



Alternative access site choice after initial radial access site failure for coronary angiography and intervention

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Abstract

Background Transradial access for coronary catheterization is more technically challenging compared to the traditional transfemoral approach and radial access failure is quite common. The aim of this study is to describe the additional steps after initial radial access site failure in a high specialized forearm approach center. **Methods** A retrospective evaluation of all coronary catheterizations performed in our Department between January 2016 and December 2016 was performed, with focus on arterial access. **Results** One thousand three hundred forty six procedures were evaluated. The initial access site used was right radial [1173 procedures (87.1%)], left radial [120 procedures (8.9%)], right ulnar [7 procedures (0.5%)], left ulnar [40 procedures (2.9%)] and femoral approach [6 procedures (0.4%)]. Radial artery cannulation failure was observed in 37 procedures (2.9% of 1293 procedures with initial radial approach). Failure of procedure completion after successful radial sheath insertion was observed in 46 procedures (3.6%). The alternative access site after initial radial approach failure was contralateral radial [43 procedures (51.8%)], ipsilateral ulnar [22 procedures (26.5%), contralateral ulnar [12 patients (14.5%)] and femoral approach [6 procedures (7.2%)]. **Conclusion** Forearm arteries can be used as alternative access site after initial radial approach failure in order to reduce the use of femoral approach during cardiac catheterization.

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1 Introduction

Transradial approach (TRA) for coronary catheterization is a world-wide fast growing technique. Compared to the traditional femoral approach it is associated with less access site bleeding complications^[1] improved patients' comfort^[2] and shorter duration of hospitalization.^[3] Complex procedures can be performed through the transradial approach^[4] and some of them may additionally be discharged the same day.^[5] However, one of the disadvantages of the TRA is the high conversion rate to another approach.^[1,6] The small size of the radial artery and the fact that it is often tortuous and prone to spasm makes TRA more challenging, with higher crossover rates^[6] and longer learning curves.^[7] Crossover from TRA to TFA is not without risks. The fact that TRA

failed represents an additional risk factor, since if femoral approach is the next choice, femoral artery cannulation will be performed from a tired physician to a tired and anticoagulated patient, as the majority of the operators administer unfractionated heparin to prevent radial artery occlusion. The aim of this study is to investigate alternative access site choice after TRA failure in a center highly specialized in forearm approach.

2 Methods

2.1 Population of the study

This is a cohort study. All consecutive patients who underwent coronary angiography and/or coronary intervention at the 2nd Cardiology Department of Hellenic Red Cross Hospital of Athens from January 2016 to December 2016 were retrospectively evaluated. Patients undergoing chronic total occlusion percutaneous coronary intervention (PCI) with planned dual access site utilization and patients participating in trials and randomized between forearm and femoral approach were excluded from the analysis. All op-

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erators were high volume (more than 200 procedures per year the last five years) and experienced in both forearm and femoral approach, although the last years the great majority of the procedures in our institute were performed by the transforearm approach. The routines of our institute concerning access site indications and treatment have not changed significantly during the study period.

2.2 Transforearm catheterization procedure

The cannulation of the radial or ulnar artery was previously described.^[8] Neither Allen's nor Barbeau's test were performed before the procedure since they are not part of our laboratory routine,^[9] except of patient's participating in randomized trials. Diagnostic and non complex PCI procedures were performed with 6Fr hydrophobic 11-cm long sheaths (KDL, China) or 6Fr hydrophilic 11-cm long sheaths (St. Jude, USA). More complex procedures, like chronic total occlusions with single access site, rotational atherectomy facilitated PCI or bifurcation lesions were performed in most of the cases with 7Fr Guiding catheters. The exchange to the 7Fr sheath was performed over a 0.038" wire and a 7Fr femoral introducer (Cordis, USA) was inserted in the forearm artery.

2.3 Transfemoral catheterization procedure

After local lidocaine administration, the femoral artery was punctured with a 18G needle and a 0.038 inches wire was introduced in the artery. Then, a 6Fr or 7Fr femoral introducer (Cordis, USA) was inserted in the artery.

2.4 Access site choice

The initial access site choice and the sequence of alternative access sites, in case of initial access site failure, were both on operating physician discretion. The following algo-

rithm was followed: main approach was the right radial approach. In case of failed right radial artery cannulation, the right ulnar approach was then evaluated. In case of right ulnar artery puncture failure or if the operator decided not to proceed to right ulnar puncture, the left radial and ulnar arteries were then evaluated. If right radial approach failed after successful sheath insertion due to spasm, radial artery dissection or perforation the left forearm arteries were then evaluated. If there was a right radial access site failure due to tortuosity or anatomic variations, then the choice was influenced by the type of problem: if there was inability to advance the catheters below the level of the brachial artery (tortuosity, high take off radial artery) then the next access point was the right ulnar artery. At the end of the procedure, these patients have two sheaths in the same forearm, one in the radial and one in the ipsilateral ulnar artery. If the difficulties were at the level of the brachial artery, subclavian artery or aortic arch, then the next access site was one of the left forearm arteries. This algorithm is presented in Figure 1.

2.5 Patients with prior by-pass operation

These patients represent a challenging group for forearm catheterization.^[10] In general, the following protocol was followed: (1) patients with only vein grafts were treated like not operated patients; (2) patients with in situ left internal mammary artery (IMA) implantation were catheterized initially from the left radial artery. If the left radial artery was extracted and used as a free graft or it was not successfully catheterized, then the right forearm arteries were used as an alternative approach. The left internal mammary visualization from the right arm can be technically challenging, but can be performed as previously described.^[11] In rare cases, where catheterization of right forearm arteries was not an option, the procedure was performed through the left ulnar

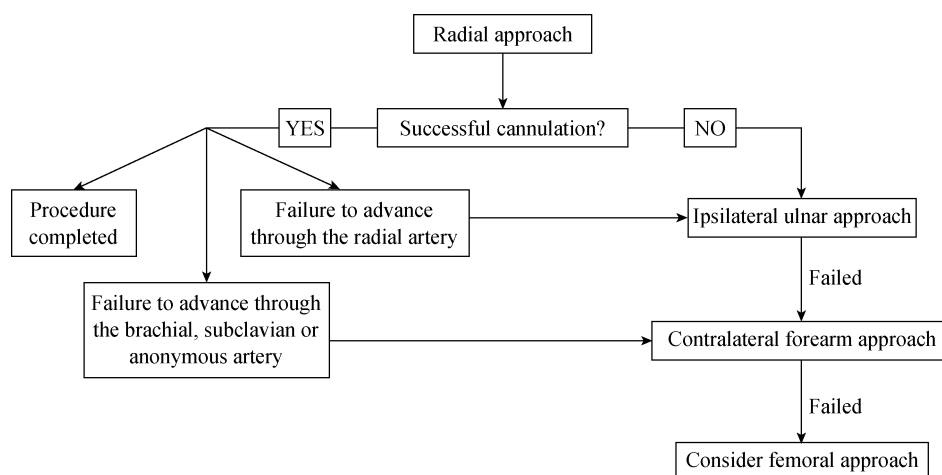


Figure 1. The algorithm proposed in order to utilize all four forearm arteries and reduce the rate of femoral approach.

approach,^[12] although the left radial artery was extracted. The femoral access was left as the last option. (3) Patients with implantation of both left and right IMA were catheterized from the right forearm and in order to visualize the left IMA, techniques of manipulating the catheter from right subclavian to left subclavian artery were utilized. However, if there was a failure to complete the procedure from the right forearm approach, a second introducer was then inserted in a left forearm artery, in order to complete the procedure.

2.6 Patients with end stage renal failure

Many centers exclude patients with end stage renal failure (ESRD) from forearm approach candidacy.^[13] The risk of forearm artery occlusion may prohibit future arteriovenous fistula formation, in case of hemodialysis access site failure and necessity of new hemodialysis access site formation. However, the risk of major access site complication in ESRD patients when they are treated transfemorally is high.^[14] The protocol in our institute concerning ESRD patients is to utilize the forearm arteries of the arm that was never used for a hemodialysis access site formation. Patients undergoing hemodialysis through a central vein catheter were treated like patients without need for hemodialysis.

2.7 Patients on oral anticoagulation treatment

Patients on oral anticoagulation treatment (warfarin or new oral anticoagulants) were treated exactly like patients not taking these kinds of medicines. No discontinuation of anticoagulation treatment was performed before cardiac catheterization, since the rate of femoral approach was very low in our center. Patients on oral anticoagulation with a non ST elevation acute coronary syndrome we catheterized as soon as possible, in case an invasive strategy was selected.

2.8 Post-procedure care

Forearm artery hemostasis was performed with a tourniquet based closure device (KDL, China). Strategies to reduce postprocedural forearm artery occlusion, like patent hemostasis^[15] or ULTRA technique^[16] were applied to all forearm treated patients. The forearm artery closure device was removed as soon as bleeding from access site was controlled.

For patients with transfemoral puncture, hemostasis was achieved with either manual compression or a femoral artery closure device application (Angioseal, St. Jude, USA).

Same day discharge was an option for all our patients, if it was not contraindicated by their clinical condition. However, the threshold for overnight stay was high,^[17] and even

patients undergoing uneventful complex procedures were considered as candidates for same day discharge.^[5]

2.9 Definition of major access site complications

Major access site complications were defined as those needed special medical attention or treatment and those leading to hospital stay prolongation.

2.10 Statistical methods

Categorical variables are expressed as numbers and percentages and continuous variables as the mean \pm SD or median (interquartile range). The baseline and procedural characteristics were compared using the chi-square test for categorical variables and Student's *t* test for continuous variables. A *P* value < 0.05 was considered significant. All tests were performed using SPSS, version 20.0, software (IBM version 20.0, SPSS Inc, IL, Chicago, USA).

3 Results

One thousand four hundred fourteen procedures were performed from our Department during the study period. Forty six procedures were chronic total occlusion PCI procedures with planned dual arterial access site utilization and were excluded from the analysis. Twenty two patients who participated in randomized trials comparing forearm and femoral approach were also excluded from the analysis. One thousand three hundred forty six procedures were finally evaluated. Seven hundred twenty seven procedures (54.0%) were only diagnostic procedures, while the rest 619 procedures were PCI procedures with (561 procedures, 90.6%) or without (58 procedures, 9.4%) coronary angiography. The baseline characteristics of the study population are presented in Table 1, according to the initial access site. The initial access site used was right radial [1173 procedures (87.1%)], left radial [119 procedures (8.9%)], right ulnar [7 procedures (0.5%)], left ulnar [41 procedures (2.9%)] and femoral approach [6 procedures (0.4%)]. Prior cannulation of the access site was observed in 202 procedures (15.0%). Radial artery cannulation failure was observed in 37 procedures (2.7%). Failure of procedure completion after successful radial sheath insertion was observed in 46 procedures (3.6%). The alternative access site after initial radial approach failure was contralateral radial [43 procedures (51.8%)], ipsilateral ulnar [22 procedures (26.5%)], contralateral ulnar [12 patients (14.5%)] and femoral approach [6 procedures (7.2%)]. The reasons for choosing femoral artery as an initial approach in these procedures were cardiogenic shock with low blood pressure and no palpable forearm arteries (one procedure), a rotator procedure in a low body

Table 1. Baseline characteristics.

	Right radial approach <i>n</i> = 1173	Right ulnar approach <i>n</i> = 7	Left radial approach <i>n</i> = 119	Left ulnar approach <i>n</i> = 41	Femoral approach <i>n</i> = 6
Age, yrs	62.1 ± 10.4	61.7 ± 11.3	63.2 ± 10.9	66.1 ± 10.7	59.2 ± 9.2
Male gender	846 (72.1%)	3 (42.8%)	101 (84.2%)	38 (92.6%)	2 (33.3%)
Current smoker	417 (35.5%)	2 (28.6%)	38 (31.7%)	14 (34.1%)	3 (50.0%)
Diabetes	272 (23.2%)	1 (14.3%)	27 (22.5%)	15 (36.5%)	3 (50.0%)
Hypertension	709 (60.4%)	5 (71.4%)	83 (69.2%)	28 (68.3%)	5 (83.3%)
Hyperlipidemia	673 (57.4%)	5 (71.4%)	82 (68.3%)	31 (75.6%)	5 (83.3%)
Prior PCI	254 (21.7%)	3 (42.8%)	47 (39.2%)	16 (39.0%)	3 (50.0%)
Prior CABG	7 (0.5%)	0	48 (40.0%)	27 (65.9%)	0
ESRD	14 (1.2%)	0	13 (10.8%)	0	2 (33.3%)

Data are presented as mean ± SD or *n* (%). CABG: coronary artery bypass grafting; ESRD: end stage renal failure; PCI: percutaneous coronary intervention.

weight woman with ESRD (one procedure), an angiography in an ESRD patient with utilization of both arms for fistula formation (functional in the right forearm and non functional in the left forearm) (one procedure), a reintervention after a failed initial intervention from the radial approach (ostial right coronary lesion, one procedure) and patient's preference (two procedures both performed in the same patient who experienced a prior painful intervention from the radial approach). Three or more access site was used in 11 procedures (three approaches in six procedures, four approaches in two procedures and five approaches in three procedures), that could not be successfully performed from the second access site or when second access site cannulation failed. The final access site used during our procedures was right radial [1134 procedures (84.2%)], left radial [138 procedures (10.3%)], right ulnar [25 procedures (1.9%)], left ulnar [31 procedures (2.3%)] and femoral approach [18 procedures (1.4%)].

There were three procedures with major access site complications (0.2%), all in patients with initial forearm approach (3/1340 vs. 0/6, *P* = 1.000). All three had a hematoma EASY class ≥ IV and one of them had a compartment syndrome treated with forearm intermittent bandage. There was no patient with clinically significant hand ischemia. Forearm artery occlusion was not systematically evaluated pre-discharge in all study cohort, since this evaluation was not part of our Department routine. However, the utilization of the ULTRA method for forearm artery hemostasis, that has shown to reduce post-interventional forearm artery occlusion, may have contributed in reducing the rate of this complication.

4 Discussion

Our study shows that utilization of all four forearm arter-

ies may facilitate decreasing the rate for transfemoral access during cardiac catheterization. This may contribute in reduction of access site complications that are associated with increased mortality.

However, applying an algorithm similar with that applied in our laboratory needs a high specialization on forearm approach medical and nursing staff. Routine puncture of the ulnar artery, catheterization of left internal mammary from the right forearm approach, treating ESRD patients from the forearm and utilizing techniques in order to reduce post-procedural forearm artery occlusion are necessary steps in order to improve outcomes when the forearm artery is used.

In our study we showed that initial radial artery failure does not necessary mean switch to the femoral approach. On the contrary, when our algorithm was applied, the total rate of femoral approach is very low (1.4%), while the rest of the procedures were performed from the forearm approach (98.6%).

There is special concern for patients with ST elevation myocardial infarction, where a needle to balloon time prolongation may lead in worse clinical outcomes.^[18] Utilization of all forearm arteries before choosing the femoral approach may lead to delays in successful artery cannulation in order to perform the catheterization. However, these are the patients that will benefit the most from the forearm access and are the only patients' group where a mortality reduction was observed in many randomized trials.^[19] In an analysis by Wimmer, *et al.*,^[20] it was found that a time delay up to 83 min may be acceptable in order to apply radial approach in patients undergoing primary PCI.

The benefits of forearm approach may be maximized when this approach is applied in high risk patients, who are more fragile and prone to access site complications. Patients with previous coronary artery by pass grafting, ESRD pa-

tients, older patients that are more likely to have tortuosity issues with their arteries are the ones that would benefit the most when forearm artery approach is applied.^[21]

However, decreasing the rate of transfemoral approach does not necessarily mean better outcomes. There are reports with conflicting data about this issue.^[22,23] There are data showing that many dedicated radial operators have higher complication rate when they have to perform a procedure through the transradial approach.^[23] It is also important for interventional cardiologists to be more familiar with treating the complications after forearm artery catheterization in order to maximize the benefit that this approach has to offer in patient undergoing cardiac catheterization.

4.1 Limitations

There are several limitations in this study. This is a non-randomized, retrospective evaluation of the clinical routine of our laboratory and no definite conclusions can be extracted. The algorithm proposed can be applied only by experienced forearm operators and it is not sure that the same results can be reproducible, if it is applied by operators with less experience in the forearm approach.

4.2 Conclusions

Utilization of all four forearm arteries may decrease the rate of transfemoral procedures during cardiac catheterization. The effect of the algorithm used in our laboratory on access site complication must be further evaluated in a randomized way.

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