Is Radial Access and Transradial Cardiac Catheterization Feasible without the Use of Any Vasodilator?

Cemil Izgi, MD¹ Hasan Feray, MD²

¹ Department of Cardiology, International Hospital, Istanbul, Turkey

² Department of Cardiology, Acibadem Maslak Hospital, Istanbul, Turkey

Address for correspondence Cemil Izgi, MD, Department of Cardiology, International Hospital, Istanbul Caddesi, No. 82, Yesilkoy, Istanbul, Turkey (e-mail: cemil_izgi@yahoo.com).

Int J Angiol 2014;23:41–46.

Abstract

Keywords

- ▶ radial access
- ▶ transradial
- ▶ catheterization
- ▶ spasm
- ▶ vasodilator
- ▶ verapamil
- ▶ myocardial infarction

This is a “proof of concept” study to assess feasibility of transradial access without use of vasodilators. Radial artery spasm (RAS) is an important cause of patient discomfort and procedural failure with use of radial access. Vasodilators are routinely used to prevent RAS. However, the use of vasodilators may not be appropriate in substantial groups of patients. These include patients with myocardial infarction and low blood pressure who will benefit from radial access the most. No specific recommendations about use of vasodilators in these settings are stated on consensus documents on radial access. During a short period of shortage of verapamil in our country, 15 consecutive patients underwent cardiac catheterization by transradial route without the use of vasodilators. Procedural success, and pain perceived by the patients along with radial occlusion after the procedure were assessed. In 14 of the 15 patients, the procedure was completed successfully without the use of vasodilators. In one patient, RAS developed and the procedure could be completed after injection of verapamil. Mean pain score was 5.3 on a scale of 0 to 10. No radial occlusion was detected early after the procedure. In three of the patients, a reason that would otherwise preclude use of a vasodilator was identified. Radial access can safely and effectively be performed without the use of vasodilators. Consideration of this approach when use of vasodilators is not appropriate should be formally discussed by the interventional cardiology community.

Use of radial access for diagnostic and interventional procedures has been increasing worldwide in recent years.¹ Improved patient comfort combined with reduced risk of vascular complications attract operators to choose radial access.² Radial artery spasm (RAS) is an important cause of patient discomfort and procedural failure with the use of radial access.³ Use of several vasodilators is routinely recommended to prevent and/or overcome RAS. However, there is no well-defined recommendation about the type, dose, or combination of vasodilator drugs. Most operators use their own empiric recipe.⁴ On the contrary, with increasing experience radial access is now being used

more commonly in complex interventional procedures and high-risk patients. More patients with acute myocardial infarction (MI) and even the ones that present with cardiogenic shock are being treated through the transradial route.⁵ In fact, this is the patient group that radial approach has been shown to have favorable impact on cardiac mortality compared with femoral access.^{5,6} However, the use of vasodilators may not be appropriate or even be harmful in these clinical settings. No specific recommendation about the use of vasodilators in these patients has been addressed in a recent consensus document on radial approach.⁷

In this “proof of concept” study, we document the results of radial procedures performed without any vasodilators in small number of consecutive patients during a period when verapamil was out of stock in our country.

Methods

The study was conducted in a center with experienced radial operators who routinely use radial access for diagnostic and interventional procedures including in patients with ST elevation MI (STEMI). Our routine approach to prevent RAS has been intra-arterial 3 to 5 mg verapamil injected after radial access. However, over time, we decreased the dose of or completely omitted verapamil in patients whom we felt that verapamil would not be suitable. These include patients with left ventricular (LV) systolic dysfunction, hypotension or low-normal blood pressure, bradycardia or heart block, acute MI particularly those with inferior and/or right ventricular infarction, and complex coronary interventions particularly those involving the right coronary artery. Our observation from these patients was that transradial procedures could be successfully performed without the use of any vasodilators in majority of cases.

During a short period of 2 weeks, there was shortage of verapamil in our country when we continued transradial procedures without routine use of verapamil or any other vasodilators. We document the results in this article. We had a few vials of verapamil stored that we decided to use only in the case of an absolute necessity, namely, occurrence of significant RAS. Fifteen unselected and consecutive patients in whom transradial access was attempted for diagnostic and/or interventional purposes during this 2 weeks period were included in this observational study. We assessed three aspects of the outcome of these procedures (1) successful completion of the intended procedure through transradial route without need of any vasodilators, (2) pain perceived and scored by the patients, and (3) occurrence of radial artery (RA) occlusion after the procedure. All the patients gave informed consent, and the study was approved by the hospital review committee.

All the patients had a palpable radial pulse and a normal Allen test. All the procedures were performed through the left RA which is the default radial access site in our center. No premedication was given to patients. However, immense effort was put on by all the catheter laboratory staff to provide a calm and reassuring atmosphere for the patients. For local anesthesia, 2 mL of 2% lidocaine was injected subcutaneously by an insulin needle along the side of RA. RA access was achieved by the use of 20 G open bore needles, 0.025” hydrophilic short introducer guidewires, and 6F, 10 cm hydrophilic sheaths. After sheath insertion, 5,000 IU unfractionated heparin was injected through the side arm. In all the patients, hydrophilic 0.035” guidewires were used for advancing the catheters. Standard 6F left and right Judkins diagnostic and/or guiding catheters were used for all the procedures. If left ventriculography was performed, a 6F pigtail catheter was also used. Throughout the procedure, operators were free to use verapamil or nitroglycerin if they needed vasodilation to overcome RAS preventing catheter

manipulation and to continue the procedure. Arterial sheaths were removed in the catheterization laboratory immediately after the procedure. Puncture site was compressed with a TR band (Terumo, Tokyo, Japan), which was removed 2 to 4 hours after the procedure. Patients were asked to score the pain they felt throughout the procedure on a scale of 0 to 10; with 10 being the worst possible pain and 0, no pain. RA occlusion/thrombosis was assessed 1 to 3 days after the procedure by evaluation of patency of the RA with plethysmography.

Results

Patient characteristics and procedure details are summarized in ►Table 1. In five of the patients, 6F pigtail and in one patient, 6F Amplatz R2 guiding catheters were also used in addition to the 6F Judkins catheters. Single dedicated radial catheters were not used and in all the patients, at least two catheters were exchanged. The intended procedure was completed in 14 of the 15 patients without any need of vasodilators (93% success rate). In all of these 14 patients, the operators did not experience any difficulty or resistance during advancement and retraction of the catheters and cannulation of the coronary arteries. In patient 8, after right coronary angiography severe RAS occurred while the 6F right Judkins catheter was being retracted. The patient felt severe pain; therefore, the catheter was not retracted any further. Verapamil 5 mg was injected through the side of arm of the radial sheath and 2 mg morphine was injected intravenously. After 10 minutes of waiting, RAS and pain were relieved and the catheter was retracted without any resistance. Just as a precaution, the procedure was continued with a 5F left Judkins catheter and was completed successfully. Interestingly, this patient was a well-built middle-aged male; a patient that one would consider as an ideal candidate for transradial access. In another patient (patient 11), intracoronary injection of 200 µg nitroglycerin was used during the procedure for assessment of coronary artery lesion severity.

Mean pain score was 5.3 which reflects moderate severity of pain perceived by the patients. Although there was no control group to compare with, this score at least appears to suggest a reasonable pain level. There was wide range of pain scores from as little as 2 to 8 over 10 suggesting that other factors besides use of vasodilators and individual perception of pain may be playing a role on the pain perceived by the patients. No vascular access site complications were observed. Also, there were no cases of thrombotic occlusion of the RA detected early after the procedure, a concern that could be raised with increased rates of RAS.

Of note, in three of these unselected consecutive patients, use of calcium blockers or nitroglycerin would either be contraindicated or at least unfavorable in our view. The clinical information of these patients is summarized in ►Table 2.

Discussion

The results of this observational study suggest that transradial approach for diagnostic and/or interventional

Table 1 Characteristics of the patients and procedures

Patient no.	Age/sex	Height (cm)	Weight (kg)	Diagnosis	Risk factors	Procedure	Procedure success	Vasodilator use	Pain score	Radial occlusion
1	50/F	160	80	SAP	DM, HT, HL	TRA	+	–	5	–
2	48/M	172	84	SAP	HT, SMK	TRA/TRI	+	–	4	–
3	39/M	182	99	SAP	HL, SMK	TRA	+	–	5	–
4	56/F	150	69	USAP	DM, HT, HL	TRA	+	–	6	–
5	60/M	165	74	SAP	HT, HL	TRA	+	–	4	–
6	64/M	174	80	USAP	HL, DM, SMK	TRI	+	–	3	–
7	68/F	167	78	USAP	HT, HL	TRA/TRI	+	–	5	–
8	49/M	182	110	SAP	DM, HT, HL, SMK	TRA	+	+	8	–
9	48/M	182	85	SAP	HL	TRA	+	–	6	–
10	54/F	156	73	USAP	HT, SMK	TRA/TRI	+	–	6	–
11	67/F	160	78	USAP	DM, HT, HL	TRA	+	+	7	–
12	67/F	159	64	SAP	HL, SMK	TRA	+	–	4	–
13	46/M	174	73	USAP	HT	TRA	+	–	7	–
14	61/F	160	80	SAP	DM, HT, HL	TRA	+	–	8	–
15	46/M	169	62	SAP	SMK	TRA	+	–	2	–

Abbreviations: DM, diabetes mellitus; HT, hypertension; HL, hyperlipidemia; SMK, smoking; SAP, stable angina pectoris; TRA, transradial angiography; TRI, transradial intervention; USAP, unstable angina pectoris.

procedures can be effectively and safely performed without the use of any vasodilators. Also, the pain perceived by the patients appears to be moderate and reasonable, and there was no increased risk of radial occlusion. Our experience was about omitting verapamil as a vasodilator, but the findings apply to any vasodilators used in transradial access. However, our aim with this study is not to advocate performing transradial procedures without using vasodilators. We aimed to provide observational evidence to question routine and empiric use of vasodilators during transradial procedures. Our

rationale on doing this was as follows: First, there are substantial numbers of patients that the use of vasodilators, particularly verapamil is inappropriate, such as patients with severely impaired LV systolic function. Second, use of calcium channel blockers (CCB) for any reason is not recommended in the setting of acute MI and may have hazardous effects.⁸ However, this is the patient group that transradial access has particular advantage.^{5,6,8} Third, while there are several different vasodilators used by operators, the choice is mostly empiric and experience based rather than depending on objective evidence.⁴ Accordingly, we think that performing transradial procedures without the use of vasodilators should also be formally considered as a viable option for patients, in whom use of vasodilator drugs will not be appropriate. In fact, despite a clear recommendation and contrary to the common practice, transradial access is performed without the use of vasodilators by some operators in Japan, as revealed in the first international transradial practice survey.¹ However, no further details about this practice were available from this registry data.

Occurrence of RAS is one of the most important problems during radial procedures that may be the determining factor of procedure success. Rates of RAS have been reported to be in the range of 3 to 20% in different studies.^{3,4} The RA is very prone to spasm in structure, but it is also the level of provocation and size of the RA that determines the

Table 2 Patients unsuitable for vasodilator use

Patient no.	Procedure	Reason why CCBs or NTG would not be favored
4	TRA	Post-MI, LV EF 30%, bp: 90/60 mm Hg
6	TRI	Post-MI, thrombotic complex RCA PCI, bp: 105/60 mm Hg
15	TRA	Bradycardia (54/min) and borderline bp (90/55 mm Hg)

Abbreviations: bp, blood pressure; CCB, calcium channel blockers; LV EF, left ventricular ejection fraction; MI, myocardial infarction; NTG, nitroglycerine; PCI, percutaneous coronary intervention; RCA, right coronary artery; TRA, transradial angiography; TRI, transradial intervention.

occurrence and severity of spasm. It is well known that one of the most important factors related to occurrence of RAS is operator experience. Besides the drugs to prevent spasm, a smooth transradial procedure with cannulation in first puncture, gentle catheter advancement and manipulation, and a calm atmosphere to minimize adrenergic discharge in the patient are as important. Although vasodilators are widely used, effectiveness of different drugs on RAS has not always been consistent among studies and may not be predictable. Also, it is difficult to compare different studies as the methods of assessment and defining RAS are not consistent. Some studies report about the change in diameter of RA while others define clinical occurrence of RAS or pain perceived by patients. For example, although widely used, effectiveness of verapamil may be as low as only 9% increase in RA diameter as demonstrated in a well-conducted study.⁹ Combination of a CCB with nitroglycerine was shown to be superior to CCB alone in one study¹⁰ but has been shown to be indifferent in another study.¹¹ Moreover, some vasodilators may be effective in relieving existing spasm but their effectiveness may be less to prevent its occurrence. In a model of vasopressin-induced RAS, Wei et al showed that both nitroglycerin and sodium nitroprusside reversed RAS, but they were not effective for prevention of RAS when they were applied prophylactically.¹² On the contrary, other studies have underlined the importance of controlling the stimuli itself that provokes RAS. Deftereos et al have shown that use of low-dose benzodiazepine and opioid combination during transradial procedures significantly reduced RAS.¹³ Such a combination most probably will not have a significant effect on the hemodynamics of the patient. It is now well known that hydrophilic sheaths by being less traumatic are effective in reducing RAS and patient discomfort.¹⁴ Noninvasive induction of reactive hyperemia has been shown to provide up to 20% mean increase in RA diameter.¹⁵ These studies suggest that there are other effective maneuvers to decrease the incidence of RAS which should be vigorously attempted particularly when vasodilators are not an option.

Recently, in the RIVAL trial radial route has been shown to improve outcome in patients with STEMI when performed by experienced radial operators.⁶ These results have been welcomed with great enthusiasm in the cardiology community, as in the era of very effective pharmacological treatment further improvement in the outcome of STEMI patients could be achieved simply by the choice of vascular access. In the recent STEMI guidelines, use of radial access is a class IIa recommendation in primary percutaneous interventions (PCI) when performed by an experienced radial operator.⁸ Another study, RIFLE-STEACS trial provided further evidence on superiority of radial over femoral access in primary PCI.⁵ However, there have been no details on use of vasodilators provided in these studies. In the RIFLE-STEACS trial, patients with cardiogenic shock were not excluded from the radial access study group. In a recent study, radial access have been shown to be effective in patients with cardiogenic shock and yielded superior patient outcome compared with femoral access.¹⁶ These were patients whose systolic blood pressure was < 90 mm Hg or vasopressors were needed to sustain

blood pressure above 90 mm Hg. Again, there were no details about use of vasodilators in this study. Lack of specific data about use of vasodilators in these studies suggests that this issue may not be attracting the attention that it deserves. It is obvious that, conventionally, use of vasodilators will most probably be contraindicated in patients with cardiogenic shock. On the contrary, there is significant activation of the sympathetic tone throughout the body in the setting of cardiogenic shock. Feasibility of radial access in these patients suggests that RAS is preventable or at least manageable in the hands of experienced operators even in these patient groups.

Two different expert consensus documents on transradial approach in PCI were published recently; one endorsed by the European Association of Percutaneous Cardiovascular Interventions⁷ and the other endorsed by the Society of Coronary Angiography and Interventions (SCAI).¹⁷ In both of these documents, specific recommendations about use of vasodilators in the setting of STEMI and cardiogenic shock (or other clinical situations that use of vasodilators will be unfavorable) are either scarce or totally absent. In the former, this issue has not been addressed. In the SCAI document, a concern about use of vasodilators in patients prone to hypotension is stated without making any specific recommendation. For primary PCI in STEMI patients, SCAI document suggests that femoral access may be favored in hemodynamically unstable patients who may not tolerate spasmolytic cocktail.¹⁷ However, this may exclude substantial number of STEMI patients from use of radial access. Also, this is a vague statement as most of the patients with STEMI are potentially prone to hemodynamic instability. For instance, theoretically the use of a vasodilator cocktail of nitroglycerin combined with verapamil will be of significant concern in a patient presenting with acute inferior MI. Another word of caution is about use of calcium blockers in the setting of acute MI. In the 2004 ACC/AHA STEMI guidelines, use of verapamil and diltiazem was noted to be contraindicated in patients with STEMI and associated LV systolic dysfunction.¹⁸ In the more recent ESC guidelines, it is stated that "There is no case for using calcium antagonists for prophylactic purposes in the acute phase," as a meta-analysis of trials on use of calcium antagonists early in the course of a STEMI revealed a trend toward harm.⁸ All these data put the safety of routine use of vasodilator cocktails in STEMI patients under question. As an analogy, use of IV β blockers, once a popular and recommended therapy in STEMI, has only recently been found to be increasing rates of cardiogenic shock in STEMI patients.⁸ There is no evidence that routine use of vasodilators particularly CCBs for transradial access in STEMI does not have such a similar end result.

Conclusion

In conclusion, the results of this study suggest that transradial access may be performed without the use of vasodilators. This approach should be considered when use of vasodilators is not appropriate. Larger studies are needed to understand the absolute necessity and effectiveness of vasodilators in transradial procedures. Consensus documents and guidelines

should include more clear recommendations on how to perform transradial procedures in patients when use of vasodilators is not appropriate.

Conflict of Interest

The authors declare no conflict of interest related to this article.

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