

STS/EACTS Latin America Cardiovascular Surgery Conference

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Hilton Cartagena | Cartagena, Colombia



Incremental Value of Multiple Arterial conduits in CABG

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Disclosure

- Founding Member of HRT – Equity interest
- None for this presentation

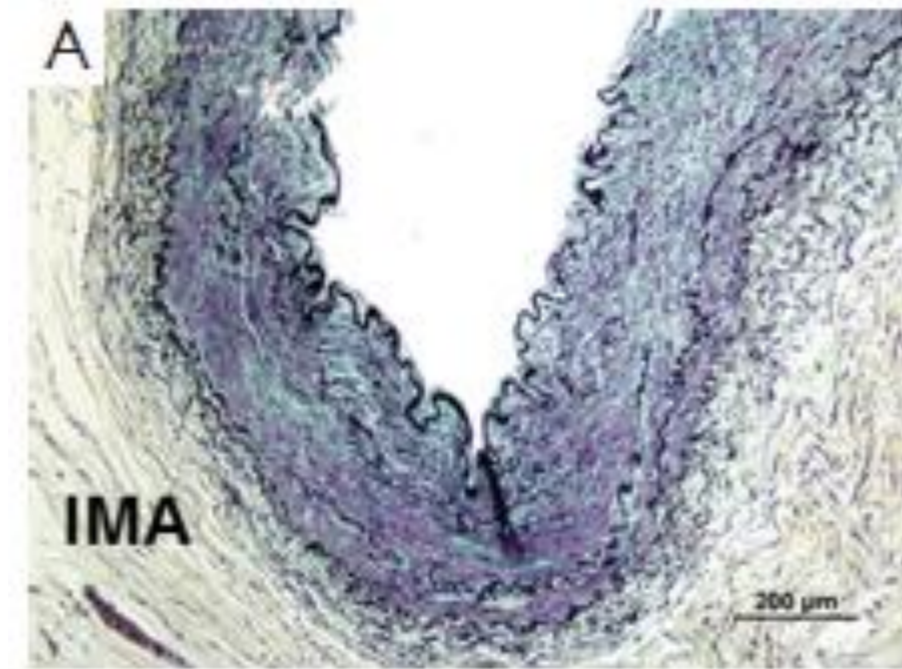
Why did 'Lord Bramha' design *Homo sapiens* with a left internal mammary artery (LIMA)?

.....to use as a conduit to graft the LAD !

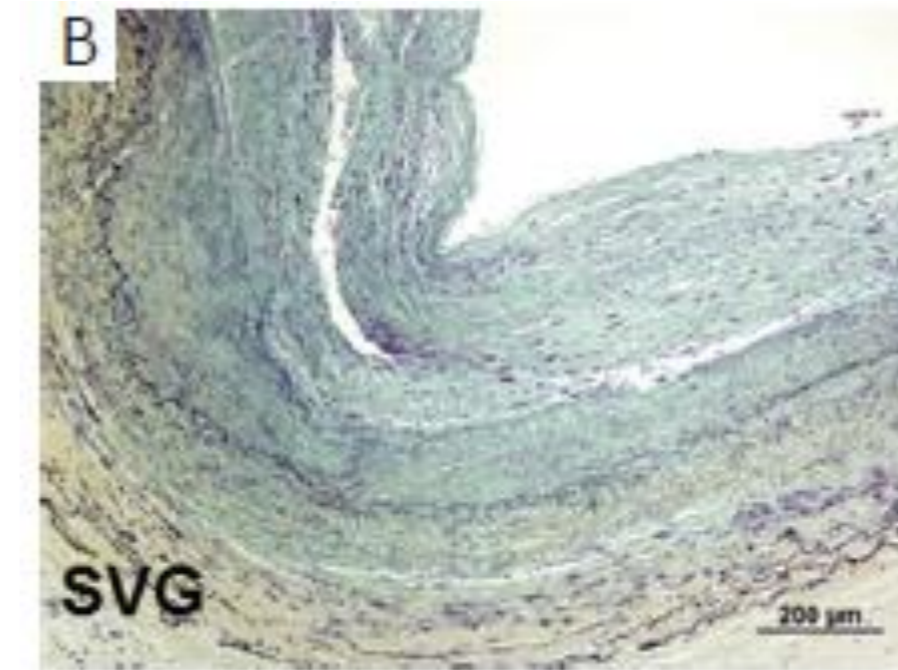
Table 1 Comparative anatomic and physiological properties of internal mammary artery (IMA) and saphenous vein (reproduced with permission from Motwani JG and Topol EJ. Circulation 1998;97:916-31.)

| | IMA | Saphenous vein |
|--|--------------|----------------|
| Anatomic properties | | |
| Endothelial fenestrations | Few | Many |
| Intercellular (IC) processes | Many | Few |
| IC junction permeability | Low | High |
| Internal elastic lamina (IEL) | Well defined | Poorly defined |
| Heparan sulfate in IEL/media | High | Low |
| Dependence on vasa vasorum | Minimal | High |
| Valves | Absent | Present |
| Size match with grafted native vessel | Good | Poor |
| Resistance to trauma of harvesting | High | Low |
| Physiological properties | | |
| Flow reserve | High | Low |
| Shear stress | High | Low |
| Nitric oxide/prostacyclin production | High | Low |
| Vasomotor response to thrombin | Relaxation | Constriction |
| Vasoconstrictor sensitivity | Low | High |
| Vasodilator sensitivity | High | Low |
| Basic fibroblast growth factor receptors | Few | Many (8x IMA) |
| Lipolysis | Rapid | Slow |
| Lipid synthesis | Less active | More active |
| Lipid uptake | Slow | Rapid |

2 years after CABG:



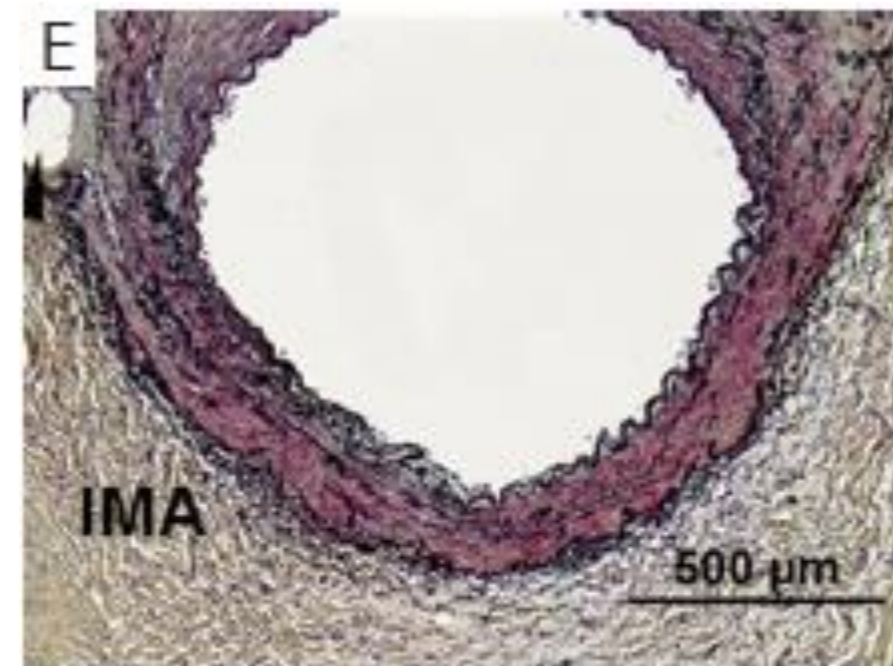
VS.



Virtually no neointimal changes

Moderate neointimal proliferation with rich extracellular collagen matrix

12 years after CABG:



VS.



Minimal intimal thickening

Moderate to severe neointimal growth with extracellular matrix, smooth muscle cells and angiogenesis

The wealth of data supporting LIMA – LAD is now irrefutable:

- **Survival advantage**
- **Increased freedom from myocardial infarction**
- **Increased freedom from recurrent symptoms**
- **Reduced requirement for further coronary interventions**
- **Long-term patency**

Given the clear benefits of the LIMA graft, we then need to ask ourselves...

Are multiple arterial grafts better than one?

(Is it possible to have too much of a good thing?)

(Do we have enough evidence to prove benefit of multiple arterial grafts?)

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LIMA vs BIMA



The Society
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Surgeons



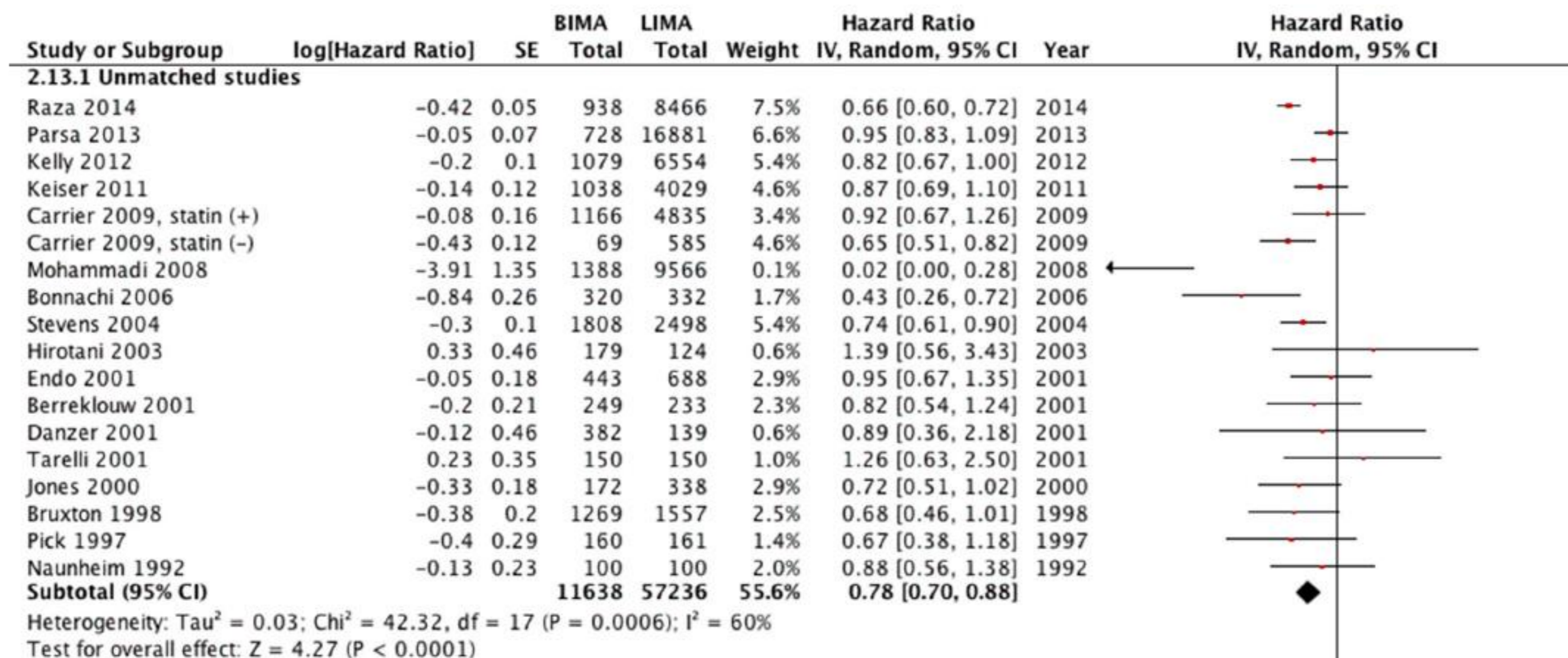
EACTS
European Association For Cardio-Thoracic Surgery

ORIGINAL RESEARCH ARTICLE

Long-term and short-term outcomes of using bilateral internal mammary artery grafting versus left internal mammary artery grafting: a meta-analysis

Sana N Buttar,¹ Tristan D Yan,^{1,2} David P Taggart,³ David H Tian^{1,4}

Long-term survival



Long-term Survival

2.13.2 Propensity matched studies

| | | | | | | | |
|--------------------------|-------|------|-------------|--------------|--------------|--------------------------|------|
| Tsuneyoshi 2015 | 0.54 | 0.34 | 118 | 118 | 1.1% | 1.72 [0.88, 3.34] | 2015 |
| Dalen 2014 | 0.04 | 0.15 | 558 | 558 | 3.6% | 1.04 [0.78, 1.40] | 2014 |
| Benedetto 2014 | -0.49 | 0.24 | 750 | 750 | 1.9% | 0.61 [0.38, 0.98] | 2014 |
| Kinoshita 2012 | -0.58 | 0.3 | 217 | 217 | 1.3% | 0.56 [0.31, 1.01] | 2012 |
| Grau 2012 | -0.4 | 0.11 | 928 | 928 | 5.0% | 0.67 [0.54, 0.83] | 2012 |
| Locker 2012 | -0.31 | 0.11 | 1153 | 1153 | 5.0% | 0.73 [0.59, 0.91] | 2012 |
| Puskas 2012 | -0.43 | 0.15 | 812 | 2715 | 3.6% | 0.65 [0.48, 0.87] | 2012 |
| Joo 2012 | -0.03 | 0.23 | 366 | 366 | 2.0% | 0.97 [0.62, 1.52] | 2012 |
| Kurlansky 2010 | -0.19 | 0.04 | 2197 | 2197 | 7.8% | 0.83 [0.76, 0.89] | 2010 |
| Toumpoulis 2006 | -0.12 | 0.13 | 490 | 490 | 4.3% | 0.89 [0.69, 1.14] | 2006 |
| Lytle 2004 | -0.26 | 0.06 | 1152 | 1152 | 7.1% | 0.77 [0.69, 0.87] | 2004 |
| Calafiore 2004 | -0.66 | 0.26 | 570 | 570 | 1.7% | 0.52 [0.31, 0.86] | 2004 |
| Subtotal (95% CI) | | | 9311 | 11214 | 44.4% | 0.78 [0.71, 0.86] | |

Heterogeneity: $\text{Tau}^2 = 0.01$; $\text{Chi}^2 = 21.05$, $\text{df} = 11$ ($P = 0.03$); $I^2 = 48\%$

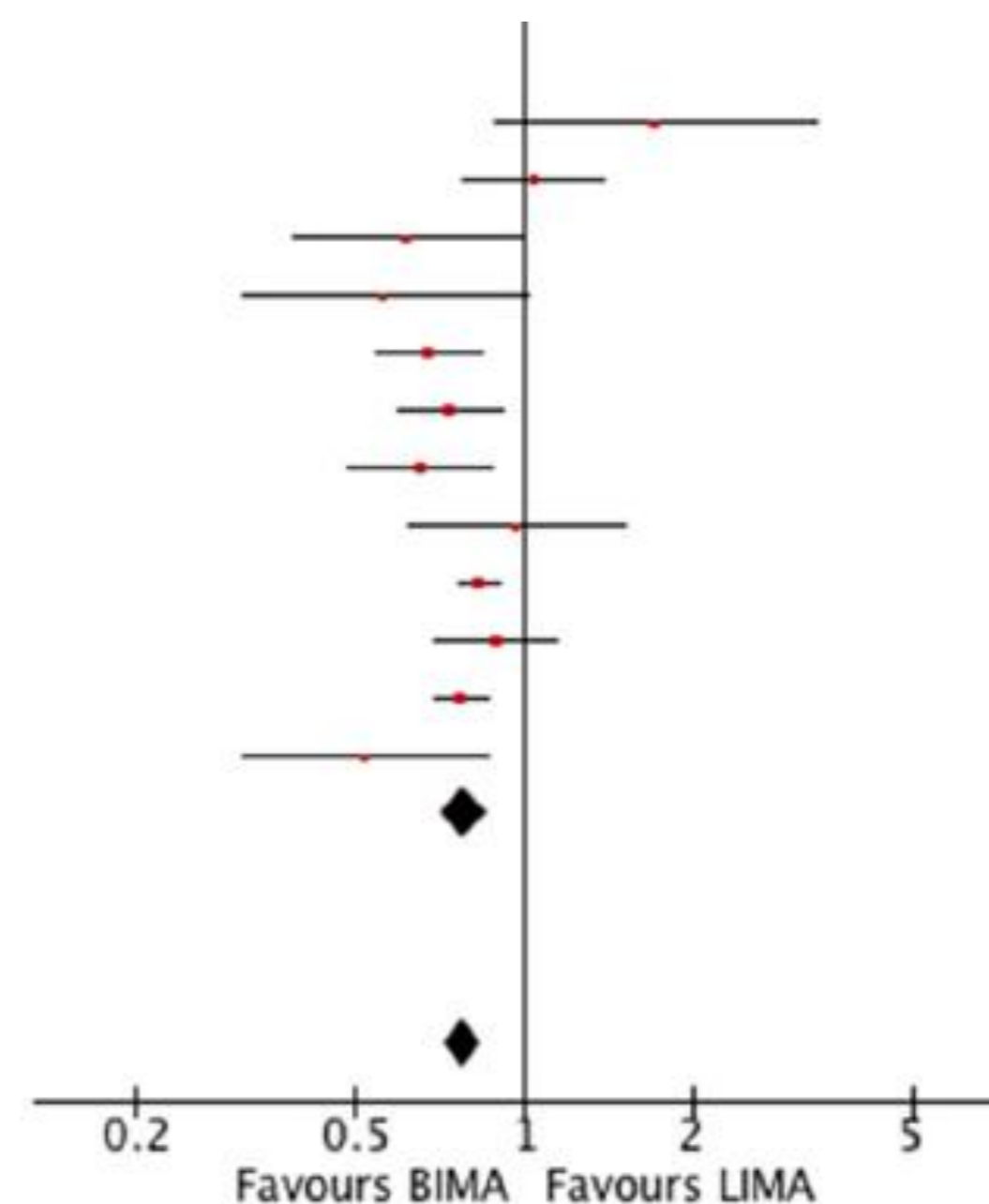
Test for overall effect: $Z = 4.90$ ($P < 0.00001$)

Total (95% CI) **20949** **68450** **100.0%** **0.78 [0.72, 0.84]**

Heterogeneity: $\text{Tau}^2 = 0.02$; $\text{Chi}^2 = 64.57$, $\text{df} = 29$ ($P = 0.0002$); $I^2 = 55\%$

Test for overall effect: $Z = 6.58$ ($P < 0.00001$)

Test for subgroup differences: $\text{Chi}^2 = 0.00$, $\text{df} = 1$ ($P = 0.98$), $I^2 = 0\%$



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BIMA + Radial/GEA vs BIMA + SVG



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BIMA + Radial

European Journal of Cardio-Thoracic Surgery 49 (2016) 203–210
doi:10.1093/ejcts/ezv176 Advance Access publication 23 May 2015

ORIGINAL ARTICLE

Cite this article as: Grau JB, Kushner CE, Johnson CK, Ferrari G, Zapolanski A, Brizzio ME *et al*. The effects of using a radial artery in patients already receiving bilateral internal mammary arteries during coronary bypass grafting: 30-day outcomes and 14-year survival in a propensity-matched cohort. *Eur J Cardiothorac Surg* 2016;49:203–10.

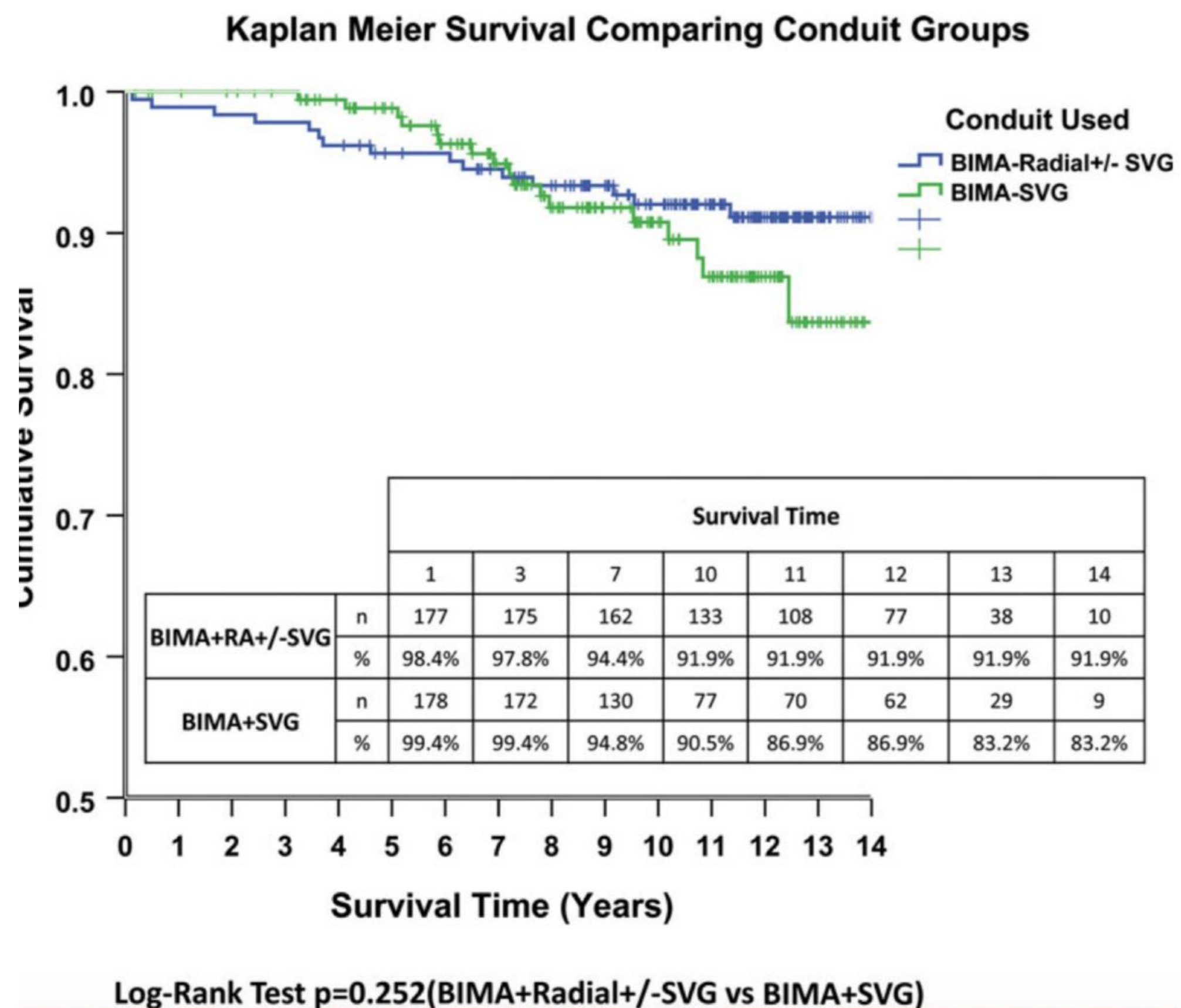
The effects of using a radial artery in patients already receiving bilateral internal mammary arteries during coronary bypass grafting: 30-day outcomes and 14-year survival in a propensity-matched cohort[†]

Juan B. Grau^{a,b,*}, Cyrus E. Kushner^a, Christopher K. Johnson^a, Giovanni Ferrari^{a,b}, Alex Zapolanski^a,
Mariano E. Brizzio^a and Richard E. Shaw^a

^a The Valley Columbia Heart Center, Columbia University College of Physicians and Surgeons, Ridgewood, NJ, USA

^b The University of Pennsylvania School of Medicine, Philadelphia, PA, USA

Long-term survival





Survival benefit of multiple arterial grafting in a 25-year single-institutional experience: the importance of the third arterial graft[†]

David Glineur^{a,*}, William D'hoore^b, Joel Price^a, Sarah Dorméus^a, Laurent de Kerchove^a, Robert Dion^c,
Philippe Noirhomme^a and Gebrine El Khoury^a

^a Department of Cardiovascular Medicine and Surgery, Cliniques Universitaire St Luc, Université Catholique de Louvain, Brussels, Belgium

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^c Department of Cardiac Surgery, Hospital ZOL Genk, Genk, Belgium

Long-term Survival

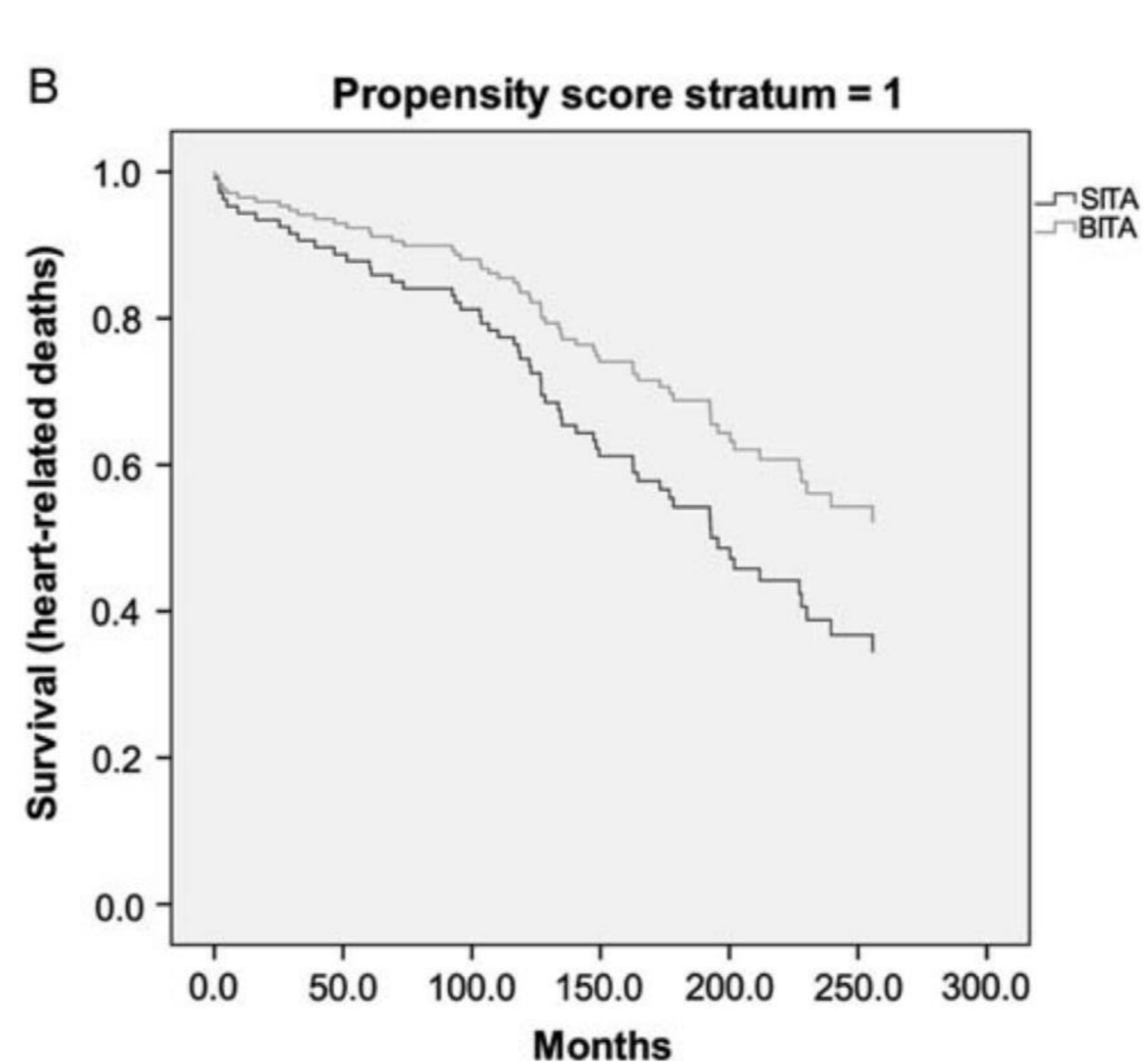


Figure 1: The Kaplan-Meier curves for the lowest quintile of the propensity score in the BITA vs. SITA comparison: (a) overall survival; (b) cardiac death.

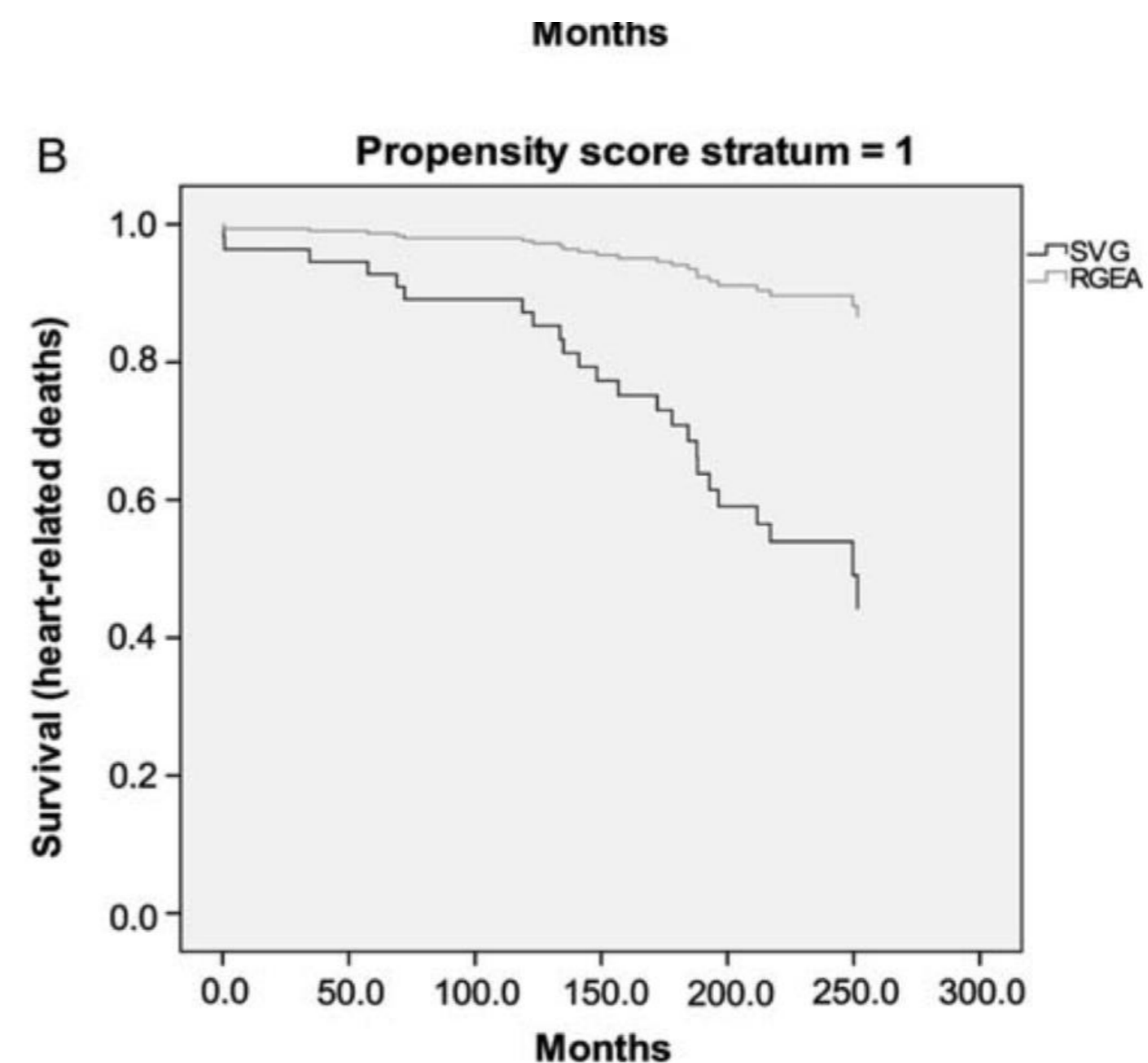


Figure 2: The Kaplan-Meier curves for lowest quintile of the propensity score in the BITA/RGEA vs. BITA/SVG comparison: (a) overall survival; (b) cardiac death.

BIMA sequential vs BIMA SVG

European Journal of Cardio-Thoracic Surgery 51 (2017) 368–375
doi:10.1093/ejcts/ezw282 Advance Access publication 24 October 2016

ORIGINAL ARTICLE

Cite this article as: Glineur D, Etienne P-Y, Kuschner CE, Shaw RE, Ferrari G, Rioux N *et al.* Bilateral internal mammary artery Y construct with multiple sequential grafting improves survival compared to bilateral internal mammary artery with additional vein grafts: 10-year experience at 2 different institutions. *Eur J Cardiothorac Surg* 2017; 51:368–75.

Bilateral internal mammary artery Y construct with multiple sequential grafting improves survival compared to bilateral internal mammary artery with additional vein grafts: 10-year experience at 2 different institutions[†]

David Glineur^{a,b}, Pierre-Yves Etienne^a, Cyrus E. Kuschner^c, Richard E. Shaw^c, Giovanni Ferrari^d, Nancy Rioux^c, Spiridon Papadatos^a, Mariano Brizzio^c, Bruce Mindich^c, Alex Zapolanski^c and Juan B. Grau^{c,d,*}

Long-term survival

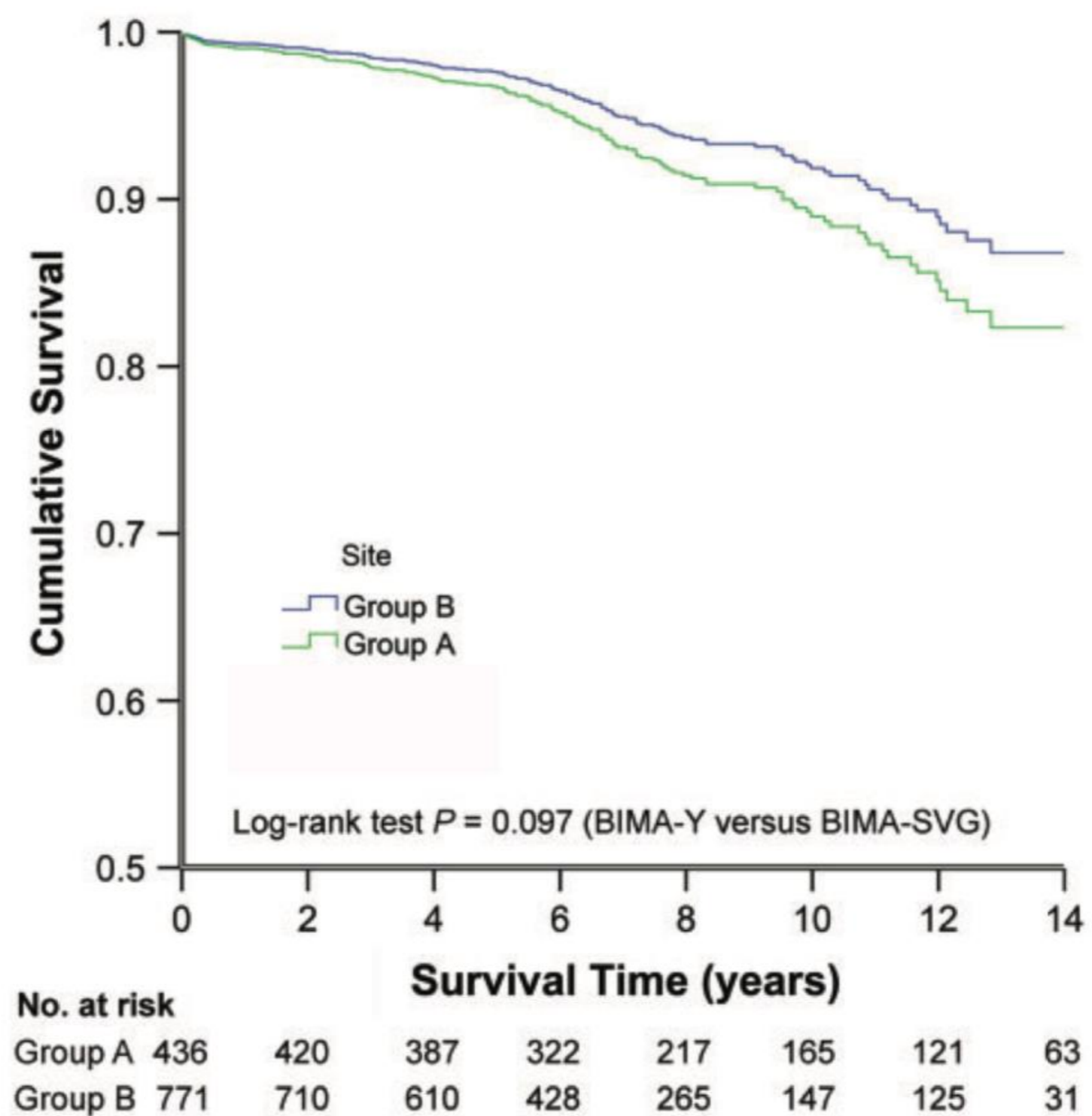


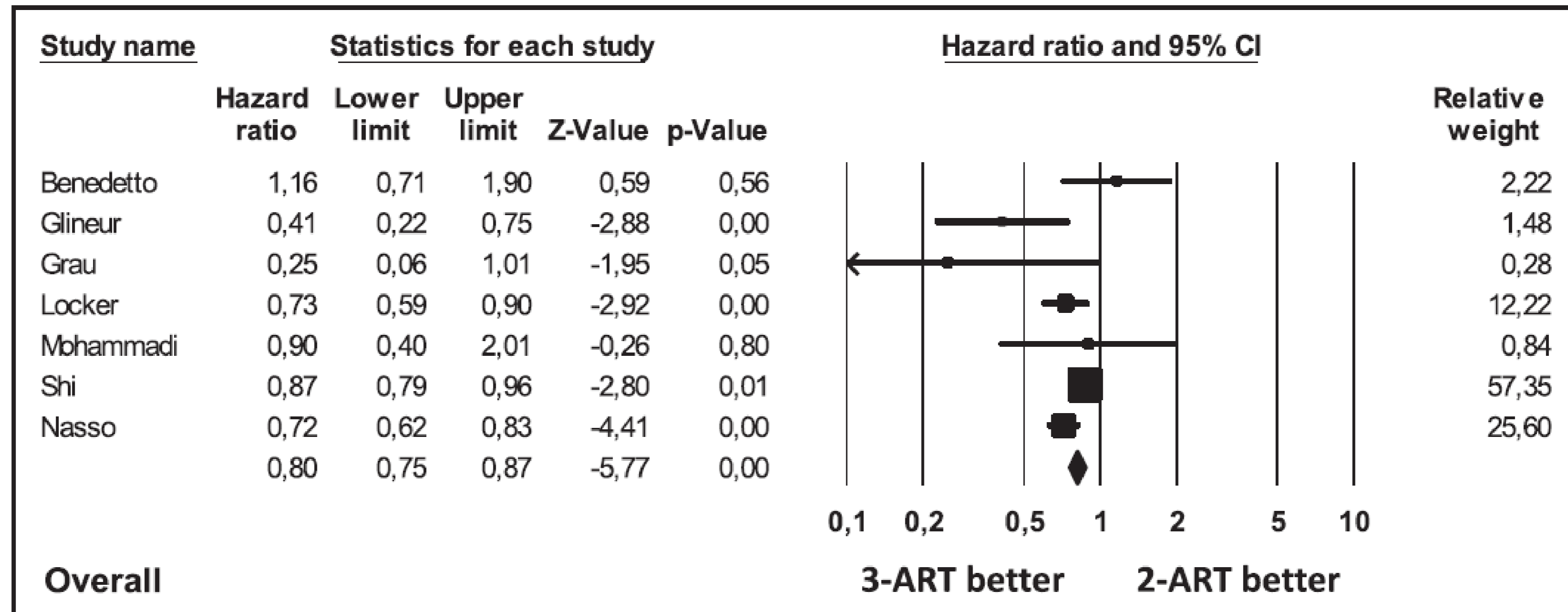
Figure 1: Long-term survival comparing Groups A and B over 14 years. BIMA: bilateral internal mammary arteries; SVG: saphenous vein grafts.

Three Arterial Grafts Improve Late Survival

A Meta-Analysis of Propensity-Matched Studies

Mario Gaudino, MD
John D. Puskas, MD
Antonino Di Franco, MD
Lucas B. Ohmes, MD
Mario Iannaccone, MD
Umberto Barbero, MD
David Glineur, MD
Juan B. Grau, MD
Umberto Benedetto, MD
Fabrizio D'Ascenzo, MD
Fiorenzo Gaita, MD
Leonard N. Girardi, MD
David P. Taggart, MD

Circulation. 2017;135:1036–1044. DOI: 10.1161/CIRCULATIONAHA.116.025453



Arterial Revascularization Trial (ART)

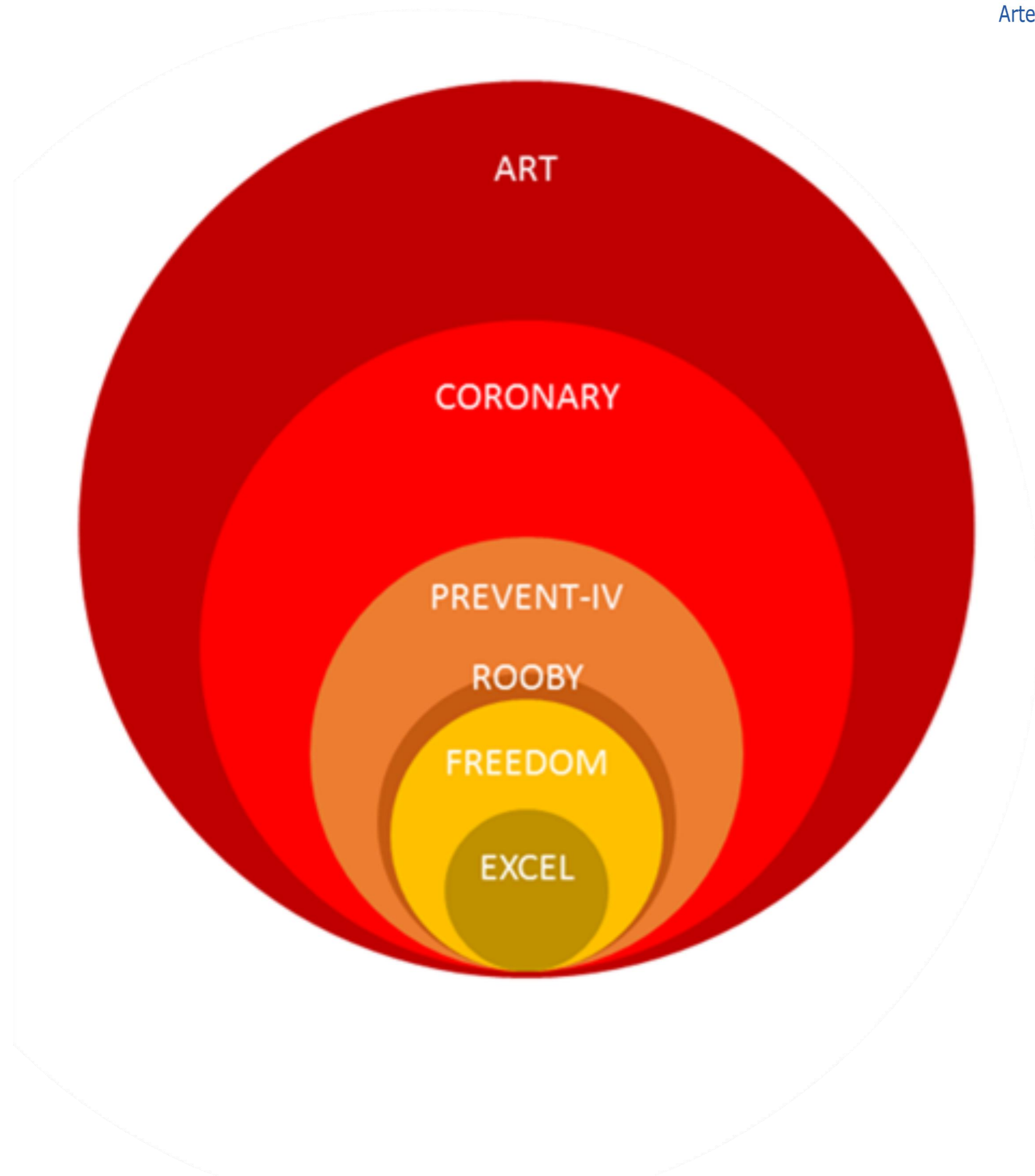
Randomized comparison of single versus bilateral internal thoracic artery grafts in 3102 CABG patients:
Major cardiovascular outcomes at ten years of follow up

David P Taggart MD (Hons), PhD, FRCS, FESC
Professor of Cardiovascular Surgery
University of Oxford, United Kingdom

for the Arterial Revascularization Trial Investigators
(No conflicts declared)

ESC 2018





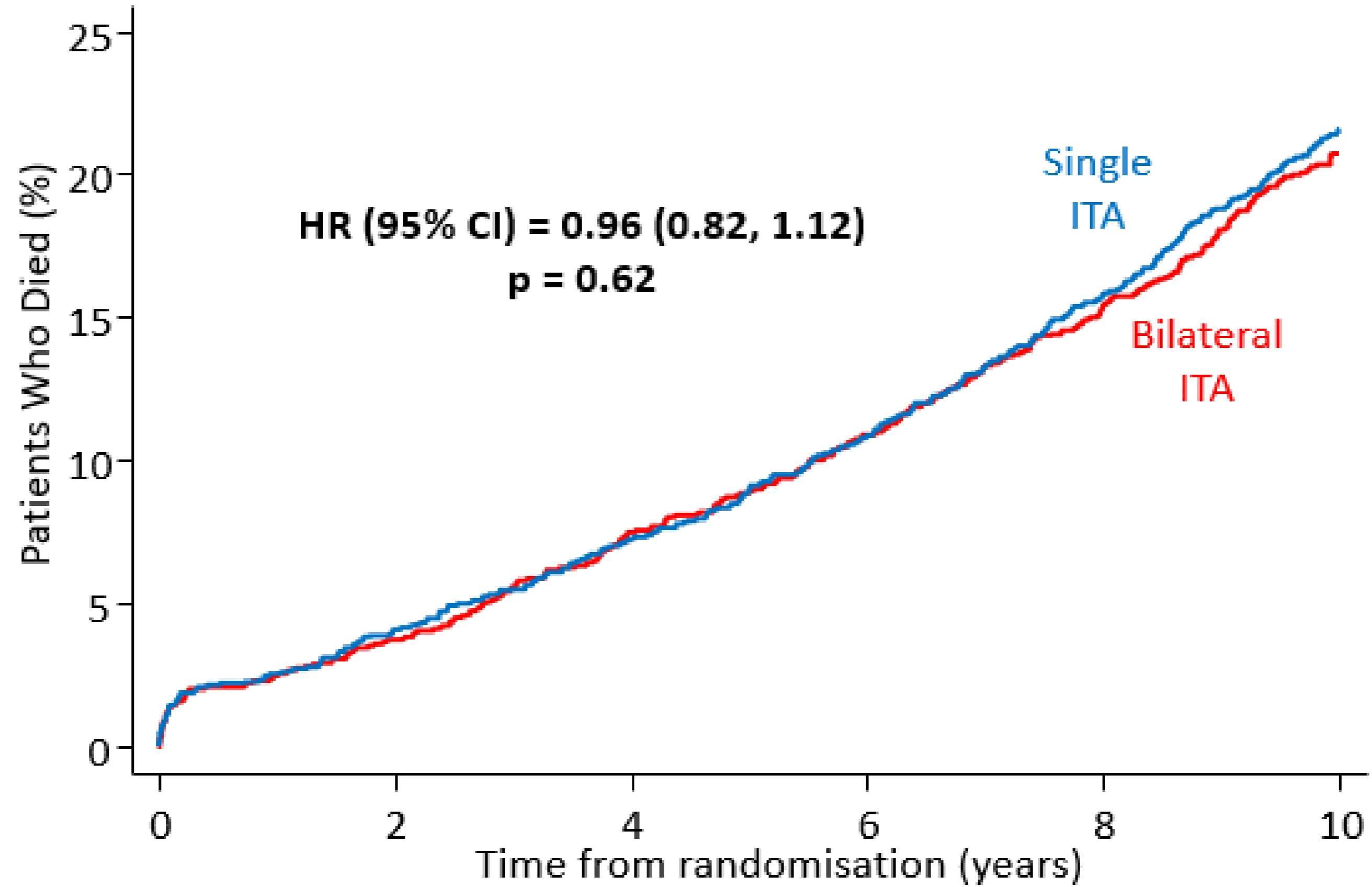
Largest cardiac surgery trials
(sample size is adjusted by the length of the follow-up)

Analysis of Results at 10 Years:

**98.4% of Patients With Vital
Status**

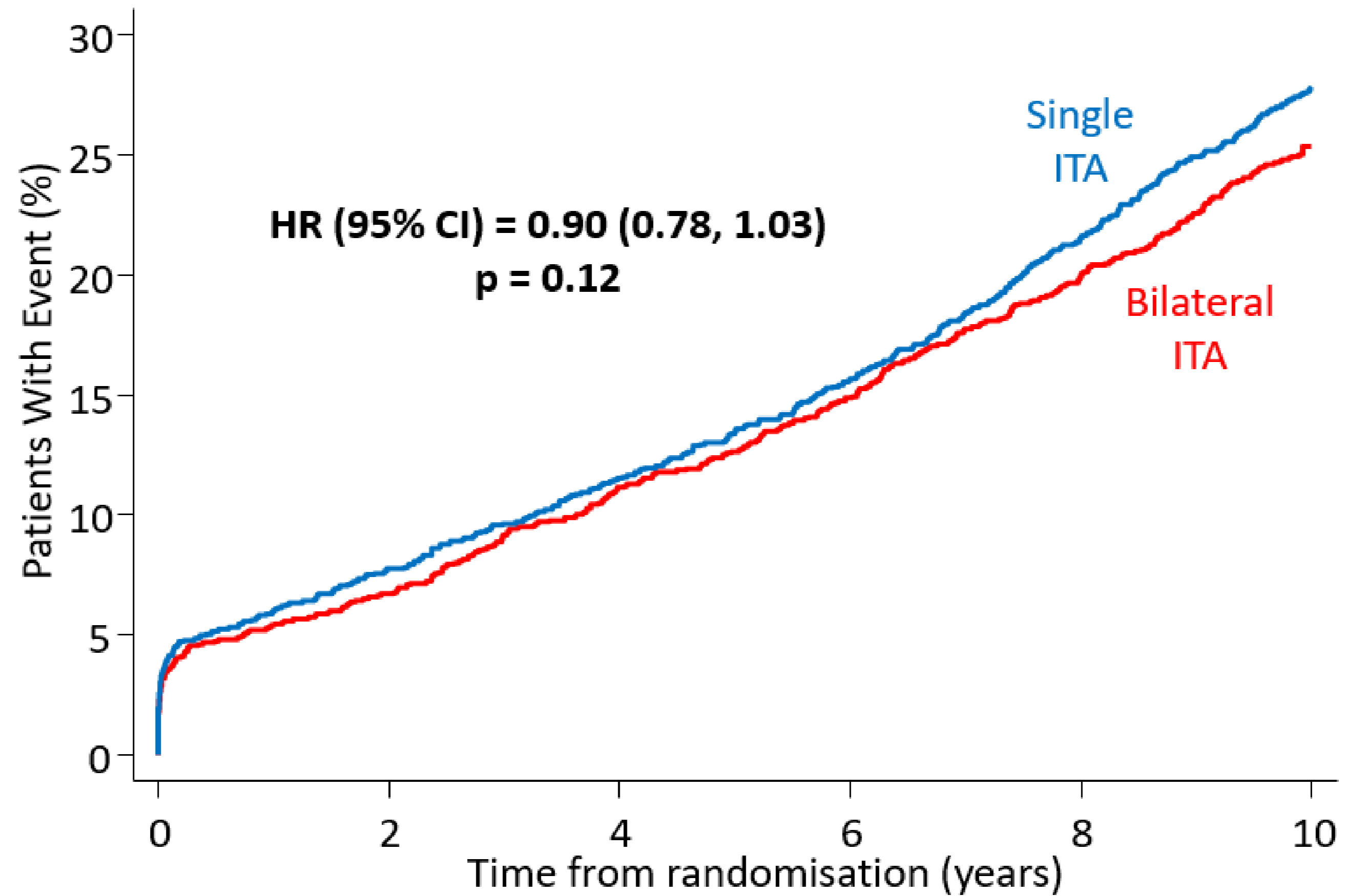
- Intention To Treat (ITT):
- (As Treated (AT)): Non-Randomized
- 36% of Patients Received A 'Different' Treatment Strategy
- 14% of Bilateral ITA crossed to Single ITA
- 22% of Single ITA received a 2nd Arterial Graft (Radial Artery)

Mortality at 10 years (Intention to treat)



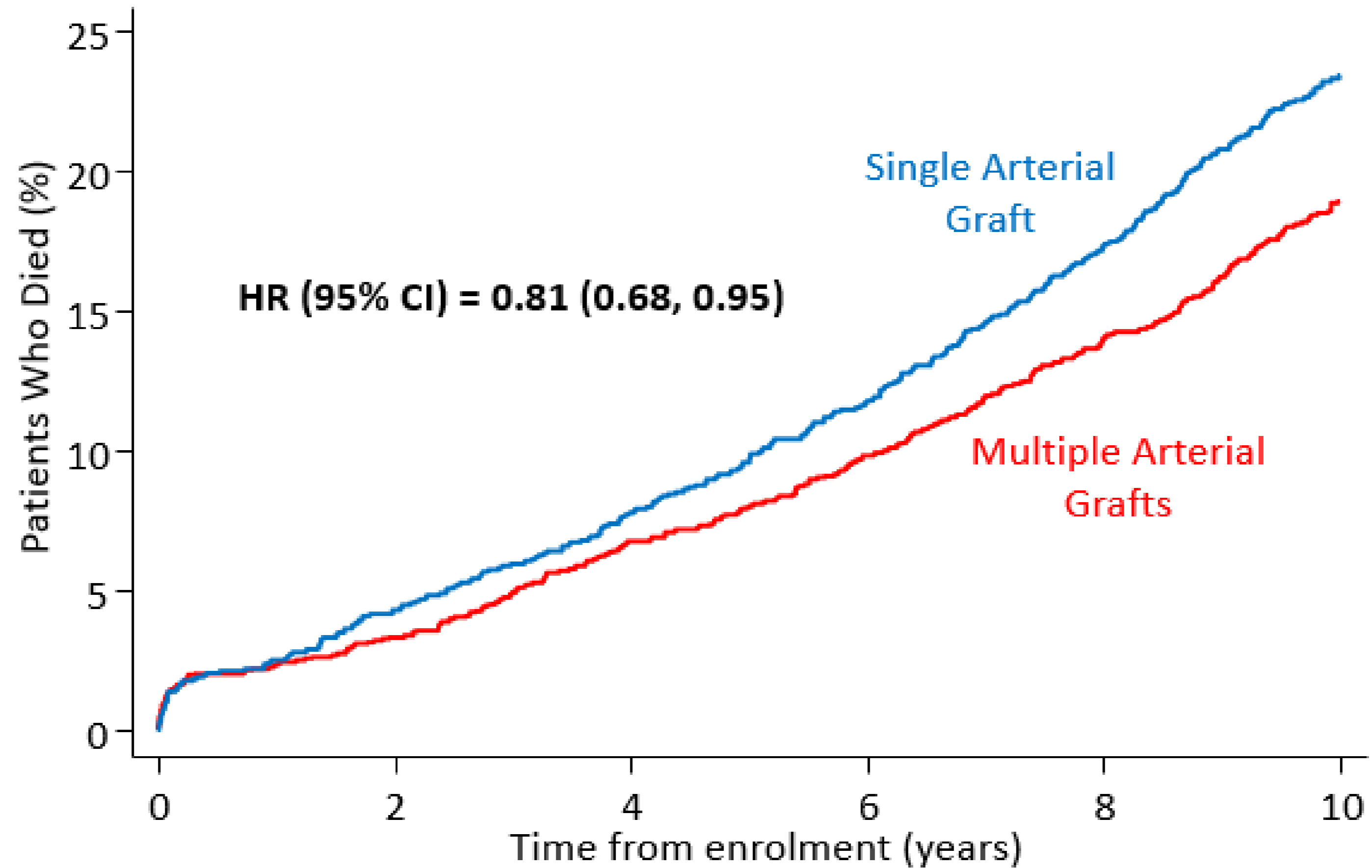
| No. at risk | | | | | | | |
|-----------------|------|------|------|------|------|-----|--|
| Bilateral graft | 1548 | 1481 | 1417 | 1359 | 1283 | 882 | |
| Single graft | 1554 | 1484 | 1432 | 1370 | 1283 | 894 | |

Death/MI/Stroke 10 years (Intention to treat)



| No. at risk | | | | | | | |
|-----------------|------|------|------|------|------|-----|--|
| Bilateral graft | 1548 | 1435 | 1362 | 1299 | 1214 | 830 | |
| Single graft | 1554 | 1427 | 1366 | 1296 | 1194 | 821 | |

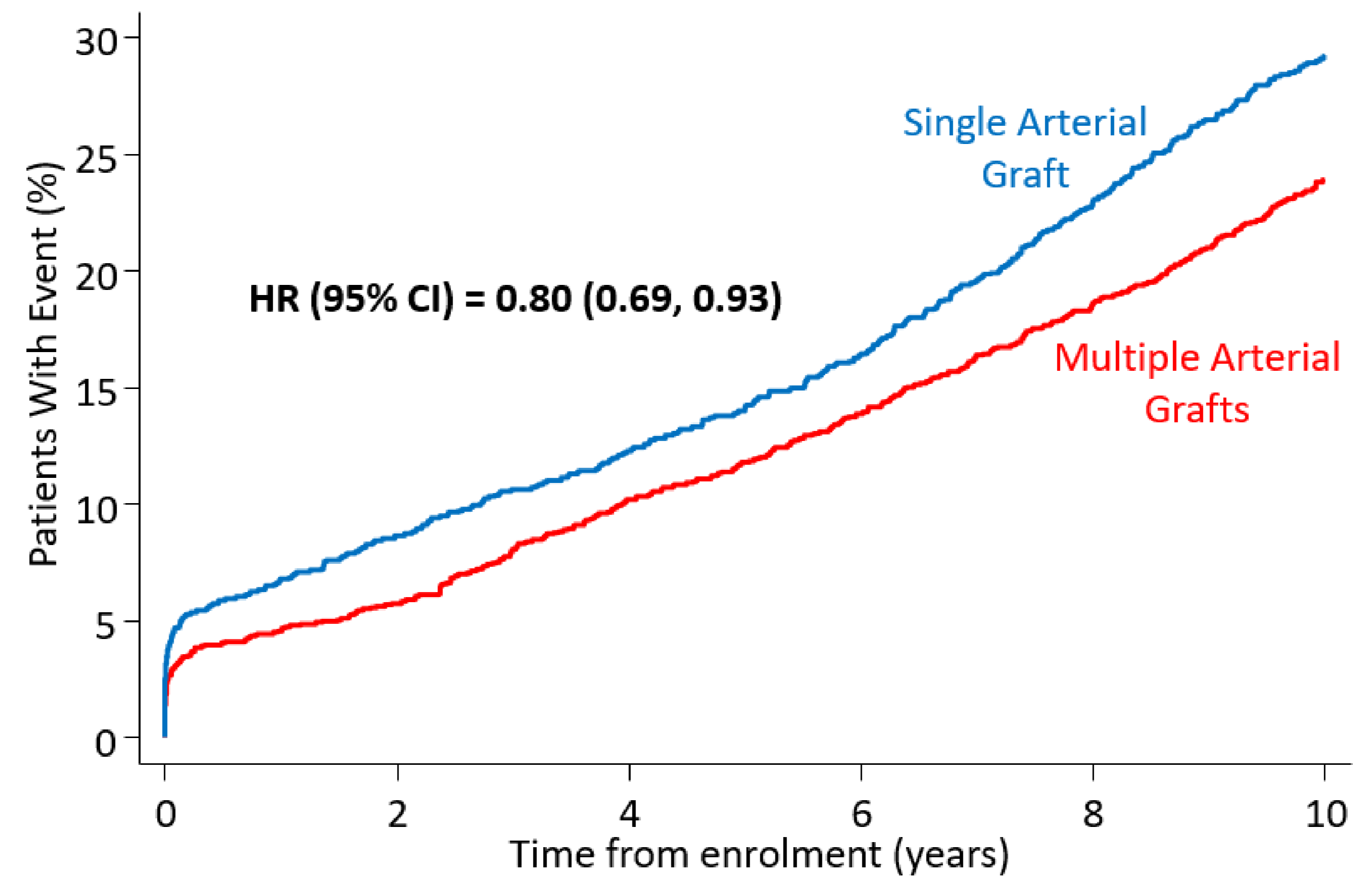
Mortality at 10 years (As treated)



No. at risk

| | | | | | | |
|-----|------|------|------|------|------|-----|
| MAG | 1690 | 1632 | 1567 | 1510 | 1430 | 998 |
| SAG | 1330 | 1270 | 1222 | 1163 | 1081 | 750 |

Death/MI/Stroke 10 years (as treated)

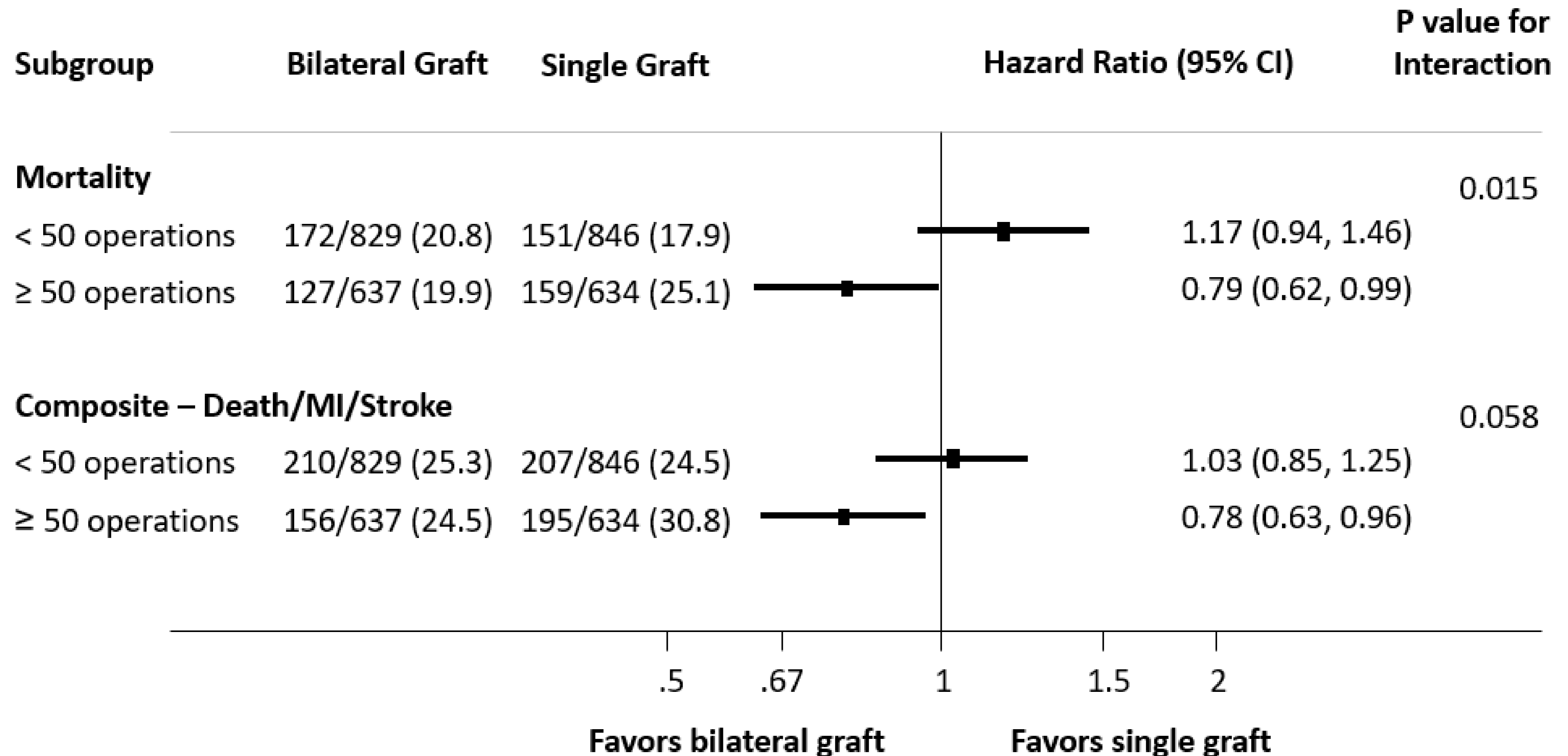


| No. at risk | | 0 | 2 | 4 | 6 | 8 | 10 |
|-------------|--|------|------|------|------|------|-----|
| MAG | | 1690 | 1591 | 1510 | 1442 | 1353 | 934 |
| SAG | | 1330 | 1212 | 1162 | 1101 | 1006 | 692 |

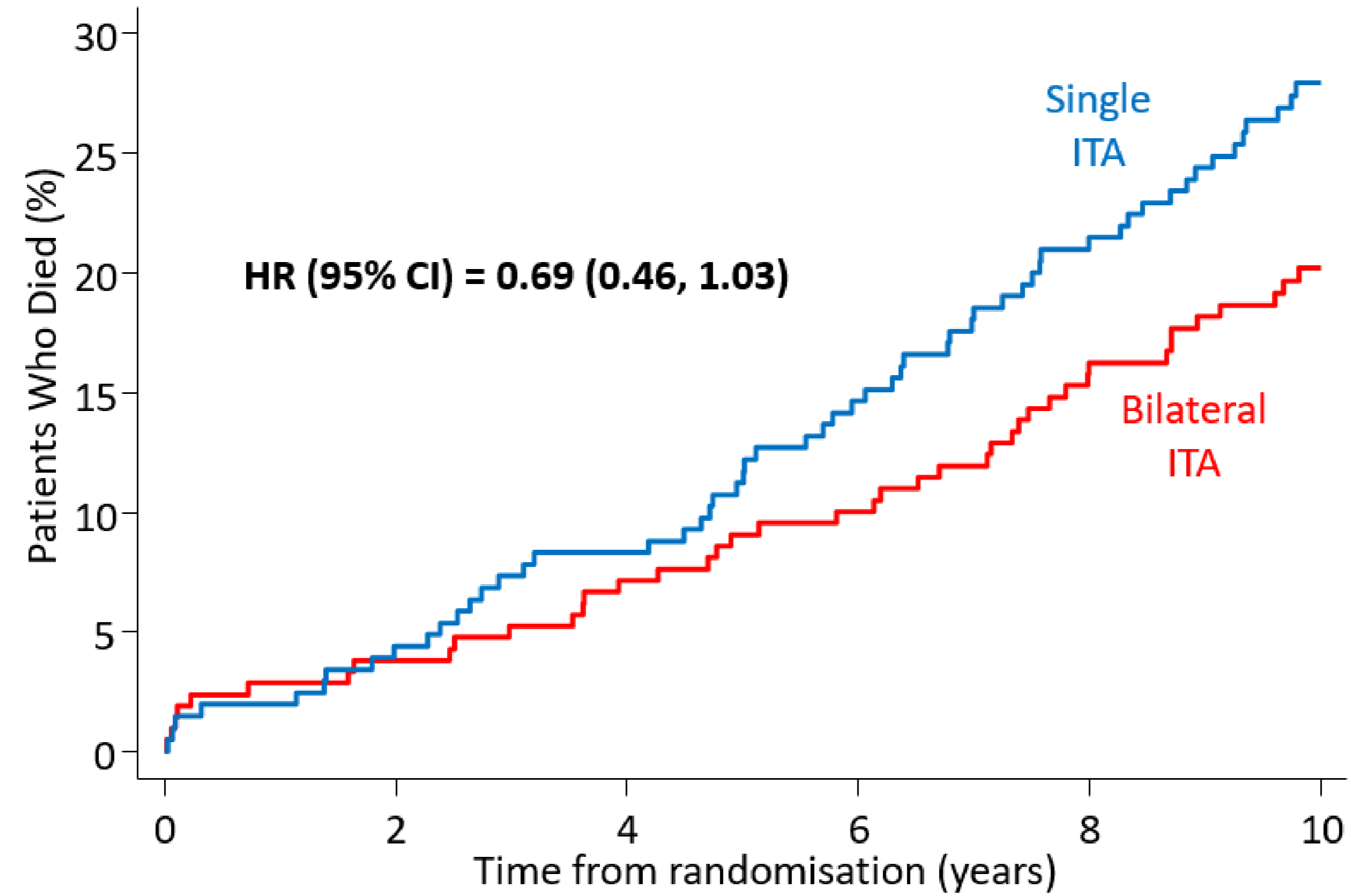
Why No Difference in Bilateral vs Single ITA Grafts at 10 years (Intention To Treat)?

- ① **Genuinely NO Difference:**
(Concept of Complete vs Incomplete Revascularization?)
- ② **Guideline Based Medical Therapy:**
in > 80% (slows vein graft failure?)
- ③ **Radial Artery Use:**
22% of Single ITA: (superior 5yr patency and clinical outcomes)
- ④ **Differential X-over:**
14% of Bilateral ITA → Single ITA; 4% Single ITA → Bilateral ITA
- ⑤ **Surgeon Experience:**
Individual Surgeon X-over for Bilateral ITA to Single ITA : 0%-100%

Effect of surgeon volume in ART



10-Year mortality for highest volume surgeon in ART: 1.2% crossover from BITA to SITA



| No. at risk | | 0 | 2 | 4 | 6 | 8 | 10 |
|-----------------|--|-----|-----|-----|-----|-----|-----|
| Bilateral graft | | 211 | 202 | 195 | 188 | 175 | 122 |
| Single graft | | 205 | 196 | 188 | 175 | 161 | 114 |

- **More than 95% of CABG patients currently receive a single IMA graft, almost invariably to the LAD territory**
- **However, currently, only approx 10-15% of CABG patients in Europe, and only approx 5-8% of CABG patients in the USA, receive BIMA grafts**
- **Concerns raised re BIMA include:**
 - **More technically challenging**
 - **Longer operative times**
 - **May be associated with more perioperative bleeding**
 - **May be associated with impaired sternal wound healing**
 - **“Not worth it,” especially in older patients with comorbidities**

Step by step introduction of Multiple arterial grafts

- Skeletonizing of IMAs
 - Use in-situ grafts initially
- Use Radial
- Composite grafting
 - LIMA Radial Y – LIMA RIMA Y
 - T grafts
- Sequential grafting
 - Vein first then radial and finally IMA
 - Interrupted suturing technique

OFF PUMP vs ON PUMP

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THANK YOU

