Left coronary artery lesion: surgical revascularization or angioplasty: An update in light of the latest studies

Abstract

Coronary artery bypass grafting (CABG) has been considered the technique for revascularisation of complex coronary artery disease such as left anterior descendy coronary artery. The advent of percutaneous coronary angioplasty modified this attitude, particularly with the improvement in technical modalities and human experience, making the feasibility of multi-vessel and left coronary artery (LCA) involvement technically feasible by angioplasty. Several studies have been carried out over the years to determine the optimal method of revascularisation of patients with LCA lesions between angioplasty or coronary artery bypass grafting, taking into account the occurrence of major cardiovascular events. The recent studies concerning this topic are the SYNTAX, the NOBLE and the EXCEL studies. Bypass surgery remains the first choice. Angioplasty is an interesting alternative for patients with uncomplicated coronary disease and a low syntax score.

Keywords : Left coronary artery, angioplasty, bypass grafting

Introduction

Ischaemic heart disease is one of the leading causes of death worldwide. Acute and chronic coronary syndromes have a variable prognosis, however, the presence of a lesion in the left coronary artery (LCA) significantly worsens the prognosis due to the risk of sudden death from sudden occlusion of the LCA and because of the large myocardial territory involved. (1) A LCA stenosis is defined as a stenosis of more than 50% of the coronary lumen. If this vessel is not protected by collateral flow, it compromises the flow to the left ventricle by more than 75%. (2) Coronary artery bypass grafting (CABG) has been considered the technique for revascularisation of complex coronary artery disease since its introduction in 1968. The advent of percutaneous coronary angioplasty in 1972 modified this attitude, particularly with the improvement in technical modalities and human experience, making the feasibility of multi-vessel and LCA involvement technically feasible by angioplasty (3). Several studies have been carried out over the years to determine the optimal method of revascularisation of patients with LCA lesions between angioplasty or coronary artery bypass grafting, taking into account the occurrence of major cardiovascular events. (4-6) The advent of new generations of stents as well as some angioplasty techniques have improved the prognosis and success rate of unprotected LCA. In this paper, we will study a systematic literature review and summarise the different studies comparing the results obtained by angioplasty and coronary artery bypass grafting.

I. Treatment of lesions of the left coronary artery (LCA)

1. Medical Treatment

Medical treatment remains a staple for all patients with ischemic heart disease (7). It should be combined with other surgical and percutaneous means. Medical treatment alone may be prescribed in isolation in symptomatic patients who cannot be operated for technical reasons or because of the high surgical risk. Medical treatment includes several components: anti-ischemic treatment with beta-blockers or nitrates or calcium channel blockers with antithrombotic treatment such as antiplatelet agents and P2Y12 inhibitors such as clopidogrel, ticagrelor and prasugrel, which are the cornerstone of this treatment. Fibrinolytics remain an important means of medical revascularization if the patient is unable to be taken to the cattheterisation ward before 120 minutes in the case of STEMI (8).

2. Left coronary artery (LCA) surgery by coronary artery bypass grafting

In old studies, the 3-year mortality in patients with LCA stenosis receiving only medical treatment with beta-blockers and nitrates was 50%. Surgical treatment has shown better results and has become the reference treatment for these lesions (9).

The operative procedure has a mortality of between 1.5 and 3% depending on the severity of the coronary lesions and the quality of the left ventricular function (10)

3. Left coronary artery (LCA) Angioplasty

As soon as coronary angioplasty appeared, Andreas Gruentzig tried to use this technique to treat LCA lesions. Because of the poor results, this technique was quickly abandoned and especially because of the concomitant appearance of several publications showing the effectiveness of surgical treatment for the management of these types of lesions. However, the significant growth in stenting rates during the 1990s fueled by the significant reduction in thrombotic complications brought about by the advent of ticlopidine have prompted new attempts to restore LCA angioplasty. (11) The revascularization strategy for LCA lesions should be decided by a multidisciplinary team ("Heart Team") for stable patients. Ad hoc LCA angioplasty is only conceivable in an emergency setting. Angioplasty must be performed by an experienced operator. Indeed, it has been shown that patients treated by high-volume operators have a better prognosis (12).

II. PCI vs CABG

The debate between the use of angioplasty or CABG as treatment of LCA lesions has persisted for years as one of the most important issues in ischemic heart disease.

Indeed, despite the introduction of the standard angioplasty technique in 1972, surgical treatment by CABG has been the reference treatment for the treatment of LCA lesions, but with the advent of the new angioplasty techniques, this discussion has resurfaced with numerous studies that have tried to compare the two techniques and present the advantages and disadvantages of each of them. Thus, some consensus and recommendations and scores were derived from these studies.

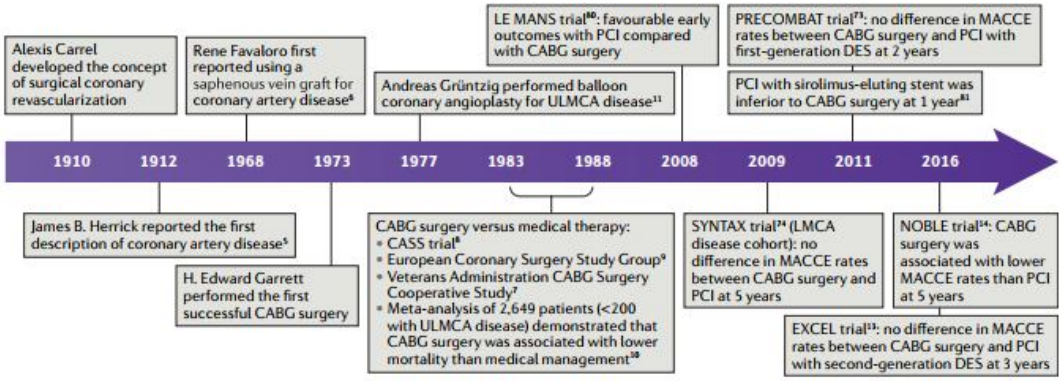

Figure 1: Chronology of studies regarding LCA revascularization. (9)

Among the main studies carried out on the comparison between the two techniques are the SYNTAX study, and recently the NOBLE and EXCEL studies.

1. SYNTAX study

SYNTAX is a randomized clinical study with registries that were carried out in 85 centers in the United States and Europe. Each center was composed of a cardiovascular surgeon and an interventional cardiologist with a screening of patients with multivessel or LCA damage or both. The patients were divided into two groups according to their condition (technical feasibility of angioplasty with a first generation stent or bypass surgery). (3)

The objective was to monitor the occurrence of cardiovascular and cerebral events and to study the severity of the lesions by using the SYNTAX score. Of 1800 patients enrolled in the randomized cohort, 897 were assigned to CABG and 903 to PCI. 805 (89-7%)patients in the CABG group and 871 (96.5%) in the PCI group completed their 5-year follow-up. The 5-year results showed superiority of CABG over angioplasty in the management of patients with complex coronary lesions by low rates of cerebrovascular disease, myocardial infarction, cardiac death, or necessity of revascularization at 5 years.

In the SYNTAX trial, we note a significant difference in outcomes by severity of coronary lesions. In patients with low SYNTAX scores (0-22), there is not a significant difference between the two groups in any end point at 5 years. In contrast, in patients with intermediate SYNTAX scores (23-32), 5-year rates of myocardial infarction and necessity of new revascularization were significantly increased with the PCI group compared with the CABG group. In patients with the highest baseline SYNTAX scores (≥33), all clinical end points except stroke were significantly increased in the PCI group compared with the CABG group. These results suggest that patients with intermediate or high SYNTAX scores are best treated with CABG, but patients with a SYNTAX score ≤22 can be treated with angioplasty with a first-generation stent with equivalent results. (3)

Overall, surgical outcomes are better but angioplasty remains an excellent alternative to surgery. (3)

	CABG	PCI	Hazard ratio (95% CI)	p value
SYNTAX score 0–22, n	275	299		
MACCE	74 (28·6%)	94 (32·1%)	1·13 (0·83–1·53)	0·43
Death or stroke or MI	39 (14·9%)	47 (16·1%)	1·05 (0·69–1·61)	0·81
Death, all-cause	26 (10·1%)	26 (8·9%)	0·88 (0·51–1·51)	0·64
Cardiac death	10 (3·8%)	14 (4·8%)	1·24 (0·55–2·80)	0·60
Stroke	10 (4·0%)	5 (1·8%)	0·43 (0·15–1·26)	0·11
MI	11 (4·2%)	22 (7·8%)	1·79 (0·87–3·70)	0·11
Repeat revascularisation	41 (16·9%)	66 (23·0%)	1·46 (0·99–2·16)	0·056
SYNTAX score 23–32, n	300	310		
MACCE	72 (25·8%)	110 (36·0%)	1·50 (1·11–2·01)	0·008
Death or stroke or MI	50 (18·0%)	63 (20·7%)	1·17 (0·80–1·69)	0·42
Death, all-cause	35 (12·7%)	42 (13·8%)	1·10 (0·70–1·72)	0·68
Cardiac death	19 (7·1%)	26 (8·8%)	1·25 (0·69–2·26)	0·45
Stroke	10 (3·6%)	6 (2·0%)	0·55 (0·20–1·53)	0·25
MI	10 (3·6%)	33 (11·2%)	3·11 (1·53–6·31)	0·0009
Repeat revascularisation	34 (12·7%)	70 (24·1%)	2·03 (1·35–3·06)	0·0005
SYNTAX score ≥33, n	315	290		
MACCE	80 (26·8%)	126 (44·0%)	1·89 (1·43–2·50)	<0·0001
Death or stroke or MI	51 (17·1%)	75 (26·1%)	1·63 (1·14–2·32)	0·007
Death, all-cause	33 (11·4%)	55 (19·2%)	1·84 (1·19–2·83)	0·005
Cardiac death	14 (4·9%)	38 (13·6%)	2·99 (1·62–5·52)	0·0002
Stroke	11 (3·7%)	9 (3·5%)	0·89 (0·37–2·16)	0·80
MI	12 (3·9%)	28 (10·1%)	2·57 (1·31–5·06)	0·004
Repeat revascularisation	35 (12·1%)	83 (30·9%)	2·86 (1·93–4·25)	<0·0001

Data are Kaplan-Meier estimates of event rates, expressed as percent of patients. Some patients had missing data for baseline SYNTAX score and were excluded from the analysis. Some patients had more than one event. CABG=coronary artery bypass graft surgery. PCI=percutaneous coronary revascularisation. MACCE=major adverse cardiac and cerebrovascular events. MI=myocardial infarction.

Table 1: Study outcomes at 5 years' follow-up, by baseline SYNTAX score tercile

Figure 2 : SYNTAX study results at 5 years (3)

2. NOBLE Study

The NOBLE study is a prospective, randomized, open-label study including patients with LCA involvement recruited from 36 centers in Europe and randomized 1:1 to receive either surgical or angioplasty treatment. Patients included in this study had either stable or unstable angina or NSTEMI with an exclusion criterion of patients with STEMI. The primary endpoint was major adverse cardiac or cerebrovascular events (MACCE), a composite of all-cause mortality, occurrence of myocardial infarction, necessity of new revascularization and stroke. Between December 9, 2008, and January 21, 2015, 1201 patients were randomly assigned, 598 to angioplasty and 603 to CABG. (13)

The main findings of the NOBLE study were that CABG was better than angioplasty for the MACCE composite endpoint. All-cause mortality was similar between the two groups. Nonprocedural myocardial infarction and the need for repeated revascularizations were increased after angioplasty. A higher rate of stroke was observed in the CABG group after 30 days compared with the angioplasty group, but an unexpectedly higher rate of stroke was found in patients treated with angioplasty over 5 years (13).

	PCI (n=592)	CABG (n=592)	Risk difference (95% CI)	p value
MACCE	42 (7%)	42 (7%)	0·0% (−2·9 to 2·9)	1·00
All-cause mortality	9 (2%)	17 (3%)	−1·3% (−3·0 to 0·3)	0·11
Cardiac death	8 (1%)	13 (2%)	−0·8% (−2·3 to 0·6)	0·27
Vascular death	0	1 (<1%)	0·1 (−0·1 to 0·3)	0·32
Non-procedural myocardial infaction	11 (2%)	8 (1%)	0·5% (−0·9 to 1·9)	0·49
Revascularisation (total)	32 (5%)	24 (4%)	1·4% (−1·1 to 3·8)	0·27
Symptomatic graft occlusion or definite stent thrombosis	2 (<1)%	7 (1%)	−0·8% (−1·8 to 0·1)	0·09
Stroke	2 (<1%)	6 (1%)	−0·7% (−1·6 to 0·3)	0·16

Data are n (%) unless otherwise specified. MACCE=major adverse cardiac or cerebrovascular events. CABG=coronary artery bypass grafting. PCI=percutaneous coronary intervention.

Figure 1 : NOBLE study results after 1 year of follow-up (13)

The NOBLE study show that even patients with a low score SYNTAX had better results with CABG than with angioplasty (13).

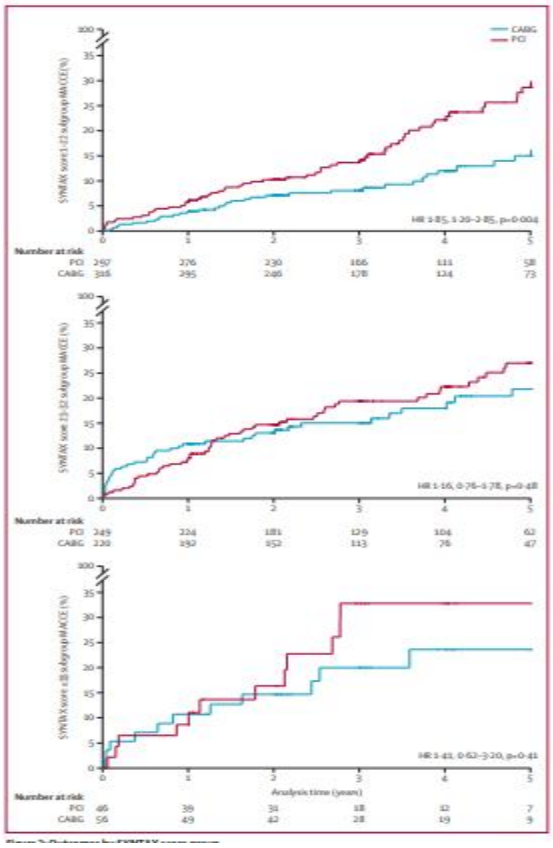

Figure 4 : Results according to SYNTAX score (13)

3. EXCEL study

The EXCEL study is a randomized study that was held more or less at the same time as the NOBLE study (2010-2014). It is an international, open-label, randomized study comparing

angioplasty with everolimus-eluting stents with coronary artery bypass grafting in patients with LCA stenosis. (14)

Patient eligibility was assessed at each participating site by a cardiac team consisting of an interventional cardiologist and a cardiac surgeon. Inclusion criteria were defined as a visually estimated tight LCA stenosis of >70% or a hemodynamically significant lesion of 50-70%. The heart team of this study established a consensus to define the patients eligible for angioplasty or surgery. All patients had uncomplicated anatomic lesions with a SYNTAX score of less than 33. The total population of this study was 1905 patients. 948 patients underwent angioplasty with cobalt-chromium fluoropolymer everolimus-eluting stents and 957 patients underwent CABG. The primary endpoint was the rate of a composite of all-cause death, stroke, or myocardial infarction at 3 years and as a secondary objective the occurrence of the same events at 30 days. (14)

At 3 years, a primary end point event had occurred in 15.4% of patients in the angioplasty group and in 14.7% of patients in the CABG group. The primary end point of death, stroke, or myocardial infarction at 30 days occurred in 4.9% of patients in the angioplasty group and in 7.9% in the CABG group. The secondary end point of death, stroke, myocardial infarction, or ischemia-induced revascularization at 3 years occurred in 23.1% of patients in the angioplasty group and in 19.1% in the CABG group.

Table 3. Primary and Hierarchical Secondary Clinical End Points.

End Point	PCI (N = 948)		CABG (N = 957)		Difference in Event Rates	P Value for Noninferiority	Hazard Ratio (95% CI)	P Value for Superiority
	Events	Event Rate*	Events	Event Rate*				
	no.	%	no.	%	percentage points (upper confidence limit)			
Primary end point								
Death, stroke, or myocardial infarction at 3 yr	137	15.4	135	14.7	0.7 (4.0†)	0.02	—	—
Secondary end points								
Death, stroke, or myocardial infarction at 30 days	46	4.9	75	7.9	−3.1 (−1.2‡)	<0.001	—	—
Death, stroke, myocardial infarction, or ischemia-driven revascularization at 3 yr	208	23.1	174	19.1	4.0 (7.2‡)	0.01	—	—
Death, stroke, or myocardial infarction at 3 yr§	137	15.4	135	14.7	—	—	1.00 (0.79–1.26)	0.98

Figure 5: Results of the EXCEL study (14)

Thus, for the primary endpoint concerning the occurrence of death from any cause and the occurrence of stroke or myocardial infarction at three years, there was no significant difference between angioplasty and bypass surgery. The occurrence of events between the procedure and the 30th day was lower in the angioplasty group than in the CABG group, whereas the opposite was observed between the 30th day and 3 years. The risk of repeated revascularization was more than 5% in the PCI group than in the CABG group. (14)

In the results of the EXCEL study, it was found that in patients with significant LCA stenosis with a low or intermediate SYNTAX score, there was no significant difference between the groups treated by bypass or angioplasty, the latter remains an acceptable alternative to bypass

(14). This decision should be made by the heart team after a personalized discussion with each patient.

Study	Years	PCI versus CABG surgery (n)	Primary end point	Type of stent	Follow-up duration (years)	Result of primary end point	Refs
LE MANS	2001–2004	52 versus 53	Change in LVEF	DES (first-generation) and BMS	10	PCI superior to CABG surgery	80
Boudriot et al.	2003–2009	100 versus 100	Death, MI, or revascularization	DES (first-generation PES)	1	PCI noninferior to CABG surgery	81
PRECOMBAT	2004–2009	300 versus 300	Death, MI, stroke, or ischaemia-driven revascularization	DES (first-generation)	5	PCI noninferior to CABG surgery	75
SYNTAX	2005–2007	357 versus 348	Death, MI, stroke, or revascularization	DES (first-generation PES)	5	PCI noninferior to CABG surgery for the ULMCAD subgroup	74
EXCEL	2010–2014	948 versus 957	Death, MI, or stroke	DES (second-generation EES)	3	PCI noninferior to CABG surgery	13
NOBLE	2008–2015	592 versus 592	Death, MI, stroke, or revascularization	DES (first-generation SES and/or second-generation BES)	5	Noninferiority of PCI was not demonstrated	14

BES, biolimus-eluting stent; BMS, bare-metal stent; DES, drug-eluting stent; EES, everolimus-eluting stent; LVEF, left ventricular ejection fraction; MI, myocardial infarction; PCI, percutaneous coronary intervention; PES, paclitaxel-eluting stent; SES, sirolimus-eluting stent; ULMCAD, unprotected left main coronary artery disease.

Figure 6: Results of studies comparing CBAG and PCI in terms of death and occurrence of cardiovascular and cerebral events (9)

AHA recommendations for LAD

The 2021 US recommendations were based on the SYNTAX, NOBLE, EXCEL studies to try to answer the dilemma of angioplasty vs. bypass surgery in case of LAD involvement. These recommendations clearly state that coronary artery bypass grafting should be chosen in cases of LAD stenosis to improve prognosis.

COR	LOE	RECOMMENDATIONS
1	B-R	1. In patients who require revascularization for significant left main CAD with high-complexity CAD, it is recommended to choose CABG over PCI to improve survival (1,2).
2a	B-R	2. In patients who require revascularization for multivessel CAD with complex or diffuse CAD (e.g., SYNTAX score >33), it is reasonable to choose CABG over PCI to confer a survival advantage (2-5).

Figure 7 : 2021 US recommendations for LAD

Conclusion

The topic of revascularisation of a lesion of the left coronary artey is a vast one, still being explored with great importance, particularly with regard to improving the survival rate of patients. The advent of new endo-vascular imaging techniques and new generations of stents makes revascularisation by angioplasty a very tempting alternative. Nevertheless, the various studies carried out over the years have shown that bypass surgery remains the first choice, given the number of studies carried out and the more or less reassuring prognosis compared with angioplasty. Although the Syntax study has opened the door to angioplasty as an interesting alternative for patients with uncomplicated coronary disease and a low syntax score, further studies are still needed to get a more global idea and especially to get an idea of the different subgroups in order to have a more personalised management not only based on the syntax score but also on the clinical, electrical profile and echocardiography of each patient.

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