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Outcomes Comparison of Direct Stenting versus Pre-Dilation in Percutaneous Coronary Intervention

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ABSTRACT

Introduction: Percutaneous coronary intervention (PCI) is a standard treatment of coronary artery disease. Direct stenting versus pre-dilation is still a matter of clinical concern, particularly regarding the efficiency of the procedure and outcomes. **Objective**: To compare the clinical outcomes, safety, and procedural efficiency of direct stenting versus pre-dilation in patients undergoing PCI. **Materials and Method**: This was a prospective observational study conducted at Department of Interventional Adult Cardiology, Sheikh Mohamed Bin Zayed Al Nahyan (SMBZAN) Institute of Cardiology Quetta, from 15th December, 2024 to 15th June, 2025. Two hundred patients undergoing PCI were randomly assigned to two groups direct stenting and pre-dilation. The baseline data, procedural factors, and 30-day outcomes were collected and analyzed. **Findings**: Direct stenting resulted in a lower contrast volume, a considerable reduction in procedure time, and a shorter fluoroscopy duration. The incidence of major adverse cardiac events was comparable between the two groups, but the minor vascular adverse events were less in the direct stenting group. **Conclusion**: Direct stenting is safe and an efficient procedure, which is an alternative to pre-dilation among properly identified PCI patients.

INTRODUCTION

Percutaneous coronary intervention (PCI) has revolutionized the treatment of coronary artery disease by offering a minimally invasive approach to revascularization. Two major procedures of directing the stent and pre-dilating with balloon angioplasty have attracted significant discussion and study among the many procedural techniques. Direct stenting is seen as the insertion of a stent without inflation of the balloon before stent introduction, and pre-dilation is the inflation of the balloon to prepare the lesion before stent insertion. The effectiveness and safety potential of the methods remain to be evaluated in different patient groups and under various conditions. According to Bendary et al., direct stenting could be used in patients with chronic coronary syndrome, as it demonstrates shorter working time and less contrast compared to BMS without increasing the number of complications, which indicates the possible benefits in specific patient groups (1). During ST-segment elevation myocardial infarction (STEMI), the priority is restoring the coronary blood flow. Observations by Xu and Zhao on STEMI patients after post-dilation showed both improvements in coronary blood flow and the need to emphasize the significance of the proper stent implantation (2).

In patients with STEMI, coronary microvascular dysfunction is a crucial issue during PCI. Aldujeli et al. emphasized that the selection of the primary PCI strategy and the use of pre-dilation may also play a significant role in determining the incidence of microvascular dysfunction (3). Their results support the inference that PCI methods, which reduce epicardial stenosis but harm the integrity of the microvascular, must be chosen. Moreover, Xu et al. noted that post-dilation after PCI can substantially reduce major adverse cardiac events (MACE), particularly in patients with suboptimal coronary flow after stenting, confirming the importance of technique optimization in clinical outcomes (4). Yu et al. assessed the addition of intracoronary pro-urokinase to low-pressure balloon pre-dilatation and reported increased reperfusion in anterior

STEMI patients, but increased complexity could counteract the simplicity of direct stenting procedures (5). This supports the simplicity-potential hemodynamic trade-off, which is based on the clinical scenario and thrombus burden.

The wide scenario of PCI in Pakistan has also helped in understanding these techniques to a great level. Farooqi et al. have provided an overview of the development and application of PCI among various populations, including high-risk patients who are commonly found in Pakistan (6). When lesions are highly complex, including extremely calcified ones, as described by Dumitrascu et al., lesion preparation, including pre-dilation, may become necessary to facilitate optimal stent deployment (7). In their own experience with a tertiary care hospital in South Punjab, Akhtar et al. reported positive results with the use of primary PCI, including direct stenting in some cases, demonstrating the viability of this approach in practice (8). Recent innovative adjunctive technologies, such as intravascular lithotripsy, offer greater choice in the approach to lesion preparation, particularly in calcified vessels, Gardiner et al. have argued that even in these adjuncts, direct stenting can be a viable approach to some less complex lesions, maintaining procedural efficiency (9).

Baqi and Saadia demonstrated that the periprocedural results of vein graft PCI depend considerably on the applied technique, and with direct stenting, some cases may have fewer embolic complications (10). Similarly, Osborn et al. demonstrated that the standard optical coherence tomography procedure provides increased safety and high accuracy, which may be an advantage of direct stenting, as it ensures correct stent positioning and size measurements without requiring pre-dilation (11). On the other hand, Kumar et al. criticized a significant risk of slow-flow/no-reflow phenomenon secondary to pre-dilation angioplasty in high thrombus-laden STEMIs, leading to a high recommendation against pre-dilation in thrombus-rich lesions (12). The long-term results of direct stenting were confirmed by Scarparo et al., who showed durable improvements and reduced restenosis, especially in STEMI patients, also solidifying its place in primary PCI (13). The result is consistent with that of Upreti et al., who also highlighted that with limited manipulation of vessels, such as those experienced during direct stenting, the number of cases of no-reflow and slow-flow events after PCI can be decreased (14).

Direct stenting has short-term advantages, but the supporting evidence does not stop there. By using long-term follow-up data demonstrating sustained patency and lower adverse events, Zijlstra et al. strengthened the overall effectiveness of this strategy in STEMI patients (15). But lesion morphology is a significant determinant. The authors emphasized that due to the high levels of coronary calcification, pre-dilation of vessels may be necessary to allow proper stent expansion; thus, the use of direct stenting has limited general value (16). The thrombus burden is significant to be considered in the Pakistani context. Hassan et al. observed that pre-dilation in patients with high thrombus loads resulted in a greater incidence of slow-flow/no-reflow, suggesting that direct stenting should be considered in cases of high thrombus load to reduce microvascular interruption (17). Finally, Jia et al. investigated the biochemical context in PCI and found that indicators of oxidative stress and ferroptosis were considerably altered due to the technique used in the procedures. They observed that the use of nicorandil during PCI served to facilitate the inhibition of those stress responses, and this was probably more relevant in less traumatic procedures such as direct stenting (18).

Objective

To compare the clinical outcomes, procedural efficiency, and safety of direct stenting versus pre-dilation in patients undergoing percutaneous coronary intervention at a tertiary care hospital in Pakistan.

MATERIALS AND METHODS

Design: Prospective, Comparative Observational study.

Study Setting: This study was conducted at the Department of Interventional Adult Cardiology, Sheikh Mohamed Bin Zayed Al Nahyan (SMBZAN) Institute of Cardiology Quetta.

Duration: The study was conducted over a six-month period, from 15th December, 2024 to 15th June, 2025.

Inclusion Criteria

Patients aged 30-75 years who have a diagnosis of chronic coronary disease or ST-segment elevation myocardial infarction (STEMI) undergoing elective or primary PCI were included. Only patients with single or multi-vessel angiographically visible disease, suitable to either direct stenting or pre-dilation, were enrolled following informed consent.

Exclusion Criteria

Patients with left main coronary artery disease, severe vessel calcification, cardiogenic shock, bleeding disorders or known contraindication to antiplatelet therapy were excluded in the study.

Methods

The patients were selected to have either chronic coronary syndrome or ST-segment elevation myocardial infarction (STEMI) and were included according to the specified inclusion criteria. Consequently, they were divided into two groups. Group A, in which participants underwent direct stenting, and Group B, whose techniques consisted of pre-dilation followed by stent insertion. An interventional cardiologist selects the method to use, which depends on the characteristics of the lesions, the size of the vessel, and the extent of the thrombus. The administration of antiplatelet therapy and unfractionated heparin were done using standard PCI protocols. Procedural data, including stent diameter and length, fluoroscopy time, total contrast volume, and procedural success, were documented. Patients were observed during their stay to deal with in-hospital complications such as arrhythmias, myocardial infarction, bleeding, and contrast-induced nephropathy. At 30 days, there was a follow-up that included follow-up of major adverse cardiovascular events (MACE) such as death, reinfarction, and target vessel revascularization. To compare findings between the two groups, the analyses of data through means of suitable statistics tests were carried out with $p < 0.05$ taken as a significant value.

RESULTS

A sample size of 200 patients undergoing percutaneous coronary intervention (PCI) was recruited for the study and evenly allocated to two groups. Group A (n=100) was involved in direct stenting, and Group B (n=100) stenting after pre-dilation. The baseline risk factors and baseline characteristics like age, gender, risk factors like diabetes, hypertension, and smoking status showed no difference in the groups.

Table 1

Baseline Clinical and Demographic Characteristics

Variable	Group A (Direct Stenting)	Group B (Pre-dilation)	p-value
Mean Age (years)	59.8 ± 9.2	58.6 ± 10.1	0.34
Male (%)	74 (74%)	72 (72%)	0.72
Diabetes Mellitus	36 (36%)	38 (38%)	0.78
Hypertension	48 (48%)	50 (50%)	0.81
Smoking	30 (30%)	32 (32%)	0.75

There were significant differences in the procedural parameters of the two techniques. It was noted that direct stenting was less invasive in terms of fluoroscopy time and contrast volume consumed but had the advantage of improved procedural efficiency. Group A also had a slightly lower average time of procedure.

Table 2

Procedural Characteristics

Variable	Group A (Direct Stenting)	Group B (Pre-dilation)	p-value
Mean Procedure Time (min)	32.5 ± 5.8	38.2 ± 6.4	<0.01
Fluoroscopy Time (min)	10.1 ± 2.3	13.6 ± 3.0	<0.01
Contrast Volume (mL)	145 ± 30	172 ± 28	<0.01
Stent Success Rate (%)	98 (98%)	97 (97%)	0.65

In-hospital comparisons indicated that the rate of no-reflow phenomenon reduced a little with a tendency toward the direct stenting group, but it was not considered very significant. The rate of minor vascular complications also decreased in Group A, but this difference proved to be statistically significant. There was no major difference between the two groups as far as major adverse cardiac events (MACE) at the 30-day follow-up was concerned.

Table 3

In-Hospital and 30-Day Outcomes

Outcome	Group A (Direct Stenting)	Group B (Pre-dilation)	p-value
No-reflow (%)	5 (5%)	8 (8%)	0.39
Minor Vascular Complications	2 (2%)	7 (7%)	0.04
In-hospital MACE (%)	3 (3%)	4 (4%)	0.70
30-day MACE (%)	5 (5%)	6 (6%)	0.75

In general, direct stenting approach proved to be more procedure-efficient with less minor adverse events and did not impact the clinical outcomes compared to pre-dilation in PCI.

DISCUSSION

The objective of this study was to compare the efficiency, safety, and short-term results of direct stenting and pre-dilation before percutaneous coronary intervention (PCI) in patients visiting a tertiary care facility in Pakistan. There is a correlation between the results and an increasingly large level of evidence demonstrating that direct stenting may prove a better solution than conventional pre-dilation in some patient groups. Our findings indicate that direct stenting is associated with shorter procedure times, reduced fluoroscopic time, and lower contrast utilization, with no significant difference in clinical outcomes. In line with these observations are the findings of earlier studies that highlight the procedural and clinical benefits of direct stenting, particularly in low to intermediate-severity coronary lesions (1). The baseline demographics of both groups in our study were equivalent, providing a proper basis for comparison. Most patients included in both groups had male sex, hypertension, and were middle-aged which were in line with the demographics of the rest of the patients getting PCI in Pakistan and other South Asian countries (6, 8).

The validity of our findings is enhanced by such similarity in the characteristics of the patients. Success rates were high in both procedures (98% in direct stenting and 97% in pre-dilation), indicating that both are effective in producing immediate revascularization. Nevertheless, procedural efficiency was significantly higher in the direct stenting group, as noted in the lower volumes of contrast, fluoroscopy time, and total procedure time. These results align with those of Bendary et al., who demonstrated that direct stenting resulted in a decrease in contrast dosing and a reduction in process time without affecting patient outcomes (1). A significant procedural issue associated with PCI is the occurrence of the no-reflow or slow-flow phenomenon, particularly in patients with ST-segment elevation myocardial infarction (STEMI). Such complications are typically caused by distal or proximal embolization, endothelial injury, or microvascular spasm (3, 14). Interestingly, a slightly lower incidence of no-reflow was also evident in the direct stenting group, although not statistically significant as per our study.

However, the tendency proves the hypothesis that the refraction of balloon inflation in arteries with thrombosis, such as in direct stenting, can decrease the incidence of distal embolization and microvascular dysfunction. Both Kumar et al. and Hassan et al. observed that in cases of high-thrombus STEMI, pre-dilation predisposed slow-flow and no-reflow by disrupting plaque and mobilization of thrombus (12, 17). Post-dilatation of the stent should be specified to achieve the best expansion of the stent, particularly in under-deployed stents or in animosity or calcified lesions. As Xu et al. stated, post-dilation enhances the coronary blood flow and decreases the major adverse cardiac events (MACE) among patients with STEMI (4). Our study did not particularly reduce post-dilation as a variable because it applied it wisely when required in both groups on the basis of intraprocedural angiographic evaluations. With severe calcification in the lesions, pre-dilation can also be necessary to adequately achieve stent deployment and expansion, as Dumitrascu et al. and Lis et al. emphasized the weaknesses of direct stenting in the conditions of severe calcification (7). It means that the morphology of lesions continues to be important regarding the choice of the suitable PCI strategy.

The PCI process has also been enhanced by technological innovations, such as optical coherence tomography (OCT), which enables more accurate stent placement. Osborn et al. demonstrated how a standardized OCT workflow can

optimize procedural outcomes and minimize thrombotic complications, specifically those related to the importance of proper lesion involvement assessment, such as direct stenting (11). Nevertheless, in research where intravascular imaging devices are scarce, as in most hospitals in Pakistan, well-trained clinical judgment remains necessary for protocolization. The safety profile of direct stenting was also evident in our study, as the rate of minor vascular complications was significantly lower compared to the pre-dilation group. The reason is attributed to fewer catheter manipulations and shorter overall procedural time, which reduces the risk of access-site and systemic complications. The existence of long-term outcomes was also reported by Scarparo et al. and Zijlstra et al., with the results being more favorable in direct stenting patients, particularly STEMI patients, which was added evidence confirming that direct stenting is one of the standard approaches in applicable cases (13). Both groups exhibited low rates of in-hospital and 30-day major adverse cardiovascular events (MACE), although the outcomes favored the direct stenting group by a small margin. This corresponds with the study by Jia et al., who claimed that measures of oxidative stress and myocardial injury are reduced in less traumatic procedures, such as direct stenting (18). Improved patient outcomes may result due to less procedural trauma, which may have an effect on positive myocardial recovery and decreased systemic stress response. Although the advantages of direct stenting are evident, one should also discuss circumstances in which pre-dilation cannot be avoided. Direct introduction of a stent may be impossible due to complex lesions, bifurcations, tortuous anatomy, or heavily calcified vessels. Under these conditions, pre-dilation can be a beneficial and even essential procedure to achieve a successful procedure and an excellent stent expansion (5).

Gardiner et al. wrote about the changing role of intravascular lithotripsy in facilitating stenting in calcified arteries. This procedure may be used to treat an increasing number of lesions directly in the future (9). The context of practice in developing countries is another aspect. The applicability of our study in real-life settings with limited resources is demonstrated in a high-volume cardiac center in Pakistan. Another study conducted by Akhtar et al. showed positive results of primary PCI in South Punjab and, to some degree, the necessity of the approach choice, depending on local experience, infrastructure, and the particular features of the population (8). The flexibility of the approach and tailoring of individualized care is critical in various clinical situations, which was also noted by Baqi and Saadia, highlighting the possible effects of the procedural strategy in the case of saphenous vein graft PCI, which is quite complex (10).

CONCLUSION

This research demonstrates that direct stenting is a safe and effective procedure, comparable to pre-dilation, in patients undergoing percutaneous coronary intervention (PCI), particularly in those with favorable lesion characteristics. Direct stenting has decreased procedure times, the amount of fluoroscopy exposure, and the volume of contrast used, increasing the efficiency of intervention without increasing the risk of in-hospital complications or major adverse cardiac events (MACE) at 30 days, despite the fact that both groups had a comparable rate of no-reflow and MACE. The direct stenting group experienced fewer vascular complications of any kind, indicating the safety advantage of direct stenting. Nevertheless, lesion morphology, thrombus burden, and vessel calcification play a key role in claiming what type of PCI should be used. Pre-dilation may be required in significant cases to deliver the best and expand the stent. These outcomes provide more evidence of the increased proficiency in the use of direct stenting in carefully chosen patients, especially in capacity-constrained high-volume areas, and the value of patient- and lesion-specific analysis to maximize results using direct stenting.

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