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Brachial arterial access for PCI: an analysis of the British Cardiovascular Intervention Society database

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Introduction

Percutaneous coronary intervention (PCI) has evolved from femoral arterial access predominance to radial arterial access. Despite the widespread use of the radial and femoral approaches, there remains a small but consistent subgroup of patients in whom the brachial approach is still chosen[1]. The study hypothesis was that, although clinical outcomes of patients undergoing PCI using brachial access might be inferior to other access sites, in procedures utilising brachial access undertaken by default radial operators clinical outcomes might be similar to procedures utilising femoral access.

Methods

STUDY DESIGN AND PARTICIPANTS

We analysed data from the British Cardiovascular Intervention Society (BCIS) National PCI Audit of all patients undergoing PCI in the UK between 2006 and 2017 (study consort flow in **Supplementary Figure 1**). The study was approved by the National Institute for Cardiovascular Outcomes Research (NICOR) ethics committee. The final study population consisted of 861,773 PCI procedures. Study definitions were used as in the BCIS National PCI Audit (available at https://www.bcis.org.uk/resources/bcis-ccad-database-resources/datasets-history/). The clinical outcomes of interest were in-hospital mortality, major adverse cardiac and cerebrovascular events (MACCE), major bleeding, emergency coronary artery bypass surgery (CABG) or repeat PCI, acute coronary procedural complications, and access-site complications **(Supplementary Appendix 1)**.

DATA ANALYSES

Statistical analysis was performed using the R coding environment (Open Source, RStudio version 3.5.1; RStudio, Boston, MA, USA). We tested for associations between each categorical variable and access site using a chi-squared test, and for continuous variables using the Wilcoxon-Mann-Whitney test. Multiple imputations were carried out using the Multivariate Imputation by Chained

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Equations (mice) package to reduce the potential bias from missing data **(Supplementary Table 1)**. We performed an analysis of the predictors of access site using multivariate inverse probability of treatment weighting (IPTW) analysis **(Supplementary Appendix 2)**.We examined the influence of brachial access on PCI outcomes using the IPTW-adjusted model to investigate the independent odds of adverse outcomes by access site. Using the same methodology, we performed a sensitivity analysis on default radial operators (defined as having performed more than 75% of their cumulative procedures through radial access) and for the most recent study years (2013-2017) **(Supplementary Figure 2)**[2].

Results

TEMPORAL CHANGES IN BRACHIAL ACCESS SITE CHOICE FOR PCI BETWEEN 2006 AND 2017

In total 1,133 procedures were undertaken from the brachial artery (0.13%). Annual numbers of brachial access increased through the study period, driven by an increase in overall PCI volume (**Central illustration**, left panel).

BASELINE DEMOGRAPHICS AND PROCEDURAL DETAILS BY ACCESS SITE

In comparison to both radial and femoral access, those patients treated using brachial access were older, and had significantly greater baseline comorbidity **(Supplementary Table 2)**. In comparison to radial access, patients treated using brachial access were more likely to present with stable angina, to have undergone previous CABG, and to present in cardiogenic shock **(Supplementary Table 2)**. Brachial access for PCI was also associated with characteristics representing PCI complexity compared to femoral and radial access, including greater baseline disease severity, left main and chronic total occlusion (CTO)-PCI **(Supplementary Table 3)**. Baseline demographics, and procedural details for brachial and femoral cases undertaken by default radial operators are presented in **Supplementary Table 4** and **Supplementary Table 5**.

INDEPENDENT ASSOCIATES OF BRACHIAL ACCESS USE FOR PCI FROM 2006 TO 2017

The independent predictors of brachial access use for PCI are presented in **Table 1**. The strongest independent associates of brachial access included peripheral vascular disease, rotational atherectomy, female sex, chronic renal disease, left main target vessel and age per year.

CLINICAL OUTCOMES BY ACCESS SITE FOR PCI FROM 2006 TO 2017

Crude unadjusted procedural and clinical outcomes are presented in **Supplementary Table 6**. After adjustment, brachial access remained strongly associated with adverse clinical outcomes compared to femoral access (**Supplementary Figure 3**, left panel). Similarly, in comparison with radial access, brachial access was associated with increased rates of these adverse outcomes but also increased rates of access-site haemorrhage and major bleeding (**Supplementary Figure 3**, right panel). The same associations were observed using multivariable logistic regression to adjust for baseline differences between groups **(Supplementary Figure 4)**. In a sensitivity analysis for the study years 2013-2017 when radial access predominated as the default strategy, in a brachial versus femoral access comparison, there were no increased odds of MACCE associated with brachial access **(Supplementary Figure 5)**. Within the group of patients who experienced an access-site vascular complication, the impact of this compared to patients without an access-site vascular complication on in-hospital outcomes was observed to be greater for patients in the brachial group (MACCE odds ratio [OR] 18.1, 95% confidence interval [CI]: 1.5-50.4, and mortality OR 35.0, 95% CI: 2.4-105.4) than in the femoral cohort (MACCE OR 2.5, 95% CI: 2.0-3.1, and mortality OR 2.6, 95% CI: 1.9-3.4), or radial cohort (MACCE OR 1.7, 95% CI: 1.2-2.3, and mortality OR 1.6, 95% CI: 1.1-2.4). In default radial operators, brachial arterial access was associated with similar IPTW weight-adjusted clinical outcomes to femoral access with only arterial complications observed to occur more frequently (OR 1.7, 95% CI: 1.1-2.7) (**Central illustration**, right panel).

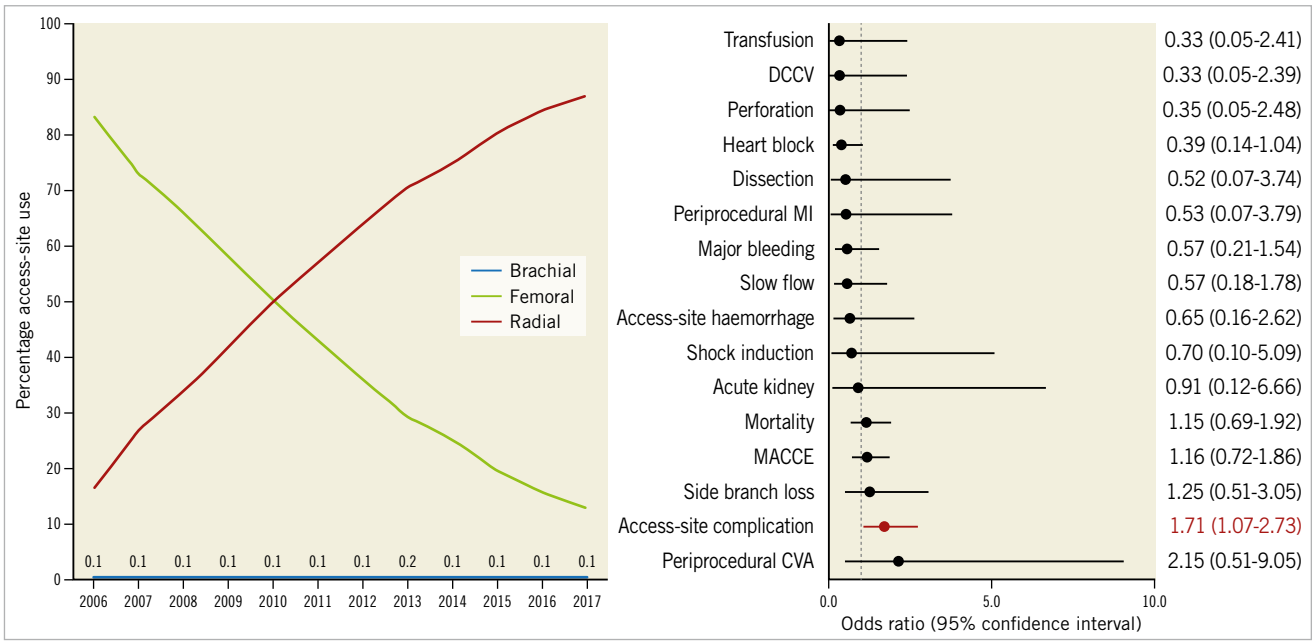
Table 1. Multivariable analysis of the independent predictors of brachial access for PCI in the United Kingdom 2006-2017.

Variable	OR for brachial access versus other access site	95% CI
Peripheral vascular disease	5.66	4.85-6.60
Rotational atherectomy use	1.61	1.19-2.10
Female sex	1.55	1.37-1.76
Chronic renal disease	1.50	1.18-1.91
Left main target vessel	1.39	1.10-1.76
Previous MI	1.36	1.17-1.58
Previous stroke	1.32	1.06-1.64
Previous CABG	1.28	1.06-1.54
Age of procedure/year	1.01	1.00-1.01

Discussion

The current data suggest that brachial arterial access is used infrequently to facilitate PCI. Amongst the associates of its use identified in the predictive analysis, peripheral vascular disease predominates along with procedural factors consistent with large guide catheter use, including left main PCI and use of rotational atherectomy. These data would imply that brachial access is chosen as a bail-out option in patients without femoral access who have either small or absent radial arteries.

The existing evidence for brachial artery access for PCI is limited in contemporary practice. The only randomised trial of access site for PCI to include brachial artery use, the Randomized Comparison of Percutaneous Transluminal Coronary Angioplasty by the Radial, Brachial and Femoral Approaches: The Access Study, randomised 900 patients to radial, femoral or brachial access for PCI. Clinical outcomes were similar for all three groups



Central illustration. *Access site changes and brachial artery predictors. Left panel: temporal changes in access site for PCI in the United Kingdom 2006-2017. Right panel: IPTW weight-adjusted procedural and clinical outcomes of brachial access procedures compared to femoral access in default radial operators for PCI in the United Kingdom 2006-2017.*

and, although vascular access-site complications were more frequent in the femoral and brachial subgroups compared to the radial subgroup, the rates of vascular complications were similar between the femoral and brachial groups[3]. However, these data reflect the very early evolution of access-site practice for PCI and may not be relevant to current practice. In the current series, the observed vascular complication rate was 3.1%, a rate that is consistent with more contemporary case series published which report rates ranging from 2 to 8%[4]. These data also demonstrate that vascular complications occur more frequently with brachial access than with femoral or radial access.

The clinical outcomes of patients undergoing PCI using brachial access were also significantly worse than the radial and femoral cohorts. An excess of in-hospital death, stroke and access-site complications was observed compared to both cohorts, together with an excess of major bleeding and acute kidney injury compared to the radial cohort, perhaps driven by unmeasured comorbidity which could not be corrected for combined with an excess of access-site complications and of major bleeding. It is also interesting to note that a vascular complication from brachial access was associated with a greater impact on MACCE, compared to femoral and radial access-site complications, perhaps reflecting a combination of factors including significant underlying comorbidity and the nature of the vascular complication itself.

The most novel and noteworthy finding of the current study is that, when brachial access is undertaken by default radial operators, aside from a small excess of vascular complications, the clinical outcomes of these procedures were similar to the outcomes of femoral access procedures undertaken by default radial operators. Brachial artery access in such cases presumably reflects patients with small or non-patent radial arteries in whom femoral arterial access is complicated by peripheral arterial disease or other comorbidity.

Limitations

In considering the limitations of the present study, as with any database, the robustness of the conclusions is related directly to the quality of data entered. Secondly, the BCIS database does not capture sheath size and therefore the influence of this on the findings of the current study cannot be addressed. The current iteration of the BCIS data set does not capture the indication for access choice nor does it capture crossover; thus, we are unable to add further data on this aspect. Additionally, use of ultrasound to guide puncture is also not recorded. Finally, because of the observational nature of this study, any conclusions may be influenced by unmeasured confounders.

Conclusion

Patients undergoing PCI using brachial arterial access have significant comorbidity and undergo complex procedures. Although adjusted in-hospital clinical outcomes were significantly worse than in femoral or radial access cases, in default radial operators, clinical outcomes were similar between femoral and brachial access. Further studies are warranted.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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Supplementary data

Supplementary Appendix 1. Study endpoint definitions.

Supplementary Appendix 2. Statistical methodology.

Supplementary Table 1. Percent missing values for each variable in the analysed datasets.

Supplementary Table 2. Baseline patient characteristics by access site for PCI in the United Kingdom 2006-2017.

Supplementary Table 3. Procedural variables by access site for PCI in the United Kingdom 2006-2017.

Supplementary Table 4. Baseline patient characteristics by access site for PCI in the United Kingdom 2006-2017 for default radial operators.

Supplementary Table 5. Procedural characteristics by access site for PCI in the United Kingdom 2006-2017 for default radial operators.

Supplementary Table 6. Crude unadjusted outcomes by access site for PCI in the United Kingdom 2006-2017.

Supplementary Figure 1. Patient number flow for study.

Supplementary Figure 2. Density plot.

Supplementary Figure 3. Weight-adjusted procedural and clinical outcomes.

Supplementary Figure 4. Multivariate-adjusted procedural/clinical outcomes.

Supplementary Figure 5. IPTW weight-adjusted procedural and clinical outcomes.

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Supplementary data

Supplementary Appendix 1. Study endpoint definitions

MACCE - defined as death, in-hospital CVA or MI.

In-hospital bleeding - defined as either gastrointestinal bleed, intracerebral bleed, retroperitoneal haematoma, blood or platelet transfusion, access-site haemorrhage, or an arterial access-site complication requiring surgery.

Acute coronary procedural complication - defined as no flow, perforation, dissection and major side branch loss.

Access-site complication - defined as either a false aneurysm, haemorrhage (without haematoma), haemorrhage with delayed discharge, retroperitoneal haematoma, arterial dissection, or any access-site complication requiring surgical repair.

Supplementary Appendix 2. Statistical methodology

To adjust for baseline imbalances in order to balance for important covariates that might bias estimates for causal inferences, propensity scores (PS) were calculated using fitted probabilities generated from a logistic regression model by access site which included all covariates described below. These scores were then used to calculate IPTW weights, as previously described, which were utilised to model adjusted outcomes [2]. Prior to performing this, multiple imputations were carried out using the mice package to reduce the potential bias from missing data **(Supplementary Table 1)**, assuming missingness at random mechanisms, by using chained equations to impute the data for all variables with missing information generating five data sets to be used in the analyses with satisfactory density plots demonstrating a similar distribution between the imputed and observed data sets **(Supplementary Figure 2)**. Covariates included in the adjustment were age, gender, clinical presentation, cardiogenic shock, previous MI, previous CABG, previous PCI, diabetes, baseline disease severity, LV function, smoking status, history of hypertension, stroke, renal failure, valvular heart disease, peripheral vascular disease, left main stem PCI (LMS-PCI), chronic total occlusion PCI (CTO-PCI) attempted, restenosis indication, rotational or laser atherectomy use, use of intracoronary imaging, use of cutting/scoring balloons, use of microcatheter support and mechanical LV support.

Supplementary Table 1. Percent missing values for each variable in the analysed data sets.

Variable	Brachial vs femoral (%)	Brachial vs radial (%)
Age	0.1	0.0
Number of disease lesions	11.7	6.0
Number of vessels attempted	0.9	1.3
Number of lesions attempted	1.3	1.0
Number of CTO attempted	11.0	6.2
Length of stay	0.0	0.0
Female gender	0.2	0.2
Clinical syndrome (ACS)	0.0	0.0
Cardiogenic shock pre procedure	1.7	0.9
Previous MI	11.3	3.7
Previous CABG	4.2	2.0
Previous PCI	4.9	1.9
Diabetes	5.7	2.4
Ejection fraction <30%	51.6	47.8
Smoking history	14.1	8.1
Hypertension	2.6	1.9
Stroke	2.6	1.9
PVD	2.6	1.9
Valve disease	2.6	1.9
Renal disease	8.0	3.7
Ventilated pre procedure	17.4	7.7
LMS	4.0	4.7
Rota	7.0	4.9
Laser	7.0	4.9
Cutting	7.0	4.9
Microcatheter	7.0	4.9
IABP	4.9	2.8
Periprocedural MI	0.0	0.0
Transfusion	0.0	0.0
Periprocedural stroke	0.0	0.0
AKI	0.0	0.0
In-hospital death	0.0	0.0
MACCE	0.0	0.0
Major bleeding	0.0	0.0
Slow flow	0.0	0.0
Side branch loss	0.0	0.0
Dissection	0.0	0.0
Perforation	0.0	0.0
Heart block	0.0	0.0
DCCV	0.0	0.0
Shock induction	0.0	0.0
Arterial complications	0.0	0.0
Arterial haemorrhage	0.0	0.0
Access site	0.0	0.0

Supplementary Table 2. Baseline patient characteristics by access site for PCI in the United Kingdom 2006-2017.

Variable	All (n=861,773)	Brachial (n=1,133)	Femoral (n=329,591)	*p*-value*	Radial (n=531,049)	*p*-value†
Age (years), ±SD	65.2±11.9	66.6±11.6	65.7±11.9	0.009	64.9±11.8	<0.001
Female sex, n (%)	222,796 (25.9)	377 (33.4)	92,764 (28.2)	0.001	129,655 (24.5)	<0.001
History of smoking, n (%)	481,911 (62.4)	669 (66.4)	176,142 (62.2)	0.007	305,100 (62.5)	0.012
Diabetes mellitus, n (%)	190,879 (23.3)	353 (32.2)	82,705 (26.4)	<0.001	104,087 (20.1)	<0.001
Previous MI, n (%)	222,831(27.7)	437 (40.9)	93,490 (32.0)	0.001	128,904 (25.2)	<0.001
Hypertension, n (%)	454,553 (53.9)	693 (63.0)	173,763 (54.1)	<0.001	280,097 (53.8)	<0.001
Peripheral vascular disease, n (%)	37,275 (4.4)	277 (25.2)	14,732 (4.6)	<0.001	22,266 (4.3)	<0.001
Previous stroke, n (%)	33,113 (3.9)	98 (8.9)	12,330 (3.8)	<0.001	20,685 (4.0)	<0.001
Chronic renal disease, n (%)	22,012 (2.7)	78 (7.3)	11,733 (3.9)	<0.001	10,201 (2.0)	<0.001
Valvular heart disease, n (%)	12,615 (1.5)	31 (2.8)	4,627 (1.4)	<0.001	7,957 (1.5)	0.001
Previous CABG, n (%)	69,036 (8.2)	163 (14.8)	43,292 (13.7)	0.308	25,581 (4.9)	<0.001
Previous PCI, n (%)	203,019 (24.3)	353 (32.2)	82,705 (26.4)	<0.001	119,961 (23.0)	<0.001
Cardiogenic shock pre, n (%)	17,981 (2.1)	41 (3.7)	10,634 (3.3)	0.509	7,306 (1.4)	<0.001
ACS presentation, n (%)	526,638 (61.1)	672 (59.3)	186,046 (56.4)	0.052	339,920 (64.0)	0.001
Ejection fraction <30%, n (%)	25,282 (5.8)	55 (8.9)	11,498 (7.2)	0.120	13,729 (5.0)	<0.001
Ventilated pre procedure, n (%)	12,359 (1.9)	28 (2.8)	7,231 (2.7)	0.923	5,100 (1.0)	<0.001

* p-value brachial vs femoral. † p-value brachial vs radial.

Supplementary Table 3. Procedural variables by access site for PCI in the United Kingdom 2006-2017.

Variable	All (n=861,773)	Brachial (n=1,133)	Femoral (n=329,591)	*p*-value*	Radial (n=531,049)	*p*-value†
Number of diseased vessels ±SD	1.36±0.8	1.51±0.9	1.41±0.8	0.001	1.32±0.7	<0.001
No. of vessels attempted ±SD	1.19±0.7	1.26±0.6	1.20±0.6	0.019	1.18±0.6	0.001
No. of lesions attempted ±SD	1.35±0.6	1.42±0.6	1.39±0.6	0.772	1.31±0.6	<0.001
No. of CTO PCI attempted, ±SD	0.07±0.3	0.10±0.3	0.09±0.3	0.906	0.06±0.3	<0.001
Rotational atherectomy, n (%)	15,250 (1.9)	51 (4.8)	7,225 (2.4)	<0.001	7,974 (1.6)	<0.001
Circulatory support, n (%)	9,700 (1.5)	14 (1.3)	6,729 (2.2)	0.040	2,957 (0.7)	0.018
Pressure wire, n (%)	88,569 (10.7)	94 (8.8)	20,793 (6.6)	0.005	67,682 (13.3)	<0.001
Intracoronary imaging, n (%)	54,819 (6.6)	78 (7.3)	15,488 (4.9)	0.001	39,253 (7.7)	0.668
Target vessels, n (%)						
Left main	34,027 (4.3)	96 (8.8)	15,525 (4.9)	<0.001	18,406 (3.6)	<0.001
Left anterior descending	398,693 (48.1)	495 (45.4)	145,063 (45.8)	0.821	253,135 (50.0)	0.003
Circumflex	202,846 (24.6)	291 (26.7)	76,985 (24.3)	0.071	125,570 (24.8)	0.157
Right	295,309 (35.9)	392 (36.0)	113,790 (36.0)	1.000	181,127 (35.8)	0.918
Atherectomy balloon, n (%)	25,058 (3.1)	68 (6.4)	9,936 (3.2)	<0.001	15,054 (3.0)	<0.001
Microcatheter, n (%)	12,348 (1.5)	28 (2.6)	4,404 (1.4)	0.001	7,916 (1.6)	0.013
Glycoprotein inhibitor, n (%)	163,895 (20.3)	181 (17.3)	68,251 (22.2)	<0.001	95,463 (19.0)	0.175
Longest stent (mm) ±SD	25.8±14.5	25.6±14.2	24.1±13.7	0.005	27.2±15.2	<0.001
No. of stents used ±SD	1.46±1.0	1.50±1.0	1.48±1.0	0.679	1.43±1.0	0.239

* p-value brachial vs femoral. † p-value brachial vs radial.

Supplementary Table 4. Baseline patient characteristics by access site for PCI in the United Kingdom 2006-2017 for default radial operators.

Variable	All (n=43,605)	Femoral (n=43,050)	Brachial (n=555)	*p*-value
Age (years), ±SD	67.3±12.1	67.3±12.1	66.2±11.4	0.02
Number of disease lesions, ±SD	1.6±0.9	1.6±0.9	1.5±0.9	0.15
Female gender, n (%)	15,052 (34.6)	14,863 (34.6)	189 (34.2)	0.87
Clinical syndrome (ACS), n (%)	27,335 (62.7)	26,978 (62.7)	357 (64.3)	0.46
Cardiogenic shock pre procedure, n (%)	3,296 (7.6)	3,275 (7.7)	21 (3.8)	0.00
Previous MI, n (%)	17,202 (41)	16,955 (41)	247 (45.7)	0.03
Previous CABG, n (%)	9,598 (22.3)	9,512 (22.4)	86 (15.8)	0.00
Previous PCI, n (%)	14,693 (34.4)	14,508 (34.4)	185 (34.1)	0.91
Diabetes, n (%)	11,056 (26.1)	10,900 (26.1)	156 (28.8)	0.17
Ejection fraction <30%, n (%)	2,701 (10.8)	2,673 (10.8)	28 (9.2)	0.43
Smoking history, n (%)	23,907 (61.3)	23,555 (61.2)	352 (69.3)	0.00
Hypertension, n (%)	25,418 (59.7)	25,074 (59.7)	344 (63.2)	0.10
Stroke, n (%)	2,672 (6.3)	2,612 (6.2)	60 (11)	0.00
PVD, n (%)	3,384 (8)	3,252 (7.7)	132 (24.3)	0.00
Valve disease, n (%)	1,119 (2.6)	1,101 (2.6)	18 (3.3)	0.38
Renal disease, n (%)	2,640 (6.4)	2,597 (6.3)	43 (8.1)	0.11
Ventilated pre procedure, n (%)	2,236 (5.5)	2,220 (5.6)	16 (3.1)	0.02
Q-wave on ECG, n (%)	6,326 (15.8)	6,260 (15.8)	66 (13)	0.10

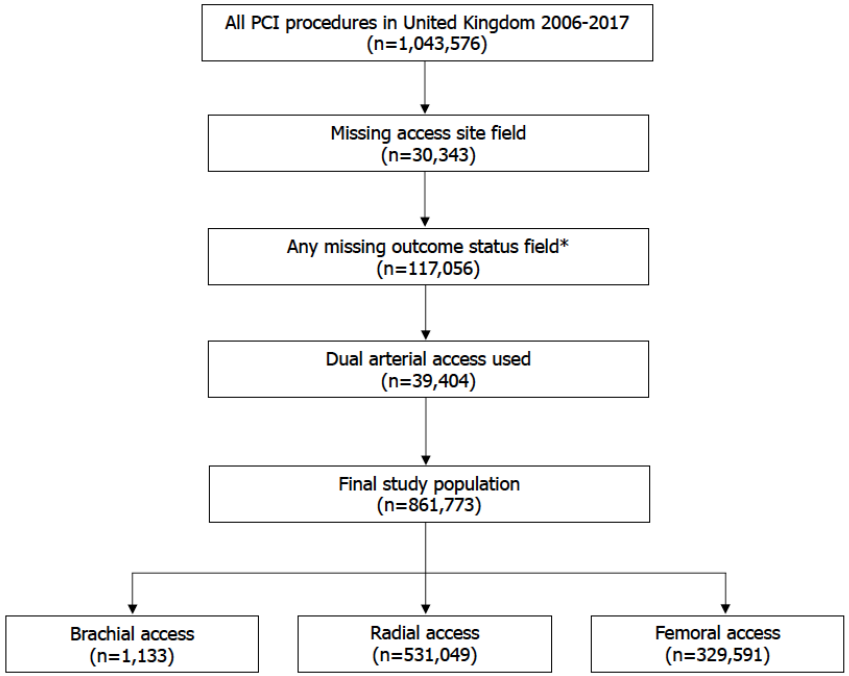
Supplementary Table 5. Procedural characteristics by access site for PCI in the United Kingdom 2006-2017 for default radial operators.

Variable	All (n=43,605)	Femoral (n=43,050)	Brachial (n=555)	*p*-value
No. of vessels attempted, ±SD	1.3±0.6	1.3±0.6	1.2±0.6	0.81
No. of lesions attempted, ±SD	1.4±0.8	1.4±0.8	1.4±0.8	0.33
No. of chronic total occlusions attempted, ±SD	0.1±0.3	0.1±0.3	0.1±0.3	0.20
LMS disease pre PCI, n (%)	3,894 (9.3)	3,843 (9.3)	51 (9.6)	0.87
Rotational atherectomy, n (%)	1,932 (4.6)	1,903 (4.6)	29 (5.3)	0.50
Laser, n (%)	217 (0.5)	217 (0.5)	0 (0)	-
Cutting balloon use, n (%)	1,287 (3.1)	1,257 (3)	30 (5.5)	0.00
Microcatheter use, n (%)	1,590 (3.8)	1,570 (3.8)	20 (3.7)	0.99
Intra-aortic balloon pump use, n (%)	1,488 (3.5)	1,480 (3.5)	8 (1.5)	0.02

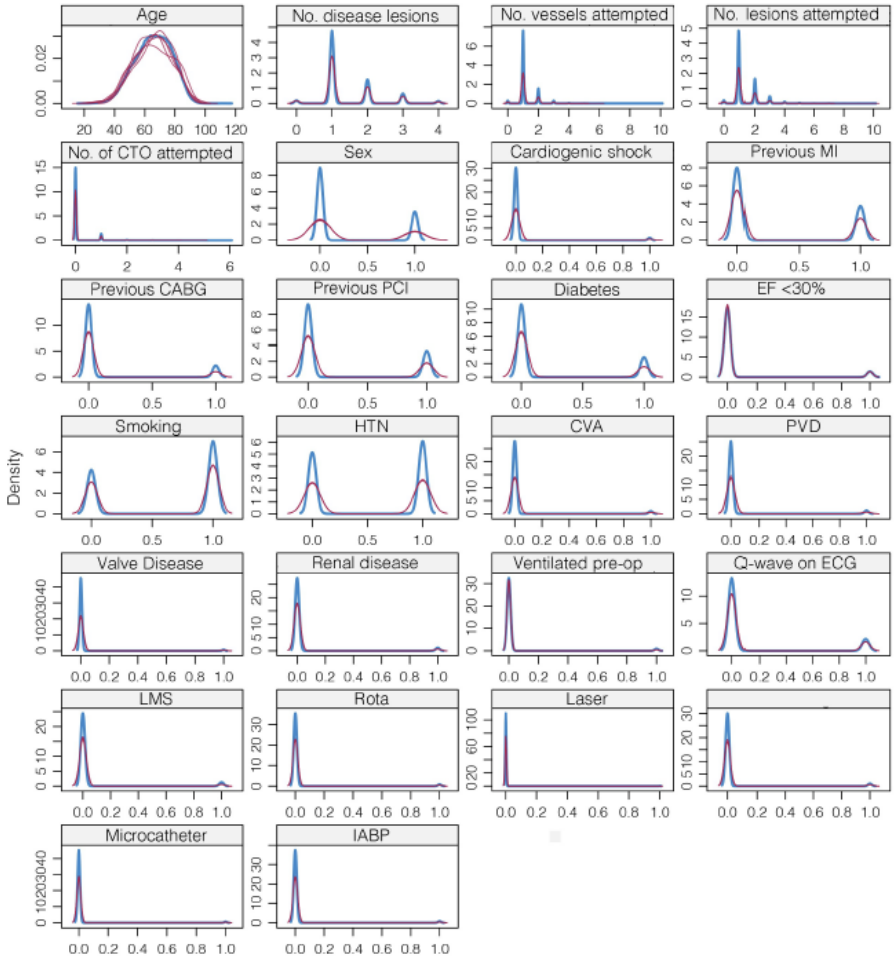
Supplementary Table 6. Crude unadjusted outcomes by access site for PCI in the United Kingdom 2006-2017.

Outcome	All (n=861,773)	Brachial (n=1,133)	Femoral (n=329,591)	*p*-value*	Radial (n=531,049)	*p*-value†
Procedural success, n (%)	716,877 (92.0)	943 (91.0)	265,452 (91.2)	0.885	450,482 (92.5)	0.0283
Number of successful vessels, ±SD	1.05±0.49	1.09±0.57	1.05±0.50	0.002	1.06±0.48	0.009
Number of successful lesions, ±SD	1.27±0.77	1.33±0.85	1.31±0.80	0.298	1.25±0.75	<0.001
Major side branch loss, n (%)	5,042 (0.6)	9 (0.8)	1,753 (0.6)	0.501	3,280 (0.6)	0.500
Slow flow, n (%)	7,698 (0.9)	9 (0.8)	2,948 (1.0)	0.601	4,741 (0.9)	0.844
Coronary dissection, n (%)	12,455 (1.5)	11 (1.0)	4,777 (1.6)	0.143	7,657 (1.5)	0.215
Coronary perforation, n (%)	2,417 (0.3)	2 (0.2)	955 (0.3)	0.773	1,460 (0.3)	0.773
Acute kidney injury, n (%)	790 (0.1)	4 (0.4)	316 (0.1)	0.012	470 (0.1)	0.014
Access-site complication, n (%)	11,311 (1.3)	35 (3.1)	6,020 (1.8)	0.002	5,256 (1.0)	<0.001
Transfusion, n (%)	1,690 (0.2)	1 (0.1)	1,165 (0.4)	0.211	524 (0.1)	1.000
Access-site haemorrhage, n (%)	2,205 (0.3)	5 (0.4)	1,818 (0.6)	0.465	382 (0.1)	0.004
In-hospital major bleeding, n (%)	4,926 (0.6)	10 (0.9)	3,284 (1.0)	0.855	1,632 (0.3)	0.001
In-hospital mortality, n (%)	13,036 (1.5)	50 (4.4)	7,577 (2.3)	<0.001	5,409 (1.0)	<0.001
Periprocedural CVA, n (%)	970 (0.1)	6 (0.5)	444 (0.1)	<0.001	524 (0.1)	<0.001
Periprocedural MI, n (%)	2,537 (0.3)	3 (0.3)	1,280 (0.4)	0.803	1,254 (0.2)	0.724
In-hospital MACCE, n (%)	16,305 (1.9)	58 (5.1)	9,134 (2.8)	<0.001	7,113 (1.3)	<0.001
Length of stay (days), ±SD	2.7±8.0	3.7±14.8	3.0±8.7	0.032	2.5±7.3	<0.001

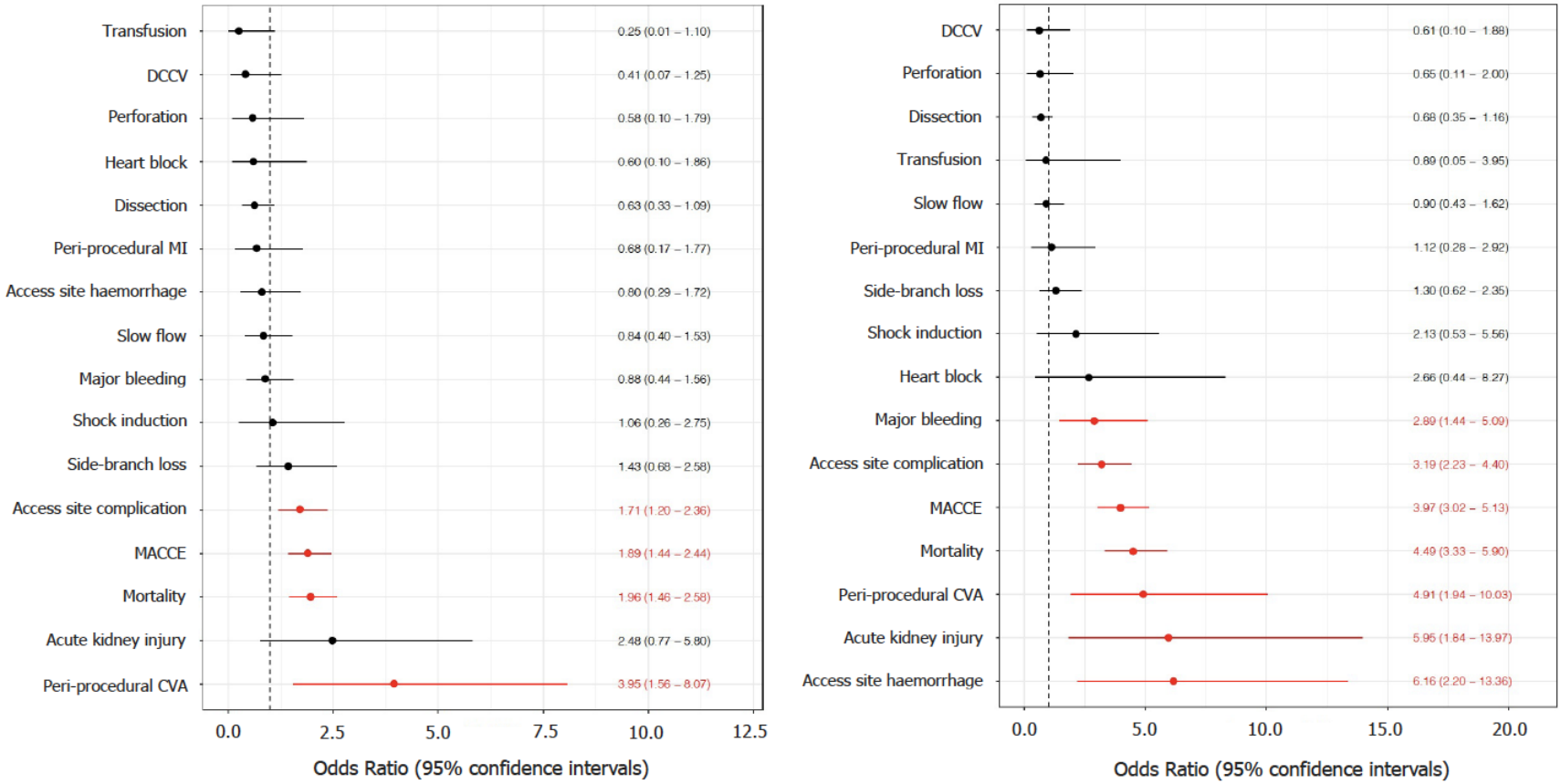
* p-value brachial vs femoral. † p-value brachial vs radial.



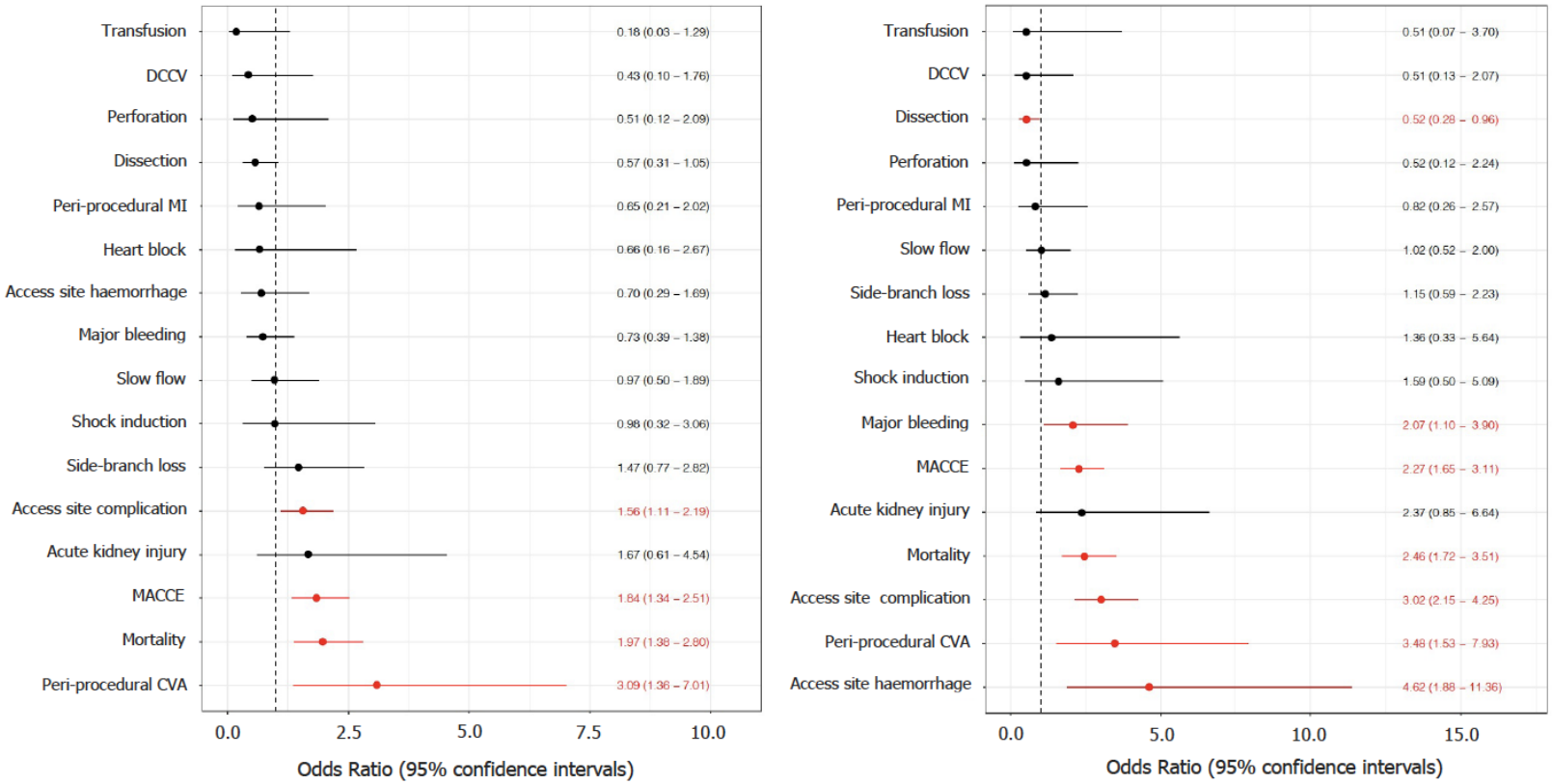
Supplementary Figure 1. Patient number flow for study.
*Fields included were MACCE, mortality, arterial complication and major bleeding.



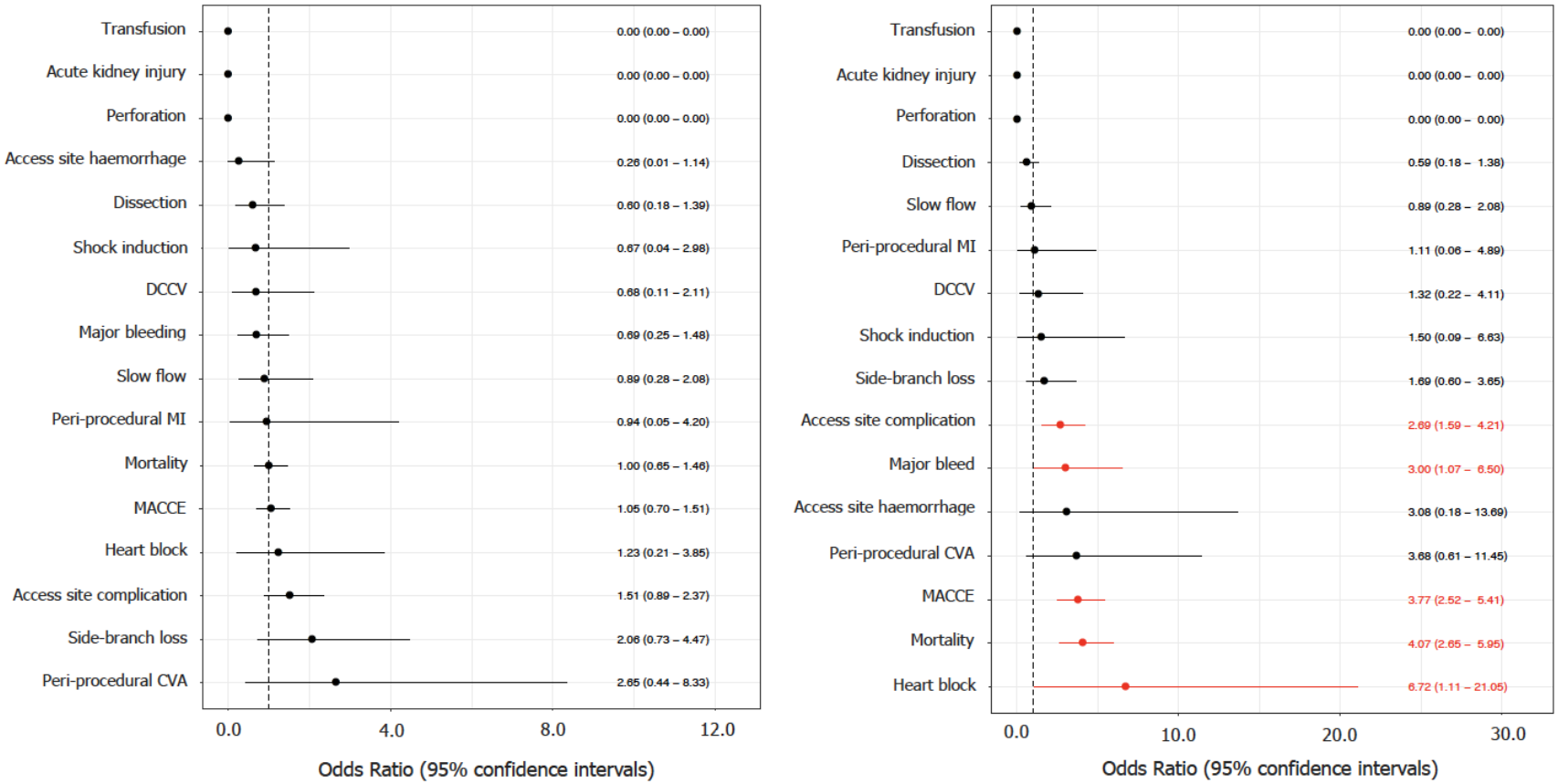
Supplementary Figure 2. Density plot.
Density plot of all imputed variables demonstrating that the imputed data set distribution (red curves; one from each of the five imputed data sets) is similar to the observed data set distribution (blue curves) indicating that the multiple imputation with chained equations (mice) process has successfully imputed values that are “plausible”. X-axis indicates the range of values for each variable. Y-axis is the density distribution.



Supplementary Figure 3. Weight-adjusted procedural and clinical outcomes.
Left panel - IPTW weight-adjusted procedural and clinical outcomes of brachial access procedures compared to femoral access for PCI in the United Kingdom 2006-2017. Right panel - IPTW weight-adjusted procedural and clinical outcomes of brachial access procedures compared to radial access for PCI in the United Kingdom 2006-2017.



Supplementary Figure 4. Multivariate-adjusted procedural/clinical outcomes.
Left panel - Multivariate-adjusted procedural/clinical outcomes of brachial access procedures compared to femoral access for PCI in the UK 2006-2017. Right panel - Multivariate-adjusted procedural/clinical outcomes of brachial access procedures compared to radial access for PCI in the UK 2006-2017.



Supplementary Figure 5. IPTW weight-adjusted procedural and clinical outcomes.
Left panel - IPTW weight-adjusted procedural and clinical outcomes of brachial access procedures compared to femoral access for PCI in the United Kingdom 2013-2017. Right panel - IPTW weight-adjusted procedural and clinical outcomes of brachial access procedures compared to radial access for PCI in the United Kingdom 2013-2017.IPTW: inverse probability of treatment weighting