Early ambulatory discharge is safe and feasible after transradial coronary interventions

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A B S T R A C T
Background: At present, there are no definite criteria for selecting patients eligible for same-day discharge after percutaneous coronary interventions (PCI). With rapid ambulation and reduced vascular complication rates, transradial PCI have many features that favorably reduce costs and hospital stay. This study aimed to demonstrate the possibility of early ambulatory discharge following transradial percutaneous coronary interventions.

Methods: 254 consecutive patients undergoing transradial PCI (elective, urgent, and emergent) at our center was observed during hospital stay. Patient demographics, angiographic characteristics, post-procedural complications, and timing of these post-procedural events were recorded.

Results: A total of 336 lesions were treated among 299 vessels with 277 stents. One hundred fifty-two (45.2%) lesions were Type C. There were 26 chronic total occlusions (CTO). One hundred fifty-five (61%) patients were discharged on the same day after the procedure. 24 complications (12.6%) occurred and were divided into three groups according to occurrence time. 13 (54.2%) occurred within the first 2 h and 11 (45.8%) occurred after the 24-hour period. No complications were observed between the 2nd and 24th hours.

Conclusions: Same-day discharge with a 2-hour observation period is safe and feasible after successful transradial PCI in appropriate patients. Although a minor number of complications occurred, these did not occur between the 2nd and 24th hours. Same-day discharge after successful transradial PCI could be an alternative for better utilization of resources.

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1. Introduction
Hospitalization is one of the major causes of rising costs in health care. Despite the increasing cost, overnight hospitalization is still usually required after therapeutic coronary interventions. Major reasons for hospitalization are surveillance for access site complications and peri-procedural events in the first 24 h. The frequency of access site complications, in particular, is further increased by aggressive antiplatelet or antithrombotic therapy as in patients with stent implantation [1], which is an additional factor for the increased need for hospitalization in recent years.

With the increasing number of patients who needs coronary interventions, hospital resources must be used cost effectively. The transradial route has some advantages over the transfemoral route, with lower rate of access site complications and earlier ambition of patients [2–5]. The need for hospitalization following the transradial approach still has to be explored.

In this study, we aimed to demonstrate the post-procedural clinical course in the first 24 h following transradial PCI in order to determine the possibility of early ambulatory discharge.

2. Methods
This observational study was conducted in our center in which all diagnostic and PCI procedures are routinely performed via the transradial route. The study group consisted of 254 consecutive patients who underwent transradial intervention. Patient demographics, angiographic characteristics, post-procedural complications, and timing of these post-procedural events were recorded. The study was approved by the local ethics committee and an informed consent form was obtained from all patients.

2.1. Radial PCI technique
Following local anesthesia with 0.3 cm³ verapamil and 0.7 cm³ prilocaine 2% mixture, sheath insertion into the radial artery was performed using the standard Seldinger technique with a 21-gauge needle and a 0.018-inch guidewire. Short and hydrophilic 5- and 6-Fr sheath
introducers were used. The left radial approach was used for the saphenous vein graft (SVG) \(n = 23\) and left internal mammary artery (LIMA) \(n = 2\) interventions. After sheath insertion, 1 mg verapamil was administered intra-arterially against radial artery spasm.

### 2.2. Anticoagulation

Unfractionated heparin (5000 IU) was administered intra-arterially after sheath insertion. All patients were pretreated with aspirin and clopidogrel 75 mg/day and 600 mg loading dose of clopidogrel was given if the patient was not on clopidogrel therapy. GP IIb/IIIa inhibitors were used upon operator’s choice. The radial sheath was removed immediately after the procedure and compression was applied by sterile gauze bandage with the help of adhesive medical tape. The bandage was released gradually.

### 2.3. After the procedure

Patients were transferred either to a specially designed room with expandable comfort chairs (radial lounge) or to a normal ward (operator’s choice). The cardiologist who performed the procedure decided on hospitalization. If the patient was discharged within 24 h, a telephone call was made the following day by a fellow to learn about minor and major complications including bleeding, chest pain, palpitation, or any complaints, which needed admission to an emergency unit.

### 2.4. Definitions of complications

Local vascular complications were defined as local hematoma, bleeding, regional ischemia, arteriovenous fistula, and pseudo-aneurysm. Major bleeding was defined as a decrease in hemoglobin level > 5 g/dl or hematocrit ≥ 15%, or whole blood or packed red cell transfusions. Post-procedural myocardial infarction (MI) was defined as new pathological Q waves or elevation of creatinine kinase MB (CKMB) fraction greater than twice the normal upper limit.

### 2.5. Statistical methods

Data are expressed either as frequencies or medians (range). Data regarding occurrence of post-procedural MI and timing of events between groups were compared by Mann–Whitney U test. SPSS 15.0 (SPSS Inc., Chicago, IL, USA) statistical software package was used for all calculations.

### 3. Results

A total of 254 patients were included in the study. The demographics of the patients are given in Table 1.

A total of 336 lesions were treated among 299 vessels with 277 stents (95 bare metal stents (BMS), 102 cobalt-chromium, 72 drug eluting stents (DES), 2 graft-covered stents, and 6 polymer-coated stents). Those lesions were on the left main coronary artery (LMCA) in one, left anterior descending artery (LAD) in 132, circumflex artery (Cx) in 83, right coronary artery (RCA) in 107, LIMA in 2, and SVG in 11 interventions. One hundred fifty-two (45.2%) lesions were Type C. There were 26 CTO. Mean procedure time was 41.7 ± 21.1 min. In 53 patients, angiogram was performed via the left radial route (due to prior bypass surgery in 51 patients and a failure in the right radial artery cannulation in 2 patients). Seven (2.8%) patients received GP IIb/IIIa inhibitors. One hundred fifty-five (61%) patients were discharged on the same day after the procedure. Ninety-nine (39%) patients required prolonged hospitalization (>24 h).

### 3.1. Summary of complications

Twenty-four complications (12.6%) occurred and were divided into three groups according to occurrence time (0–2 h, 2–24 h, and >24 h) (Table 2). Of these, 13 (54.2%) occurred within the first 2 h and 11 (45.8%) occurred after the 24-hour period. No complications were observed between the 2nd and 24th hours.

There were no major bleedings. All minor bleeding events (8 patients) were observed during the first 2-hour period and were treated with manual compression and reapplying gauze bandage. Six of them were discharged on the same day after 4 h of surveillance. The other two were hospitalized because of the diagnosis of non-ST segment elevation MI.

There were eight post-procedural MI events. Four of them happened in the first 2 h. Two of these patients had chest pain and ST segment elevation in ECG as well as repeat catheterization during the 0–2 hour period. One of them had LMCA thrombosis after successful stent implantation to the Cx ostial region and this patient had post-procedural MI, VF, and was the only patient who required urgent coronary artery bypass graft surgery (CABG) during the 0–2 hour period. This patient also had stroke one day after CABG surgery. The other patient had LAD thrombosis after successful balloon dilatation only to LAD (because of small vessel size) and was treated with stent implantation. The other

### Table 1

| Demographics. |
|---------------|
| Male          | 196 (76.8%) |
| Age           | 62 ± 10     |
| Weight        | 80.9 ± 14.2 |
| BMI           | 28.35 ± 4.6 |
| Diabetes mellitus | 79 (31.1%)  |
| Hypertension  | 173 (68.1%) |
| Hyperlipidemia| 139 (54.7%) |
| Smoking       | 134 (52.8%) |
| Family history for CAD | 123 (48.4%) |
| Previous myocardial infarction | 87 (34.3%) |
| Previous CABG | 51 (20.1%)  |
| Renal failure | 13 (5.1%)   |
| Previous stroke| 4 (1.6%)    |
| Peripheral artery disease | 12 (4.7%)  |

| PCI indication          |               |
|-------------------------|---------------|
| Stable angina           | 157 (61.8%)   |
| Unstable angina         | 88 (34.6%)    |
| NSTEMI                  | 8 (3.1%)      |
| STEMI                   | 1 (0.4%)      |
| GP IIb/IIIa inhibitors  | 7 (2.8%)      |
| Type A/B1 lesion        | 75 (22.3%)    |
| Type B2 lesion          | 109 (32.4%)   |
| Type C lesion           | 152 (45.2%)   |
| CTO                     | 26 (10.2%)    |
| Single vessel PTCA      | 207 (81.5%)   |
| Multi vessel PTCA       | 47 (18.5%)    |

| CAD: coronary artery disease, NSTEMI: non ST elevation MI, STEMI: ST elevation MI. |

### Table 2

| Complications.          | 0–2 h | 2–24 h | >24 h |
|-------------------------|-------|--------|-------|
| Minor bleeding          | 6     | None   | 2     |
| Major bleeding          | None  | None   | None  |
| Post procedural MI      | 2     | None   | 6     |
| VT-VF                   | 1     | None   | None  |
| CABG                    | 1     | None   | None  |
| rePCI                   | 2     | None   | 2     |
| Death                   | None  | None   | None  |
| Atrial fibrillation     | None  | None   | None  |
| Stroke                  | None  | None   | 1     |

VT: ventricular tachycardia, VF: ventricular fibrillation, AF: atrial fibrillation.
two patients had chest pain without ECG changes and were managed medically. A total of six patients were diagnosed as post-procedural MI due to elevated CKMB levels the day after the procedure. Two of them had repeat coronary angiograms the next day. One of them had slow coronary flow in LAD, which was treated medically, and the other patient had critical RCA stenosis which was omitted during stent implantation to LAD and was treated with stent implantation. There was no statistically significant difference regarding stent size, length, and left ventricular ejection fraction on the occurrence of post-procedural MI between early and late post-procedural MI groups (Table 3). When cases were divided according to the complex nature of the procedure (bifurcation lesion, CTO, SVG lesion, and lesion containing thrombus) (Table 4), there was a statistically significant difference between patients with and without post-procedural MI (6 (75%) and 69 (28%) respectively p = 0.009). However, there was no statistically significant difference between early and late MI groups regarding whether the procedure was complex PCI or not.

As arrhythmias, there was one atrial fibrillation episode during the 0–2 hour period, which resolved spontaneously. The only ventricular fibrillation occurred in the patient mentioned above, who had LMCA thrombosis and urgent CABG in the first 2 h.

4. Discussion

This study was conducted to evaluate whether a same-day procedure is possible and to determine the appropriate discharging time after a successful transradial percutaneous coronary procedure.

As evidenced by the growing number of clinical reports, transradial intervention (TRI) is rapidly emerging as a widely practiced technique, with progressive advocacy for use as a first-line option rather than for bailout scenarios. Advantages of TRI include lower bleeding risk, fewer vascular-access complications, and increased patient comfort. Other benefits of TRI compared to femoral access are decreased management needs and length of stay, both of which might translate into measurable economic savings [2,3].

Two major concerns related to early discharge of PCI patients are stent thrombosis and bleeding risk. In recent studies, which utilize dual antiplatelet therapy and high-pressure balloon inflations, the incidence of stent thrombosis is reported between 0.5% and 1.9% [4,5]. Furthermore, with modern devices and antithrombotics, this rare complication occurs mostly in the first 6-hour period [6,7]. In accord with the literature in our study, there were only two patients with stent thrombosis, which occurred within the first 2 h. No patients had stent thrombosis during the 2nd to 24th hours.

TRI were shown to reduce access site complications [8,9]. Even with the use of aggressive antithrombotic agents, bleeding complication rates were extremely lower than for femoral access [10,11]. In our study, no major bleeding which required transfusion was observed despite intensive antithrombotic therapy. Two patients had forearm hematoma due to radial artery perforation with the guidewire and were successfully managed conservatively with pressure bandage.

At present, there are no definite criteria for selecting patients eligible for same-day discharge after PCI. The U.S. Society of Cardiac Angiography and Intervention (SCAI) published a white paper defining the length of stay after PCI [12]. They proposed limiting outpatient practice to patients with stable angina or silent ischemia presenting with single-vessel disease and normal ejection fraction. Although there were substantial amounts of high-risk patients in our study (34.6% unstable angina, 20.1% previous CABG, 45.2% type C lesion, 10.2% CTO, 18.5% multivessel disease), there were no procedure-related complications and no discharge delays as a result of adverse events between 2 and 24 h. Also, no subject was readmitted for an acute complication that might have been prevented by overnight hospitalization. These results show that same-day PCI can be applied to a large variety of patients.

With rapid ambulation and reduced vascular complication rates, transradial percutaneous coronary interventions have many features that favorably reduce costs and enhance quality of life. Although overnight hospitalization after PCI is routine, same-day discharge after successful transradial PCI could be an alternative for better utilization of resources. In elective PCI, Amoroso et al. reported a 50% reduction in nursing time post procedure with TRI compared to femoral access [13]. In 142 acute coronary syndrome patients undergoing PCI randomized to femoral or TRI, Roussanov also reported a 1.5-day reduction in length of stay with cost savings calculated at $2193 per procedure [14].

There are two studies in the literature investigating the complication rates via transradial interventions. The first one is a retrospective study where the authors investigated the appropriateness of SCAI discharge guidelines for transradial interventions in 100 PCI patients [15]. Although there were no readmissions for acute complications in patients who were discharged early, only 15% of these patients were eligible in the decision for early discharge given according to the statement in this study. In the second study, 450 transradial PCI patients were followed up for occurrence time of complications and it was concluded that the patients can be safely discharged after 6-hour surveillance [16]. In that study, transradial patients were selected among all PCI patients that could potentially cause a selection bias of non-complex PCI patients such as there being only 1.4% CTO, 7% three vessel disease, and 8% type C lesions.

Our study has the advantage of being prospective and being performed in a center where all interventions were via the transradial route. This way, more complex PCI patients were also included in the study without the conflict of selecting a low-risk profile, and therefore, representing real-world practice. Additionally, the absence of any major complications in the 2–24 hour period also demonstrates that it could be safe to discharge patients after a 2-hour surveillance. Although post-procedural MI was seen more frequently in complex PCI group, it did not affect occurrence time of MI. One-night surveillance in the hospital is standard after PCI but it does not prevent complications from occurring after a 24-hour period. Any adverse events before the 2nd hour would have disqualified the patients from early discharge; complications after 24 h would not have been prevented by traditional discharge schedule, and thus, did not impact protocol safety. An

| Complex PCI | Non-complex PCI |
|-------------|-----------------|
| 0–2 hour    | 2–24 h          | >24 h            |
| 0–2 hour    | 2–24 h          | >24 h            |
| Minor bleeding | (5.3%) | (5.0%) | (5.0%) |
| Major bleeding | (5.3%) | (5.0%) | (5.0%) |
| Postprocedural MI | (5.3%) | (5.0%) | (5.0%) |
| VT-VF       | (5.3%) | (5.0%) | (5.0%) |
| CABG        | (5.3%) | (5.0%) | (5.0%) |
| Death       | (5.3%) | (5.0%) | (5.0%) |
| AF          | (5.3%) | (5.0%) | (5.0%) |
| Stroke      | (5.3%) | (5.0%) | (5.0%) |
| Same day discharge | (54%) | (52%) | (54%) |

Table 3
Timing of post-procedural MI and patient characteristics.
additional period of overnight inpatient observation rarely leads to the diagnosis of unsuspected adverse events. Transradial interventions may reduce hospitalization costs and improve utilization of resources.

5. Study limitations

Requirement of special coronary equipment and multiple catheters, as well as more contrast, slowed overall catheter lab throughput, particularly early in the learning curve, thus the balance might have been less convincing. There might be a need for studies with more patients to understand the real cost effectiveness of transradial same-day procedures. This study was also conducted in a tertiary care center with extensive experience in transradial cardiac interventions since 2004; the results may not be generalizable.

6. Conclusions

Same-day discharge with a 2-hour observation period is safe and feasible after successful transradial PCI in appropriate patients. Although a minor number of complications occurred, these did not occur between the 2nd and 24th hours. Same-day discharge after successful transradial PCI could be an alternative for better utilization of resources.

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