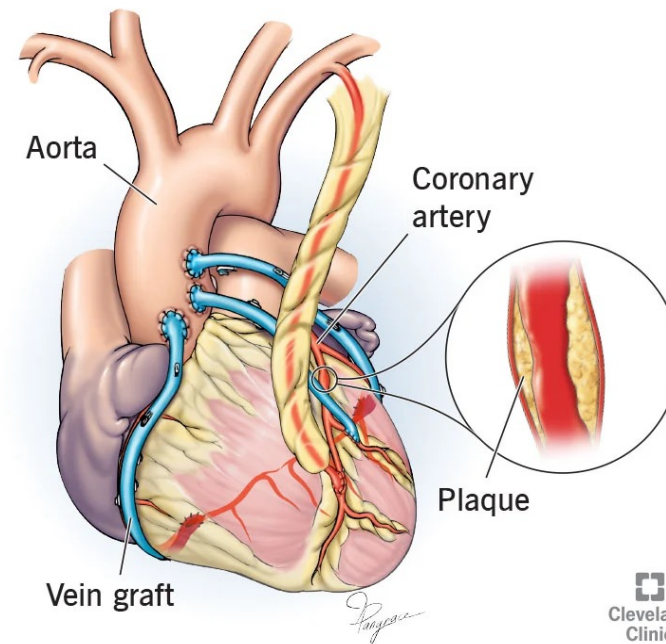


Open Vein Harvest (OVH) vs. Endoscopic Vein Harvest (EVH) in CABG:

Comparative Outcomes

Thuy Le PA-C
Department of Cardiac Surgery
University of Michigan

Coronary artery bypass grafting (CABG)



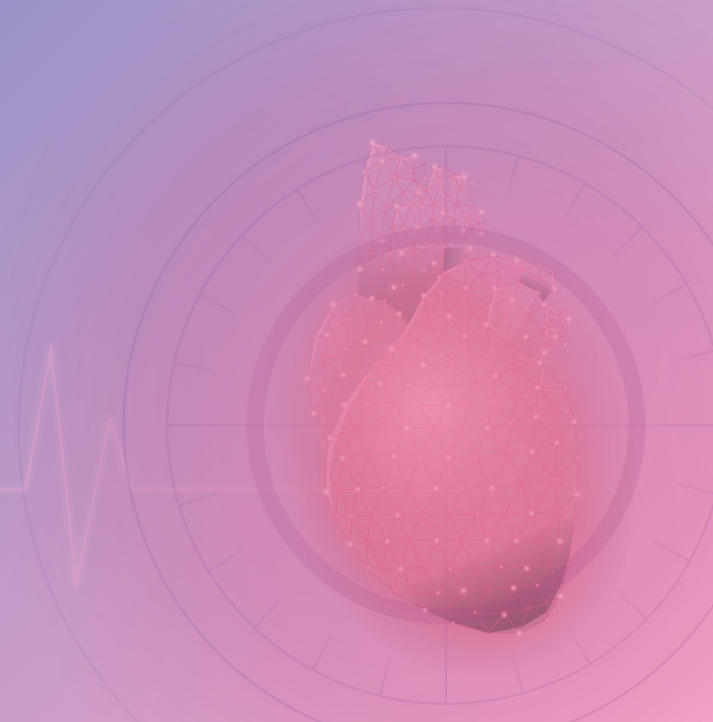


OVH vs. EVH in CABG: Comparative Outcomes



Disclosures:

- None



OVH vs. EVH in CABG: Comparative Outcomes

- Background:
 - A. CABG most Common Procedure Done in open heart surgery.
 - B. Multi-arterial Conduits.
 - C. Saphenous Vein Grafts are the Most Commonly use Conduits.



OVH vs. EVH in CABG: Comparative Outcomes

OVH



Okay

EVH



BETTER ??

OVH vs. EVH in CABG: Comparative Outcomes

Incidence of leg wound infection after CABG surgery has been shown to be as high as 24%¹

In one study, the infection Rate **DOUBLED** for those with Diabetes, Obesity

- An increasing proportion of CABG patients are diabetic² and > 1/3 are obese³
- Diabetic and obese patients have **twice** the risk for saphenectomy wound infection⁴⁻⁶

1. M. Abbaszadeh, M. K. Arabnia, A. Rabbani, M. H. Mandegar, and S. Vahedi, "The risk factors affecting the complications of saphenous vein graft harvesting in aortocoronary bypass surgery," *Brazilian Journal of Cardiovascular Surgery*, vol. 23, no. 3, pp. 317–322, 2008.
2. Ferguson TB Jr, Hammill BG, Peterson ED, DeLong ER, Grover FL; STS National Database Committee. A decade of change—risk profiles and outcomes for isolated coronary artery bypass grafting procedures, 1990-1999: a report from the STS National Database Committee and the Duke Clinical Research Institute. *Society of Thoracic Surgeons. Ann Thorac Surg.* 2002 Feb;73(2):480-9; discussion 489-90.
3. Shahian DM, O'Brien SM, Filardo G, Ferraris VA, Haan CK, Rich JB, Normand SL, DeLong ER, Shewan CM, Dokholyan RS, Peterson ED, Edwards FH, Anderson RP; Society of Thoracic Surgeons Quality Measurement Task Force. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: part 1—coronary artery bypass grafting surgery. *Ann Thorac Surg.* 2009 Jul;88(suppl 1):S2-22.
4. Allen et al. Risk factors for leg wound complications following endoscopic versus traditional saphenous vein harvesting. *Heart Surg Forum.* 2000;3(4):325-30.
5. Fowler et al. Clinical predictors of major infections after cardiac surgery. *Circulation.* 2005;112(suppl 1):I-358-I-365.
6. Brandt et al. Coronary artery bypass surgery in diabetic patients. *J Card Surg.* 2004;19:36-40



OVH vs. EVH in CABG: Comparative Outcomes



ORIGINAL ARTICLES

Endoscopic Vascular Harvest in Coronary Artery Bypass Grafting Surgery: A Consensus Statement of the International Society of Minimally Invasive Cardiothoracic Surgery (ISMICS) 2005

Keith Allen, MD,* Davy Cheng, MD,† William Cohn, MD,‡ Mark Connolly, MD,§ James Edgerton, MD,¶ Volkmar Falk, MD,|| Janet Martin, Pharm D,† Toshiya Ohtsuka, MD,# and Richard Vitali, PA§

Objective: This purpose of this consensus statement was to compare endoscopic vascular graft harvesting (EVH) with conventional open vascular harvesting (OVH) in adults undergoing coronary artery bypass grafting (CABG) surgery and to determine which resulted in improved clinical and resource outcomes.

Methods: Before the consensus conference, the consensus panel reviewed the best available evidence, whereby systematic reviews, randomized trials, and nonrandomized trials were considered in descending order of importance. Evidence-based statements were created, and consensus processes were used to determine the ensuing statements. The AHA/ACC system was used to label the level of evidence and class of recommendation.

Results: The consensus panel agreed upon the following statements:

4. EVH is recommended for vein harvesting to improve patient satisfaction and postoperative pain when compared with OVH in CABG surgery (Class I, Level A).

5. EVH is recommended for vein harvesting to reduce postoperative length of stay and outpatient wound management resources (Class I, Level A).

Conclusions: Given these evidence-based statements, the consensus panel stated that EVH should be the standard of care for patients who require saphenous vein grafts for coronary revascularization (Class I, Level B). Future research should address long-term safety, cost-effectiveness, and endoarterial harvest.

Key Words: endoscopic vascular harvest, coronary artery bypass grafting, consensus statement

(*Innovations* 2005;1: 51–60)

TABLE 1. Levels of Evidence

Level of Evidence A	Data derived from multiple randomized clinical trials
Level of Evidence B	Data derived from a single randomized trial, or nonrandomized studies
Level of Evidence C	Consensus opinion of experts

Class I	Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective
Class II	Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment
IIa	Weight of evidence/opinion is in favor of usefulness/efficacy
IIb	Usefulness/efficacy is less well established by evidence/opinion
Class III	Conditions for which there is evidence and/or general agreement that the procedure/treatment is NOT useful/effective, and in some cases may be harmful

OVH vs. EVH in CABG: Comparative Outcomes

➤ Endoscopic Vein Harvest Technique

A. Controversial

i. Quality

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JULY 16, 2009 VOL. 361 NO. 3

Endoscopic versus Open Vein-Graft Harvesting in Coronary-Artery Bypass Surgery

Renato D. Lopes, M.D., Ph.D., Gail E. Hafley, M.S., Keith B. Allen, M.D., T. Bruce Ferguson, M.D., Eric D. Peterson, M.D., M.P.H., Robert A. Harrington, M.D., Rajendra H. Mehta, M.D., C. Michael Gibson, M.D., Michael J. Mack, M.D., Nicholas T. Kouchoukos, M.D., Robert M. Califf, M.D., and John H. Alexander, M.D., M.H.S.

ABSTRACT

BACKGROUND

Vein-graft harvesting with the use of endoscopy (endoscopic harvesting) is a technique that is widely used to reduce postoperative wound complications after coronary-artery bypass grafting (CABG), but the long-term effects on the rate of vein-graft failure and on clinical outcomes are unknown.

METHODS

We studied the outcomes in patients who underwent endoscopic harvesting (1753 patients) as compared with those who underwent graft harvesting under direct vision, termed open harvesting (1247 patients), in a secondary analysis of 3000 patients undergoing CABG. The method of graft harvesting was determined by the surgeon.

From the Duke Clinical Research Institute (R.D.L., G.E.H., E.D.P., R.A.H., R.H.M., J.H.A.) and the Duke Translational Medicine Institute (R.M.C.) — both at Duke University Medical Center, Durham, NC; the Mid America Heart Institute, St. Luke's Hospital, Kansas City, MO (K.B.A.); East Carolina University, Greenville, NC (T.B.F.); the PERFUSE Angiographic Laboratory, Boston (C.M.G.); the Cardiopulmonary Research Science and Technology Institute, Dallas (M.J.M.); and Missouri Baptist Medical Center, St. Louis (N.T.K.).

whether the preparation solution might influence vein patency and long-term outcomes is unknown. A plausible explanation for our findings is that endoscopic harvesting is more traumatic to the vein, leading to accelerated atherosclerosis and worse long-term patency and clinical outcomes. Open harvesting, though more invasive and associated with more wound complications, may be less traumatic to the vein and could result in a better conduit.

Our study was not randomized, and unmeasured confounders between patients who underwent endoscopic harvesting and those who underwent open harvesting could explain our findings. However, we did adjust for differences in prognostically important variables. At the time of the PREVENT IV trial, at least two different endoscopic devices for harvesting the vein were commercially available. These devices use different techniques to harvest the vein, and these differences could have played a role in our findings. Unfortunately, we did not collect information regarding the type of device used. In addition, for both the endoscopic-harvesting group and the open-harvesting group, we were not able to account for the effect of the level of experience of, or the volume of procedures performed by, the practitioner who harvested the veins, since these data were not collected in the PREVENT IV trial. Previous studies, however, have shown that in current practice, graft harvesting is overwhelmingly performed by nonphysician practitioners.^{7,37} We developed a propensity score for endoscopic harvesting; however, information on variables other than the enrolling center that might have influenced the decision to use endoscopic harvesting

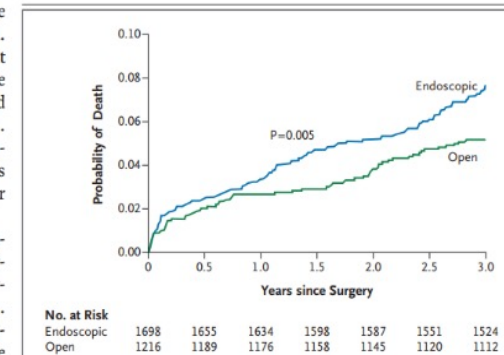


Figure 2. Adjusted Kaplan-Meier Curves for Death after Endoscopic or Open-Graft Harvesting.

In conclusion, our study shows that in patients undergoing CABG, endoscopic harvesting is an independent predictor of vein-graft failure and is associated with worse clinical outcomes, including higher mortality, than is open harvesting. The mechanism behind these findings requires further investigation, and randomized clinical trials evaluating the effect of endoscopic harvesting on long-term angiographic and clinical outcomes are needed. Until further data are available, the increased risk of worse outcomes with endoscopic harvesting should be weighed against its known short-term benefits.

The PREVENT IV trial, on which this study was based, was funded by a grant from Corgentech (now Anesiva).

Dr. Mack reports receiving consulting fees from MAQUET;



OVH vs. EVH in CABG: Comparative Outcomes

NICE National Institute for
Health and Care Excellence

- 26 May 2010, Interventional procedures guidance [IPG343] Published: this procedure should only be used with special arrangements for “**clinical governance, consent and audit or research.**”





OVH vs. EVH in CABG: Comparative Outcomes



Circulation

Volume 123, Issue 2, 18 January 2011; Pages 147-153
<https://doi.org/10.1161/CIRCULATIONAHA.110.960765>



CARDIOVASCULAR SURGERY

Long-Term Outcomes of Endoscopic Vein Harvesting After Coronary Artery Bypass Grafting

Editorial see p 127

Lawrence J. Dacey, MD, John H. Braxton, Jr, MD, Robert S. Kramer, MD, Joseph D. Schmoker, MD, David C. Charlesworth, MD, Robert E. Helm, MD, Carmine Frumiento, MD, Gerald L. Sardella, MD, Robert A. Clough, MD, Stephan R. Jones, PA-C, David J. Malenka, MD, Elaine M. Olmstead, BA, Cathy S. Ross, MS, Gerald T. O'Connor, DSc, PhD, Donald S. Likosky, PhD, and for the Northern New England Cardiovascular Disease Study Group

Conclusions

The use of EVH was not associated with harm, as measured by a significant diminishment in long-term survival or repeat revascularization. These findings, along with the previously reported short-term benefits of reduced morbidity, suggest that EVH is a safe and viable technique for obtaining saphenous vein conduit for CABG surgery. Additional studies are warranted to improve our understanding of the mechanism by which EVH influences long-term outcomes, as well as how clinical teams can maximize the utility of this technique.

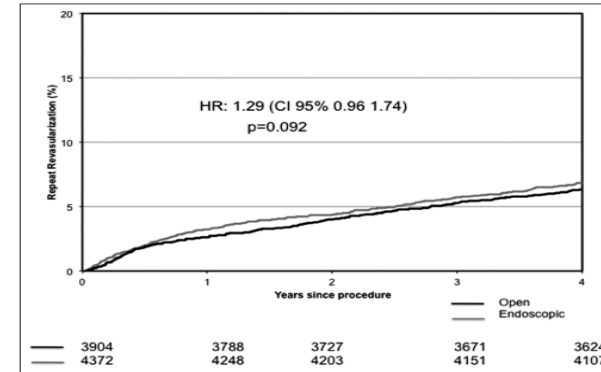


Figure 3. Adjusted risk of repeat revascularization by vein harvesting approach (2001 to 2004). The HR is for EVH relative to OVH related to risk of repeat revascularization. Adjusted for age, sex, ejection fraction, number of diseased vessels, left main disease, white blood cell count, history of myocardial infarction, acuity, vascular disease, diabetes mellitus, renal failure and/or elevated creatinine, chronic obstructive pulmonary disease, body mass index, and medical center.

95% CI are shown in Figure 3 in the Online-Only Data Supplement.

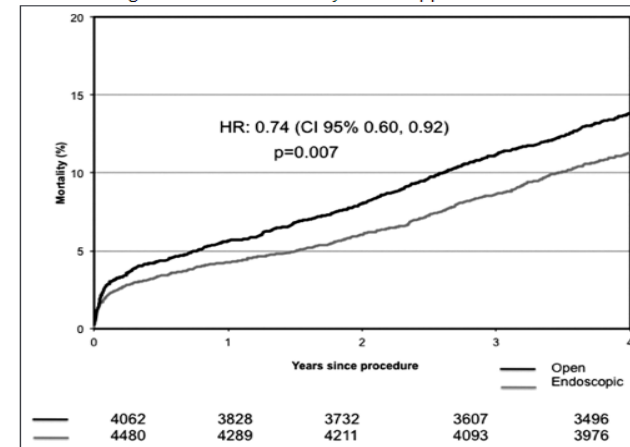


Figure 2. Adjusted risk of mortality by vein harvesting approach (2001 to 2004). The HR is for EVH relative to OVH related to mortality. Adjusted for age, sex, ejection fraction, number of diseased vessels, left main disease, white blood cell count, history of myocardial infarction, acuity, vascular disease, diabetes mellitus, renal failure and/or elevated creatinine, chronic obstructive pulmonary disease, body mass index, and medical center.



OVH vs. EVH in CABG: Comparative Outcomes



ORIGINAL CONTRIBUTION

JAMA The Journal of the
American Medical Association

Association Between Endoscopic vs Open
Vein-Graft Harvesting and Mortality,
Wound Complications, and Cardiovascular
Events in Patients Undergoing CABG Surgery

235,000+ patient study 2012

235,394 CABG patients tracked for a median of 3 years

- EVH (n = 122,899, 52%)
- Open (n = 112,495, 48%)

Primary Outcome: All-cause mortality.

Secondary Outcome: Measures included wound complications and the composite of death, myocardial infarction, and revascularization.

Author Affiliations: Duke Clinical Research Institute (Drs Williams, Peterson, Brennan, Alexander, Lopes, Zhao, and O'Brien and Ms Dokholyan) and Departments of Surgery (Drs Williams and Smith) and Medicine (Drs Peterson, Brennan, Alexander, and Lopes), Duke University Medical Center, Durham, North Carolina; Weill Cornell Medical College, New York, New York (Dr Sedrakyan); US Food and Drug Administration, Silver Spring, Maryland (Drs Tavis, Duggirala, Gross, and Marinac-Dabic); Department of Cardiovascular and Thoracic Surgery, Montefiore Medical Center/Albert Einstein College of Medicine, New York, New York (Dr Michler); Joseph B. Whitehead Department of Surgery, Emory University School of Medicine, Atlanta, Georgia (Dr Thourani); and Shands Hospital, University of Florida, Jacksonville (Dr Edwards).

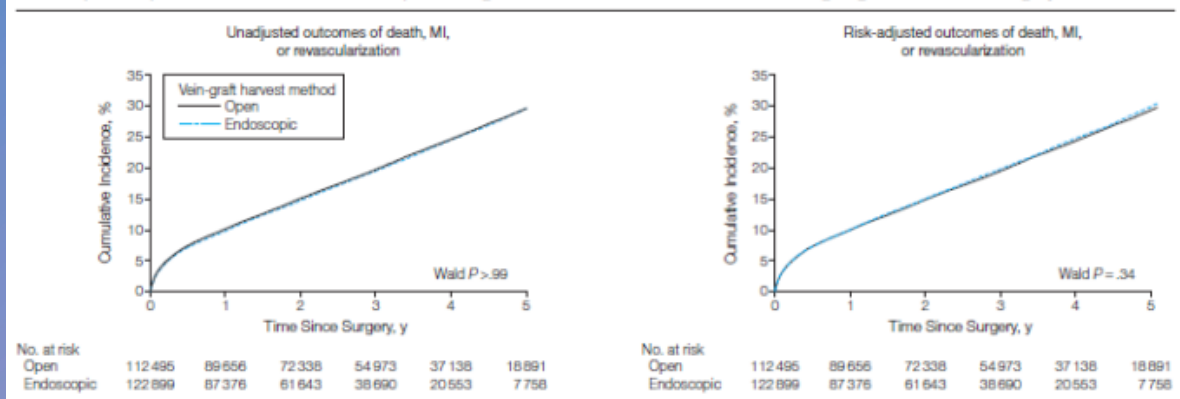
JAMA. 2012;308(5):475-484. doi:10.1001/jama.2012.8363

OVH vs. EVH in CABG: Comparative Outcomes

No Difference In:

- ✓ Long Term Mortality, MI or Repeat Revascularization
- ✓ Significantly Reduced Wound Complications with EVH

Figure 3. Kaplan-Meier Curves for Unadjusted and Risk-Adjusted Composite Outcomes of Death, MI, or Revascularization According to Endoscopic vs Open Vein-Graft Harvest Technique Among 235 394 North American Patients Undergoing Isolated CABG Surgery, 2003-2008



MI indicates myocardial infarction; CABG, coronary artery bypass graft.

Table 3. Marginal Common Baseline Hazard Model Before and After Risk Adjustment for Endoscopic vs Open Vein-Graft Harvesting

Outcomes	Events by Harvest Technique		Unadjusted HR (95% CI)	P Value	Risk-Adjusted HR (95% CI)	P Value
	Endoscopic (n = 122 899)	Open (n = 112 495)				
Primary analysis ^a						
Mortality (through 3 y)	12 429	13 096	0.99 (0.95-1.02)	.45	1.00 (0.97-1.04)	>.99
Death, MI, or revascularization (through 3 y)	18 419	19 232	1.00 (0.97-1.03)	>.99	1.00 (0.98-1.05)	.34
Wound complications (through 30 d)	3654	4047	0.82 (0.78-0.86)	<.001	0.83 (0.77-0.89)	<.001

Williams JB, Peterson ED, Brennan JM, Sedrakyan A, Tavis D, Alexander JH, Lopes RD, Dokholyan RS, Zhao Y, O'Brien SM, Michler RE, Thourani VH, Edwards FH, Duggirala H, Gross T, Marinac-Dabic D, Smith PK. Association between endoscopic vs open vein-graft harvesting and mortality, wound complications, and cardiovascular events in patients undergoing CABG surgery. JAMA. 2012 Aug 1;308(5):475-84.

OVH vs. EVH in CABG: Comparative Outcomes

Meta-Analyses of OVH vs. EVH:

Wound Complications & MACE

¹Deppe et al. 2013 43 Studies (n=27,789) ↓73% with EVH

No Difference in MACE

²Sastry et al. 2013 44 Studies (n=267,525) ↓69% with EVH

No Differences in MACE

1. Deppe AC, Liakopoulos OJ, Choi YH, Slottosch I, Kuhn EW, Scherer M, Stange S, Wahlers T. Endoscopic vein harvesting for coronary artery bypass grafting: a systematic review with meta-analysis of 27,789 patients. *J Surg Res.* 2013 Mar;180(1):114-24.
2. Sastry P, Rivinius R, Harvey R, Parker RA, Rahm AK, Thomas D, Nair S, Large SR. The influence of endoscopic vein harvesting on outcomes after coronary bypass grafting: a meta-analysis of 267,525 patients. *Eur J Cardiothorac Surg.* 2013 Apr;12.

OVH vs. EVH in CABG: Comparative Outcomes



The International Society for Minimally Invasive Cardiac Surgery (ISMICS)

76 studies across a total of 281,459 patients. In addition to

- reaffirming the highly significant impact of endoscopic conduit harvest in reducing postoperative wound complications
- EVH and ERAH were associated with significant reductions in postoperative pain and disability and superior patient satisfaction compared with traditional, open incisions guidance.

1. EVH should be the standard of care for patients requiring saphenous vein for CABG

I

B

Ferdinand FD et al. Endoscopic Conduit Harvest in Coronary Artery Bypass Grafting Surgery: An ISMICS Systematic Review and Consensus Conference Statements. *Innovations (Phila)*. 2017 Sep/Oct;12(5):301-319.

OVH vs. EVH in CABG: Comparative Outcomes



➤ 2018 ESC/EACTS Guidelines on myocardial revascularization.

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

- “There is no unequivocal evidence concerning patency rates, most data from meta-analyses and randomized and non-randomized trials do not demonstrate inferior clinical outcomes with endoscopic vein harvest.”



OVH vs. EVH in CABG: Comparative Outcomes



The NEW ENGLAND JOURNAL *of* MEDICINE

Randomized Trial of Endoscopic or Open Vein-Graft Harvesting for Coronary-Artery Bypass

Marco A. Zenati, M.D., Deepak L. Bhatt, M.D., M.P.H., Faisal G. Bakaeen, M.D., Eileen M. Stock, Ph.D., Kousick Biswas, Ph.D., J. Michael Gaziano, M.D., Rosemary F. Kelly, M.D., Elaine E. Tseng, M.D., Jerene Bitondo, P.A.-C., Jacquelyn A. Quin, M.D., M.P.H., G. Hossein Almassi, M.D., Miguel Haime, M.D., Brack Hattler, M.D., Ellen DeMatt, M.A., Alexandra Scrymgeour, M.S., Pharm.D., and Grant D. Huang, M.P.H., Ph.D., for the REGROUP Trial Investigators*

ABSTRACT

BACKGROUND

The saphenous-vein graft is the most common conduit for coronary-artery bypass grafting (CABG). The influence of the vein-graft harvesting technique on long-term clinical outcomes has not been well characterized.

METHODS

We randomly assigned patients undergoing CABG at 16 Veterans Affairs cardiac surgery centers to either open or endoscopic vein-graft harvesting. The primary outcome was a composite of major adverse cardiac events, including death from any cause, nonfatal myocardial infarction, and repeat revascularization. Leg-wound complications were also evaluated.

RESULTS

A total of 1150 patients underwent randomization. Over a median follow-up of 2.78 years, the primary outcome occurred in 89 patients (15.5%) in the open-

The authors' affiliations are listed in the Appendix. Address reprint requests to Dr. Zenati at the Division of Cardiac Surgery, Veterans Affairs Boston Healthcare System, 1400 VFW Parkway, Boston, MA 02132, or at marco_zenati@hms.harvard.edu.

*A complete list of the REGROUP Trial Investigators is provided in the Supplementary Appendix, available at NEJM.org.

This article was published on **November 11, 2018, at NEJM.org.**

N Engl J Med 2019;380:132-41.

DOI: 10.1056/NEJMoa1812390

Copyright © 2018 Massachusetts Medical Society.

OVH vs. EVH in CABG: Comparative Outcomes

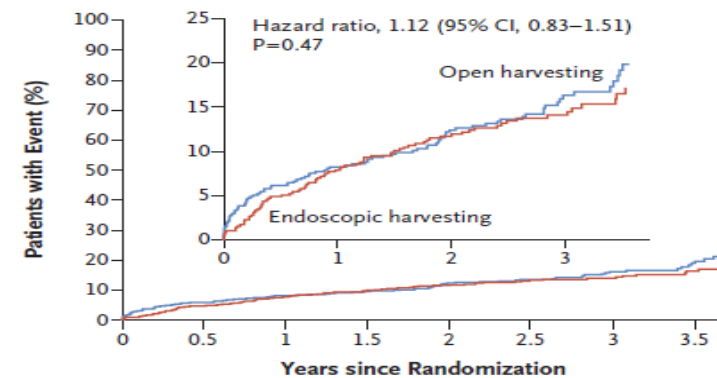
1150 patients underwent randomization from March 2014 through April 2017.

- 574 patients in OVH group
- 576 patients in EVH group

Primary Outcome: composite of major adverse cardiac events (MACE), including death from any cause, nonfatal myocardial infarction, and repeat revascularization.

Secondary Outcome: Leg-wound complications

Veins were harvested by expert* harvesters



No. at Risk								
Open harvesting	574	535	523	474	399	326	216	125
Endoscopic harvesting	576	543	526	470	398	312	215	128

Figure 2. Composite Outcome of Death from Any Cause, Myocardial Infarction, or Repeat Revascularization during the Active Follow-up Period. The inset shows the same data on an enlarged y axis.

In conclusion, our trial did not show a significant difference between endoscopic vein-graft harvesting in the rate of major adverse cardiac events among the patients undergoing CABG surgery during a follow-up period with a median duration of 2.78 years. The rate of wound complications was lower in the endoscopic-harvest group than in the open-harvest group.



OVH vs. EVH in CABG: Comparative Outcomes



JAMA
Network | Open



Research Letter | Surgery

Intermediate-Term Outcomes of Endoscopic or Open Vein Harvesting for Coronary Artery Bypass Grafting The REGROUP Randomized Clinical Trial

Marco A. Zenati, MD; Deepak L. Bhatt, MD, MPH; Eileen M. Stock, PhD; Brack Hattler, MD; Todd H. Wagner, PhD; Faisal G. Bakaeen, MD; Kousick Biswas, PhD

Introduction

Endoscopic vein harvesting (EVH) for coronary artery bypass grafting (CABG) was introduced in the 1990s to reduce the rates of leg wound complications.¹ Technical mastery of EVH requires a significant learning curve.² In 2009, a study in 3000 patients raised the concern that, compared with conventional harvesting, EVH was associated with a 50% increase in mortality.³ With the aim of assessing the safety of EVH, we report the intermediate-term results of the Randomized Endo-Vein Graft Prospective (REGROUP) trial.^{4,5}

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

Methods

The randomized clinical trial was approved by the institutional review board at each participating center. Patients gave written informed consent before participation. This study is reported following the Consolidated Standards of Reporting Trials (CONSORT) reporting guideline. The trial protocol and statistical analysis plan are available in Supplement 1. This study is registered on ClinicalTrials.gov (Identifier: NCT01850082).

Discussion

This randomized clinical trial found that there was no significant difference in MACE occurrence among patients who underwent EVH compared with those who underwent OVH for CABG over a median follow-up of 4.7 years. The saphenous vein is the most common supplementary conduit for CABG, but concerns have been raised about long-term ischemic events when EVH is used. This uncertainty has translated into variable adoption rates of EVH in North America (>80% of patients) compared with Europe (<50% of patients).⁶

The intermediate-term results of REGROUP are reassuring and demonstrate no significant difference in cardiovascular events between endoscopic or open approaches; leg-wound complications were reduced with EVH.⁵ Limitations of this study include lack of imaging evaluation of graft patency and use of only expert harvesters. These results provide strong reassurance that EVH is safe up to 4.7 years after the procedure; a 10-year follow-up is planned.

ARTICLE INFORMATION

Accepted for Publication: January 21, 2021.

Published: March 15, 2021. doi:10.1001/jamanetworkopen.2021.1439

Open Access: This is an open access article distributed under the terms of the CC-BY License. © 2021 Zenati MA et al. JAMA Network Open.



OVH vs. EVH in CABG: Comparative Outcomes



➤ Adoption in USA

✓ 2019: Approx. 90% of CABGs. Forecast 2% CAGR (2019-2027)¹

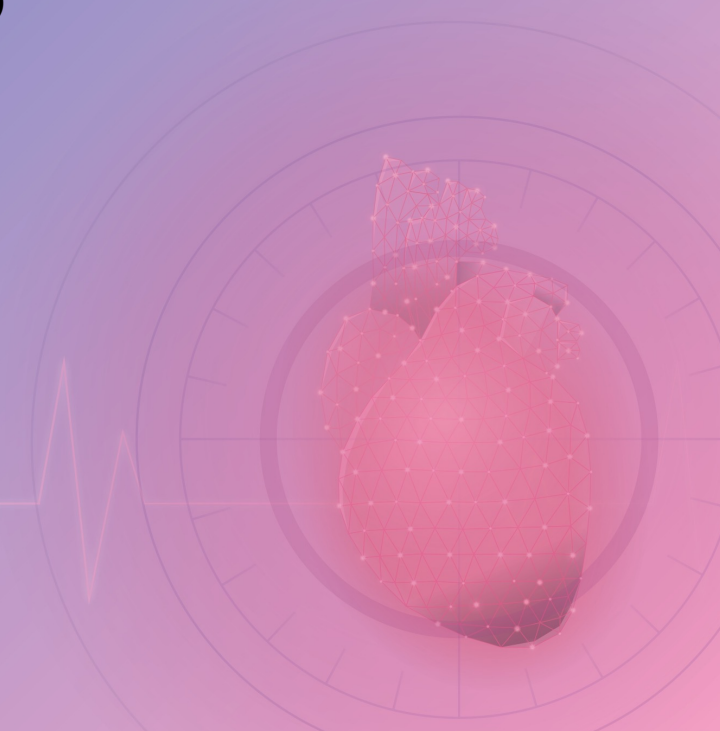
➤ Adoption in Europe

➤ 2019 approx. 50%

➤ Global Growth

➤ 2019 approx. 1.5% per year (2019-2027)¹

¹www.transparencymarketresearch.com





OVH vs. EVH in CABG: Comparative Outcomes



OVH vs. EVH in CABG: Comparative Outcomes

Conclusion:

- EVH:**
1. No Difference in MACE vs OVH.
 2. Much Less Prone to Wound Infection
 3. Smaller Incisions = Less Pain
 4. Ambulate Earlier = Short Length of Stay
 5. Cost Effective in long term
 6. Improved Patient's Satisfaction





OVH vs. EVH in CABG: Comparative Outcomes

EVH:

STANDARD OF CARE

in CABGs (When needed)!!





The International Society for Minimally Invasive Cardiothoracic Surgery

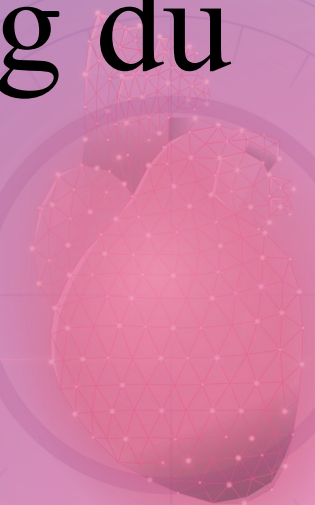




Thank You

Xin chân thành cảm ơn!

“Ta về ta tắm ao ta dù trong dù đục ao nhà vẫn hơn!”



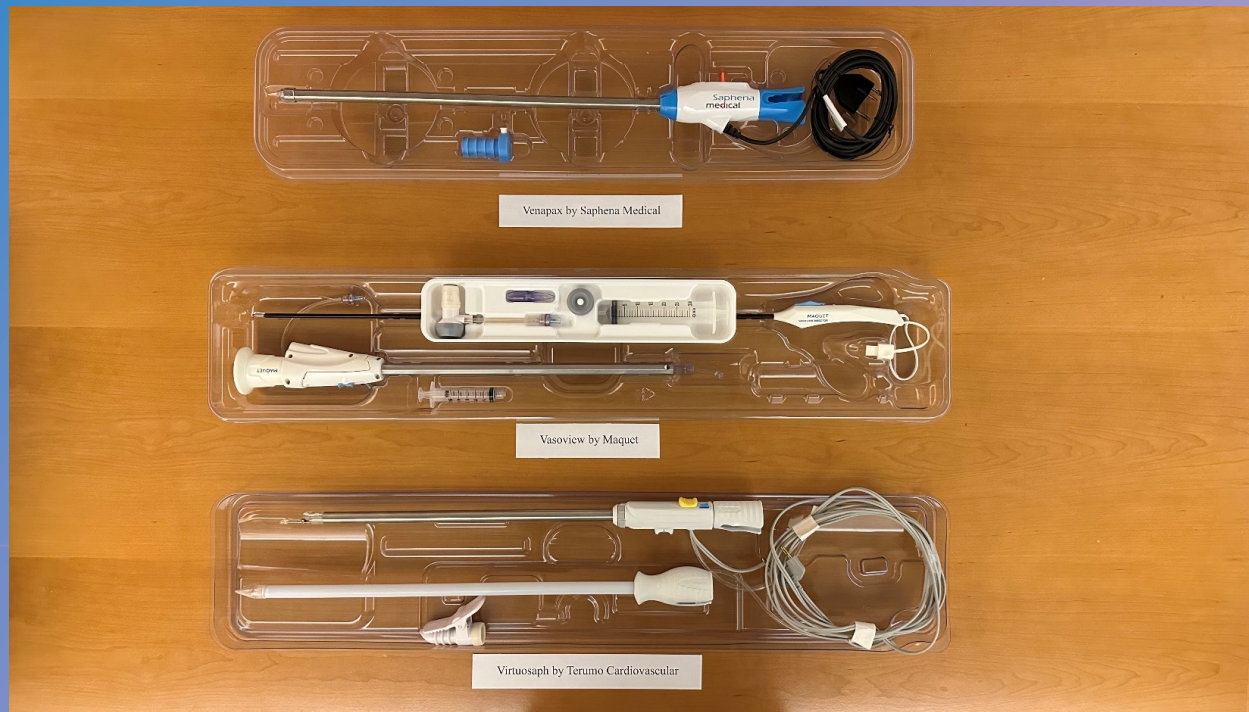


Content



OVH vs. EVH in CABG: Comparative Outcomes

➤ Endoscopic Vein Harvest Systems



OVH vs. EVH in CABG: Comparative Outcomes

➤ Endoscopic Vein Harvest System

	Vasoview by Getinge	VirtuoSaph by Terumo	Venapax by Saphena Medical
Introduction	1995	2005	2015
EVH	Binary	Binary	Unitary
System	Close	Open	Open
Coag/Cutting	DC Hemopro	Bipolar	Bipolar
Insufflation CO2	Distal & Proximal	Distal	Proximal
Lens/Scope End	Open	Open	Enclosed
Ease of Use (cases)	20	10	5
Cost (s)	Power Supply (Hemopro): \$5000 USD		
	Kit: ≈ \$1000 USD	Kit: ≈ \$800 USD	Kit: ≈ \$700 USD