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Compendium of STEMI Clinical Trials
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Introduction
As we constructed our fourth textbook of interventions for ST-elevation myocardial infarction (STEMI), the need for including a chapter on clinical trials was paramount. To provide a complete compendium of relevant STEMI guidelines and clinical trials, two distinct chapters have been created. We recognize that this information is easily obtained from searching the internet; however, we deemed it important to present in this book the most up-to-date guidelines and clinical trials. In this chapter, we have divided the trials into stents (Table 1.1), no-reflow (Table 1.2), thrombectomy (Table 1.3), percutaneous coronary interventions for non-culprit lesions (Table 1.4), and the role of left ventricular support devices (Table 1.5). In Chapter 2, we have separated out those guidelines from the American College of Cardiology and the European Society of Cardiology. These topics are discussed further in various chapters of the textbook. However, we firmly believe that a compendium of guidelines and clinical trials will provide a useful summary of these STEMI-related studies.
SES and PES are safe and associated with significant benefits in terms of TLR up to 4 years of follow-up, compared with BMS. PES and SES were associated with significant reduction in TLR at 1 year. No difference was observed in terms of death and reinfarction.

**Table 1.1 Which stent is most desirable for STEMI interventions?**

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<td>COBALT: long-term clinical outcome of thin-strut CoCr stents in the DES era [1].</td>
<td>To assess characteristics and outcomes of patients treated with 2 different new-generation CoCr BMS, the MULTI-LINK VISION® and PRO-Kinetic Energy® stents.</td>
<td>1176 patients: MLV (n = 438); PRO-Kinetic (n = 738).</td>
<td>TLR and TVR were lower in the MLV group. Death, MI, ARC and definite stent thrombosis were similar.</td>
<td>The use of last-generation thin-strut BMS in selected patients is associated with acceptable clinical outcome, with similar clinical results for both the MLV and PRO-Kinetic stents.</td>
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<td>Comparison of newer-generation DES with BMS in patients with acute STEMI [2].</td>
<td>Efficacy and safety of newer-generation DES compared with BMS in patients with STEMI.</td>
<td>2665 STEMI patients: 1326 received a new-generation DES (EES or biolimus A9 eluting stent) and 1329 received BMS.</td>
<td>Newer-generation DES substantially reduced the risk of repeat TVR, target-vessel infarction, definite stent thrombosis compared with BMS at 1 year.</td>
<td>Newer-generation DES improves safety and efficacy compared with BMS throughout 1st year.</td>
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<td>Meta-analysis of long-term outcomes for DES compared with BMS in PCI for STEMI [3].</td>
<td>Available literature examining the outcomes of DES and BMS in PCI after &gt;3 years of follow-up.</td>
<td>8 RCTs and 5 observational studies. 5797 patients in whom 1st-generation DES (SES or PES) were compared with BMS control arms.</td>
<td>Patients with DES had lower risk of TLR, TVR, and MACE. Incidence of stent thrombosis equal between groups. No difference in mortality or recurrent MI. Those receiving DES had lower mortality.</td>
<td>DES use resulted in decreased repeat revascularization with no increase in stent thrombosis, mortality, or recurrent MI.</td>
</tr>
<tr>
<td>Outcomes with various DES or BMS in patients with STEMI [4].</td>
<td>Efficacy (TVR) and safety (death, MI, and stent thrombosis) outcomes at the longest reported follow-up times with DES compared with BMS.</td>
<td>28 randomized clinical trials; 34,068 patients comparing any DES against each other or BMS.</td>
<td>No increase in the risk of death, MI, or stent thrombosis with any DES compared with BMS. EES was associated with a statistically significant reduction in the rate of stent thrombosis when compared with SES, PES, and even BMS.</td>
<td>DES versus BMS was associated with substantial decrease in the risk of TVR. EES had substantial reduction in the risk of stent thrombosis with no increase in very late stent thrombosis.</td>
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<tr>
<td>Benefits of DES compared with BMS in STEMI: 4-year results of PES or SES vs. BMS in primary angioplasty (PASEO) randomized trial [5].</td>
<td>To evaluate the short and long-term benefits of SES and PES vs. BMS in patients undergoing primary angioplasty.</td>
<td>270 patients with STEMI were randomized to BMS (n = 90), PES (n = 90), or SES (n = 90).</td>
<td>PES and SES were associated with significant reduction in TLR at 1 year. No difference was observed in terms of death and reinfarction.</td>
<td>SES and PES are safe and associated with significant benefits in terms of TLR up to 4 years of follow-up, compared with BMS.</td>
</tr>
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**PPCI for AMI: long-term outcome after BMS and DES implantation** [6].

Safety and efficacy outcomes of first- and second-generation durable polymer DES and biodegradable polymer BES in clinical practice: comprehensive network meta-analysis [7].

**EXAMINATION trial (EES Versus BMS in STEMI):** 2-year results from a multicenter randomized controlled trial [8].

2-year outcomes after first- or second-generation DES or BMS implantation in patients undergoing PCI. A pre-specified analysis from the PRODIGY study [9].

**New DES for STEMI: A new paradigm for safety** [10].

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To investigate the long-term outcomes of unselected patients undergoing PPCI with BMS and DES.

1738 patients undergoing PPCI for a new lesion. 3 cohorts of BMS (n = 531), SES (n = 185) or PES (n = 1022).

No differences in all-cause mortality or repeat revascularization between DES and BMS. SES was associated with lower rates of all-cause death, nonfatal MI, or TVR compared with PES. Very late stent thrombosis only occurred in the DES groups.

DES are not associated with an increase in adverse events compared with BMS when used for PPCI, neither DES reduced repeat revascularizations.

The newer durable polymer EES and EZES and the BP-BES maintain the efficacy of SES. EES and EZES are the safest stents to date.

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To investigate the safety and efficacy of durable polymer DES and biodegradable polymer BES.

60 randomized controlled trials were compared, which involved 63,242 patients treated with DES.

At 1 year, there were no differences in mortality. Resolute and EZES, EES and SES were associated with reduced odds of MI compared with PES. Compared with EES, BP-BES were associated with increased odds of MI, while EZES and PES were associated with increased odds of ST. EES and EZES offering the highest safety profiles.

Both rates of TLR and stent thrombosis were reduced in recipients of EES.

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To evaluate the outcomes of the population included in the EXAMINATION trial.

1498 patients were randomized to receive EES (n = 751) or BMS (n = 747).

Rate of TLR, definite or probable stent thrombosis was significantly lower in EES group than in BMS group.

MACE rate was lowest in EES, highest in BMS, and intermediate in PES and ZESS. The 2-year incidence of stent thrombosis in the EES group was similar to that in ZESS group, but lower compared with PES and BMS groups.

MACE rate was lowest for EES, highest for BMS, and intermediate for PES and ZESS groups. EES outperformed BMS with safety endpoints and stent thrombosis.

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To assess device-specific outcomes with respect to the occurrence of MACE, after implantation of BMS, ZESS, PES, or EES in patients undergoing PCI.

2013 randomized patients undergoing CA in a 1:1:1:1 fashion to BMS, ZESS, PES, or EES implantation.

At 2 years, new-generation DES had lower mortality, similar reinfarction, and fewer stent thromboses compared with BMS; and similar mortality, similar reinfarction, and trends for fewer stent thromboses compared with early-generation DES.

New-generation DES in STEMI patients have fewer stent thromboses compared with BMS and trends for fewer stent thromboses compared with early-generation DES.

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<td>Safety and effectiveness of DES in patients with STEMI undergoing primary angioplasty [11].</td>
<td>To confirm the safety and effectiveness of DES in patients with STEMI.</td>
<td>370 patients (120 in DES group and 250 in BMS group) with STEMI treated with primary PCI. Patients were retrospectively followed for the occurrence of MACE.</td>
<td>There was no difference in rate of stent thrombosis in the BMS group. Incidence of MACE was lower in the DES group principally due to the lower rate of TVR.</td>
<td>Use of DES in the PPCI for STEMI was safe and improved the 3-year clinical outcome compared with BMS, reducing the need of TVR.</td>
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<td>Outcomes with DES vs. BMS in acute STEMI results from the Strategic Transcatheter Evaluation of New Therapies Group [12].</td>
<td>To evaluate the outcomes with DES compared with BMS in patients undergoing PPCI for STEMI.</td>
<td>Patients with STEMI treated with either a DES (1292 patients) or BMS (548 patients). Of those treated with DES, 46% were treated with SES and 54% with PES.</td>
<td>There were no differences between DES and BMS in death, reinfarction, or MACE. DES had lower rates of stent thrombosis and lower rates of TVR. There was a mild increase in stent thrombosis with DES versus BMS from 1-2 years.</td>
<td>DES used with PPCI for STEMI is more effective than BMS in reducing TVR and is safe for up to 2 years.</td>
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<tr>
<td>Clinical outcomes with BP-BES vs. DP-DES and BMS: evidence from a comprehensive network meta-analysis [13].</td>
<td>Safety and efficacy of BP-BES versus DP-DES and BMS.</td>
<td>Data from 89 trials including 85,490 patients. 1-year follow-up.</td>
<td>BP-BES was associated with lower rates of cardiac death/MI and TVR than BMS and lower rates of TVR than fast-release Z-ES. BP-BES had similar rates of cardiac death, MI, and TVR compared with other second-generation DP-DES but higher rates of 1-year stent thrombosis than CoCr EES. BP-BES was associated with improved late outcomes compared with BMS and PES, with different outcomes compared with other DP-DES, although higher rates of definite stent thrombosis compared with CoCr EES.</td>
<td>BP-BES was associated with superior clinical outcomes compared with BMS and first-generation DES and similar rates of cardiac death/MI, MI, and TVR compared with second-generation DP-DES but higher rates of definite stent thrombosis than CoCr EES.</td>
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<tr>
<td>DES vs. BMS in primary angioplasty. A pooled patient-level meta-analysis of randomized trials [14].</td>
<td>Evaluated the risks and benefits of DES compared with BMS in patients undergoing PPCI for STEMI.</td>
<td>6298 patients were randomized; 3980 assigned to DES and 2318 assigned to BMS.</td>
<td>DES implantation reduced the occurrence of TVR with no difference in mortality, reinfarction, and stent thrombosis. DES implantation was associated with an increased risk of very late stent thrombosis and reinfarction.</td>
<td>SES and PES compared with BMS are associated with TVR reduction at long-term follow-up. The incidence of very late reinfarction and stent thrombosis was increased with DES.</td>
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</table>
First results of the DEB-AMI trial. A multicenter randomized comparison of DEB plus BMS vs. BMS vs. DES in PPCI, With 6-month angiographic, intravenous, functional, and clinical outcomes [15].

DES vs. BMS in STEMI at a follow-up of 3 years or longer: A meta-analysis of randomized trials [16].

Clinical outcomes with DES and BMS in Patients with STEMI: Evidence from a comprehensive network meta-analysis [17].

Long-term outcome after DES vs. BMS implantation in patients with STEMI: 5-year follow-up from the randomized DEDICATION trial [18].

Test the DIOR® DEB combined with a modern CoCr BMS in PPCI with the goal of obtaining improved angiographic results and comparable vessel healing and preserved endothelial function and fewer malapposed stent struts than PES DES. 150 patients were randomized; BMS implantation (group A), vs. sequential DEB (with paclitaxel) dilatation and BMS implantation (group B), and paclitaxel DES implantation (group C).

In groups A, B, and C, respectively, binary restenosis was 26.2%, 28.6%, and 4.7%, and MACE rates were 23.5%, 20%, and 4.1%, respectively.

DES use reduced the odds of TLR and TVR. Patients in DES group experienced MACE less frequently than patients in BMS group, which was driven mainly by the decreased revascularization rate. There were no differences in rates of death or MI.

DES continues to be associated with a lower repeat revascularization rate in patients with STEMI, with a small but significantly increased risk of very late stent thrombosis compared with BMS.

Steady improvements in outcomes have been realized with the evolution from BMS to first- and second-generation DES, with the most favorable safety and efficacy profile thus far demonstrated with CoCr EES.

MACE rate was insignificantly different, but cardiac mortality was higher after DES. Stent thrombosis was the main cause of late cardiac deaths.

6298 patients were randomized; 3980 assigned to DES and 2318 assigned to BMS.

BP-BES was associated with superior clinical outcomes compared with BMS and first-generation DES and similar rates of cardiac death/MI, MI, and TVR compared with second-generation DP-DES but higher rates of definite stent thrombosis than CoCr EES.

Evaluated the risks and benefits of DES compared with BMS in patients undergoing PPCI for STEMI.

DES vs. BMS in primary angioplasty. A pooled patient-level meta-analysis of randomized trials [14].

BP-BES was associated with lower rates of cardiac death/MI and TVR than BMS and lower rates of TVR than fast-release ... different outcomes compared with other DP-DES, although higher rates of definite stent thrombosis compared with CoCr EES.

Data from 89 trials including 85,490 patients. 1-year follow-up.

DES used with PPCI for STEMI is more effective than BMS in reducing TVR and is safe for up to 2 years.

Safety and efficacy of BP-BES versus DP-DES and BMS.

Increase in stent thrombosis with DES versus

Clinical outcomes with DES vs. BMS in acute STEMI results from the Strategic Transcatheter Evaluation of New Therapies (Continued)
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<td>5-year follow-up after PPCI with a PES vs. a BMS in acute STEMI: a follow-up study of the PASSION trial [19].</td>
<td>Evaluate the long-term outcomes of the PASSION trial.</td>
<td>619 patients presenting with STEMI were randomized to a PES group or the similar BMS group.</td>
<td>Occurrence of composite of cardiac death, recurrent MI, or TLR was comparable. Incidence of definite or probable stent thrombosis had no differences in the PES group and in the BMS group.</td>
<td>No significant difference in MACE was observed. stent thrombosis was almost exclusively seen after the use of PES.</td>
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<tr>
<td>Effect of BES with biodegradable polymer vs. BMS on cardiovascular events among patients with AMI [20].</td>
<td>To compare BES from a biodegradable polymer with BMS in PPCI.</td>
<td>1161 patients presenting with STEMI were randomized 1:1 to receive BES (n = 575) or BMS (n = 582).</td>
<td>MACE at 1 year occurred in 4.3% of patients receiving BES with biodegradable polymer and 8.7% in those receiving BMS. Difference was driven by a lower risk of TVR and ischemia-driven TLR. Rates of cardiac death and definite stent thrombosis were not different.</td>
<td>Compared with a BMS, use of BES with a biodegradable polymer resulted in a lower rate of MACE at 1 year.</td>
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AMI, acute myocardial infarction; BES, biolimus-eluting stent; BMS, bare-metal stent; BP-BES, bioabsorbable polymer-based biolimus-eluting stent; CoCr, cobalt chromium; DEB, drug-eluting balloon; DES, drug-eluting stent; DP-DES, durable polymer drug-eluting stent; EES, everolimus-eluting stent; EZES, endeavor zotarolimus-eluting stent; MACE, major adverse cardiac events (death from any cause, nonfatal myocardial infarction, or target vessel revascularization); MI, myocardial infarction; MLV, MULTI-LINK VISION™; PCI, percutaneous coronary intervention; PES, paclitaxel-eluting stent; PPCI, primary percutaneous coronary intervention; SES, sirolimus-eluting stent; STEMI, ST-elevation myocardial infarction; TLR, target-lesion revascularization; TVR, target-vessel revascularization; ZESS, zotarolimus-eluting endeavor sprint stent.
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<td>Safety and efficacy of IC adenosine administration in patients with AMI undergoing PPCI: a meta-analysis of randomized controlled trials [21].</td>
<td>Safety and efficacy of IC adenosine in patients with AMI undergoing PPCI.</td>
<td>1030 patients, IC adenosine treatment group (n = 460), placebo group (n = 570).</td>
<td>IC adenosine therapy led to more post-PCI STRes and reduction in residual ST-segment elevation but did not improve TIMI 3 flow, MBG 3, peak CK-MB concentration and post-PCI ejection fraction. Slight trend toward improvement of MACE, incidence of heart failure and cardiovascular mortality but no difference in all-cause mortality.</td>
<td>IC adenosine may be a useful therapy as indicated by improvement in EKG findings. A trend toward improvement was noted in MACE and heart failure events but data are lacking to reach strong conclusions.</td>
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<td>IC versus intravascular bolus abciximab during PPCI in patients with acute STEMI: a randomized trial [22].</td>
<td>Safety and efficacy of IC vs. standard intravascular bolus of abciximab in patients with STEMI undergoing PPCI.</td>
<td>2065 patients, IC abciximab (n = 1032) or intravascular abciximab (n = 1033).</td>
<td>IC, compared with intravascular abciximab, resulted in a similar rate of all-cause mortality, reinfarction or CHF at 90 days. Incidence of all-cause mortality and reinfarction did not differ between the treatment groups. Fewer patients in the IC group had new CHF.</td>
<td>IC compared with intravascular abciximab did not result in a difference in death, reinfarction, or CHF. Since IC abciximab bolus administration is safe and might be related to reduced rates of CHF, the IC route might be preferred.</td>
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<td>IC versus intravascular administration of abciximab in patients with STEMI undergoing PPCI intervention with thrombus aspiration [23].</td>
<td>Discover beneficial effects of IC over intravascular abciximab in patients with STEMI undergoing PPCI and TA.</td>
<td>534 patients, intravascular (n = 263) vs. IC (n = 271) administration of abciximab.</td>
<td>Incidence of complete STRes was similar. Incidence of MBG 2/3 was higher in the IC group. Enzymatic infarct size was smaller in the IC group. Incidence of MACE was similar in both groups.</td>
<td>IC abciximab does not improve myocardial reperfusion as assessed by STRes, but is associated with improved MBG and a smaller enzymatic infarct size.</td>
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<tr>
<td>Adenosine and verapamil for no-reflow during PPCI in people with AMI [24].</td>
<td>Evaluate the evidence related to the use of verapamil or adenosine for no-reflow phenomenon during PPCI.</td>
<td>939 patients; adenosine group (n = 899) verapamil group (n = 40).</td>
<td>No evidence that adenosine reduced short- and long-term all-cause mortality, short-term nonfatal MI or incidence of angiographic no-reflow (TIMI flow grade &lt; 3 after PPCI, and MBG 0 to 1). Incidence of adverse events with adenosine was increased.</td>
<td>No evidence that adenosine and verapamil can reduce all-cause mortality, nonfatal MI or the incidence of angiographic no-reflow, there was evidence of increased adverse events.</td>
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<td>Pexelizumab for acute STEMI in patients undergoing PPCI [25].</td>
<td>Effectiveness of pexelizumab as an adjunct to PCI in improving 30-day mortality from STEMI.</td>
<td>5745 patients. Placebo (n = 2885), pexelizumab group (n = 2860).</td>
<td>No difference in mortality was observed between the pexelizumab and placebo. End points of death, shock, or heart failure were similar.</td>
<td>Mortality was low and unaffected by pexelizumab.</td>
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(Continued)
Pre-procedural IC single high-dose bolus of adenosine does not provide any benefit in terms of periprocedural myonecrosis in patients undergoing elective PCI.

Greater prevalence of calcified lesions was observed in the adenosine group. Greater prevalence of type C lesions, chronic occlusions, worse pre-procedural TIMI flow, and more severely stenotic lesions were observed in the placebo group.

To investigate the benefits of pre-procedural IC administration of high-dose adenosine during elective PCI.

MBG 2/3 occurs in 80% of STEMI patients treated with PPCI and is associated with smaller infarct size, less MVO, improved ejection fraction, and significantly lower 30-day mortality.

STRes >70% occurred more in adenosine-treated patients. Angiographic MVO and MACE occurred less often in adenosine-treated patients.

Verapamil treatment was more effective in decreasing the incidence of no-reflow, CTFC, improving the TMPG and reducing the 30-day WMI. Decreased the incidence of MACE during hospitalization and 2 months after PCI. Verapamil did not provide an additional improvement of LVEF.

Infarct size was significantly lower in patients with MBG 2/3 (n = 367) than in those with MBG 0/1. IC abXimab further reduced infarct size in patients with MBG 2/3 and was associated with a 30% reduction in infarct mass and 90% reduction in MVO. Ejection fraction was higher with MBG 2/3 at 30 days and rate of death was significantly lower.

Pre-procedural IC single high-dose bolus of adenosine does not provide any benefit in terms of periprocedural myonecrosis in patients undergoing elective PCI.
IC fixed dose of NTP via thrombus aspiration catheter for the prevention of the no-reflow phenomenon following PPCI in AMI [30].

New method of IC adenosine injection to prevent MVR injury in patients with AMI undergoing PCI [31].

High-dose IC adenosine for myocardial salvage in patients with acute STEMI [32].

Evaluation of IRA patency and microcirculatory function after facilitated PPCI [33].

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<td>Pre‐catheter administration of abciximab with half-dose reteplase, abciximab alone or with abciximab administered immediately before the procedure.</td>
<td>637 patients; half-dose reteplase + abciximab (n = 213), abciximab alone (n = 222), placebo (n = 202).</td>
<td>Patients in combination‐facilitated group exhibited higher rates of baseline IRA patency compared with abciximab‐facilitated and primary PCI group. There were no differences in the post-PCI corrected TIMI frame count or the rates of post-PCI TIMI flow grade 3 MBG 2/3.</td>
<td>Pre‐catheter administration of abciximab alone and in combination resulted in higher rates of IRA patency at baseline. Post‐procedural angiographic and microcirculatory variables were unaffected.</td>
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<tr>
<td>IC administration of NTP + tirofiban is a safe and superior compared to tirofiban alone for the prevention of no-reflow.</td>
<td>162 patients; NTP + tirofiban (n = 80), tirofiban alone (n = 82).</td>
<td>NTP group had a lower CTFC, higher proportion of complete STRes, enhanced TMPG 2–3 ratio and lower peak CK‐MB value. There were no differences in the final TIMI. LVEF at 6 months was higher in NTP group; incidence of MACE was not different.</td>
<td>IC adenosine administration improved the angiographic and EGK results. Seemed to be associated with a more favorable clinical course.</td>
</tr>
<tr>
<td>To investigate the benefits of pre‐procedural IC administration of high‐dose adenosine during elective PCI.</td>
<td>260 patients; IC adenosine (n = 130), IC placebo (n = 130).</td>
<td>Greater prevalence of calcified lesions was observed in the adenosine group. Greater prevalence of type C lesions, chronic occlusions, worse pre‐procedural TIMI flow, and more severely stenotic lesions were observed in the placebo group.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
</tr>
<tr>
<td>Evaluation of IC adenosine to prevent periprocedural myonecrosis in elective PCI (PREVENT ICARUS) [29].</td>
<td>240 patients; adenosine group (n = 80), saline group (n = 80), NTP group (n = 80).</td>
<td>PCI resulted in TIMI 3 flow after PCI in 91.4% in group 1 and 77.1% in group 2. MBG 3 was observed at the end of PCI in 65.7% and 37.1% respectively. STRes elevation was more frequently observed in group 1.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<td>To compare infarct size measured by MRI in patients with successful (MBG 2/3) vs. unsuccessful (MBG 0/1) microcirculatory reperfusion.</td>
<td>110 patients; MBG 2/3 (n = 36), MBG 0/1 (n = 74).</td>
<td>Infarct size was significantly lower in patients with MBG 2/3 (n = 367) than in those with MBG 0/1. IC abciximab further reduced infarct size in patients with MBG 2/3 and was associated with a 90% reduction in MVO. Ejection fraction was higher with MBG 2/3 at 30 days and rate of death was significantly lower.</td>
<td>There are no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<tr>
<td>To assess whether IC adenosine or NTP following thrombus aspiration is superior to thrombus aspiration alone for the prevention of MVO in STEMI PCI.</td>
<td>213 patients; combination‐facilitated group (n = 110), abciximab alone (n = 70), placebo (n = 33).</td>
<td>There were no significant differences in MSI. Extent of MVO was comparable in both groups, TIMI flow grade, TIMI frame count, MBG, and STRes after PPCI were similar. After 4 months, infarct size was similar in both treatment groups.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<td>Pre‐catheter administration of abciximab alone and in combination resulted in higher rates of baseline IRA patency at baseline. Post‐procedural angiographic and microcirculatory variables were unaffected.</td>
<td>102 patients; group 1 (n = 54), group 2 (n = 58).</td>
<td>No significant difference in MSI was found between groups. Extent of MVO was comparable in both groups, TIMI flow grade, TIMI frame count, MBG, and STRes after PPCI were similar. After 4 months, infarct size was similar in both treatment groups.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<td>High‐dose IC adenosine for myocardial salvage in patients with acute STEMI [32].</td>
<td>110 patients; high‐dose bolus injection of IC adenosine (n = 56), placebo (n = 54).</td>
<td>No significant difference in MSI was found between groups. Extent of MVO was comparable in both groups, TIMI flow grade, TIMI frame count, MBG, and STRes after PPCI were similar. After 4 months, infarct size was similar in both treatment groups.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
</tr>
<tr>
<td>To examine the role of IC adenosine performed during PCI on the immediate angiographic results and clinical course.</td>
<td>70 patients; group 1 (n = 35) IC adenosine, group 2 (n = 35) placebo.</td>
<td>PCI resulted in TIMI 3 flow after PCI in 91.4% in group 1 and 77.1% in group 2. MBG 3 was observed at the end of PCI in 65.7% and 37.1% respectively. STRes elevation was more frequently observed in group 1.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<td>To evaluate the effects on clinical outcomes of PPCI facilitated with pre‐catheter abciximab with half‐dose reteplase, abciximab alone or with abciximab administered immediately before the procedure.</td>
<td>110 patients; high‐dose bolus injection of IC adenosine (n = 56), placebo (n = 54).</td>
<td>No significant difference in MSI was found between groups. Extent of MVO was comparable in both groups, TIMI flow grade, TIMI frame count, MBG, and STRes after PPCI were similar. After 4 months, infarct size was similar in both treatment groups.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<tr>
<td>IC administration of NTP + tirofiban is a safe and superior compared to tirofiban alone for the prevention of periprocedural myonecrosis in patients undergoing elective PCI.</td>
<td>260 patients; IC adenosine (n = 130), IC placebo (n = 130).</td>
<td>Greater prevalence of calcified lesions was observed in the adenosine group. Greater prevalence of type C lesions, chronic occlusions, worse pre‐procedural TIMI flow, and more severely stenotic lesions were observed in the placebo group.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<tr>
<td>New method of IC adenosine injection to prevent MVR injury in patients with AMI undergoing PCI [31].</td>
<td>260 patients; IC adenosine (n = 130), IC placebo (n = 130).</td>
<td>Greater prevalence of calcified lesions was observed in the adenosine group. Greater prevalence of type C lesions, chronic occlusions, worse pre‐procedural TIMI flow, and more severely stenotic lesions were observed in the placebo group.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<tr>
<td>Evaluation of IRA patency and microcirculatory function after facilitated PPCI [33].</td>
<td>637 patients; half-dose reteplase + abciximab (n = 213), abciximab alone (n = 222), placebo (n = 202).</td>
<td>Patients in combination‐facilitated group exhibited higher rates of baseline IRA patency compared with abciximab‐facilitated and primary PCI group. There were no differences in the post-PCI corrected TIMI frame count or the rates of post-PCI TIMI flow grade 3 MBG 2/3.</td>
<td>There is no evidence that selective high‐dose IC administration of adenosine distal to the occlusion site of the culprit lesion in STEMI patients results in incremental myocardial salvage index or a decrease in MVO.</td>
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<td>The impact of pre-PPCI βB use on the no-reflow phenomenon in patients with AMI [34].</td>
<td>To investigate the impact of PPCI βB use on the development of non-reflow in STEMI patients post PCI.</td>
<td>618 patients; βB group (n = 257), no βB (n = 1,358).</td>
<td>Incidence of the no-reflow was significantly lower in the βB group than in non-βB group.</td>
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<td>Clinical and procedural predictors of no-reflow in patients with AMI after PPCI [35].</td>
<td>To identify possible clinical predictors for no-reflow in patients with AMI after PPCI.</td>
<td>Total: 312 patients. Divided into 2 subgroups.</td>
<td>Age &gt; 65 years, time from onset to reperfusion &gt; 6 hours, SBP on admission &lt; 100 mmHg, IABP use before PCI, low (≤1) TIMI flow grade before PPCI, high thrombus burden and long target lesion on angiography were independent predictors of no-reflow.</td>
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<tr>
<td>Effect of high-dose IC adenosine during PPCI in AMI: a randomized controlled trial [36].</td>
<td>To assess the improvement of myocardial perfusion and reduction in infarct size with intracoronary adenosine.</td>
<td>448 patients; IC adenosine (n = 226), placebo (n = 222).</td>
<td>Incidence of residual ST-segment deviation &lt;0.2mV did not differ between patients. No significant difference in secondary outcomes measures.</td>
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<tr>
<td>Coronary artery calcification score is an independent predictor of the no-reflow phenomenon after reperfusion therapy in AMI [37].</td>
<td>To investigate whether the CAC score is associated with impaired reperfusion during the acute phase of STEMI.</td>
<td>60 patients. Optimal reperfusion (n = 27), No-reflow (n = 33)</td>
<td>CAC score &gt;100 was associated with the presence of no-reflow. CAC score of non-culprit coronary arteries was higher in no-reflow individuals. CAC score of the IRA correlated negatively with the TIMI flow rate and with the MBG.</td>
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</table>
IC NTP for the prevention of the no-reflow phenomenon after PPCI in AMI. A randomized, double-blind, placebo-controlled clinical trial [38].

Impact of PercuSurge device conjugative with IC administration of NTP on no-reflow phenomenon following PPCI [39].

To assess whether NTP injected IC immediately before primary angioplasty for acute STEMI prevents no-reflow and improves vessel flow and myocardial perfusion.

When administered in conjunction with a PercuSurge device for treatment of AMI, IC NTP is safe and superior to IC administration of NTP for reversing slow flow or no-reflow.

98 patients with STEMI, randomized to receive either NTP (60 µg) or placebo.

Compare ST-segment resolution was achieved in 61.7% and 61.2% of NTP and placebo subjects. At 6 months, the rate of TVR, MI, or death occurred in 6.3% of the NTP group and 20% of the placebo group.

In patients with STEMI, selective IC administration of a fixed dose of NTP failed to improve coronary flow and myocardial tissue reperfusion but improved clinical outcomes at 6 months.

Subgroup analysis demonstrated that final MBG and corrected TIMI frame count time were significantly higher in patients with than in patients without the PercuSurge. No significant NTP related adverse events occurred, apart from insignificant transient hypotension.

IC administration of NTP is safe and superior to NTG for improving final epicardial blood flow and microvascular circulation in patients with AMI undergoing PPCI. Combination therapy of PercuSurge device and NTP improved microvascular circulation.

AD, adenosine; AMI, acute myocardial infarction; CAC, coronary artery calcium; CTFC, corrected thrombolysis in myocardial infarction (TIMI) frame count; CHF, congestive heart failure; EKG, electrocardiogram; IABP, intra-aortic balloon pump; IC, intracoronary; IRA, infarct-related artery; LVEF, left ventricular ejection fraction; MACE, major cardiac adverse events; MBG, myocardial blush grade; MI, myocardial infarction; MRI, magnetic resonance imaging (type C lesion from the American College of Cardiology/American Heart Association classification); MSI, myocardial salvage; MVO, microvascular obstruction; MVR, microvascular reperfusion; NTG, nitroglycerin; NTP, sodium nitroprusside; PCI, percutaneous coronary intervention; PPCI, primary percutaneous coronary intervention; SBP, systolic blood pressure; STRes, ST-segment resolution; TA, thrombus aspiration; TIMI, thrombolysis in myocardial infarction; TMPG, TIMI myocardial perfusion grade; WMSI, wall motion score index.
In a real-world setting of patients admitted with STEMI, use of TA during PPCI was not associated with improved 1-year survival.

To assess 1-year outcome in patients participating in the FAST-MI 2010 Registry treated with primary PCI for STEMI.

LAT without balloon angioplasty or stenting is feasible and is associated with favorable short- and long-term outcomes.

Cardiac death at 1 year was 19 of 535 patients in group 1 and 36 of 536 in group 2. 1-year cardiac death or nonfatal reinfarction occurred in 30 of 535 patients in group 1 and 53 of 536 patients in group 2.

Compared with conventional PCI, TA before stenting of the IRA seems to improve 1-year clinical outcome after PCI for STEMI.

Table 1.3 Is thrombectomy an available tool in STEMI?

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<td>Impact of MT on myocardial reperfusion as assessed by STRes in STEMI patients treated by primary PCI [40].</td>
<td>To evaluate the impact of MT on STRes as a surrogate of reperfusion.</td>
<td>239 patients; MT before primary PCI (n = 102) group 1, conventional PCI (n = 137) group 2.</td>
<td>A complete resolution of ST-segment elevation occurred in 51.4% of patients in group 1 and in 35.6% in group 2. MT was associated with lower use of stents. Estimate of MACE was not significantly different between 2 groups at 1-year and 3-year follow-up.</td>
<td>In STEMI patients, MT improves myocardial reperfusion, assessed by the percentage of STRes and a lower use of stents. This strategy did not improve cardiovascular outcomes at 1-year follow-up.</td>
</tr>
<tr>
<td>Cardiac death and reinfarction after 1 year in the thrombus aspiration during PCI in AMI study (TAPAS) [41].</td>
<td>The TA during PCI in MI improves myocardial reperfusion compared with conventional PCI, but benefit improving clinical outcome is unknown.</td>
<td>1071 patients with STEMI were randomly assigned in a 1:1 ratio either TA (group 1) or conventional treatment (group 2).</td>
<td>Cardiac death at 1 year was 19 of 535 patients in group 1 and 36 of 536 in group 2. 1-year cardiac death or nonfatal reinfarction occurred in 30 of 535 patients in group 1 and 53 of 536 patients in group 2.</td>
<td>Compared with conventional PCI, TA before stenting of the IRA seems to improve 1-year clinical outcome after PCI for STEMI.</td>
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<td>Lone aspiration thrombectomy without stenting in young patients with STEMI [42].</td>
<td>TA alone may be a viable option in patients presenting with STEMI or rescue angioplasty.</td>
<td>202 young patients underwent PPCI for acute STEMI; 10 patients had LAT as definitive therapy.</td>
<td>At 1 month, all remaining patients were free of MACE. At 6 weeks, 1 patient had recurrent STEMI after abruptly discontinuing all medication. Follow-up revealed no adverse consequences.</td>
<td>LAT without balloon angioplasty or stenting is feasible and is associated with favorable short- and long-term outcomes.</td>
</tr>
<tr>
<td>Effect of coronary TA during PPCI on 1-year survival (from the FAST-MI 2010 Registry) [43].</td>
<td>To assess 1-year outcome in patients participating in the FAST-MI 2010 treated with primary PCI for STEMI.</td>
<td>4169 patients; 2087 patients had STEMI, 1538 had primary PCI, with TA used in 671.</td>
<td>To assess 1y outcome in 30-day mortality and the rate of 1-year survival were similar with both strategies.</td>
<td>In a real-world setting of patients admitted with STEMI, use of TA during PPCI was not associated with improved 1-year survival.</td>
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TA in PPCI in high-risk patients with STEMI: a real-world registry [44].

Evaluate the effect of TA in real-world, all-comer patient population with STEMI undergoing PPCI.

313 patients; TA (n = 194), Conventional PCI (n = 119).

TA was associated with lower post-PCI TIMI frame count values and higher TIMI 3. Post-procedural myocardial perfusion assessed by MBG was increased in TA group. No difference in clinical outcome at 30 days. Patients treated with TA showed significantly higher survival and MACE-free at 1 year.

Rheolytic thrombectomy with PCI, for infarct size reduction in AMI: 30-day results from a multicenter randomized study [45].

RT as an adjunct to PCI reduces infarction size and improves myocardial perfusion during treatment of STEMI.

480 patients; RT as an adjunct to PCI (n = 240), PCI alone (n = 240).

Final infarct size was higher in the RT group compared with PCI alone. Final TIMI 3 was lower in the RT group. There were no differences in TMP blush scores or STRes. 30-day MACE was higher in the RT group.

TA during PPCI [46].

Evaluate whether manual aspiration is superior to conventional treatment during PPCI.

1071 patients randomly assigned to the TA group 1 or the conventional PCI group 2 before undergoing coronary angiography.

MBG of 0–1 occurred in 17.1% of the patients in group 1 and in 26.3% of those in group 2. Complete STRes occurred in 56.6% and 44.2% of patients, respectively. At 30 days, rate of death in patients with MBG of 0–1, 2, and 3 was 5.2%, 2.9%, and 1.0%, respectively; rate of adverse events was 14.1%, 8.8%, and 4.2%, respectively.

TA reduces MVO after PCI: A myocardial contrast echocardiography substudy of the REMEDIA trial [47].

To clarify the role of micro-embolization in the genesis of MVO after PCI.

25 patients randomized to be pretreated with TA before PCI of the culprit lesion and 25 received standard PCI.

In patients treated with a TA filter device, WMSI, CSI, WML, and CDL were significantly lower and EF higher; LV volumes were slightly smaller compared with control. The extent of MVO significantly correlated with temporal changes in LV volumes.

IC thrombectomy improves myocardial reperfusion in patients undergoing direct angioplasty for AMI [48].

Evaluate the effects of MT on myocardial reperfusion during direct angioplasty for AMI.

92 patients with AMI and angiographic evidence of intraluminal thrombus were randomized to either IC thrombectomy followed by stenting or to a conventional strategy of stenting.

Post-procedure thrombolysis in MI TIMI 3 was not different between groups. Myocardial blush 3 was observed in 71.7% of patients undergoing MT and in 36.9% of patients undergoing conventional strategy. STRes ≥50% occurred more often in patients undergoing MT. Adjuvantic thrombectomy was an independent predictor of blush 3.

STEII patients with occluded IRA, TA prior to PCI improves coronary flow, myocardial perfusion, and clinical outcomes compared with PCI in the absence of TA.

Despite effective thrombus removal, RT with primary PCI did not reduce infarct size or improve TIMI, TMP blush, STRes or 30-day MACE.

TA is applicable in a large majority of patients with STEMI and it results in better reperfusion and clinical outcomes than conventional PCI, irrespective of clinical and angiographic characteristics at baseline.

TA significantly reduces the extent of MVO and myocardial dysfunction, although it does not have a favorable effect in preventing LV remodeling.

IC thrombectomy as adjunct to stenting during direct angioplasty for AMI improves myocardial reperfusion.

(Continued)
Use of MAT does not appear to be associated with a reduction in mortality in patients undergoing PPCI and routine use of this approach cannot be recommended.

No difference in hospital mortality. MAT was associated with increases in stroke and need for dialysis, and a decrease in post-PCI CABG. No difference in long-term survival observed.

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<td>Impact of TA on angiographic and clinical outcomes in patients with STEMI [49].</td>
<td>Assess the impact of EAC on angiographic and clinical outcomes in patients with STEMI.</td>
<td>535 patients; EAC was used in 165 patients before angioplasty (group 1), 370 patients underwent PCI without TA (group 2).</td>
<td>More patients in group 1 had initial TIMI 0–1 compared with group 2. Final TIMI 3 was the same in both groups. An analysis restricted to patients with initial TIMI flow 0–1 yielded similar results. No difference in clinical outcomes was observed.</td>
<td>Selective use of the EAC results in excellent angiographic and clinical results. Further clinical investigation needed.</td>
</tr>
<tr>
<td>Results of MT in STEMI: real-world experience [50].</td>
<td>Evaluate the outcomes of STEMI patients undergoing TA in a real-world setting.</td>
<td>359 patients; 270 thrombectomy (group 1), 89 standard PCI (group 2).</td>
<td>Group 1 had a lower baseline IV systolic function and were more likely to receive IABP support. After adjusting for demographics, initial CK, GFR and IRA, thrombectomy was associated with lower peak CK, but was neither associated with improved LV repair nor with reduced no-reflow.</td>
<td>Thrombectomy in STEMI resulted in lower enzymatic infarct size, but did not reduce no-reflow phenomenon or improve early LV function recovery.</td>
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<tr>
<td>Aspiration thrombectomy for treatment of STEMI: meta-analysis [51].</td>
<td>Evaluate clinical and procedural outcomes of TA-assisted PPCI compared with conventional PPCI in patients with STEMI.</td>
<td>26 randomized controlled trials with a total of 11,943 patients.</td>
<td>No difference in the risk of all-cause death, reinfarction, TVR, or definite stent thrombosis between the 2 groups at 10.4 months. There were significant reductions in failure to reach thrombolysis in MI 3 flow or myocardial blush grade 3, incomplete ST-segment elevations, and evidence of distal embolization with TA.</td>
<td>Among unselected patients with STEMI, TA-assisted PPCI does not improve clinical outcomes, despite improved epicardial and myocardial parameters of reperfusion.</td>
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<td>MAT does not impact in short- or long-term survival in PPCI: Insights from the Blue Cross Blue Shield of Michigan Cardiovascular Collaborative [52].</td>
<td>MAT does not impact in short- or long-term survival in PPCI.</td>
<td>12,961 patients; MAT (n = 4,972), conventional PCI (n = 7,989).</td>
<td>No difference in hospital mortality. MAT was associated with increases in stroke and need for dialysis, and a decrease in post-PCI CABG. No difference in long-term survival observed.</td>
<td>Use of MAT does not appear to be associated with a reduction in mortality in patients undergoing PPCI and routine use of this approach cannot be recommended.</td>
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<tr>
<td>Role of aspiration and MT in patients with acute MI undergoing primary angioplasty [53].</td>
<td>The clinical efficacy of thrombectomy in acute MI remains uncertain.</td>
<td>18 clinical trials randomized MI patients to aspiration ($n = 3936$) and 7 trials to mechanical thrombectomy ($n = 1,598$) before PCI compared with conventional PCI alone.</td>
<td>TA vs. conventional PPCI: MACE significantly reduced with TA. Beneficial trends noted for recurrent MI and TVR. Final infarction size and EF at 1 month were similar. STREs and thrombolysis In MI blush grade (TBG) 3 post-procedure were both improved with TA. MT vs. conventional PPCI: no difference in the incidence of MACE, mortality, recurrent MI, TVR, or final infarction size. Benefit in ST-segment resolution, but not TBG 3, was noted.</td>
<td>Thrombectomy during MI by manual catheter aspiration, but not mechanically, is beneficial in reducing MACE, including mortality, at 6–12 months compared with conventional PPCI alone.</td>
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<td>Manual TA is not associated with reduced mortality in patients treated with PPCI [54].</td>
<td>Impact of TA on mortality in patients with STEMI treated with PPCI.</td>
<td>Observational cohort study of 10,929 STEMI patients; 3572 patients (32.7%) underwent TA during PPCI.</td>
<td>Procedural success rates were higher and in-hospital MACE rates were lower in patients undergoing TA. No difference in mortality rates between patients with and without TA during follow-up period. Thrombus aspiration was still not associated with decreased mortality.</td>
<td>Routine TA was not associated with a reduction in long-term mortality in patients undergoing PPCI, although procedural success and in-hospital MACE rates improved. Results suggest that adjunctive TA to PCI may be associated with modest benefits related to MACE reduction.</td>
</tr>
<tr>
<td>Clinical outcomes of manual TA in patients with AMI: An updated meta-analysis [55].</td>
<td>Systematically evaluate prospective randomized trials and assess the effects of TA on all-cause mortality, MACE, TVR and MI.</td>
<td>10,756 patients; 5404 controls underwent conventional PCI, and 5352 patients underwent PCI with TA.</td>
<td>A significant reduction in MACE with TA was noted. However TA did not significantly reduce all-cause mortality, TVR, or MI.</td>
<td>Routine TA before PCI compared with PCI alone did not reduce 30-day mortality among patients with STEMI.</td>
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<tr>
<td>TA during STEMI [56].</td>
<td>Evaluate whether TA reduces mortality.</td>
<td>7244 patients randomized to TA followed by PCI or PCI only.</td>
<td>Death from any cause occurred in 2.8% and 3.0% in TA and PCI only. Rates of hospitalization for recurrent MI at 30 days were 0.5% and 0.9%, respectively, and rates of stent thrombosis were 0.2% and 0.5%, respectively. No significant differences in rate of stroke or neurologic complications.</td>
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<td>Impact of TA during PPCI on mortality in STEMI [57].</td>
<td>To assess the impact of TA during PPCI on the mortality of patients with STEMI patients.</td>
<td>2567 patients, thrombectomy ($n = 1095$).</td>
<td>Post-PPCI thrombolysis in M1 3 flow was more frequently achieved in TA group. TA was associated with a significant reduction in in-hospital and long-term mortality.</td>
<td>TA during PPCI is associated with a significant reduction in mortality, especially in those with a short total ischemic time.</td>
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<td>The impact of IC TA on STEMI outcomes [58].</td>
<td>Evaluate the outcome of aspiration in a “real-world” setting of PPCI.</td>
<td>1035 patients; TA (aspiration group; $n = 189$), standard PCI (standard group; $n = 846$).</td>
<td>No significant differences were noted in the outcome of aspiration vs. standard treatment at 30 days and at 1 year. A significant advantage in favor of aspiration was evident in patients with proximal culprit lesions, anterior infarcts, and right ventricular involvement.</td>
<td>When STEMI involved a large jeopardized myocardium, aspiration was associated with sustained improved clinical outcomes.</td>
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AMI, acute myocardial infarction; CABG, coronary artery bypass graft; CDL, contrast defect; CK, creatine kinase; CSI, contrast score index; DAPT, dual antiplatelet therapy; EAC, Export aspiration catheter; EF, ejection fraction; GFR, glomerular filtration rate; IABP, intra-aortic balloon pump; IRA, infarct-related artery; LAT, lone aspiration thrombectomy; LV, left ventricular; MAT, manual aspiration thrombectomy; MCE, myocardial contrast echocardiography; MI, myocardial infarction; MT, manual thrombectomy; MVO, microvascular obstruction; PCI, percutaneous coronary intervention; PPCI, primary percutaneous coronary intervention; RT, rheolytic thrombectomy; STRes, ST segment resolution; STEMI, ST-segment elevation myocardial infarction; TA, thrombus aspiration; TVR, target vessel revascularization; WML, endocardial length of wall motion abnormality; WMSI, regional wall motion score index.
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<td>Culprit-only vs. complete CR during PPCI [59].</td>
<td>Complete CR during PPCI can be achieved safely with an improved clinical outcome during the indexed hospitalization.</td>
<td>120 patients with STEMI and MCS; 95 CR, 25 COR.</td>
<td>CR associated with reduced incidence of MACE, lower rate of recurrent ischemic episodes, MI, reintervention, acute heart failure and shorter hospitalization. Transient renal dysfunction was more common in CR patients. In-hospital and 1-year mortality were similar.</td>
<td>Complete revascularization resulted in an improved acute clinical course.</td>
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<td>Complete vs. culprit vessel PCI in MVD: A randomized comparison [60].</td>
<td>Compare safety, efficacy, and costs of CR versus COR in MVD disease treated with PCI.</td>
<td>219 patients with MVD were randomly assigned; CR of vessels ≥ 50% stenosis (n = 108), COR (n = 111).</td>
<td>Despite equal MACE at 24-hour strategy, success was higher in COR. MACE rates were similar. Repeat PCI was performed more often in COR group.</td>
<td>CR in MVD was associated with a lower strategy success rate, similar MACE rates.</td>
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<tr>
<td>PRAMI: randomized trial of preventive angioplasty in MI [61].</td>
<td>Whether performing preventive PCI would reduce the combined incidence of death from cardiac causes, nonfatal MI, or refractory angina.</td>
<td>465 patients with STEMI randomly assigned to: preventive PCI (n = 234), no preventive PCI (n = 231).</td>
<td>Primary outcome occurred in 21 patients assigned to preventive PCI and in 53 patients assigned to no preventive PCI.</td>
<td>In patients with STEMI and MVD undergoing IRA-PCI, preventive PCI in non-infarct CA with major stenosis reduced the risk of MACE.</td>
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<tr>
<td>A randomized trial of TVR versus MVR in STEMI: MACE during long-term follow-up [62].</td>
<td>Primary endpoint was incidence of MACE.</td>
<td>263 patients were randomly assigned to COR group, staged revascularization (SR group) and simultaneous treatment of non-IRA (CR group).</td>
<td>In 2.5 years, 50% of COR group experienced at least one MACE, 20% in the SR group and 23.1% in the CR group. In-hospital death, repeat revascularization and rehospitalization occurred more frequently in the COR group, there was no difference in reinfarction among the 3 groups. Survival free of MACE was reduced in the COR group but was similar in the CR and SR groups.</td>
<td>COR was associated with the highest rate of long-term MACE. Patients scheduled for SR experienced a similar rate of MACE to patients undergoing CR treatment of non-IRA.</td>
</tr>
<tr>
<td>Management of MVD in STEMI patients: A systematic review and meta-analysis [63].</td>
<td>RCTs or observational studies reporting about STEMI patients with MVD treated with either a culprit-only or CR strategy.</td>
<td>9 studies with 4686 patients compared culprit-only vs. complete PCI performed during PPCI.</td>
<td>No difference was found for the components of the primary outcome, apart from a reduction in repeated revascularization for complete PCI during the STEMI procedure.</td>
<td>CR performed during PPCI appears safe and offers a reduction in repeated revascularization.</td>
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<td>Multivessel PCI in patients with MVD and AMI [64].</td>
<td>Optimal percutaneous interventional strategy for dealing with significant non-culprit lesions in patients with MVD with AMI at presentation remains controversial.</td>
<td>820 patients with MVD were subdivided in 3 groups: (1) PCI of the IRA only; (2) PCI of both the IRA and non-IRA during the initial procedure; (3) PCI of the IRA followed by staged, in-hospital PCI of the non-IRA.</td>
<td>In patients with MVD, compared with PCI restricted to the IRA only, MV-PCI was associated with higher rates of reinfarction, revascularization and MACE. MV-PCI was an independent predictor of MACE at 1 year.</td>
<td>In patients with MVD, PCI should be directed at the IRA only, with decisions about PCI of non-culprit lesions guided by objective evidence of residual ischemia at late follow-up.</td>
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<tr>
<td>Early angio-guided CR vs. COR followed by ischemia-guided staged PCI in STEMI patients with MVD [65].</td>
<td>To compare short- and long-term clinical outcomes of early-staged, angio-guided approach and delayed, ischemia-guided treatment of non-IRA.</td>
<td>800 PPCIs were performed; 417 addressed to early-staged, angio-guided PCI of non-IRAs (CR group), 383 incomplete revascularizations (IncR group).</td>
<td>No difference in terms of death and MI was found between the CR and IncR group. MACE-free survival was significantly higher in IncR group, mainly driven by lower incidence of re-PCI.</td>
<td>Early CR based only on angiographic findings in patients with STEMI and MVD is associated with an excess of re-MI and with a higher incidence of MACE. Non-culprit coronary interventions were significantly associated with increased mortality.</td>
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<tr>
<td>Non-culprit CA PCI during acute STEMI: insights from the APEX-AMI trial [66].</td>
<td>To examine the incidence of and propensity for non-culprit interventions performed at the time of the PPCI and its association with 90-day outcomes.</td>
<td>5373 patients underwent primary PCI in the APEX-AMI trial; 2201 had MVD; 9.9% underwent non-IRA PCI, 90.1% underwent PCI of the IRA alone.</td>
<td>Death/congestive heart failure/shock were higher in non-IRA group compared with IRA-only PCI group. Non-IRA PCI remained independently associated with an increased hazard of 90-day mortality.</td>
<td>Non-culprit PCI should be performed at the time of the PPCI and its association with 90-day outcomes.</td>
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<td>In-hospital and long-term outcomes of multivessel PCI after AMI [67].</td>
<td>Outcomes of MV-PCI early after AMI were evaluated.</td>
<td>Patients with multivessel PCI (n = 239), patients with treatment of the IRA alone (n = 1145).</td>
<td>Multivessel PCI group had a higher prevalence of adverse prognostic indicators. 1-year survival free of recurrent infarction and TVR rates were similar between 2 groups.</td>
<td>Multivessel PCI in patients with MVD after AMI compared with 1-vessel PCI was not associated with an excess risk death, MI, coronary artery bypass graft, or TVR.</td>
</tr>
<tr>
<td>Single vs. multivessel treatment during primary angioplasty: results of the HELP AMI Study [68].</td>
<td>With modern non-thrombogenic stents CR with MVD treatment can be safely achieved during the PPCI with a lower need of subsequent revascularization and at a lower cost.</td>
<td>69 patients; culprit lesion treatment only (n = 17), complete MV treatment (n = 52).</td>
<td>Similar incidence of in-hospital MACE. Increase in incidence of new revascularization in culprit treatment group at 12-month follow-up was sufficient to compensate initial higher in-hospital cost, with a similar 12-month hospital cost.</td>
<td>A staged approach to MV treatment during primary angioplasty avoids treating unnecessarily non-clinically relevant lesions.</td>
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</table>
A staged approach to MV treatment during primary angioplasty avoids treating unnecessarily non-clinically relevant lesions. Similar incidence of in-hospital MACE. Increase in incidence of new revascularization in culprit treatment group at 12-month follow-up was sufficient to compensate initial higher in-hospital cost, with a similar 12-month hospital cost.

With modern non-thrombogenic stents CR with MVD treatment can be safely achieved during the PPCI with a lower need of subsequent revascularization and at a lower cost.

MV-PCI in patients with MVD after AMI compared with 1-vessel PCI was not associated with an excess risk death, MI, coronary artery bypass graft, or TVR.

MV-PCI during the index of PPCI in STEMI is associated with a higher mortality and more bleeding, but a lower risk of reintervention and reinfarction.

MV-PCI that included non-culprit vessels during the acute STEMI reperfusion procedure was strongly associated with a greater hazard for 1-year all-cause mortality, MACE, and stent thrombosis.

In patients with MVD, compared with PCI restricted to the IRA only, MV-PCI was associated with higher rates of reinfarction, revascularization and MACE. MV-PCI was an independent predictor of MACE at 1 year.

MV-PCI during the index of PPCI in STEMI patients with MVD; 9.9% underwent non-IRA PCI, 90.1% underwent PCI of the IRA alone.

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Table 1.4 (Continued)

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<tr>
<td>COR vs. MVR using DES in patients with STEMI: A Korean AMI registry-based Analysis [74].</td>
<td>Compare clinical outcomes of MV vs. IRA-only revascularization in patients undergoing PPCI for STEMI. Primary endpoint was incidence of MACE at 1 year.</td>
<td>3791 eligible STEMI patients with MVD and who underwent primary PCI using DES were collected. COR group and MVR group.</td>
<td>During the 1-year follow-up, 102 patients in COR group and 32 in MVR group experienced at least 1 MACE. No differences between 2 groups in rates of death, MI, or revascularization.</td>
<td>Although MV angioplasty during PPCI for STEMI did not reduce the MACE rate compared with COR, CR was associated with a lower rate of repeat revascularization after MV-PCI.</td>
</tr>
<tr>
<td>Complete vs. COR for patients with MVD undergoing PCI for STEMI: A systematic review and meta-analysis [75].</td>
<td>Meta-analysis comparing the benefits and risks of routine culprit-only PCI vs. MV-PCI in STEMI.</td>
<td>26 studies, 46,324 patients (7886 multivessel PCI and 38,438 culprit-only PCI).</td>
<td>Of the patients who received MV-PCI during index catheterization, an increase in in-hospital mortality was observed compared with patients who had COR. Patients undergoing MV-PCI as a staged procedure in-hospital, a survival benefit was observed. Combined analysis found a survival benefit with MV-PCI compared with COR.</td>
<td>Staged MV-PCI improved short- and long-term survival and reduced repeat PCI. Large randomized trials are still required.</td>
</tr>
<tr>
<td>Non-IRA revascularization during PPCI for STEMI: A systematic review and meta-analysis [76].</td>
<td>Compare outcomes of non-IRA PCI as an adjunct to PPCI in the setting of STEMI.</td>
<td>14 studies with 35,239 patients.</td>
<td>Death, MI, and revascularization were higher in same-sitting PCI group. In analyses limited to randomized controlled trials, primary end point was similar during short term and significantly lower for SS-PCI group in the long term.</td>
<td>SS-PCI group has higher baseline risk compared with IRA-PCI. Findings underscore need for a large, randomized controlled trial to guide therapy.</td>
</tr>
<tr>
<td>Single or MV-PCI in STEMI patients [77].</td>
<td>To evaluate clinical results of PCI in STEMI in patients with MVD, in relation to single or MV-PCI and to patients with SVD.</td>
<td>745 PCI, 346 (46%) SVD 399 (54%) MVD, among MVD patients, 156 (39%) had IRA-only treatment and 243 had MV-PCI.</td>
<td>At median follow-up mortality was 6.3% in SVD and 12% in MVD, new revascularization 2.9% and 9%, respectively.</td>
<td>MV-PCI in patients without hemodynamic compromise yields good short-term results, even if performed very early.</td>
</tr>
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</table>

AMI, acute myocardial infarction; CR, coronary revascularization; COR, culprit-only revascularization; ICR, incomplete revascularization; IRA, infarct-related artery; MCS, multivessel coronary stenosis; MV, multivessel; MVD, multivessel disease; MVR, multivessel revascularization; PCI, percutaneous coronary intervention; PPCI, primary percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction; SVD, single-vessel disease.
### Table 1.5 Role of the intra-aortic balloon pump and counterpulsation in STEMI intervention.

<table>
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<tr>
<td>Impact of IABP on long-term mortality of unselected patients with STEMI complicated by CS [78].</td>
<td>To assess the impact of IABP on 1-year mortality of unselected patients with STEMI presenting in CS.</td>
<td>Total of 51 patients; intervention (n = 30), controls (n = 21).</td>
<td>No difference in 30-day mortality between both groups and no impact on 1-year mortality.</td>
<td>No benefit of IABP on short- and long-term mortality of unselected patients with STEMI complicated by CS.</td>
</tr>
<tr>
<td>Systematic review and meta-analysis of IABP therapy in STEMI: should we change the guidelines? [79].</td>
<td>To assess whether IABP in STEMI with and without CS improves diastolic coronary and systemic blood flow, and reduces afterload and myocardial work.</td>
<td>First meta-analysis 7 randomized trials (n = 1009). Second meta-analysis included cohorts of STEMI patients with cardiogenic shock (n = 10,529).</td>
<td>IABP showed neither a 30-day survival benefit nor improved LVEF; with higher stroke and bleeding rates. In patients treated with thrombolysis, IABP was associated with an 18% decrease in 30-day mortality, with higher revascularization rates.</td>
<td>There is insufficient evidence endorsing the current guideline recommendation for the use of IABP therapy in the setting of STEMI complicated by CS.</td>
</tr>
<tr>
<td>Use and impact of IABP on mortality in patients with AMI complicated by CS; results of the Euro Heart Survey on PCI [80].</td>
<td>To assess use and impact on mortality of IABP in current practice of PCI in Europe.</td>
<td>653 patients; intervention (n = 163), control (n = 490).</td>
<td>In the multivariate analysis the use of IABP was not associated with an improved survival.</td>
<td>No beneficial effect of IABP on outcome. Large RCT urgently needed to define the role of IABP in patients with PCI for shock.</td>
</tr>
<tr>
<td>Effects of IABP on mortality of AMI [81].</td>
<td>Meta-analyses to analyze the relevant RCT data on the effect of IABP on mortality and occurrence of bleeding in AMI.</td>
<td>Total patients 2237; IABP (n = 1112), controls n = 1125.</td>
<td>The 6-month mortality in IABP group was not lower than in controls in the 4 RCTs that enrolled 59 AMI patients with CS. In the 4 that enrolled AMI 66 patients without CS, the data showed opposite conclusion.</td>
<td>IABP cannot reduce within 2-month and 6–12-month mortality of AMI patients with CS as well as within 2 months mortality of AMI patients without CS. IABP can increase the risk of bleeding.</td>
</tr>
<tr>
<td>Long-term safety and sustained LV recovery: long-term results of percutaneous LV support with Impella LP2.5 in STEMI [82].</td>
<td>To evaluate long-term effects of Impella LP2.5 support on the aortic valve and LVEF.</td>
<td>20 patients; treatment (n = 10), control (n = 20).</td>
<td>No differences in aortic valve abnormalities and LVEF were demonstrated between the groups. LVEF increase from baseline was greater in Impella-treated patients.</td>
<td>3-day support with the Impella LP2.5 is not associated with adverse effects on aortic valve at long-term follow-up. LVEF was similar in both groups. Recovery was greater in Impella group.</td>
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(Continued)
Impella 2.5 system is safe, easy to use, and provides effective hemodynamic support during high-risk PCI. With increasing levels of Impella support, an increase in mean distal coronary pressure, hyperemic flow velocity, and coronary flow reserve has been observed. Significant decrease in myocardial oxygen consumption was seen.

To demonstrate the hemodynamic support provided by the Impella 2.5 system when used in patients undergoing high-risk PCI.

All patients underwent PCI \( n = 14 \) unprotected LMCA; \( n = 6 \) on a last remaining conduit.

With increasing levels of Impella support, an increase in mean distal coronary pressure, hyperemic flow velocity, and coronary flow reserve has been observed. Significant decrease in myocardial oxygen consumption was seen.

Impella 2.5 system is safe, easy to use, and provides effective hemodynamic support during high-risk PCI.

6 patients; treatment group \( n = 3 \), control group \( n = 3 \).

Normal MC depending on both functional capillary density and flow velocity or quality as observed in healthy control, was only achieved in the Impella group and paralleled improvement in LV function.

Microcirculation assessed by sidestream dark field improved in STEMI patients treated with the Impella LP 2.5 to levels observed in healthy people and remained suboptimal after 72 hours in patients without support.

In CS caused by AMI, use of a percutaneous placed LV assist device (Impella LP 2.5) is feasible and safe, and provides superior hemodynamic support compared with standard treatment using an IABP.

Data currently not available.

The current use of Impella 2.5 in AMI complicated by CS: Results from the USpella Registry [84].

Randomized clinical trial to evaluate the safety and efficacy of percutaneous LV assist device vs. IABP for treatment of CS caused by MI [85].

Effects of mechanical LV unloading by Impella on LV dynamics in high-risk and PPCI patients [86].

The PROTECT I Trial: Investigating the use of the Impella 2.5 system in patients undergoing high-risk PCI [87].

To investigate use and impact of outcome of IABP in current practice of PCI in Germany.

Table 1.5 (Continued)

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<td>Improved microcirculation in patients with an acute STEMI treated with the Impella LP2.5 percutaneous LV assist device [83].</td>
<td>Circulatory support during PCI in patients with STEMI aims at maintaining hemodynamic stability and organ perfusion.</td>
<td>6 patients; treatment group ( n = 3 ), control group ( n = 3 ).</td>
<td>Normal MC depending on both functional capillary density and flow velocity or quality as observed in healthy control, was only achieved in the Impella group and paralleled improvement in LV function.</td>
<td>Microcirculation assessed by sidestream dark field improved in STEMI patients treated with the Impella LP2.5 to levels observed in healthy people and remained suboptimal after 72 hours in patients without support.</td>
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<td>The current use of Impella 2.5 in AMI complicated by CS: Results from the USpella Registry [84].</td>
<td>Outcomes of patients supported with Impella 2.5 pre-PCI vs. those who received post-PCI in CS complicating AMI.</td>
<td>63 patients received Impella 2.5 support prior to PCI and 91 patients received it post-PCI.</td>
<td>In pre-PCI support with Impella, more extensive revascularization with more vessels treated and more stents placed compared with Impella post-PCI. Higher survival rate in the pre-PCI group.</td>
<td>Early hemodynamic support is associated with more complete revascularization and improved survival in the setting of refractory CS complicating an AMI.</td>
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<tr>
<td>Randomized clinical trial to evaluate the safety and efficacy of percutaneous LV assist device vs. IABP for treatment of CS caused by MI [85].</td>
<td>In CS, Impella LP 2.5 may help to bridge patients to recovery compared with an IABP.</td>
<td>26 patients; PCI ( n = 24 ), Impella ( n = 12 ), IABP ( n = 13 ).</td>
<td>The cardiac index after 30 minutes of support was significantly increased in the Impella LP2.5 group compared IABP group. 30-day mortality was 46% in both groups.</td>
<td>In CS caused by AMI, use of a percutaneous placed LV assist device (Impella LP 2.5) is feasible and safe, and provides superior hemodynamic support compared with standard treatment using an IABP.</td>
</tr>
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<td>Effects of mechanical LV unloading by Impella on LV dynamics in high-risk and PPCI patients [86].</td>
<td>To demonstrate that the Impella has beneficial effects in patients undergoing high-risk PCI and PPCI for acute STEMI.</td>
<td>6 patients with elective high-risk PCI, 5 patients with PPCI.</td>
<td>The response to increased LV unloading was not different between both groups. No change on global and systolic LV function, while diastolic function improved. There was a decrease in end-diastolic pressure, elastance, and wall stress.</td>
<td>LV unloading decreases end-diastolic wall stress and improves diastolic compliance dose-dependently. Beneficial LV unloading effects of Impella during high-risk and PPCI.</td>
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<td>The PROTECT I Trial: Investigating the use of the Impella 2.5 system in patients undergoing high-risk PCI [87].</td>
<td>To demonstrate the hemodynamic support provided by the Impella 2.5 system when used in patients undergoing high-risk PCI.</td>
<td>All patients underwent PCI ( n = 14 ) unprotected LMCA; ( n = 6 ) on a last remaining conduit.</td>
<td>With increasing levels of Impella support, an increase in mean distal coronary pressure, hyperemic flow velocity, and coronary flow reserve has been observed. Significant decrease in myocardial oxygen consumption was seen.</td>
<td>Impella 2.5 system is safe, easy to use, and provides effective hemodynamic support during high-risk PCI.</td>
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Impella 2.5 system is safe, easy to use, and provides effective hemodynamic support during high-risk PCI. With increasing levels of Impella support, an increase in mean distal coronary pressure, hyperemic flow velocity, and coronary flow reserve has been observed. Significant decrease in myocardial oxygen consumption was seen.

To demonstrate the hemodynamic support provided by the Impella 2.5 system when used in patients undergoing high-risk PCI. The PROTECT I Trial: Investigating the use of the Impella 2.5 system in patients undergoing high-risk PCI [87].

The response to increased LV unloading was not different between both groups. No change on global and systolic LV function, while diastolic function improved. There was a decrease in end-diastolic pressure, elastance, and wall stress.

In CS caused by AMI, use of a percutaneously placed LV assist device (Impella LP 2.5) is feasible and safe, and in 6 patients with elective high-risk PCI, 5 patients with PPCI. Early hemodynamic support is associated with more complete revascularization and improved survival in the setting of refractory CS complicating an AMI.

Effects of mechanical LV unloading by Impella on LV dynamics in high-risk and PPCI patients [86].

IABP group. 30-day mortality was 46% in both groups. Patients to recovery compared with an IABP. Randomized clinical trial to evaluate the safety and efficacy of percutaneous LV assist device vs. IABP for treatment of CS caused by MI [85].

63 patients received Impella 2.5 support prior to PCI and 91 patients received it post-PCI. Outcomes of patients supported with Impella 2.5 pre-PCI vs. those who received post-PCI in CS complicating AMI.

Microcirculation assessed by sidestream dark field improved in STEMI patients treated with the Impella LP2.5 to levels observed in healthy people and remained suboptimal after 72 hours in patients without support.

The current use of Impella 2.5 in AMI complicated by CS: Results from the USpella Registry [84].

Normal MC depending on both functional capillary density and flow velocity or quality as observed in healthy control, was only achieved in the Impella group and paralleled improvement in LV function.

Hemodynamic support with Impella 2.5 did not result in a superior outcome of the 30-day MACE but showed a strong trend to superior outcome at 90 days.

In-hospital mortality with and without IABP was 43.5% and 37.4%. In the multivariate analysis, use of IABP was associated with a strong trend for an increased mortality.

Addition of IABP in CS patients was associated only with modest effects on reduction of APACHE II score, improvement of CI, reduction of inflammatory state, or BNP biomarker status were seen compared with medical therapy alone.

Addition of IABP to standard therapy did not result in a significant improvement in MODS.

Mean infarct size was not different. At 30 days, there were no differences between the IABC and PCI groups. Among patients with acute anterior STEMI without shock, IABC plus primary PCI compared with PCI alone did not result in reduced infarct size.

No benefit of IABP on outcome.

Addition of IABC therapy in patients undergoing revascularization was associated with a higher mortality than those without IABP therapy.

Routine use of IABC therapy in patients with STEMI complicated by CS does not add any mortality benefit, and may be harmful.

Hemodynamic support with Impella 2.5 provided superior hemodynamic support in comparison with IABP. 30-day MACE was not different. At 90 days, a strong trend toward decreased MACE was observed in Impella 2.5.

Among patients with acute anterior STEMI without shock, IABC plus PCI compared with PCI alone did not result in reduced infarct size.

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<td>Long-term mortality data From the BCIS-1. A randomized, controlled trial of elective BCP during high-risk PCI [93].</td>
<td>To find long-term mortality benefits on patients undergoing PCI assisted with IABP.</td>
<td>301 patients were randomly assigned to receive elective IABP insertion or to have PCI without planned IABP.</td>
<td>All-cause mortality at follow-up was 33% in the overall cohort, with fewer deaths occurring in the elective IABP group (n = 42) than in the group that underwent PCI without planned IABP support.</td>
<td>Elective IABP use during PCI was associated with a 34% relative reduction in all-cause mortality compared with unsupported PCI.</td>
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<tr>
<td>Early outcomes with marginal donor hearts compared with LV device support in patients with advanced heart failure [94].</td>
<td>To examine differences in wait list survival of patients with continuous flow LV assist devices and post-transplantation survival of patients receiving a marginal donor heart.</td>
<td>7298 patients; LV assist device support (n = 2561) and marginal donor heart (n = 4737).</td>
<td>The 30-day, 1-year, and 2-year survival was 96%, 89%, and 85%, for patients with LV assist device support on waiting list, and 97%, 89%, and 85%, respectively, for recipients of marginal donor hearts.</td>
<td>There was no between waiting list survival of patients with LV assist device support as bridge-to-transplant and post-transplant survival of recipients with marginal donor hearts. There could be clinical benefits for using LV assist device support as bridge-to-transplant to allow time for better allocation of optimal donor.</td>
</tr>
<tr>
<td>Intra-aortic balloon support for MI with CS [95].</td>
<td>Test the hypothesis that IABP, as compared with best available medical therapy alone, results in a reduction in mortality among patients with AMI complicated by CS.</td>
<td>600 patients; IABP group (n = 301), no IABP (n = 299).</td>
<td>At 30 days, 119 patients in IABP group and 123 patients in control group had died. Groups did not differ in rates of major bleeding, peripheral ischemic complications, sepsis and stroke.</td>
<td>Use of IABP did not reduce 30-day mortality in patients with CS complicating AMI for whom an early revascularization strategy was planned.</td>
</tr>
<tr>
<td>Comparison of hospital mortality with IABP insertion before vs. after PPCI for CS complicating AMI [96].</td>
<td>Insertion of IABP before PPCI might result in better survival of patients with CS compared with postponing the insertion.</td>
<td>Retrospectively studied 48 patients: 26 IABP before (group 1) and 22 IABP after (group 2).</td>
<td>Mortality, MACE and cerebrovascular events were significantly lower in group 1. Multivariate analysis identified renal failure and insertion of the IABP after PCI as the only independent predictors of in-hospital mortality.</td>
<td>Patients with CS complicating AMI who undergo PPCI assisted by IABP have a more favorable in-hospital outcome and lower in-hospital mortality.</td>
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</table>
Randomized comparison of intra-IABP with a percutaneous LV assist device in patients with revascularized AMI complicated by CS [97].

Mortality in CS following AMI remains unacceptably high despite PCI of IRA and use of IABP. Percutaneous LV assist device with active circulatory support might have positive hemodynamic effects and decrease mortality.

IABP (n = 20) or percutaneous VAD support (n = 21).

Hemodynamic and metabolic variables could be improved more effectively by VAD support from 0.22–0.28 W/m². Complications: severe bleeding or limb ischemia were found more frequently after VAD support, 30-day mortality was similar.

Hemodynamic and metabolic parameters can be reversed more effectively by VAD than by standard treatment with IABP. However, more complications were encountered.

AMI, acute myocardial infarction; APACHE II, Acute Physiology and Chronic Health Evaluation II; CS, cardiogenic shock; IABP, intra-aortic balloon pump; IRA, IRA, infarct-related artery; LV, left ventricular; LVEF, left ventricular ejection fraction; MACE, major adverse cardiac events; MI, myocardial infarction; MOSD, multiple-organ dysfunction syndrome; MVO, microvascular obstruction; PCI, percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction; VAD, ventricular assist device.
References


Compendium of STEMI Clinical Trials


