# Trans-brachial artery access for coronary artery procedures is feasible and safe: data from a single-center in Macau

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*To the Editor:* Compared with trans-femoral artery access (TFA), trans-radial artery access (TRA) for percutaneous coronary interventions (PCI) has been shown to significantly reduce 30-day mortality, in-hospital major adverse cardiac and cardiovascular events (a composite of 30-day mortality and in-hospital myocardial re-infarction, target vessel revascularization, and cerebrovascular events), major bleeding, and access site complications.[1] TRA is more easily compressible, minimizing hematoma risk, and lower crossover rates to another access. Patients may ambulate immediately after procedure, that hospitalization can be shortened significantly. In some centers, patient with TRA can be discharged on the same day of procedure. It is also superior to TFA with closure devices, and becomes the preferred access site for recent PCI.[2]

However, TRA has its own limitations, including small diameter, arterial spasm, tortuosity, anatomic variants, longer learning curve for junior operators, and even asymptomatic radial artery occlusion. In addition, an occluded radial artery restricts future cardiac catheterization, bypass grafts, and dialysis fistulae. Similarly, trans-ulnar artery access (TUA) shares above benefits and limitations with TRA.[3] Once both TRA and TUA fail, TFA is usually the alternative or even the last available access to continue coronary procedure. Actually, the usage of different access should depend on the situation of the patient. Risk/benefit ratio has to be taken into account in decision process.

Trans-brachial artery access (TBA) is being performed more frequently in daily practice for its similar benefit with forearm artery access (TRA and TUA) when it fails to have radial artery access, but the vascular and neurological complications become hurdles to interventional cardiologists. This study was to evaluate the feasibility and safety of TBA for PCI when TRA failed.

In this study, 1708 consecutive patients undergoing coronary angiography and PCI between January 1, 2013 and December 31, 2017 from Centro Hospital Conde de Sao Januario were investigated. Of these, 143 cases who failed to have TRA were enrolled in this single-center study, and all of them were switched to receive TBA or TFA according to the operator's preference. Risk factors and co-morbidities of both TBA and TFA groups were collected. During the percutaneous procedure, modified Seldinger technique and size six-French sheaths were used for brachial and femoral artery puncture. A total of routine 3000 units unfractionated heparin was administered for angiography and 100 units/kg body weight was given for PCI. The sheath was removed immediately after angiography (2 h for TBA group and 4 h for TFA group after PCI). Direct compression was applied to achieve hemostasis. After that, further compression was applied to brachial or femoral artery by elastic bandage, which permitted palpation of the distal pulse with moderate tightness under oximetry monitor. Elbows were immobilized by arm boards for TBA group. In-patient and cardiology clinic medical records and details for all complications were collected for both groups.

This study investigated the in-hospital procedural outcome, including vascular complication, cardiac death, non-fatal myocardial infarction, and stroke events, and also the follow-up clinical outcome, including vascular and neurological complication in cardiology clinic. Vascular complication included bleeding event, acute arterial occlusion, thrombosis, compartment syndrome, extremity ischemia, and aneurysm. Bleeding event was categorized as major and minor bleeding by thrombolysis in myocardial infarction criteria: Major bleeding is overt clinical bleeding (including documented intra-cranial and retroperitoneal hemorrhage) associated with a drop in hemoglobin of ≥50 g/L; Minor

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bleeding is overt clinical bleeding associated with a fall in 30 g/L≤ hemoglobin <50 g/L. In calculating the fall in hemoglobin, a transfusion of whole blood or packed red blood cells are counted as 10 g/L hemoglobin. All patients were followed in cardiology clinic. Vascular and neurological injuries (mainly for median nerve injury) were assessed after discharge and on every clinic visit, including paresthesia, numbness, and weakness.[4]

Continuous variables were expressed as mean ± standard deviation and compared by Student's *t* test. Categorical variables were presented as number (percentage) and analyzed by Chi-square test and Fisher exact test. The multiple logistic regression analysis was performed to identify if there was a difference between TBA and TFA regarding the risk of in-hospital procedure outcomes. Furthermore, the Cox regression analysis was conducted to examine whether there was a difference between TBA and TFA concerning the risk of follow-up clinical outcomes. A $P < 0.05$ was considered statistically significant. All statistical analysis was performed using IBM SPSS statistics version 22.0 software (IBM Corporation, Armonk, NY, USA).

Between January 1, 2013 and December 31, 2017, a total of 1708 coronary artery procedures were performed during this 5-year study period. Of these, the successful rate of TRA was 91.6% (1565/1708). The rest of 143 consecutive cases (8.4%) were enrolled to this study. Respectively, 25 cases of TBA (17.5%) and 118 cases of TFA (82.5%) approaches were applied according to the operator's preference when TRA failed. The successful rate of TBA was 96.2% (25/26), that one case was switched from TBA to TFA.

Regarding the in-hospital procedural outcome, TBA group had no significant difference in vascular complication compared with TFA group (8.0% *vs.* 3.4%, $P > 0.05$). There were no significant differences in cardiac death, non-fatal myocardial infarction and stroke event between two groups. Moreover, after adjusting for age, gender, hypertension, diabetes mellitus, tobacco use, dyslipidemia, primary PCI, and glycoprotein (GP) IIb/IIIa inhibitors, multiple logistic regression analysis identified that there was no statistical difference between TBA and TFA groups regarding the risk of in-hospital procedure outcomes (odds ratio: 3.39, 95% confidence interval [CI]: 0.33–34.44, $P = 0.302$) [Figure 1A]. The average follow-up interval in cardiology clinic was 889.3 days (approximately 29.6 months). The clinic follow-up rates on TBA and TFA groups were 100.0% and 97.2%, respectively. Regarding the clinical outcome, neither vascular nor neurological complication presented in both groups during every cardiology clinic visit. Similarly, after adjusting for age, gender, hypertension, diabetes mellitus, tobacco use, dyslipidemia, primary PCI, and GP IIb/IIIa inhibitors, the Cox regression analysis found that there was no statistical difference between TBA and TFA groups concerning the risk of follow-up clinical outcomes (hazard ratio: 1.36, 95% CI: 0.50–3.73, $P = 0.551$) [Figure 1B].

When it came to the vascular complication, there were two cases in TBA group: one of them was minor bleeding on puncture site and needed re-admission for managing vascular complication; another one was major bleeding on puncture site and discharge event-free after blood transfusion. There were four cases of vascular complication in TFA group: one of them was femoral vein thrombosis; for other three cases of bleeding complication,

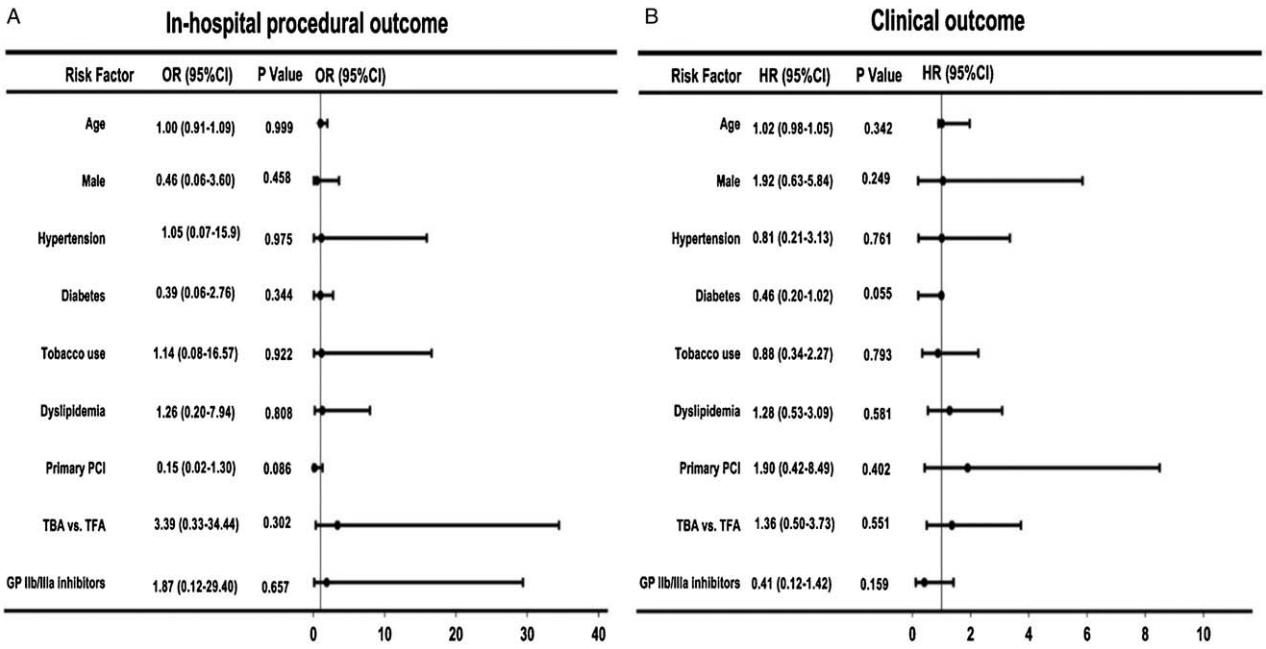


**Figure 1:** Multivariate logistic regression analysis for in-hospital procedural outcome (A). Cox regression analysis for clinical outcome (B). GP: Glycoprotein; PCI: Percutaneous coronary intervention; TBA: Trans-brachial artery access; HR: Hazard ratio; OR: Odds ratio; TFA: Trans-femoral artery access.

**Table 1: Baseline characteristics of patients in trans-brachial and trans-femoral groups.**

| Characteristics | Trans-brachial group ($n = 25$) | Trans-femoral group ($n = 118$) | Statistical values | $P$ |
|---|---|---|---|---|
| Male, *n* (%) | 19 (76.0) | 95 (80.5) | 0.259† | 0.611 |
| Local resident, *n* (%) | 25 (100.0) | 114 (96.6) | 0.872† | 0.459 |
| Hypertension, *n* (%) | 21 (84.0) | 98 (83.1) | 0.013† | 0.587 |
| Diabetes, *n* (%) | 13 (52.0) | 43 (36.4) | 2.096† | 0.148 |
| Tobacco use, *n* (%)* | 2 (8.0) | 37 (31.4) | 6.553† | 0.038 |
| Dyslipidemia, *n* (%) | 16 (64.0) | 70 (59.3) | 0.188† | 0.664 |
| Renal failure on dialysis, *n* (%) | 1 (4.0) | 14 (11.9) | 1.430† | 0.489 |
| Atrial fibrillation or flutter, *n* (%) | 6 (24.0) | 17 (14.4) | 1.407† | 0.185 |
| LDL (mmol/L), mean ± SD | 2.3 ± 0.8 | 2.5 ± 1.9 | 0.705‡ | 0.306 |
| PCI, *n* (%) | 16 (64.0) | 82 (69.5) | 0.288† | 0.591 |
| Primary PCI, *n* (%)* | 1 (4.0) | 22 (18.6) | 3.230† | 0.061 |
| Contrast (mL), mean ± SD | 108 ± 62 | 143 ± 73 | 2.233‡ | 0.669 |
| Heparin (units), mean ± SD | 5895 ± 1996 | 5720 ± 2122 | –0.366‡ | 0.632 |
| Use of anti-platelet | | | | |
| Aspirin, *n* (%) | 21 (84.0) | 105 (89.0) | 0.489† | 0.342 |
| P2Y12 inhibitor, *n* (%) | 20 (80.0) | 92 (78.0) | 1.938† | 0.585 |
| GP IIb/IIIa inhibitors, n (%)* | 1 (4.0) | 17 (14.4) | 2.031† | 0.134 |

* $P > 0.05$ in both groups except tobacco use (logistic regression $r^2 = 0.019$), primary PCI ($r^2 = 0.023$) and use of GP IIb/IIIa inhibitors ($r^2 = 0.07$). † $\chi^2$ values. ‡ $t$ values. CKD: Chronic kidney disease; GP: Glycoprotein; LDL: Low-density lipoproteins; PCI: Percutaneous coronary intervention; P2Y12: Adenosine diphosphate receptor antagonists; SD: Standard deviation.

all of them were ST-segment elevation myocardial infarction (STEMI) cases with major bleeding and needed blood transfusion. One of them died eventually because of acute myocardial infarction. No case died during hospitalization nor due to vascular complication during the follow-up period. The cases of vascular complication are shown in Table 1.

Many interventional cardiologists considered that TBA is outdated and risky access. It has been demonstrated significantly higher rate of vascular and neurological complications than other access in previous studies. From the view of anatomy, brachial artery, brachial vein, and median nerve are contained by the medial brachial fascial compartment between axilla and elbow. Adequate manual compression is difficult to perform on limited underlying bone surface. These anatomies led to hemostasis challenging and nerve injury, especially in aggressive anticoagulated patients.[5] Kiemeneij *et al*[6] studied 900 cases undergoing percutaneous transluminal coronary angioplasty with size six-French catheters. Evenly, 300 cases were randomized in each TRA, TBA, and TFA groups. Results showed that the successful rate of coronary cannulation was achieved in 279 (93.0%), 287 (95.7%), and 299 (99.7%) cases in each group. Respectively, 264 (88.0%), 263 (87.7%), and 269 (90.0%) patients were event-free at 1-month follow-up ($P > 0.05$). Major puncture site complications were 0, 7 (2.3%) and 6 (2.0%) ($P < 0.05$). The nine cases (3.0%) suffered from asymptomatic loss of radial pulsations in TRA group. The study concluded that procedural and clinical outcomes of PTCA were similar among TRA, TBA, and TFA groups, but access failure was more common in TRA group. Major access site complications were more frequently in TBA and TFA groups.[6] Considering patients' safety, TBA is usually not a routine access for coronary procedure in many centers for years.

The main issue for TBA should be the ability and experience of preventing and handling vascular and neurological complication. Newcomers are trying to overcome and make it possible to substitute TFA when TRA fails. Sabbah *et al*[7] studied 4955 cases undergoing coronary revascularization. Respectively, 1102 (22.2%), 2797 (56.4%), and 1054 (21.2%) cases were divided into TBA, TRA, and TFA groups. Results showed that forearm artery access in TBA and TRA groups was associated with higher procedural success compared with TFA group (98% *vs.* 98.4% *vs.* 95.6%, $P < 0.05$). Compared with TRA group, TFA group had higher rate of MACE (1.9% *vs.* 1.2% *vs.* 2.6%, $P < 0.05$) and in-hospital cardiac death (0.1% *vs.* 0.1% *vs.* 0.6%, $P < 0.05$), and also higher incidence of major access site hematoma (0.3% *vs.* 0.1% *vs.* 1.2%, $P < 0.05$). TBA and TFA groups had higher rate of access site pseudoaneurysm (0.7% *vs.* 0.01% *vs.* 0.5%, $P < 0.05$). The study concluded that TBA for PCI could be a good alternative with considerable safety and efficacy.[7] Gan *et al*[8] studied 5110 cases undergoing coronary procedures. Of these, 180 and 121 cases were enrolled to TBA and TFA groups, respectively. Results showed that TBA group had a slighter lower incidence of major complications compared with TFA group (0.6% *vs.* 2.5%, $P > 0.05$), without significant difference, even in minor complications (4.4% *vs.* 5.0%, $P > 0.05$). There was no incidence of brachial artery thrombosis and no puncture-related neurological dysfunction in TBA group. The study concluded that TBA might be a viable, safe, and efficient alternative to TFA in a center that is experienced with the arm approach when TRA is not possible.[8] Melon *et al*[9] studied 16,438 cases undergoing transradial coronary

procedures. Of these, 459 cases (2.8%) failed to have TRA. The alternative accesses were 45 cases (9.8%) for TBA group and 414 cases (90.2%) for TFA group. Results showed that no significant differences in rates of bleeding or other complications were found between TBA and TFA groups. Furthermore, TBA group had reduced time of procedure (38.4 min *vs.* 44.4 min, $P < 0.05$) and fluoroscopy (9.1 min *vs.* 16.4 min, $P < 0.05$). The study concluded that TBA was as safe and effective as TFA. TBA was associated with shorter procedure and fluoroscopy time, which resulted in lesser dose of radiation for both patients and operators.[9] In our hospital, TRA was the default access for most of the coronary angiography and PCI, even in primary PCI. For those who were post coronary artery bypass graft or complicated coronary anatomy, we usually used TFA to approach left internal mammary artery or to apply larger-size lumen artery sheath.

Compared with TFA, the forearm artery access including TRA, TUA, and TBA, had its own advantage to be earlier ambulation, especially for patients with severe aorto-iliac disease (eg, Leriche's syndrome or aortic aneurysm) or difficulty laying (eg, heart failure or spine disease) cases.[10] It also decreased post-procedure nursing workload, hospital cost, and length of stay. What is more, it expanded our capability to perform complex procedures such as intra-aortic balloon pumping insertion via TBA. It was worth to give a chance to patients a forearm artery access. Therefore when it fails to have TRA, we usually try TBA as the alternative in our center. From the result of this study, the successful rate of TRA and TBA were very high (91.6% and 96.2%, respectively). The only one failing to have TBA was because of complicated anatomy of brachiocephalic trunk. Furthermore, most of the patients (100% for TBA group and 97.2% for TFA group) have been followed up in cardiology clinic for more than 29 months. Although the size of sample was relatively small, we tried to fully follow up all the patients face-to-face in order to evaluate vascular and neurological complications. There was no significant difference between TBA and TFA groups in vascular and neurological complications. When we investigated the two cases of vascular complication in TBA group, they were the first and ninth cases of TBA. No more procedure complication after learning curve became smooth. For the four cases of vascular complication in TFA group, one femoral vein thrombosis might come from over compression and prolonged immobilization, other three cases developed bleeding complication due to coagulation abnormality under STEMI states.

There were several limitations of this study. First, the sample size of TBA and TFA groups was small since most of the patients underwent PCI by TRA, and also the population in Macau is not large enough. Second, we were at the beginning of learning curve at that time. All TBA cases were performed by one operator who had no experience before the study. Third, this was not a randomized control study that the decision of having TBA or TFA was according to the operator's preference when TRA failed. Last, the operators did not spend much time to puncture brachial artery on primary PCI. When it was difficult to have TRA or TBA, they switched to TFA shortly to shorten the door-to-balloon in all primary PCI cases.

This study concluded that TBA is a feasible and safe alternative for PCI when TRA fails in Macau. Further experiences will be attained through more TBA cases in the future.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

### Conflicts of interest

None.

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