of randomized and observational studies

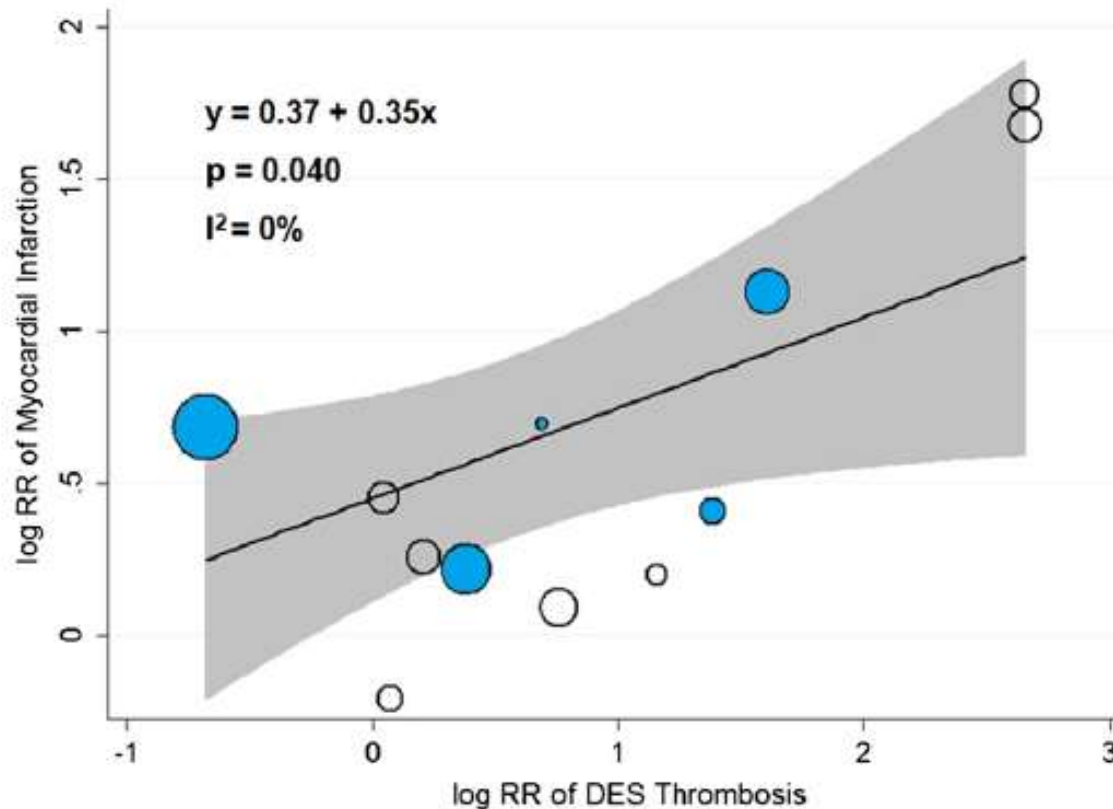
C

Myocardial Infarction



Late thrombosis after 2 versus 1 DES in the treatment of coronary bifurcations. Meta-analysis of randomized and observational studies

Association Between Log-Transformed Risk of DES Thrombosis and Myocardial Infarction



The size of each circle represents the precision of each estimate (the inverse variance of the log RR in the trial), and the line is the best fit for the meta-regression model. Randomized, controlled trials (filled circles); nonrandomized observational studies (open circles).

Randomized study comparing DK Crush with Provisional Stenting for treatment of coronary bifurcation lesions: DK-CRUSH-II

Clinical outcome (2)

	DK Group (n = 185)	PS Group (n =185)	p Value
Procedural success	179 (96.8)	173 (93.5)	0.217
At 6-month			
Cardiac death	1 (0.5)	2 (1.1)	1.000
MI	6 (3.2)	4 (2.2)	0.751
CABG	0 (0)	1 (0.5)	0.500
TLR	2 (1.1)	6 (3.2)	0.284
TVR	3 (1.6)	8 (4.3)	0.220
MACE	6 (3.2)	11 (5.9)	0.321
Stent thrombosis definite	4 (2.2)	1 (0.5)	0.372
At 12-month			
Cardiac death	2 (1.1)	2 (1.1)	1.000
MI	6 (3.2)	4 (2.2)	0.751
CABG	0 (0)	1 (0.5)	0.500
TLR	8 (4.3)	24 (13.0)	0.005
TVR	12 (6.5)	27 (14.6)	0.017
MACE	19 (10.3)	32 (17.3)	0.070
Stent thrombosis	5 (2.7)	2 (1.1)	0.449
Definite	4 (2.2)	1 (0.5)	0.372
Possible	1 (0.5)	1 (0.5)	1.000

Follow-up coronary angiography at 8 months / Endpoint at 12-months

Incomplete and Inappropriate Coronary Bifurcation Classification

« The use of incomplete and inappropriate Medina coronary bifurcation classification has led to major flaws in randomized clinical trials of coronary bifurcation interventions »

« The authors did not realize that all of the randomized clinical studies in their meta-analysis:

- did not separate so called "true bifurcation lesions" from other less relevant lesions
- failed to include bifurcation angle in their analysis (more / less than 70°: T or V).
- B2 type of the Movahed classification are the only relevant lesions at high risk of SB occlusion using a single stent
- the risk of a side or main branch occlusion in 1m or 1s lesions using single stent technique is very low
- we recommend that the most appropriate and complete Movahed coronary bifurcation classification »

1,1,1; 0,1,1; 1,0,1;

Visual evaluation

New predictor ! Datas ?

Dedicated QCA ?

Randomized trial ?

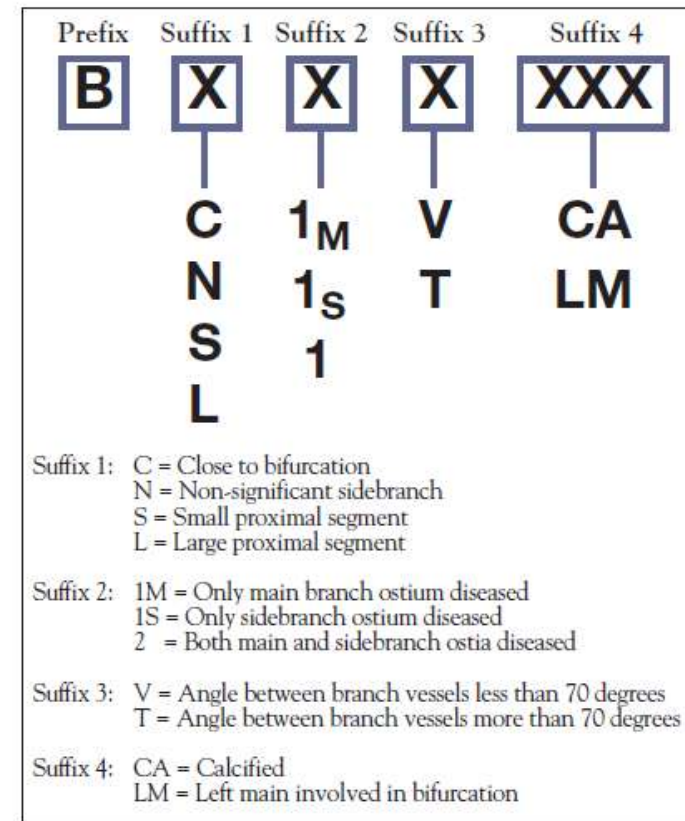
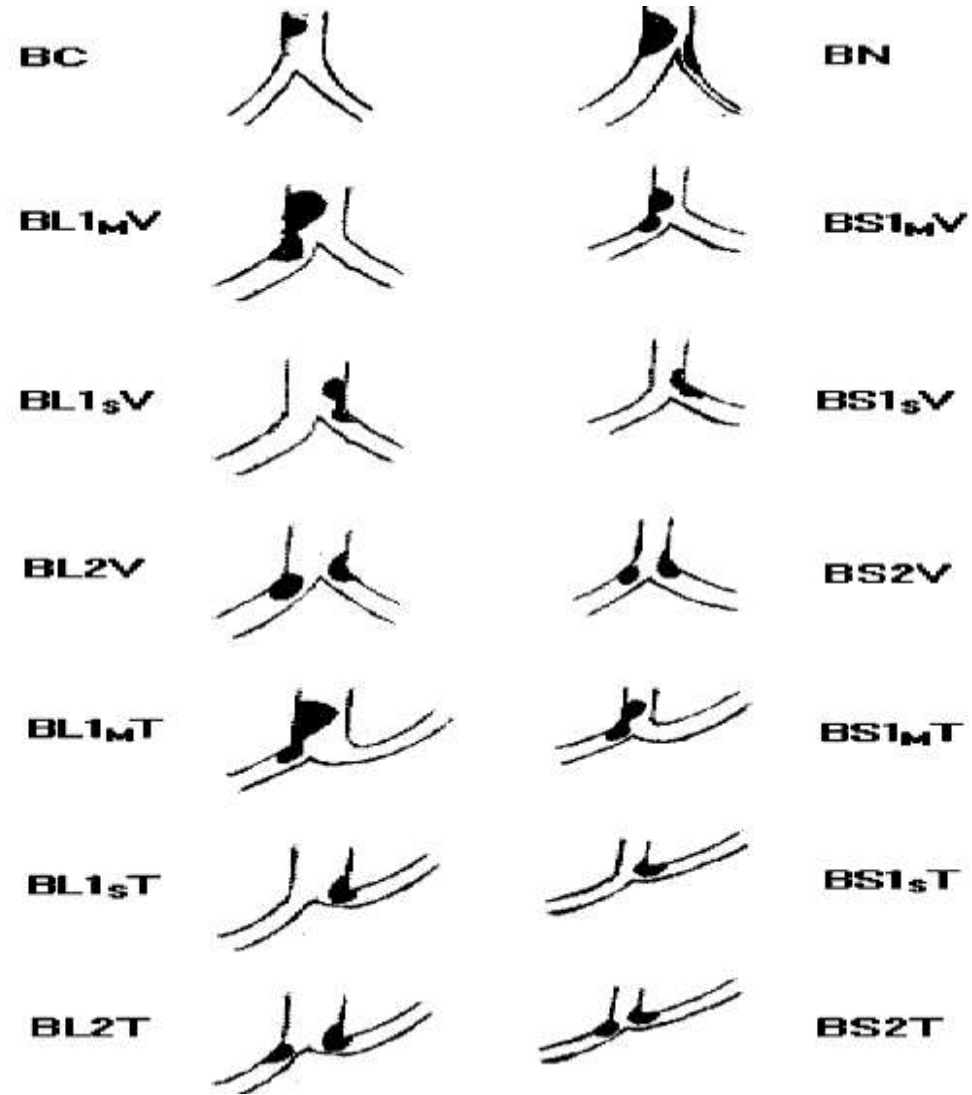


Figure 2. Movahed's classification. Originally published in the Journal of Invasive Cardiology 2006;18:199-204.

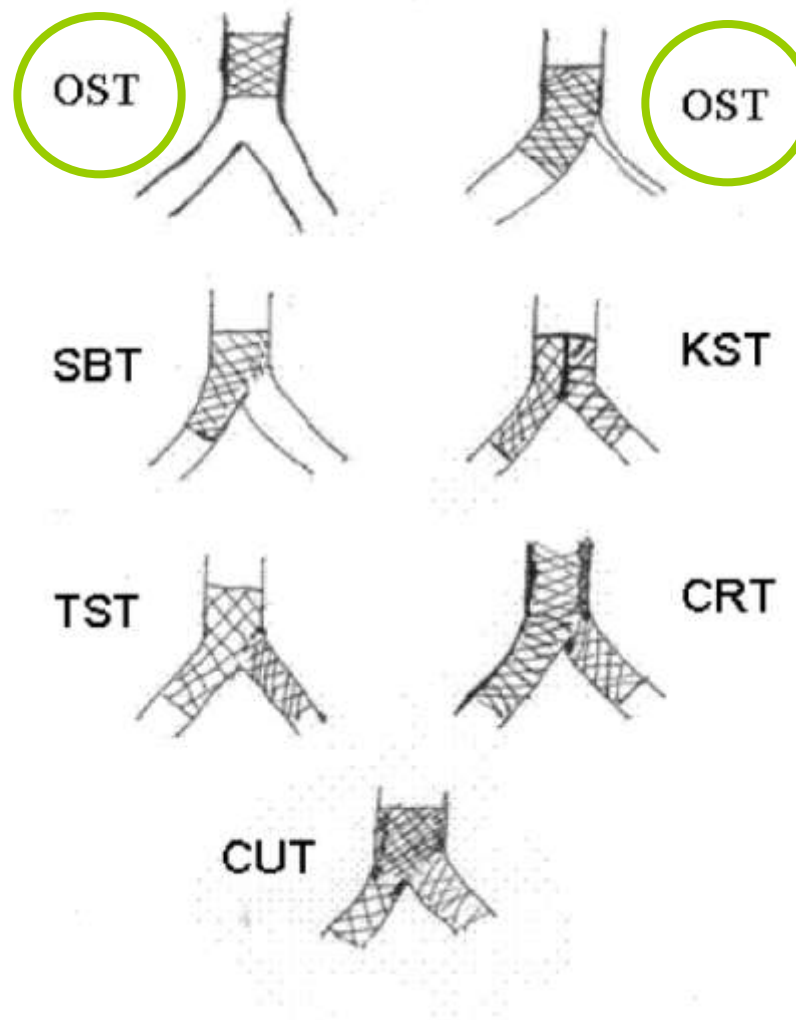
A new proposed simplified classification of coronary artery bifurcation lesions



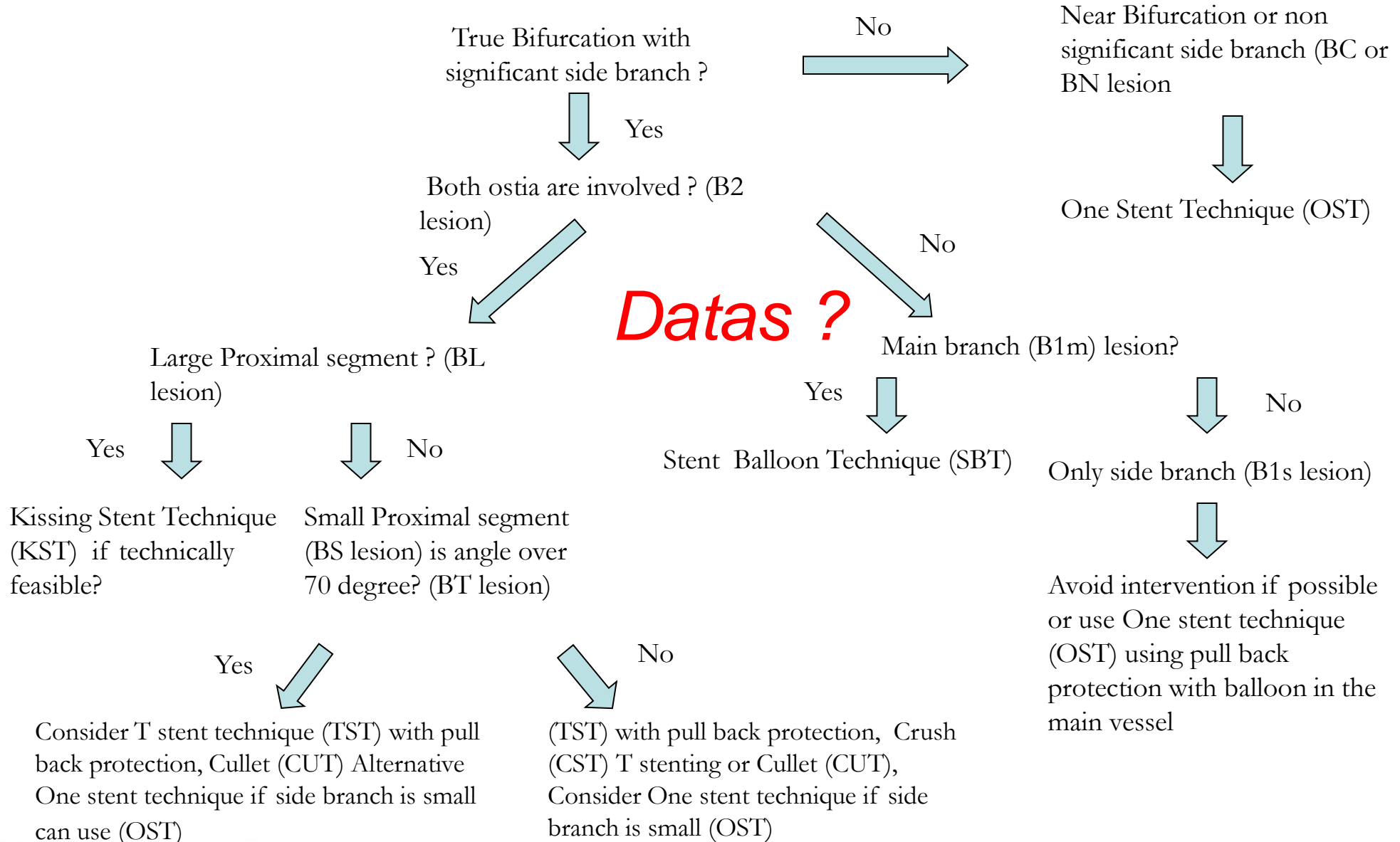
Exhaustive ? Simple ?

Schematic description of interventional bifurcation techniques:

OST = one stent technique;
 SBT = stent with balloon technique;
 KST= kissing stent technique;
 TST = "T" stenting technique;
 CRT = crush stenting technique;
 CUT = culotte stenting technique



Bifurcation Lesion Intervention Algorithm



Conclusions (1)

Solid datas coming from meta-analysis of randomized and non randomized trials regarding Provisional vs complex strategies for non-LM bifurcation stenting:

1. No difference in total / cardiac mortality acutely and at FU
2. No difference in TLR
3. Less MI
 - in-hospital / 30 days depending of definition (BBC one)
 - at FU
 - linked to stent thrombosis (Zimarino)
4. Less stent thrombosis
5. No difference in restenosis rate for MV and SB
6. Smaller acute gain and late loss in SB ostium
7. Less time, X-Ray, contrast medium, wires, balloons, stents, GPIIb/IIIa ...

Conclusions (2)

Medina classification is a research instrument completed by other Classifications (stent thrombosis...), dedicated QCA softwares (3 segments references and MLD, 3D angle, lesion length), and Intraluminal online guidance (IVUS and OCT) used to make possible new randomized trials on last technical aspects (POT), DAPT duration, new stents (BVS)...