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Brachial and Axillary Artery Vascular Access for Endovascular Interventions

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Background: Endovascular access is usually achieved through the common femoral artery due to its large size and accessibility. Access through the upper extremity can however be necessary due to anatomic reasons, obesity, or peripheral arterial disease. The 2 main methods of access are surgical cutdown and percutaneous puncture. In this single-centre retrospective cohort study we compared complication risks for both surgical cutdown and percutaneous puncture of an upper arm approach.
Materials and Methods: Data was obtained from patients receiving endovascular access through the brachial or axillary artery between 2005 and 2018. A total of 109 patients were included. Patient demographics including age, sex, medical history, smoking status, and actual medication were registered, as well as postoperative complications including hematoma, thrombosis, dissection, infection, pseudoaneurysm, nerve injury, reoperation, and readmission.
Results: Access was achieved through surgical cutdown in 53% ($n = 58$) and through percutaneous puncture in 47% ($n = 51$) of patients. Fifty-eight percent ($n = 63$) received access via the brachial artery (BA) and 42% ($n = 46$) via the axillary artery. Complication rate was 25.0% (3 of 12) for surgical cutdown via the BA, 29.4% (15 of 51) for percutaneous puncture via the BA, and 10.9% (5 of 46) for surgical cutdown via the axillary artery. Major complication rate was 8.3% (1 of 12) for surgical cutdown via the BA, 13.7% (7 of 51) for percutaneous puncture via the BA, and 4.3% (2 of 46) for surgical cutdown via the axillary artery. There was no association between baseline patient characteristics and complication rate.
Conclusions: In this nonrandomized retrospective study, surgical cutdown via the axillary artery was the safest option with fewest complications, but selection of patients may have blurred the results. Surgical cutdown and percutaneous puncture seem equally safe in terms of complication rate in the BA.

INTRODUCTION

In the last 2 decades endovascular treatment of both aortic aneurysmal and aortic occlusive disease has gained widespread adoption, mainly due to high efficacy and safety.[1] Vascular access is usually achieved through the common femoral artery as it is easily accessible and can accommodate large sheaths.[2] Access through the upper extremity is however sometimes necessary due to specific anatomic configurations, obesity, or peripheral arterial disease, and can be achieved through the brachial artery (BA) and axillary artery (AxA).[3] Vascular access through the upper extremity is especially useful in fenestrated and branched

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endovascular aneurysm repair (FEVAR, BEVAR), as well as in PTA/stenting of the mesenteric or renal arteries.[3] Access through the upper extremity is however associated with smaller vessel size and spasms, resulting in complications such as dissection, bleeding, arteriovenous fistula, pseudoaneurysm formation, or thrombosis.[3] As a consequence, increased morbidity and reinterventions may be seen following vascular access through the upper extremity.[4] Results in literature report a wide range of complication rates in brachial versus femoral access. Possible explanations include differences in patient selection and study design.[5–8]

Surgical cutdown and percutaneous puncture can both be used to gain arterial access.[9] The general consensus is that percutaneous puncture is associated with more complications in BA access, varying from 1.3–17%.[6–8,10–16] Based on previous studies similar results are expected to be found for BA and AxA access. This study aimed to evaluate complication rates for BA and AxA access and to analyse the possible differences between surgical cutdown and puncture. The secondary objective was to evaluate the influence of comorbidities and intraoperative variables on complication rates.

MATERIALS & METHODS

This is a retrospective observational study of patients treated in a tertiary academic referral center between 2005 and 2018. Patients were identified by querying the Picture Archiving and Communications System (PACS) of the hospital. Patients aged above 18 years of age requiring brachial or axillary access for endovascular interventions for mesenteric stent or endograft placement were considered eligible for inclusion into this study. Patients were excluded if they suffered from coagulopathy, bleeding disorder, connective tissue disease or were allergic to any device component.

The Institutional Review Board approved the study (non-WMO number: 201900181). Research studies involving the retrospective review, collection, and analysis of patient records do not fall under the Dutch Act on Medical Scientific Research involving Human Beings (WMO), and therefore, individual patient informed consent was not required. The opt-out registry of the institution was consulted to see whether patients had objected to participating in scientific research. Data was stored and analysed anonymously.

Patient Demographics and Clinical Information

Clinical characteristics were extracted from electronic patient records. Patient data recorded included age, sex, height, weight, Body Mass Index (BMI in kg/m^2, calculated by dividing weight by height squared), smoking status, preoperative systolic and diastolic blood pressure, a history of hypertension, diabetes mellitus (DM), cerebrovascular disease, cardiovascular disease (CVD), pulmonary disease, renal disease (estimated glomerular filtration rate <60 mL/min/1.73 m^2 and/or proteinuria). Furthermore, preoperative use of statins, acetylsalicylic acid, clopidogrel, anticoagulants, diuretics, beta blockers, ACE-inhibitors, AT-2 inhibitors, and calcium antagonists were recorded. Details regarding operative technique and use of vascular closure devices were recorded in the database (CML, DZ, HKW) and a double reading was carried out (CML, DZ, HKW). Procedural time, access method, sheath size in French, and the use of anticoagulation were recorded. Arterial access method included surgical cutdown or puncture. The method of closure was recorded, including open surgical closure, use of percutaneous closure devices or manual compression.

Treatment and Follow-up

Immediate postoperative complications were recorded including presence of brachial or axillary plexus injury, access site infection, hematoma, brachial or axillary artery thrombosis, dissection, and puncture site pseudoaneurysm. Access site hematoma was further divided into mild (no treatment needed), moderate (transfusion required), and severe (reoperation required). Reoperations, readmissions, length of hospital stay, in-hospital mortality and 30-day survival were also recorded. Minor or moderate hematoma and infection were classified as minor complication, while severe hematoma (defined as hematomas requiring reoperation), reoperation, readmission, nerve injury, dissection and pseudoaneurysm were classified as major complication.

Statistical Analysis

Pearson's Chi-square test was used for analysis of categorical data where appropriate. Fisher's exact test was used for those variables that did not meet the criteria for Pearson's Chi square test. Continuous variables were expressed as mean ± SD. Continuous data was tested for normality using the Kolmogorov-Smirnov test. Differences between groups were determined by the student *t*-tests for normally distributed data and the Mann-Whitney U test for skewed distributed data.

A univariate analysis was carried out to identify predictors of complications. Logistic regression analysis was carried out to disclose the independent associations of surgical characteristics (type of blood vessel used, access method, and size of the blood vessel) and baseline patient characteristics (age, sex, height, weight, BMI, systolic blood pressure (SBP), diastolic blood pressure, estimated glomerular filtration rate, medication use, kidney failure, CVD, pulmonary dysfunction, DM and history of cerebrovascular disease) with the occurrence of complications. A 2-sided P value of <0.05 was considered significant. IBM SPSS software (SPSS, version 22.0, SPSS Inc. Chicago, IL, USA) was used for data analysis.

RESULTS

Between 2005 and 2018, 1143 patients were identified that underwent an endovascular procedure for placement of 1 or more mesenteric stents or insertion of an endograft. Of those patients, in 109 cases access was established via the arm.

Access was achieved through surgical cutdown in 53% (58 of 109) and through percutaneous puncture in 47% (51 of 109) of patients. Fifty-eight percent (63 of 109) received access via the BA and 42% (46 of 109) via the AxA. Within the BA group, 19.0% (12 of 63) received access via surgical cutdown, and 80.9% (51 of 63) via puncture. The closure techniques for patients that underwent BA were manual compression 63.5% ($n = 40$), surgical closure 19.0% ($n = 12$), and percutaneous closure devices including AngioSeal (St. Jude Medical, St. Paul, MN, USA) 11.1% ($n = 7$), ProGlide (Abbott Vascular, Redwood City, USA) 3.2% ($n = 2$), both AngioSeal and ProGlide 1.6% ($n = 1$), and 3.2% ($n = 2$) other closure techniques. All axillary access was achieved through surgical cutdown and closure was performed surgically in all these patients.

Patient characteristics are reported inTable I. The mean age of patients that underwent BA access was 67.2 years compared to 70.0 years in those that underwent AxA access. Sex distribution between the BA (57.1% men, 42.9% women) and AxA (80.4% men, 19.6% women) groups was significantly different ($P = 0.008$). Significantly more patients in the AxA group suffered from hypertension ($P= 0.012$) and diastolic blood pressure (DBP) was significantly higher ($P= 0.011$) compared to the BA group. Within the BA group those with surgical cutdown had a significantly lower estimated glomerular filtration rate ($P= 0.033$) and a significantly higher BMI ($P= 0.02$). In the BA group significantly more patients suffered from diabetes mellitus compared to the AxA group. Surgery duration was significantly longer ($P< 0.001$) and sheath size significantly larger ($P< 0.001$) in the AxA group compared to the BA group. Within the BA group, surgery duration was significantly longer ($P= 0.005$), and sheath size was significantly larger ($P= 0.004$) in the surgical cutdown group. 30-day survival, discharge status and length of hospital stay did not differ significantly between both groups, nor between brachial surgical cutdown and puncture (Table II).

Twenty-three of the 109 patients suffered from complications, that is, 3 in the brachial surgical cutdown group and 15 in the puncture group ($P= 0.732$) and 5 in the axillary group. Complication rates were significantly higher in the BA group, compared to the AxA group (28.6% [18/63] ± 0.46 and 10.9% [5/46] ± 0.31, $P= 0.025$). This significant difference was lost when corrected for surgical technique. There was no significant difference in complication rates within the brachial group.

Use of anticoagulants or antiplatelets (alone or combined) was not associated with an increased risk of hematoma ($P= 0.281$) and did not influence complication rates. In a logistic regression model, access type could not predict complication rate within the BA ($P= 0.761$). This relationship remained after correction for age and sex ($P= 0.612$). In the logistic regression model closure technique could not predict complications ($P= 0.732$). No baseline patient demographics, comorbidity or medication used could predict complication occurrence (Table III). BA access, decreasing height and percutaneous access were significant predictors of complications (Table III). Sheath sizes and their associated complication rates are reported in Table IV. Sheath size could not predict complications in the logistic regression model for BA and AxA groups ($P= 0.958$, $P= 0.489$). This relationship remained after correction for access type, age, and sex ($P= 0.961$, $P= 0.375$).

DISCUSSION

This study evaluated vascular access complications seen in BA and AxA endovascular approaches for mesenteric stents or endograft procedures. AxA cutdown was associated with the lowest

Table I. Comparison of baseline patient demographics in brachial access, brachial percutaneous access, brachial surgical access, and axillary surgical access groups

Patient demographics	BA access *N* = 63	BA PP *N* = 51	BA SC *N* = 12	*P* value (BA PP versus BA SC)	AxA SC *N* = 46	*P* value (BA versus AxA)
Age in years	67.2 ± 13.9	65.8 ± 14.9	73.9 ± 5.5	0.060	70 ± 9.8	0.380
Sex				**0.048**		**0.008**
Male	36 (57.1%)	26 (51.0%)	10 (83.3%)		37 (80.4%)	
Female	27 (42.9%)	25 (49.0%)	2 (16.7%)		9 (19.6%)	
Height (cm)[a]	170.9 ± 9.9	170.5 ± 10.7	172.2 ± 7.0	0.615	175.9 ± 7.0	**0.004**
Weight (kg)[a]	74.6 ± 17.8	73.1 ± 19.3	81.7 ± 8.3	**0.033**	83.5 ± 17.9	**0.016**
BMI (kg/m^2)[a]	25.2 ± 4.5	24.7 ± 4.8	27.5 ± 2.3	**0.020**	27.1 ± 6.3	0.083
Smoking status[a]				0.407		0.930
Current smoker	19 (30.2%)	17 (33.3%)	2 (16.7%)		16 (34.8%)	
Former smoker	18 (28.6%)	14 (27.5%)	4 (33.3%)		13 (28.3%)	
Systolic blood[a] pressure (mm Hg)	137.0 ± 26.8	137.3 ± 30.3	136.6 ± 8.8	0.920	143.3 ± 22.9	0.210
Diastolic blood[a] pressure (mm Hg)	72.6 ± 16.	72.7 ± 17.9	71.7 ± 13.7	0.857	80.8 ± 14.5	**0.011**
Hypertension[a]	37 (58.7%)	29 (56.9%)	8 (66.7%)	0.615	37 (80.4%)	**0.012**
Diabetes mellitus[a]	17 (27.0%)	13 (25.5%)	4 (33.3%)	0.638	4 (8.7%)	**0.015**
Cerebrovascular disease[a]	8 (12.7%)	7 (13.7%)	1 (8.3%)	0.584	7 (15.2%)	0.731
Cardiovascular disease[a]	26 (41.3%)	22 (43.1%)	4 (33.3%)	0.468	25 (54.3%)	0.201
Pulmonary dysfunction[a]	14 (22.2%)	13 (25.5%)	1 (8.3%)	0.179	17 (37.0%)	0.102
eGFR[a] (mL/min[a]1.73m^2)	66.2 ± 31.5	68.9 ± 32.9	52.2 ± 19.9	**0.033**	67.3 ± 22.6	0.833
Kidney failure[a]	20 (31.7%)	14 (27.5%)	6 (50.0%)	0.171	11 (23.9%)	0.573
Medication use						
Statin[a]	28 (44.4%)	21 (41.2%)	7 (58.3%)	0.365	28 (60.9%)	0.125
Acetylsalicylic acid[a]	30 (47.6%)	26 (51.0%)	4 (33.3%)	0.245	22 (47.8%)	0.890
Clopidogrel[a]	12 (19.0%)	11 (21.6%)	1 (8.3%)	0.259	4 (8.7%)	0.115
Anticoagulation[a]	26 (41.3%)	21 (41.2%)	5 (41.7%)	0.896	18 (39.1%)	0.716
Antihypertensives[a]	48 (76.2%)	37 (72.5%)	11 (91.7%)	0.221	38 (82.6%)	0.613
Anticoagulation and antiplatelet[a]	50 (79.4%)	41 (80.4%)	9 (75.0%)	0.484	37 (80.4%)	0.840

Data are shown as number (percentage). Continuous variables are expressed as mean ± SD. *t*-test was used to compare unpaired parametric data with normal distribution, otherwise the Mann-Whitney U test was used. Pearson's Chi-square test was used to compare categorical data where appropriate.
Significant values are shown in bold.
PP, percutaneous puncture; SC, surgical cutdown; eGFR, estimated glomerular filtration rate.
[a]Missing data <15%.

complication rate (10.9%). BA cutdown and BA puncture did not differ significantly in terms of complication rates (25.0%, and 29.4% respectively). AxA cutdown was associated with 4.3% major complications, which is comparable to a previous study with 7.4% major complications.[17] Previous literature suggests that BA puncture results in a higher complications rate than BA cutdown,[6–8,10–16] which was also the case in this study, although the difference was not significant. BA puncture complication rates ranged from 1.3% to 17% in other studies, which appeared to be higher in our study at 29.4%.[6–8,11–16] This lower complication rate is most likely due to the inclusion of diagnostic procedures with the usage of smaller sheath sizes than the therapeutic interventions included in our study.[7,13,15,18]

BA and AxA access are becoming an increasingly important option as anatomic problems in the femoral artery are seen in as many as 13% of patients, making them unsuitable candidates for endovascular aortic aneurysm repair.[3] Atherosclerotic disease affects the femoral artery more frequently than the AxA, highlighting its

Table II. Comparison of intraoperative and postoperative characteristics following brachial access, brachial percutaneous access, brachial surgical access, and axillary surgical access groups

Patient demographics	BA access $N = 63$	BA PP $N = 51$	BA SC $N = 12$	*P* value (BA PP versus BA SC)	AxA SC $N = 46$	*P* value (BA versus AxA)
Procedure time[b] (min)	258.6 ± 109.7	216.6 ± 78.8	357.3 ± 113.8	**0.005**	409.4 ± 136.2	**0.000**
Sheath size[a] (French)	6.2 ± 1.9	5.7 ± 1.0	8.8 ± 2.8	**0.000**	10.0 ± 2.6	**0.000**
Nerve injury	2 (3.2%)	2 (3.9%)	0 (0%)	1.000	1 (2.2%)	1.000
Infection at access site	1 (1.6%)	1 (2.0%)	0 (0%)	1.000	0 (0%)	1.000
Hematoma				0.912		0.143
Mild	9 (14.3%)	7 (13.7%)	2 (16.7%)		3 (6.5%)	
Moderate	2 (3.2%)	2 (3.9%)	0 (0%)		0 (0%)	
Severe	5 (7.9%)	4 (7.8%)	1 (8.3%)		1 (2.2%)	
Thrombosis	0 (0%)	0 (0%)	0 (0%)	/	1 (2.2%)	0.422
Dissection	0 (0%)	0 (0%)	0 (0%)	/	1 (2.2%)	0.422
Pseudoaneurysm	2 (3.2%)	2 (3.9%)	0 (0%)	1.000	0 (0%)	0.508
Reoperation	2 (3.2%)	2 (3.9%)	0 (0%)	1.000	4 (8.7%)	0.748
Readmission	1 (1.6%)	1 (2.0%)	0 (0%)	1.000	0 (0%)	1.000
Length of hospital stay (days)	9.3 ± 8.6	9.6 ± 9.6	8.2 ± 2.6	0.437	10.4 ± 9.6	0.296
In-hospital mortality	9 (14.3%)	9 (17.6%)	0 (0%)	0.185	4 (8.7%)	0.374
30-day mortality	12 (19.0%)	12 (23.5%)	0 (0%)	0.100	4 (8.7%)	0.131
Complications	18 (28.6%)	15 (29.4%)	3 (25.0%)	0.732	5 (10.9%)	**0.025**
Major complication	8 (12.7%)	7 (13.7%)	1 (8.3%)	0.614	2 (2.2%)	0.136
Minor complication	11 (17.5%)	9 (17.6%)	2 (16.7%)	0.936	3 (6.5%)	0.092

Data are shown as number (percentage). Continuous variables are expressed as mean ± SD. *t*-test was used to compare unpaired parametric data with normal distribution, otherwise the Mann-Whitney U test was used. Pearson's Chi-square test was used to compare categorical data where appropriate.
Significant values are shown in bold.
PP, percutaneous puncture; SC, surgical cutdown.
[a]Missing data <15%.
[b]Missing data 15–70%.

important role in endovascular procedures in those affected by arterial disease.[3] BA or AxA access may also be useful in gaining access to mesenteric and renal vessels and provide essential alternative access points in procedures during which several deployment systems are needed.[3]

AxA cutdown has been demonstrated to be the safest option in terms of complication rates. The current nonrandomized study demonstrates that BA cutdown and BA puncture have comparable complication rates. Previous studies found that increasing sheath size, age, female sex, and diabetes mellitus were associated with increasing complication rates.[7,19] Our study demonstrated that no patient characteristics or intraoperative variables influenced complication rates significantly. Sheath size could not predict complication rates in both BA and AxA groups. When corrected for access type, age, and sex no differences could be demonstrated. This might be due to selection bias; small sheath sizes were mostly used in BA access; large sheath sizes were only used in exceptional cases. The opposite was true for AxA access, large sheath sizes were mostly used, and small sizes were only used rarely. Sample sizes in BA access with a large sheath size and AxA access with a small sheath size were therefore small, indicating a selection bias. Although nonsignificant, complication rates when using sheath sizes greater than 7 Fr were lowest in the AxA cutdown group.

As with any retrospective cohort study, there are some inherent limitations, including uncertainty about cause-effect relationships. Indications to utilise open surgical access versus percutaneous access, and BA versus AxA access were lacking. The comparison between BA versus AxA access is limited by the lack of information regarding the procedure the access was used for; future studies would need to take procedural differences into account when comparing access sites. A significant

Table III. Comparison of baseline patient demographics and operative variables in patients with and without complications

Patient demographic	Complication present $N = 23$	Complication absent $N = 86$	P value
Age in years	69.4 ± 10.3	68.1 ± 12.9	0.772
Sex			0.089
Male	12 (52.2%)	61 (70.9%)	
Female	11 (47.8%)	25 (29.1%)	
Height (cm)[a]	169.4 ± 8.1	174.2 ± 9.1	**0.031**
Weight (kg)[a]	78.9 ± 23.6	78.6 ± 16.7	0.952
BMI (kg/m^2)[a]	27.4 ± 8.4	25.8 ± 4.4	0.817
Smoking status			0.136
Current smoker	4 (17.4%)	31 (36.0%)	
Former smoker	8 (34.8%)	23 (26.7%)	
Systolic blood pressure (mm Hg)[a]	138.8 ± 23.7	140.1 ± 25.8	0.836
Diastolic blood pressure (mm Hg)[a]	74.2 ± 17.1	76.8 ± 16.1	0.549
Hypertension[a]	18 (78.3%)	56 (65.1%)	0.969
Diabetes mellitus[a]	7 (30.4%)	14 (16.3%)	0.133
Cerebrovascular disease[a]	3 (13.0%)	12 (14.0%)	0.895
Cardiovascular disease[a]	11 (47.8%)	40 (46.5%)	0.948
Pulmonary dysfunction[a]	6 (26.1%)	25 (29.1%)	0.755
eGFR (mL/min[a]1.73m^2)[a]	63.5 ± 29.5	67.6 ± 27.9	0.551
Kidney failure[a]	5 (21.7%)	26 (30.2%)	0.289
Medication use			
Statin[a]	11 (47.8%)	45 (52.3%)	0.625
Acetylsalicylic acid[a]	13 (56.5%)	39 (45.3%)	0.391
Clopidogrel[a]	5 (21.7%)	11 (12.8%)	0.303
Anticoagulation[a]	10 (43.5%)	34 (39.5%)	0.795
Antihypertensives[a]	21 (91.3%)	65 (75.6%)	0.136
Anticoagulation and antiplatelets[a]	19 (82.6%)	65 (75.6%)	0.589
Artery			**0.025**
Axillary	5 (21.7%)	41 (47.7%)	
Brachial	18 (78.3%)	45 (52.3%)	
Access			**0.046**
Surgical	8 (34.8%)	50 (58.1%)	
Percutaneous	15 (65.2%)	36 (41.9%)	
Procedure time (min)[b]	323.2 ± 191.4	362.8 ± 137.3	0.459
Sheath size (French)	6.9 ± 2.4	8.1 ± 3.0	0.095
Length of hospital stay (days)[a]	8.0 ± 4.9	10.3 ± 9.8	0.637
In-hospital mortality	2 (8.7%)	11 (12.8%)	0.590
30-day mortality	3 (13.0%)	13 (15.1%)	0.803

Data are shown as number (percentage). Continuous variables are expressed as mean ± SD. *t*-test was used to compare unpaired parametric data with normal distribution, otherwise the Mann-Whitney U test was used. Pearson's Chi-square test was used to compare categorical data where appropriate.
Significant values are shown in bold.
eGFR, estimated glomerular filtration rate.
[a]Missing data <10%.
[b]Missing data 40–60%.

bias in this study was that surgeons decided on access method based on personal experience, resulting in unequal distribution of patient groups.

Due to the retrospective nature of the study, there was some missing data as patient files were sometimes incomplete. No patients received AxA access via puncture, as this was deemed high risk for potential bleeding which might be difficult to control as well as the risk of plexus injury.[20] However, some studies have shown success rates ranging from 70% to 100%,[3,21–23] suggesting it might be a safe and viable option. Furthermore, 30-day survival and length of hospital stay were confounded by comorbidities. Length of hospital

Table IV. Sheath size and complication rates in brachial percutaneous access, brachial surgical access, and axillary surgical access

Sheath size	BA PP complication rate $N = 51$	BA SC complication rate $N = 11$	AxA SC complication rate $N = 46$	Categorical relation, 4–5 French group as reference
4–5 French	6/22 (27.3%)	0/0 (0.0%)	0/2 (0.0%)	0.203
6–7 French	8/27 (29.6%)	2/6 (33.3%)	2/10 (20.0%)	0.797
>7 French	1/2 (50.0%)	1/5 (20.0%)	3/34 (8.8%)	0.192

Data are shown as number (percentage). Differences between the different groups were determined by logistic regression.
PP, percutaneous puncture; SC, surgical cutdown.

stay was recorded from time of admission, leading to inconclusive variation.

Certain baseline patient characteristics differed between groups including age, sex, height, weight, DBP, diabetes status and hypertension, meaning confounding factors cannot be excluded. Strengths of this study include a relatively large sample size and a long period (13 years) being evaluated.

CONCLUSION

This study found that AxA cutdown is the safest option with the lowest complication rate. Consequently, AxA cutdown may be regarded as the preferred option where possible, ensuring maximum patient safety. BA cutdown and BA puncture did not differ significantly in terms of complication rates. Patients related variables did not influence complication rates. Further studies are required to draw definite conclusions.

REFERENCES

1. Kalra K, Arya S. A comparative review of open and endovascular abdominal aortic aneurysm repairs in the national operative quality improvement database. Surg 2017;162:979–88.
2. Tayal R, Barvalia M, Rana Z. Totally percutaneous insertion and removal of Impella device using axillary artery in the setting of advanced peripheral artery disease. J Invasive Cardiol 2016;28:374–80.
3. Harris E, Warner CJ, Hnath JC, et al. Percutaneous axillary artery access for endovascular interventions. J Vasc Surg 2018;68:555–9.
4. Sos T. Brachial and axillary arterial access, an overview of when and how these approaches are used. Endovasc today 2010;55:55–8.
5. Gan H, Yip H, Wu C. Brachial approach for coronary angiography and intervention: totally obsolete, or a feasible alternative when radial access is not possible? Ann Acad Med Singapore 2010;39:368–73.
6. Kiemeneij F, Laarman GJ, Odekerken D, et al. A randomized comparison of percutaneous transluminal coronary angioplasty by the radial, brachial and femoral approaches: the access study. J Am Coll Cardiol 1997;29:1269–75.
7. Kret MR, Dalman RL, Kalish J, et al. Arterial cutdown reduces complications after brachial access for peripheral vascular intervention. J Vasc Surg 2016;64:149–54.
8. Otsuka M, Shiode N, Nakao Y, et al. Comparison of radial, brachial, and femoral accesses using hemostatic devices for percutaneous coronary intervention. Cardiovasc Interv Ther 2018;33:62–9.
9. Schäfer U, Deuschl F, Schofer N, et al. Safety and efficacy of the percutaneous transaxillary access for transcatheter aortic valve implantation using various transcatheter heart valves in 100 consecutive patients. Int J Cardiol 2017;232:247–54.
10. Knowles M, Nation DA, Timaran DE, et al. Upper extremity access for fenestrated endovascular aortic aneurysm repair is not associated with increased morbidity. J Vasc Surg 2015;61:80–7.
11. Lupattelli T, Clerissi J, Clerici G, et al. The efficacy and safety of closure of brachial access using the AngioSeal closure device: Experience with 161 interventions in diabetic patients with critical limb ischemia. J Vasc Surg 2008;47:782–8.
12. Belenky A, Aranovich D, Greif F, et al. Use of a collagen-based device for closure of low brachial artery punctures. Cardiovasc Intervent Radiol 2007;30:273–5.
13. Franz RW, Tanga CF, Herrmann JW. Treatment of peripheral arterial disease via percutaneous brachial artery access. J Vasc Surg 2017;66:461–5.
14. Parviz Y, Rowe R, Vijayan S, et al. Percutaneous brachial artery access for coronary artery procedures: feasible and safe in the current era. Cardiovasc Revasc Med 2015;16:447–9.
15. Armstrong PJ, Han DC, Baxter JA, et al. Complication rates of percutaneous brachial artery access in peripheral vascular angiography. Ann Vasc Surg 2003;17:107–10.
16. Heenan SD, Grubnic S, Buckenham TM, et al. Transbrachial arteriography: indications and complications. Brain Lang 1996;51:205–9.
17. Wooster M, Powell A, Back M, et al. Axillary artery access as an adjunct for complex endovascular aortic repair. Ann Vasc Surg 2015;29:1543–7.
18 DeCarlo C, Latz CA, Boitano LT, et al. Percutaneous brachial access associated with increased incidence of complications compared to open exposure for peripheral vascular interventions in contemporary series. J Vasc Surg 2020;73(5):1723–30 Epub ahead of print 5 October.
19. Alvarez-Tostado JA, Moise MA, Bena JF, et al. The brachial artery: a critical access for endovascular procedures. J Vasc Surg 2009;49:378–85.
20. Kuo F, Park J, Chow K, et al. Avoiding peripheral nerve injury in arterial interventions. Diagn Interv Radiol 2019;25:380–91.
21. Bertoglio L, Mascia D, Cambiaghi T, et al. Percutaneous axillary artery access for fenestrated and branched

thoracoabdominal endovascular repair. J Vasc Surg 2018;68:12–23.
22. Puippe GD, Kobe A, Rancic Z, et al. Safety of percutaneous axillary artery access with a suture-mediated closing device for parallel endograft aortic procedures – a retrospective pilot study. Vasa - Eur J Vasc Med 2018;47:311–17.
23. Schäfer U, Ho Y, Frerker C, et al. Direct percutaneous access technique for transaxillary transcatheter aortic valve implantation: 'the Hamburg Sankt Georg approach. JACC Cardiovasc Interv 2012;5:477–86.