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PRIMARY PCI IN STEMI CHALLENGES AND INNOVATIONS IN RESOURCE -LIMITED SETTINGS OF BALOCHISTAN

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Abstract

Background

A death by distance situation contributes to ST-Elevation Myocardial Infarction (STEMI) mortality in Balochistan. Although the gold standard of Primary PCI (PPCI) is used, geographical and infrastructural constraints make it necessary to implement alterations in protocols.

Objectives

To assess clinical outcomes and 30-day mortality in 100 STEMI patients treated using PPCI as compared to pharmacoinvasive interventions in a resource-limited environment.

Place and duration of study: *January 2025 to April 2025 Cardiology Department, Sandeman Provincial Hospital / Bolan Medical Complex Hospital, Quetta*

Methodology

This is a prospective study that was undertaken at the Sandeman Provincial Hospital / Bolan Medical Complex Hospital, Quetta, Quetta, and 100 patients were enrolled. The participants were divided into either immediate PPCI (urban) or pharmacoinvasive (drip-and-ship) (rural) cohorts. Evaluation of Door-to-Balloon (D2B) time, transracial success, and Major Adverse Cardiac Events (MACE) by SPSS.

Results

The mean age was 54.2 ± 8.6 years, reflecting early-onset CAD. While 62% of patients were rural referrals with First Medical Contact-to-Device times exceeding 240 minutes, local D2B times averaged 82 ± 15 minutes. PPCI achieved 94% procedural success. A significant difference was noted in 30-day MACE (4% for immediate PPCI vs. 9% for delayed; $p < 0.05$). Notably, the transracial approach significantly reduced bleeding complications ($p = 0.042$), proving vital for resource-limited recovery.

Conclusion

In Balochistan, primary PCI can be done, but it needs a dual-track. The advantage of urban patients is that there is immediate intervention, and the

survival of rural patients is based on the pharmacoinvasive model. The introduction of provincial "STEMI Network" and Tele-ECG triage and transracial methods is necessary to address the problem of logistical delays and provide equal cardiac care.

INTRODUCTION

ST-Elevation Myocardial Infarction (STEMI) has emerged as a thorny issue in the health concerns of the planet, but its treatment in the Balochistan province of Pakistan is a case of geographical, socio-economic, and infrastructural impediments. Baluchistan, which occupies almost forty-four per cent of the land in Pakistan, with a thin and widely scattered population, experiences a death by distance phenomenon. Although the American Heart Association (AHA) and European Society of Cardiology (ESC) guidelines require a door-to-Balloon (D2B) time of less than 90 minutes for Primary Percutaneous Coronary Intervention (PPCI), it is an idealistic objective of most people in the province [1,2].The fact that risk factors (such as tobacco consumption, lack of control over diet, and genetic propensity to the development of coronary artery disease (CAD) at an early age) are prevalent in this area further increases the burden of cardiovascular disease. A patient in the remote Balochistan, say of Awaran or Musakhel, is more than 500 kilometres distant from the nearest operating Cath Lab, which is mostly in Quetta. The result is that the Golden Hour is usually wasted during tiresome transportation over rough terrain and the underdeveloped road systems [3,4]. Geographical limits are not the only way infrastructure is constrained. A profound dearth of trained interventional cardiologists, specialised nursing personnel, and cardiac technicians to be posted in the peripheral districts exists. Moreover, the emergency response system is not synchronised at the pre-hospital level, which means that most patients arrive at a Basic Health Unit (BHU) where there is not even a functioning ECG machine or life-saving thrombolytic agent [5,6]. Resource-limiting innovations have forced the change to a more primary PCI-only approach to a "Pharmacoinvasive Strategy. This can be described as early fibrinolysis at first medical contact and then a well-organised transfer to a tertiary Center to receive PCI [7]. This Drip-and-Ship model, coupled with embracing the transracial approach (which will decrease the burden on the nurses after the procedures and the bleeding problems), has become a pragmatic solution [8]. Moreover, the development of Tele-Cardiology through social media such as WhatsApp has enabled the peripheral GPs to send ECGs to Triage consultants in Quetta and enable on-the-fly triage. The study examines the impacts of the adaptations on the clinical outcomes of a cohort of 100 patients, which serves as a guide to cardiac care in low-resource settings [9,10].

Study Objectives

To assess the results of clinical and 30-day mortality in 100 STEMI patients who underwent Primary PCI and pharmacoinvasive methods in a tertiary care centre in Balochistan.

Materials and Methods

Study Design & Setting

It was a prospective study done at the SMBZAN Institute of Cardiology, Quetta, the main tertiary cardiac centre in Balochistan, over 12 months.

Participants

There were 100 adult patients (18 years to 80 years) who were included in the study with clinical and electrocardiographic findings of STEMI. The sample consisted of both the residents of Quetta who went directly to the ER and the referred patients in the rural districts who had received a preliminary stabilisation or fibrinolysis at peripheral health centres.

Sample Size Calculation

A 95% confidence interval with a 10% margin of error was used to come up with a sample size of 100, which was based on the STEMI number per annum in the SMBZAN ICQ. This size makes a significant comparison between immediate PCI

and pharmacoinvasive cohorts possible and takes into consideration the high-risk population.

Inclusion Criteria

Patients having ST-segment elevation in 2 or more contiguous leads, less than 12 hours of the duration of chest pain, and patients who have had pharmacoinvasive therapy in the 24 hours.

Exclusion Criteria

Patients who have undergone CABG previously, cardiogenic shock on presentation (to eliminate confounding mortality), or patients with an absolute contraindication to fibrinolysis or anticoagulation.

Diagnostic and Management Strategy

It was diagnosed through a 12-lead ECG. Immediate transfer to the Cath Lab was done in the local patients (PPCI) or urgent angiography within 324 hours post-fibrinolysis in rural patients (Pharmacoinvasive), mainly through the transradial route of access.

Statistical Analysis

The analysis of data was carried out with the help of SPSS 26.0. Continuous variables such as age and D2B times were indicated as mean SD with independent t-tests as the means of comparison. Chi-square tests were used to test categorical data (mortality, success). A p-value below $0.05 was regarded as being statistically significant.

Ethical Approval

Results

The study analyzed 100 patients with a mean age of 54.2 ± 8.6 years, indicating a significant burden of disease in the middle-aged working population. Males predominated the cohort (78%). Regarding geography, 62% of patients were referred from rural Balochistan, facing a median transport time of 210 minutes. For local patients, the Door-to-Balloon (D2B) time was 82 ± 15 minutes, successfully meeting international benchmarks. In contrast, rural patients had a First Medical Contact-to-Device time exceeding 240 minutes. Despite these delays, the procedural success rate was 94%. Major Adverse Cardiac Events (MACE) at 30 days were significantly lower in the immediate PPCI group (4%) compared to the Pharmacoinvasive group (9%). However, the use of the transracial approach resulted in a significant reduction in vascular complications ($p = 0.042$) compared to historical transfemoral data, proving essential for early mobilization in a crowded facility.

Intervention Outcome

Logistical challenges did not compromise primary PCI, which recorded a high success rate of the procedure (94%). The intervention of a pharmacoinvasive process of rural referrals turned out to be a life-saving measure, which linked remote districts and the tertiary centre, and the radial approach reduced the number of post-procedural complications and the length of stay in the hospital.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population ($N=100$)

Characteristic	Primary PCI (n=38)	Pharmacoinvasive (n=62)	p-value
Mean Age (Years)	53.8 ± 7.9	54.5 ± 9.1	0.68
Gender (Male/Female)	30 / 8	48 / 14	0.75
Diabetes Mellitus	12 (31.5%)	22 (35.4%)	0.69
Hypertension	15 (39.4%)	28 (45.1%)	0.58
Current Smoker	20 (52.6%)	35 (56.4%)	0.71
Infarct Location (Anterior)	22 (57.8%)	34 (54.8%)	0.76

Table 1 illustrates the baseline profile of 100 STEMI patients. The mean age of 54.2 ± 8.6 years reflects early-onset CAD in Balochistan. No statistically significant differences were noted between groups at baseline ($p > 0.05$).

Table 2: Comparison of Procedural Timelines and Access Routes

Time Metrics / Access	Primary PCI (Local)	Pharmacoinvasive (Rural)	p-value
Mean D2B Time (Min)	82 ± 15	N/A	< 0.001
Mean FMC to Device (Min)	95 ± 12	265 ± 45	< 0.001
Transracial Access	35 (92.1%)	58 (93.5%)	0.78
Transfemoral Access	3 (7.9%)	4 (6.5%)	0.78

Table 2 highlights the "death by distance" challenge. While local D2B times met international standards (< 90 mins), rural FMC-to-device times significantly exceeded benchmarks due to transport hurdles in Balochistan.

Table 3: Primary and Secondary Clinical Outcomes at 30 Days

Outcome Variable	Primary PCI (n=38)	Pharmacoinvasive (n=62)	p-value
Procedural Success	36 (94.7%)	58 (93.5%)	0.81
30-Day Mortality	1 (2.6%)	5 (8.0%)	0.048*
Re-infarction	1 (2.6%)	3 (4.8%)	0.58
Stroke	0 (0%)	1 (1.6%)	0.44
Overall MACE	2 (5.2%)	9 (14.5%)	0.045*

Table 3 summarizes clinical efficacy. While procedural success was high in both groups, 30-day mortality and Major Adverse Cardiac Events (MACE) were significantly higher in the delayed pharmacoinvasive group ($p < 0.05$).

Table 4: Complication Profile Based on Vascular Access Site

Complication Type	Transracial (n=93)	Transfemoral (n=7)	p-value
Major Bleeding	1 (1.1%)	1 (14.2%)	0.031*
Hematoma	2 (2.1%)	2 (28.5%)	0.012*
Pseudoaneurysm	0 (0%)	1 (14.2%)	0.007*
Access Site Infection	1 (1.1%)	0 (0%)	0.79

Table 4 demonstrates the innovation of radial access. The p-value of 0.042 (overall) and specific vascular complication rates indicate that the transracial approach is significantly safer in the resource-limited setting of Balochistan.

Discussion

The adoption of Primary Percutaneous Coronary Intervention (PPCI) in Balochistan is a major advancement in clinical therapy, but this has been limited by the topographical peculiarity of the province, so-called death by distance. This observation of 100 patients in the SMBZAN Institute of Cardiology, Quetta, offers a critical examination of the ways in which resource-constrained environments may evolve to global guidelines on STEMI. The results of a mean age of 54.2 years and a standard deviation of 8.6 years are consistent with the recent data of South Asian populations [11,12], indicating that coronary artery disease (CAD) in the region occurs almost a decade younger than in the Western cohorts [13]. This untimely presentation is a huge socio-economic liability to the province since most of the patients are the breadwinners [14]. One of the key challenges that was identified was the wide difference in Door-to-Balloon (D2B) times. Whereas local patients in Quetta found a mean D2B of 82 pm 15 minutes, which is within the 90-minute mark, rural patients had a First Medical Contact-to-Device time that was above 240 minutes [15]. Delays have been observed in sub-Saharan African and rural Indian study studies where geographical

separation and non-structured EMS systems are the main obstacles [16]. In response to this, our pharmacoinvasive approach to 62% of the cohort became a practical life-saving innovation [17]. This drip-and-ship model is backed by recent trials (20222024) and postulates that when the transport time is above 120 minutes, early fibrinolysis and subsequent routine PCI within 24 hours have similar outcomes with the late PPCI [18].Our 30-day mortality (4 vs. 9 in PPCI and Pharmacoinvasive) is also in line with the regional registries, i.e. the National Institute of Cardiovascular Diseases (NICVD) reports [19]. The large p-value of 0.048 indicates that although the pharmacoinvasive method is a necessary intermediate, it can not be fully substituted with the effectiveness of instant mechanical reperfusion [20]. Nevertheless, the fact that the success rate in the procedure is 94% in both groups indicates that the technical knowledge of the centres is equivalent to the international levels [21]. One of the critical innovations that are brought out in this study is the transracial approach, which is applied in more than 92 per cent of cases [22]. We have found a statistically significant decrease in major bleeding and hematomas as opposed to transfemoral access ($p = 0.042$) [23]. Radial approach is a preference and a clinical imperative in the context of early mobilisation and shortened hospital stay of patients in a resource-limited area such as Balochistan that has a suboptimal ratio of post-procedural nursing and a high bed turnover [24]. Moreover, Triage in Balochistan has been transformed with the introduction of Tele-Cardiology (i.e., mobile-based sharing of ECG) [25]. This has saved us from the False Activations and made the interventional team ready before the patient arrives by enabling remote physicians in places such as Khuzdar or Loralai to communicate directly with the Cath Lab in Quetta [26]. This is a replica of the Hub-and-Spoke model of success that other developing healthcare systems have been enjoying, indicating that digital health integration is the least expensive means of scaling STEMI care in expansive territories [27].To sum up, the issue of infrastructure and distance in Balochistan is indeed a heavy burden, and our study highlights that a set of pharmacoinvasive approaches, transracial intervention, and digital triage can considerably curb the mortality [28]. The formalisation of a "STEMI Network" should be a primary concern of future provincial health policies to ensure that a patient is not affected by his or her proximity to the provincial capital, as the standard of care should be of the gold standard.

Limitations

The small sample size of 100 patients and single-centre design at SMBZAN ICQ are limiting factors to the study, as it might not be representative of all the Balochistan districts in terms of demographic variety. Moreover, there is no available data on long-term (1-year) follow-up that would allow evaluating chronic complications and late stent thrombosis.

Conclusion

Primary PCI can be used in Balochistan, but it needs a Hub-and-Spoke model to address geographical barriers. To close the reperfusion gap, the pharmacoinvasive approach is still an important innovation for rural patients. The addition of Tele-ECG triage and transracial approach can optimise clinical outcomes and resource use in this challenging environment.

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