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Should patients with asymptomatic significant carotid stenosis undergo simultaneous carotid and cardiac surgery?

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Abstract

A best evidence topic in cardiovascular surgery was written according to a structured protocol. The question addressed was whether patients with severe asymptomatic carotid and coronary artery diseases should undergo simultaneous carotid endarterectomy (CEA) and coronary artery bypass grafting (CABG). A total of 624 papers were found using the reported search, of which 20 represent the best evidence to answer the clinical question. The author, journal, date and country of publication, patient group studied, study type, relevant outcomes, results and study results of these papers are tabulated. Previous cohort studies showed mixed results, while advocating for the necessity of a randomized controlled trial (RCT). A recent RCT showed that patients undergoing prophylactic or simultaneous CEA + CABG had lower rates of stroke (0%) compared with delayed CEA 1–3 months after CABG (7.7%), without significant perioperative mortality difference. This study included patients with unilateral severe (>70%) asymptomatic carotid stenosis requiring CABG. An earlier partly randomized trial also showed better outcomes for patients undergoing simultaneous procedures ($P = 0.045$). Interestingly, systematic reviews previously failed to show compelling evidence supporting prophylactic CEA. This could be partly due to the fact that these reviews collectively analyse different cohort qualities. Neurological studies have, however, shown reduced cognitive and phonetic quality and function in patients with unilateral and bilateral asymptomatic carotid artery stenosis. Twenty-one RCTs comparing lone carotid artery stenting (CAS) and CEA informed the American Heart Association guidelines, which declared CAS comparable with CEA for symptomatic and asymptomatic carotid stenosis (CS). However, the risk of death/stroke for CAS alone is double that for CEA alone in the acute phase following onset of symptoms, while CEA alone is associated with a doubled risk of myocardial infarction. There is, however, no significant difference for combined 30-day risk of death/stroke/myocardial infarction. Outcomes of hybrid or simultaneous CAS/CABG procedures show comparable results, albeit from rather small cohorts. While current evidence leans towards simultaneous CEA/CABG, the emergence of hybrid operating theatres in various institutions may allow larger cohorts with subsequent significant data on simultaneous CAS/CABG. A randomized controlled trial comparing both approaches would be crucial in informing future updates of existing guidelines.

Keywords: Cardiac surgery • Carotid stenosis • Carotid thrombendarterectomy • Carotid stenting

INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This protocol is fully described in the *ICVTS* [1].

THREE PART QUESTION

In [patients undergoing cardiac surgery], does [simultaneous carotid artery endarterectomy or stenting] for [concomitant severe carotid artery stenosis] reduce postoperative incidences of [stroke, myocardial infarction and mortality]?

CLINICAL SCENARIO

A 65-year old normally fit and healthy gentleman is referred to you for coronary artery bypass grafting (CABG) following an acute onset of angina and demonstrated severe three-vessel coronary artery disease on angiogram. Preoperative workup reveals bilateral severe asymptomatic carotid artery stenosis. Carotid Doppler documents 60 and 90% stenosis of right and left internal carotid arteries, respectively. He has a positive family history of cerebrovascular accidents (CVAs) and transient ischaemic attacks. He specifically enquires whether he should first get his carotids treated before cardiac surgery or undergo both procedures simultaneously, and what the risk of stroke is for either option. Determined to give him evidence-based advice, you search the literature.

SEARCH STRATEGY

Medline 1966 to October 2012 using OVID interface [exp thoracic surgery/OR cardiac surgery.mp OR exp cardiac surgical procedures/OR exp coronary artery bypass/OR CABG.mp] AND [exp carotid stenosis/OR carotid stenosis.mp/OR carotid artery stenosis.mp] AND [exp endarterectomy/OR carotid stenting, carotid/OR

Table 1 Best evidence papers

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Hertzer *et al.* (1989), J Vasc Surg, USA [2] Randomized trial (level I)	275 patients with simultaneous CD, 80 had previous neurological events, 195 with severe asymptomatic CS Group I: CEA prior to CABG (*n* = 24) Group II: 129 patients with unstable disease IIA: CEA/CABG (*n* = 71) IIB: CABG + delayed CEA (*n* = 58) Group III: symptomatic or bilateral CS, non-randomized (*n* = 122)	Composite stroke: IIA IIB Early stroke rates: I II III Postoperative stroke: Prior or simultaneous CEA Delayed CEA CEA within 2 weeks of CABG CEA >2 weeks after CABG	 2.8% 14% (*P* = 0.045) 4.2% 7.8% 11% 4.7% 7.4% 11% 2.2%	In this institution, combined CEA + CABG was performed if incidental CD was severe enough to warrant surgical treatment on its own merit and the cardiac situation was unfavourable for staged operations. This study confirms that a comprehensive surgical approach is associated with low incidence of late neurological complications after CABG. Composite data among prospectively randomized patients with unilateral asymptomatic CS suggest that simultaneous operations were safer than 'reverse-staged' procedures. Combined operations had slightly less risk of perioperative stroke (4.7 vs 7.4%) at the cost of slightly higher early mortality rates (4.7 vs 2.5%) than CABG alone in comparable patients, neither distinction being statistically significant. However, because the correction of symptomatic or truly severe CD appears to be in the best long-term interests of the selected patients who have it, the convenience and economy of simultaneous procedures also must be taken into consideration
Illuminati *et al*. (2011), J Vasc Surg, France, Italy [3] Randomized trial (level I)	185 patients randomized into 2 groups: A: CEA/CABG (79 patients, combined procedure: 15, CEA a few days before CABG) B: CEA 1–3 months following CABG (91 patients)	 Operative mortality All strokes 90-day combined stroke/death Operative mortality All strokes 90-day combined stroke/death	 1 (1.0%) 0 (0.0%) 1 (1.0%) 1 (1.1%) 7 (7.7%) 8 (8.8%)	This study included patients with unilateral CS >70% requiring elective CABG. Emergency, off-pump, arch atheroma and associated cardiac cases were excluded. It shows that CEA before CABG or combined with CABG can prevent stroke better in patients with an asymptomatic carotid artery stenosis >70% undergoing CABG than delayed CEA
Nwakanma *et al.* (2006), Interact CardioVasc Thorac Surg, USA [4] Retrospective cohort study (level IIb)	412 patients CEA/CABG (27) Mean age: 70.3 (*P* = 0.03) Male: 20 Aorto/iliac disease: 4 (*P* = 0.04) Fem./pop. disease: 5 (0.048) Prev. heart surg.: 2 (<0.01) CABG alone (385) Mean age: 66.7 Male: 235 Aorto/iliac disease: 17 Femoral/popliteal disease: 27 Previous heart surgery: 18	**Death** Postoperative: - CEA/CABG - CABG Follow-up: - CEA/CABG - CABG **MI** Postoperative Follow-up - CEA/CABG - CABG	 0 3 (*P* = 1.00) 4 (14.8%) 51 (13.4%) 0 3 (11.1%) 19 (6.1%)	Same surgeon performed all CABG and present during all CEA procedures. There was no significant difference in MI, stroke and death at 30 days or late follow-up. Simultaneous CEA/CABG did not increase short- and long-term morbidity and mortality compared with isolated CABG. This study is, however, limited by the low number of patients undergoing CEA/CABG

Continued

Table 1 (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
		Stroke		
		Postoperative:		
		- CEA/CABG	1 (3.7%)	
		- CABG	6 (1.6%)	
			(*P* = 0.38)	
		Follow-up:		
		- CEA/CABG	2 (7.4%)	
		- CABG	7 (2.3%)	
			(*P* = 0.16)	
Santos *et al*. (2012), Ann Vasc Surg, USA [5]	40 patients CEA then delayed CABG within 30 days	Death	2 (5%)	The authors conclude that CEA followed by delayed CABG within 30 days may be a reasonable approach. The cohort size is, however, small; a larger cohort might have had a different statistical outcome. The rate of postoperative complications is, however, comparable with those reported in other larger studies, including meta-analyses
		Stroke	2 (5%)	
Retrospective cohort study (level IIb)	Age: 66 ± 9.51			
	Male: 33	MI	2 (5%)	
	Unilateral: 37			
Baiou *et al*. (2009), Eur J Vasc Endovasc Surg, UK [6]	Audit of 61 patients No prophylactic CEA, unilateral asymptomatic 70–99% stenosis, cardiac procedures alone: CABG: 44 Valves: 6 Valves + CABG: 9 CABG + LV repair: 2	30-day risk of:		This study challenges the opinion that prophylactic CEA can be expected to significantly reduce the risk of stroke in this category of patients. The mortality rate was, however, relatively high and all 3 deaths related to MI. Comparable studies have shown much lower 30-day mortality rates
		- Stroke	0	
Retrospective cohort study (level IIb)		- Death	3 (4.9%)	
Kougias *et al*. (2007), Ann Vasc Surg, USA [7]	277 patients simultaneous CEA/CABG Group: A—unilateral CD B—bilateral CD C—contralateral CO	**Death**		277 patients with severe CS (>70%) were screened from a cohort of 8277 undergoing CABG. There was no statistical difference in cumulative mortality in the 3 groups compared with the control group. Stroke rates were, however, significant between Groups C and B (*P* = 0.034), and Groups C and A (*P* = 0.003). CABG/CEA for unilateral and bilateral severe CS presents no greater risk of mortality or stroke than control group (CABG alone)
		CEA/CABG	3.61%	
Retrospective cohort study (level IIb)		CABG (control)	1.7%	
		Group A	6 (3%)	
		Group B	2 (3.6%)	
		Group C	2 (9.09%)	
		Early stroke		
		CEA/CABG	2.8%	
		CABG (control)	1.28%	
		Group A	4 (2%)	
		Group B	1 (1.8%)	
		Group C	3 (13.64%)	
		MI		CABG/CEA for contralateral CO demonstrates increased risk of perioperative stroke and death
		CEA–CABG	0.72%	
		CABG (control)	0.58%	
Kolh *et al*. (2006), Eur Heart J, Belgium [8]	311 patients CEA/CABG	Hospital death	19 (6.1%)	23 (7.5%) patients developed neurological complications, while 12 (4%) suffered permanent stroke. This is higher than in other studies with similar cohorts. 8 developed ipsilateral permanent strokes. Of the 19 deaths, 16% were urgent or emergent cases. This raises the
	Age: 67.2 ± 7.7	MI	7 (2.3%)	
Retrospective cohort study (level IIb)	Male: 230			
	Previous MI: 126	Permanent stroke	12 (3.8%)	
	Unstable angina: 177			
	Neurological history:	TIA	6 (2%)	
	- Asymptomatic: 236			
	- TIA: 49	RND	5 (1.5%)	

Continued

Table 1 (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
	- Reversible neurological deficit (RND): 3 - Permanent stroke: 23	10-year actuarial event-free rates: - Death - MI - Stroke	 50% 84% 93%	question whether these patients should undergo concomitant procedures. CEA/CABG can be performed with acceptable operative mortality and morbidity, and good long-term freedom from coronary and neurological events
Kaul *et al.* (2000), Cardiovasc Surg, USA [9] Retrospective cohort study (level IIb)	408 patients Ipsilateral CEA/CABG: 338 Bilateral CEA/CABG: 12 Ipsilateral CEA/CABG + sequential/staged CEA: 58 Group A: bilateral 80% stenosis Group B: contralateral occlusion Group C: contralateral subcritical disease	Overall combined hospital mortality from stroke and MI Predictors of late stroke **Freedom from stroke** Group A 3 months 1 year 5 years 10 years 15 years Group B 3 months 1 year 5 years 10 years 15 years Group C 3 months 1 year 5 years 10 years 15 years	2.45% Progression of bilateral ($P = 0.007$) and intracranial ($P = 0.04$) cerebrovascular disease 85% 84% 80% 73% 68% 99% 85% 85% 78% 74% 90% 85% 82% 76% 66%	408 patients with significant CAS screened from a control group of 11 862. Risk of stroke was higher in the study group (peak difference: 1.35 vs 0.73%, $P = 0.008$) at 30 days. In the early follow-up phase (7–8 years), risk of subsequent stroke was comparably low in both groups. A late hazard phase emerged thereafter in the study group, with recurrent/progressive bilateral CD ($P = 0.007$) and intracranial cerebrovascular disease ($P = 0.04$) being incremental risk factors of stroke. The authors have shown that prophylactic CEA prevented subsequent strokes to almost a similar extent as reported in the literature. These observations further support a regular use of a synchronous combined approach in different specific groups of patients with coexistent coronary and CS
Naylor *et al*. (2003), Eur J Vasc Endovasc Surg, UK [10] Systematic review (level Ib)	8972 patients in 97 studies following: I. Staged CEA/CABG II. Staged CABG/CEA III. Synchronous CEA/CABG	Mortality Any stroke MI	3.9% 2.0% 4.6% 2.7% 6.3% 4.6% 6.5% 0.9% 3.6%	There was no significant difference for staged or combined procedures. 10–12% of patients undergoing either procedure suffer stroke or MI within 30 days of surgery
Levy *et al*. (2012), Interact CardioVasc Thorac Surg, Israel [11] Retrospective cohort study (level IIb)	80 patients combined CEA/CABG Male: 63 Asymptomatic unilateral CS: 60% History of stroke: 22% History of TIA: 18.4% Bilateral CS: 38% Contralateral occlusion: 12.6%	Operative mortality Perioperative CVA Perioperative MI Combined events Mean follow-up of 10 ± 3.2 years: Neurological events	3.7% 2.5% 3.7% 10% 7.6%	The perioperative results in this cohort are similar to those reported in the literature for a simultaneous approach. A meta-analysis by Naylor *et al*. showed a 6.3% rate of CVA in reversed staged cohort. The authors also show a 92% freedom from neurological events at 10 years. In contrast, the 10-year survival rate is only 62%

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Table 1 (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
		Freedom from neurological events at 10 years	92 ± 4%	
		Late cardiac events	21.5%	
		5-year survival rate	74 ± 5%	
		10-year survival rate	62 ± 6%	
Naylor *et al*. (2009), Eur J Vasc Endovasc Surg, UK [12] Systematic review (level IIb)	760 patients (11 published studies) Staged CAS/CABG 87% neurologically asymptomatic, 82%, unilateral CS	Mortality	5.5%	Cumulative risks following CABG within 48 h of CAS were not higher than in comparable studies where CABG was delayed by >2 weeks. Staged CAS + CABG is a less invasive alternative to CEA + CABG, with comparable risks
		Ipsilateral stroke risk	3.3%	
		Risk of any stroke	4.2%	
		30-day risk of: - MI - Death + ipsilateral stroke - Death + any stroke - Death/stroke/MI	 1.8% 7.5% 9.1% 9.4%	
Naylor *et al*. (2011), Eur J Vasc Endovasc Surg, UK [13] Systematic review (level Ib)	3 systematic reviews (166 studies) analysing rate of stroke in CD following CABG Any combination symptomatic/asymptomatic with unilateral/bilateral 50–99% stenosis or occlusion. CABG only Asymptomatic patients with uni- or bilateral significant CS. CABG only Patients undergoing unilateral, synchronous CEA + CABG, in the presence of severe bilateral CD	**Review I** Stroke (50–99% stenosis or occlusion) Stroke (80–99% stenosis or occlusion) **Review II** 30-day risk of ipsilateral stroke Any stroke Death Death/ipsilateral stroke Death/any stroke **Review III** 30-day risk of stroke: - Severe stenosis - 80–99% stenosis	 7.4% 9.1% 2% 2.9% 4.8% 3.8% 5.7% 4% 5.7%	No compelling evidence supporting prophylactic CEA or CAS in patients with unilateral asymptomatic CD. Prophylactic CEA or CAS may still be considered in patients with severe bilateral asymptomatic disease undergoing cardiac surgery
Versaci *et al*. (2009), JACC Cardiovasc Interv, Italy [14] Retrospective cohort study (level IIb)	101 patients CAS/CABG Male: 86 Symptomatic CS: 15 Bilateral CS: 56 3 vessel disease: 79 Left main involvement: 41 Percent CS (symptomatic): 79 Percent CS (asymptomatic): 80 Mean EuroSCORE: 8.6	Rate of procedural success 30-day cumulative incidence of disabling stroke, AMI or death Death (postoperative) Stroke (immediately after CAS and before CABG)	98% 4% 2% 2%	Hybrid revascularization by CAS immediately followed by CABG is a feasible and promising therapeutic strategy. The immediate postoperative rate of events is lower than in most reports in the literature. The cohort size is small and the authors acknowledge and conclude that randomized trials are warranted to verify these results
Timaran *et al*. (2008), J Vasc Surg, USA [15] Retrospective cohort study (level IIb)	27 084 patients CEA/CABG: 96.7% Female: 33% Symptomatic CS: 3.6% CAS/CABG: 3.3%	CAS/CABG: - Stroke - In-hospital death - Combined stroke/death CEA/CABG: - Stroke	 2.4% 5.2% 6.9% 3.9%	Patients who undergo CAS/CABG have significantly decreased in-hospital stroke rates compared with patients undergoing CEA/CABG ($P < 0.001$) but similar in-hospital mortality. CAS may provide a

Continued

Table 1 (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
		- In-hospital death - Combined stroke/death	5.4% 8.6%	safer carotid revascularization option for patients who require CABG. With a high number of total patients in the study, the percentage of those undergoing CAS/CABG is very small. This may suggest the lack of confidence in the procedure, as well as long-term results
Tomai *et al*. (2011), JACC Cardiovasc Interv, Italy [16] Prospective study (level IIb)	239 patients Staged (201) or simultaneous (38) CAS/PCI Age: 73 ± 7.77 Male: 182 Symptomatic: 49 Bilateral CS: 42 Previous CEA: 13 Previous CAS: 7	Long-term follow-up (median 520 days): - Death - MI - Stroke	 4.2% 2.1% 3.8%	In patients with concomitant carotid obstructive and coronary artery disease, a combined percutaneous treatment compares favourably with previous surgical or hybrid experiences. Such strategy may be particularly suited to complex patients at high surgical risk. This study included symptomatic and asymptomatic patients, while the number of patients undergoing staged was 5-fold that for simultaneous procedures
Van der Heyden *et al.* (2011), JACC Cardiovasc Interv, Netherlands [17] Prospective, single-center study (level IIb)	57 patients CAS, delayed cardiac surgery Age: 69.7 ± 8.4 Female: 19 Previous PCI: 7 Previous CEA: 1 Major stroke: 3 Minor stroke: 12 TIA: 42	Combined death, stroke and MI rate Death and major stroke rate (from CAS to 30 days after cardiac surgery) MI rate (from CAS to 30 days after cardiac surgery)	12.3% 3.5% 1.5%	Though the cohort size is small, the combined risk of death/stroke/MI is much higher than in similar cohorts' data following simultaneous or hybrid CAS/CABG. This strategy might offer a valuable alternative to the combined surgical approach; however, a large randomized trial is clearly warranted
Velissaris *et al.* (2011), J Vasc Surg, Greece [18] Prospective non-randomized study (level IIb)	90 patients CAS/CABG Mean age: 69.6 Male: 68 Positive family history: 30 Symptomatic: 12 Asymptomatic: 78	Early neurological complications 30-day: - Death - Stroke - TIA - MI - Death/stroke	0 1 (1.1%) 1 (1.1%) 1 (1.1%) 0 2 (2.2%)	CAS followed immediately by cardiac surgery is safe and represents a reasonable option for selected patients. This study was non-randomized to include asymptomatic and symptomatic patients with ≥70 and ≥60% stenosis, respectively. Of 2239 patients, 103 were selected. Excluded patients underwent CEA/CABG, while 13 who had initially been included for CAS/CABG underwent CEA/CABG mainly due to anatomic conditions unfavourable for CAS. A high selectivity and thus selection bias may be suspected in this cohort
Versaci *et al*. (2007), Ann Thorac Surg, Italy [19] Retrospective cohort study (level IIb)	37 patients Hybrid CAS/CABG Age: 70.3 ± 8.5 Male: 30 Symptomatic: 8 Bilateral CS: 24 Asymptomatic: 19 EuroSCORE: 8 ± 2.1	30-day incidence of: - Stroke - MI - Death - Cumulative 6-month incidence of: - Stroke, MI, death - Stroke - Death	 1 (2.7%) 0 (0%) 2 (5.4%) 3 (8.1%) 4 (10.8) 1 (2.7%) 3 (8.1)	CABG was performed immediately after CAS. Post-operative anticoagulation with clopidogrel was commenced after 6 h in 22 patients and after 10 h in 15. It is not clear why there was a difference or how the various decisions were met. The authors conclude that hybrid CAS + CABG is a feasible and promising therapeutic

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Table 1 (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
				strategy, albeit based on data from a small cohort
Balucani *et al*. (2012), Neurology, Italy [20] Prospective cohort study (level IIb)	Comparing cerebral haemodynamics and cognitive performance in asymptomatic CS in 333 subjects, mean age 70 ± 3.78 years, 65% male: I. 127 bilateral (B-ACS) II. 73/77 left/right unilateral III. 56 without CS	**Verbal fluency scores** Phonemic: - B-ACS + left impaired haemodynamics - No CS Categorical: - B-ACS + left impaired haemodynamics - No CS Coloured progressive matrices score: - B-ACS + right impaired haemodynamics - No CS Complex figure copy scores: - B-ACS + right impaired haemodynamics - No CS	 7.5 13.4 10.8 19.7 24.6 34.2 27.1 37.0	Subjects with B-ACS and subjects with unilateral ACS are more likely to have cognitive dysfunction compared with subjects with no CS. There appears to be a link between cognitive dysfunction and haemodynamics impairment due to CS. Subjects with B-ACS and subjects with unilateral ACS showed significantly lower scores in all cognitive tests compared with subjects with no CS ($P = 0.05$). Though this study involves non-surgical subjects, it provides baseline information that may determine the surgical outcomes of patients with asymptomatic CS undergoing surgery
Executive Committee for Asymptomatic Carotid Atherosclerosis Study (ACAS), (1995), JAMA, USA [21], Canada Multicentre PRCT (level 1b)	1662 patients with 60–99% asymptomatic carotid artery stenosis were randomized to: I. CEA plus medical therapy ($n = 828$) II. Medical therapy alone ($n = 834$)	5-year risk of stroke Absolute risk reduction	 5.1% 11% 5.9% ($P = 0.004$)	The committee concluded that hybrid revascularization by CAS immediately followed by CABG is a feasible and promising therapeutic strategy that warranted randomized trials. Various RCTs have since been published, most of which included symptomatic patients. The results above by Illuminati *et al*. [3], however, had a focus on asymptomatic patients

carotid endarterectomy.mp OR CEA.mp OR CAS.mp] LIMIT to human studies. In addition, the American Heart Association (AHA), European Society for Vascular Surgery (ESVS) guidelines and National Institute for Health and Care Excellence (NICE) guidelines were hand searched.

SEARCH OUTCOME

Six hundred and twenty-four papers were found, of which 25 were deemed to be relevant. These papers are presented in Table 1.

RESULTS

According to the ESVS guidelines [22], the incidence of significant carotid stenosis (CS) in patients undergoing CABG ranges between 2.8 and 22% [2, 23]. Of note, 28–40% of patients undergoing carotid endarterectomy (CEA) have significant concomitant coronary artery disease [2, 24]. An individual surgical approach based on specific risk profiles is hitherto recommended.

A randomized controlled trial (RCT) by Illuminati *et al*. [3] compared simultaneous CEA/CABG with delayed CEA 1–3 months following CABG. They concluded that previous or simultaneous CEA prevents stroke better than delayed CEA without increasing overall surgical risk.

A partly randomized study by Hertzer *et al*. [2] suggested lower perioperative risk of stroke in patients undergoing combined CEA and CABG compared with CABG alone.

Nwakanma *et al*. [4] showed that short- and long-term morbidity was not significantly higher for CEA/CABG vs CABG alone.

Santos *et al*. [5] retrospectively reported a 5% combined risk of death, stroke and MI for staged CEA–CABG within 30 days.

Baiou *et al*. [6] showed a 5% death rate due to MI and no stroke incidence in patients with significant carotid disease (CD) undergoing CABG without prophylactic CEA. Santos *et al*. [5] documented similar rates for death and myocardial infraction (MI), and higher stroke rate for delayed CEA–CABG.

Kougias *et al*. [7] compared patients with unilateral, severe bilateral CD and contralateral carotid occlusion (CO) undergoing CEA/CABG or CABG alone. The risk of stroke or mortality was comparable following CEA/CABG for unilateral and bilateral CD

compared with CABG alone. Perioperative stroke and death risk in contralateral CO was higher.

Kolh *et al*. [8] reported 10-year actuarial event-free rates of MI and stroke following CEA/CABG of 84 and 93%, respectively.

Kaul *et al*. [9] showed that progression of bilateral ($P = 0.007$) and intracranial ($P = 0.04$) CD are predictors of stroke following CEA/CABG.

A systematic review by Naylor *et al*. [10] showed 4.6% mortality for combined CEA/CABG. The risk of ipsilateral and any stroke after staged CABG–CEA was 5.8 and 6.3%, respectively. Perioperative MI following staged CABG–CEA and CEA–CABG was 0.9 and 6.5%, while combined risk of death/stroke or MI following CEA/CABG and CEA–CABG was 11.5 and 10.2%, respectively.

Levy *et al*. [11] documented actuarial freedom from neurological events at 10 years of 92 ± 4% for CEA/CABG.

Naylor *et al*. [12] documented a comparable 30-day risk of death and any stroke for both staged carotid artery stenting (CAS) and CABG, and CEA–CABG.

A meta-analysis by Naylor and Bown [13] on patients with severe asymptomatic bilateral or unilateral CD undergoing CEA/CABG or CABG alone concluded that whereas there was no compelling evidence supporting prophylactic carotid procedures in patients with unilateral asymptomatic CD, prophylactic CEA or CAS may still be considered for severe bilateral asymptomatic CD in patients requiring CABG.

While Versaci *et al*. [14] reported a 30-day cumulative incidence of stroke, MI and death of 4% for CAS/CABG, Timaran *et al*. [15] showed a significantly decreased stroke rate ($P < 0.001$) compared with CEA/CABG and similar in-hospital death.

Tomai *et al*. [16] conducted a prospective study of staged or simultaneous CAS and PCI, reporting a death, MI and stroke rate of 4.2, 2.1 and 3.8%, respectively. They concluded that these outcomes compare favourably with previous surgical hybrid experiences, but recommended the strategy for complex patients at high surgical risk.

A single-centre prospective study by Van der Heyden *et al*. [17] for staged CAS-CABG reported a 12.3% rate of combined death, stroke and MI, while Velissaris *et al*. [18] reported a 2.2% rate for hybrid CAS/CABG.

CLINICAL BOTTOM LINE

Previous or simultaneous CEA/CABG prevents stroke better than delayed CEA, as shown by a recent randomized study. There is little evidence supporting prophylactic CEA for unilateral asymptomatic, but for severe bilateral asymptomatic CD. Current evidence suggests that outcomes of hybrid CAS/CABG may be comparable with those of simultaneous CEA/CABG.

Conflict of interest: none declared.

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