

Brachial Approach for Coronary Angiography and Intervention: Totally Obsolete, or a Feasible Alternative When Radial Access is Not Possible?

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Abstract

Introduction: This study aims to assess the safety and feasibility of brachial arterial puncture for coronary procedures when radial access is not possible. Radial arterial approach is the usual option for coronary procedures in our hospital. Whenever radial access is not possible, the brachial approach is preferred instead of the femoral approach. As many clinicians considered percutaneous brachial coronary angiography as an obsolete and hazardous procedure, we carried out this study to compare the outcomes of the brachial approach to the femoral approach in our centre. **Materials and Methods:** We retrospectively evaluated all cases of brachial artery puncture and femoral artery puncture in our centre from 1 January 2007 to 31 March 2009 through a prospectively collected database and looked for all complications which occurred in both groups. **Results:** The femoral group had a slightly higher incidence of major complications – 3 out of 121 cases (2.5%) in the femoral group and 1 out of 180 cases (0.6%) in the brachial group, even though this was not statistically significant ($P = 0.15$). There was also no difference between these 2 groups for minor complications: 8 patients (4.4%) in the brachial group and 6 patients (5%) in the femoral group developed haematoma that did not require any blood transfusion or surgery. There was no incidence of brachial artery thrombosis and no puncture-related neurological deficit documented in the brachial group. **Conclusion:** Brachial artery puncture and catheterisation may be a viable, safe and efficient alternative to the transfemoral approach in a centre that is experienced with the arm approach, when radial access is not possible.

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Introduction

The possible methods of reaching the coronary vasculature using a percutaneous technique are limitless: the radial, femoral, brachial, ulnar, subclavian and axillary arteries, and even direct puncture of the aorta from a translumbar approach, have been utilised in the past.¹⁻³

Radial arterial approach is now gaining popularity and has become the default option for coronary procedures in many centres as it carries a substantially lower risk of vascular complications. It also allows almost immediate mobilisation of the patient, facilitate to earlier discharge, and potentially shorten hospital stays.^{4,5} However, there are situations when radial arterial access is not possible:⁶ (i) Congenital radial artery atrophy/hypoplasia, tortuous configurations, radioulnar loop and abnormal origin of the radial artery; (ii) Damage to the radial artery and loss of

radial pulsation secondary to previous catheterisation and (iii) Weak radial pulse secondary to vessel spasm or severe atherosclerosis. In such patients, a common second-line approach is used, either the femoral approach or brachial approach.

Traditionally, most clinicians will go for the femoral approach as they have been trained in it and have picked up the radial approach later as a new technique. Many of them considered the brachial approach as an extremely high-risk, hazardous and obsolete procedure. In literature, occasional-operator percutaneous brachial coronary angiography has reported an unacceptable high risk of adverse event and complications (36%).⁷ Other series had documented major complication rates of brachial access around 7%.⁸ It is not certain as to whether high complication rates of brachial access occurred in a centre with vast experience in the

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arm approach. Thus, we carried out this study to examine the outcome of the brachial approach as compared to the femoral approach in our centre.

Materials and Methods

We retrospectively evaluated all cases of brachial artery puncture and femoral artery puncture in our centre from 1 January 2007 to 31 March 2009 through a prospectively collected database. Inpatient and outpatient medical records of those cases were traced and details for all complications were looked into in both groups.

Exclusion Criteria

In order to make the femoral group a more comparable control group to the brachial group, the following cases were excluded from our study:

- i) All ST-elevation myocardial infarction that underwent primary percutaneous coronary intervention (PCI).
- ii) All patients who were in the state of shock, who required inotrope support and intra-aortic balloon pump (IABP).
- iii) All patients who were severely ill and required mechanical ventilatory support.
- iv) All patients who needed prolonged anticoagulation after the procedure.
- v) Cases in which closure devices (Angioseal, St Jude) were used.

Selection Criteria for the Brachial Approach in our Centre

- i) Failure of radial artery access (both left and right radial arteries).
- ii) Operators not familiar with the transulnar approach.
- iii) Operators not keen on the femoral approach.

In all cases, there was always a failure to radial access, but there was no failure to the femoral approach because the femoral approach had never been attempted. If the radial approach failed secondary to congenital abnormalities of the upper extremity arterial system (extreme tortuosity), the femoral approach was used instead of the brachial approach. The puncture side (left or right) was chosen according to the best detectable pulse. The brachial cut-down procedure or Sones procedure had never been used.

Selection Criteria for the Femoral Approach in our Centre

- i) Severely ill patients who required mechanical ventilatory support, inotrope support or may require an IABP.
- ii) Operators' preference (Especially foreign visiting cardiologists or fellows).
- iii) Failure of arm approach.

Right femoral approach should be used whenever possible. However, left femoral approach was used: (i) when the right femoral pulse was weak secondary to underlying

peripheral vascular disease, and (ii) when there was a presence of double lumen catheter in the right groin of a patient who underwent haemodialysis. Both right and left femoral punctures were used in cases of chronic total occlusion intervention.

Procedure of Brachial Artery Punctures

Following sterile preparation with a povidone-iodine solution, the antecubital fossa is draped in a sterile fashion. A 2% xylocaine solution is injected subdermally just above the crease in the elbow region where the brachial pulsation is best palpated. Using the modified Seldinger technique or single puncture technique, a 30-cm guidewire was advanced, over which a sheath was introduced. Dosage of heparin given depends on the procedure type: 10,000 i.u heparin if coronary angioplasty was done, otherwise only 5000 i.u heparin would be given. Catheters were used according to operator preference, most commonly pre-shaped Kimny Mini or Ikari IL3.5 catheters.

At the end of the procedure, the arterial sheath was removed and direct digital pressure was applied to the brachial artery for a minimum of 10 minutes in order to achieve haemostasis. Following this, further local compression was applied to the brachial artery using an elastic bandage (to a moderate tightness, still permitting palpation of the radial pulse) and the elbow immobilised by an arm board. The patient was instructed to keep the arm in such a position for 4 to 6 hours, before he was wheeled back to the ward in a wheelchair.

Procedure of Femoral Artery Punctures

Following sterile preparation with a povidone-iodine solution, the groin was draped in a sterile fashion. The femoral artery was approached percutaneously under local anaesthesia with an 18-G arterial needle (Cordis). A short 0.0359 J-wire was passed (direct anterior puncture or modified Seldinger technique) followed by a valved introducing sheath. Hydrophilic guidewires were used if required for iliac negotiation and catheters were used according to operator preference, most commonly pre-shaped Judgkin Left, Judgkin Right, Kimny Mini, Ikari or Amplatz catheters. Dosage of heparin given depends on the procedure type: no heparin given if only a diagnostic procedure was done and 10,000 i.u heparin if coronary angioplasty was carried out. At the end of the procedure, if no heparin was given, the arterial sheath was removed immediately. If 10,000 i.u heparin was given, the arterial sheath would be removed 4 to 6 hours later to ensure activated clotting time (ACT) < 180 seconds. Manual digital pressure was applied to the femoral artery for a minimum of 15 minutes in order to achieve haemostasis. Following this, further local compression was applied to the femoral artery using an elastic bandage and sand bag for 4 hours.

The patient was instructed not to move or bend the affected leg for 8 hours. He will need to be bed bound during the whole process.

Definition of Complications

Complications could be categorised as major and minor. Major complications include major bleeding that required blood transfusion and vascular complications that required surgery and permanent neurological deficit in the arm or lower limb. Minor complications include all vascular complications not requiring blood transfusion or surgery and transient neurological deficit in the arm or lower limb. All patients will usually be closely monitored throughout their hospital stay and re-evaluations are done before the discharge and during the outpatient clinic visits.

Statistical Analysis

All analyses were performed with the SPSS 13.0 statistical package for Windows. Results were shown as the means $\pm$ standard deviation and percentage. Student's *t*-test was used for comparison of mean values and chi-square test for comparison of percentages. The Mann-Whitney U test was used to compare continuous variables that were not distributed normally. The differences between groups were statistically significant with $P < 0.05$.

Results

During the 27-month study period, a total of 5110 coronary procedures were performed in our centre. Of these, 180 (3.5%) cases in 164 patients underwent the brachial approach. Two hundred and five (4.0%) cases in 200 patients underwent the femoral approach (including bilateral femoral access), 46 (0.9%) cases in 45 patients underwent the transulnar approach and the rest (91.6%) underwent the transradial approach (including bilateral radial access). After excluding those cases that fulfilled exclusion criteria, there were 180 cases selected in the brachial access group and 121 cases in the femoral access group.

Baseline demographic and clinical characteristics of patients are shown in Table 1. The majority of patients were males. There were no significant differences in gender, incidence of diabetes, pre-existing stroke and end-stage renal failure between the 2 groups. Nonetheless, in the femoral group, patients were slightly older and there were more patients with confirmed peripheral vascular disease and prior coronary artery bypass graft (CABG) surgery.

In Table 2, the type of procedure, the size of the sheath used, the access time and total procedure time were compared between 2 groups. We found no discrepancy between brachial and femoral groups in the type of procedure done except for left ventriculogram. The percentage of patients who used the 7F sheath was significantly higher in the femoral group. In terms of access time, there were no differences between the 2 approaches, yet the femoral group had a relatively longer procedure time. In Table 3, the incidence of complications in the brachial group was compared to the femoral group. The incidences of complications (both major and minor) were slightly higher in the femoral group but the difference was not statistically significant ($P = 0.38$).

In the brachial access group, there was only 1 case (0.6%) of major complication where the patient developed pseudoaneurysm of the brachial artery, which later required surgical correction. This patient has underlying schizophrenia, and did not comply fully with our instruction of arm movement restriction after sheath removal. Although 8 patients (4.4%) developed ecchymosis and haematoma of the antecubital fossa, which resolved over 2 to 3 weeks, there were no cases where blood transfusion or surgical evacuation of haematoma was required. There were also no cases of brachial artery thrombosis and no incidence of either transient or permanent puncture-related neurological deficit in the arm.

In the femoral access group, there were 3 cases (2.5%) of major complication. The first patient developed

Table 1. Baseline Demographic and Clinical Characteristics

Approach	Brachial approach, n = 180	Femoral approach, n = 121	P value
Age (y)	67.7 $\pm$ 10.8	64.8 $\pm$ 12.9	0.03
Gender			
Male (%)	52.8	51.2	0.82
Female (%)	47.2	48.8	0.82
Diabetes mellitus (%)	46.7	48.8	0.72
ESRF (%)	22.8	28.9	0.22
History of stroke (%)	8.3	14	0.11
History of CABG (%)	5.6	15.7	<0.01
Confirmed PVD (%)	16.7	28.9	0.02

CABG: coronary artery bypass graft surgery; ESRF: end-stage renal failure; PVD: peripheral vascular disease

Table 2. Procedure-Related Information

Procedure		Brachial approach, n = 180	Femoral approach, n = 121	P value
Angiogram alone (%)		50	54.5	0.44
Coronary angiogram + angioplasty (%)		50	45.5	0.44
Left ventriculogram (%)		14.4	31.4	<0.01
Access time (min)		2.5 ± 1.5	2.6 ± 2.8	0.53
Procedure time (min)		52.7 ± 37.5	66.5 ± 48.2	0.01
Sheath size	5F (%)	5.6	2.5	0.20
	6F (%)	93.8	90.9	0.33
	7F (%)	0.6	6.6	<0.01
Side	Left (%)	63	20.7	<0.01
	Right (%)	37	73.6	<0.01
	Both left and right (%)	0	5.7	<0.01

Table 3. The Incidence of Complications in Brachial Group versus Femoral Group

Complication	Brachial group n = 180 (%)	Femoral group n = 121 (%)	P value
Major	0.6	2.5	0.15
Minor	4.4	5.0	0.84
Total	5	7.5	0.38

pseudoaneurysm of the right femoral artery which was discovered the next day after the procedure. The second patient had iatrogenic femoral arteriovenous fistula and right femoral venous dissection. There was another patient with pre-existing peripheral vascular disease developed critical limb ischaemia after a femoral puncture, which necessitated embolectomy and femoral-popliteal bypass operation. Six patients (5%) had ecchymosis and haematoma over the groin that did not require any blood transfusion or surgery and had resolved after 2 to 3 weeks. Table 4 listed all clinical features of those patients who had major complications.

Discussion

The major finding of this paper is that the brachial approach can be performed with equal or even lower risk as compared with the femoral approach. The complication rate of the brachial approach in our series (5%) was among the lowest in the literature.⁹ In our opinion, local vascular complications were normally diminished by a cautious and sensitive puncture technique with additional care in patients at higher risk for vascular complications (females, pre-diagnosed peripheral vascular disease, mandatory anticoagulation, necessity for large sheaths). By using smaller sized catheters and an adequate, defensive anticoagulation regimen, the rate of arterial access site complications may be significantly

reduced. Proper methods for achievement of haemostasis (especially mandatory digital compression for a minimum of 10 minutes after sheath removal) as well as a close and careful observation by the nursing team after sheath withdrawal played an essential role.

Major risks and complications of brachial artery puncture, such as thrombosis, dissections, median nerve injury, which were frequently reported previously, were not observed in our study. This was likely because all cases in our series were not performed by occasional operators but cardiologists with adequate experience in this technique.

Technical success for percutaneous brachial access in our series was 100%, without any failure. Other groups have reported almost similar rates (>99%).^{10,11} Previously, Basche et al^{10,11} and Aschenbach et al¹² reported effectiveness and safety of brachial access in peripheral angiography (including digital subtraction angiography) and intervention; our report further confirmed its safety and feasibility in coronary angiogram and intervention.

The brachial approach provides another access site for arm approach when radial access is not possible. It has all the advantages of the arm approach over the femoral approach as shown in the following.

- Suitable for patients with severe occlusive aortoiliac disease.
- Suitable for patients with difficulty laying/lot (back pain, obesity, chronic heart failure).
- Allows earlier patient ambulation, potentially decrease post-procedure nursing requirements, hospital cost and length of stay.
- Feedback from patients show that most patients prefer the arm approach as they feel more comfortable.

However, disadvantages of the brachial approach over the femoral approach include:

Table 4. Clinical Features of Patients who Developed Major Complication

	Patient 1	Patient 2	Patient 3	Patient 4
Approach	Brachial	Femoral	Femoral	Femoral
Complications	Pseudoaneurysm of brachial artery	Pseudoaneurysm of femoral artery	Femoral AV fistula and venous dissection	Critical ischaemic limb
Salvage	Surgical repair	Surgical repair	Surgical repair and ligation of AV fistula	Embolectomy and femoral-popliteal bypass
Sheath	6F	7F	7F	6F
Age	54	59	51	67
Gender	Female	Male	Male	Female
Diabetes	No	No	No	Yes
Confirmed PVD	No	No	No	Yes
ESRF	No	No	Yes	Yes
History of CABG	No	No	Yes	No
PT (min)	83	166	98	24

CABG: coronary artery bypass graft surgery; ESRF: end-stage renal failure; PT: procedure time; PVD: peripheral vascular disease

- i) An unsuccessful attempt of brachial artery puncture which produces bleeding may cause a compartment syndrome with ischaemic injury to the median nerve and ischaemia to the hand from decreased blood flow.
- ii) Heparin should routinely be given in the brachial approach to prevent artery thrombosis in view of the relatively small size of the brachial artery as compared to the femoral artery.
- iii) Guide placement is more challenging and requires learning a different technique.
- iv) Many physicians are not familiar with the equipment and anatomy, and thus are reluctant to give it a try.

Hildick-Smith et al¹³ suggested peripheral vascular disease as a relative contraindication to the femoral approach for coronary angiography. Their series showed that patients with peripheral vascular disease who undergo coronary angiography from the femoral artery had a 1-in-5 risk of procedural failure, necessitating the use of an alternative vascular approach, and a 1-in-20 risk of a major vascular complication. Our findings were fairly consistent with theirs – because of a higher incidence of peripheral vascular disease, our femoral group also had a higher rate of major vascular complications (2.5%), compared to the brachial group (0.6%). There were 3 cases with technical failure of the right femoral artery puncture and crossover to left femoral artery puncture.

In literature, brachial approach had been used successfully in patients with prior CABG. Erdol et al¹⁴ described the cannulation of the left internal mammary artery (LIMA) graft via the right brachial arterial route using a MANI catheter. Hadase et al¹⁵ described angiography of the right internal mammary artery (RIMA) via a right brachial approach, using the YUMIKO catheter.

Our study has some limitations. Even though we have excluded many femoral cases from our study (those who fulfilled exclusion criteria), our femoral group is still not a true comparable control group for our brachial group. Some operators in our centre routinely go for the femoral approach to treat complex lesions that required 7F catheters and patients with prior CABG. This practice is based on individual preference, despite the facts that: (i) intervention for complex lesions including use of high speed rotational atherectomy can be carried out safely through the transradial approach,^{16,17} and (ii) CABG grafts (including LIMA) study and intervention can be done safely through the transradial approach.¹⁸ Those operators had contributed a significant number of patients to the femoral group in our study.

In our study, the brachial group did not have any chronic total occlusion (CTO) interventions but there were 8 CTO interventions in the femoral group. This may explain why the mean procedure time was longer in the femoral group than in the brachial group.

Conclusions

Our study provides evidence that the brachial approach may be a viable, safe and efficient alternative to the femoral approach for coronary angiogram and intervention when radial access is not possible.

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