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Reducing Radial Artery Spasm

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Take Home Messages

• Reducing Radial Artery Spasm. It is important because it is one of the most common complications encountered by interventionists while performing trans-radial coronary angiography. It causes patient discomfort and reduces procedure success rates.

• SPASM Study[1]: This study was a first double-blinded randomized controlled trial evaluating the effectiveness of vasodilatory medications including nitroglycerine, verapamil, etc. upon reducing RAS.

•Key Take-home message: Every operator must learn those tips and tricks in this editorial to overcome the challenge of radial spasm and leads to better patient outcomes.

Introduction

Radial artery spasm (RAS) is a commonly encountered complication with the evolution of trans-radial access as the preferred approach worldwide for cardiac catheterizations. It is believed that the reported incidences of RAS is variable between 4% and 20% during trans-radial diagnostic or interventional cardiology procedures in recent years[9]. However, the occurrence of problematic RAS could hinder and complicate subsequent trans-radial interventional procedures if it is not anticipated and prevented by operators in time. Thus, these editorial aims to describe methods for reducing RAS, including a simple catheter-in-guide technique, pre-medications, and choice of sheaths, for interventional cardiologists to implement during trans-radial procedures.

What is radial artery spasm?

Radial artery spasm is defined as a temporary, sudden narrowing of the radial artery and it frequently occurs during diagnostic coronary catheterization[2]. Clinically, RAS is associated with severe pain or discomfort in the forearm, which is exaggerated by catheter or sheath movement, and subsequently limits the operator's ability to manipulate the coronary catheters[2]. There is also loss of radial pulse and damping of radial arterial pressure[2]. When it occurs, the operators usually perform a radial arteriogram (fig 1-A)[9] to confirm spasm and to rule out vessel dissection. Thus, it is crucial for operators to understand the role of angiographic confirmation as sometimes pain in the arm may not be caused by spasm alone but by other factors tortuosity or loops in radial,

brachial or subclavian arteries, which makes the catheter movement difficult and cause discomfort to the patients. Overall, it is believed that inadequate patient premedication (vasodilator therapy such as nitro-glycerine, verapamil, etc), difficult arterial access, excessive catheter manipulation and exchanges, suboptimal sheath or catheter sizing, and smaller or tortuous radial arteries, contributes to radial artery irritation and the development of problematic RAS[2].

While the exact physiological mechanism causing RAS remains unclear[2] and radial artery spasm cannot be prevented entirely, there are interventions that have been proven to reduce the rate of this complication. Therefore, this editorial would like to guide several evidence-based protocols to reduce radial spasm, which generally target to

(1) maximize patient comfort,

(2) avoid radial artery irritation

(3) Increase the chance of radial procedural success rates[2]

Figure 1: (A) Arteriogram showing diffuse spasm in radial artery[9]. (B) Arteriogram showing resolution of spasm after bolus injection of intraarterial nitro-glycerine[9]

Rationale of reducing radial artery spasm

(1) Rationale of Intra-arterial Vasodilatory Medications (SPASM trial)[1]

Most vasodilatory cocktails will incorporate nitro-glycerine or verapamil or other less commonly used agents such as molsidomine[3], diltiazem, on top of intraarterial heparin, and its effectiveness in reducing RAS has been widely reported in several evidence-based randomised controlled trials

(RCTs) including the SPASM 1,2, and 3 studies, that have robustly evaluated the effectiveness of vasodilatory medications upon reducing radial artery spasm[1].

1.1. Study Outcomes (SPASM studies)[3]

The study characteristics in Table 1 summarizes several factors that were associated with the occurrence of RAS during percutaneous coronary intervention (PCI). Patients with RAS were younger (57.2 vs. 61.6 yr, $P < 0.0001$), and were more frequently female (55.4 vs. 25%, $P < 0.0001$)[1]. It was demonstrated in studies that the rate of RAS was significantly reduced by molsidomine 1 mg (13.3%, $P = 0.02$ vs. placebo), further reduced by verapamil 2.5 mg (8.3%, $P < 0.0001$ vs. placebo) and by the combination of verapamil and molsidomine (4.9% vs. placebo, $P < 0.0001$). No difference was noted between patients receiving verapamil 2.5 mg or 5 mg (7.9% vs. 8.3%; $P = 0.78$)[3]. Moreover, Table II [3]demonstrates the univariate and multi-variate odds ratios of vasodilatory medications in comparison with placebo, all vasodilators reduced the odds of having a RAS during the procedure. The relative risk reduction ranged from 46% for molsidomine to 87% for the combination of verapamil and molsidomine[3].

Table I. Characteristics of Patients with Radial Spasm[3]

	Spasm (*n* = 132)	**No spasm (*n* = 1087)**	***P****
Age (years)	57.2 (12.9)	61.6 (11.3)	<0.0001
Male	72 (54.6)	811 (75.0)	<0.0001
Procedure duration (min)	35.2 (18.4)	33.9 (19.4)	0.48
Number of catheters used	3.15 (1.15)	3.30 (1.05)	0.14
5F sheath	87 (65.9)	683 (63.3)	0.51
6F sheath	45 (34.1)	402 (36.7)	

Table II. Univariate and Multivariate Odds Ratio of Radial Spasm [3]

	Univariate			Multivariate*		
	OR	**CI 95%**	***P***	**OR**	**CI 95%**	***P***
Placebo	1	–		1	–	
Molsidomine	0.54	0.32–0.91	0.02	0.47	0.27–0.81	0.007
Verapamil 2.5 mg	0.26	0.14–0.50	<0.0001	0.23	0.12–0.45	<0.0001
Verapamil 5 mg	0.21	0.08–0.54	0.001	0.22	0.07–0.66	0.007
Verapamil 2.5 mg + molsidomine	0.13	0.05–0.35	<0.0001	0.16	0.05–0.49	0.002

- OR were estimated by logistic regression and were systematically adjusted for the trial[3].
- * Analysis was additionally adjusted for age, sex, angioplasty procedure, sheath and wrist diameters, number of catheters, and pain scale[3].

(2) Rationale of using procedural sedation[5]

It is suggested that the vascular tone of radial artery is susceptible to the patient's sympathetic tone, thus RAS can be easily induced by anxiety and pain. Thus, it has been shown that achieving adequate procedural sedation[4] can dramatically reduce RAS with an odds ratio of 0.26 compared to no sedation (95% CI 0.18-0.47)[4]. Moreover, adequate sedation improves patient satisfaction with no significant differences in safety outcomes.

(3) Rationale of 'Hydrophilic Sheaths' and 'Sheathless Guiding Catheter' [5]

It is proposed that sheath selection plays a crucial role in reducing RAS. The evidence suggests that hydrophilic sheaths have been shown to reduce RAS incidences and should be used in preference to uncoated alternatives[5]. In a feasibility study [5], the innovation of Asahi sheathless

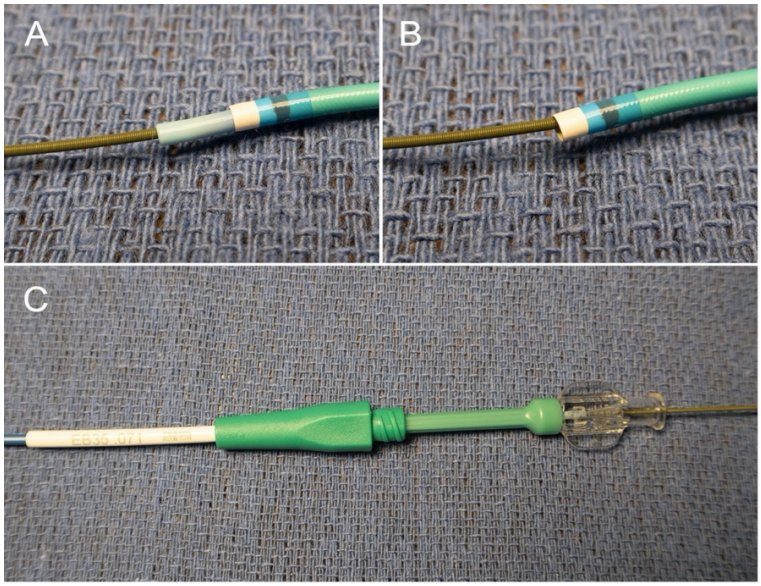
hydrophilic guiding catheters has enabled interventional cardiologists to perform complex coronary intervention using radial approach, instead of using 7-French guiding catheter using femoral access. The rationale behind this design of catheter is that it has hydrophilic coating along its entire length, making it advantageous for prevention of radial artery spasm. Currently, in some areas, operators have strongly recommended trainees or fellows to employ sheathless guiding catheters in patients who have developed severe radial artery spasm during trans-radial coronary angiogram, although there is still paucity of data on further evidence of those new devices[2].

(4) Rationale of Catheter-in-Guide Technique[6,7,8,9]

From an era of transition from trans-radial diagnostic coronary angiogram to more complex trans-radial coronary intervention, the impact of radial artery spasm was inevitable and most experienced operators utilize the catheter-in-guide technique[7], which is sometimes regarded as 'spasm-saving manoeuvre'. This may be a simple additional trick to successfully and safely advance the guide catheter through the radial artery, though the mechanism is to clearly avoid the traumatic "razor effect''[7]. Of note, it is recommended for operators to utilize ballon-assisted tracking to facilitate guide catheter advancement for patients with severe RAS as this technique can minimize the 'razor effect' and reduce radial artery irritation.

The below figure demonstrates the stepwise proforma of 'catheter-in-guide' technique[6,7,8], which has been proven to reduce RAS and improve procedural success rate. [6]

Figure 2. Catheter-in-guide assembly for a trans-radial coronary intervention[6].



(Figure 2-A, B, C illustration)[6] (Figure A- illustrates the tip of 1 5F TIG 4.0 diagnostic catheter (light blue colour) protrudes beyond the tip of a 6F EBU 3.5 guide catheter (white colour), and two of them assembly over the 0.035-inch guidewire).

(Figure B- Guide catheter alone, without diagnostic catheter, which demonstrates howe aggressive the tip of the catheter, due to 'razor effect' when advanced along the inner wall of radial artery) (copyright permission taken)[6]

(Figure C- The TIG 4.0 diagnostic catheter (110cm long) is completely embraced within the guide catheter (100cm long), then, the catheter assembly is advanced smoothly together in this fixed configuration across the radial artery).

Conclusion

Radial artery spasm is a frequently encountered complication with the evolution of trans-radial coronary angiography. As prevention is always better than cure, reducing radial artery spasm has been an area of interest in the field of interventional cardiology as there are multiple evidence-based preventative strategies that can be adopted. Thus, this editorial aims to guide the use of vasodilatory medications, sedation, choice of sheaths, and a simple 'catheter-in-guide' technique (in severe RAS cases) , which can ultimately help operators successfully overcome the challenges of radial artery spasm and achieve higher trans-radial procedural success rates in future[9].

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