REVIEW

Clinical usefulness of a new method to improve transradial crossing by coronary catheters

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Abstract: Aims – The objective of this study was to evaluate the feasibility of a new technique for crossing the radial artery in case of severe refractory arterial spasm. **Methods and Results –** We conducted a prospective, non-randomized, single center study to evaluate a new technique „Pressure Facilitated Crossing" (PFC) that can facilitate radial artery crossing with coronary catheters by injecting saline solution directly by an automated pump system trough the introducer sheath. The primary endpoint was technical success which was defined as successful catheter passage after PFC. The secondary endpoint was the rate of access-site vascular complications. From January 2018 to December 2019, 22 patients with severe and refractory radial artery spasm, with an inability to advance coronary catheters, were prospectively included in a single center. The PFC technique was used as a bailout option and was successful in 21 patients (95%). No vascular complication was noted. Overall, this strategy was well tolerated despite a short-duration of pain during saline injection. **Conclusion –** In case of severe radial artery spasm during transradial access, the use of the PFC technique was effective and safe for crossing the radial artery with coronary catheters after failure of conventional approaches. This bailout method has the potential to decrease the need for vascular access conversion during transradial access.

Keywords: radial spasm, coronary catheters, percutaneous coronary intervention, radial pharmacological vasodilators, pressure-mediated radial dilatation.

INTRODUCTION

Transradial access (TRA) is becoming the access of choice for most coronary procedures due to reductions in vascular complications and major bleeding events[1-2].

In addition, emerging data suggest a decrease in mortality in high-risk patients presenting with acute coronary syndromes[3-4]. Moreover, TRA is associated with less discomfort and earlier ambulation than Transfemoral access (TFA).

However, there are some limitations of TRA which include a prolonged learning curve, an increased risk of operators radiation exposure and, in 2 up to 34% of cases, the presence of radial artery spasm (RAS)[5].

The main limitation to perform a coronary intervention by TRA and the most frequent cause of access-site crossover is severe RAS.

RAS can occur at any phase of the procedure increasing the failure of artery cannulation or difficulty in sheath or catheter introduction, provoking severe pain when the catheters are being advanced or retrieved RAS is also a predictor of a vascular complications and may induce radial artery (RA) injury or occlusion (RAO)[6].

In order to prevent and minimize the incidence of RAS, multiple options and techniques have been described and include downsizing of radial sheaths and catheters, use of hydrophilic coated sheaths, peri procedural sedation and pre-procedure administration of vasodilators[7-10].

However, when severe RAS occurs, treatment options are limited. In this setting, the induction of pressure overload in the radial artery[11-13] could represent an attractive concept. In previous trial, a direct injection of saline solution through the sheath was superior to pharmacological vasodilators for the treatment of RAS[14].

Based on this proven concept we evaluated a new approach „Pressure Facilitated Crossing" (PFC) to facilitated the advancement of catheters trough the

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radial artery when the pharmacological vasodilators failed.

METHODS

The study was performed during a 12 month period from January 2018 to December 2019 in a single center. All procedures were performed by 3 experienced operators (more than 1000 PCI in total per operator and with radial approach being used in 90% of cases).

After consecutive screening of 1420 patients who underwent coronary angiography and 755 patients who underwent coronary angioplasty, we included 22 patients who had a failed attempt to cross the radial artery by conventional catheters.

A failure to cross was defined based on at least one criteria:

- severe pain and friction when advancing the catheters;
- „feel of a stop or resistance" inducing pain.

Patients with an initial femoral access or with a need for larger guiding catheters >6 Fr were excluded.

In case of pressure damping at the level of the radial artery, the injection of saline was not performed and patients were not included in the study.

Procedure Description

After assessment of the radial artery pulse, local anaesthesia was applied by subcutaneous injection of 0.5 ml lidocaine 2%.

Radial artery puncture was performed using the Radifocus 5 Fr or 6 Fr introducer sheet kit (Terumo, Tokyo, Japan).

All patients received intravenous administration of unfractionated heparin, 5,000 U for diagnostic procedures and 100 U/kg for percutaneous coronary interventions.

Preventive administration of verapamil 2mg was performed for all patients.

A prophylactic anxiolytic standard treatment with midazolam 1-2 mg was administrated for all patients.

In cased of failure to cross the radial artery a pharmacologic regime with nitroglycerine 100 mcg plus verapamil 2 mg was infused through the sheath. The drugs were diluted in saline and administered slowly. After this treatment the operator reattempt to cross with catheters and in case of failure the patient was included in the trial.

The „Pressure Facilitated Crossing" (PFC) technique:

ACIST Injector (ACIST Medical Systems, Eden Prairie, MN, USA) is a universal, fully automatic contrast system for angiographic studies. Automatic valve can switch the supply of contrast and saline. Using the remote control, the operator was able to inject saline (0.9% sodium chloride) through the side port of the radial sheath with a flow rate of 1.6 ml per second (Figure 1).

In all cases, an attempt was made to advance the coronary catheter during saline injection, which represents an important technical aspect.

Data Collection and study endpoints:

This was a prospective and non randomised study which included every consecutive patient which had a failed attempt to cross the radial artery by a 5 or 6 Fr diagnostic or guiding catheters.

The primary endpoint was the technical success rate which was defined as successful catheter passage after the PFC technique. The secondary endpoint was the rate of access-site vascular complications.

RESULTS

During the study period, 22 patients were included and treated by the PFC technique. Baseline patient characteristics are shown in Table 1.

The primary end-point was achieved in 95%. There was no case of access-site vascular complications during the hospitalization stay (Table 2). At 30 days clinical follow-up, one patient 4.54% had an asymptomatic occlusion of the radial artery.

None of patients required a downsizing in catheters during the procedure.

Of note; 18 patients (81.81%) had a very short and transient episode of pain during saline injection.

No significant difference was observed between the operators in terms of failure to cross initially the radial artery.

Eighteen patients with failed catheters crossing had a pressure damping in in the radial artery and were not included in this study.

DISCUSSION

In this single-center study, The PFC technique was effective and safe in routine clinical practice when the operators failed initially to cross the radial artery despite the use of conventional approaches.

The previously described balloon-assisted tracking (BAT) technique was not tried in our series, mainly related to the supplementary steps needed with a significant increase in procedure time and resources use[15].

The PFC technique involved just one simple step, being neither time or cost consuming. The technique

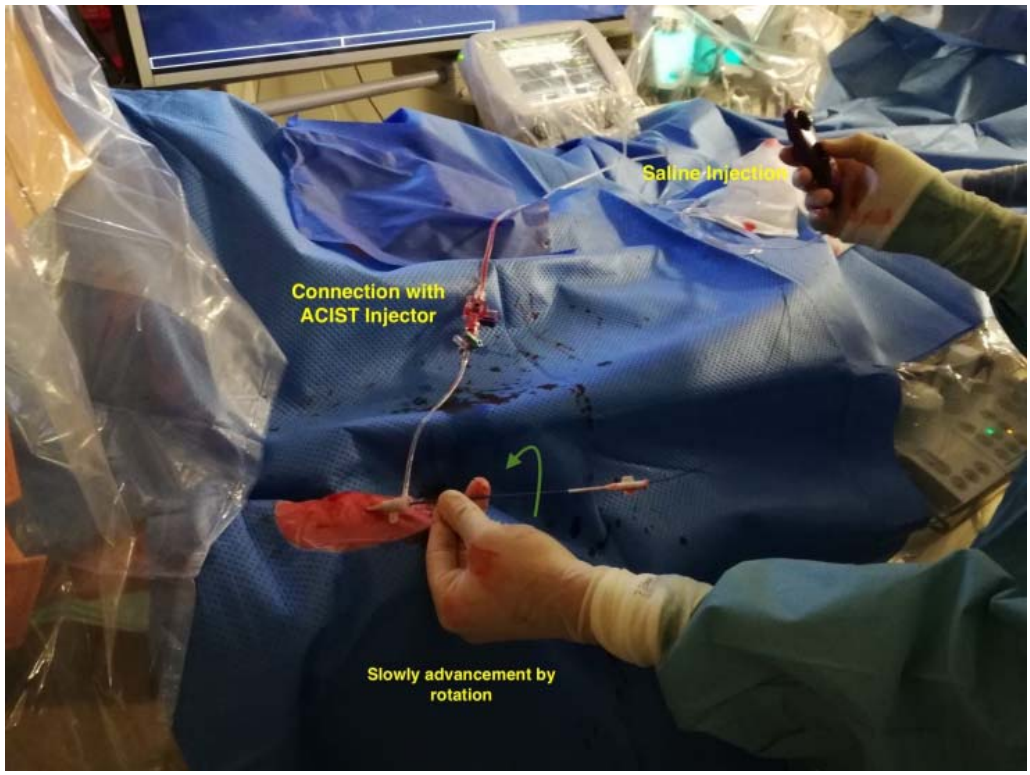

Figure 1.

is easily reproducible with all operators having similar results in terms of efficacy and safety in our study.

The possible mechanisms leading to vasodilatation when using this technique is the strain on the radial artery created by pressure overload in the vessel wall which causes mechanical distension and the activation of the stretch-activated calcium channels in the endothelium, which increases the production of nitric oxide (NO), a well-known potent vasodilator[16].

This mechanisms could explain the significant increase in the radial artery diameter by pressure-mediated technique in comparison with pharmacological vasodilators[13].

One other important aspects for the PFC technique could be the significant decrease of the friction between the arterial wall and the guiding catheter that may enhance the advancement and crossing of the most narrowed and spastic segment that is often located at the level of proximal radial artery.

Transradial access has been proven in contemporary trials to have multiple advantages even in term of mortality in comparison with the femoral access. This benefit can be lost in case of refractory radial artery

Table 1

Baseline Characteristics	
Number of Patients	22
Age (years)	62.8±25.7
BMI	31.1±11.1
Male gender	16 (72.7%)
Diabetes	8 (36.3%)
Hypertension	18 (81.81%)
Chronic kidney disease	3 (13.63%)
Acute coronary syndrome	2 (9.09%)
Congestive heart failure	2 (9.09%)
Tobacco abuse	10 (45.45%)
Previous Stroke	3 (13.63%)
Peripheral Arterial Disease	6 (27.2%)
Prior PCI	6 (27.2%)
Prior CABG	1 (4.54%)
Number of catheters	2.58±2.42
Procedure length (min)	59.7±120.3
Operator 1 rate of initial failure cross	8 (36.3%)
Operator 2 rate of initial failure cross	6 (27.2%)
Operator 3 rate of initial failure cross	8 (36.3%)

Table 2

Primary and Secondary end points	
Procedural succes of RSC technique	21 (95%)
Major access site complication during hospitalisation	0 %
In-hospital major bleeding	0 %
Conversion to another vascular access	0 %

spasm and 5% of patients in the RIVAL trial underwent a conversion in vascular access.

A more effective and safer treatment of severe RAS is needed in order to decrease the need for vascular access conversion.

The use of vasodilators can trigger adverse effects, including a significant drop in systemic blood pressure while pressure-mediated techniques have no influence on the systemic pressure.

The PFC is a very simple, inexpensive and easy novel technique to facilitate crossing with catheters through radial artery in case of severe RAS.

To avoid any vascular complication we need to avoid the saline injection in case of pressure damping and to advance slowly and carefully the guiding through the radial artery.

CONCLUSION

In case of severe radial artery spasm during transradial access, the use of the PFC technique was effective and safe for crossing the radial artery with coronary catheters after failure of conventional approaches.

This simple and readily available method has the potential to decrease the need for vascular access conversion during transradial access

Conflict of interest: none declared.

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