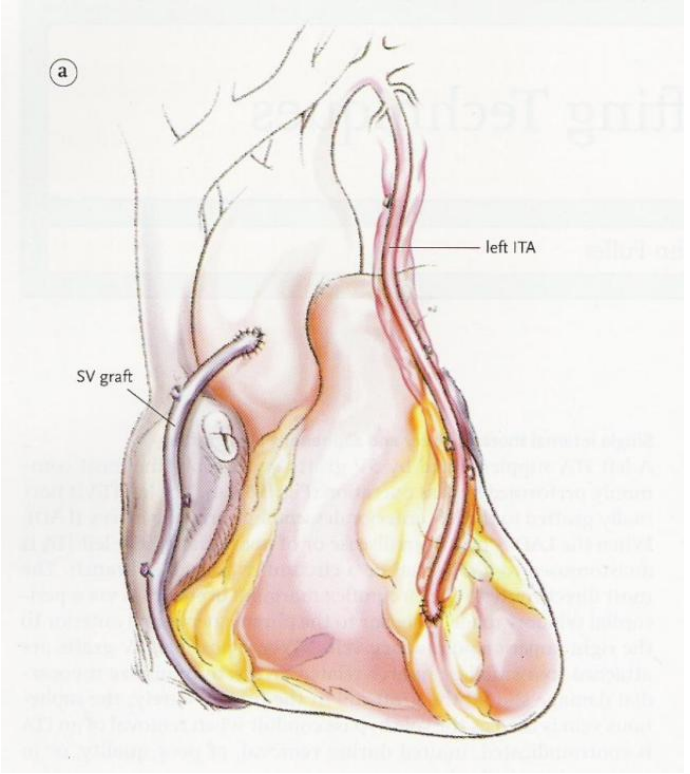
Conduit choice for CABG

경북대학교병원 흉부외과
김근직

Purposes of CABG

- **Relief of anginal symptoms**
- **Better quality of life**
- **Risk of a MI ↓**
- **Life expectancy ↑**



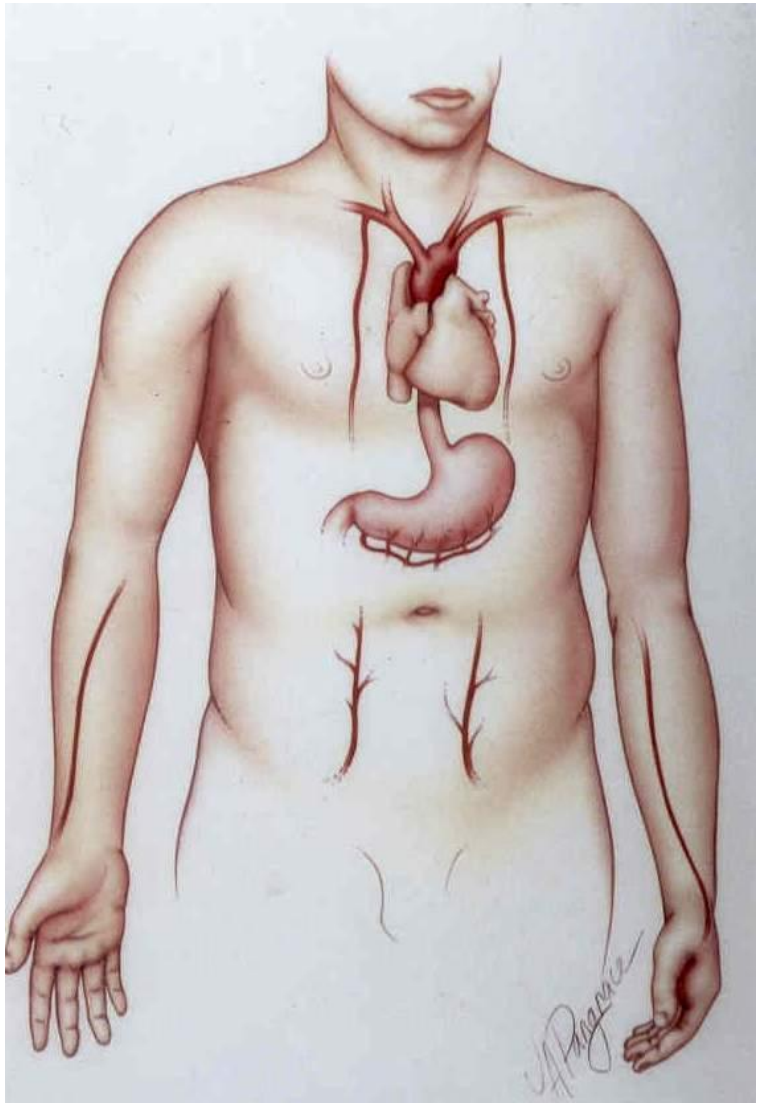
directly related to graft patency !

Conduit selection is important in determining the long-term efficacy.

Conduits for CABG

- **Arterial graft**
  - **Internal mammary artery**
  - **Radial artery**
  - **Gastroepiploic artery**
  - **Inferior epigastric artery**

- **Venous grafts**
  - **Greater saphenous vein**
  - **Lesser saphenous vein**



2011 ACCF/AHA Guideline

SIZE OF TREATMENT EFFECT

ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT

	CLASS I *Benefit >>> Risk* Procedure/Treatment **SHOULD** be performed/ administered	CLASS IIa *Benefit >> Risk* *Additional studies with focused objectives needed* **IT IS REASONABLE** to perform procedure/administer treatment	CLASS IIb *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment **MAY BE CONSIDERED**	CLASS III *No Benefit* or CLASS III *Harm* Procedure/Test / Treatment COR III: No benefit — Not Helpful / No Proven Benefit COR III: Harm — Excess Cost w/o Benefit or Harmful / Harmful to Patients
LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Sufficient evidence from multiple randomized trials or meta-analyses
LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Evidence from single randomized trial or nonrandomized studies
LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation's usefulness/efficacy less well established ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Only expert opinion, case studies, or standard of care

Journal of the American College of Cardiology
© 2011 by the American College of Cardiology Foundation and the American Heart Association, Inc.
Published by Elsevier Inc.

Vol. 58, No. 24, 2011
ISSN 0735-1097/$36.00
doi:10.1016/j.jacc.2011.08.008

PRACTICE GUIDELINE

2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery: Executive Summary

A Report of the American College of Cardiology Foundation/
American Heart Association Task Force on Practice Guidelines

Developed in Collaboration With the American Association for Thoracic Surgery, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons

Writing Committee Members*

L. David Hillis, MD, FACC, *Chair*†
Peter K. Smith, MD, FACC, *Vice Chair**†

Jeffrey L. Anderson, MD, FACC, FAHA*‡
John A. Bittl, MD, FACC§
Charles R. Bridges, MD, ScD, FACC, FAHA*†
John G. Byrne, MD, FACC†
Joaquin E. Cigarroa, MD, FACC†
Verdi J. DiSesa, MD, FACC†
Loren F. Hiratzka, MD, FACC, FAHA†
Adolph M. Hutter, Jr, MD, MACC, FAHA†
Michael E. Jessen, MD, FACC*†
Ellen C. Keeley, MD, MS†
Stephen J. Lahey, MD†
Richard A. Lange, MD, FACC, FAHA†§
Martin J. London, MD‖
Michael J. Mack, MD, FACC*¶
Manesh R. Patel, MD, FACC†
John D. Puskas, MD, FACC*†
Joseph F. Sabik, MD, FACC*#
Ola Selnes, PhD†
David M. Shahian, MD, FACC, FAHA**
Jeffrey C. Trost, MD, FACC*†
Michael D. Winniford, MD, FACC†

*Writing committee members are required to recuse themselves from voting on sections to which their specific relationships with industry and other entities may apply; see Appendix 1 for recusal information. †ACCF/AHA Representative. ‡ACCF/AHA Task Force on Practice Guidelines Liaison. §Joint Revascularization Section Author. ‖Society of Cardiovascular Anesthesiologists Representative. ¶American Association for Thoracic Surgery Representative. #Society of Thoracic Surgeons Representative. **ACCF/AHA Task Force on Performance Measures Liaison.

ACCF/AHA Task Force Members

Alice K. Jacobs, MD, FACC, FAHA, *Chair*
Jeffrey L. Anderson, MD, FACC, FAHA, *Chair-Elect*

Nancy Albert, PhD, CCNS, CCRN, FAHA
Mark A. Creager, MD, FACC, FAHA
Steven M. Ettinger, MD, FACC
Robert A. Guyton, MD, FACC
Jonathan L. Halperin, MD, FACC, FAHA
Judith S. Hochman, MD, FACC, FAHA
Frederick G. Kushner, MD, FACC, FAHA
E. Magnus Ohman, MD, FACC
William Stevenson, MD, FACC, FAHA
Clyde W. Yancy, MD, FACC, FAHA

2.2. Bypass Graft Conduit

CLASS I

1. If possible, the left internal mammary artery (LIMA) should be used to bypass the left anterior descending (LAD) artery when bypass of the LAD artery is indicated (29–32). *(Level of Evidence: B)*

CLASS IIa

1. The right internal mammary artery is probably indicated to bypass the LAD artery when the LIMA is unavailable or unsuitable as a bypass conduit. *(Level of Evidence: C)*
2. When anatomically and clinically suitable, use of a second internal mammary artery to graft the left circumflex or right coronary artery (when critically stenosed and perfusing LV myocardium) is reasonable to improve the likelihood of survival and to decrease reintervention (33–37). *(Level of Evidence: B)*

CLASS IIb

1. Complete arterial revascularization may be reasonable in patients less than or equal to 60 years of age with few or no comorbidities. *(Level of Evidence: C)*
2. Arterial grafting of the right coronary artery may be reasonable when a critical (≥90%) stenosis is present (32,36,38). *(Level of Evidence: B)*
3. Use of a radial artery graft may be reasonable when grafting left-sided coronary arteries with severe stenoses (>70%) and right-sided arteries with critical stenoses (≥90%) that perfuse LV myocardium (39–44). *(Level of Evidence: B)*

CLASS III: HARM

1. An arterial graft should not be used to bypass the right coronary artery with less than a critical stenosis (<90%) (32). *(Level of Evidence: C)*

European Heart Journal (2010) 31, 2501–2555
doi:10.1093/eurheartj/ehq277

ESC/EACTS GUIDELINES

Guidelines on myocardial revascularization

The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Developed with the special contribution of the European Association for Percutaneous Cardiovascular Interventions (EAPCI)‡

Authors/Task Force Members: William Wijns (Chairperson) (Belgium)*, Philippe Kolh (Chairperson) (Belgium)*, Nicolas Danchin (France), Carlo Di Mario (UK), Volkmar Falk (Switzerland), Thierry Folliguet (France), Scot Garg (The Netherlands), Kurt Huber (Austria), Stefan James (Sweden), Juhani Knuuti (Finland), Jose Lopez-Sendon (Spain), Jean Marco (France), Lorenzo Menicanti (Italy) Miodrag Ostojic (Serbia), Massimo F. Piepoli (Italy), Charles Pirlet (Belgium), Jose L. Pomar (Spain), Nicolaus Reifart (Germany), Flavio L. Ribichini (Italy), Martin J. Schalij (The Netherlands), Paul Sergeant (Belgium), Patrick W. Serruys (The Netherlands), Sigmund Silber (Germany), Miguel Sousa Uva (Portugal), David Taggart (UK)

10.2.2 Bypass graft

The long-term benefit of CABG is maximized with the use of arterial grafts, specifically the ITA.[194] Available grafts include internal thoracic, radial, and gastro-epiploïc arteries. All except the radial artery can remain connected to their anatomical inflow or be used as free graft, with the aorta or another graft as inflow.

The side-to-side anastomosis used in arterial and venous grafting eliminates an aortic anastomosis, decreases the amount of graft required, and increases total graft flow. The latter factor contributes to a higher patency rate. Partially or total ITA skeletonization increases its length and possibility of use. Rates of sternal wound infection and angiographic results are similar whether ITA is skeletonized or not. These techniques may allow a complete arterial revascularization.

Use of bilateral ITA is associated with higher post-operative sternal dehiscence and increased rate of mediastinitis in obese and possibly diabetic patients.[195] But event-free long-term survival, reduced risk of recurrent angina or MI, and reduced need for re-operation correlate well with the extensive use of arterial grafts.[49,196,197]

Using radial artery grafts increases the number of arterial anastomoses beyond the use of both ITAs. At 5 years, patency rates of radial artery are possibly superior to saphenous grafts but certainly inferior to ITA. This patency is strongly related to target vessel size and stenosis severity.

Graft flow measurement, related to graft type, vessel size, degree of stenosis, quality of anastomosis, and outflow area, is useful at the end of surgery. Flow <20 mL/min and pulsatility index >5 predict technically inadequate grafts, mandating graft revision before leaving the operating theatre.[198]

Table 32 lists the evidence-based technical recommendations for CABG.

Greater Saphenous Vein (GSV)

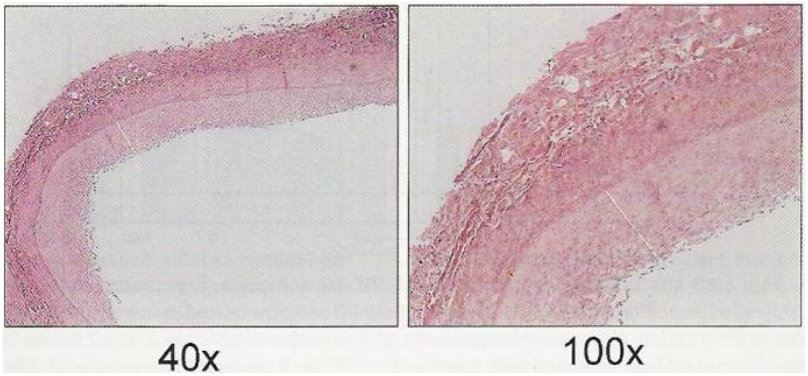
Advantages	Disadvantages
Ease of harvest	Low graft patency
Ready availablitiy	Vein graft disease
Versability	Wound complication
Resistance to spasm	

Patency of GSV

- **10-yr graft patency: 50~60%**

  Postop 1 - 5 yrs: occlusion rate 1~2%/yr

  Postop 6 - 10 yrs: occlusion rate 4~5%/yr

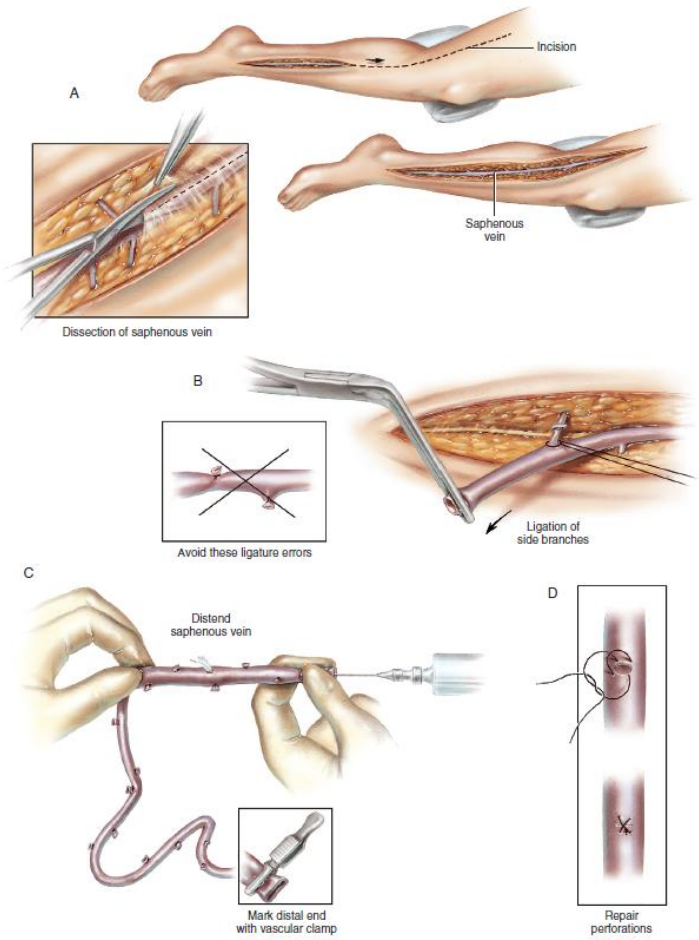


- **Modes of failure**
  - **acute thrombosis**
  - **subacute intimal hyperplasia**
  - **chronic graft atherosclerosis**

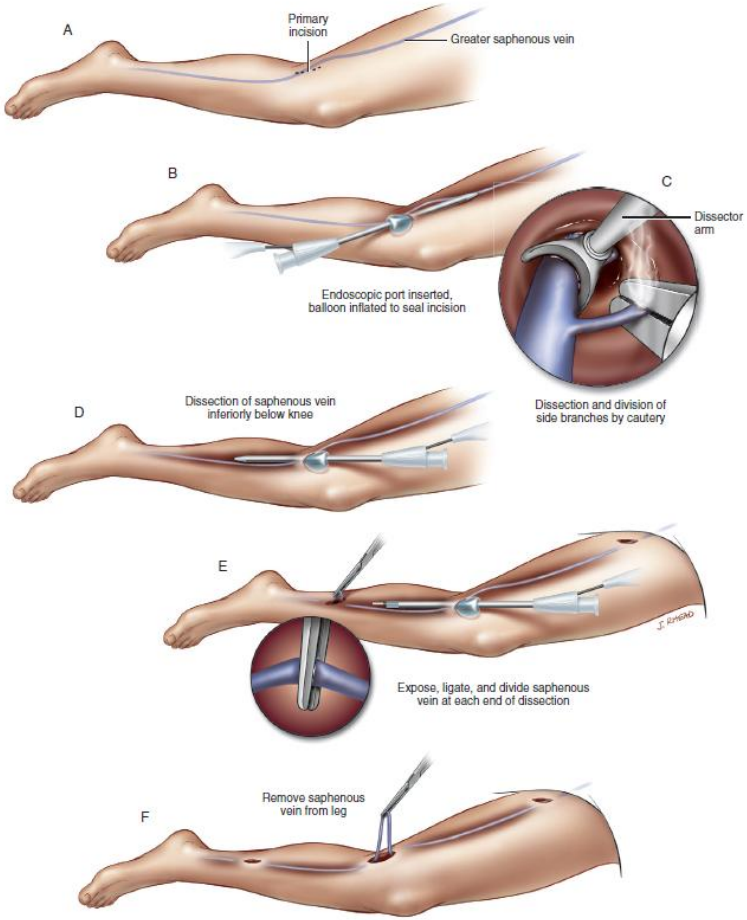
Harvesting of GSV

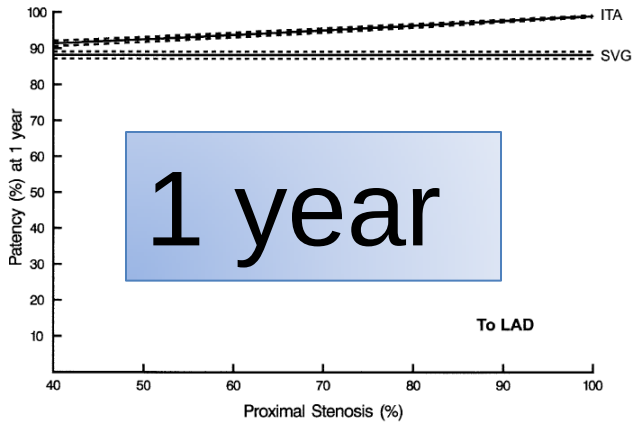
- **Preop. Evaluation of GSV : USG guided vein mapping**
- **Open (OVH) vs Endoscopic (EVH)**
- **No touch technique**
  - **avoids vein stripping,**
  - **taking surrounding tissue**
  - **avoids over-distending**

Open saphenous vein harvest

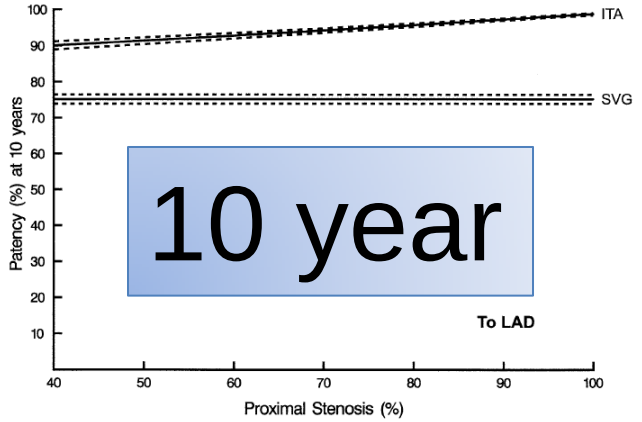


Endoscopic saphenous vein harvest

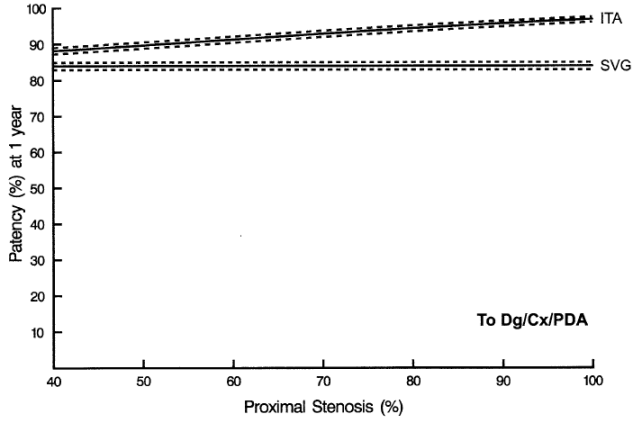




A



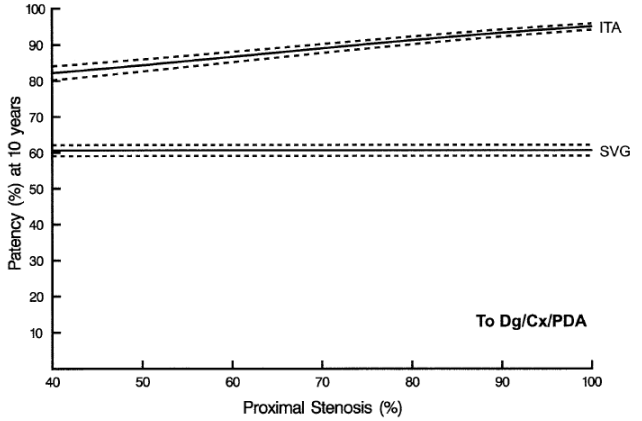
B



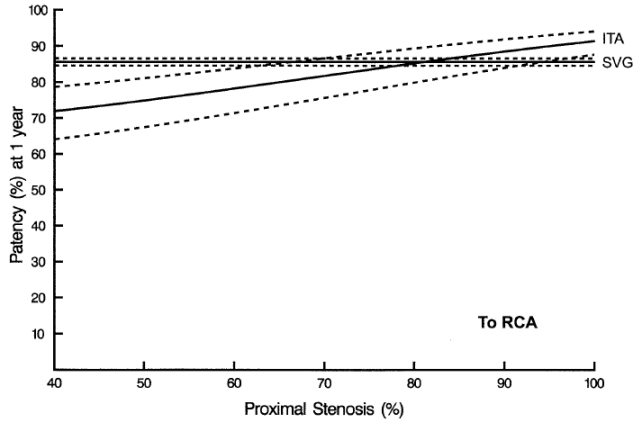
C

ITA

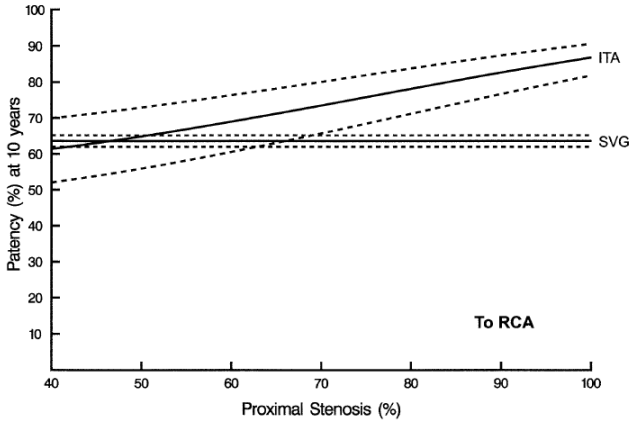
SVG



D



E



F

Biologic Characteristics of Arterial Graft

	IMA	RA	GEA	IEA
Size	adequate	adequate	adequate	small at distal
Wall thickness and hyperplasia	+++	+++	++	+
Structure (Histology)	elastic	muscular	muscular	muscular/ elastic
Length	adequate	adequate	adequate	limited
Possible pedicle graft	yes	no	yes	no
Incidence of spasm	low	high	high	low
incidence of atherosclerosis	low	unknown	low	may be higher

Internal Thoracic(Mammary) Artery

- **The conduit of first choice for MI**
- **LIMA bypass to LAD**
  - **well defined advantages & benefits**
- **10-yr graft patency: 90~95%**
- **Resistant to atherosclerosis < 4%**
  - **Nearly continuous internal elastic lamina**
  - **Release of prostacyclin, NO, inhibitor of PLT Fx**

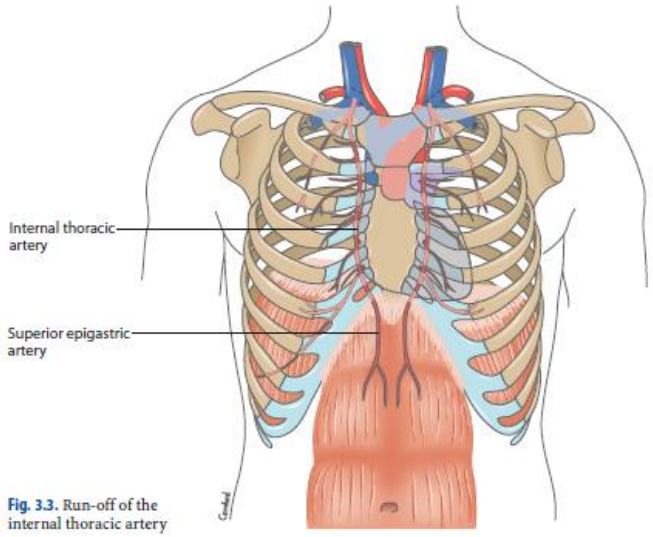
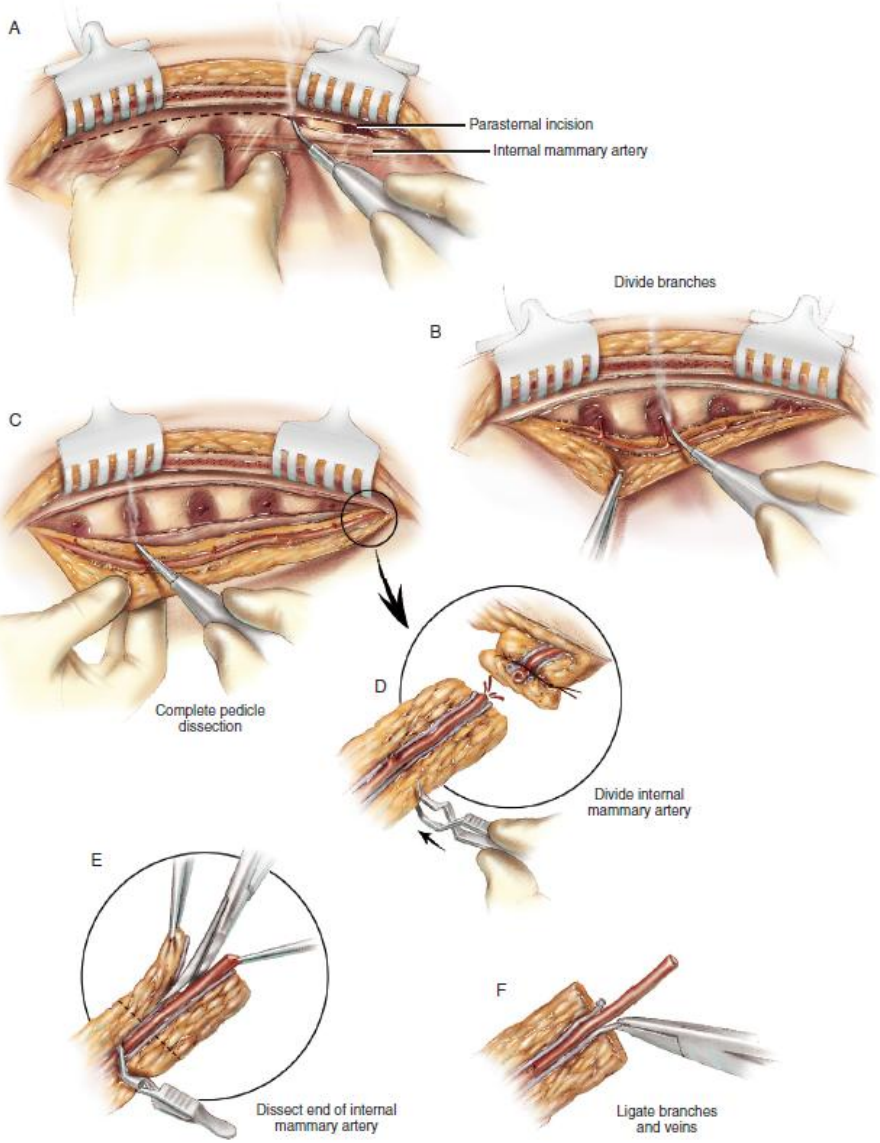
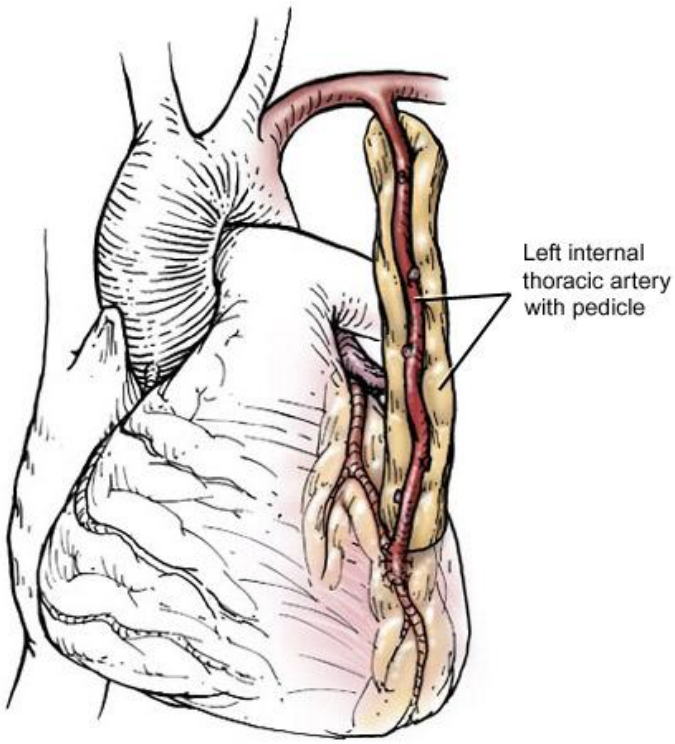
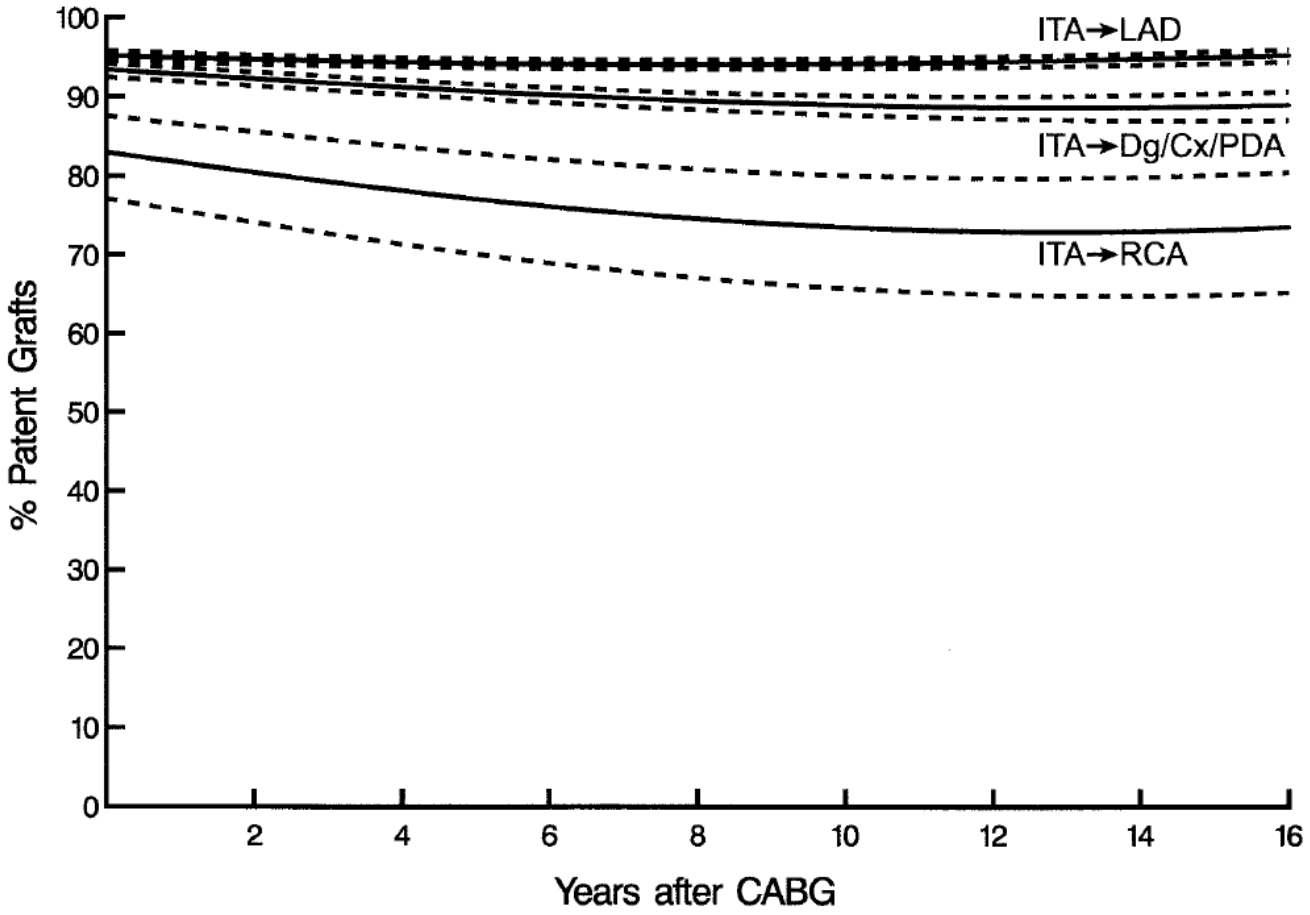


Fig. 3.3. Run-off of the internal thoracic artery

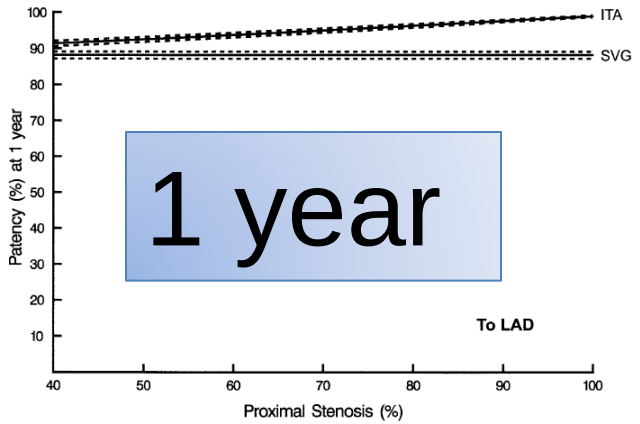

A
Parasternal incision
Internal mammary artery
Divide branches
B
C
Complete pedicle dissection
D
Divide internal mammary artery
E
Dissect end of internal mammary artery
F
Ligate branches and veins


Left internal thoracic artery with pedicle

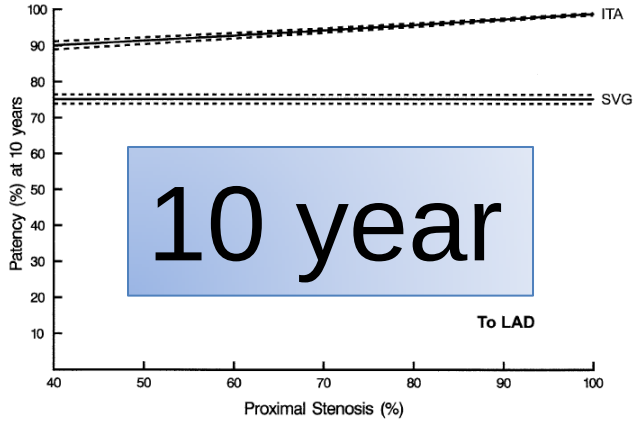
Graft patency in LAD & non-LAD arteries



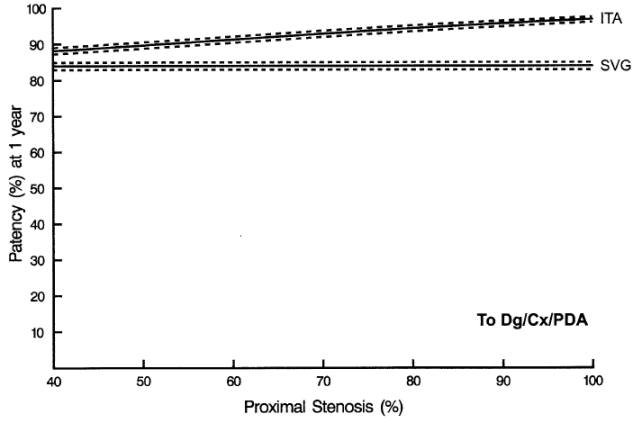
Sabik JF III, et al. Ann Thoracic surg 2005;79:544-51



A



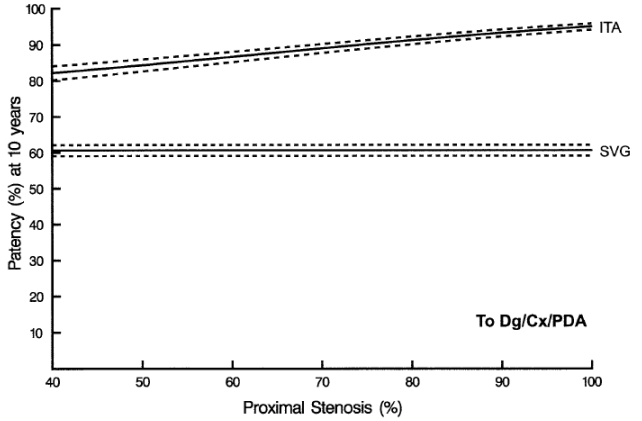
B



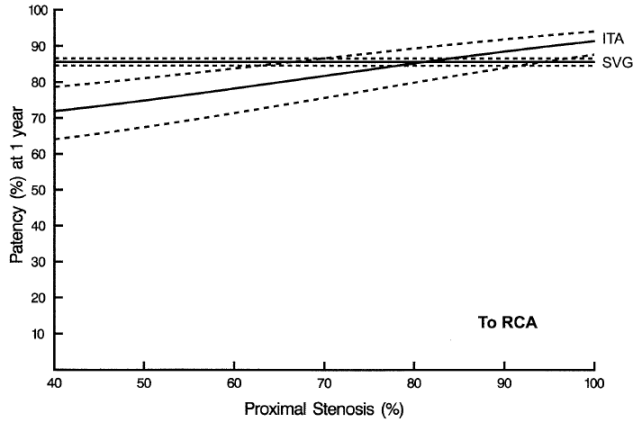
C

ITA

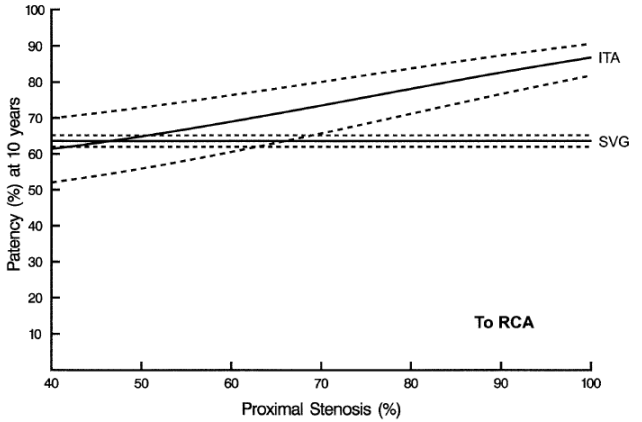
SVG



D



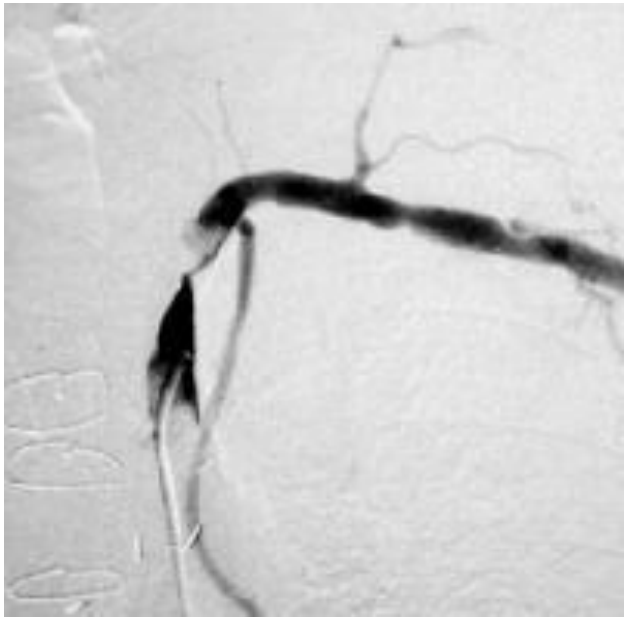
E



F

Internal Mammary Artery

- **Contraindications**
  - **Emergency surgery**
  - **Poor LIMA blood flow**
  - **Subclavian artery stenosis**
  - **Radiation injury**
  - **Atherosclerosis**



- **Routine IMA angiogram – not recommendable**
- **Check the BP for all extremities**

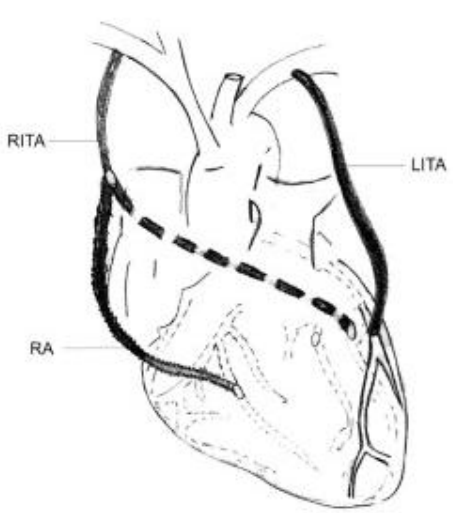
Bilateral IMA Grafting

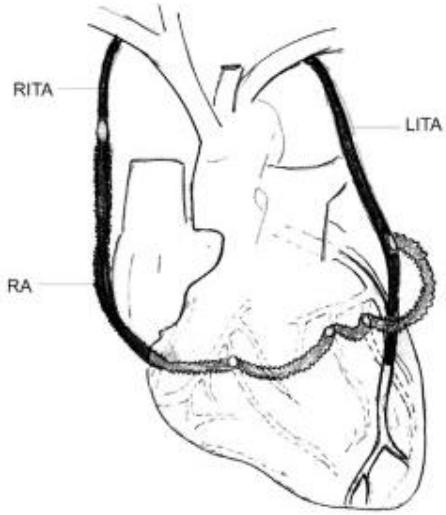
- **Original description – Kay in 1969**
- **Advantages**
  - **better long-term graft survival**
  - **better freedom from re-intervention**
- **Disadvantages**
  - **poor mediastinal healing, leading to mediastinitis,**
  - **Increase op time & postop bleeding**
  - **Length of RIMA ; always a matter of concern**

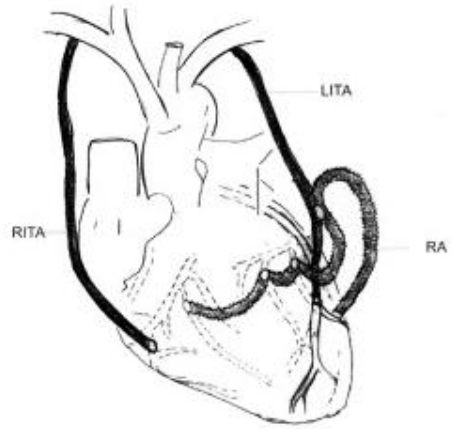
Bilateral IMA Grafting Strategy

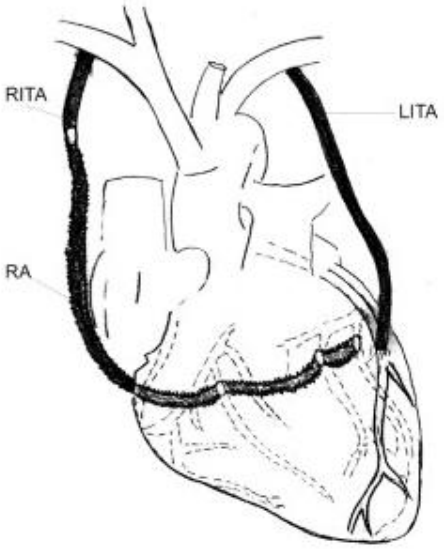
- **Target CA**
  - **LAD**
  - **Diagonal**
  - **OM**
  - **RCA**
  - **PDA**

- **Blood in-flow**
  - **In-situ graft**
  - **Free graft**
  - **Composite graft**









Radial Artery

- **1973 1st used for CABG(Carpentier)**

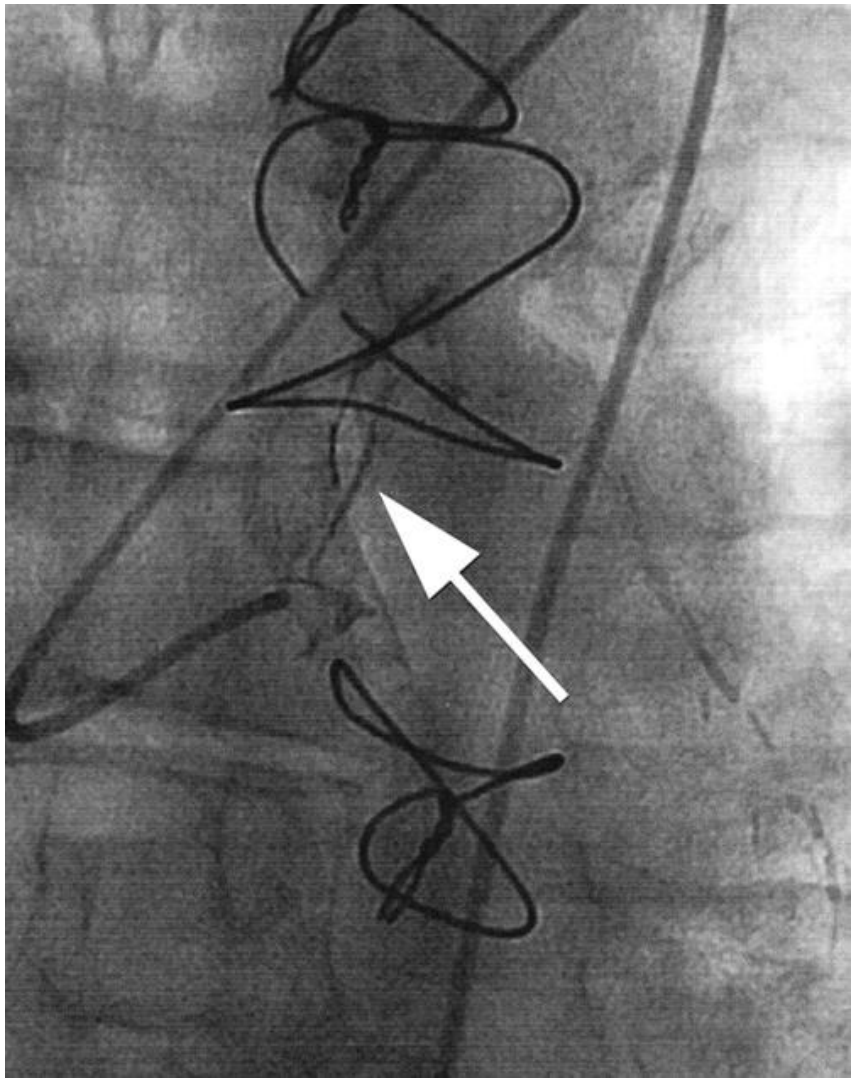
  : early results ↓↓ ~~conduit for CABG~~

- **1990 Revived(Acar)**

- **Muscular artery**
  - **Susceptible to spasm and atrophy**
- **Mode of failure**
  - **Flow competition, autoregulation of lumen**

Radial Artery

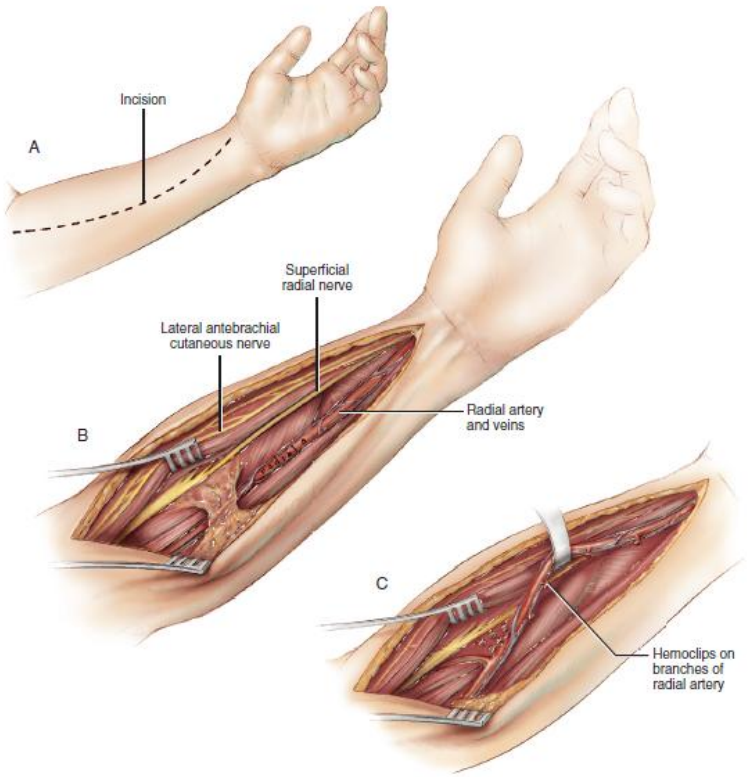
- **String sign**
  - **Eventually occluded**
- **Best patency**
  - **Lt. coronary system**
  - **> 70% stenosis**
- **Worst patency**
  - **Rt. coronary system**
  - **Moderate stenosis**



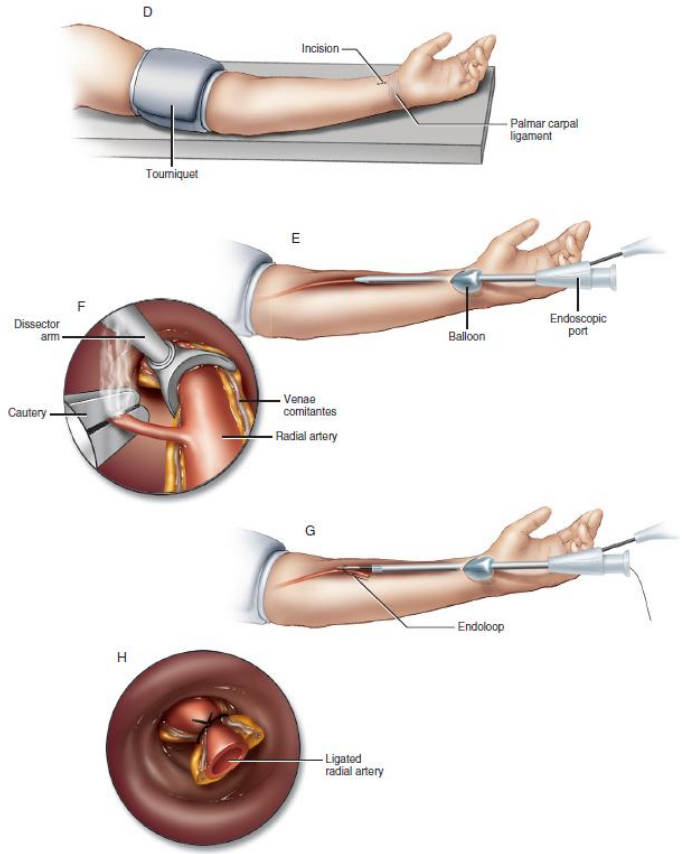
Radial Artery

- **Identification of palmar arch communication**
  - **Allen test, Palmar arch test**
- **Harvesting**
  - **enblock with fat and concomitant veins with perioperative use of Ca channel antagonist**
- **Contraindications for harvest**
  - **Inadequate ulnar artery collaterals**
  - **Raynaud's / Buerger's disease**
  - **Known subclavian bruits**
  - **Planned AV fistula**

Open radial artery harvest

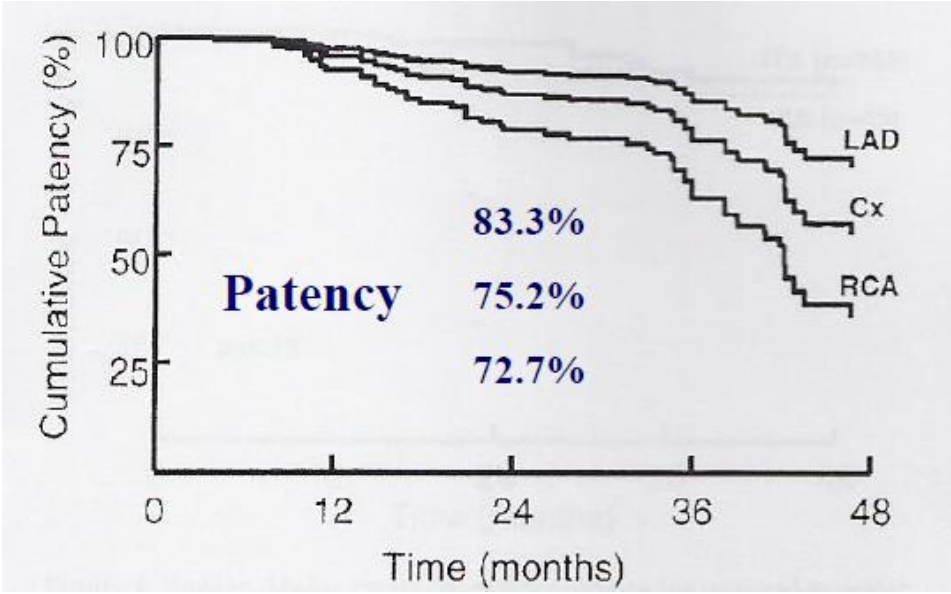


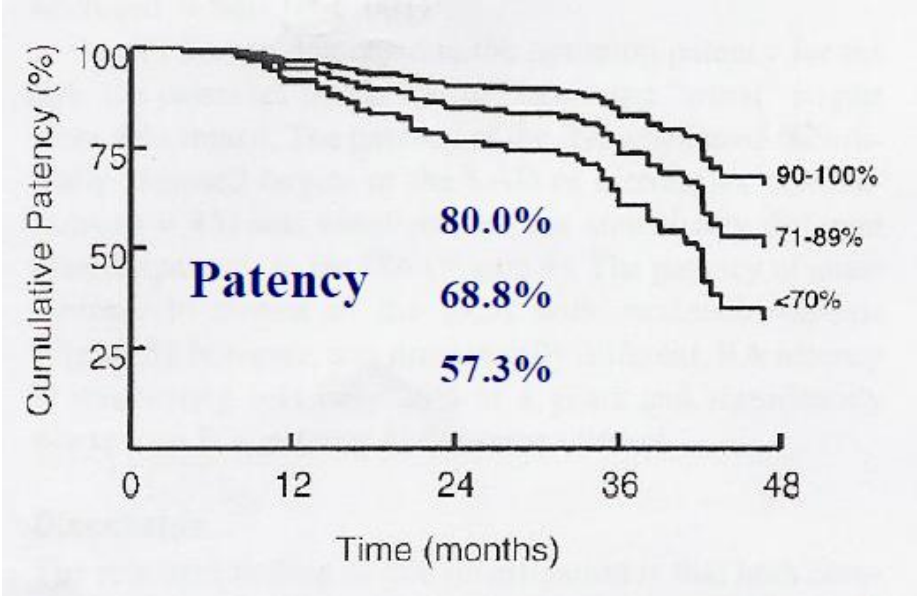
Endoscopic radial artery harvest



Patency of Radial Artery

- **Five-year graft patency: 83~96%**
- **Effects of target stenosis and location**





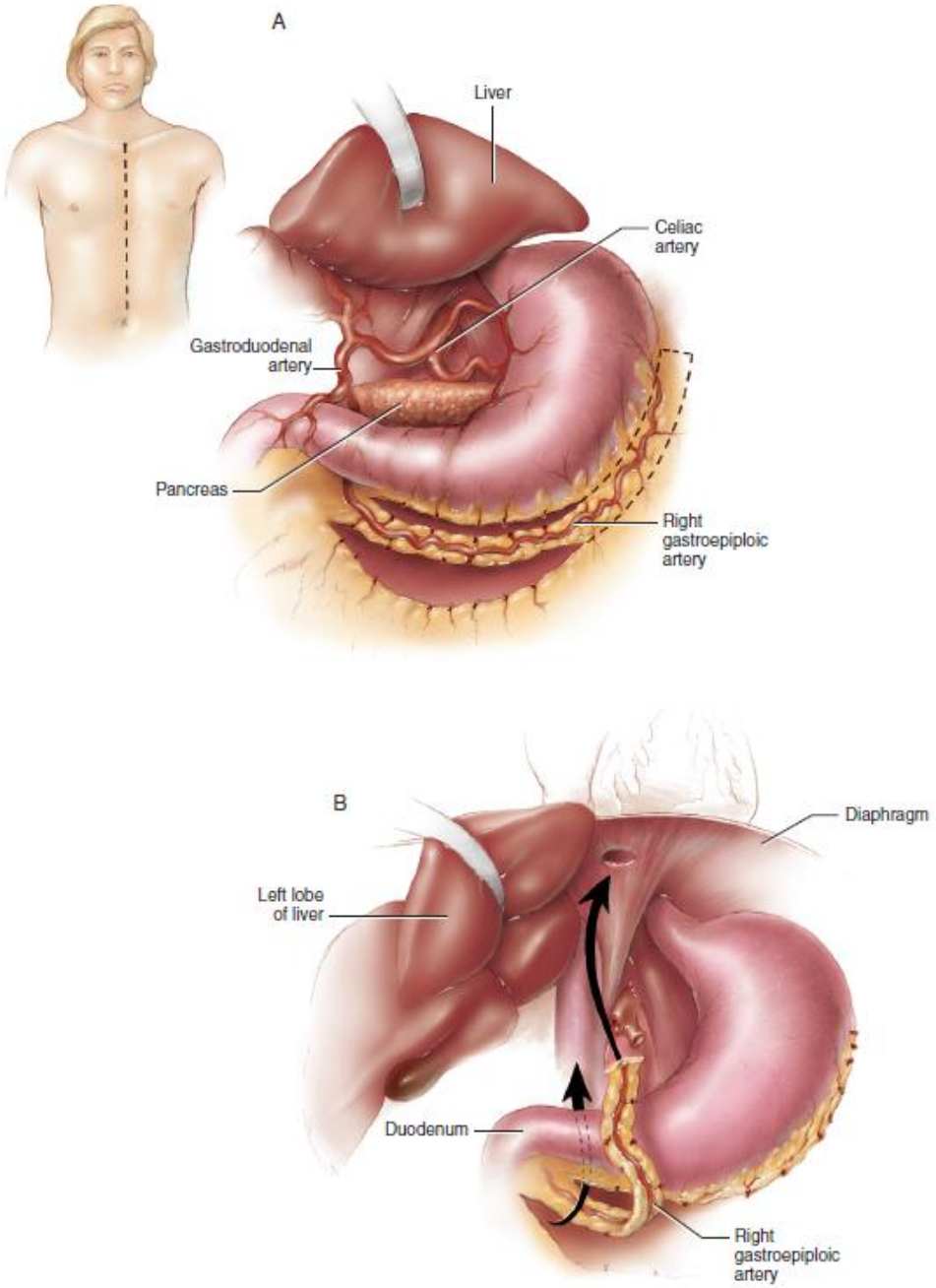
Maniar et al, J ThoracCardiovasc Surg 2002

Rt. Gastroepiploic Artery

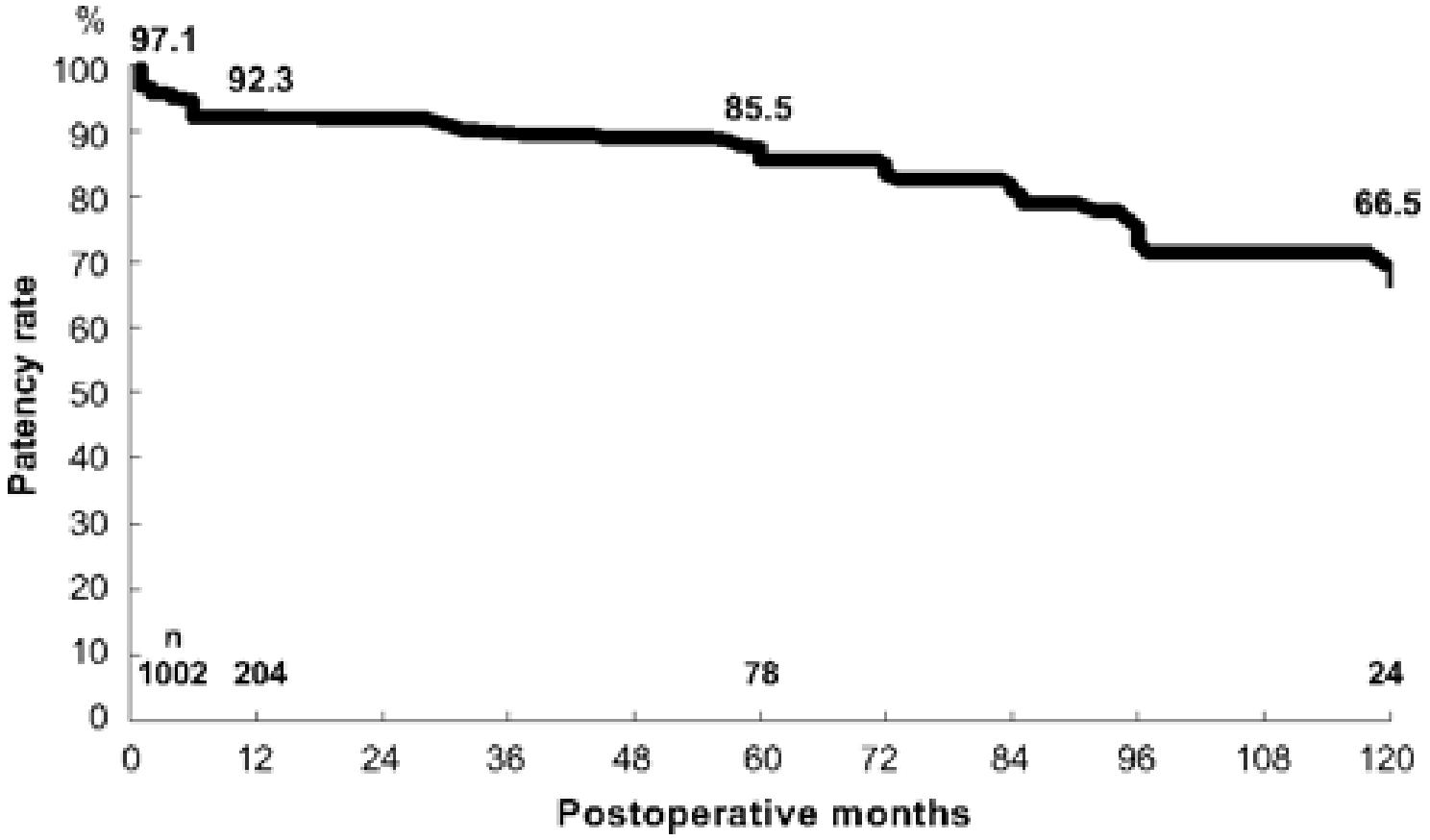
- First used for CABG by Pym et al. (1987)
- Atherosclerosis is rare
- Muscular artery
  - Less elastic tissue / Fewer smooth muscle cells
  - Susceptible to spasm and atrophy
- Mode of failure
  - Flow competition, autoregulation of lumen
- Common target
  - Rt. CAS and its branch

Rt. Gastroepiploic Artery

- **Good alternative arterial conduit**
- **Difficult to do anastomosis –small size,spasm**
- **Sensitive to competitive flow**
- **Graft to artery stenosis > 70%**


A
Liver
Celiac artery
Gastroduodenal artery
Pancreas
Right gastroepiploic artery
B
Diaphragm
Left lobe of liver
Duodenum
Right gastroepiploic artery

Rt. Gastroepiploic Artery



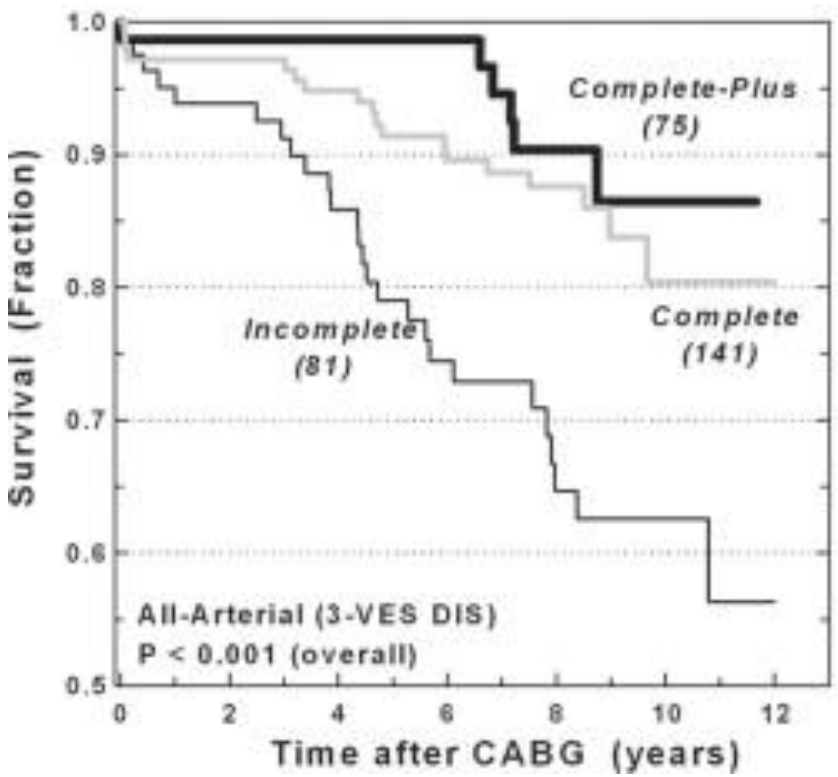
Suma et al, Circulation 2007

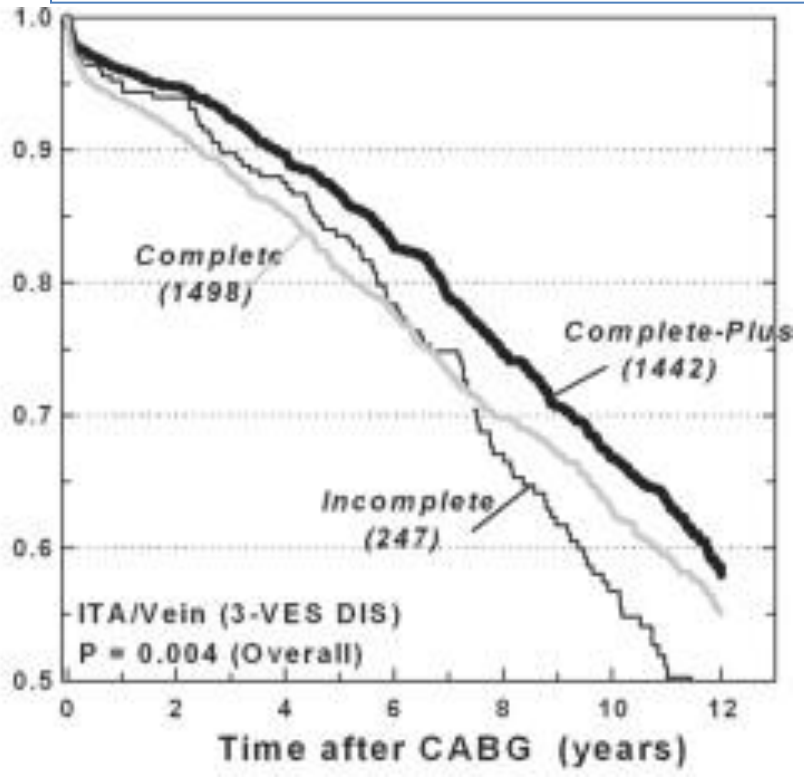
Total Arterial Revascularization

CLASS IIb

1. Complete arterial revascularization may be reasonable in patients less than or equal to 60 years of age with few or no comorbidities. *(Level of Evidence: C)*

Zacharias et al, . Ann Thoracic surg 2007





Conclusion

- **The choice of conduit for CABG will continue to play a large role in long-term outcomes.**
- **Currently, use of the IMA to bypass the LAD artery has well-defined advantages and benefits for patient outcomes.**
- **The choice of the second conduit for additional grafts remains less clear**