Comparison of Access-Site Complications after Brachial Artery Approach for Endovascular Treatment of Lower Extremity Peripheral Arterial Disease: Open Vs Percutaneous Access

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Introduction: Endovascular treatment of lower extremity peripheral arterial disease (PAD) is in continuous development. Although the groin is the commonplace gate for the majority of peripheral endovascular interventions, still the brachial artery (BA) access has its indications. Recently we have noticed an unexplained personal variation among interventionists in our unit in performing a brachial percutaneous access versus open surgical cutdown.

Aim of work: The aim of this study is to look at the short-term access site complications after brachial artery approach for PAD endovascular interventions, comparing open to percutaneous access.

Patients and methods: This was a retrospective observational study, where 90 patients who underwent PAD endovascular interventions through a brachial approach at three university-based vascular services; Alexandria, Benha and Ain Shams universities between July 2022 and May 2024 were reviewed. Patients were divided into 2 groups: Open access (OA) and Percutaneous access (PA) groups.

Results: OA group patients had longer hospital stay; 7.42 + 3.4 days as compared to 5.18 + 1.2 days in PA group. However, the complication rate was far less in OA group; 6 (12%) cases if compared to 10 (24%) in PA group. In a logistic regression model, the factors that were found to predict complications -regardless to the approach performed – were smoking, dual anti-platelets therapy and increasing the size of the sheath used.

Conclusion: The study findings recommend for the BA access to use the open surgical approach, use the ultra-sound guided technique if PA is chosen and minimize the size of sheaths used as much as possible.

Key words: Peripheral arterial disease, brachial artery access, open brachial artery access, percutaneous access brachial artery access.

Introduction

Endovascular treatment of lower extremity peripheral arterial disease (PAD) is in continuous development and expansion. The groin is the commonplace gate for the majority of peripheral endovascular interventions.[1] However, the brachial artery (BA) access has its indications some of which are hostile groin, occluded iliac axis, bilateral iliac artery disease and previous aorto-femoral bypass.[2] Previous studies have focused on comparison between femoral and brachial access or between axillary and brachial access, most of which come from the percutaneous coronary intervention's publications.[3,4] Recently we have noticed an unexplained personal variation among interventionists in our unit in performing a brachial percutaneous access versus open surgical cutdown.

Aim of work: The aim of this study is to look at the short-term access site complications after brachial artery approach for PAD endovascular interventions, comparing open to percutaneous access.

Patients and methods

This was a retrospective observational study, where the hospital notes of patients who underwent PAD endovascular interventions through a brachial approach at three university-based vascular services; Alexandria, Benha and Ain Shams universities, were reviewed. The study was conducted during the period between July 2022 and May 2024. Patients included were all above 18 years of age and had balloon angioplasty +/- stenting for lesions anywhere from the aorta down to the tibial arteries. Exclusion criteria were patients who underwent EVAR or interventions for acute leg ischemia, had axillary artery approach and those with documented coagulopathy or connective tissue disease. Patients were divided into 2 groups: Open access (OA) and Percutaneous access (PA) groups.

Information collected were patients' demography, preoperative, operative and postoperative data. Demography included age, sex, co-morbidities and medication history. Preoperative data were the coagulation profile, upper extremity radiological scans and previous BA intervention / access. Operative data were access-site type and laterality, target-artery site and laterality, procedure type, number and maximum size of sheaths, mode of repair for open access and compression time for percutaneous access. Postoperative data included on-table surveillance, length of hospital stay and in-hospital mortality rate. Endpoints were access site complications during the first month, looking at the type of complications and modality of their management. **(Fig. 1)** shows an example of each of the two different approaches among the study group.

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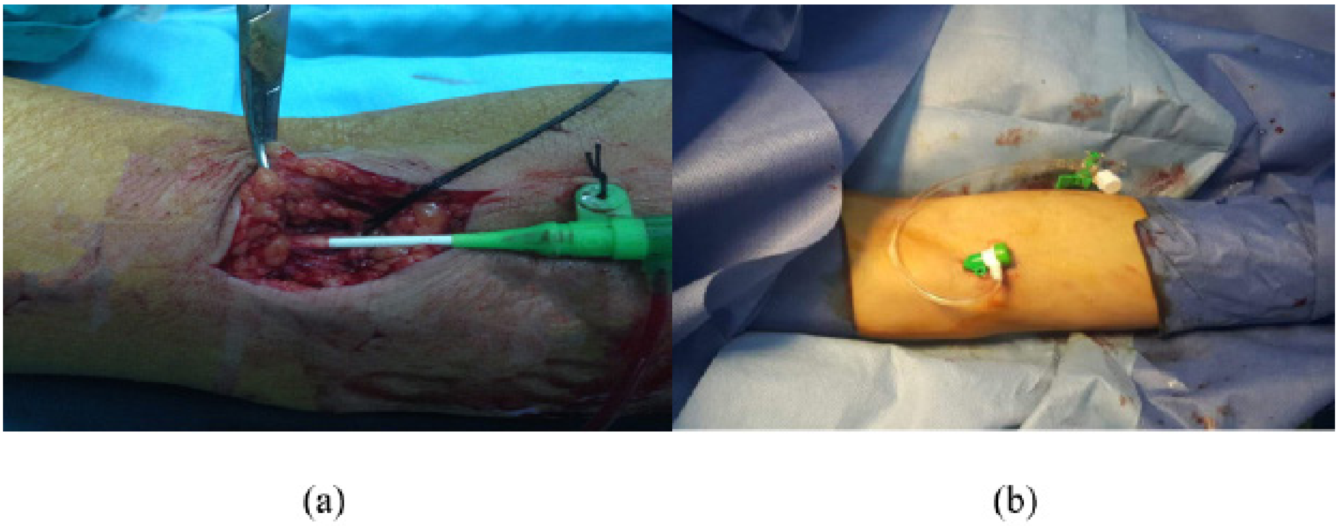

Fig 1: A) An example of the open access. B) An example of the percutaneous access.

This study was ethically approved by the Institutional Review Board of the three universities. Pearson's Chi-square was used for analysis of categorical data. Continuous variables were stated as mean ±SD and tested for normality using the Kolmogorov-Smirnov test. Variations between the 2 groups were determined by the student t -test. A univariate analysis was agreed upon to interpret the complications. Logistic regression analysis was used to show the independent associations of patients' demography and peri-operative data with the incidence of complications. A 2-sided P value of < 0.05 was considered significant. IBM SPSS software (SPSS, version 24.0, SPSS Inc. Chicago, IL, USA) was used for data analysis.

Results

Between July 2022 and May 2024, 90 patients who underwent PAD endovascular interventions through a brachial approach were studied. **Table 1** summarizes the baseline demographics of the study group. It did not show any statistically significant data between the 2 groups. Six (12%) of patients were already on dual anti-platelets therapy prior to intervention in OA group as compared to 8 (20%) in PA group. Correspondingly, the mean platelets count was 325.2±89.6 x 103/UL in OA group as compared to 317.6±91.5 x 103/UL in PA group. Patients who had a CT thoracic aorta before peripheral interventions were extremely rare; only 2 (4%) in OA group and none in the PA group. Similarly, those who had color duplex ultrasound on arm arteries were infrequent; only 6 (12%) in OA group compared to 14 (34%) in PA group.

Table 2 compared intra- and post-operative data between the 2 groups. Most of the patients had no previous interventions for the BA; 45 (92%) cases in OA group and 33 (80%) cases in PA group. The majority had iliac artery interventions as the target lesion; 28 (57%) patients in OA group and 30 (73%) in PA group. Remarkably, most surgeons opt to the left BA as the preferred access side; 42 (86%) patients in OA group and 40 (98%) patients in PA group. The number of sheaths used per access was less in OA group; 1.5 + 0.4 as compared to 2.82 + 0.96 in PA group. However, the maximum size of sheath (Fr) introduced was larger in OA group; 7.6 + 2.1 Fr as compared to 5.2 + 1.4 Fr in PA group. All surgeons relied on the presence of wrist pulses to ensure efficient puncture site closure, and some used hand-held doppler or duplex ultrasound to ensure distal patency. OA group patients had longer hospital stay; 7.42 + 3.4 days as compared to 5.18 + 1.2 days in PA group. When comparing the end results, the complication rate was far less in OA group; 6 (12%) cases if compared to 10 (24%) in PA group. Most complications occurred intra-operatively. The sort of complication and its management are clearly demonstrated in the table.

In a logistic regression model, the factors that were found to predict complications -regardless to the approach performed – were smoking, dual anti-platelets therapy and increasing the size of the sheath used. Ultrasound-guided approach was found to guard against complications in the Percutaneous access group (PA) **(Table 3).**

Table 1: Comparison of patient demographics in open access (OA) and percutaneous access (PA) groups

Patient demography	Open access group (OA) N= 49	Percutaneous access group (PA) N= 41	P-value
Age (years)	65.2 $\pm$ 11.1	61.7 $\pm$ 5.6	
Sex			
Male	38 (78%)	32 (78%)	0.954
Female	11 (22%)	9 (22%)	
Smoking			
Non-smoker	5 (10%)	8 (20%)	
Current smoker	37 (76%)	25 (60%)	0.302
Ex-smoker	7 (14%)	8 (20%)	
Comorbidity			
Hypertension	30 (61%)	25 (61%)	0.980
Diabetes Mellitus	41 (84%)	39 (95%)	0.085
History of Stroke	4 (8%)	6 (15%)	0.330
Ischemic heart disease	12 (24%)	14 (34%)	0.314
Congestive heart failure	6 (12%)	5 (12%)	0.994
Asthma	7 (14%)	6 (15%)	0.962
Renal impairment	17 (35%)	13 (31%)	0.764
Liver impairment	9 (18%)	8 (20%)	0.890
Medication			
Statin	40 (82%)	37 (90%)	0.247
Anti-coagulant only	2 (4%)	1 (2%)	0.665
Single anti-platelets	37 (76%)	30 (73%)	0.064
Dual anti-platelets	6 (12%)	8 (20%)	0.799
Single anti-platelets + Anti-coagulant	4 (8%)	2 (5%)	0.533
Laboratory findings			
Platelets x 10^3/UL	325.2±89.6	317.6±91.5	0.265
INR	1.24 $\pm$ 0.9	0.93 $\pm$ 1.1	0.107
CTA thoracic aorta	2 (4.0%)	0 (0.0%)	0.665
Color duplex ultrasound arm	6 (12%)	14 (34%)	0.012

Table 2: Comparison of intraoperative and postoperative data following brachial open access (OA), and percutaneous access (PA) groups

Patient demography	Open access group (OA) N= 49	Percutaneous access group (PA) N= 41	P-value
Access			
Virgin	45 (92%)	33 (80%)	
Percutaneous	3 (6%)	5 (12%)	0.265
Open	1 (2%)	3 (7%)	
Target artery			
Aorta	2 (4%)	3 (7%)	
Iliac	28 (57%)	30 (73%)	
Femoral	12 (25%)	7 (17%)	0.396
Popliteal	5 (10%)	1 (2%)	
Tibial	2 (4%)	0	
Access side			
Right	7 (14%)	1 (2%)	
Left	42 (86%)	40 (98%)	0.041*
P2	0.001*	0.001*	
Treated side			
Right	17 (34%)	10 (24%)	
Left	16 (33%)	11 (27%)	0.287
Bilateral	16 (33%)	20 (49%)	
Procedure type			
POBA	15 (31%)	18 (44%)	2.613
Stenting	30 (61%)	22 (54%)	0.270
Diagnostic	4 (8%)	1 (2%)	
Number of sheaths	1.5 $\pm$ 0.4	2.82 $\pm$ 0.96	0.016*
Maximum size of sheath (Fr)	7.6 $\pm$ 2.1	5.2 $\pm$ 1.4	0.026*
Ultra-sound guided approach	-	10 (24%)	0.001*
Mean compression time (Minutes)	-	16.45 $\pm$ 3.42	0.011*
Postoperative surveillance			
Wrist pulses	49 (100%)	41 (100%)	1.0
Doppler flow	25 (51%)	31 (76%)	0.085
Duplex ultrasound	8 (16%)	28 (68%)	0.013*
Length of hospital stay (days)	7.42$\pm$3.4	5.18 $\pm$ 1.2	0.025*
In-hospital mortality	3 (6%)	5 (12%)	0.082
Access-site complication			
Yes	6 (12%)	10 (24%)	0.043*
No	43 (88%)	31 (67%)	
Timing (As per number of complications)			
Intra-operative	5 (83%)	8 (80%)	0.868
Within 1 month	1 (17%)	2 (20%)	
Type			
Hematoma	1 (2%)	2 (5%)	0.455

Patient demography	Open access group (OA) N= 49	Percutaneous access group (PA) N= 41	P-value
Pseudo-aneurysm	0	1 (2%)	0.898
Dissection	2 (4%)	0	0.665
Thrombosis	1 (2%)	4 (10%)	0.115
Disruption	2 (4%)	1 (2%)	0.665
Arterio-venous fistula	0	0	-
Nerve injury	0	1 (2%)	0.898
Management			
Manual compression	0	0	
Open repair			
Direct repair	1 (2%)	4 (10%)	
End-to-end anastomosis	4 (8%)	1 (2%)	0.086
Thrombectomy	1 (2%)	4 (10%)	
Reoperation	0	3 (7%)	0.046*

Table 3: Comparison of patient demographics and operative variables in patients with and without complications in both groups

Patient demography	Complications in Open access group (OA)		P value	Complications in Percutaneous access group (PA)		P-value
	No (43)	Yes (n=6)		No (31)	Yes (N=10)	
Age (years)	63±2.4	66.4 ± 9.8	>0.05	60.8±5.21	62.1±4.7	>0.05
Male	33 (76.7%)	5 (83.3 %)	>0.05	25 (80.6%)	7 (70.0%)	>0.05
Female	10 (23.3%)	1 (16.7 %)		6 (19.4%)	3 (30.0%)	
Non-smoker	5 (11.6%)	0 (0.0 %)		8 (25.8%)	0 (0.0%)	
Current smoker	32 (74.4%)	5 (83.3 %)	0.013*	15 (48.4%)	10 (100.0%)	0.003*
Ex-smoker	6 (14.0%)	1 (16.7 %)		8 (25.8%)	0 (0.0%)	
Hypertension	25 (58.1%)	5 (83.3 %)	>0.05	17 (54.8%)	8 (80.0%)	>0.05
Diabetes Mellitus	37 (86.0%)	4 (66.7 %)	>0.05	30 (96.8%)	9 (90.0%)	>0.05
History of Stroke	4 (9.3%)	0 (0.0 %)	>0.05	5 (16.1%)	1 (10.0%)	>0.05
Ischemic heart disease	10 (23.3%)	2 (33.3 %)	>0.05	12 (38.7%)	2 (20.0%)	>0.05
Congestive heart failure	6 (14.0%)	0 (0.0 %)	>0.05	5 (16.1%)	0 (0.0%)	>0.05
Asthma	7 (16.3%)	0 (0.0 %)	>0.05	6 (19.4%)	0 (0.0%)	>0.05
Renal impairment	15 (34.9%)	2 (33.3 %)	>0.05	10 (32.3%)	3 (30.0%)	>0.05
Liver impairment	9 (20.9%)	0 (0.0 %)	>0.05	7 (22.6%)	1 (10.0%)	>0.05
Statin	36 (83.7%)	4 (66.7 %)	>0.05	34 (109.7%)	3 (30.0%)	>0.05
Anti-coagulant only	2 (4.7%)	0 (0.0 %)	>0.05	0 (0.0%)	1 (10.0%)	>0.05
Single anti-platelets	37 (86.0%)	0 (0.0 %)	>0.05	28 (90.3%)	2 (20.0%)	>0.05
Dual anti-platelets	32 (74.4%)	5 (83.3 %)	0.011*	1 (3.2%)	7 (70.0%)	0.004*
Single anti-platelets + Anti-coagulant	3 (7.0%)	1 (16.7 %)		2(6.5%)	0 (0.0%)	
Platelets x 10^3/UL	328.2±88.5	316.1±84.2	>0.05	322.1±87.2	314.2±86.7	>0.05
INR	1.32±0.41	1.36±0.31	>0.05		1.1±0.83	>0.05
CTA thoracic aorta	2 (4.65%)	0 (0.0%)	>0.05	0 (0.0%)	0 (0.0%)	>0.05
Color duplex ultrasound arm	6 (%)	0 (0.0%)	>0.05	12 (38.7%)	2 (20.0%)	>0.05

Table 3: Comparison of patient demographics and operative variables in patients with and without complications in both groups

Access						
Virgin	41 (95.35%)	4 (66.7%)	>0.05	27 (87.1%)	6 (60.0%)	>0.05
Percutaneous	1 (2.33%)	2 (33.3%)	>0.05	2 (6.5%)	3 (30.0%)	>0.05
Open	1 (2.33%)	0 (0.0%)	>0.05	2 (6.5%)	1 (10.0%)	>0.05
Target artery						
Aorta	2 (4.65%)	0 (0.0%)	>0.05	2 (6.5%)	1 (10.0%)	>0.05
Iliac	25 (58.14%)	3 (50.0)	>0.05	25 (80.6%)	5 (50.0%)	>0.05
Femoral	9 (20.93%)	3 (50.0)	>0.05	2 (6.5%)	5 (50.0%)	>0.05
Popliteal	5 (11.63%)	0 (0.0%)	>0.05	1 (3.2%)	0 (0.0%)	>0.05
Tibial	2 (4.65%)	0 (0.0%)	>0.05	0 (0.0%)	0 (0.0%)	>0.05
Access side						
Right	7 (16.28%)	0 (0.0%)	>0.05	0 (0.0%)	1 (10.0%)	>0.05
Left	36 (83.72%)	6 (100.0%)	>0.05	32 (103.2%)	8 (80.0%)	>0.05
Treated side						
Right	13 (30.23%)	4 (66.7%)	>0.05	3 (9.7%)	7 (70.0%)	>0.05
Left	14 (32.56%)	2 (33.3%)	>0.05	8 (25.8%)	3 (30.0%)	>0.05
Bilateral	16 (37.21%)	0 (0.0%)	>0.05	20 (64.5%)	0 (0.0%)	>0.05
Procedure type						
POBA	11 (25.58%)	4 (66.7%)	>0.05	15 (48.4%)	3 (30.0%)	>0.05
Stenting	28 (65.12%)	2 (33.3%0	>0.05	16 (51.6%)	6 (60.0%)	>0.05
Diagnostic	4 (9.30%)	0 (0.0%)	>0.05	0 (0%)	1 (10.0%)	>0.05
Number of sheaths	1.68±0.09	1.9 ± 0.11	>0.05	2.97±1.13	3.1 ± 1.31	>0.05
Maximum size of sheath (Fr)	7.69±0.23	8.62±0.22	0.0254*	5.23±2.06	7.2±2.14	0.016*
Ultrasound -guided approach	-	-	-	9 (29.0%)	1 (10.0%)	0.035*
Mean compression time (minutes)	-	-	-	14.96±1.26	15.92 ± 1.27	>0.05
Postoperative Surveillance						
Wrist pulses	43 (100.00%)	6 (100.0%)	>0.05	31 (100.0%)	10 (100.0%)	>0.05
Doppler flow	19 (44.19%)	6 (100.0%)	>0.05	21 (67.7%)	10 (100.0%)	>0.05
Duplex ultrasound	8 (18.60%)	0 (0.0%)	>0.05	20 (64.5%)	8 (80.0%)	>0.05
Length of hospital stay (days)	9.22±4.26	9.42±4.11	>0.05	8.07±2.1	7.73±2.71	>0.05
In-hospital mortality	2 (4.65%)	1 (16.7%)	>0.05	5 (16.1%)	0 (0.0%)	>0.05

Discussion

Brachial artery access for peripheral vascular interventions is getting more acceptance with the evolution of technology. It allows an antegrade access to the whole arterial tree from the thorax down to the foot. It is an easily controlled remote access when compared to the femoral gate. Because there is no gold standard when choosing between open and percutaneous access, this study was carried out to try to answer this question.

There were no demographic differences between the two study groups; open access (OA) and percutaneous access (PA) groups. The left BA was the chosen side in most interventions; 91% of all cases and larger sheath sizes were used whenever open cutdown was carried; 7.6 + 2.1 Fr. Looking at the complication rate, it was statistically lower in OA group; 6 (12%) cases in comparison to 10 (24%) in PA group. Equally, previous literature,[5-9] showed similar results. Brachial percutaneous puncture complication rates ranged from 1.3% to 17% in other studies,[5,10-12] which seemed to be higher in our study at 24%. This lower complication rate is most probably due to the inclusion of higher number of diagnostic procedures with the utilization of smaller sheath sizes than in our study.

Previous studies,[13,14] found that age, female sex, diabetes mellitus, using larger sheath sizes and not using ultrasound guided puncture for PA were associated with higher complication rates. Our study failed to demonstrate any correlation with age, sex and diabetes mellitus. However, similar findings were yielded regarding smoking, larger sheath sizes and use of ultrasound. We could not find variables like preoperative arm scan, access side, procedure type, number of sheaths used or postoperative surveillance that have a significant influence on complication rates.

Among the strengths of this study were being a comparative one and a multi-center study. Nevertheless, few limitations were faced the included lack of the operative time. There is a believe that the longer the time the sheath is kept inside the BA occluding it, the higher the incidence of thrombosis, something that unfortunately could not be studied due to the absence of documentation of the length of the procedure in the patients' notes. Another limitation was the inability to study the effect IV Heparin has on complication rate. This was because all patients genuinely received 5000 IU of IV Heparin, that was repeated in longer procedures at different doses according to the surgeons' preferences without having Activated Clotting Time (ACT) intraoperative monitoring. Moreover, this was a short-term study that could not comment on long-term complications like late BA occlusion, arterio-venous fistula, infection or pseudo-aneurysms, in spite of the morbidity these complications have on patients.

Of note, requesting a pre-operative CT angiography of thoracic aorta and arm or duplex ultrasound scan of arm was not a common practice in the three units. This could be due to financial or logistic issues; however, other studies,[15,16] have shown that these investigations might be decision-changer as they provide data like thoracic and upper limb arterial tree flow pattern, diameters, calcium score and tortuosity. Regarding vascular closure devices (VCDs), although no device is yet CE approved for peripheral interventions, a recent systematic review,[17] has concluded that off-label VCDs for BA approach carry a high technical success rate with similar complication rate to manual compression. Having said that, no closure devices were used in any of our study cases.

As previously illustrated, most surgeons used the left BA as their access side. Although, previous studies,[18,19] showed that right BA access is easier being more anatomically in line with the aortic arch and carries similar risk of stroke, but probably because most patients in our study did not have a CT angiography of the thoracic aorta to exclude innominate artery calcification, therefore refraining from the right BA seemed a wise decision. This goes in line with a previous study,[20] that involved 323 cases with BA access for non-cardiac interventions.

Conclusions

In conclusion, the study findings recommend for the BA access to use the open surgical approach, use the ultra-sound guided technique if PA is chosen and minimize the size of sheaths used as much as possible. Further studies are needed to correlate lengths of sheaths used, dose of IV Heparin and compression time post PA with access-site complications.

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