Case Report

Debate of Percutaneous Coronary Intervention versus Coronary Artery Bypass Grafting in a Multimorbidity Patient with Complex Coronary Lesions

Sotirios Mitsiadis, Nikolaos Miaris, Antonios Dimopoulos, Anastasios Theodosis-Georgilas, Spyridon Tsiamis, Nikolaos Patsourakos, Nikolaos Papakonstantinou, and Evangelos Pisimisis

Department of Cardiology, “Tzaneio” General Hospital of Piraeus, Piraeus, Greece

Correspondence should be addressed to Nikolaos Miaris; nmiaris@gmail.com

Received 28 August 2019; Accepted 18 April 2020; Published 18 May 2020

Academic Editor: Ertugrul Erkan

Copyright © 2020 Sotirios Mitsiadis et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Background. While complete revascularization in coronary artery disease is of high priority, the method of implementation in patients with complex coronary lesions and multiple comorbidities is not directed by published guidelines. Case Presentation. A 53-year-old female with a chronic total occlusion of the right coronary artery and a bifurcation lesion of the left anterior descending artery and the first diagonal branch, presented with non-ST elevation myocardial infarction. Her past medical history concerned thymectomy and prior chest radiation for thymoma, myasthenia gravis, peripheral artery disease, and cervical cancer treated with surgery and radiation. Although SYNTAX score II favored surgical revascularization, the interventional pathway was finally successfully followed. However, it was complicated with vessel perforation and tamponade managed with pericardiocentesis. Conclusion. Comorbidities are not all involved in common risk models and require individualization until more evidence comes to light.

1. Introduction

Complete revascularization (CR) in patients with multivessel coronary artery disease (CAD) is a crucial prognostic factor that should be taken into consideration in the decision between percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG), as it is associated with reduced cardiovascular mortality regardless of the method of implementation [1, 2]. Frequently, the best reperfusion strategy has to be considered with prudence, as CABG in patients with comorbidities may be accompanied by an increased risk for adverse outcomes, which is also high when performing PCI in very complex lesions along with a lower success rate in those cases [3, 4]. The aim of this paper is to present the case of a female patient with two-vessel CAD and such lesion complexity that created skepticism over interventional management, while on the other hand, her simultaneous comorbidities were actually discouraging the surgical option.

2. Case Presentation

A 53-year-old woman presented to our emergency department with non-ST elevation myocardial infarction (NSTEMI). She was a 30-pack-year smoker and dyslipidemic on ezetimibe. Her past medical history involved peripheral artery disease (PAD), cervical cancer treated with surgery and radiotherapy 9 years before admission, myasthenia gravis (MG) currently on steroids and pyridostigmine, and thymoma managed with thymectomy (complicated with a myasthenic crisis) and radiotherapy one year before admission.

Four months preceding her current admission, the patient had been hospitalized with non-ST elevation acute coronary syndrome (NSTEMACS) and diagnosed with two-vessel CAD that involved a bifurcation lesion extending from the left anterior descending (LAD) artery to the first diagonal branch (D1) and a proximal total occlusion of the right
coronary artery (RCA). Lesion complexity indicated reperfusion with CABG, which was then rejected by the patient, and optimal medical treatment was finally adopted.

On admission, the patient presented with chest pain, dynamic electrocardiography changes in multiple precordial leads, and elevated serum cardiac troponin I levels (maximum level of 250 ng/L, cutoff level of 15 ng/L), while mild left ventricular dysfunction (ejection fraction of 45-50%) and inferior wall hypokinesis were revealed by echocardiography. A new invasive coronary angiography (ICA) showed no significant changes in comparison with previous findings (Figure 1).

At this stage, the most beneficial reperfusion strategy should be followed. Although the common risk stratification models indicated an intermediate surgical risk (EuroSCORE II 1.2%, STS score 8.4%) and the SYNTAX scores favored CABG (SYNTAX score I was 23, SYNTAX score II was 39.4 for PCI with 4-year mortality of 14.4% and 21 for CABG with 4-year mortality of 3.3%), our patient’s comorbidities made the actual surgical risk higher than that typically calculated. On the other hand, the implementation of a successful PCI was challenging with a high periprocedural risk, as coronary lesions were complex; they concerned, firstly, a chronic total occlusion (CTO) of the RCA and secondly, an acute-angled bifurcation lesion involving the LAD and a major diagonal branch (D1) with diffuse disease extending more than 15 mm from its ostium. Those bifurcation characteristics made the use of a complex 2-stent technique unavoidable.

The final joint decision of the Heart Team and the patient was the interventional approach, while the surgical option was kept as a minor alternative. Although computed tomography angiography could provide some more information, this was not feasible. Based on the ICA, the Japanese CTO score of the RCA lesion was calculated to be 0, as it would be the first attempt of PCI in a short-length CTO lesion with tapered entry and without calcification or bending within the segment. Our strategy involved beginning with the CTO PCI of the RCA due to its favorable anatomical features and in order to avoid any complications of the donor artery and afterwards, continuing with the PCI of the LAD/D1 bifurcation lesion.

At the same time, another issue was the lack of a second arterial access, as there was a patent left radial artery, whereas the right radial artery was occluded following the previous ICA and the common femoral arteries were severely diseased.

**Figure 1:** Coronary angiography of the patient. (a) CTO of RCA. (b, c) Collaterals from LAD to RCA territory. Retrograde filling of RCA. (d) LAD/D1 bifurcation lesion.
(radiation-induced PAD). Patient’s frailty and the fact that we wanted to avoid any complications of the brachial arteries made us proceed with a single left radial artery access using the antegrade wire escalation technique. The proximal lesion of the RCA was crossed, and a stiff guidewire was advanced to the distal vessel with a free wire movement. After having confirmed the position of the guidewire with two consecutive vertical views, a predilatation with a 1.5/15 mm semicompliant balloon was performed. Unfortunately, an Ellis type III perforation of the vessel was caused (Figure 2), as the balloon predilatation was found to have been implemented in an acute marginal branch that ran parallel to the main vessel [5]. Inflating a balloon proximally to the perforation was intended to stop further blood extravasation. Nevertheless, the patient soon became severely symptomatic with hemodynamic compromise because of rapid fluid accumulation into the pericardial cavity. Urgent pericardiocentesis under fluoroscopic guidance (Figure 3) fortunately stabilized the patient. Restoration of blood flow was finally achieved with the deployment of three drug-eluting stents after wiring the lumen of the RCA. The final angiographic result of the CTO PCI of the RCA was very good (TIMI flow grade 3) (Figure 4), and the patient was transferred to the coronary care unit being hemodynamically stable and asymptomatic.

A week later, the patient reentered the catheterization laboratory. The severity of the LAD lesion was assessed with fractional flow reserve (FFR) measurement that turned out to be 0.8. Double kissing crush technique using two stents was adopted due to the anatomical features of the bifurcation lesion that involved a large lumen diagonal branch with rich blood distribution arising at a steep angle from LAD (steep angle between D1 and LAD distal to the bifurcation).

An excellent angiographic result was finally succeeded (Figure 4), and 3 days later, the patient was discharged being asymptomatic. Eighteen months later, she still remains in the same good asymptomatic condition.

3. Discussion

The therapeutic strategy in patients with CAD and comorbidities is challenging and should be individualized based on the anatomical and functional characteristics of coronary arterial lesions, technical feasibility, and perioperative risk. Besides, after having been fully informed regarding revascularization alternatives, patient’s will play the major role.

As mentioned above, our patient had plenty of comorbidities and even though the usual perioperative risk scores seemed to be intermediate and the SYNTAX score II indicated CABG for myocardial revascularization, there actually exist many features that are not taken into account by these risk models. MG and the history of myasthenic crisis experienced when operated with thymectomy, the prior sternotomy and thoracic radiation therapy creating uncertainty about the patency of the left internal mammary artery, and the long-term treatment with steroids discouraged essentially the option of CABG in our case.

MG is a rare disease caused by autoantibody-mediated blockade of the neuromuscular junction resulting in muscle disability [6]. Such patients are unpredictably resistant or sensitive to various anesthetic medications and may develop either a myasthenic crisis, which is an exacerbation of the disease, or a cholinergic crisis caused by cholinesterase inhibitor overdose [6]. Both conditions may need endotracheal intubation, while surgery may be by itself a triggering factor of myasthenic crisis frequently requiring immediate immunomodulating treatment [6].

There is an ongoing discussion regarding whether prior chest radiation exposure increases adverse outcomes of patients undergoing cardiac surgery. According to Wu et al., increased long-term mortality was observed in patients with prior thoracic radiation exposure treated with cardiac surgery [7]. In particular, the authors concluded with considering other treatment options as more appropriate in such cases. In contrast, Fender et al. demonstrated in their study that surgical revascularization in such patients could be performed as safely as in the control group [8]. Nevertheless, multiple studies conclude with the adverse effect of radiotherapy on internal mammary artery integrity and on its potential usage in CABG, which is a major factor of long-term survival [8, 9]. So, preoperative angiographic evaluation of the integrity of the graft may be considered.

Another field of discrepancy is whether repeat sternotomy portends a poorer prognosis. While some studies report that intraoperative injury can occur in as many as 9-9.1% of redo sternotomies, other authors report much lower risk [10–12]. Although redo sternotomies have been traditionally thought to carry higher mortality rate than first-time operations, this cannot be supported by all ongoing research and neither can its association with intraoperative injuries [10–13]. In either case, detailed preoperative planning including computed tomography scans may be very beneficial, along with a proper surgery technique such as hemisternotomy [12].

CR with complex PCI is a common practice nowadays and is associated with favorable outcomes concerning both morbidity and mortality. Farooq et al. showed that residual CAD with SYNTAX score greater than 8 following PCI was a determinant of 5-year mortality [14]. According to the 2018 guidelines of the European Society of Cardiology and the European Association for Cardio-Thoracic Surgery on myocardial revascularization, the choice of CABG instead
of PCI should be guided by the potential for achieving CR
Moreover, FAME and FAME 2 studies showed that
the goal of CR via PCI should be preferably directed by func-
tional characteristics and not by anatomical ones [15–17].
However, complex PCI procedures are associated with higher
rates of complications; therefore, operators must be well pre-
pared regarding not only the preprocedural planning but also
the intervention itself in order to achieve a high quality result
and deal with possible complications [4].
CTO PCI is a rapidly growing field of interventional car-
diology that needs particular attention in safety issues. After
obtaining dual contrast injection, several factors such as the
position and the morphological features of the proximal
and distal cap, the lesion length, the presence of branches,
and retrograde techniques adequacy have to be assessed prior
to the intervention [18]. However, PAD and the frailty of our
patient made it hard to obtain a second arterial access that
proved an unwise decision after all. Then, the similar course
of RCA and acute marginal branches may mislead even an
experienced operator. Imaging devices such as intravascular
ultrasound may have beneficial contribution in proper wire
crossing and balloon dilation. As regards complications,
Patel et al. showed in their study that vessel perforation
seemed to be the most common concern among cardiolo-
gists, whereas death and tamponade were their second and
third most frequent single responses accordingly [19]. Con-
sequently, urgent pericardiocentesis is a life-saving skill that
all interventional cardiologists should be familiar with, while
readily available pericardiocentesis kits in combination with
either fluoroscopic or echocardiographic guidance may facil-
itate the procedure.
Last but not least, there comes the reliability of FFR in
evaluating the severity of LAD lesions prior to and following
the CTO PCI of RCA. Even though FFR in the culprit vessel
is not reliable in the acute phase of ST-elevation myocardial
infarction [20, 21], transient microvascular dysfunction is
likely to be more limited in NSTEACS, so lesions in both
the culprit and the nonculprit arteries may be reliably evalu-
ated with FFR in those cases [20–22]. Then, as shown in
Figure 1, the RCA territory is supplied by collaterals from

Figure 3: (a) Extravasation causing cardiac tamponade. (b) Urgent pericardiocentesis under fluoroscopic guidance.

Figure 4: Final angiographic results. (a) CTO PCI of RCA; (b) PCI of LAD/D1 bifurcation lesion.
the LAD. This results in larger total blood supply from the LAD compared to this vessel’s supply in case of patent RCA. Regarding CTOs, the supply of the occluded-vessel territory depends on the patenty and flow of the donor artery. When the last is affected by intermediate stenosis, FFR in the donor artery may normalize after successful PCI of the vessel with the CTO [23, 24]. Therefore, CTO recanalization followed by reassessment of the donor artery stenosis seems to be the proposed treatment plan in these cases [24].

In conclusion, although the common risk score models guiding the decision between PCI and CABG are helpful, in fact, they do not take into account various patient comorbidities. Individualization, case-by-case analysis, and patient’s wishes are the key points of the therapeutic strategy. The evolution of PCI techniques, particularly in the field of CTO, makes interventional treatment possible in cases that were formerly managed exclusively with CABG. Nevertheless, this nonsurgical approach does not lack complications that every catheterization laboratory should be adequately trained to deal with.

**Abbreviations**

CABG: Coronary artery bypass grafting  
CAD: Coronary artery disease  
CR: Complete revascularization  
CTO: Chronic total occlusion  
D1: First diagonal branch  
FFR: Fractional flow reserve  
ICA: Invasive coronary angiography  
LAD: Left anterior descending  
MG: Myasthenia gravis  
NSTEACS: Non-ST elevation acute coronary syndrome  
NSTEMI: Non-ST-elevation myocardial infarction  
PAD: Peripheral artery disease  
PCI: Percutaneous coronary intervention  
RCA: Right coronary artery.

**Conflicts of Interest**

The authors certify that they have no conflict of interest.

**References**

[1] C. De Innocentiis, M. Zimarino, and R. De Caterina, “Is complete revascularisation mandated for all patients with multivessel coronary artery disease?,” *Interventional Cardiology Review*, vol. 13, no. 1, pp. 45–50, 2017.

[2] R. D. Vieira, W. Hueb, B. J. Gersh et al., “Effect of complete revascularization on 10-year survival of patients with stable multivessel coronary artery disease: MASS II trial,” *Circulation*, vol. 126, no. 11, Supplement 1, pp. S158–S163, 2012.

[3] D. Scrutinio and P. Giannuzzi, “Comorbidity in patients undergoing coronary artery bypass graft surgery: impact on outcome and implications for cardiac rehabilitation,” *European Journal of Preventive Cardiology*, vol. 15, no. 4, pp. 379–385, 2009.

[4] J. R. Estrada, J. D. Paul, A. P. Shah, and S. Nathan, “Overview of technical and cost considerations in complex percutaneous coronary intervention,” *Interventional Cardiology Review*, vol. 9, no. 1, pp. 17–22, 2011.

[5] S. G. Ellis, S. Ajjuni, A. Z. Arnold et al., “Increased coronary perforation in the new device era: incidence, classification, management, and outcome,” *Circulation*, vol. 90, no. 6, pp. 2725–2730, 1994.

[6] L. Blichfeldt-Lauridsen and B. D. Hansen, “Anesthesia and myasthenia gravis,” *Acta Anaesthesiologica Scandinavica*, vol. 56, no. 1, pp. 17–22, 2012.

[7] W. Wu, A. Masri, Z. B. Popovic et al., “Long-term survival of patients with radiation heart disease undergoing cardiac surgery: a cohort study,” *Circulation*, vol. 127, no. 14, pp. 1476–1485, 2013.

[8] E. A. Fender, P. Chandrashekar, J. J. Liang et al., “Coronary artery bypass grafting in patients treated with thoracic radiation: a case–control study,” *Open Heart*, vol. 5, no. 1, article e000766, 2018.

[9] F. D. Loop, B. W. Lytle, D. M. Cosgrove et al., “Influence of the internal-mammary–artery graft on 10-year survival and other cardiac events,” *The New England Journal of Medicine*, vol. 314, no. 1, pp. 1–6, 1986.

[10] C. B. Park, R. M. Suri, H. M. Burkhart et al., “Identifying patients at particular risk of injury during repeat sternotomy: analysis of 2555 cardiac reoperations,” *The Journal of Thoracic and Cardiovascular Surgery*, vol. 140, no. 5, pp. 1028–1035, 2010.

[11] P. I. Ellman, R. L. Smith, M. E. Girotti et al., “Cardiac injury during re sternotomy does not affect perioperative mortality,” *Journal of the American College of Surgeons*, vol. 206, no. 5, pp. 993–997, 2008.

[12] A. Lemaire, G. Batsides, S. Saadat et al., “Effect of repeat sternotomy on cardiac surgery outcomes,” *Annals of Surgery and Perioperative Care*, vol. 1, no. 1, p. 1001, 2016, https://austinpublishinggroup.com/annals-surgery/fulltext/aspc-v1-id1001.php.

[13] S. Launcelott, M. Ouzounian, K. J. Buth, and J.-F. Légaré, “Predicting in-hospital mortality after redo cardiac operations: development of a preoperative scorecard,” *The Annals of Thoracic Surgery*, vol. 94, no. 3, pp. 778–784, 2012.

[14] V. Farooq, P. W. Serruys, C. V. Bourantas et al., “Quantification of incomplete revascularization and its association with five-year mortality in the synergy between percutaneous coronary intervention with taxus and cardiac surgery (SYNTAX) trial validation of the residual SYNTAX score,” *Circulation*, vol. 128, no. 2, pp. 141–151, 2013.

[15] ESC Scientific Document Group, “2018 ESC/EACTS guidelines on myocardial revascularization,” *European Heart Journal*, vol. 40, no. 2, pp. 87–165, 2019.

[16] P. A. L. Tonino, B. De Bruyne, N. H. J. Pijs et al., “Fractional flow reserve versus angiography for guiding percutaneous coronary intervention,” *The New England Journal of Medicine*, vol. 360, no. 3, pp. 213–224, 2009.

[17] P. Xaplanteris, S. Fournier, N. H. J. Pijs et al., “Five-year outcomes with PCI guided by fractional flow reserve,” *The New England Journal of Medicine*, vol. 379, no. 3, pp. 250–259, 2018.

[18] E. S. Brilakis, J. A. Grantham, S. Rinfret et al., “A percutaneous treatment algorithm for crossing coronary chronic total occlusions,” *JACC. Cardiovascular Interventions*, vol. 5, no. 4, pp. 367–379, 2012.
[19] S. M. Patel, R. V. Menon, M. N. Burke et al., “Current perspectives and practices on chronic total occlusion percutaneous coronary interventions,” *The Journal of Invasive Cardiology*, vol. 30, no. 2, pp. 43–50, 2018.

[20] W. F. Fearon, “Percutaneous coronary intervention should be guided by fractional flow reserve measurement,” *Circulation*, vol. 129, no. 18, pp. 1860–1870, 2014.

[21] W. F. Fearon, B. De Bruyne, and N. H. J. Pijls, “Fractional flow reserve in acute coronary syndromes,” *Journal of the American College of Cardiology*, vol. 68, no. 11, pp. 1192–1194, 2016.

[22] J. Layland, D. Carrick, M. McEntegart et al., “Vasodilatory capacity of the coronary microcirculation is preserved in selected patients with non-ST-segment-elevation myocardial infarction,” *Circulation. Cardiovascular Interventions*, vol. 6, no. 3, pp. 231–236, 2013.

[23] H. Matsuo and Y. Kawase, “Physiological impact of CTO recanalization assessed by coronary pressure measurement: a case report,” *Catheterization and Cardiovascular Interventions*, vol. 82, no. 4, 2013.

[24] R. Sachdeva, M. Agrawal, S. E. Flynn, G. S. Werner, and B. F. Uretsky, “Reversal of ischemia of donor artery myocardium after recanalization of a chronic total occlusion,” *Catheterization and Cardiovascular Interventions*, vol. 82, no. 4, 2013.