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Percutaneous Coronary Reperfusion (PCI) Strategies in ST- Segment Elevation Myocardial Infarction

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Abstract

Background: Primary PCI of the infarct artery is preferred to fibrinolytic therapy when time-to-treatment delays are short and the patient presents to a high- volume, well-equipped center with experienced interventional cardiologists and skilled support staff. Compared with fibrinolytic therapy, primary PCI produces higher rates of infarct artery patency, TIMI 3 flow, and access site bleeding and lower rates of recurrent ischemia, reinfarction, emergency repeat revascularization procedures, intracranial hemorrhage (ICH), and death.

Keywords: Percutaneous Coronary Reperfusion, ST- Segment Elevation Myocardial Infarction

Introduction

Primary PCI of the infarct artery is preferred to fibrinolytic therapy when time-to-treatment delays are short and the patient presents to a high- volume, well-equipped center with experienced interventional cardiologists and skilled support staff. Compared with fibrinolytic therapy, primary PCI produces higher rates of infarct artery patency, TIMI 3 flow, and access site bleeding and lower rates of recurrent ischemia, reinfarction, emergency repeat revascularization procedures, intracranial hemorrhage (ICH), and death **(1).**

1) Primary PCI:

Primary PCI is defined as percutaneous catheter intervention in the setting of STEMI, without previous fibrinolysis. Primary PCI is the preferred reperfusion strategy in patients with STEMI within 12h of symptom onset, provided it can be performed expeditiously (i.e. 120min from STEMI diagnosis) by an experienced team. Prompt PCI (with a performance goal of ≤90 minutes from the first medical contact) is the preferred approach at PCI-capable hospitals for STEMI with onset of symptoms within the previous 12 hours (ACC–AHA class I recommendation, evidence level A) and for STEMI with cardiogenic shock, regardless of the timing (ACC–AHA class I recommendation, evidence level B) **(2).**

Primary PCI is superior to fibrinolysis in reducing mortality, reinfarction, or stroke **(3,4) .** However, in some circumstances, primary PCI is not an immediate option and fibrinolysis could be initiated expeditiously. The extent to which the PCI-related time delay diminishes the advantages of PCI over fibrinolysis has been widely debated.

A) Table (1): Indications of primary PCI for myocardial reperfusion in STEMI modified from "2018 ESC/EACTS Guidelines on myocardial revascularization''

Recommendations			**Ref**
Reperfusion therapy is indicated in all patients with symptoms of ischaemia of<_12h duration and persistent ST-segment elevation.			**(5)**
A primary PCI strategy is recommended over fibrinolysis within indicated timeframes.			**(1)**
In patients with time from symptom onset >12h, a primary PCI strategy is indicated in the presence of ongoing symptoms suggestive of ischaemia, haemodynamic instability, or life-threatening arrhythmias.			**(6)**
In the absence of ST-segment elevation, a primary PCI strategy is indicated in patients with suspected ongoing ischaemic symptoms suggestive of MI and at least one of the following criteria present: haemodynamic instability or cardiogenic shock recurrent or ongoing chest pain refractory to medical treatment – life-threatening arrhythmias or cardiac arrest mechanical complications of MI acute heart failure recurrent dynamic ST-segment or Twave changes, particularly with intermittent ST-segment elevation.			
A routine primary PCI strategy should be considered in patients presenting late (12–48h) after symptom onset.			**(7,8)**

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 07, 2021

B) Access route:

Trans- radial intervention. Compared with traditional trans- femoral intervention (TFI), trans- radial intervention (TRI) is less invasive and has proved to be a safer approach in emergency PCI for ACS **(9,10)**.

With TRI, access to the occluded coronary artery is gained through the radial artery, which is a smaller artery than the femoral artery that is used with TFI. The smaller size of the radial artery compared with the femoral artery and the superficial location at the hand wrist with good possibility of manual compression are associated with lower bleeding risk.

TRI was demonstrated to be superior to TFI in terms of reducing not only bleeding complications, particularly access site bleeding, but also mortality in the MATRIX trial and in a meta- analysis **(10)**.

The current European clinical guidelines recommend trans- radial access for PCI in ACS as class Ia (as a general rule, the numeral in the class of recommendation indicates the strength of the recommendation (the lower the numeral the higher the strength), and the letter indicates the quality of the supporting evidence (from strongest to weakest) **(11).**

c) Stenting in primary percutaneous interventionnew generation drug- eluting stents.

Stent implantation for the culprit lesion in STEMI during primary PCI is the recommended treatment (class Ia recommendation) **(11)**

O'Gara et al., (2). Compared with balloon angioplasty alone, PCI with bare- metal stent implantation decreased the risk of reinfarction and subsequent target vessel revascularization (that is, the need for a recurrent revascularization with PCI or CABG surgery of the initially treated vessel), although there was no significant mortality benefit **(12).**

First- generation drug- eluting stents (DESs) are coated with an antiproliferative agent (such as everolimus) and reduced the risk of repeat coronary revascularization even further **(13)**.

Newer- generation DESs have several improvements compared with first- generation DESs, such as thinner stent struts and biocompatible polymers, potentially reducing the risk of stent thrombosis. In the EXAMINATION trial, second- generation everolimus-eluting stents with durable, biocompatible acrylic and fluorinated copolymer showed significantly lower rates of repeat target vessel revascularization and stent thrombosis than bare- metal stents **(14).**

D) Aspiration thrombectomy and distal protection device.

Aspiration thrombectomy is a procedure in which the thrombus in the culprit lesion is aspirated and removed through the guiding catheter. However, large- scale clinical trials

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evaluating the efficacy of PCI with aspiration thrombectomy reported no clinical benefits compared with primary PCI alone **(9).**

Furthermore, in the TOTAL trial, routine aspiration thrombectomy was associated with an increased rate of stroke within 30 days **(9)**. On the basis of these results, routine aspiration thrombectomy during primary PCI is not recommended in the clinical guidelines **(11,15).**

Distal protection devices are used to capture debris from the atherosclerotic plaques and thrombi to prevent distal embolization and no- reflow phenomenon during PCI, but there is no strong evidence supporting their routine use during primary PCI. However, these devices might be beneficial in selective situations, such as large thrombus burden.

E) Multivessel coronary revascularization

Multivessel disease is common (in approximately 50%) in patients with STEMI. **(16)**

Complete revascularisation including severely stenosed non-infarct vessels at the time of primary PCI is a class IIb recommendation in the ACC/AHA primary PCI guidelines**. (15)**

Staged revascularisation of non-culprit lesions following STEMI is a class IIa recommendation in the ESC guidelines **(17).**

Revascularization of non-IRA lesions should be considered in STEMI patients with multivessel disease before hospital discharge.

As the optimal timing of revascularization (immediate vs. staged) has not been adequately investigated, no recommendation in favour of immediate vs. staged multivessel PCI can be formulated.

Follow-up stress testing is not routinely indicated after PCI for myocardial infarction, it is reasonable in patients with unrevascularised non-culprit lesions, or recurrent ischaemic symptoms despite PCI.

SYNTAX score

Risk stratification for PCI is a relatively young field of interest, fueled in recent years by the introduction of several specific risk models and scores.

The SYNTAX (Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery) score (SxS) has been developed as a comprehensive angiographic scoring system for the prospective quantification of coronary lesions with respect to their number, location, and complexity **(18).**

In addition, the SxS is a good predictor of adverse cardiovascular events including cardiac death, myocardial infarction (MI) and target lesion revascularisation in multi-vessel diseases treated with percutaneous coronary intervention (PCI) or surgery **(10)**.

According to ESC guidelines

SYNTAX score has been given a class I, and 3 scores (Logistic Clinical SYNTAX score, SYNTAX score II, and ACCF and STS Database Collaboration on the Comparative

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 07, 2021

Effectiveness of Revascularization Strategies [ASCERT] PCI) have been given a class IIa degree of recommendation for assessing the risk of medium- to long-term (1 year) outcomes.

With more than 50 validation studies, the SYNTAX score is the most-studied risk model in the setting of PCI.

Decision-making between surgery and percutaneous based revascularisation strategies in complex CAD has historically remained difficult **(19).** To aid this process, European revascularisation guidelines currently advocate a multidisciplinary "Heart-Team" approach – consisting of at least a cardiologist and cardiac surgeon – and clinical tools, such as the anatomical SYNTAX Score and SYNTAX Score II, to objectively quantify CAD burden and clinical co-morbidity **(17).**

SYNTAX Score I (Anatomical SYNTAX Score)

The anatomical SYNTAX Score was developed during the design of the SYNTAX Trial as a tool to force the interventional cardiologist and cardiac surgeon to systematically analyse the coronary angiogram and to specify the number of coronary lesions requiring treatment, their angiographic location and anatomical complexity **(20).**

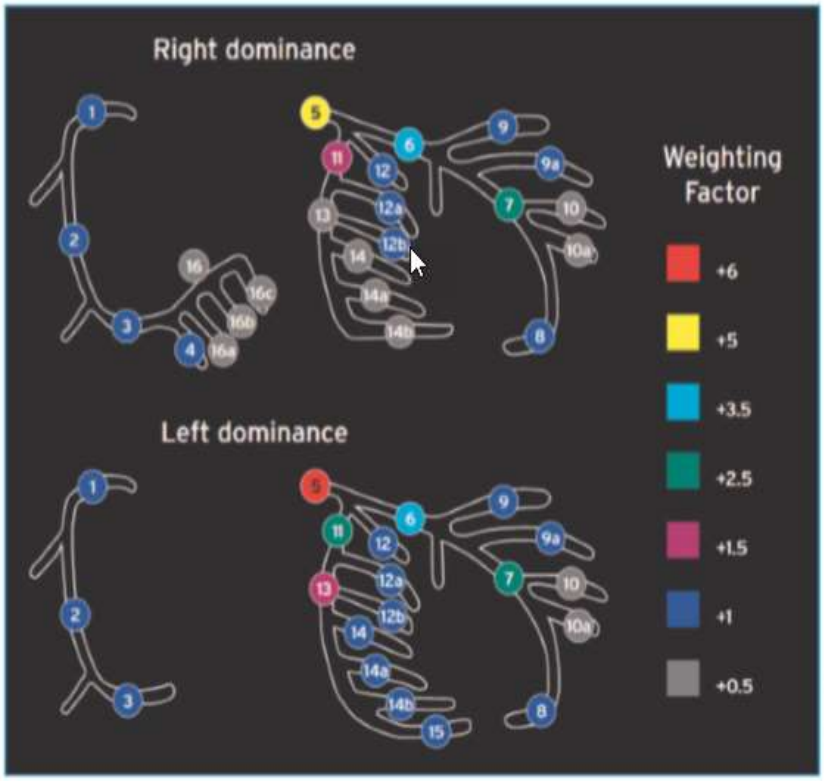
The anatomical SYNTAX Score combines the importance of a diseased coronary artery segment in terms of its severity (i.e., obstructive or occlusive), anatomical location and importance in supplying blood to the myocardium ('vessel-segment weighting' based on the Leaman Score) **(21),** adverse characteristics of the coronary lesion for revascularisation (ACC/AHA lesion classification) **(22)**

the Medina Classification System for bifurcation lesions, **(23)** and total occlusion characteristics from the European TOTAL Surveillance Study **(24).**

It is calculated by a computer program consisting of sequential and interactive self-guided questions. SYNTAX score is categorized to detect patients at low (≤22), intermediate (23 to 32), and high risk (≥33) **(18)**.

Table (2): Guide for calculating the SYNTAX score according to 2018 ESC/EACTS Guidelines on myocardial revascularization

Steps	Variable assessed	Description
Step 1	**Dominance**	The weight of individual coronary segments varies according to coronary artery dominance (right or left). Codominance does not exist as an option in the SYNTAX score

Step 2	**Coronary segment**	The diseased coronary segment directly affects the score as each coronary segment is assigned a weight depending on its location, ranging from 0.5 (i.e. the posterolateral branch) to 6 (i.e. left main in case of left dominance). 
Step 3	**Diameter stenosis**	The score of each diseased coronary segment is multiplied by two in case of a stenosis 50–99% and by five in case of total occlusion. In case of total occlusion, additional points will be added as follows: • Age >3 months or unknown +1 • Blunt stump +1 • Bridging +1 • First segment visible distally +1 per non-visible segment • Side branch at the occlusion +1 if <1.5 mm diameter +1 if both <1.5 mm and >_1.5 mm diameter +0 if >_1.5 mm diameter (i.e. bifurcation lesion)

ISSN: 0975-3583, 0976-2833 VOL 12, ISSUE 07, 2021

Step 4	**Trifurcation lesion**	The presence of a trifurcation lesion adds additional points based on the number of diseased segments: ●1 segment +3 ●2 segments +4 ●3 segments +5 ●4 segments +6
	Bifurcation lesion	The presence of a bifurcation lesion adds additional points based on the type of bifurcation according to the Medina classification:126 • Medina 1,0,0–0,1,0–1,1,0 +1 • Medina 1,1,1–0,0,1–1,0,1–0,1,1 +2 Moreover, the presence of a bifurcation angle <70——— adds one additional point
	Aorto-ostial lesion	The presence of aorto-ostial lesion segments adds one additional point
	Severe tortuosity	The presence of severe tortuosity proximal of the diseased segment adds two additional points
	Lesion length	Lesion length >20 mm adds one additional point
	Calcification	The presence of heavy calcification adds two additional points
0	**Thrombus**	The presence of thrombus adds one additional point
1	**Diffuse disease/ small vessels**	The presence of diffusely diseased and narrowed segments distal to the lesion (i.e. when at least 75% of the length of the segment distal to the lesion has a vessel diameter <2 mm) adds one point per segment number.

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