Experience of primary percutaneous coronary intervention in patients with ST-segment elevation myocardial infarction at a referral healthcare centre in India

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ABSTRACT

Background. India has the highest burden of coronary artery disease in the world. It also has a higher rate of ST-segment elevation myocardial infarction than that in developed countries. Primary percutaneous coronary intervention is an effective treatment, yet little is known about its feasibility and outcome in India. We studied the outcomes of primary percutaneous coronary intervention at an Indian tertiary care centre.

Methods. We did a prospective observational study of 1000 consecutive patients with ST-segment elevation myocardial infarction, who were treated with primary percutaneous coronary intervention from December 2010 to May 2014 at Sri Venkateswara Institute of Medical Sciences, Tirupati, India. Patient characteristics, procedural details, in-hospital and 3-month adverse events were assessed.

Results. The mean (SD) age of our patients was 54.5 (11.3) years. Among the study population, 82.9% were men, 32.8% had diabetes mellitus, and 36.3% had hypertension. Only 18.2% of the patients came to hospital in an ambulance, and 6% were in cardiogenic shock. Most frequently, the left anterior descending artery was the infarct-related artery (57.9%). The mean (SD) time from onset of symptoms to arrival at hospital was 369.6 (204.6) minutes and the mean door-to-balloon time was 58.6 (17.1) minutes. The in-hospital adverse event rate was 5.7% (mortality 3.6%, non-fatal reinfarction 0.9%, stroke 0.3%, major bleeding 0.9%). Patients without cardiogenic shock had an in-hospital survival rate of 99.1%. During 3 months of follow-up, 0.9% of patients died and 0.8% had non-fatal reinfarction. The 3-month survival rate was 95.5%.

Conclusion. Primary percutaneous coronary intervention is feasible in India with an acceptable door-to-balloon time and low rates of adverse events despite longer time to presentation.

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INTRODUCTION

Coronary artery disease (CAD) is the leading cause of mortality worldwide. Of about 2.9 million deaths due to CAD in 2015 in India, 40% were expected to be among those <45 years of age.[1] India has a disproportionately higher burden than most developing countries and also has higher rates of ST-elevation myocardial infarction (STEMI) than those in developed countries. STEMI adds to the economic burden of a nation due to loss of productive years of life. Mortality and morbidity can be significantly reduced when reperfusion therapy is promptly instituted. Primary percutaneous coronary intervention (PPCI) is the most effective therapy for STEMI.[2] Most available data concerning PPCI is from developed countries with only a few, small studies from India. Moreover, most of the Indian data are from metropolitan cities. Therefore, we aimed to document patient characteristics, angiographic data, time variables and outcomes at a referral healthcare centre in a suburban area in India.

METHODS

This prospective, observational study was done at Sri Venkateswara Institute of Medical Sciences (SVIMS), Tirupati, India between December 2010 and May 2014. The study was approved by the Institutional Ethics Committee. SVIMS is a high-volume, low-cost referral healthcare centre located in a suburban area. Patients from rural and suburban areas and from all economic strata come to this hospital. One thousand consecutive patients with STEMI, who underwent PPCI within 12 hours of onset of chest pain, were enrolled in the study. Patients were included if they had angina or angina equivalent lasting for more than 20 minutes with ST segment elevation of ≥1 mm in ≥2 contiguous leads or new onset left bundle branch block or true posterior myocardial infarction with ST depression of ≥1 mm in ≥2 contiguous anterior leads. Patients who underwent rescue angioplasty were excluded.

As soon as a patient presented to the emergency department and was diagnosed to have STEMI, the in-house catheterization laboratory team was informed. Patients were treated with a loading dose of aspirin (325 mg) and clopidogrel (300–600 mg). A brief history was taken and a clinical examination done to assess the patient's condition and to rule out any mechanical complications. After obtaining a written informed consent, the patient was transferred to the catheterization laboratory. The procedure was done through the femoral route: 70–100 U/kg unfractionated heparin was administered intra-arterially through the sheath during the procedure. Glycoprotein IIb/IIIa inhibitors were used on the discretion of the operator. Routine diagnostic angiography was performed. The infarct-related artery (IRA) was engaged with a guiding catheter and the lesion was crossed with a 0.014 inch guidewire. If the thrombus burden was high, it was aspirated manually with an export aspiration catheter (Medtronic,

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Minneapolis, Minnesota). Direct stenting was attempted if thrombolysis in myocardial infarction (TIMI) grade III flow was present and the lesion allowed the passage of a stent. Drug-eluting or bare metal stents were used as preferred (for economic reasons) by the patient. PPCI was limited to the IRA except in patients with cardiogenic shock who had critical stenosis and less than TIMI grade III flow in a non-IRA. Echocardiography was done immediately after the procedure. Percutaneous coronary intervention (PCI) of the non-IRA with significant stenosis was done during the index hospital stay. Angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, beta-blockers and statins were used as standard therapy during hospital stay and follow-up, if not contraindicated.

Clinical and procedural details were recorded. These included demographic details, history of diabetes (fasting blood sugar >126 mg/dl or on treatment), systemic hypertension (systolic blood pressure >140 mmHg or diastolic blood pressure >90 mmHg or on treatment), cardiogenic shock (sustained hypotension with systolic blood pressure <90 mmHg for at least 30 minutes, unresponsive to fluid administration and associated with features of tissue hypoperfusion), patient delay (time from onset of chest pain to first medical contact [FMC]), door-to-balloon time (DBT), total ischaemia time (time from onset of chest pain to establishment of IRA flow), left ventricular ejection fraction (assessed by echo-cardiography). The time from 8 a.m. to 4 p.m. was termed as on-time hours and from 4 p.m. to 8 a.m. as off-time hours. The success of PPCI was defined as achievement of patency of the vessel to a residual stenosis of ≤30%. Major bleeding was defined as haematoma >10 cm in diameter or bleeding requiring transfusion, vascular surgery or major morbidity. Patients were followed up to 3 months after discharge.

The primary outcome was in-hospital and all-cause mortality within 3 months. Secondary outcomes were non-fatal reinfarction, stroke and major bleeding. All the patients were reviewed at 3 months in the outpatient department and those who did not come were contacted by telephone.

Statistical analysis

Data were recorded on a predesigned proforma and managed using MS-Excel 2007 (Microsoft Corporation, Redmond, WA, USA). All the entries were double-checked for any possible error. Descriptive statistics for categorical variables such as gender and type of disease were done by computing frequencies in each category. For quantitative variables such as age, left ventricular ejection fraction and DBT, approximate normality of the distribution was assessed. Variables following normal distribution were summarized by mean and SD. All the statistical analyses were done using Statistical Package for Social Sciences (SPSS) version 20.0 (IBM Corp., Armonk, NY: USA).

RESULTS

One thousand patients were included in the study. The mean (SD) age of the patients was 54.5 (11.33) years, and 82.9% were men. Just under half were smokers and one-third had diabetes (Table I). Killip class III/IV was present in 11% of the study population. The mean (SD) time from chest pain to arrival in hospital was 369.6 (204.6) minutes. Only 18.2% used an ambulance to reach hospital. While most patients used private transport (75.2%) including autorickshaws (10.3%), a few used public transport (6.6%) to reach hospital. Patients presenting directly to SVIMS were 342 (34.2%). An intra-aortic balloon pump (IABP) was used in 30 (3%) patients, of whom 25 (2.5%) had cardiogenic shock and 5 (0.5%) had multivessel disease. In 16 (1.6%) patients, an IABP was inserted before PPCI and in 14 (1.4%) after the PPCI.

Two-thirds of the patients had single-vessel disease (Table II). The most common IRA was the left anterior descending artery (57.9%). Stents were deployed in 96.4% and two-thirds had bare metal stents. The mean DBT was 58 minutes. The median total ischaemia time was 412 minutes (Table III). The post-procedure thrombolysis in myocardial infarction (TIMI) III, TIMI-II, TIMI-I and TIMI-0 flow was achieved in 94.4%, 3.8%, 1.5% and 0.3%, respectively. Intracoronary urokinase was used in 62 (6.2%) patients. Staged PCI of a non-IRA was done in 131 (13.1%) patients during the index hospital stay.

Only 20.6% of patients presented within 3 hours after onset of symptoms, while 39% presented after 6 hours. The mean (SD) duration of chest pain to FMC was 139.50 (117.56) minutes and the duration of FMC to our centre was 230.09 (109.53) minutes. The median time from FMC to reperfusion therapy was 272.38 minutes. A DBT of less than 90 minutes was achieved in 81.9%. A total of 658 patients (65.8%) were treated during on-time hours with a median DBT of 54 minutes and 342 patients (34.2%) during off-time hours with median DBT of 61.5 minutes.

The hospital expenses of 73% of patients were funded by the government-sponsored *Arogyasree* programme, 20% by insurances and reimbursement and 7% paid out-of-pocket.

Thirty-six patients died during hospital stay, of which 28 had cardiogenic shock. The in-hospital mortality rate in the cardiogenic shock group was 46.7%. Nine patients died during follow-up. The incidence of stent thrombosis was 0.14% over 3 months, of which 11 patients had early stent thrombosis and 3 had late stent thrombosis. The total rate of adverse events was 5.7% during hospital stay and it was 1.7% during 3 months of follow-up (Table IV).

TABLE I. Characteristics of the patients

Characteristic	*n* (%)
Mean (SD) age (years)	54.47 (11.33)
<45	188 (18.8)
46–65	631 (63.1)
>65	181 (18.1)
Men	829 (82.9)
Smokers	480 (48)
Alcoholic	234 (23.4)
Diabetes mellitus	328 (32.8)
Hypertension	363 (36.3)
Mean (SD) systolic blood pressure (mmHg)	121.91 (23.12)
Mean (SD) diastolic blood pressure (mmHg)	78.01 (14.19)
Mean (SD) heart rate (beats per minute)	81.58 (17.22)
Killip class	
I	670 (67.00)
II	220 (22.00)
III	58 (5.80)
IV	52 (5.20)
Mean (SD) serum creatinine (mg/dl)	1.10 (0.35)
Mean (SD) left ventricular ejection fraction (%)	44.44 (7.83)
Window period (minutes)	369.6 (204.6)
Cardiogenic shock	60 (6.0)
Intra-aortic ballon pump	30 (3.0)
Mean (SD) duration of hospital stay (days)	4.57 (0.51)
Mode of transport	
Ambulance	182 (18.2)
Private vehicle	752 (75.2)
Public transport	66 (6.6)

TABLE II. Angiographic and procedural details

Characteristic	*n* (%)
Number of diseased vessels	
Single-vessel disease	674 (67.4)
Double-vessel disease	270 (27.0)
Triple-vessel disease	56 (5.6)
Infarct-related artery	
Left anterior descending	579 (57.9)
Right coronary artery	301 (30.1)
Left circumflex	120 (12.0)
Thrombus aspiration	248 (24.8)
Intracoronary urokinase	62 (6.2)
Stent placement	964 (96.4)
Bare metal stent	609 (63.2)
Drug-eluting stent	355 (36.8)
GpIIb/IIIa inhibitors	773 (77.3)
Mean (SD) stent length (mm)	19.61 (6.14)
Mean (SD) stent diameter (mm)	3.01 (0.5)
Plain old balloon angioplasty	36 (3.6)
Mean (SD) procedure time (minutes)	29.23 (12.7)
Mean (SD) fluro time (minutes)	7.67 (3.51)
Mean (SD) door-to-balloon time (minutes)	58.63 (17.1)
Post-procedure TIMI-III flow	944 (94.4)
Temporary pacemaker	96 (9.6)
Procedure-related complications	
Side branch occlusions	102 (10.2)
Edge dissections and vessel perforations	0
No reflow	18 (1.8)
PCI of non-infarct-related artery during hospital stay	131 (13.1)

TIMI thrombolysis in myocardial infarction PCI percutaneous coronary intervention

TABLE III. Time variables

Time variable	*n* (%)
Median symptom onset to hospital arrival time (minutes)	352
≤60	43 (4.3)
61–180	163 (16.3)
181–360	404 (40.4)
361–720	390 (39.0)
Median door-to-balloon time (minutes)	60
≤60	531 (53.1)
61–90	288 (28.8)
>90	181 (18.1)
Median total ischaemia time	412

TABLE IV. Major adverse cardiovascular events (MACE)

Outcomes	*n* (%)
In-hospital outcomes	
Death	36 (3.6)
Death (cardiogenic shock)	28 (2.8)
Non-fatal reinfarction	9 (0.9)
Target vessel revascularization	9 (0.9)
Stroke	3 (0.3)
Major bleeding	9 (0.9)
3-month outcomes	
Death	9 (0.9)
Non-fatal reinfarction	8 (0.8)
Stroke and major bleeding	0

DISCUSSION

We report our experience of managing 1000 STEMI patients in an unselected rural and semi-urban population as well as poor and rich, at a large-volume, low-cost cardiac care centre in India.

In our series, with a mean age of 54.5 years, patients were younger than those in developed countries, reflecting premature atherosclerosis among Indians. This is similar to the age of the CREATE registry participants.[3] About 1 in 5 patients (18.8%) were in the <45 years age group, and 82.9% who underwent PPCI were men, akin to the CREATE registry STEMI subset (81.5%) and slightly less than that reported by Subban *et al.* (86.6%).[4] Compared to the CREATE STEMI subset, our study had more patients with diabetes and hypertension, and were smokers.

Our patients took longer to reach hospital (median 352 minutes) and our patient delay was more than that of the CREATE registry (median 300 minutes), the study by Subban *et al.* (median 200 minutes) and of developed countries (range 140–170 minutes).[4–8] Only 4.3% of patients presented within the first hour, 20.6% within the first 3 hours while 39% presented after 6 hours of chest pain. This delay in presentation was due to fewer patients using ambulance services, delay at local hospitals, inaccurate diagnosis, lack of awareness and longer distance from the hospital (patients came from as far as 200 km). There is a need to improve the network of nearby hospitals and ambulance services to decrease pre-hospital delay.

The benefits of PPCI decline as the DTB exceeds 90 minutes.[9,10] An acceptable DTB time (median 60 minutes) was achieved, which is within the range recommended by the American and European guidelines.[11,12] Just over half our patients (531, 53.1%) had DBT ≤60 minutes and 81.9% had a DBT ≤90 minutes. In the USA, according to the Center for Medicare and Medicaid Services, from 2005 to 2010, the proportion of STEMI patients who had DBT within 90 minutes increased from 44% to 91%.[13] In the study by Subban *et al*.,[4] the median DBT was 65 minutes with 46% of patients achieving DBT ≤60 minutes and 75.3% ≤90 minutes. The DBT is an indicator of the quality of care. With a decrease in the DBT, the risk of mortality from STEMI also decreases.[9,10,14] To achieve a shorter DBT, we took organizational measures such as preparing protocols, staff education including of those in the emergency unit, an in-house PCI-capable team, performing an echocardiogram after the procedure, undertaking the procedure after a financial agreement form without waiting for payments and patient education through media and meetings. The major reason for loss of time in our study was due to delay in taking decisions for PPCI by relatives of the patient due to lack of awareness of acute myocardial infarction. A DBT of <90 minutes can be achieved in the majority of patients with effective strategies.

In the management of STEMI, time is crucial—a minute means muscle. From the patient's perspective, minimizing the total ischaemia time is associated with improved outcomes with reperfusion therapy.[15] In our study, the total ischaemia time was prolonged (median 412 minutes). In the study by Subban *et al*.,[4] the median total ischaemia time was 275 minutes. The time from the onset of chest pain to reaching a PCI-capable hospital is a major contributor to the total ischaemia time. Two-thirds of patients were referred from local hospitals. Therefore, emphasis has to be placed on pre-hospital care and there is a need to focus on the FMC-to-balloon time. Pre-hospital thrombolysis is preferable at a non-PCI-capable hospital when the expected transfer time to a PCI-capable hospital is more than 120 minutes. Morbidity and mortality can be further reduced by minimizing delay in presentation to a PCI-capable hospital.

Arogyasree, an Andhra Pradesh state government social insurance programme for people below the poverty line, provides fast-track telephonic approval for PPCI at any time of the day. It has a profound effect on STEMI care. Up to three-fourths of our patients were funded by this programme. It also decreased the time taken for financial decisions, which in our population is a major hurdle to achieving a shorter DBT.[16] The CREATE registry found that a higher mortality in the low socioeconomic class is due to difference in treatment. Mortality can be reduced in the lower socioeconomic strata, a majority of the Indian population, by providing access to advanced healthcare by government insurance policies such as the *Arogyasree*.

The index procedure had a high success rate (98.2%). The major adverse cardiac events occurred in 5.7% of patients during the in-hospital course and in 1.7% during the 3-month follow-up. In-hospital mortality in patients with cardiogenic shock was 46.7%, which is less than that reported by Subban *et al.*[4] (61.3%) and similar to that of Jafary *et al.*[17] (43.9%) and the SHOCK trial (46.7%).[18] In the non-cardiogenic shock group, in-hospital survival was 99.1%. The outcomes of our study are comparable to those of developed countries.[2] An excellent in-hospital survival rate of 96.4% and 3-month survival rate of 95.5% was observed. These results could be obtained because of the expertise of the team, coordinated teamwork, shorter DBT and probably younger age of our patients.

Our study has shown that PPCI is feasible in India with outcomes similar to those obtained in developed countries. The mean age in our study was just under 55 years, an age group that constitutes the workforce of India. Total years of productive life lost due to all cardiovascular disease among Indians in the age group 35–64 years are higher than those in developed countries such as USA[19] and comparable to countries such as China and Brazil.[20] Moreover, most patients present after 3 hours, and as time passes thrombolysis become less effective. Hence, developing countries such as India need a wider network of PPCI services. The major component of the total ischaemia time being the time taken from FMC to a PCI-capable centre; pre-hospital thrombolysis should be considered in Indian settings when appropriate. Outcomes can be improved by delivering reperfusion therapy expeditiously by developing regional network systems. At the same time, ambulance teams should be trained and equipped to identify STEMI and administer initial therapy including thrombolysis, when appropriate. Extensive state-funded PPCI programmes together with massive health education and mass media efforts are essential for India to control the cardiovascular epidemic.

Limitations

There are several limitations of our study. It is a single-centre observational study. The patterns of practice at our centre may not necessarily represent the practice at other hospitals in India and hence the findings of our study have limited generalizability to other centres. Our study also lacks long-term follow-up.

Conclusion

PPCI is a viable therapeutic option in India and can be done with immediate and short-term outcomes similar to those in developed countries, with an acceptable DBT despite relatively longer time from chest pain to presentation. The need of the hour of developing countries, especially India, is the widespread practice of PPCI through high-volume and low-cost cardiac care centres.

Conflict of interest: None

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