<<ΥΒΡΙΔΙΚΕΣ>> ΚΑΙ ΑΛΛΕΣ ΠΑΡΕΜΒΑΣΕΙΣ ΜΕΤΑ ΣΤΕΦΑΝΙΑΙΑ ΠΑΡΑΚΑΜΨΗ

Α. ΖΙΑΚΑΣ

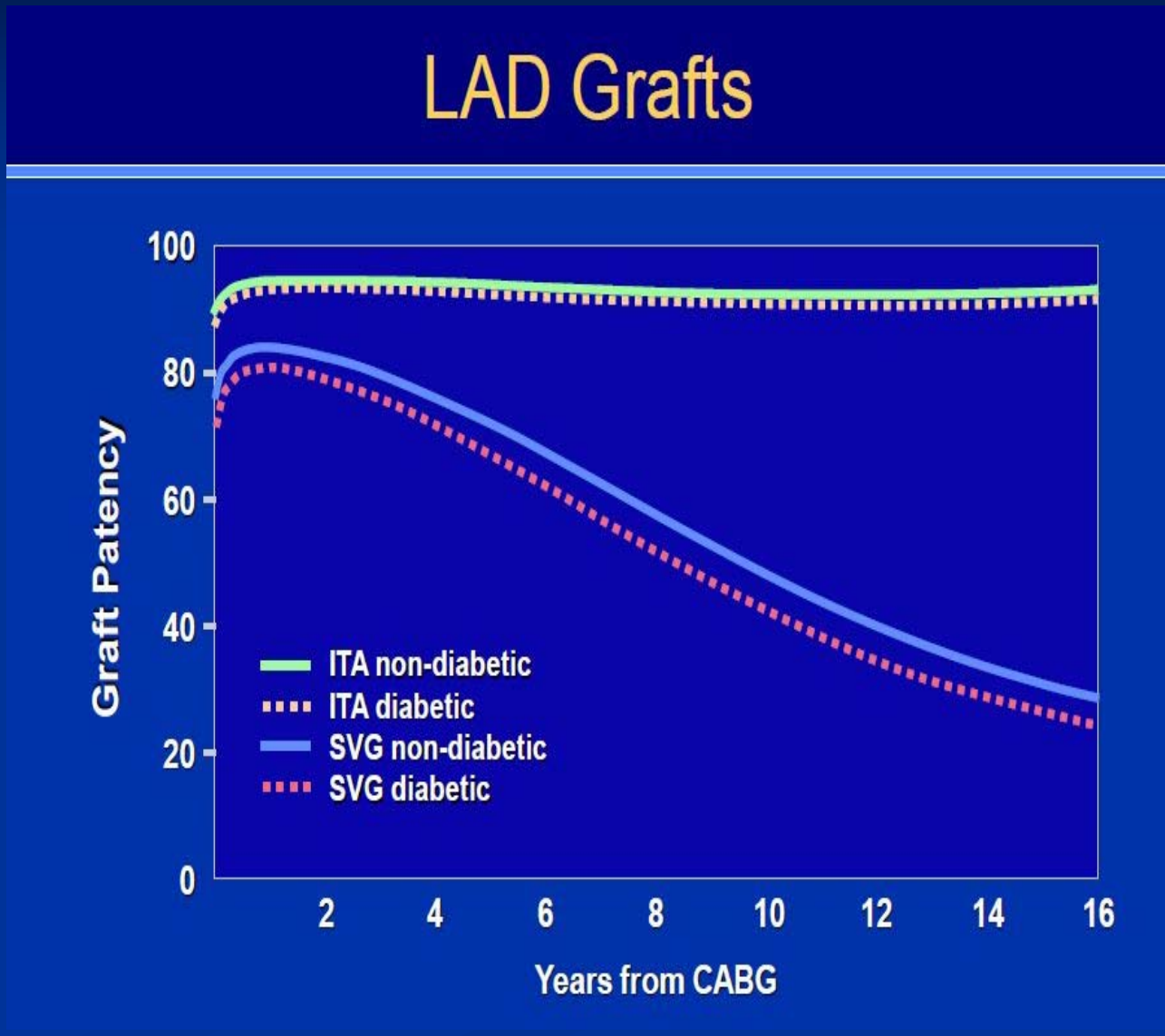
Α'ΚΑΡΔΙΟΛΟΓΙΚΗ ΚΛΙΝΙΚΗ ΑΧΕΠΑ

Hybrid coronary revascularization

- Coronary artery disease remains one of the most well-studied pathologic diseases, yet controversy still exists over the most appropriate therapy for patients with multivessel CAD.
- Prospective randomized studies have documented the superior long-term symptom relief and survival that coronary artery bypass grafting (CABG) affords compared with both medical therapy and PCI.
- However, PCI offers a lower level of invasiveness, a more rapid recovery, and less short-term complications than CABG in appropriately selected patients.
- A revascularization strategy that combines the durability of CABG with the minimally invasiveness of PCI is the rationale for "hybrid" coronary revascularization (HCR).

Hybrid coronary revascularization

- The most important feature of CABG that confers its longterm survival advantage is a patent left internal mammary artery (LIMA) graft sewn to the LAD.
- HCR employs a minimally invasive surgical approach for LIMA-LAD bypass.

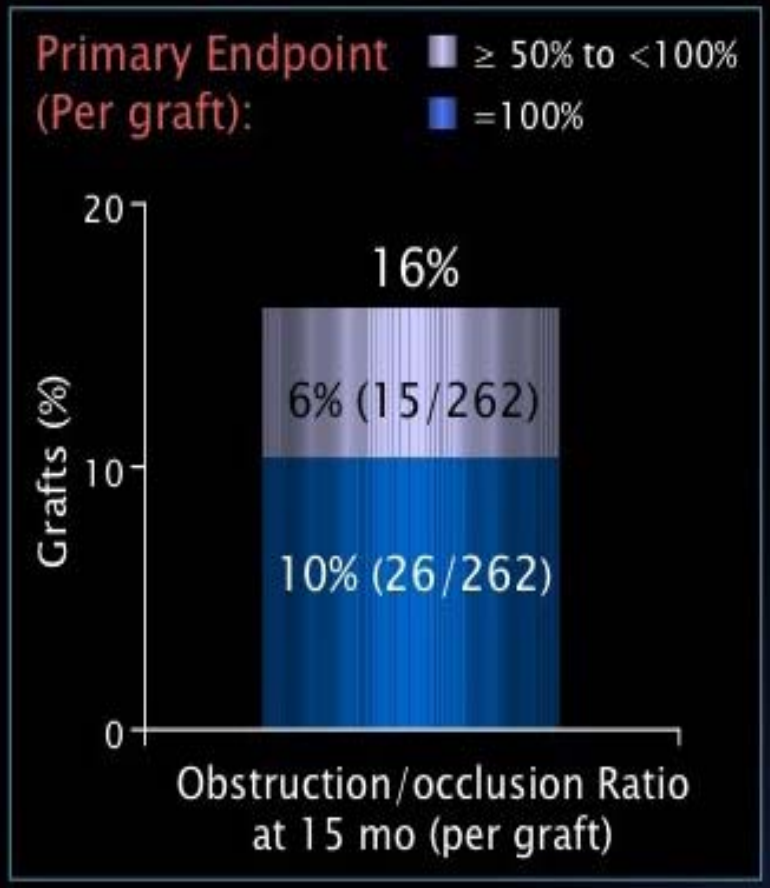


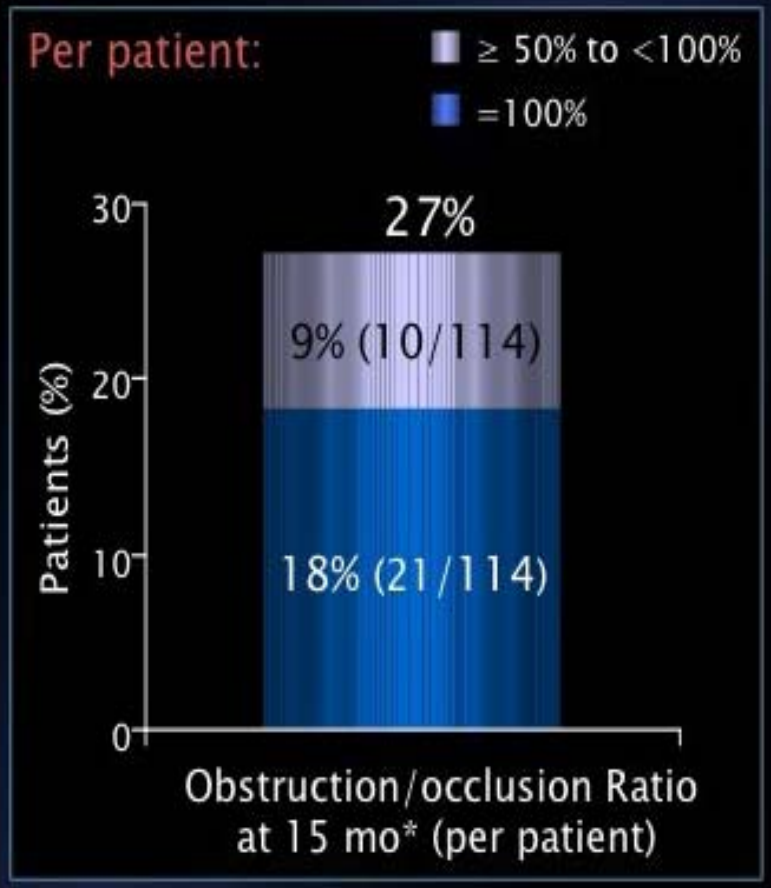
Hybrid coronary revascularization

- Saphenous vein grafts remain the most commonly employed conduit for non-LAD targets during conventional CABG. However, the 6- to 12-month occlusion rates for such 15% to 20%.

- Yun and colleagues reported 6-month saphenous vein graft occlusion rates of 17.6% and 21.7% on routine angiography of 144 patients.

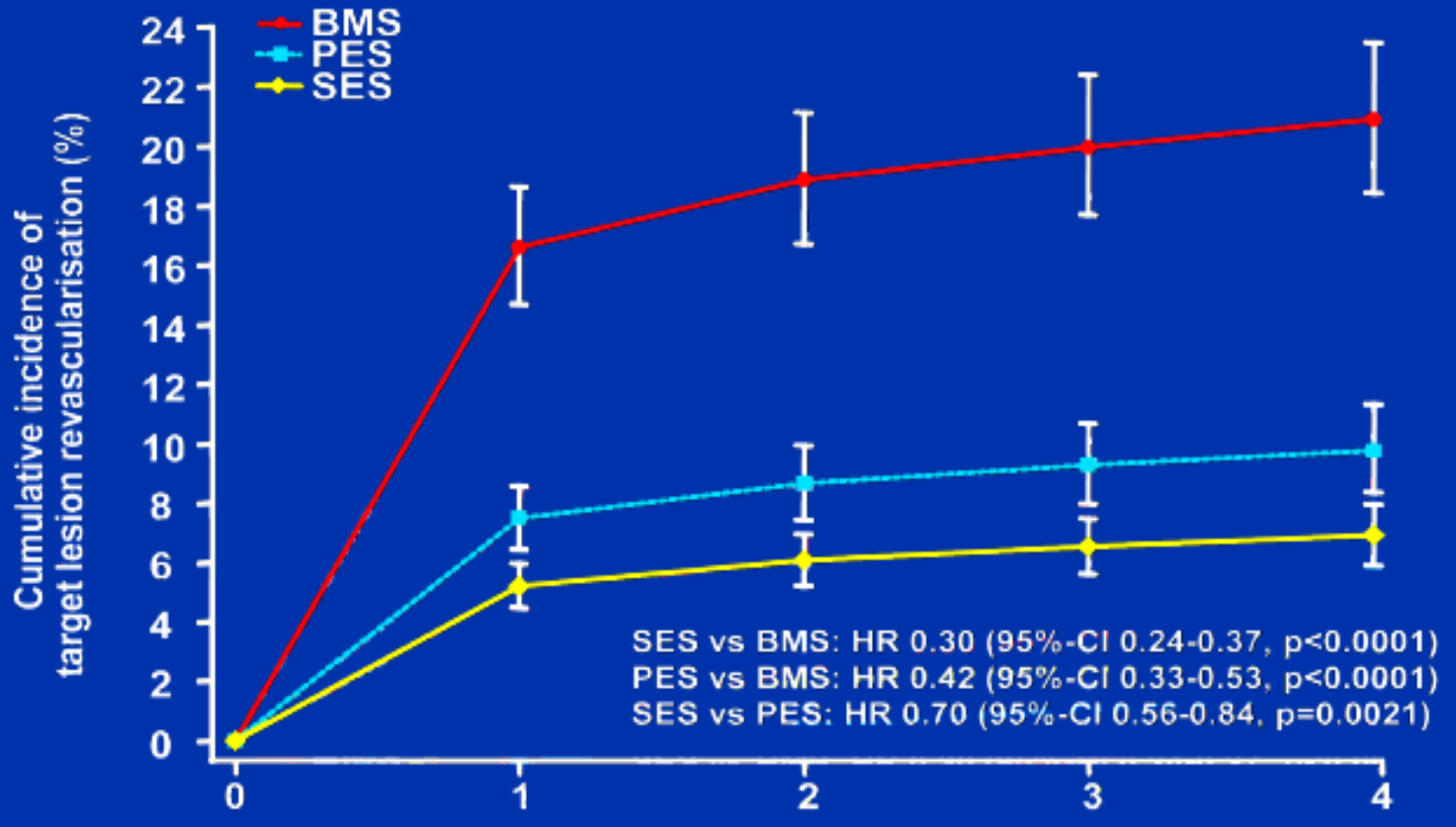
Principal Results
CABG Cohort





Definitions:
Occlusion Ratio: ratio of ≥50% obstructed or 100% occluded grafts/anastomoses (visual estimate) to the number of grafts/anastomoses placed
*Proportion of patients with at least 1 obstructed/occluded graft

Cumulative Incidence of TLR



N of events/patients					
BMS	4763	820/4746	53/2795	22/1871	10/1543
PES	6328	448/6280	98/3950	15/1999	6/832
SES	6621	356/6580	68/3801	16/2153	14/999

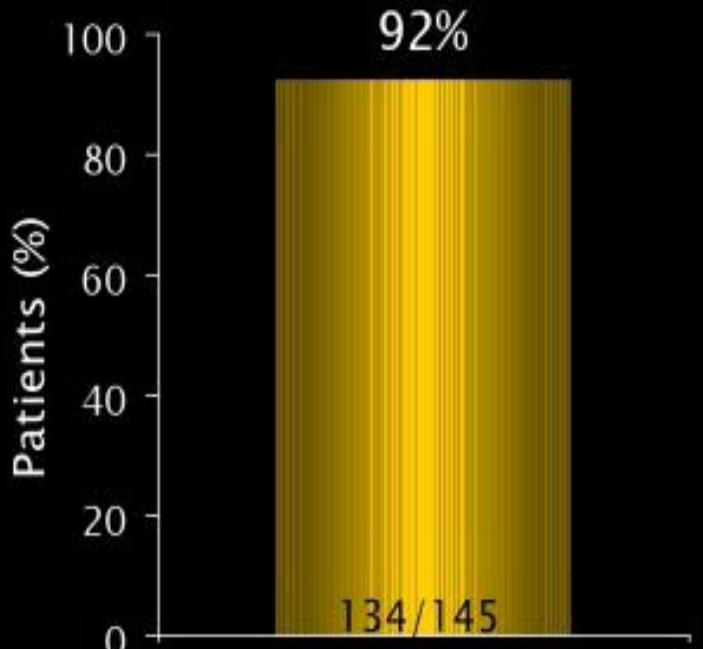
TVR was used as a proxy for 3 studies

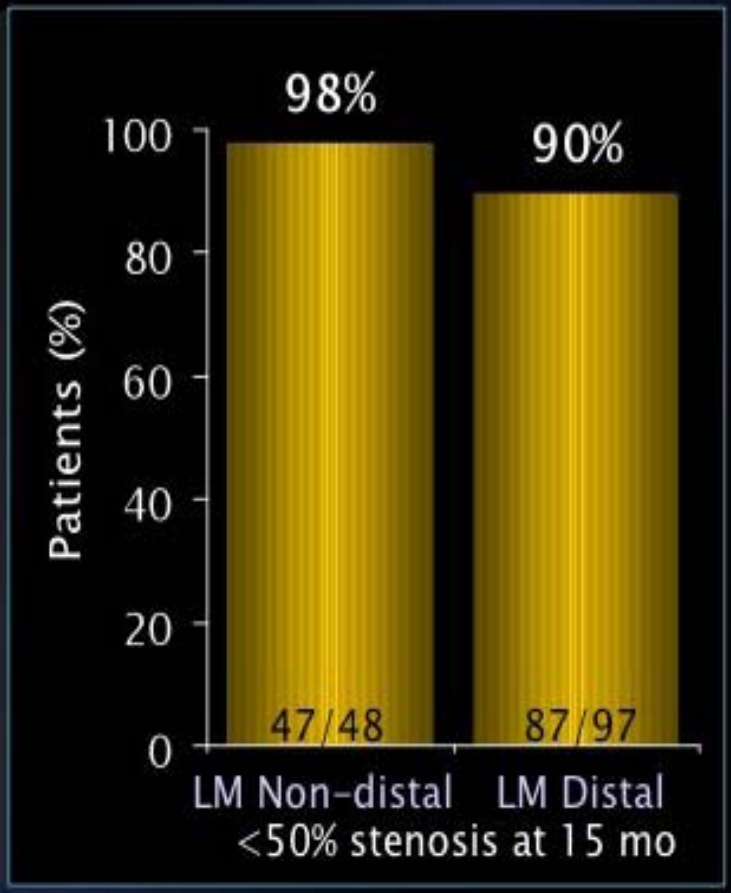
Stettler C., et al., Lancet 2007;370:937-48.

Principal Results
TAXUS Cohort

SYNTAX

Primary Endpoint:





Definitions:
Diameter stenosis was assessed by QCA

Hybrid Revascularization

Rationale

- Multivessel CABG most frequently involve
  - LIMA-LAD
  - SVG to other vessels
- SVG may have a limited lifespan
- Limited surgery may have lower risk
- LIMA-LAD can be performed
  - Through small incision (MID-CAB)
  - With robotic surgery
  - Without CPB (Off-Pump)

Hybrid Revascularization

Definition

- Combination of CABG and PCI for complete myocardial revascularization.
- Most frequently involves LIMA-LAD grafting and stenting of RCA and/or circumflex.

"Hybrid" Procedure

Minimally invasive surgical revascularization of LAD with the LIMA

combined with

PCI of Stenoses in non-LAD Vessels with DES

Techniques of Minimally Invasive Coronary Artery Bypass Grafting

- Minimally invasive cardiac surgery, aims to ameliorate 2 potentially invasive surgical components: the CPB machine and the sternotomy incision.
- The first minimally invasive CABG surgery was reported in 1967 by Dr. V.I. Kolessov in Russia
- Kolessov's series included 6 patients who underwent beating heart LIMA to LAD bypass through a limited left thoracotomy.

Techniques of Minimally Invasive Coronary Artery Bypass Grafting

- With the introduction of stabilizer technology, suturing to the beating heart became easier and more reproducible. The field of off-pump CABG(OPCAB) was developed in the early 1990s and now accounts for 20%-30% of all CABGs performed in the USA.
- Simultaneous with the development of OPCAB was renewed interest in Kolessov's beating-heart CABG performed through the left chest.
- MidCAB operation became the formal term for open LIMA takedown through a small anterior thoracotomy and revascularization of the LAD through this incision.
- Robotic technology and thoracoscopic approaches have been used. Totally endoscopic operations have been reported as well

MidCAB

- A MidCAB is performed with a limited anterior thoracotomy incision in the fourth or fifth interspace.
- Costal cartilage removal or disarticulation (αφαιρεση πλευρικου χονδρου) is necessary and a special chest wallretractor (διαστολεας θωρακικου τοιχωματος)is used to allow for open LIMA takedown.
- Cardiac stabilization can be accomplished with a stabilizer, which is delivered directly through the wound.
- Alternatively, an endoscopic stabilizer can be delivered into the operative field through a separate port, which can be used for chest tube insertion.
- Identification of the LAD and its branches through the small anterior thoracotomy requires attention to certain anatomic details on the preoperative angiogram.

MidCAB

- MidCAB has the advantage of not requiring any special endoscopic or robotic skills to master the LIMA takedown.
- Although single-lung ventilation (αερισμος ενός πνευμονος) improves exposure, chest cavity insufflation (εμφυσυση αερα) is not necessary.
- However, the degree of chest wall retraction (διαστολεας) necessary to allow for open LIMA mobilization is quite extensive and postoperative pain control can be a challenge.
- It is clear that a comfort level with off-pump surgery is important with this procedure and experience with sternal sparing incisions is likewise beneficial.

ΑΠΟΤΕΛΕΣΜΑΤΑ MidCAB

- Large series of MidCAB have been reported in the literature as early as 1994 and fairly extensive data exist from routine angiography in these earliest series.

- Short-term patency rates in both the earliest series and the more contemporary series range from 95% to 97%.

MidCAB

- The advantages of MidCAB over conventional CABG are rooted in the avoidance of CPB and the absence of aortic manipulation or cross-clamping.
- It appears that open MidCAB can decrease bleeding and infection rates when compared with OPCABx1 through a sternotomy.
- However, it is not clear that there is a significant difference in pulmonary complications or postoperative pain between open MidCAB and traditional OpCABx1.

Thoracoscopic MidCAB

- To avoid the significant chest wall manipulation associated with open MidCAB and to improve postoperative pain control, thoracoscopic and robotic techniques have been employed

- The first reports of thoracoscopic LIMA takedown and LIMALAD anastomosis through mini-thoracotomy were reported in the early 1990s.

Thoracoscopic MidCAB

- Pericardiotomy and vessel identification can be accomplished thoracoscopically before LIMA takedown.
- Thoracoscopic LIMA mobilization requires chest cavity insufflation to develop the virtual space of the anterior mediastinum in which the LIMA lies. Insufflation of the chest is performed at pressures ranging from 8 to 15 mm Hg.
- During insufflation, a controlled pneumothorax is induced. The resultant cardiac displacement results in rising central venous pressure, decreased right and left heart filling, a drop in blood pressure, and an alteration in oxygenation

Thoracoscopic MidCAB

- Adequate volume loading and peripheral vasoconstriction is necessary to maintain appropriate hemodynamics.
- An assessment of preoperative chest radiography can help the surgeon and anesthesiologist predict how a particular patient will respond to insufflation.
- A small cardiac to lung ratio (small heart, large chest) will result in more dramatic hemodynamic shifts than a larger ratio (large heart, small chest).

Thoracoscopic MidCAB

- Vassiliades et al have reported the largest series of thoracoscopic LIMA takedown and open LIMA-LAD anastomosis.
- In their series of 607 patients between 1997 and 2005 Vassiliades and colleagues reported a 96% LIMA-LAD patency rate among 379 selected patients who underwent clinically indicated cardiac catheterization.
- Complications were low when compared with conventional CABG with early return to full activity.

Thoracoscopic MidCAB

- Nonetheless, thoracoscopic endo-ACAB has failed to achieve widespread adoption primarily owing to the training and learning curve of thoracoscopic LIMA takedown.

- Advanced thoracoscopic skills are required and even the most skilled surgeons will have a 25- to 50-case learning curve before they can quickly and reproducibly mobilize the LIMA.

Robotically Assisted Coronary Artery Bypass Graft

- The use of robotic technology for pericardiotomy, target vessel localization, and LIMA takedown has significantly shortened the learning curve for performing these maneuvers endoscopically.
- The enabling technology of robotics can allow the minimally invasive surgeon to more quickly and more accurately perform the critical steps in endoscopic LIMA takedown when compared with a thoracoscopic approach.
- Insufflation and single-lung ventilation are critical as in the thoracoscopic approach, and alterations in cardiac hemodynamics can occur during this period.

Robotically Assisted Coronary Artery Bypass Graft

- The robotic approach decreases the chest wall trauma associated with open MidCAB and allows a hand-sewn anastomosis through the limited thoracotomy.

- The results of robotically assisted CABG have been excellent. Patency results with routine angiogram have ranged from 95% to 100% and patient satisfaction has been excellent.

  Length of stay, return to full activity, and pain scores all seem to be reduced with robotically assisted CABG compared with conventional CABG.

Totally Endoscopic Coronary Artery Bypass Graft

- The first totally endoscopic CABG (TECAB) surgeries were performed robotically on the arrested heart during CPB.
- The complications associated with intra-aortic balloon occlusion and the inflammatory response of CPB led most minimally invasive surgeons to opt for beating-heart off-pump revascularization in lieu of a totally endoscopic approach.
- The beating-heart TECAB was the next extension of the totally endoscopic expedition.
- The beating-heart TECAB is performed in an identical way as the robotic MidCAB, with the exception of the 4-cm thoracotomy for open, hand-sewn anastomosis.
- Instead, the anastomosis is performed intracorporeally with the robot.
- The TECAB has proved to be an incredibly challenging operation that only a few have mastered.
- Early results are encouraging from a small number of skilled operators but widespread adoption of this operation had not occurred.

Selection Criteria and Special Considerations

- Absolute exclusion criteria for robotic or thoracoscopic CABG include patients with severe chronic obstructive pulmonary disease who cannot tolerate single-lung ventilation and those patients who have had prior left chest surgery.

- Patients with severe pulmonary hypertension also provide a relative contraindication as rapid desaturation and hemodynamic compromise can occur with 1-lung ventilation and thoracic insufflation.

- Actively ischemic patients also pose a challenge. The chest insufflation can exacerbate ischemia and result in malignant arrhythmias that can be challenging to handle. All patients should have external defibrillator pads on for the duration of the operation. The institution of CPB through right femoral artery and femoral vein can be very helpful in these situations for both maintaining hemodynamic stability and decompressing the heart.

Techniques of Hybrid Coronary Revascularization

- The first HCR procedures were reported in the mid-1990s during the re-emergence of MidCAB and typically were performed in a staged sitting with LIMA-LAD performed first.
- PCI typically had been performed with percutaneous transluminal coronary angioplasty (PTCA) and occasional BMS.
- Although the early results of these HCR procedures were excellent, concern regarding late restenosis led many cardiologists and surgeons to reserve this procedure for very highrisk patients.

Optimal Hybrid Coronary Revascularization

- There are 3 basic HCR approaches, all with their potential advantages and disadvantages:
- (1) PCI can be performed first followed by minimally invasive CABG;
- (2) minimally invasive CABG can be performed first followed by PCI;
- (3) minimally invasive CABG and PCI can be performed in the same sitting in a hybrid operative suite.

1. PCI then Minimally Invasive Coronary Artery Bypass Graft

- The potential advantages of a strategy that employs PCI before minimally invasive CABG are 3-fold.
- First, revascularization of non-LAD targets provides excellent collateral circulation, thereby minimizing the potential risk of ischemia during the LAD occlusion of minimally invasive CABG.
- Second, it allows the interventional cardiologist the fallback position of conventional CABG should a suboptimal PCI result be obtained.
- Finally, this approach allows for HCR in the setting of acute myocardial infarction in which the target lesion is in a non- LAD vessel. The acute lesion can be treated and the LAD can be revascularized with a minimally invasive CABG at a later sitting.

PCI Then Minimally Invasive Coronary Artery Bypass Graft

- Although this approach was used fairly commonly in the era of PTCA and BMS, the risk of acute stent thrombosis with DES has raised serious concern
- With this strategy, in hospital patients need to be maintained on eptifibatide (Integrilin;), which can be stopped for the minimally invasive CABG.
- Clopidogrel can be instituted once extubated in the postoperative period.
- However, it is clear that the risk of stent thrombosis with both BMS within 1 month and DES for up to 1 year is related to both brief discontinuation of IIIa/IIb inhibitors and the inflammatory reaction of both noncardiac and cardiac surgery.

2. Minimally Invasive Coronary Artery Bypass Graft Then PCI

- With the broad application of DES, this strategy has become the most widely adopted for HCR.
- The primary advantage of this approach is that aggressive antiplatelet therapy can be initiated early after surgery and continued long term.
- A second advantage is that the integrity of the LIMA-LAD can be confirmed via angiography at the time of the completion PCI.
- Finally, this approach gives the interventional cardiologist the ability to approach lesions that otherwise would be quite hazardous should the LAD not be protected (Left main lesions.

Minimally Invasive Coronary Artery Bypass Graft Then PCI

- The minimally invasive surgeon has to select these patients appropriately and be more cognizant of possible intraoperative ischemia with this HCR approach because the collateral non-LAD vessels are unrevascularized. Judicious use of intracoronary shunts, careful attention to cardiac-filling pressures and systemic blood pressure during insufflation, and the use of peripheral CPB when necessary are all critical to success in this setting.

optimal timing

- A period of waiting after surgery seems prudent to allow the patient to resolve the potential inflammatory milieu which exists immediately after the operation.
- This response is quite brief and usually has resolved within 3-5 days, making it possible to perform PCI on the index hospitalization or days to weeks later.
- Patients may need 7-10 days of mental and physical recovery before undergoing a second procedure. However, some physicians may feel uneasy discharging certain patients with an incomplete revascularization, prompting PCI before discharge.

Economic issues

- Economic issues also bear on the hospital system, as a single diagnosis-related group (DRG) is typically used to reimburse two separate costly procedures.
- As HCR becomes more common, these issues will likely be addressed to provide a fuller hospital reimbursement.

Simultaneous Minimally Invasive Coronary Artery Bypass Graft and PCI

With the advent of endovascular surgical procedures and percutaneous valvular therapy, operating suites have been created that have the capability of both minimally invasive surgical procedures and PCI.

Simultaneous Minimally Invasive Coronary Artery Bypass Graft and PCI

- The potential advantages of such an approach include the ability to perform routine imaging of the LIMA-LAD before closure to confirm an anatomically acceptable anastomosis.
- Complete revascularization before leaving the operating suite is the other major advantage of such an approach.
- The emotional and psychological benefit to the patient of a complete "fix" in one anesthetic sitting also has its merits.
-
- Finally, PCI performed in the setting of a completed LIMA-LAD allows a more aggressive percutaneous approach of otherwise challenging lesions. The security of general anesthesia and the operating room likewise provides a safety net should a PCI failure occur.

Simultaneous Minimally Invasive Coronary Artery Bypass Graft and PCI

- **Detractors of the simultaneous HCR point to increased operative times, increased costs, and inadequate hospital reimbursement.**
- **Bleeding also becomes a concern because full antiplatelet therapy and incomplete heparin reversal are necessary immediately after minimally invasive CABG to maximize successful intraoperative DES placement.**
- **Although the inflammatory response of minimally invasive CABG is blunted compared with conventional OpCAB some interventionalists continue to raise concern about immediate intraoperative DES placement and acute stent thrombosis.**

Results of Hybrid Coronary Revascularization

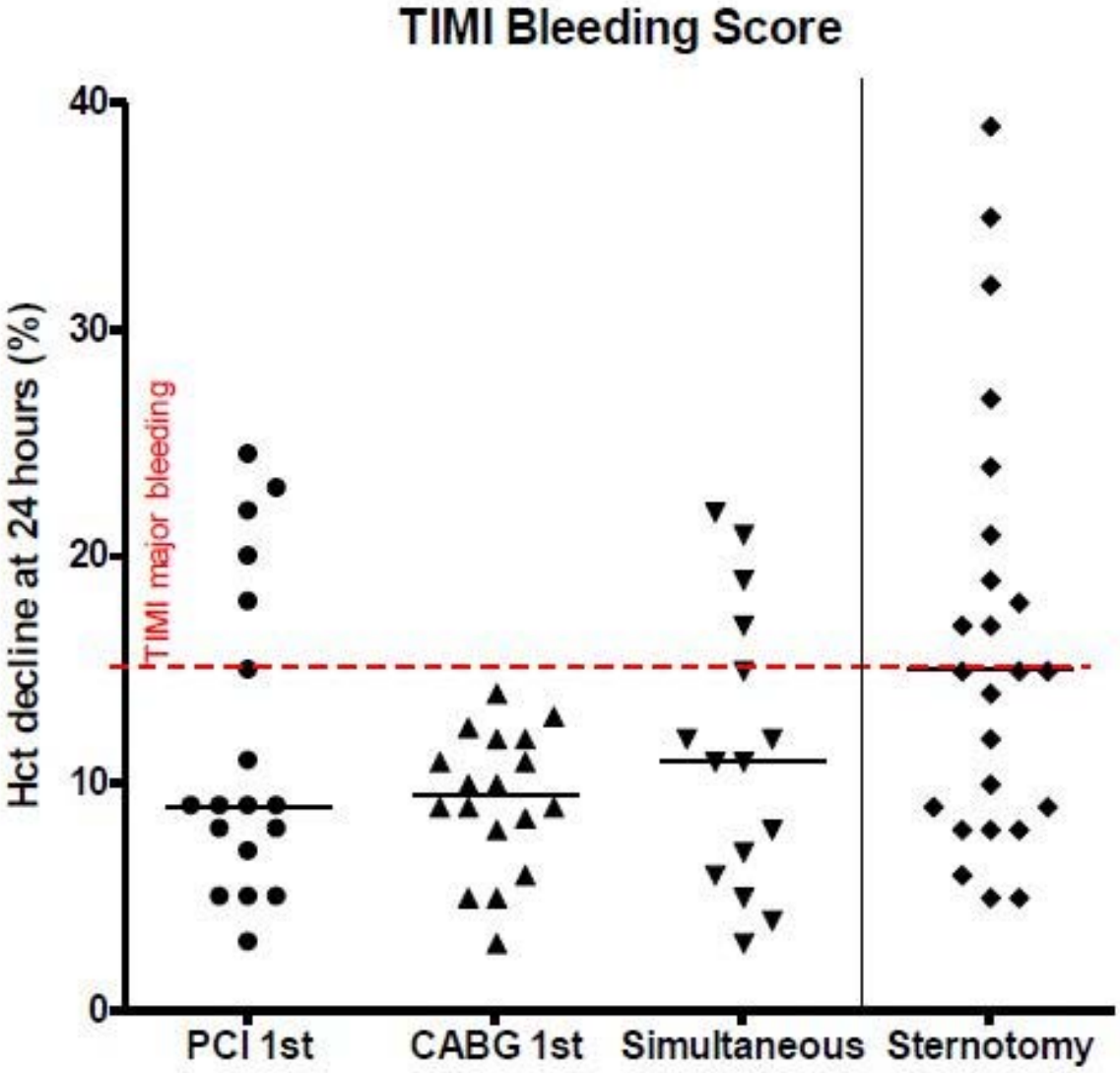
- Over the last decade, approximately 500 patients undergoing HCR have been reported in the literature
- The variable surgical approaches, HCR techniques, and the percentage of DES placement make global conclusions difficult. However, routine angiography in most studies does demonstrate that patency of minimally invasive LIMA-LAD by all previously described methods compares favorably with conventional CABG.
- Target vessel revascularization appears to vary based on number of stents placed and percentage of DES used in each study.
- Reintervention of LIMA-LAD in all studies varies from 1% to 3%, again giving support to this procedure as an equivalent revascularization strategy to conventional CABG in experienced hands.

Table 2 Hybrid Coronary Revascularization Series

Author	Institution	Date	n	MICABG	PCI	HCR Strategy	F/U	30-day Mortality (%)	LIMA Patency (%)	TVR	Event-Free Survival
Zenati[22]	Pittsburgh	1999	31	Open MidCAB	BMS—66% PTCA—34%	PCI then MICABG 7% Same day—52% MICABG then PCI—9%	10.8 mo	0	100	9.6	90
Lloyd[23]	Bristol Heart	1999	18	Open MidCAB	PTCA—52% BMS—48%	MICABG then PCI—77% Simultaneous—23%	6 mo	0	100	0	100
Wittwer[24]	Hannover	2000	35	Open MidCAB	PTCA—70% BMS—30%	MICABG then PCI	11.5 d	0	100	NA	NA
Riess[25]	Hamburg	2002	57	Lower Hemi-sternotomy	PTCA—58% BMS—42%	MICABG then PCI	24 mo	0	97	16	NA
Stahl[26]	Multi-USA	2002	54	Robotic Endo-ACAB	PTCA	PCI then MICABG—35% MICABG then PCI—65%	11.7 mo	0	100	NA	87
Cisowski[27]	Poland	2002	50	Thoracoscopic MidCAB	PTCA—22% BMS—78%	MICABG then PCI	6-24 mo	0	100	13	87
Davidavicius[14]	Belgium	2005	20	Robotic Endo-ACAB	BMS—95% DES—5%	PCI then MICABG—70% MICABG then PCI—30%	19 mo	0	100	0	100
Katz[28]	Multi-International	2006	27	Arrested heart TECAB	BMS—37% DES—63%	PCI then MICABG—41% MICABG then PCI—44% Simultaneous—15%	9 mo	0	100	29.6	70
Vassiliades[29]	Emory	2006	47	Thoracoscopic Endo-ACAB	DES	PCI then MICABG—11% MICABG then PCI—89%	7 mo	0	100	8.5	89
Gilard[30]	France	2007	70	Conventional On pump CABG	Stent to RCA	CABG then PCI	33 mo	1.4	100	NA	96
Kon[21]	Maryland	2008	15	Open MidCAB	DES	Simultaneous	12 mo	0	100	6.7	93
Kiaii[17]	Western Ontario Canada	2008	58	Robotic Endo-ACAB	DES—90% BMS—10%	Simultaneous	20 mo	0	93	10.3	NA
Gao[18]	China	2009	10	Robotic MidCAB-6 Beating heart TECAB-4	BMS—67% DES—23%	MICABG, then PCI	5 mo	0	100	NA	NA

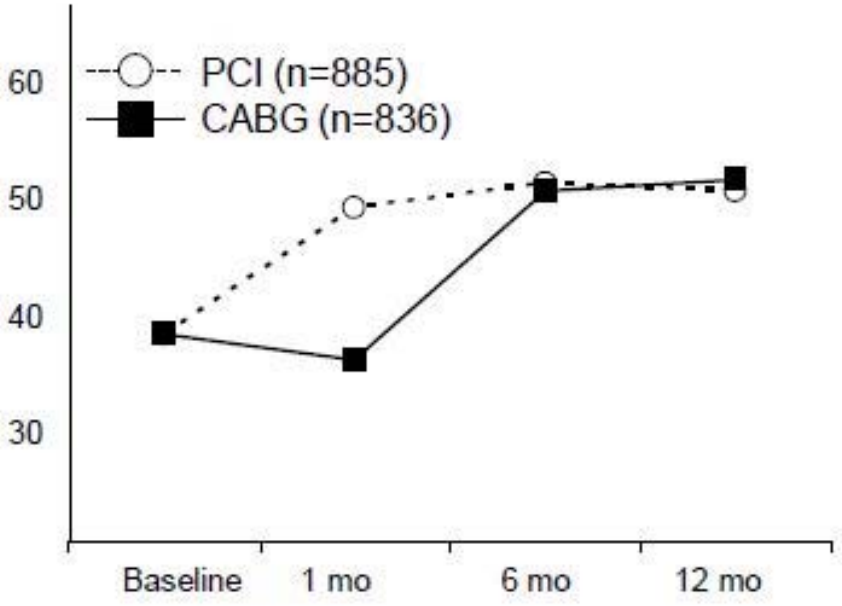
BMS, bare metal stent; DES, drug-eluting stent; endo-ACAB, endoscopic atraumatic coronary artery bypass; HCR, hybrid coronary revascularization; LIMA, left internal mammary artery; MidCAB, minimally invasive direct coronary artery bypass; MICABG, minimally invasive coronary artery bypass grafting; PCI, percutaneous coronary intervention; PTCA, percutaneous transluminal coronary angioplasty; RCA, right coronary artery; TECAB, totally endoscopic coronary artery bypass; TVR, target vessel revascularization.

Plavix and Bleeding

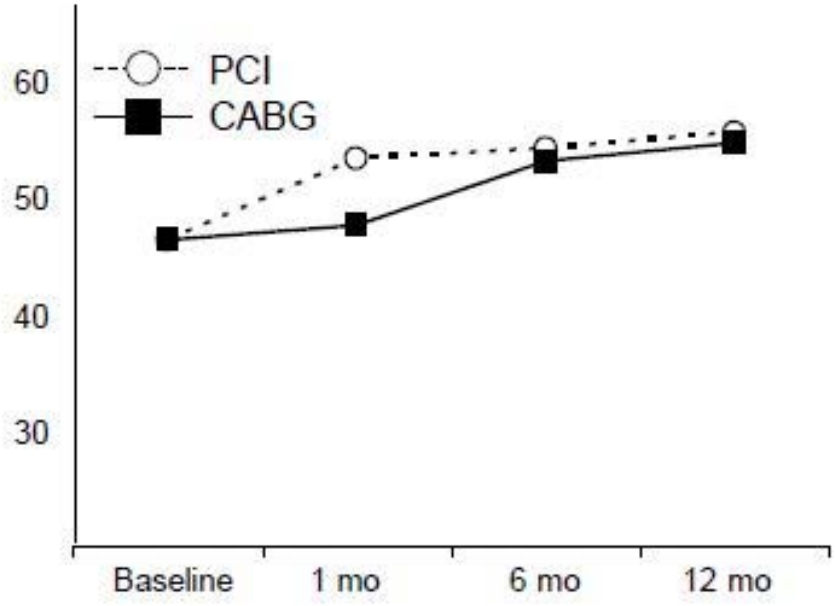


Quality of Life after CABG vs. PCI

Results from the Syntax Trial



SF-36 – PHYSICAL

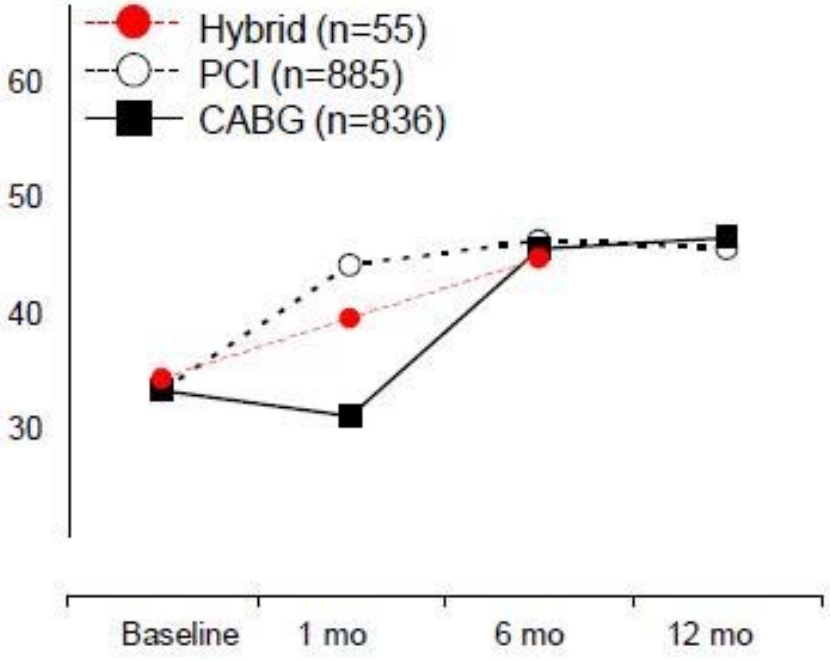


SF-36 - MENTAL

Cohen et al, ACC meeting, 3/09

Quality of Life after CABG vs. PCI

Hybrid Results vs. Syntax Trial



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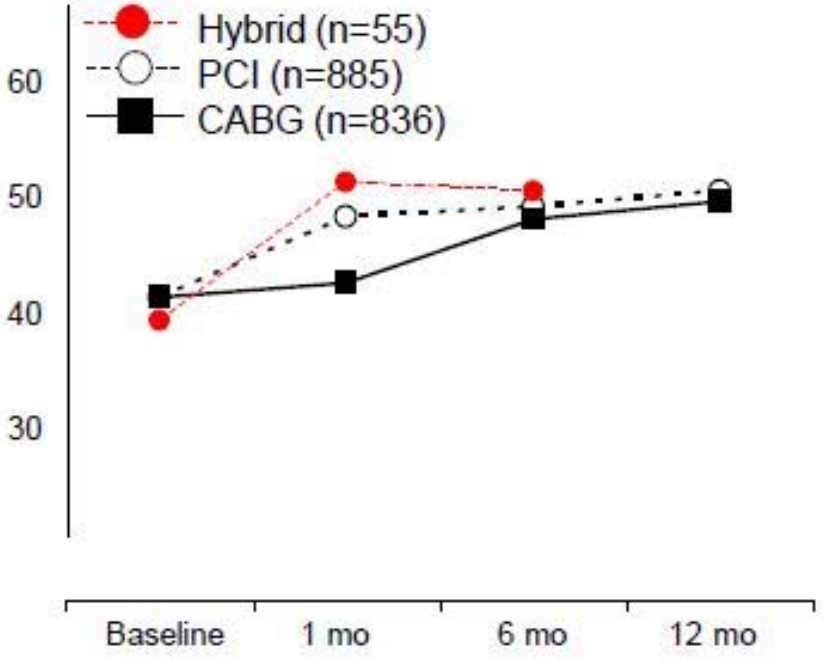


SF-36 - MENTAL

Cohen et al, ACC meeting, 3/09

Hybrid PCI – Answers needed

- Anticoagulation regimen is restricted (i.e. UFH)
- Timing of antiplatelet agents (pre vs intraoperative)
- Technically challenging, requires special facility/staff
- Cost effective?
- Potential clopidogrel-related post-op bleeding
- Stent thrombosis risk; A/C reversal with protamine
- Complications; access, contrast
- Infection risk

ΣΥΜΠΕΡΑΣΜΑΤΑ

Υβριδική επαναιμάτωση είναι μια ασφαλής εναλλακτική λύση για επιλεγμένους ασθενείς με πολυαγγειακή νόσο.

Είναι αποτέλεσμα ομάδας εργασίας (χρειάζεται καλή συνεννόηση ανάμεσα σε χειρουργούς και επεμβατικούς καρδιολόγους.

Είναι παράδειγμα λειτουργικής απευθείας συνεργασίας των δυο ειδικοτήτων

What we do together we do better'
Hybrid approach could be considered:
- in patients with increased surgical risks
(obesity, diabetes, COPD...)
-in patients with lesions too good for the surgeons

"Two - Stop " Hybrid Revascularization Issues

- Reduced patient satisfaction (minor)
- Increased length of stay and costs
- Failed PCI requiring 2nd operation (none yet)
- No surgical bleeding
- Permits optimal antiplatelet therapy for PCI
- PCI safety is superb with patent LIMA to LAD
- Special hybrid room not required
- Full cath lab functionality preserved

- Anastomotic lesions can be safely treated if needed (> 29 years treating them without complication).

Late Regression of LIMA Anastomotic Lesions is Common

- Early Angiography in 343 patients
  - > 50% Stenosis – 46 (13%)
  - > 70% Stenosis – 20 (6%)
- Late Followup Angiogram in 100 patients
  - In > 50% patients, % stenosis decreases from 69% to 35%, P < 0.001
  - In > 70% patients, most regressed

Izumi et al Circulation 2004: 110 (Suppl III); III-354

- Patients with left main with or without multivessel disease are good candidates for hybrid coronary revascularation

- Multi-vessel disease patients with
  - Ostial LAD or Circumflex
  - Multiple LAD Lesions
  - Complex LAD/D bifurcation
  - Inadequate conduits or inaccessible targets
  - Left Main Stenosis <90%
  - Diabetes with LAD Involvement
  - Advanced age
  - Renal insufficiency
  - Aortic calcification or atherosclerosis

High Risk Factors for On Pump Surgery

- Advanced Age
- Renal Dysfunction
- Poor LV function
- History of stroke
- Diffuse atherosclerosis of the aorta
- Pulmonary disease

Ann Thorac Surg 2002;74:1353-1357

Cost Effectiveness

For any revasularization choice (PCI vs Hybrid vs CABG) will require stratification using Syntax Scores and evaluate long term benefit

Syntax Scores

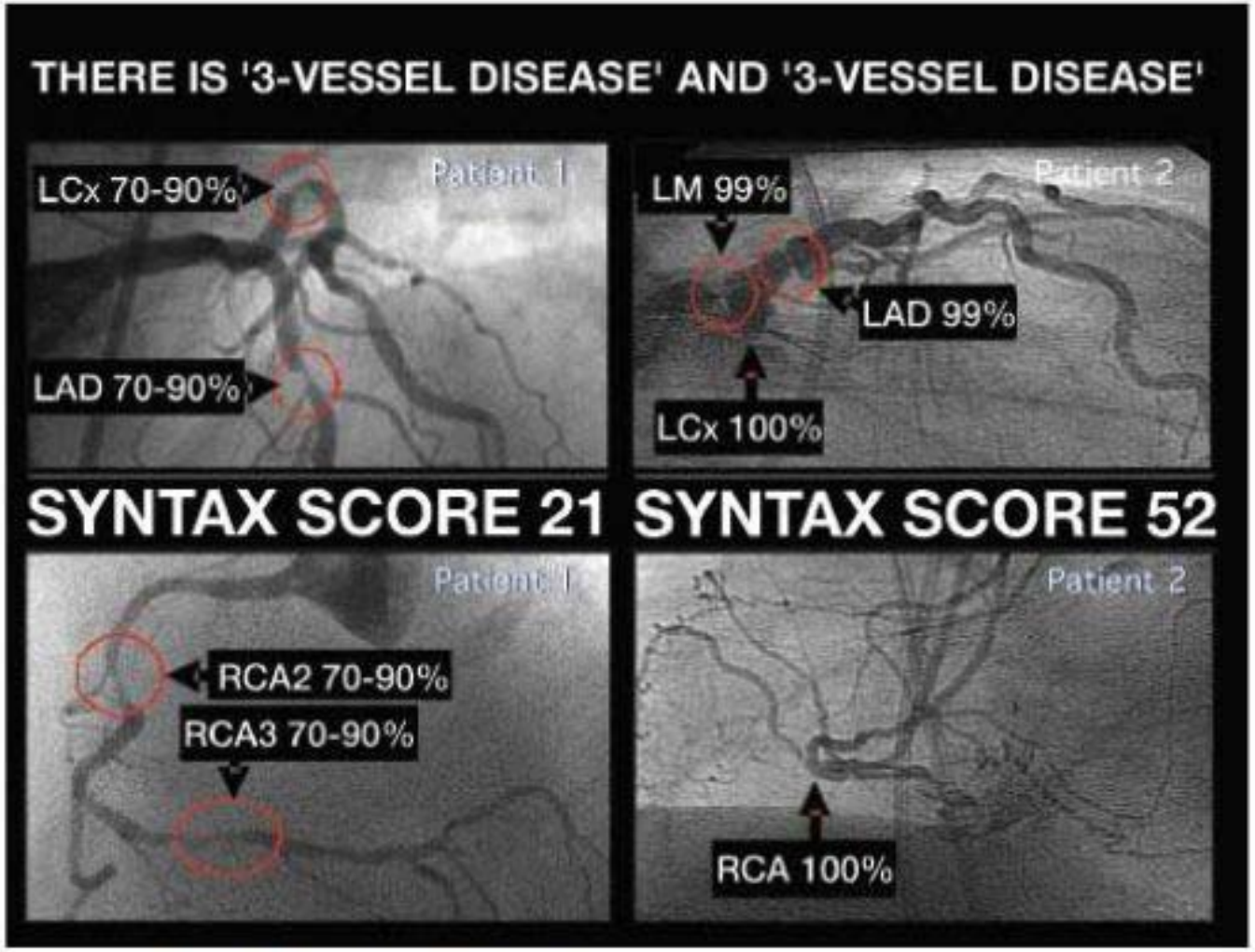


Figure 3. Examples of SYNTAX scores

Selected angiograms reprinted from Sianos G, Morel MA, Kappetein AP, et al. The SYNTAX score: an angiographic tool grading the complexity of CAD. *EuroInterv* 2005; 1: 219-227. Copyright © 2009, with permission from Europa Edition.

Comparative Cost Leger

	3V PCI	Staged Hybrid	One stop Hybrid	CABG
Cath lab fee	✓	✓		
OR fee		✓	✓	✓
Surgeon fee		✓	✓	✓
Cardiol fee	✓	✓	✓	
Stent fee	✓✓✓	✓	✓	
Plavix fee	✓	✓	✓	

Staged vs. One Stop Hybrid

- Staged
  - 2 technical fees
    - Cath lab and OR (cath lab DRG plus OR DRG)
  - Two professional fees
    - Cardiologist
    - Cardiac Surgeon
- One Stop
  - 1 technical fee
    - Hybrid OR fee
    - CABG/cath DRG
  - Two professional fees
    - Cardiologist
    - Cardiac Surgeon

Cost Effectiveness?

$$\text{Value} = \frac{\text{Quality}}{\text{Price}}$$

Only 4 ways to spend money

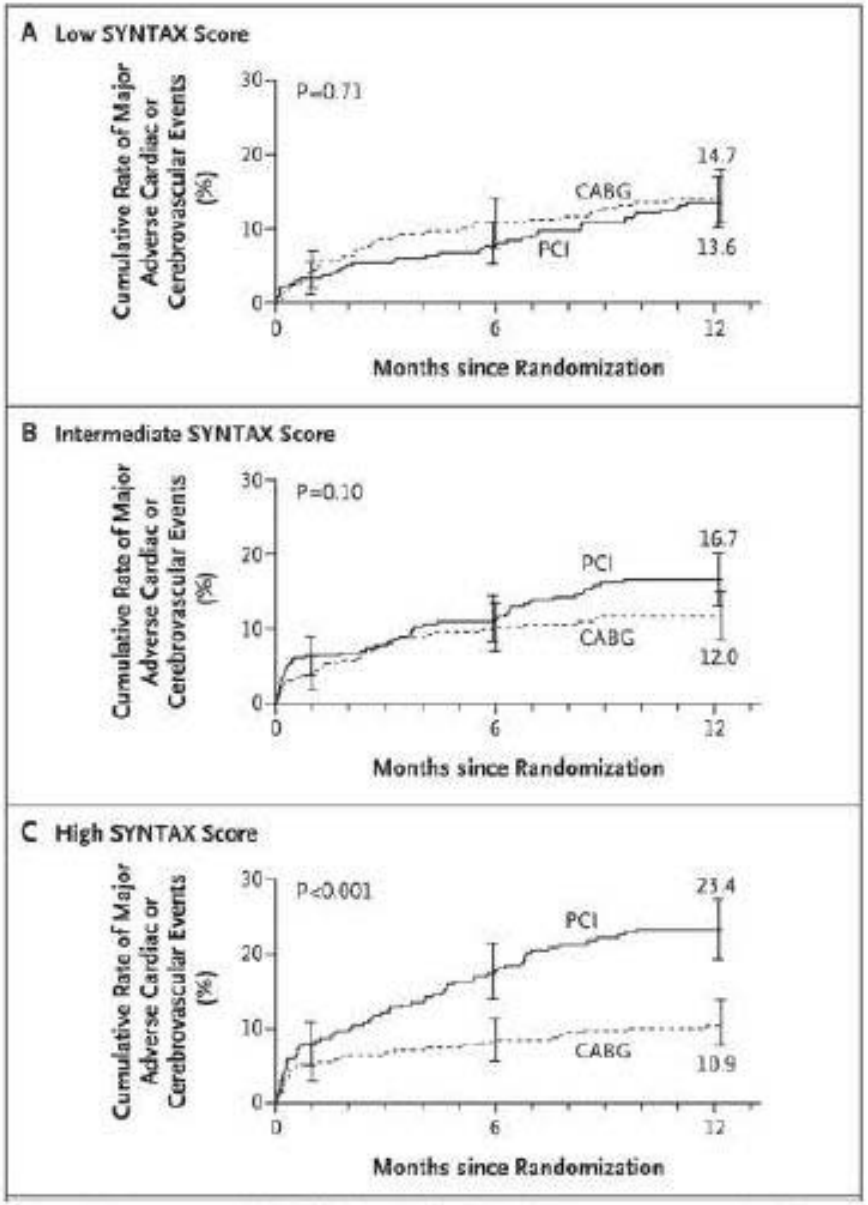
$V=Q/P$

Where Money Comes From	On Whom is Money Spent: You	On Whom is Money Spent: Someone else
Your $$	Type I The most value (V) Quality sensitive Price sensitive	Type II Value drops off (V) Less Quality sensitive Still price sensitive
Other peoples $$	Type III Value drops off dramatically (V) Still quality sensitive Price insentive	Type IV The worst valve (V) Sensitve to neither quality nor price

Conclusions from AATS debate ONCAB vs. OPCAB vs. HYBRID – Sabik vs. Puskas vs. Byrne

- Intra-operative imaging matters
  - We must embrace imaging if we want "CABG"
  - at least the LIMA-LAD - to survive
  - Cardiology has imaging – we need imaging!
  - We are at a distinct disadvantage because we have not embraced imaging
- Hybrid CABG/PCI and Hybrid Valve/PCI
  - Beneficial (clinically) in high risk patients
- As we try to do operations (MIDCAB) – where the stakes are high - through small incisions
  - Intra-operative Imaging
  - Combining the tools of the OR and the cath lab

Syntax Scores



TCT 2009: at 2 years these curves continue to separate

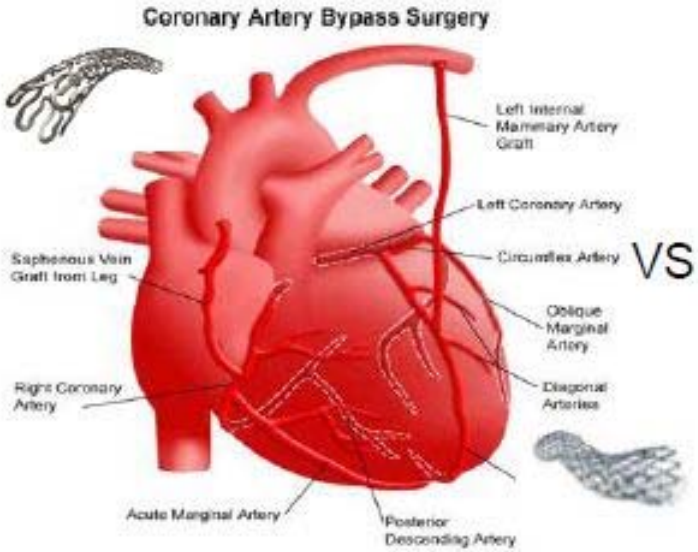
But

- **Is the benefit of "CABG" due to the use of the LIMA-LAD (protecting 95% of the vessel)?**
- **Are "CABG" results hindered by the failure to use PCI instead of SVG (20% early SVG failure)**
- **Does this make "CABG look worse then it should?**

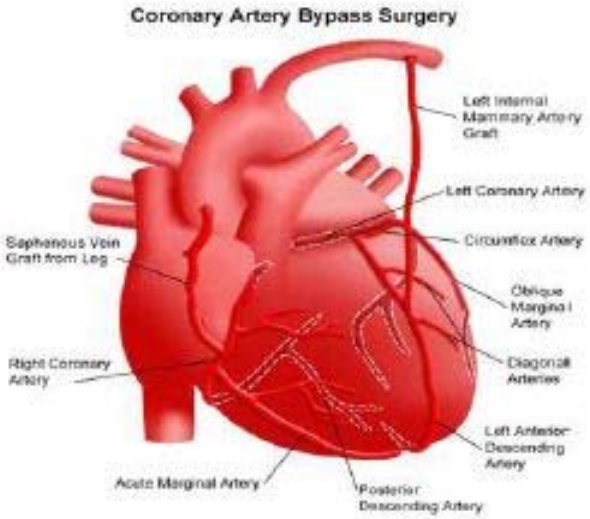
3V PCI vs. HYBRID vs. CABG for "3 vessel CAD" SYNTAX scores

3V PCI | **Hybrid LIMA-LAD + PCI** | **CABG**

VS



VS



Conclusions

- The hybrid procedure is probably most cost effective for high risk patients (high Syntax scores) in whom other options are less ideal.
- For lower risk and elective patients such as MIDCAB/PCI the cost effectiveness will need to take into account the long term benefit of the LIMA-LAD and the short term failure of SVGs (where the curves separate)

Hybrid Coronary Revascularization: Minimally Invasive CABG + PCI

- "Best of both worlds": IMA + benefits of minimally invasive
- Expands minimally invasive CABG
- Expands PCI (e.g. protected LM)
- Angiographic confirmation of grafts

Hybrid coronary revascularization

From Wikipedia, the free encyclopedia

Hybrid coronary bypass is a relatively new procedure and alternative to traditional bypass surgery that is defined by the performance of coronary bypass surgery and coronary stenting during the same operation. It is not to be confused with a MIDCAB procedure, which uses the smaller thoracotomy incision but does not involve coronary stenting. Hybrid bypass offers all the benefits of a MIDCAB 1) a much smaller incision (made through the rib cage as opposed to cutting the sternum and opening the rib cage) than with traditional bypass surgery 2) less pain for the patient and quicker recovery time and 3) less risk of complications, infections etc and also decreases the necessity for two separate cardiac procedures (bypass and stenting). However, it is more expensive, cannot be performed at all hospitals, and the long-term benefits are not proven.[1]

See also

[edit]

- Coronary artery bypass surgery

doi:10.1016/j.jacc.2004.09.050
Cite or Link Using DOI

Clinical research

Staged initial percutaneous coronary intervention followed by valve surgery ("hybrid approach") for patients with complex coronary and valve disease

Presented at the Annual Scientific Session of the American College of Cardiology, March 7 to 10, 2004, New Orleans, Louisiana.

John G. Byrne MD, FACC[*], , , Marzia Leacche MD[*], Daniel Unic MD[*], James D. Rawn MD[*], Daniel I. Simon MD, FACC[†], Campbell D. Rogers MD, FACC[†] and Lawrence H. Cohn MD, FACC[*]

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Received 22 July 2004; revised 18 September 2004; accepted 21 September 2004. Available online 30 December 2004.

Objectives

The goal of this study was to determine if a "hybrid" approach to the treatment of complex combined coronary and valve disease is superior to the results predicted by a Society of Thoracic Surgeons' (STS) algorithm with conventional coronary artery bypass graft (CABG)/valve surgery in high-risk patients.

doi:10.1016/j.ahj.2007.12.032
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Clinical Investigation

Simultaneous "hybrid" percutaneous coronary intervention and minimally invasive surgical bypass grafting: Feasibility, safety, and clinical outcomes

Barry Reicher MD[a], Robert S. Poston MD[b], Mandeep R. Mehra MD[a], Ashish Joshi[b], Patrick Odonkor[b], Zachary Kon[b], Peter A. Reyes MD[a] and David A. Zimrin MD[a]

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Surgical and percutaneous coronary artery intervention revascularization are traditionally considered isolated options. A simultaneous hybrid approach may allow an opportunity to match the best strategy for a particular anatomic lesion. Concerns regarding safety and feasibility of such an approach exist. We examined the safety, feasibility, and early outcomes of a simultaneous hybrid revascularization strategy (minimally invasive direct coronary bypass grafting of the left anterior descending [LAD] artery and drug-eluting stent [DES] to non-LAD lesions) in 13 patients with multivessel coronary artery disease that underwent left internal mammary artery to LAD minimally invasive direct coronary bypass performed through a lateral thoracotomy, followed by stenting of non-LAD lesions, in a fluoroscopy-equipped operating room. Assessment of coagulation parameters was also undertaken. Inhospital and postdischarge outcomes of these patients were compared to a group of 26 propensity score matched parallel controls that underwent standard off-pump coronary artery bypass. Baseline characteristics were similar in both groups. All hybrid patients were successfully treated with DES and no inhospital mortality occurred in either group. Hybrid patients had a shorter length of stay (3.6 ± 1.5 vs 6.3 ± 2.3 days, $P < .0001$) and intubation times (0.5 ± 1.3 vs 11.7 ± 9.6 hours, $P < .02$). Despite

State-of-the-Art Paper

Hybrid Cardiovascular Procedures

John G. Byrne MD, FACC[a], Marzia Leacche MD[a], Douglas E. Vaughan MD, FACC[a] and David X. Zhao MD, FACC[a]

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Received 27 May 2008; revised 8 July 2008; accepted 12 July 2008. Available online 21 October 2008.

A hybrid strategy combines the treatments traditionally available only in the catheterization laboratory with those traditionally available only in the operating room to offer patients the best available therapies for any given set of cardiovascular lesions. Examples include hybrid coronary revascularization (coronary artery bypass grafting [CABG]/percutaneous coronary intervention [PCI]) wherein a left internal mammary artery graft is placed on the left anterior descending artery (left anterior descending coronary artery [LAD]) either by minimally invasive or open technique and combined with PCI of non-LAD vessels. Other examples include minimally invasive valve surgery combined with PCI to coronary lesions (valve/PCI), to convert a high-risk valve/CABG into a lower-risk isolated minimally invasive valve procedure. Several questions remain unresolved, such as the order in which surgery and PCI should be performed, the duration of the staging of the 2 procedures, antiplatelet strategies, the costs, and the logistics. Other areas in which hybrid approaches are being developed include hybrid endomyocardial/epicardial atrial fibrillation procedures and hybrid aortic arch debranching combined with endovascular grafting for thoracic aortic procedures. The key requirement in all of these approaches is the need for collaboration between cardiac surgeons, vascular surgeons, and interventional cardiologists to obtain optimal patient outcomes.

Hybrid Cardiovascular Procedures

John G. Byrne, Marzia Leacche, Douglas E. Vaughan, David X. Zhao

A hybrid strategy combines treatments available only in the catheterization laboratory with those available only in the operating room to offer patients the best available therapies for any given set of cardiovascular lesions. Examples include hybrid coronary revascularization (coronary artery bypass graft/percutaneous coronary intervention [PCI]), minimally invasive valve surgery combined with PCI of coronary lesions, atrial fibrillation procedures (endocardial and epicardial approaches), and aortic debranching procedures combined with endovascular stenting for the treatment of complex thoracic aortic aneurysms. The key

1. **Routine Intraoperative Completion Angiography After Coronary Artery Bypass Grafting and 1-Stop Hybrid Revascularization: Results From a Fully Integrated Hybrid Catheterization Laboratory/Operating Room**

Journal of the American College of Cardiology, Volume 53, Issue 3, 20 January 2009, Pages 232-241

David X. Zhao, Marzia Leacche, Jorge M. Balaguer, Konstantinos D. Boudoulas, Julie A. Damp, James P. Greelish, John G. Byrne and Writing Group on behalf of the Cardiac Surgery Cardiac Anesthesiology, and Interventional Cardiology Groups at the Vanderbilt Heart and Vascular Institute

Abstract | Figures/Tables | References

Results

Among the 796 CABG grafts (345 left internal mammary artery, 12 right internal mammary artery/radial, and 439 veins), 97 (12%) angiographic defects were identified. Defects were repaired with either a minor adjustment of the graft (n = 22, 2.8%), with intraoperative open-chest PCI (unplanned hybrid, n = 48, 6%) or with traditional surgical revision (n = 27, 3.4%). Hybrid patients had clinical outcomes similar to standard CABG patients.

Conclusions

Routine completion angiography detected 12% of grafts with important angiographic defects. One-stop hybrid coronary revascularization is reasonable, safe, and feasible. Combining the tools of the catheterization laboratory and operating room greatly enhances the options available to the surgeon and cardiologist for patients with complex coronary artery disease.

Article Outline

15. **Simultaneous hybrid coronary revascularization reduces postoperative morbidity compared with results from conventional off-pump coronary artery bypass**

The Journal of Thoracic and Cardiovascular Surgery, Volume 135, Issue 2, February 2008, Pages 367-375

Zachary N. Kon, Emile N. Brown, Richard Tran, Ashish Joshi, Barry Reicher, Michael C. Grant, Seeta Kallam, Nicholas Burris, Ingrid Connerney, David Zimrin, Robert S. Poston

Abstract | Figures/Tables | References

The hybrid procedure was associated with significantly shorter lengths of intubation and stays in the intensive care unit and hospital and perioperative morbidity ($P < .05$). Intraoperative costs were increased but postoperative costs were reduced for the hybrid procedure compared with off-pump coronary artery bypass through a sternotomy. As a result, overall total costs were not significantly different between the groups. After adjusting for potential confounders, assignment to the hybrid group was an independent predictor of shortened time to return to work ($t = -2.12$, $P = .04$). Patient satisfaction after the hybrid procedure, as judged on a 6-point scale, was greater versus that after off-pump coronary artery bypass through a sternotomy. Finally, the hybrid procedure showed significantly reduced transcardiac gradients of markers of coagulation, myocardial injury, and inflammation and a trend toward significant improvement in target-vessel patency.

Conclusions

Perhaps because of reduced myocardial injury, inflammation, and activation of coagulation, patients undergoing the hybrid procedure had better perioperative outcomes and satisfaction, with excellent patency at 1 year's follow-up. These promising preliminary findings warrant further investigation of this procedure.

A hybrid strategy combines the treatments traditionally available only in the catheterization laboratory with those traditionally available only in the operating room to offer patients the best available therapies for any given set of cardiovascular lesions. Examples include hybrid coronary revascularization (coronary artery bypass grafting [CABG]/percutaneous coronary intervention [PCI]) wherein a left internal mammary artery graft is placed on the left anterior descending artery (left anterior descending coronary artery [LAD]) either by minimally invasive or open technique and combined with PCI of non-LAD vessels. Other examples include minimally invasive valve surgery combined with PCI to coronary lesions (valve/PCI), to convert a high-risk valve/CABG into a lower-risk isolated minimally invasive valve procedure. Several questions remain unresolved, such as the order in which surgery and PCI should be performed, the duration of the staging of the 2 procedures, antiplatelet strategies, the costs, and the logistics. Other areas in which hybrid approaches are being developed include hybrid endomyocardial/epicardial atrial fibrillation procedures and hybrid aortic arch debranching combined with endovascular grafting for thoracic aortic procedures. The key requirement in all of these approaches is the need for collaboration between cardiac surgeons, vascular surgeons, and interventional cardiologists to obtain optimal patient outcomes.

A completion angiogram of a LIMA graft to the LAD after MIDCAB procedure. Abbreviations as in Figure 1.

Figure 3. Hybrid Operating Room

A hybrid operating room.

doi:10.1016/j.jacc.2004.09.050
Cite or Link Using DOI

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