

# Predictors of Adverse Outcome following Percutaneous Coronary Intervention

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## Abstract:

**Key words:**  
Predictors of  
coronary  
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Coronary artery  
disease

Day by day with the experiences and advancement in technology angioplasty has become more refined with higher rate of success and lower rate of complications. In spite of these there remain some of adverse outcomes following procedure. To minimize procedural complications and adversities were looked for evaluation of high risk features. Percutaneous coronary intervention related mortality is directly related to the episode of coronary artery occlusion and is associated with pronounced left ventricular failure. The variables associated with increased mortality include type C lesion, advanced age, female gender, diabetes, ST segment elevated myocardial infarction, prior myocardial infarction, multivessel disease, left main or equivalent coronary disease, a large area of myocardium at risk, pre-existing impairment of left ventricular or renal function, post-percutaneous coronary intervention worsening of renal function, and collateral vessels supplying significant areas of myocardium that originate distal to the segment to be dilated.

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## Introduction:

Coronary angioplasty was first introduced by Andreas Gruentzig in 1977 as a non-surgical method for coronary arterial revascularization.<sup>1</sup> Now coronary angioplasty could be applied to broad group of coronary artery disease patients with success compared to initial experience.<sup>2,3</sup> Angiographic success occurs in over 95% of patients.<sup>4</sup> Percutaneous coronary intervention now includes other new techniques capable of relieving coronary narrowing including implantation of intracoronary stents, rotational atherectomy, directional atherectomy, extraction atherectomy, laser angioplasty and other catheter devices for treating coronary atherosclerosis.

During recent years, numerous clinical and procedural risk factors for adverse outcome after percutaneous coronary intervention have been identified. In the majority of patients undergoing elective percutaneous coronary intervention, death is directly related to the occurrence of coronary artery occlusion and is most frequently associated with pronounced left ventricular failure.<sup>5,6</sup> The clinical and angiographic variables associated with increased mortality include advanced age, female gender, diabetes, recent myocardial infarction, multivessel disease, cardiogenic shock, emergency percutaneous coronary intervention,

peripheral vascular disease, left main or equivalent coronary disease, a large area of myocardium at risk, pre-existing impairment of left ventricular or renal function, post-percutaneous coronary intervention worsening of renal function, AHA/ACC type C lesion and collateral vessels supplying significant areas of myocardium that originate distal to the segment to be dilated.<sup>5,7,8,9,10,11,12</sup> Peri-procedural stroke also increases in-hospital and 1-year mortality<sup>13</sup>. Percutaneous coronary intervention in the setting of ST segment elevation myocardial infarction is associated with a significantly higher death rate than is seen in elective percutaneous coronary intervention.

As the scope of percutaneous coronary intervention broadens and the complexity of cases increases, there is a pressing need to quantify individual risk to alert both the patient and the cardiologist to the likelihood of an adverse outcome. It also relieves undue anxiety for low risk patients and undue reassurance for high risk patients. In this review article we discussed the factors which influence adverse outcome of percutaneous coronary intervention.

## Lesion Morphology:

Diffuse (length greater than 2 cm) lesion, excessive tortuosity of proximal segment, extremely angulated (greater than 90°) segments, total occlusions more

than 3 months old and/or bridging collaterals, inability to protect major side branches, degenerated vein grafts with friable lesions are high-risk lesion (type C lesion) for percutaneous coronary intervention. Complex coronary lesions remain predictive of adverse events after percutaneous coronary intervention. The risk of restenosis and technical failure remains high for chronic total occlusions.

More simplified committee of the Society for Cardiac Angiography and Intervention (SCAI) lesion classification provided better discrimination for success and complications.<sup>14</sup>

Type I lesions (highest success expected, lowest risk)

- (1) Does not meet criteria for C lesion.
- (2) Patent

Type II lesions

- (1) Meets any of these criteria for C lesion  
Diffuse (greater than 2 cm length) excessive tortuosity of proximal segment extremely angulated segments greater than 90°, inability to protect major side branches degenerated vein grafts with friable lesions.
- (2) Patent

Type III lesions

- (1) Does not meet criteria for C lesion.
- (2) Occluded

Type IV lesions

- (1) Meets any of the criteria for C lesion includes diffuse (greater than 2 cm length), excessive tortuosity of proximal segment, extremely angulated segments greater than 90°, inability to protect major side branches, degenerated vein grafts with friable lesions and occluded for more than 3 months.
- (2) Occluded

#### **Clinical and biochemical factors:**

Several studies have reported specific factors associated with increased risk of adverse outcome after percutaneous translumina coronary angioplasty. These factors include advanced age, female gender, unstable angina, congestive heart failure, diabetes, and multivessel coronary artery disease.<sup>7,9,10,15</sup> Elevated baseline C-reactive protein has recently also been shown to be predictive of 30-day death and myocardial infraction.<sup>15</sup> Other markers of inflammation, such as interleukin-6 and other cytokines, have also been shown to be

predictive of outcome.<sup>16</sup> The bypass angioplasty revascularization investigation (BARI) trial found that patients with diabetes and multivessel coronary artery disease had an increased peri procedural risk of ischemia and increased 5-year mortality. Patients with impaired renal function, especially those with diabetes, are at increased risk for contrast nephropathy and increased 30-day and 1-year mortality. Renal insufficiency is a strong predictor of outcome in both primary and elective percutaneous coronary intervention. Increased risk for death or severe compromise in LV function may occur in association with a complication involving a vessel that also supplies collateral flow to viable myocardium.

Composite 4-variable scoring system, in predicting cardiovascular collapse for failed percutaneous translumina coronary angioplasty, which includes: 1) percentage of myocardium at risk (e.g., greater than 50% viable myocardium at risk and left ventricular ejection fraction of less than 25%), 2) pre-angioplasty percent diameter stenosis, 3) multivessel coronary artery disease, and 4) diffuse disease in the dilated segment or a high myocardial jeopardy score. Patients with higher pre-procedural jeopardy scores were shown to have a greater likelihood of cardiovascular collapse when abrupt vessel closure occurred during percutaneous translumina coronary angioplasty.<sup>5</sup>

#### **Left main coronary artery disease:**

Coronary artery bypass graft has long been considered the “gold standard” for revascularization of lesions in the unprotected left main coronary artery.<sup>17</sup> Stenting of the unprotected left main is feasible with unacceptably high incidence of long-term adverse events in the pre- drug eluting stent era.<sup>18,19</sup> This may be attributed to the inclusion of high risk patients, such as those not considered good surgical candidates.

In general, younger patients with preserved left ventricular function, noncalcified coronary arteries, and complete delivery of stent shows fairly better outcome.

Coronary artery bypass graft using internal mammary artery grafting is the “gold standard” for treatment of unprotected left main disease and has proven benefit on long-term outcomes. The use of drug eluting stent has shown encouraging short

term outcomes, but long term follow-up is needed. Percutaneous coronary intervention for patients with significant unprotected left main stenosis, can improve cardiovascular outcomes and is a reasonable revascularization strategy in carefully selected patients who are not suitable for coronary artery bypass graft.

#### **Women:**

Early reports of patients undergoing percutaneous transluminal coronary angioplasty revealed a lower procedural success rate in women.<sup>20</sup> In several large scale registries, in-hospital mortality is significantly higher in women.<sup>21</sup> The higher incidence of vascular complications, coronary dissection, and perforation in women undergoing coronary intervention has been attributed to the smaller vasculature in women than in men. It has also been postulated that the volume shifts and periods of transient ischemia during percutaneous transluminal coronary angioplasty are less well tolerated by the hypertrophied ventricle in women.<sup>22</sup>

Women continue to have increased bleeding and vascular complications compared with men, but these rates have decreased with the use of smaller sheath sizes and early sheath removal, weight-adjusted heparin dosing, and less aggressive anticoagulation regimens<sup>23</sup>. In bypass angioplasty revascularization investigation (BARI) trial women had a higher incidence of per procedural heart failure and pulmonary edema.<sup>24</sup>

Directional coronary atherectomy has been associated with lower procedural success and higher bleeding complications in women.<sup>25</sup>

#### **Elderly patients:**

Over 75 years age interventional procedures are associated with increased risk of complications<sup>26,27</sup>. Octogenarians undergoing percutaneous coronary intervention have a higher incidence of prior myocardial infarction, lower left ventricular ejection fraction, and more frequent HF.<sup>28,29</sup> In the stent era, procedural success and restenosis rates are comparable to those for nonoctogenarians, although with higher incidences being reported for in-hospital and long-term mortality and for vascular and bleeding complications.<sup>30</sup> There was a significant major bleeding rate in patients aged 75 years or older assigned to an invasive strategy.<sup>31</sup> The

incidence of stroke and major bleeding was also increased in the elderly at 1 year. Higher incidence of comorbidities and risk for bleeding complications should be taken into account when considering the need for percutaneous coronary intervention in elderly.<sup>32</sup>

#### **Diabetes Mellitus:**

An early invasive strategy after fibrinolysis was of little benefit in patients with diabetes.<sup>33</sup> One year mortality and repeat revascularization were significantly higher in diabetics.<sup>34</sup> Routine catheterization and percutaneous coronary intervention in patient with diabetes should be based on clinical need and ischemic risk stratification.

Stenting decreases the need for target vessel revascularization in diabetic patients compared with plain percutaneous transluminal coronary angioplasty.<sup>35</sup> The combination of stenting and use of abciximab in diabetics resulted in a significant reduction in 6-month rates of death and target vessel revascularization.<sup>36</sup>

Repeat revascularization was higher in the patients with diabetes. Drug eluting stent is superior over bare metal stent in terms of reducing late repeat revascularization.<sup>37</sup>

#### **Patients with Coronary Artery Bypass Surgery:**

Percutaneous coronary intervention of native vessels after prior coronary artery bypass graft have, in recent years, nearly equivalent interventional outcomes and complication rates compared with patients having similar interventions without prior surgery. For percutaneous coronary intervention of saphenous vein graft, studies indicate that the rate of successful angioplasty exceeds 90%, the death rate is less than 1.2%, and the rate of Q-wave myocardial infarction is less than 2.5%.<sup>38,39</sup> The incidence of non Q-wave myocardial infarction may be higher than that associated with native coronary arteries.<sup>40</sup>

In consideration of percutaneous coronary intervention for saphenous vein graft, the age of the saphenous vein graft and duration and severity of myocardial ischemia should be taken into consideration. The native vessels should be treated with percutaneous coronary intervention if feasible.

In some circumstances, percutaneous coronary intervention of a protected left main coronary artery stenosis with a patent and functional left anterior descending or left circumflex coronary conduit can be considered. Percutaneous coronary intervention should be recognized as a palliative procedure with the potential to delay the ultimate application of repeat coronary artery bypass graft surgery.

**Type of percutaneous coronary intervention:**

Primary percutaneous coronary intervention achieved modest reduction in overall mortality, need highly experienced team. Life threatening complications of elective percutaneous coronary intervention are fortunately rare. Facilitated percutaneous coronary intervention has added cost and increased risk of bleeding, may be helpful for high risk patients where percutaneous coronary intervention is not immediately available. Rescue percutaneous coronary intervention improved survival but failed to improve microcirculation. Use of antiplatelet therapy before and after procedure depends on type of stent, type of procedure and type of percutaneous coronary intervention.<sup>41</sup>

**Methods of percutaneous coronary intervention:**

Certain outcomes of percutaneous coronary intervention may be specifically related to the technology utilized for coronary recanalization. Periprocedural CK-MB elevation occurs more frequently after ablative technology such as rotational or directional atherectomy.<sup>42</sup> Antecedent unstable angina appears to be a clinical predictor of slow flow and periprocedural infarction after ablative technologies,<sup>43</sup> and direct platelet activation has been demonstrated to occur with both directional and rotational atherectomy.<sup>44</sup>

Coronary perforation may occur more commonly after the use of atheroablative devices, including rotational, directional, or extraction atherectomy, and excimer laser coronary angioplasty. However, the incidence of perforation has been reported variably to be 0.10% to 1.14% with balloon angioplasty, 0.25% to 0.70% with directional coronary atherectomy, 0.0% to 1.3% with rotational atherectomy, 1.3% to 2.1% with extraction atherectomy, and 1.9% to 2.0% after excimer laser coronary angioplasty.<sup>45,46</sup> Coronary perforation complicates percutaneous coronary intervention

more frequently in the elderly and in women. Although 20% of perforations may be secondary to the coronary guidewire, most are related to the specific technology used.

Major adverse cardiac events (MACE) rates are reduced with the use of distal protection devices especially for interventions on saphenous vein grafts.<sup>47</sup> Drug eluting bare metal stents can be used as an alternative to bare metal stents in those lesion subsets where randomized control trials have shown benefit from this technology.<sup>47</sup>

**Hemodynamic compromise:**

Hemodynamic compromise, defined as a decrease in systolic blood pressure to an absolute level less than 90 mm Hg during balloon inflation, was often associated with left ventricular ejection fraction less than 35%, greater than 50% of myocardium at risk, and percutaneous transluminal coronary angioplasty performed on the last remaining vessel.<sup>45</sup>

Cardiopulmonary support should be reserved only for patients at the extreme end of the spectrum of hemodynamic compromise, such as those patients with extremely depressed left ventricular function and patients in cardiogenic shock. However, in patients with borderline hemodynamics, ongoing ischemia, or cardiogenic shock, insertion of an intra-aortic balloon just before coronary instrumentation has been associated with improved outcomes.<sup>48,49</sup>

In patients having a higher-risk profile (such as those with left ventricular dysfunction, single patent vessel or unprotected left main, degenerated saphenous vein graft, or high thrombus burden in the obstructed vessel), consideration of alternative therapies, particularly coronary bypass surgery, formalized surgical standby, or periprocedural hemodynamic support should be addressed before proceeding with percutaneous coronary intervention. Several small retrospective studies have evaluated the use of elective balloon pump support before high-risk percutaneous coronary intervention shows successful reperfusion by percutaneous coronary intervention, with improved procedural or in-hospital morbidity and mortality.<sup>48,50,51</sup>

**Conclusion:**

Coronary angioplasty is a non-surgical technique for coronary arterial revascularization. With the experiences and advanced technology now a days angioplasty has become more developed. Coronary



angioplasty could be applied to broad group of coronary patients with higher rate of success and lower rate of complications. For the patients of percutaneous coronary intervention, variables influencing complications and outcome should be assessed to determine procedural risk, the risk of abrupt vessel closure, and potential for cardiovascular collapse. The clinical and angiographic variables associated with increased mortality need under consideration, include type C lesion, advanced age, female gender, diabetes, prior myocardial infarction, previous coronary artery bypass graft, multivessel disease, left main or equivalent coronary disease, a large area of myocardium at risk, pre-existing impairment of left ventricular or renal function and percutaneous coronary intervention in the setting of ST segment elevation myocardial infarction. For successful percutaneous coronary intervention need careful evaluation of patients and consider factors which may influence procedure adversely.

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Conflict of Interest - None.

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