



Arterial grafts for patients with low ejection fraction

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**70TH ESCVS
CONGRESS & 7TH
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No Disclosure



What is a low ejection fraction (LEF)

 < 50 % ?

 < 30 % ?

 < 20 % ?



Definition of LEF – Euroscore 2

Patient related factors			Cardiac related factors	
Age ¹ (years)	<input type="text" value="0"/>	<input type="text" value="0"/>	select	<input checked="" type="radio"/>
Gender	<input type="text" value="select"/>	<input type="text" value="0"/>		<input type="radio"/>
Renal impairment ² <small>See calculator below for creatinine clearance</small>	<input type="text" value="normal (CC >85ml/min)"/>	<input type="text" value="0"/>	good (LVEF > 50%)	<input type="radio"/>
Extracardiac arteriopathy ³	<input type="text" value="no"/>	<input type="text" value="0"/>		<input type="radio"/>
Poor mobility ⁴	<input type="text" value="no"/>	<input type="text" value="0"/>		<input type="radio"/>
Previous cardiac surgery	<input type="text" value="no"/>	<input type="text" value="0"/>	moderate (LVEF 31%-50%)	<input type="radio"/>
Chronic lung disease ⁵	<input type="text" value="no"/>	<input type="text" value="0"/>		<input type="radio"/>
Active endocarditis ⁶	<input type="text" value="no"/>	<input type="text" value="0"/>	poor (LVEF 21%-30%)	<input checked="" type="radio"/>
Critical preoperative state ⁷	<input type="text" value="no"/>	<input type="text" value="0"/>		<input type="radio"/>
Diabetes on insulin	<input type="text" value="no"/>	<input type="text" value="0"/>		<input type="radio"/>
EuroSCORE II	<input type="text" value="0"/>		very poor (LVEF 20% or less)	<input checked="" type="radio"/>

Note: This is the 2011 EuroSCORE II

Calculate Clear



What is a low ejection fraction (LEF)

- ✿ Ejection fraction < 35 % in the majority of the study
- ✿ \approx 5 – 10 % of all CABG patients



Rationale for CABG in patients with LEF

STICH Extension Study 2016

CONCLUSIONS

In a cohort of patients with ischemic cardiomyopathy, the rates of death from any cause, death from cardiovascular causes, and death from any cause or hospitalization for cardiovascular causes were significantly lower over 10 years among patients who underwent CABG in addition to receiving medical therapy than among those who received medical therapy alone.

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APRIL 21, 2016

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Coronary-Artery Bypass Surgery in Patients with Ischemic Cardiomyopathy

Eric J. Velazquez, M.D., Kerry L. Lee, Ph.D., Robert H. Jones, M.D., Hussein R. Al-Khalidi, Ph.D., James A. Hill, M.D., Julio A. Panza, M.D., Robert E. Michler, M.D., Robert O. Bonow, M.D., Torsten Doenst, M.D., Mark C. Petrie, M.D., Jae K. Oh, M.D., Lilin She, Ph.D., Vanessa L. Moore, A.A.S., Patrice Desvigne-Nickens, M.D., George Sopko, M.D., M.P.H., and Jean L. Rouleau, M.D., for the STICHES Investigators*

ABSTRACT

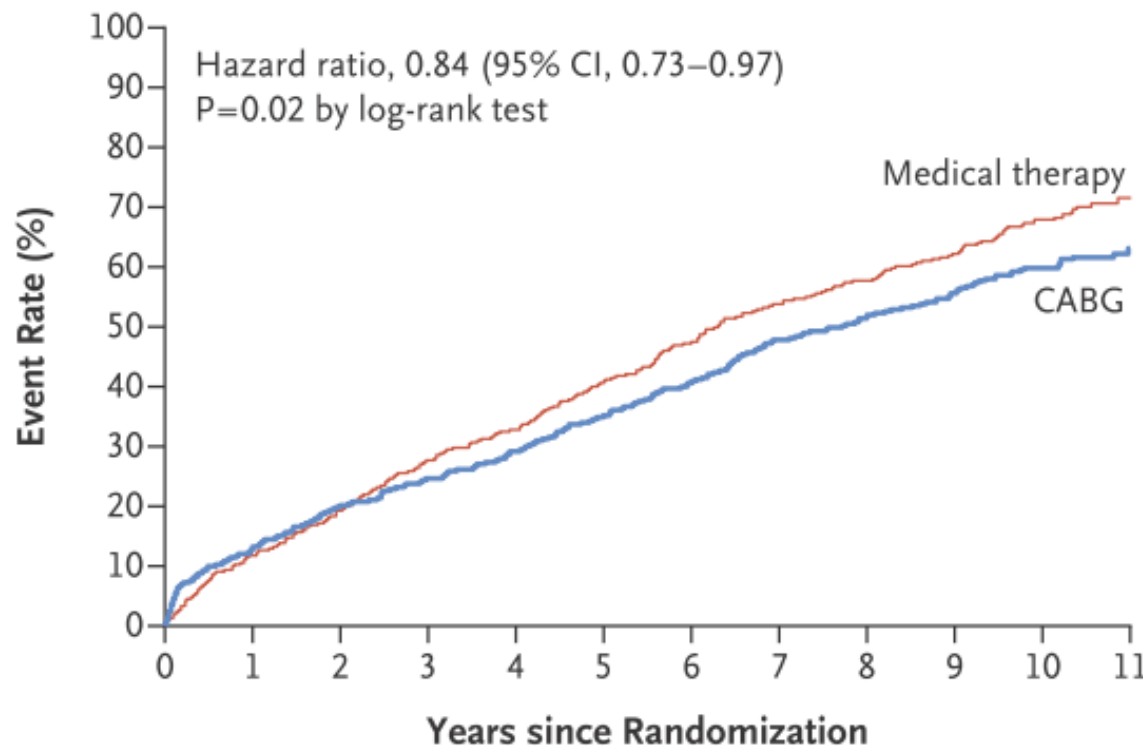
Velazquez EJ et al. N Engl J Med. 2016



STICH Extension Study 2016

Velazquez EJ et al. N Engl J Med. 2016

Death from Any Cause (Primary Outcome)



No. at Risk

Medical therapy	602	532	487	435	404	357	315	274	248	164	82	37
CABG	610	532	487	460	432	392	356	312	286	205	103	42



Bilateral internal thoracic arteries (BITA) for CABG

The Effect of Bilateral Internal Thoracic Artery Grafting on Survival During 20 Postoperative Years

Bruce W. Lytle, MD, Eugene H. Blackstone, MD, Joseph F. Sabik, MD,
Penny Houghtaling, MS, Floyd D. Loop, MD, and Delos M. Cosgrove, MD

Departments of Thoracic and Cardiovascular Surgery, and Biostatistics and Epidemiology, The Cleveland Clinic Foundation, Cleveland, Ohio

Background. To compare survival of patients receiving bilateral internal thoracic artery grafts and single internal thoracic artery grafts more than 20 postoperative years, assess magnitude of benefit, and identify predictors of benefit.

Methods. From cohorts of 8123 patients receiving single internal thoracic artery grafts and 2001 receiving bilateral internal thoracic artery grafts during primary isolated bypass operations for multivessel coronary disease between 1971 and 1989, we identified 1152 propensity-matched pairs. Mean follow-up of survivors was 16.5 years, with 51 patients followed for 20 years or more. Hazard function methodology was used to identify risk factors for mortality, compare survival, and assess magnitude of benefit.

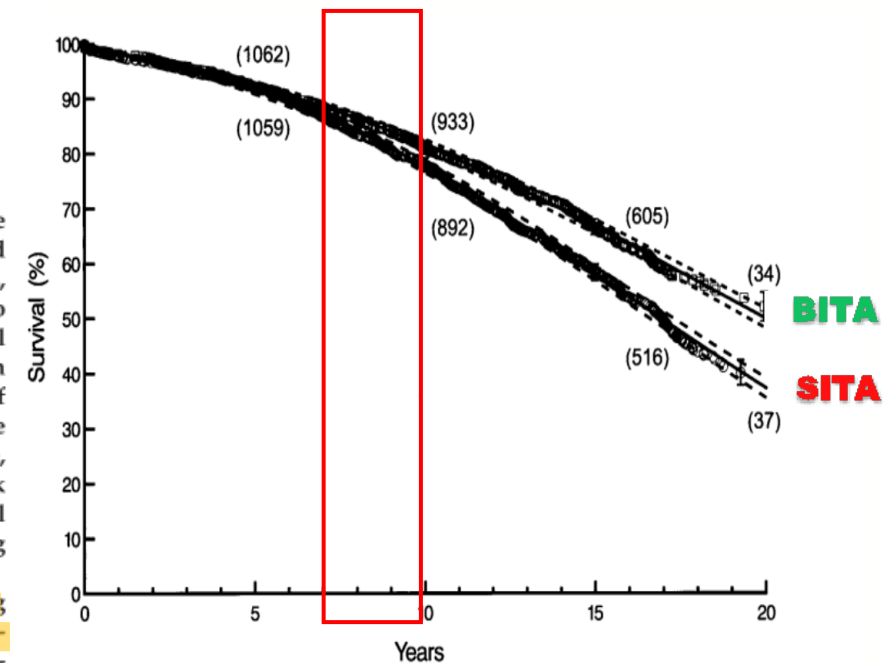
Results. Comparison of the matched pairs showed survival of the bilateral internal thoracic artery and single internal thoracic artery groups at 7, 10, 15, and 20 years was 89% versus 87%, 81% versus 78%, 67% versus 58%, and 50% versus 37%, respectively ($p < 0.0001$).

Divergence of bilateral internal thoracic artery and single internal thoracic artery hazard function curves continued to widen through 20 postoperative years. At 20 years, bilateral internal thoracic artery grafting was predicted to produce worse survival in 2.8% of patients, a survival advantage of less than 5% in 12.9%, greater than 10% in 52%, and greater than 15% in 7.6%. Combinations of cardiac and noncardiac descriptors were used to define higher and lower risk patient subsets. Advanced age, abnormal left ventricular function and noncardiac risk factors decreased overall survival but the incremental benefit of bilateral internal thoracic artery grafting persisted.

Conclusions. Bilateral internal thoracic artery grafting produces improved survival compared with single internal thoracic artery grafting during the second postoperative decade, and the magnitude of that benefit increases through 20 postoperative years.

(Ann Thorac Surg 2004;78:2005-14)

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Lytle et al. Ann Thorac Surg. 2004 Dec



Bilateral internal thoracic arteries (BITA) for CABG

The NEW ENGLAND JOURNAL of MEDICINE

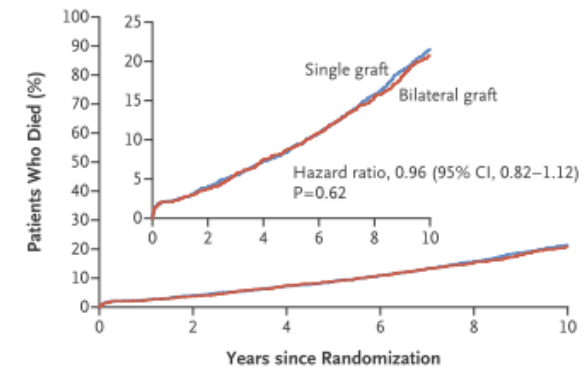
ORIGINAL ARTICLE

Bilateral versus Single Internal-Thoracic-Artery Grafts at 10 Years

David P. Taggart, M.D., Ph.D., Umberto Benedetto, M.D., Ph.D.,
Stephen Gerry, M.Sc., Douglas G. Altman, D.Sc.,* Alastair M. Gray, Ph.D.,
Belinda Lees, Ph.D., Mario Gaudino, M.D., Vipin Zamvar, M.S., F.R.C.S.,
Andrzej Bochenek, M.D., Brian Buxton, M.D., Cliff Choong, M.D.,
Stephen Clark, M.D., Marek Deja, M.D., Jatin Desai, M.D., Ragheb Hasan, M.D.,
Marek Jasinski, M.D., Peter O'Keefe, M.D., Fernando Moraes, M.D.,
John Pepper, M.D., Siven Seevanayagam, M.D., Catherine Sudarshan, M.D.,
Uday Trivedi, M.D., Stanislaw Wos, M.D., John Puskas, M.D., and
Marcus Flather, M.B., B.S., for the Arterial Revascularization Trial Investigators†

Taggart et al. *N Engl J Med.* 2016 Dec

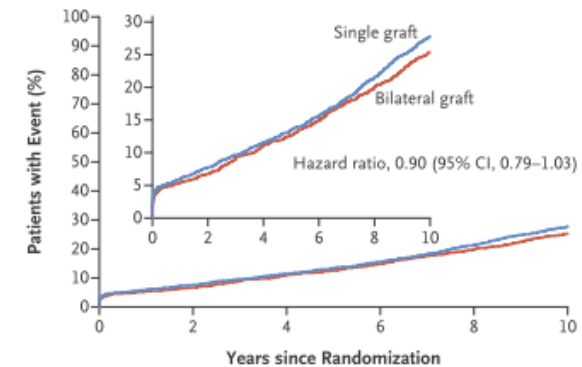
All-cause mortality @ 5 years



No. at Risk	0	2	4	6	8	10
Single graft	1554	1484	1432	1370	1283	894
Bilateral graft	1548	1481	1417	1359	1283	882

ART Trial NEJM 2019

Composite of death from any cause, myocardial infarction, or stroke @ 5 years

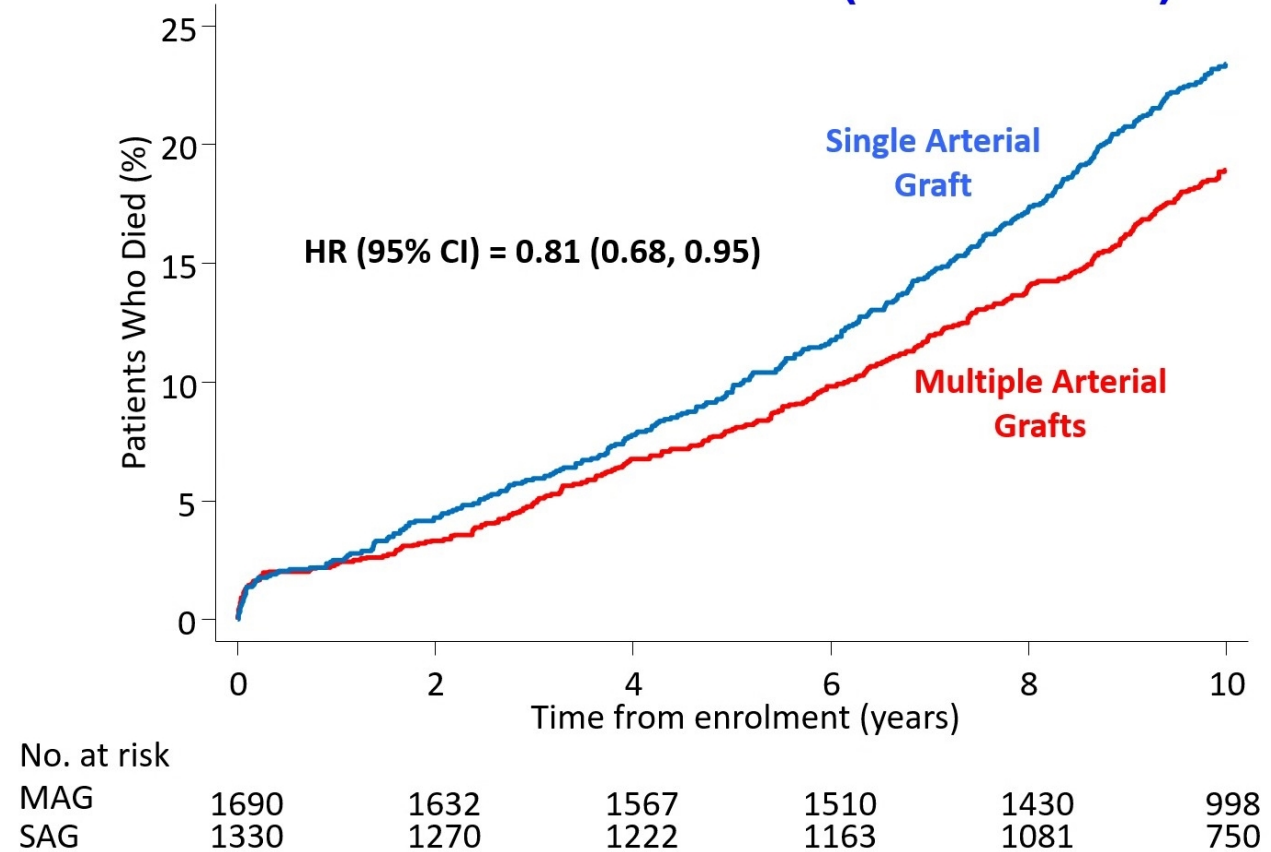


No. at Risk	0	2	4	6	8	10
Single graft	1554	1427	1366	1296	1195	820
Bilateral graft	1548	1435	1362	1299	1214	830



Bilateral internal thoracic arteries (BITA) for CABG

MORTALITY AT 10 YEARS (As Treated)





Bilateral internal thoracic arteries (BITA) for CABG

The **NEW ENGLAND**
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VOL. 378 NO. 22

Radial-Artery or Saphenous-Vein Grafts in Coronary-Artery Bypass Surgery

Mario Gaudino, M.D., Umberto Benedetto, M.D., Stephen Fremes, M.D., Giuseppe Biondi-Zoccai, M.D., M.Stat., Art Sedrakyan, M.D., Ph.D., John D. Puskas, M.D., Gianni D. Angelini, M.D., Brian Buxton, M.D., Giacomo Frati, M.D., David L. Hare, M.D., Philip Hayward, M.D., Giuseppe Nasso, M.D., Neil Moat, M.D., Miodrag Peric, M.D., Kyung J. Yoo, M.D., Giuseppe Speziale, M.D., Leonard N. Girardi, M.D., and David P. Taggart, M.D., for the RADIAL Investigators*

Table 3. Main Outcomes.*

Outcome	Radial-Artery Group (N=534)		Saphenous-Vein Group (N=502)		Treatment Effect†	
	No. of Events (%)	Events per 1000 Patient-Yr‡	No. of Events (%)	Events per 1000 Patient-Yr‡	Hazard Ratio (95% CI)	P Value
Death, myocardial infarction, or repeat revascularization	67 (12.5)	25	94 (18.7)	39	0.67 (0.49–0.90)	0.01
Death	40 (7.5)	15	42 (8.4)	17	0.90 (0.59–1.41)	0.68
Myocardial infarction	16 (3.0)	6	21 (4.2)	9	0.72 (0.53–0.99)	0.04
Repeat revascularization	23 (4.3)	9	43 (8.6)	17	0.50 (0.40–0.63)	<0.001
Graft occlusion§	28/345 (8.1)	19	61/307 (19.9)	46	0.44 (0.28–0.70)	<0.001

Gaudino et al. N Engl J Med. 2018 May



Concerns associated with multiple arterial grafting

BITA grafting

- ↑ incidence of sternal wound infection
- More technically demanding than SVG (size of the conduit, thinness of the wall)
- Time consuming (skeletonization of ITAs)

Radial artery grafting

- Competitive flow (Right coronary artery, stenosis < 70 – 80 %)

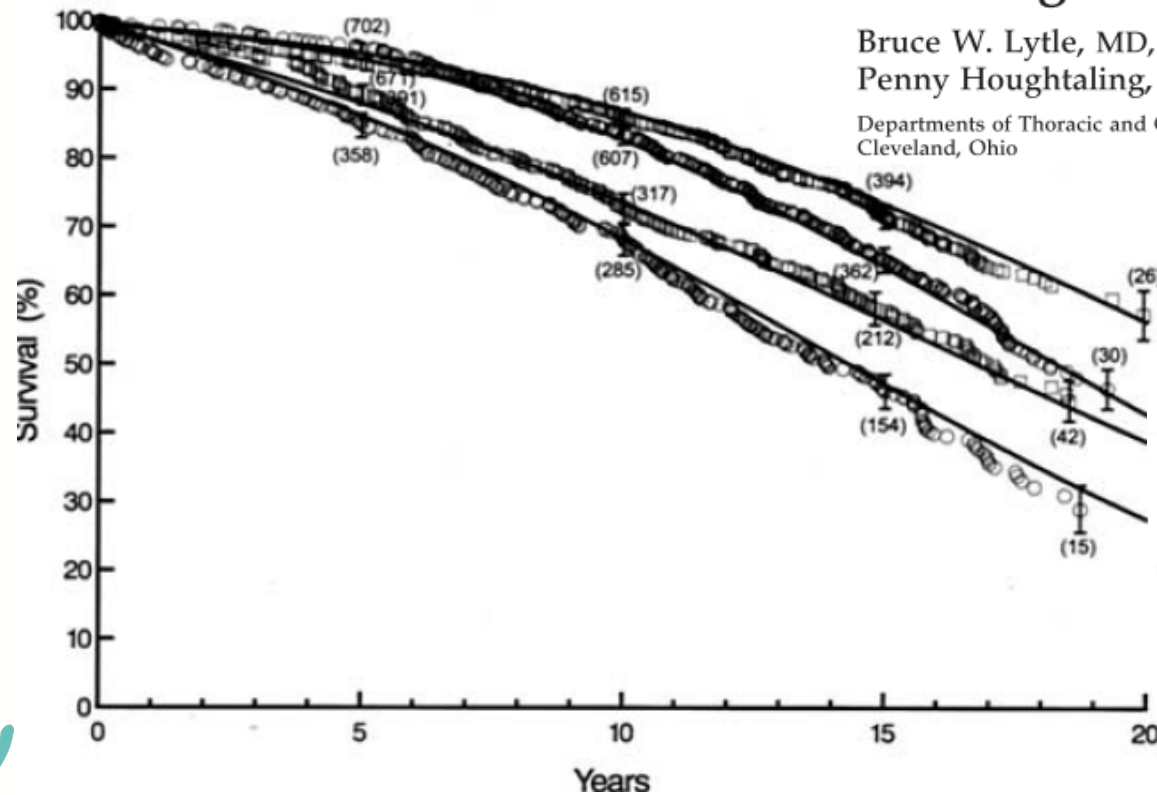


Evidence for the use of BITA in patients with LEF

The Effect of Bilateral Internal Thoracic Artery Grafting on Survival During 20 Postoperative Years

Bruce W. Lytle, MD, Eugene H. Blackstone, MD, Joseph F. Sabik, MD,
Penny Houghtaling, MS, Floyd D. Loop, MD, and Delos M. Cosgrove, MD

Departments of Thoracic and Cardiovascular Surgery, and Biostatistics and Epidemiology, The Cleveland Clinic Foundation, Cleveland, Ohio



BITA - LVF : normal / mild

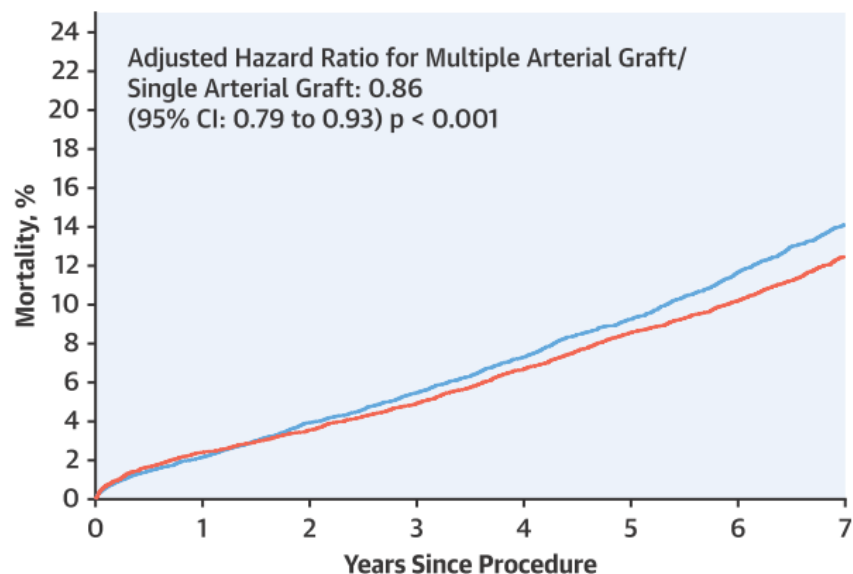
SITA - LVF : normal / mild

BITA - LVF : moderate / severe

SITA - LVF : moderate / severe



Evidence for the use of MAG in patients with LEF



No. at Risk	0	1	2	3	4	5	6	7
SAG	10,828	10,593	10,397	9,415	8,438	7,474	6,465	5,406
MAG	10,828	10,566	10,440	9,457	8,488	7,513	6,574	5,519

— SAG — MAG

Samadashvili et al. J Am Coll Cardiol. 2019 Sep

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY

VOL. 74, NO. 10, 2019

TABLE 4 7-Year Mortality for Subgroups of Multivessel Disease Patients With Single-Arterial Versus Multiple-Arterial CABG: New York, 2005 to 2014

	Multiple Artery Grafts		Single Artery Graft		Adjusted Hazard Ratio MAG/SAG (95% CI)	p Value
	Pts at Risk, n	Deaths (KM-est)	Pts at Risk, n	Deaths (KM-est)		
All patients	5,519	1,158 (12.7)	5,406	1,306 (14.3)	0.86 (0.79–0.93)	<0.001
Age ≥70 yrs						
Yes	948	541 (28.3)	945	521 (27.6)	0.98 (0.87–1.11)	0.74
No	4,571	617 (8.6)	4,461	785 (10.9)	0.78 (0.70–0.87)	<0.001
Type of surgery						
Off-pump	1,051	244 (14.4)	1,063	258 (15.5)	0.98 (0.82–1.17)	0.79
On-pump	4,468	914 (12.3)	4,343	1,048 (14.1)	0.83 (0.76–0.91)	<0.001
2-vessel disease with RCA involvement						
Yes	1,129	244 (12.9)	1,134	232 (11.9)	1.04 (0.87–1.25)	0.64
No	4,390	914 (12.6)	4,272	1,074 (15.0)	0.82 (0.75–0.89)	<0.001
Diabetes						
Yes	1,571	505 (17.4)	1,508	574 (19.9)	0.85 (0.75–0.96)	0.01
No	3,948	653 (10.5)	3,898	732 (11.8)	0.88 (0.79–0.98)	0.02
LVEF <50%						
Yes	1,752	515 (17.6)	1,683	584 (20.2)	0.82 (0.73–0.93)	0.002
No	3,767	643 (10.4)	3,723	722 (11.7)	0.89 (0.80–1.00)	0.042
Previous AMI, ≤20 days						
Yes	767	184 (13.5)	763	195 (14.5)	0.91 (0.74–1.11)	0.35
No	4,346	825 (11.8)	4,245	950 (13.5)	0.84 (0.76–0.92)	<0.001
Renal dysfunction						
Yes	174	174 (40.3)	177	173 (41.1)	1.00 (0.80–1.24)	>0.99
No	5,345	984 (11.3)	5,229	1,133 (13.1)	0.84 (0.77–0.92)	<0.001

Lahey, MD,^h





Evidence for the use of BIMA in patients with LEF

Acquired Cardiovascular Disease

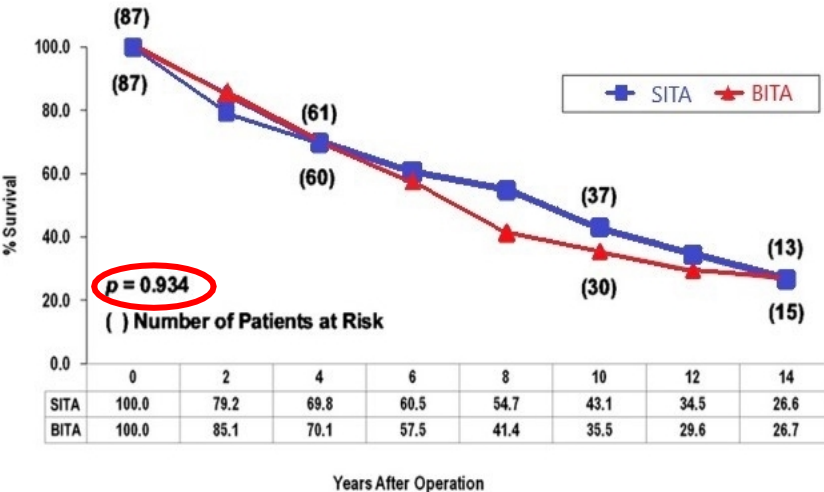
Galbut et al

Bilateral internal thoracic artery grafting improves long-term survival in patients with reduced ejection fraction: A propensity-matched study with 30-year follow-up

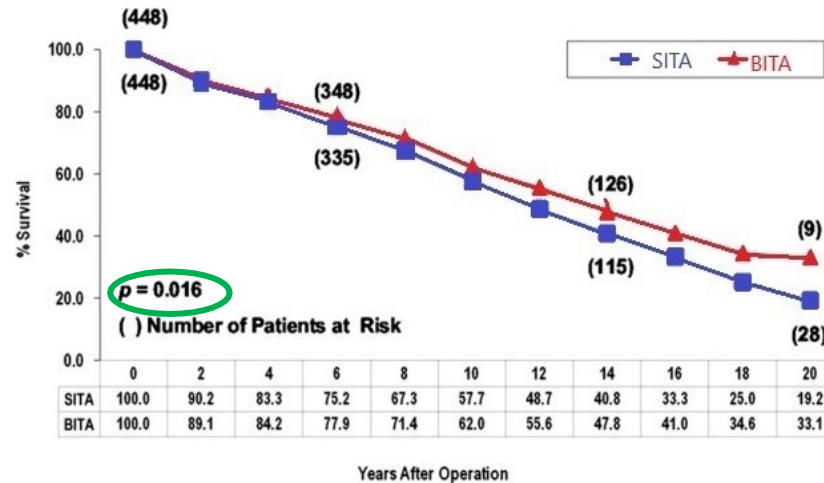
David L. Galbut, MD,^a Paul A. Kurlansky, MD,^b Ernest A. Traad, MD,^b Malcolm J. Dorman, MD,^c Melinda Zucker, MSRN,^c and George Ebra, EdD^{a,c}

J Thorac Cardiovasc Surg. 2012 Apr;143(4):844-853

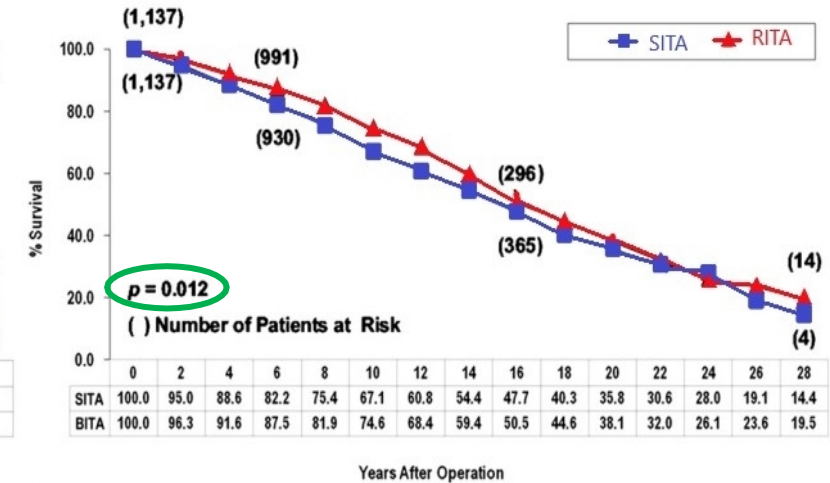
Survival Curves - EF < 30%



Survival Curves - EF : 30 - 50%



Survival Curves - EF > 50%





Evidence for the use of BITA in patients with LEF

Heart Vessels (2016) 31:1045–1055
DOI 10.1007/s00380-015-0714-9



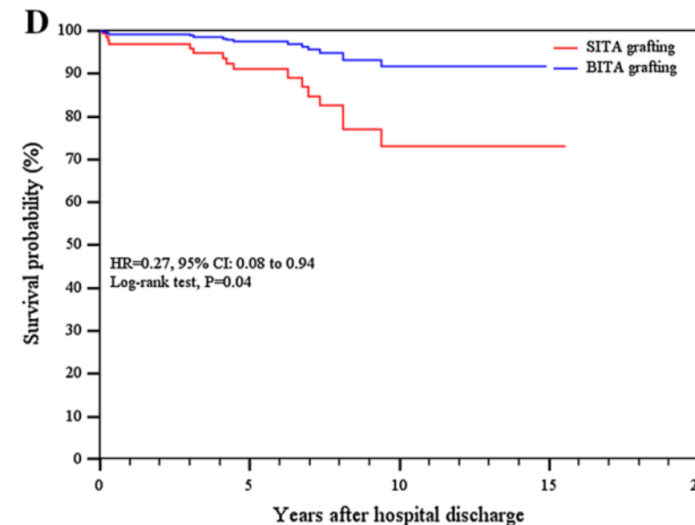
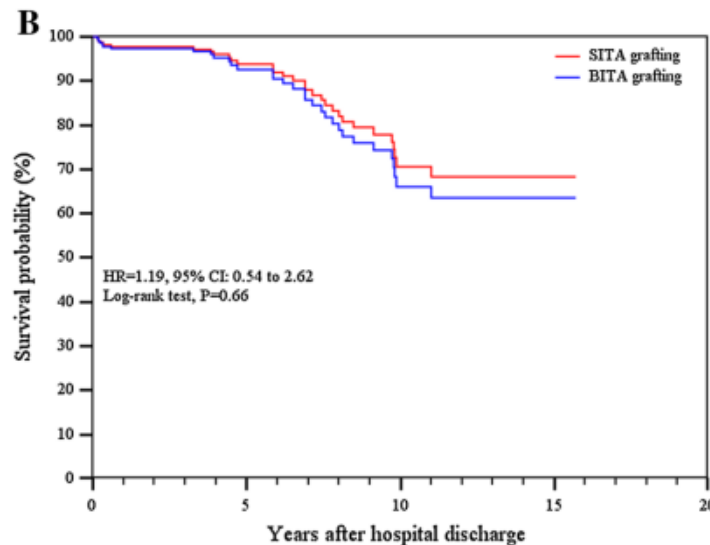
ORIGINAL ARTICLE

Predictors of immediate and long-term outcomes of coronary bypass surgery in patients with left ventricular dysfunction

Giuseppe Gatti¹ · Luca Maschietto¹ · Luca Dell'Angela² · Bernardo Benussi¹ · Gabriella Forti¹ · Lorella Dreas¹ · Petar Soso¹ · Marco Russo² · Gianfranco Sinagra² · Aniello Pappalardo¹

Gatti et al. Heart Vessels. 2016 Jul

Adjusted survival-free from cardiac death curve in patients **without early significant improvement of EF**



Adjusted survival-free from cardiac death curve in patients **with early significant improvement of EF**



Evidence for the use of radial artery in patients with LEF

The NEW ENGLAND
JOURNAL of MEDICINE

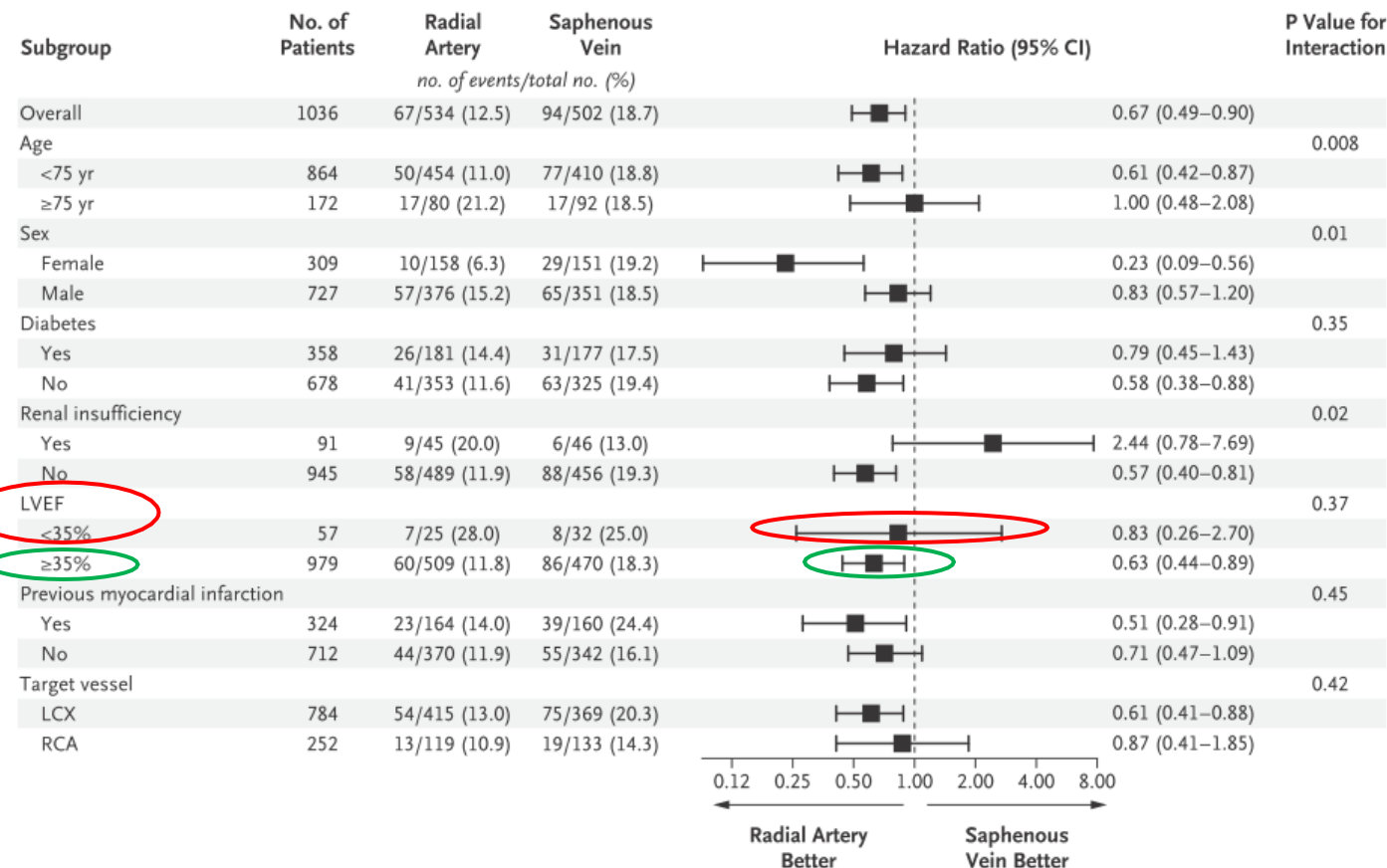
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Gaudino et al. N Engl J Med. 2018 May

Figure 2. Subgroup Analyses and Interaction Terms for the Primary Composite Outcome of Death, Myocardial Infarction, or Repeat Revascularization.



Conclusions

- ✦ The evidence supporting the routine use of a multiarterial grafting strategy in patients with severe LV dysfunction is weak.
- ✦ A tailored approach considering the characteristics of the patient, the expertise of the surgeon and the expected improvement of the LV function is required to choose the best conduits for patients with severe chronic LV dysfunction undergoing CABG.

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