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**CAS Should Replace CEA in Patients Eligible
for Bypass Surgery with Multilevel
Atherosclerosis**

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Multilevel atherosclerosis – unfavourable prognosis

Patient with **severe carotid artery stenosis coexisting with multivessel coronary disease**

Is a patient with **multilevel atherosclerosis** (simultaneous presence of clinically relevant atherosclerotic lesions in at least two major vascular territories)

that means



unfavourable long term prognosis

REACH registry: 3-year observation: myocardial infarction/stroke/vascular death/rehospitalization was 40.5% for patients symptomatic in **multiple** vascular sites vs. 25.5% for patients with symptomatic vascular disease in **one** vascular site (**P,0.001**)

Severe carotid disease in patients referred for cardiac surgery

In patients accepted for CAS:

54 – 77% patients with significant ICA stenosis has coexisting coronary artery disease, 1,2 – 7% of those has multivessel coronary artery disease and is referred for CABG, the others (12 - 41%) are referred for PCI

In patients accepted for CABG:

- significant ICA stenosis $\geq 80\%$ is found in 6-12% of patients
- ICA stenosis of $\geq 50\%$ is found in 15-22% of patients
- about 40% of patients with left main coronary artery stenosis have ICA stenosis of $\geq 50\%$

In patients referred for AVR:

- 18% have ICA stenosis $>50\%$

Diagnostic evaluation of carotid arteries in patients requiring cardiac surgery

ESC Guidelines on the diagnosis and treatment of peripheral artery diseases

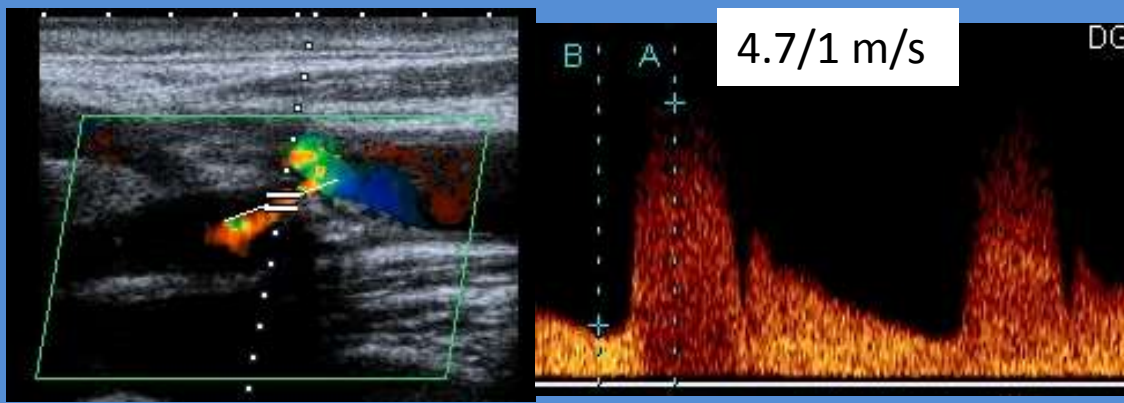
Recommendations	Class ^a	Level ^b
In patients undergoing CABG, DUS scanning is <u>recommended</u> in patients with a history of cerebrovascular disease, carotid bruit, age ≥70 years, multivessel CAD, or LEAD.	I	B

Class IIa

1. Carotid duplex ultrasound screening is reasonable before elective CABG surgery in patients older than 65 years of age and in those with left main coronary stenosis, PAD, a history of cigarette smoking, a history of stroke or TIA, or carotid bruit. (Level of Evidence: C)



The practice in our center:
 To perform carotid doppler in almost every patient accepted for cardiac surgery



Diagnostic evaluation of carotid arteries in patients requiring cardiac surgery

Other imaging studies:

European Heart Journal
doi:10.1093/eurheartj/ehu278

ESC/EACTS GUIDELINES



2014 ESC/EACTS Guidelines on myocardial revascularization

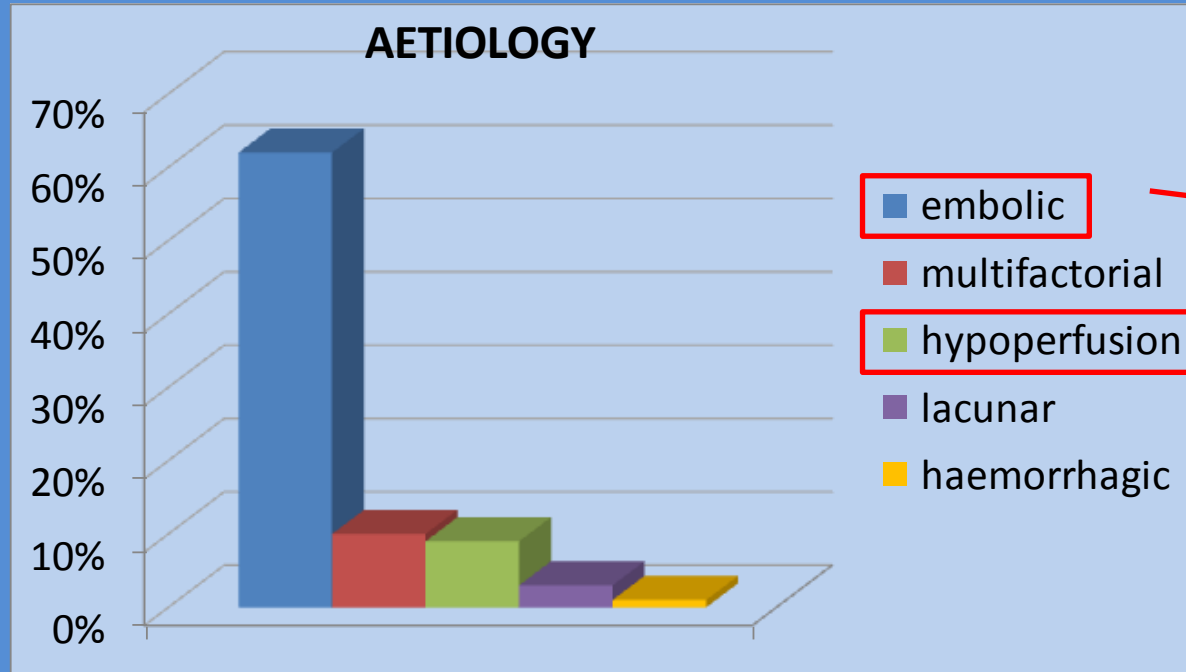
MRI, CT, or digital subtraction angiography may be considered if carotid artery stenosis by ultrasound is >70% and myocardial revascularization is contemplated.	IIb	C
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Carotid screening not recommended:

Screening for carotid stenosis is not indicated in patients with unstable CAD requiring emergent CABG with no recent stroke/TIA.	III	B
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The etiology of stroke associated with cardiac surgery

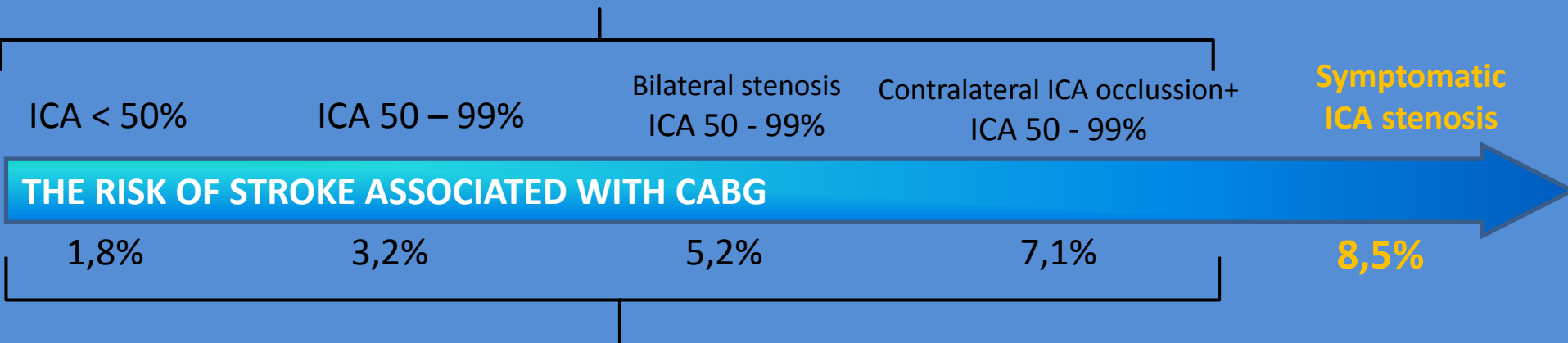


Severe ICA stenosis may play a role

- stroke is the most severe complication of CABG: about 22% of patients who had a perioperative stroke die, many remain permanently disabled
- about 60% of strokes associated with cardiac surgery are embolic (embolic material mostly from ascending aorta during clamping, but also may originate from the unstable carotid plaque)

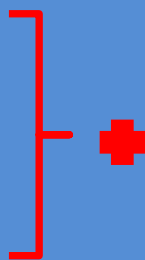
The risk of stroke associated with cardiac surgery

Neurologically asymptomatic ICA stenosis



THE RISK OF STROKE ASSOCIATED WITH CABG

- Risk factors for perioperative stroke:
- duration of extracorporeal circulation
 - blood pressure drops
 - coagulation disorders



Significant ICA stenosis



Increase the risk of CABG associated stroke – hypoperfusion of the brain

- Other important factors:
- ascending aorta atherosclerosis
 - postoperative atrial fibrillation

The decision on the revascularization strategy



European Heart Journal (2011) 32, 2851–2906
doi:10.1093/eurheartj/ehr211

ESC GUIDELINES

ESC Guidelines on the diagnosis and treatment of peripheral artery diseases

The indication for carotid revascularization should be individualized after discussion by a multidisciplinary team including a neurologist.

I

C

In case of patients with severe, multilevel atherosclerosis in our center multidisciplinary team consists of:

- Invasive cardiologist
- Cardiologist (non-invasive)
 - Cardiac surgeon
 - Vascular surgeon
 - Neurologist
 - Anesthetist

Currently available revascularization strategies

If carotid revascularization is indicated, the timing of the carotid and coronary interventions should be decided according to the clinical presentation, level of emergency, and severity of carotid disease and CAD.

I

C

Conventional - surgical

Simultaneous CEA+CABG

Staged CEA-CABG

Reverse -staged CABG-CEA

Novel, hybrid

Simultaneous, hybrid CAS+CABG

Staged CAS-CABG

Staged CAS + PCI

The guidelines



European Heart Journal (2011) 32, 2851–2906
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ESC GUIDELINES

ESC Guidelines on the diagnosis and treatment of peripheral artery diseases

ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline

2011 ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline on the Management of Patients With Extracranial Carotid and Vertebral Artery Disease

Class IIa
Carotid revascularization by **CEA or CAS with embolic protection before or concurrent** with myocardial revascularization surgery is reasonable in patients with greater than 80% carotid stenosis who have experienced ipsilateral retinal or hemispheric cerebral ischemic symptoms within 6 months. *(Level of Evidence: C)*

Stroke 2011

Recommendations	Class ^a	Level ^b
In patients undergoing CABG, with a <6-month history of TIA/stroke and corresponding carotid artery disease		
Carotid revascularization is recommended in 70–99% carotid stenosis.	I	C
Carotid revascularization may be considered in 50–69% carotid stenosis, depending on patient-specific factors and clinical presentation.	IIb	C
Carotid revascularization is not recommended if the carotid stenosis is <50%.	III	C

The guidelines – the approach to the asymptomatic ICA stenosis before CABG



European Heart Journal (2011) 32, 2851–2906
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ESC GUIDELINES

ESC Guidelines on the diagnosis and treatment of peripheral artery diseases

ASA/ACCF/AHA/AANN/AANS/ACR/ASNR/CNS/SAIP/
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SAIP/SCAI/SIR/SNIS/SVM/SVS Guideline on the
Management of Patients With Extracranial Carotid and
Vertebral Artery Disease

In patients undergoing CABG with no history of TIA/ stroke within 6 months		
Carotid revascularization may be considered in men with bilateral 70–99% carotid stenosis or 70–99% carotid stenosis and a contralateral occlusion.	IIb	C
Carotid revascularization may be considered in men with 70–99% carotid stenosis and ipsilateral previous silent cerebral infarction.	IIb	C

Class IIb

In patients with asymptomatic carotid stenosis, even if severe, the safety and efficacy of carotid revascularization before or concurrent with myocardial revascularization are **not well established**.
(Level of Evidence: C)

Stroke 2011

Revascularization options

	Operative mortality	Death ± Ipsilat CVA	Death ± any CVA	DEATH ± any CVA ± MI
(1) Synchronous CEA + CABG				
CEA pre-bypass				
Observed risk	245/5386	307/4189	442/5386	395/3426
Risk% (95%CI)	4.5% (3.9–5.2)	7.3% (6.4–8.2)	8.2% (7.1–9.3)	11.5% (10.1–13.1)
Heterogeneity (p=)	0.1469	0.0423	0.0000	0.0000
CEA performed on bypass				
Observed risk	40/844	52/807	68/844	26/273
Risk%	4.7% (3.1–6.4)	6.4% (4.7–8.2)	8.1% (5.8–10.3)	9.5% (5.9–13.1)
Heterogeneity (p=)	0.1802	0.3732	0.0770	0.3399
(2) Synchronous CEA + off-pump CABG				
Observed risk	5/324	5/318	7/318	11/309
Pooled risk (%)	1.5% (0.3–2.8)	1.6% (0.4–2.8)	2.2% (0.7–3.7)	3.6% (1.6–5.5)
Heterogeneity (p=)	1.00	1.00	1.00	0.99
(3) Staged CEA–CABG				
Observed risk	36/917	39/809	56/917	72/709
Risk%	3.9% (1.1–6.7)	4.8% (2.8–6.8)	6.1% (2.9–9.3)	10.2% (7.4–13.1)
Heterogeneity (p=)	<0.0001	<0.0001	<0.0001	<0.0001
(4) Reverse-staged CABG-CEA				
Observed risk	6/302	3/87	22/302	11/221
Risk%	2.0% (0.0–6.1)	3.4% (0.0–9.8)	7.3% (1.7–12.9)	5.0% (0.0–10.6)
Heterogeneity	<0.0001	0.0060	<0.0001	0.0102
(5) Staged CAS + CABG				
Observed risk	42/760	47/627	69/760	61/649
Risk%	5.5% (3.4–7.6)	7.5% (4.5–10.5)	9.1% (6.2–12.0)	9.4% (7.0–11.8)
Heterogeneity	0.50	0.16	0.12	0.33

Hybrid CAS+CABG - Krakow data

Result: RICA CAS

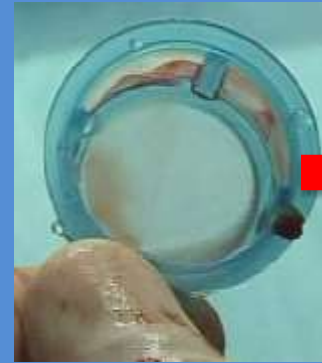
Start at: 7:20 RICA CAS

Mo.Ma NPD

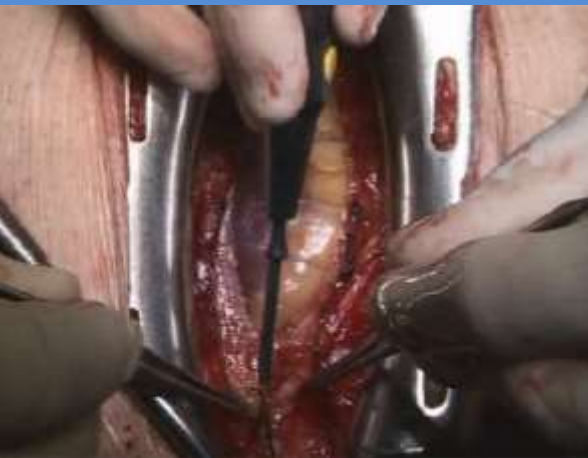
Lack of emboli



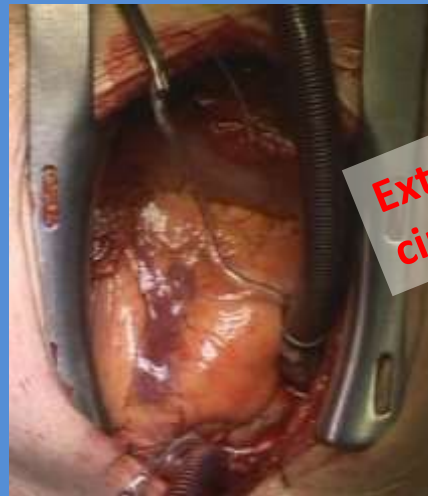
Blood aspiration



Transfer to the operating room

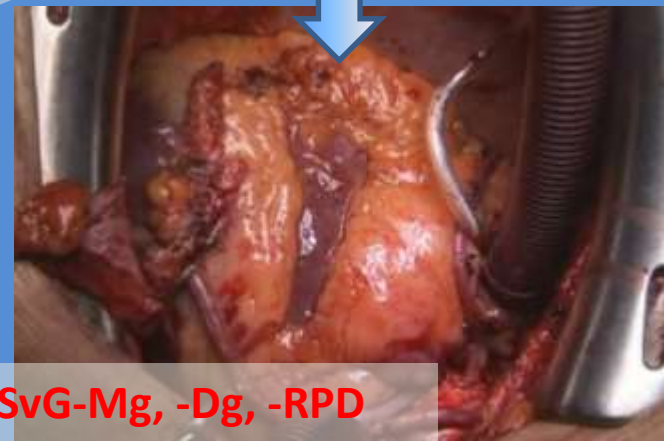


At 8:30 the cardiac surgery starts



Cannulation

Extracorporeal circulation



LIMA-LAD, SvG-Mg, -Dg, -RPD

Hybrid CAS + cardiac surgery – the data

	n (pts)	Study years	Ipsilateral stroke	Any stroke	MI	death	total
SHARP study	101	2006 - 2007	0	2 (2%)	0	2 (2%)	4 (4%)
Velissaris et al.	90	2003 - 2010	0	1 (1.1%)	0	1 (1.1%)	2 (2.2%)
Guerra et al.	23	2007 - 2008	0	0	0	1 (4.3%)	1 (4.3%)
Palombo et al.	22	2005 - 2008	0	1 (4.5%)	0	0	1 (4.5%)
Chiarello et al.	132	2004 - 2014	1 (0.75%)	0	0	5 (3.8%)	6 (4.5%)

Versaci F et al. JACC Cardiovasc Interv, 2009; , Velissaris et al. J Vasc, Surg 2011, Guerra et al. Interact Cardiovasc Thorac Surg 2009 Palombo et al. J Cardiovasc Surg, 2009, Chiarello L Ann Thorac Surg 2015;

Hybrid CAS+CABG – Our Experience !!!!

n=51	
age (years)	69,9 ± 6.5, range 53 – 83
male	38 (74%)
Ipsilateral stroke/TIA	16 (31%)
CCS class IV/UA	15 (29%)
NSTEMI	7 (14%)
Left main stenosis	16 (31%)
Mean carotid stenosis rate	85.5±10%, range 60-99%
Proximal NPD device	24 (47%)
Closed-cell/mesh-covered stent	48 (94%)
euroSCORE II	2.8 ± 1.3%, range 1.15 -6.91%
Isolated CABG	46 (90%)
Other cardiac surgery*	5 (10%)
Drainage (ml)	798.6 ±390, range 160-1800

*isolated AVR, AVR+CABG, left ventricle aneurysmectomy and CABG

Hybrid CAS+CABG – our experience (in-hospital & 30-day outcome)

n=51	In-hospital	30-day
Death	2 (3.9%)	0
Myocardial infarction	1 (1.9%)	0
Stroke	0	0
	3 (5.9%)	

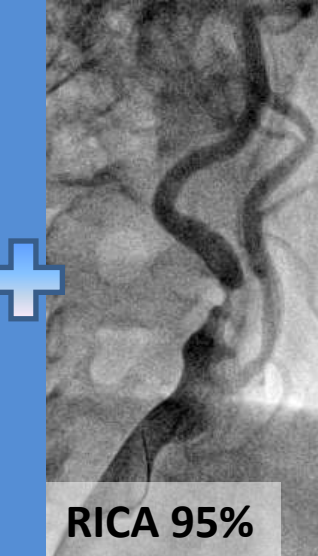
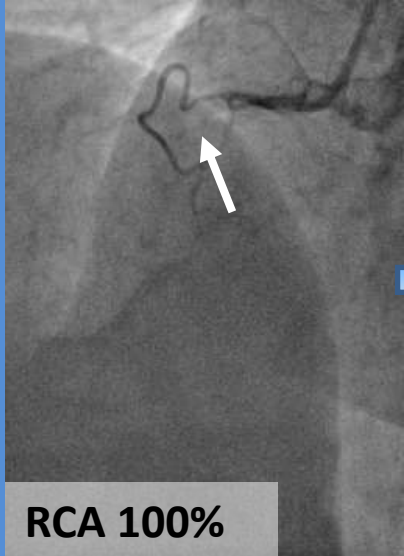
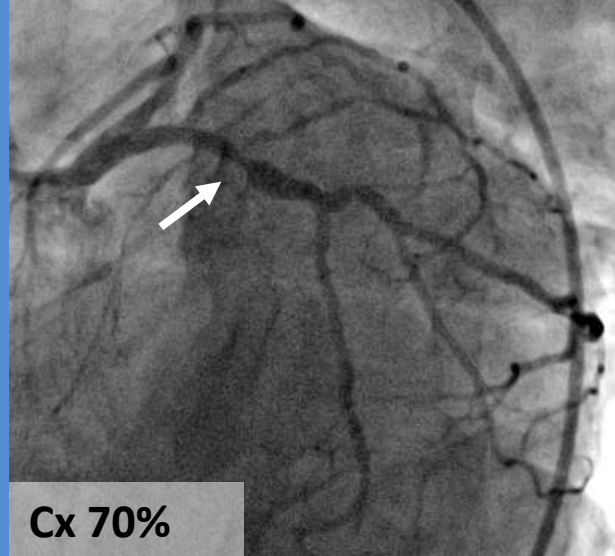
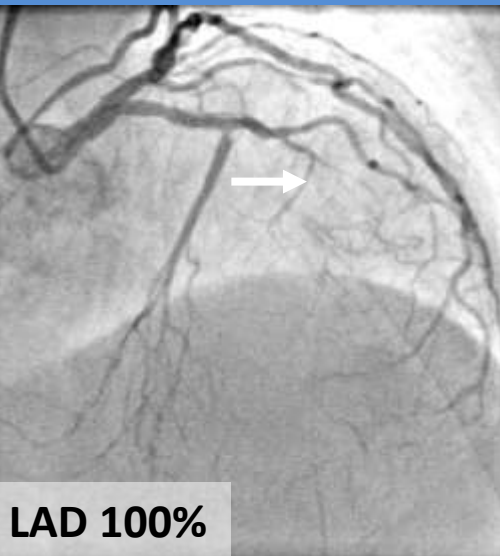
One **cardiac surgery associated death** as a result of **multiorgan failure** in a patient after CAS+ CABG and left ventricle aneurysmectomy;

Another **cardiac surgery associated death** in a patient, who underwent CAS+ isolated AVR cause by a **failure to wean off extracorporeal circulation**

Myocardial infarction on a 2nd postoperative day in a patient who had CAS+ isolated CABG **treated by successful RCA PCI.**

Staged CAS - CABG

Day 1: Patient with a history of right hemispheric stroke and stable CCS class II angina



1st stage: RICA CAS



Heart Team

2nd stage: CABG

At least month later:
patient admitted again

2 stage:

CABG: LIMA-LAD, SvG-Mg ,SVG-RCA

Day 3:
patient discharged home

Staged CAS-CABG

According to **Naylor's metaanalysis (11 studies, 760 procedures) CAS-CABG** has similar outcome to CEA-CABG:

- Death/any cerebrovascular accident/MI of 9.4%**, but
- Almost half (n=356) of patients come from one trial by van der Heyden et al.
- The vast majority (87%) of patients was neurologically asymptomatic

-Neuroprotection devices were not routinely used

CAS-CABG registries by van der Heyden et al.

- Circulation 2007*: CAS-CABG performed in 356 neurologically asymptomatic patients:
death/stroke/MI - 6.7%
- *JACC Cardiovasc Interv 2011*: CAS-CABG performed in 57 with prior neurological symptoms: **death/stroke/MI – 12.3%**

Staged CAS-CABG – Our Experience

n=40	
age (years)	67.6 ± 6.8, range 55-84
male	
Ipsilateral stroke/TIA	21 (52.5%)
CCS class II	
Left main stenosis	12 (30%)
Mean carotid stenosis rate	85.6± 8%, range 60-99%
Proximal NPD device	20 (50%)
Closed-cell/mesh-covered stent	35 (87.5%)
euroSCORE II	1.9 ± 1 %, range 0.85-4.95%
Isolated CABG	35 (87.5%)
Other cardiac surgery*	5 (12.5%)
Drainage (ml)	733± 307, range 300-1500

Bental de Bono+CABG, AVR+CABG, mitral valve repair +CABG

Staged CAS-CABG – Our Experience

n=40	In-hospital	30-day
Death	1 (2.5%)	0
Myocardial infarction		0
Stroke	0	0
	1 (2.5%)	

-one death on the 3rd postoperative day due to **cardiogenic shock** in a patient who underwent **CAS+AVR+CABG**

Antiplatelet/antithrombotic treatment strategy

Hybrid CAS+CABG

1. Before procedure: **ASA 75 - 100mg/day chronically** or started at least **3 days** before procedure.
2. During **CAS: UFH (100mg/kg)** to maintain **ACT > 250 ms.**
3. During CABG: **UFH (100mg/kg)** to maintain **ACT > 250 ms.**
4. In the end of CABG: protamin (titrated).
5. After CABG: **Clopidogrel (loading dose 300mg)** started at least at 6th postoperative hour (after extubation) depending on drainage, **then** continued **75 mg/day** for 3 months.

Staged CAS-CABG

1. Before CAS procedure: **ASA 75 - 100mg/d chronically** or started at least 3 days before and clopidogrel loading dose of 300 mg or 75 mg 1x1 for at least 4 days
2. During **CAS: UFH (100mg/kg)** to maintain **ACT > 250 ms.**
3. Patient accepted for CABG
4. **Clopidogrel for at least a month**
5. **Clopidogrel withdrawn 5-7 days before CABG**
6. CABG
7. **Clopidogrel could be re-administered in the perioperative period and continued up to 3 months.**

CAS or CEA prior to cardiac surgery???

Recommendations	Class ^a	Level ^b
CEA or CAS should be performed by teams achieving a combined death/stroke rate at 30 days of: <3% in patients without previous neurological symptoms <6% in patients with previous neurological symptoms.	I	A
It is recommended to individualize the indication for carotid revascularization after discussion by a multidisciplinary team including a neurologist.	I	C
The timing of the procedures (synchronous or staged) should be determined by local expertise and clinical presentation, targeting the most symptomatic territory first.	IIa	C

The use of NPD during CAS – class II b/B

Tailored-CAS strategy:

- the use of **NPD is mandatory** for all CAS procedures
- to fit the NPD (proximal or distal) and stent type (closed- or open-cell) to the neurological symptom status, carotid lesion morphology and severity and to carotid and aortic arch anatomy
- **minor stroke rate 0.7-1.61%; major stroke rate 0 – 0.5%**



CAS or CEA prior to cardiac surgery???



CAS:

- Less invasive
- does not require general anesthesia (coronary unstable patients!)
- neurological symptom status of the patient is known during whole procedure
- Lasts up to 20 - 30 minutes
- no serious bleedings/thrombotic events
- For tailored-CAS strategy in-hospital and 30-day death/stroke rate 2.2%; no Mis

CEA:

- Coronary unstable/severe MVD patients often postponed from CEA
- neurological symptom status during procedure is unknown (patient under general anesthesia)
- Prolongs general anesthesia (if procedures are simultaneous)

Simultaneous CAS+CABG or CEA+CABG???

- Little evidence is available

- **one, small randomized trial** by Mićović S et al. (EurJ Cardiothoracic Surg 2014)

- 1:1 randomization into two groups:

group 1 (hybrid CAS+CABG, n=10) vs. group 2 (simultaneous CEA+CABG, n=10)

- **All CAS** procedures were performed with **distal NPD devices** and open or closed cell stent implantation, all CAS procedures were successful

- cardiac surgery: only isolated CABG in both groups (one OPCAB)

- **All complications occurred in CEA+CABG group:**

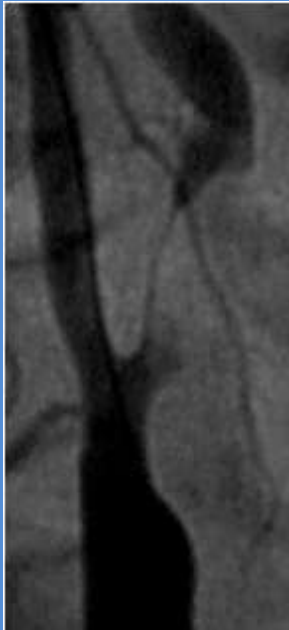
one **death** due to multiorgan failure and sepsis

one **contralateral stroke** on 4th postoperative day

Asymptomatic ICA stenosis and coronary bypass grafting

- the **benefit of prophylactic carotid revascularization** in patients with asymptomatic unilateral carotid disease is **uncertain**
- The guidelines: **class IIb/C**, selected cases...
- On the other hand **trials include asymptomatic patients mostly**

Neurologically asymptomatic ICA stenoses in patients with MVD



Who would leave one of these untreated before cardiac surgery????

Patient 65 y.o.

Multivessel coronary artery disease: LAD/Dg 90%, Cx 100%, RCA II segm 90%

CCS III, neurologically asymptomatic

History of smoking, hyperlipideamia, gastric ulcer, he had nephrectomy on the right and lobectomy of the right lung

Scheduled for CABG, not screened for ICA stenosis (although he had indications)

1st postoperative day:

- hemiplegia of the left limbs,
- Babinski (+) on the left



**Carotid Doppler:
a critical RICA stenosis,
undiagnosed before
CABG**

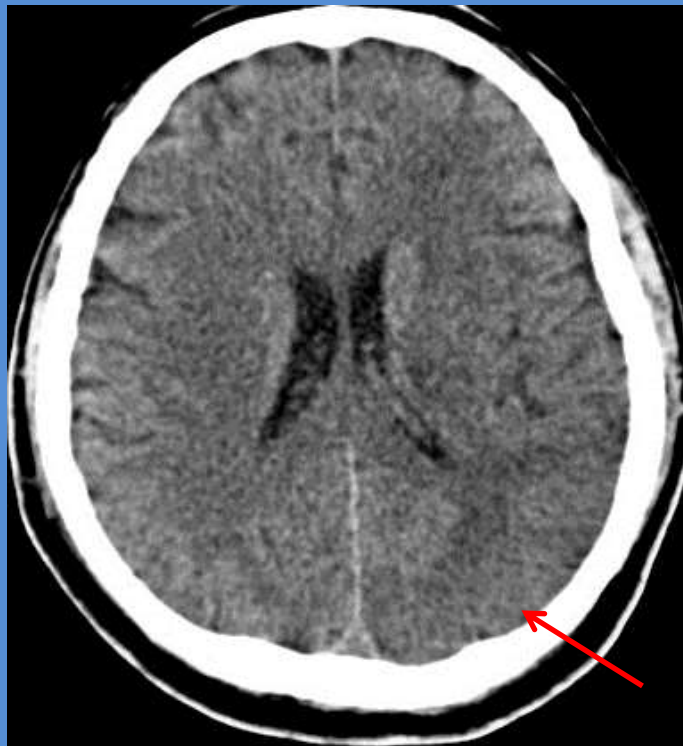
2 weeks later: RICA-CAS



Patient 62 y.o.

unstable angina and recent transient aphasia

- MVD – urgent CABG: LIMA-LAD, SvG-Mg, SvG-RPD
- on the 1st postoperative day focal neurological symptoms
- carotid doppler – occluded LICA
- CT – large left hemispheric stroke



CT 1st postoperative day

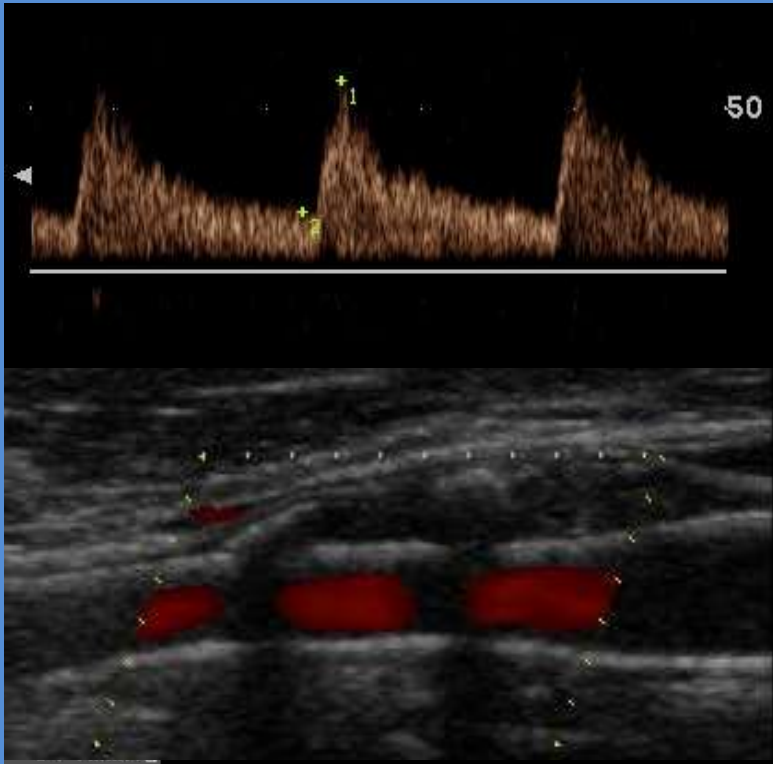


CT 2nd postoperative day

Massive cerebral oedema
Patient died on 3rd
postoperative day

CAS would take 30 minutes...

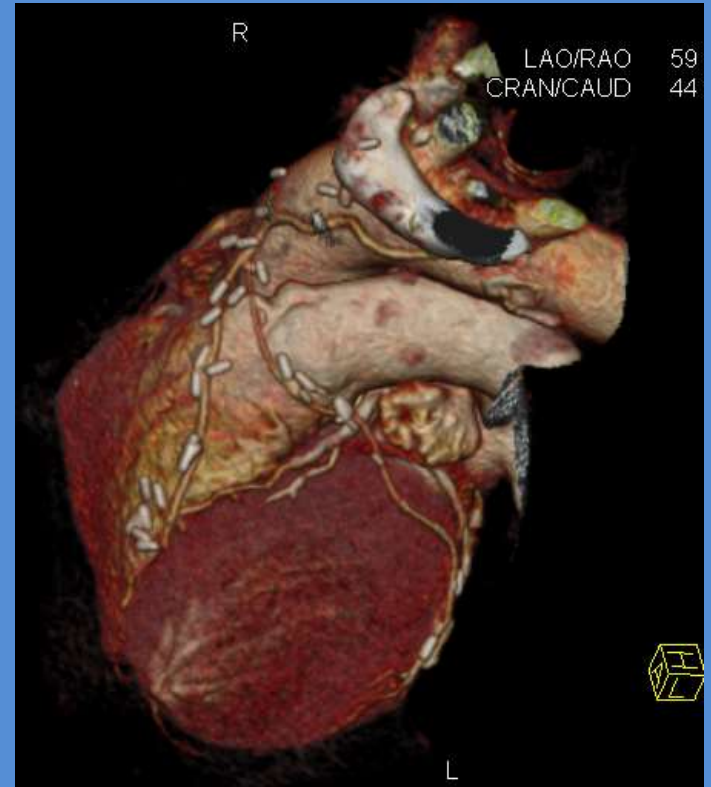
CAS



LICA – CAS



CABG



CABG: LIMA-LAD, RA-Mg
(Y-anastomosis)

New treatment strategy in 2016

Thank you for the attention