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Balloon asisted tracking technique in complex transradial access: A single center experience

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ABSTRACT

Aim: The transradial technique (TRA) has become widely accepted for coronary catheterization. While TRA offers numerous benefits, certain anatomical challenges can lead to access failure. Balloon-assisted tracking (BAT) has emerged as a valuable technique to overcome these challenges and improve success rates. This study aims to evaluate the feasibility and efficacy of BAT during coronary interventions using TRA.

Methods: A retrospective analysis was conducted on patients who underwent diagnostic or percutaneous coronary intervention (PCI) procedures between September 2020 and May 2023. Patient demographics, clinical data, and procedural information were collected for cases where BAT was employed to overcome radial or brachial arterial complexity.

Results: A total of 23 patients encountered anatomical difficulties necessitating BAT during the procedure, both elective and acute coronary syndrome (ACS). Radial artery spasm was the most common indication for BAT, with a high proportion of female patients. Successful completion of coronary intervention using BAT, without the need for femoral artery crossover, was achieved in all cases except one. Also, the complexity of anatomy (such as tortuosity, arterial loop, or small artery crossing) was another reason for BAT use. The mean procedural time was 47.9 minutes, and no complications related to the access site were observed.

Conclusions: The findings demonstrate that BAT is a safe and effective technique for overcoming complex radial artery anatomical challenges and radial spasm during TRA. The study supports the adoption of BAT in TRA procedures and highlights its potential benefits in both elective and ACS cases.

Key words: Coronary angiography, transradial angiography, balloon-assisted tracking.

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Introduction

The transradial technique (TRA) has been thoroughly explored and validated for both coronary and peripheral catheterization [1,2]. According to different studies [3-6], this approach has shown a reduction in problems connected to the access site, such as substantial bleeding, as well as significant reductions in death rates. TRA is currently used frequently and successfully in primary PCI and more complex coronary operations such as left main coronary artery PCI, multivessel PCI, bifurcation, chronic total occlusions (CTO) and PCI in patients with cardiogenic shock [7-10]. As a result, the European Society of Cardiology has recently recognized TRA as the recommended access technique for coronary procedures [8]. TRA

does, however, offer certain anatomical difficulties in some individuals, which might result in access failure and call for the use of a different vascular access method. These structural challenges may include severe spasm, decreased artery width, atherosclerotic disease, complicated routes, complex loops, and the occasional dissection or perforation induced by catheter placement [9-12]. Several strategies have been used to circumvent these restrictions [12-15]. One such strategy, balloon-assisted tracking (BAT), first described by Patel et al. has been shown to dramatically improve TRA success rates in difficult instances [12]. The aim of this paper is to evaluate the feasibility and efficacy of BAT during coronary intervention using the TRA method.

Materials and methods

Ethical consideration

The study was started once the approval was taken from the local ethics committee (Decision No: 2023/218, Date: 20/06/2023). All patients were informed about the operation and perioperative process, and their verbal and written consent was taken before the operation. The study was conducted in accordance to the ethical principles of the Declaration of Helsinki.

Study design and population

During September 2020 and May 2023, all patients who received diagnostic or PCI procedures at our single center were retrospectively documented. Patients requiring larger catheters (such as CTOs or double stent bifurcation procedures) were excluded from the study. All patients in whom the BAT approach was used to resolve radial or brachial arterial complexity had their demographic, clinical, and procedural information collected. The results of radial arteriography, problems at the access site, such as hemorrhage, hematomas, or perforations of the radial artery, were gathered.

Balloon Asisted Tracking Technique

After evaluation of the radial artery pulse in each patient, local anesthetic was administered via a subcutaneous injection of 1 ml prilocaine 2%. A brief (10 cm) hydrophilic sheath made of 6-Fr or 5-Fr was used to secure the TRA (Radifocus, Introducer II, and Terumo). After sheath implantation, a preventative spasmolytic cocktail including 200 mcg of nitrates was usually given. The decision about which and how many catheters to use during the diagnostic coronary angiography was left up to the operator. A combination of 200 mcg nitrates and 2 mg of midazolam was injected if RAS developed. Verapamil administration and any other supplementary pharmacotherapy were left up to the operator's discretion. We used the BAT approach when severe refractory RAS prevented catheter advancement to the aortic root. As stated in the first report [12], we conducted BAT. To traverse the region of resistance, we utilized a 0.014 floppy wire. At the tip of the diagnostic or guiding catheter, a 2.0 x 12 mm semicompliant balloon was inserted, with half of it projecting from the catheter tip. The catheter-balloon assembly was advanced to pass through the resistant artery portion in an atraumatic manner after the balloon was inflated to a pressure of 6–8 atmospheres (Figure 1). All patients received an unfractionated heparin dosage adjusted for weight through the catheter. At the end of the operation, the arterial hydrophilic sheath was immediately removed in the angiography room and hemostasis was established using a compression device (TR Band, Terumo) for three to four hours. The radial pulse and access site were continuously monitored after hemostasis till discharge.

Statistical analysis

Data were collected, tabulated, and statistically analyzed. Before statistical analysis, distributional properties of the data were

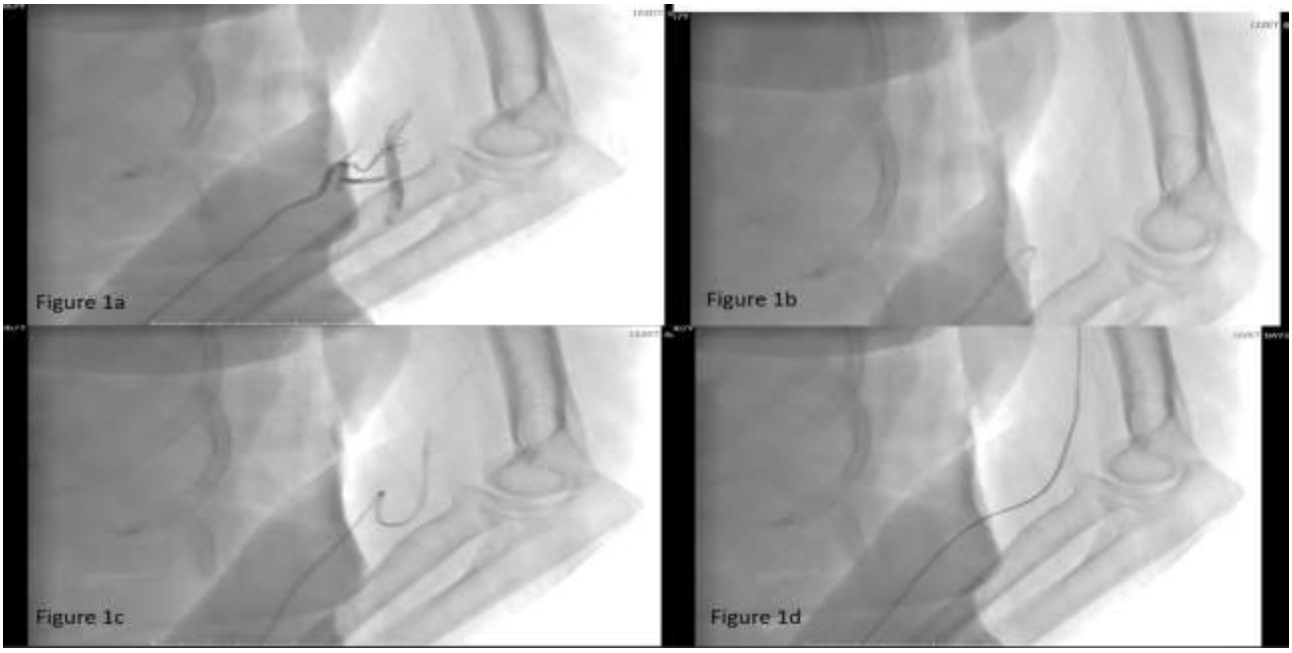

Figure 1. a) A complex radial arterial loop was showed. **b)** The arterial loop was wired but the 5F JR diagnostic catheter did not cross. **c)** A balloon was inflated in the catheter, then the balloon-catheter assembly crossed the arterial loop as a unit. **d)** After catheter passage into the brachial artery, the arterial loop was straighted by a stiff guidewire.

evaluated using the Shapiro-Wilk test. For normally distributed data, continuous variables were expressed as mean±standard deviation and group comparison was performed using independent two samples t-test. Non-normally distributed data expressed as meadian (min.-max.) and group comparison was performed using Mann Whitney U test. Categorical variables presented as the frequency and percentage and the $\chi 2$ test was used for bivariate comparison. The statistical software package 21.0 SPSS was used.

Results

The demographic characteristics of patients are shown in Table 1, while the Types of anatomical complications and procedural characteristics encountered are shown in Table 2. Overall in 23 patients, we encountered anatomical difficulties along the RA course requiring use of BAT to complete the procedure. The female gender was quite high with a rate of 73.9% in the patients who underwent BAT. Again, hypertension (82.6%) and dyslipidemia (86.9%) were more common in patients who underwent BAT. Approximately 1/3 of the cases who underwent BAT were in the form of ACS presentation (34.8%) (Table 1).

Table 1. Clinical characteristics of the patients.

Parameters	**n =23**
Female sex	17 (73.9%)
Age (years)	67 (44-81)
Diabetes mellitus	6 (26.1%)
BMI (kg/m2)	24.7 (21.3-29.8)
Smoking	6 (26.1%)
Hypertension	19 (82.6%)
CKD	1 (4.3%)
Previous CVE	1 (4.3%)
COPD	3 (13.1%)
Prior PCI	9 (39.2%)
Prior CABG	3 (13.1%)
Dyslipidemia	20 (86.9%)
Patients with ACS presentation	8 (34.8)

ACS: Acute Coronary Syndrome; BMI: Body mass index; CKD: Chronic kidney diseases; CVE: Cerebrovascular event; COPD: Chronic obstructive pulmonary disease; PCI: Percutaneous coronary intervention; CABG: Coronary artery bypass grafting.

All the patients were accessed through left radial artery; 13% being through distal radial artery in anatomical snuff box. BAT was applied from the 6F access sheet in 86.9% of the cases and 5F was used in the others. All of the patients had significant CAD and approximately three-quarters had undergone CABG and the rest were treated with PCI. The most common reason for needing BAT was radial spasm. In about half of the cases, BAT was used to overcome radial spasm and in one case it was used to treat radial perforation. Also, the complexity of anatomy (such as tortuosity, arterial loop, or small artery crossing) was another reason for BAT use. Coronary intervention was completed successfully in all 23 cases except one, without the need for femoral artery crossover. The mean total procedure time of the cases was 47.9 minutes and there were no complications related to access site (Table 2).

Table 2. Types of anatomical complications and procedural characteristics.

Parameters	**n =23**
Left radial artery Access	20 (86.9%)
Left distal radial artery access	3 (13.1%)
Access sheath size 6F	20 (86.9%)
Access sheath size 5F	3 (13.1%)
BAT for spasm	10 (43.5%)
BAT for tortuosity	5 (21.7%)
BAT for arterial loop	5 (21.7%)
BAT for small artery crossing	2 (8.7%)
BAT for arterial perforation	1 (4.4%)
Femoral artery crossover	1 (4.4%)
Visual analogue pain score	2.6 (1-5)
Total procedure time	47.9 (35.3-71.1)
Access site complication	0 (0%)

BAT: Balloon-Assisted Tracking.

Discussion

The main findings of our study are as follows: 1- BAT is a safe method that can be easily applied in complex radial artery anatomic difficulties. 2- The most common indication for BAT is radial artery spasm. 3- Most of the patients who underwent BAT are female. 4- The procedural time required for BAT is not very long. 5- There is a field of application in patients with ACS, as in elective cases.

The utilization of balloon-assisted tracking (BAT) has increasingly become a standardized approach to address a range of anatomical challenges encountered during transradial access (TRA). These challenges encompass resistant spasm, severe tortuosity, difficult loops, narrower vessels, stenotic lesions, and iatrogenic perforations [9-12]. The prevalence of these unfavorable anatomical variations varies from 2% to 10% in different studies and significantly contributes to procedure failure rates [10-15]. Larger studies investigating BAT have reported success rates ranging from 91% to 95%, with no associated complications [11-13]. Our study findings align with these outcomes, demonstrating a 100% success rate and no complications, thereby providing further support for the adoption of BAT in clinical practice.

It is critical for operators learning radial access (TRA) to comprehend the foundational ideas behind it as well as how to apply BAT in the right circumstances. When encountering resistance, getting an angiography of the radial artery to determine the underlying anatomical problem is critical, rather than blindly pressing the guide wire or catheter, which can result in iatrogenic vessel wall damage. In most cases, a hydrophilic wire can pass through, followed by the catheter. However, in more complex anatomies, early implementation of BAT is recommended. A reliable wire can successfully

navigate through challenging segments. Hydrophilic PCI wires can be useful alternatives. We commonly use 2x12 mm or 2x15 mm semi-compliant balloons, readily available in both 5Fr and 6Fr diagnostic catheters or guides, inflated at a pressure of 6-8 atmospheres, with half of the balloon protruding from the front end of the catheter (Figure 1). In instances where radial spasm is present, a cautious and direct application of pressure on the catheter typically facilitates crossing the resistant area. In some cases, gentle rotational movements may be necessary to navigate through complex loops or severe tortuosity. The utilization of a balloon-catheter assembly with a soft, conical-shaped tip and a more coaxial alignment enables the negotiation of resistant areas without causing trauma, thereby minimizing the potential risk of tissue damage due to the catheter's sharp edges when encountering resistance against the arterial wall [10,12,15]. Furthermore, the balloon-assisted tracking (BAT) technique can be adjusted by employing varying levels of balloon inflation pressure, depending on the specific anatomy of the radial artery. Lower pressure inflation (2-4 atmospheres) enhances flexibility and facilitates overcoming obstructions or tortuous segments, while medium pressure inflation (6 atmospheres) allows for better maneuverability in cases of severe radial spasm or narrower arteries [12]. Our experience indicates that interventional cardiologists find BAT relatively easy to learn, as observed in larger case series [10,12]. This ease of adoption may stem from the familiarity of cardiac interventionists with the use of percutaneous coronary intervention (PCI) wires and balloons. However, individuals primarily engaged in diagnostic coronary or peripheral procedures via transradial access (TRA) may find the learning curve for adopting this technique to be smoother. Our study has the following limitations. First, the major limitations of the study were retrospective design and a limited number of cases included reflection of the experience of a single institution. The second limitation was that due to the need for mid- and long-term data from the research population, it was unable to establish a link between BAT and mid- and long-term survival.

Conclusions

The BAT method is a safe and easy way to treat complex anatomical difficulties with the radial artery. Radial artery spasm is the most common indication for BAT, and most of the patients are women. BAT can also be applied to ACS patients, as in elective cases.

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