Percutaneous coronary interventions in left main disease: a critical overview of current recommendations
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Abstract: Recent progresses in techniques and knowledge of percutaneous interventions had changed the paradigm of myocardial revascularization in LMCA disease from a surgical procedure 20 years ago to a percutaneous approach for almost all patients nowadays. There are still pro’s and con’s for each situation and it is clearly the aim of the Heart Team to establish an adequate medical indication with respect to the clinical data, the particularities of the patient, the local surgical or PCI expertise and the preference of the patient and family. This review is trying to present the actual status of evidence – based data in the field of LMCA disease PCI.

Keywords: percutaneous coronary interventions, left main.

Rezumat: Progresele recente în tehnica intervențiilor coronariene percutane au schimbat orientarea indicației de revascularizare coronariană de la o procedură chirurgicală acum 20 de ani la o procedură percutană aproape în toate cazurile din zilele noastre. Există încă argument pro și contra pentru fiecare situație și este rolul echipei medicale să stabilească cea mai bună variantă pentru fiecare pacient în parte, în funcție de datele clinice, particularitățile anatomiche, comorbiditățile, experiența locală chirurgicală sau intervențională și preferința pacientului și a familiei. Prezentul articol încearcă să evocă stadiul actual al evidențelor medicale în acest domeniu.

Cuvinte chei: intervenție coronariană percutană, leziune de trunchi comun.

The left main coronary artery (LMCA) stenosis is associated with a severe prognosis because of several anatomical and functional particularities of this artery: it is a large, often tapered vessel, arising directly from the aorta, which nourishes a large amount of possible endangered myocardium that can lead to increased risk of major cardiac events1. The vast majority of causes of this narrowing is atherosclerosis, involving in more than 80% of cases the bifurcation of the left main artery, in a „T” shaped angulation of the emerging vessels: the left anterior descending (LAD) and circumflex (CX) arteries; in 10% of cases there is also a third vessel – the intermediate ramus- making a so called “trifurcation” and also in 15% of patients because the right coronary artery (RCA) is small, the LMCA is dominant supplying almost the whole left ventricle2. Treatment for that disease is rarely only medical, because of its poor outcome. Coronary artery bypass grafting (CABG) has been for a long time the standard revascularization technique, demonstrating a better survival rate than optimal medical treatment3. Recently published data, comparing revascularization with percutaneous coronary interventions (PCI) versus CABG for LMCA disease had shown comparable results in terms of survival rate, stroke or myocardial infarction4.

A successful interventional treatment of LMCA disease implies 2 cardinal rules:
I. Careful patient selection
II. Proper angioplasty technique including the use of intravascular imaging and physiological guidance

This review will emphasize how to do a careful selection of the patients for each strategy of treatment, according to the particular individual clinical aspects,

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and also the current data supporting different types of PCI techniques and adjunctive imaging and physiologic intracoronary evaluation modalities.

I. PATIENT SELECTION: PCI VS. CABG IN LMCA DISEASE

Randomized trials: Six randomized trials had compared percutaneous revascularization with surgery: LEMANS- 2008; SYNTAX LM- 2010; BOUDRIOT- 2011; PRECOMBAT- 2011; EXCEL- 2017 and NOBLE-2017. Only the last 2 had used second generation stents, which are currently available in worldwide cath-labs. The EXCEL trial demonstrated that, in case of low or intermediate anatomical group (Syntax score lower than 32), there is an equipoise of number of deaths, strokes and myocardial infarctions (MIs) at 3 years follow up between the surgical and the interventional groups. However, in long term, there is an excess of need of repeat revascularizations procedures in the PCI group. Still, at 30 days PCI had fewer number of deaths, strokes, or MIs and also fewer major arrhythmias, infections, reoperations, bleeding, and transfusions compared with CABG. The investigators of EXCEL stated that PCI should be the preferred strategy of revascularization in carefully selected patients, after discussion in Heart Team. The NOBLE trial showed a slight superiority of the evolution of patients treated with CABG compared to PCI, mainly driven by the excess of myocardial infarctions and repeat revascularizations. It is noteworthy that definition of periprocedural MI was different in the two trials — EXCEL has taken into account only those which are clinically significant (10x the upper limit of CK-MB), while NOBLE counted also those which do not intervene in the clinical outcome of a patient and also is important to note that in the NOBLE trial a lower quality of DES was used leading to a 3% incidence of stent thrombosis.

Meta-analyses of CABG vs. PCI: A recent meta-analysis of the six randomized trials has shown a reduced number of deaths, strokes and myocardial infarctions, also a reduced number of deaths in the PCI group when the Syntax score is low and increasing with the rise of anatomical complexity. In another

Figure 1. 5 years equipoise of mortality with PCI vs CABG, irrespective to the Syntax score complexity: Syntax score 32: before PCI (A) and after PCI (B); Syntax score 15: before PCI (C) and after PCI (D).
meta-analysis, published in 2018, involving all 11 trials performed until now, comparing PCI with CABG for LMCA disease, Head et al. demonstrated a similar rate of death at 5 years follow up – 10.5%, regardless the presence of diabetes mellitus or high anatomical complexity - Syntax score > 33\(^{13}\) (Figure 1).

**Registries of Left Main Revascularization:** FU WAI\(^{14}\), IRIS MAIN\(^{15}\) and DELTA 2\(^{16}\) compared patients who were revascularized either with PCI or with CABG between 2004-2015. The results are very similar to those observed in the EXCEL trial, with the same number of deaths, strokes and myocardial infarctions and with an excess number of repeated revascularization procedures in the PCI arm in a median of 3 years follow up.

**Meta-analysis of medical treatment compared to PCI:** A statistical comparison between the outcome of patients medically treated with those who

![Algorithm for strategy choices of LMCA PCI (adapted from EBC consensus document).](image-url)

*Figure 2.* Algorithm for strategy choices of LMCA PCI (adapted from EBC consensus document).
underwent PCI showed a similar result with surgery, with a reduction of mortality in the PCI group at 5 years with 80%17. With such a significant difference, it is very unlikely that someone could recommend only medical treatment for LMCA disease!

Thus, PCI is recommended for patients with low and intermediate scores, or to those with high surgical risk and CABG when there is a high anatomical and clinical complexity.

Choosing the indication and risk stratification: After the publication in early 2018 of Head meta-analysis, the newly appeared ESC Guidelines for Myocardial Revascularization, stipulated a Class I indication with level of evidence B for PCI in LMCA disease with low Syntax score and II a with the same level of evidence for intermediate risk. Since there is no difference in mortality at 5 years, a clinical score was added to the anatomical Syntax score, helping the physician in predicting mortality at 4 years: the Syntax 2 score which integrates 7 variables: age, sex, chronic obstructive pulmonary disease, peripheral vessel disease, left ventricular ejection fraction, creatinine clearance, presence of LMCA disease18. However, the Syntax score 2 was not extensively investigated for LMCA disease. Remarcably the patients with diabetes mellitus (DM) treated with PCI for LMCA disease have similar prognosis as those treated with CABG; on contrary for the 3 vessel coronary artery disease diabetic patients, the classical situation is still valid – surgery is a better option in term of survival13,18. In conclusion for the diabetic patient with left main disease interventional therapy is as good as surgical one!

II. IMPROVEMENTS IN THE TECHNIQUE AND INTRAVASCULAR IMAGING AND PHYSIOLOGICAL GUIDANCE

PCI technique-related issues: PCI for LMCA disease should be performed by experienced operators, with at least15 procedures/year for at least 3 consecutive years19. The ostial and mid shaft located LMCA lesions are usually straight forward procedures, with a very good long term success. The distal localization is present in 80% of cases and is a bifurcation or trifurcation lesion. The current recommendation of the European Bifurcation Club is the use of a single stent with the provisional second bail out stenting of the side branch in case of necessity. All single stent procedures should include the Proximal Optimization Techniques (POT), i.e. inflation of large non-compliant balloons inside the stented LMCA20. In certain cases (Figure 2) long CX lesions, high risk of CX compromise or difficult access, a double stent strategy should be used from the very beginning. There are several bifurcation/2 stents techniques and it is clear that any operator should choose the one which is most convenient for

![Figure 3. Distal LMCA lesion (Medina 1-1-1) treated with 2 stents with a „dkcrush” technique – before (Figure 3a) and after stenting (Figure 3b).](image-url)
him and suitable for the patient that particular situation. There are data coming from two Chinese studies that show that the „double kissing crush” technique is superior to the „culotte” technique in the treatment of LMCA stenosis and should be the elective procedure in such cases21. For any 2 stents procedure, a final POT and a kissing balloon in the LMCA/LAD/CX should be performed.

**Stent selection:** There was no difference in ischemic end points seen in three prospective registries involving various second-generation DES for LMCA disease. Stent thrombosis was observed in only 0.7% of patients and it is similar to that from the EXCEL Trial, so there should be no recommendation for a specific type of 2nd or 3rd generation of DES, if sizing and techniques of implantation are appropriate22. There are ongoing trials studying dedicated bifurcation stents (POLBOS, TRYTON) or biodegradable polymer DES (MAIN COMPARE).

**Imaging adjunctive guidance:** It is highly important to have alternative intravascular imaging tools when dealing with LMCA disease PCI, because observational studies had shown a better survival with when dealing with LMCA PCI, because observational studies had shown a better survival with PCI in such cases21. For any 2 stents procedure, a final POT and a kissing balloon in the LMCA/LAD/CX should be performed.

**Physiologic adjunctive guidance:** FFR or iFRs useful in the preoperative assessment, because, in borderline lesions, in almost 30-40% of cases a mismatch between the angiographically defined severity and the functional severity of the myocardial ischemia defined by a FFR <0.75 is observed, due the dimensions of the LMCA28. Post implantation of the stent, FFR can be used for defining the severity of the jailed ostial LAD or CX lesions or for the assessment or other distal non LMCA lesions.

**CONCLUSIONS**

For most of the patients with left main disease, the survival is similar with interventional or surgical treatment.

Clinical decision making on percutaneous revascularization for left main coronary artery disease should account for the presence of comorbidities, the extent of the anatomical disease, physiological component, likelihood for complete revascularization, and patient preference.

Physiological assessment should be performed to assess the need for revascularization in bifurcation lesions. Intravascular imaging guidance can be used before the procedure to better understand bifurcation anatomy and to optimize stent implantation; however, clinical outcomes trials are required to recommend imaging as essential part of LMCA PCI.

Bifurcation PCI should be tailored to the patientspecific anatomy and the technique selected based on the experience of the operator. Long lesions in side branch probably benefit from more complex (or 2 stent) techniques.

A collaborative effort combining individual patient datasets from randomized clinical trials has the potential to better identify which patients can benefit from which specific technique.

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**References**


