SUPPLEMENTARY MATERIAL

RESULTS

Data Distribution and Tests of Normality

The Kolmogorov-Smirnov and Shapiro-Wilk tests of normality were used to assess whether continuous data followed the normal distribution (Supplementary Table 1). Significant values ($P<0.05$) indicate that the data did not follow the normal distribution and non-parametric tests were utilized to analyze these data. In situations in which the tests did not concur non-parametric tests were selected to utilize ensure a more conservative approach to data analysis.

Supplementary Table 1. Tests for normal distribution.

Characteristic	Kolmogorov-Smirnov Test for Normality *P*-Value	Shapiro-Wilk Test for Normality *P*-Value
Fluoroscopy Time Per Vessel	**0.001**	**0.001**
Angle of Primary Innominate Subclavian Artery Curve	0.20	**0.04**
Angle of Secondary Innominate Subclavian Artery Curve	0.20	0.233
Length of Innominate Artery	0.192	0.147
Subclavian Vertebral Angle (Left)	**0.014**	**0.001**
Subclavian Vertebral Angle (Right)	**0.01**	**0.03**
Innominate Aortic Angle	**0.03**	**0.01**
Aortic Arch Diameter	0.05	0.11

Presence of Proximal Radial Loop

There were 3 cases (6%) of a proximal radial loop in our series. The cases in which a radial loop was present had a median fluoroscopy time of 4.9 minutes compared to 4.53 minutes when a loop was not present (Mann-Whitney U, $P=0.80$). All 3 cases required only one catheter (Kruskal-Wallis, $P=0.91$). One out of 3 cases (33%) required conversion to femoral access, compared with 2 of 49 cases without a loop requiring conversion to femoral access (4%) (Chi-

Square, *P*<0.03). There were 1 (33%), 1 (33%), 0 (0%), and 1(33%) cases of grade 1–4 operator rating of difficulty when a radial loop was present, compared to 32 (65%), 11 (22%), 4 (8%), and 2 (4%) without a radial loop, respectively (*P*=0.17, Chi-Square).

Diameter of Aortic Arch

The mean diameter of the aortic arch was 24.6mm (range, 17.7–31.0 mm) with the data following the normal distribution (Table 5). There was a statistically significant correlation with the fluoroscopy time per vessel (Pearson's Correlation, *P*=0.01). The mean diameter of the aortic arch when 1 catheter, 2 catheters, or 3 catheters were used was 24.3 mm (n=49), 25.5 mm (n=2), and 30.7 mm (n=1), respectively. There was not a statistically significant difference in the number of catheters used and the diameter of the aortic arch (ANOVA, *P*=0.103). The mean diameter of the aortic arch was 28 mm for cases that were converted to femoral access, compared to 24.4 mm for cases that did not convert to femoral access, which was not statistically significant (t-test, P=0.09). The median aortic arch diameter for Grades 1–4 operator rating scale of difficulty was 23.8 mm, 24.6 mm, 28.4 mm, and 28 mm, respectively. This was found to be statistically significant difference among groups (ANOVA, *P*<0.01).

Type of Aortic Arch

There were 32 cases of a type 1 arch, 16 cases of a type 2 arch, and 3 cases of a type 3 arch. The average fluoroscopy time per vessel for type 1–3 aortic arch configurations were 4.39, 5.28, and 10.10 minutes, respectively. This was found to not be statistically different (Kruskal-Wallis, *P*=0.146). The type 1 aortic arch configuration required 1 catheter only in 29 cases, 2 catheters in 16 cases, and 3 catheters in 3 cases. The type 2 and 3 aortic arch configurations only

required 1 catheter in all cases. There was no difference in the aortic arch configuration and number of catheters used (Chi-Square, *P*=0.76). All of the conversion to femoral access cases occurred in a type 1 aortic arch configuration. There was no statistical difference among different aortic arch types and conversion to femoral access (Chi Square, *P*=0.54). The type 1 aortic arch configuration was encountered 23, 7, 0, and 2 times in grades 1–4 on the operator rating scale of difficulty. The type 2 aortic arch configuration was encountered 9, 4, 3, and 0 times in grades 1–4 on the operator rating scale of difficulty. The type 3 aortic arch configuration was encountered 1, 1, 1, and 0 times in grades 1–4 on the operator rating scale of difficulty. There was no statistical difference among different aortic arch types and the operator rating scale of difficulty (Chi Square, *P*=0.14).

Presence of Bovine Anatomy

The presence of bovine anatomy was present in 12 cases. The average fluoroscopy time per vessel in the presence of a bovine arch was 6.39 minutes compared to 6.85 minutes without bovine anatomy (Mann Whitney U, *P*=0.146). The number of catheters used in the presence of bovine anatomy was one catheter in 10 cases and 2 catheters in 2 cases. The number of catheters used without the presence of bovine anatomy was 1 catheter in 38 cases and 3 catheters in 1case. There was a statistically significant difference in the number of catheters used in the presence of bovine anatomy (Chi-Square, *P*=0.03). There were no cases of conversion to femoral access in bovine anatomy. This was not found to be statistically significant (Chi-Square, *P*=0.13). Bovine anatomy was encountered in 8, 3, 1, and 0 times in grades 1–4 on the operator rating scale of difficulty, compared to 25, 9, 3, and 2 times when bovine anatomy was not present. This was not found to be statistically significant (Chi-Square, *P*=0.89).

Presence of Single Subclavian Innominate Curve

The presence of a single subclavian innominate curve was identified in 26 cases. The average fluoroscopy time per vessel was 6.8 minutes in the presence of a single subclavian innominate curve, compared to 6.9 minutes when not present (Mann Whitney U, *P*=0.624). There was 1 catheter used in 23 cases, 2 catheters in 2 cases, and 3 catheters in 1 case in the presence of a single subclavian innominate curve, compared to 1 catheter in 23 cases and no cases of multiple catheters (*P*=0.243). There was 1 case of conversion to femoral access with a single subclavian innominate curve and 1 case of conversion when a single subclavian innominate curve was not present (Chi-Square, *P*=0.929). A single subclavian innominate curve was encountered 18, 5, 2, and 1 times in grades 1–4 on the operator rating scale of difficulty, compared to 14, 6, 2, and 1 times when a single subclavian innominate curve was not present (*P*=0.938).

Presence of Double Subclavian Innominate Curve

The presence of a single subclavian innominate curve was identified in 13 cases. The average fluoroscopy time per vessel was 9 minutes in the presence of a single subclavian innominate curve, compared to 6 minutes when not present (Mann Whitney U, *P*=0.16). There was 1 catheter used in 13 cases and no cases of multiple catheters the presence of a single subclavian innominate curve, compared to 1 catheter in 35 cases, 2 catheters in 2 cases, and 3 catheters in 1 case when a double subclavian innominate curve was not present (*P*=0.58). There was 1 case of conversion to femoral access with a double subclavian innominate curve and 1 case of conversion when a double subclavian innominate curve was not present (Chi-Square,

P=0.42). A double subclavian innominate curve was encountered 4, 5, 3, and 1 times in grades 1–4 on the operator rating scale of difficulty, compared to 29, 7, 1, and 1 times when a double subclavian innominate curve was not present (*P*=0.01).

Presence of a Right CCA Loop

The presence of a right CCA loop was identified in 3 cases. The average fluoroscopy time per vessel was 5.2 minutes in the presence of a right CCA loop, compared to 9.1 minutes when not present (Mann Whitney U, *P*=0.12). There was 1 catheter used in 3 cases and no cases of multiple catheters the presence of a right CCA loop, compared to 1 catheter in 38 cases and 2 catheters in 2 cases when a right CCA loop was not present (*P*=0.69). There were no cases of conversion to femoral access in the presence of a right CCA loop. A right CCA loop was encountered 1, 1, 1, and 0 times in grades 1–4 on the operator rating scale of difficulty, compared to 27, 10, 3, and 0 times when a single subclavian innominate curve was not present (*P*=0.28).

Presence of a Left CCA Loop

The presence of a left CCA loop was identified in 5 cases. The average fluoroscopy time per vessel was 5.4 minutes in the presence of a left CCA loop, compared to 11.9 minutes when not present (Mann Whitney U, *P*=0.07). There was 1 catheter used in 5 cases and no cases of multiple catheters the presence of a left CCA loop, compared to 1 catheter in 36 cases and 2 catheters in 2 cases when a left CCA loop was not present (*P*=0.60). There was 1 case of conversion to femoral access in the presence of a left CCA loop, compared to 4 cases with a left CCA loop that did not require conversion to femoral access (Chi Square, *P*<0.01). A left CCA

loop was encountered 0, 2, 2, and 1 times in grades 1–4 on the operator rating scale of difficulty, compared to 28, 8, 2, and 0 times when a single subclavian innominate curve was not present ($P<0.001$).

Presence of a Right VA Loop

The presence of a right VA loop was identified in 3 cases. The average fluoroscopy time per vessel was 5.3 minutes in the presence of a right VA loop, compared to 5.3 minutes when not present (Mann Whitney U, $P=0.54$). There was 1 catheter used in 4 cases and no cases of multiple catheters the presence of a right VA loop, compared to 1 catheter in 32 cases and 2 catheters in 2 cases when a right VA loop was not present ($P=0.62$). There were no cases of conversion to femoral access in the presence of a right VA loop. A right VA loop was encountered 4, 0, 0, and 0 times in grades 1–4 on the operator rating scale of difficulty, compared to 22, 9, 3, and 0 times when a right VA loop was not present ($P=0.36$).

Presence of a Left VA Loop

The presence of a left VA loop was identified in 7 cases. The average fluoroscopy time per vessel was 6.6 minutes in the presence of a left VA loop compared to 6.2 minutes when not present (Mann Whitney U, $P=0.90$). There was 1 catheter used in 6 cases and 2 catheters used in 2 cases in the presence of a left VA loop, compared to 1 catheter in 20 cases, 2 catheters in 1 case, and 3 catheters in 1 case when a left VA loop was not present ($P=0.59$). There were no cases of conversion to femoral access in the presence of a left VA loop. A left VA loop was encountered 3, 3, 1, and 0 times in grades 1–4 on the operator rating scale of difficulty, compared to 15, 4, 2, and 1 times when a left VA loop was not present ($P=0.50$).

Angle of Innominate Subclavian Primary Curve

The average angle of the innominate subclavian primary curve was 107 degrees (range, 17–86). There was no correlation between the primary curve angle and fluoroscopy time per vessel (*P*=0.60). The innominate subclavian primary curve angle when using one catheter was 107, 96, and 158 degrees respectively when using 1, 2 or 3 catheters (Kruskal-Wallis, *P*=0.41). The innominate subclavian primary curve angle mean was 108 degrees on cases requiring conversion to femoral access, compared to 108 degrees on cases not requiring conversion to femoral access (Mann Whitney U, *P*=1). The mean angle of the innominate subclavian primary curve was 113, 95, 99 and 108 degrees with no statistical difference between mean angle and operator rating of difficulty found (Kruskal Wallis, *P*=0.63).

Angle of innominate Subclavian Secondary Curve

The average angle of the innominate subclavian secondary curve was 55 degrees (range, 17–86). There was no correlation between the secondary curve angle and fluoroscopy time per vessel (Pearson's Correlation, *P*=0.39). The innominate subclavian secondary curve angle when using 1 catheter was 58 and 71 degrees when using 3 catheters (t-test, *P*=0.54). There were no cases of 2 catheters with a secondary subclavian curve. The innominate subclavian secondary curve angle mean was 67 degrees on cases requiring conversion to femoral access, compared to 53 degrees on cases not requiring conversion to femoral access (t-test, *P*=0.50). The mean angle of the innominate subclavian primary curve was 52, 60, 44, and 67 degrees for grades 1–4 on the operator rating scale of difficulty, respectively. There was no statistical difference between mean angle and operator rating of difficulty found (ANOVA, *P*=0.79).

Length of Innominate Artery

The mean length of the innominate artery was 33mm (range, 14–60mm). There was no statistical correlation found between the length of the innominate artery and fluoroscopy time per vessel (Pearson's Correlation, *P*=0.87). The average length the innominate artery was 33.9mm, 30.3mm, and 25mm when 1, 2, or 3 catheters were used (ANOVA, *P*=0.55). The average length of the innominate artery was 34.8 mm on cases that converted to femoral access, compared to 33.5 mm on cases that did not require conversion (t-test, *P*=0.84). The average length of the innominate artery was 32.5, 33.6, 41.4, and 34.8 mm for grades 1–4 on the operator rating scale of difficulty (ANOVA, *P*=0.29).

Subclavian Vertebral Angle

The mean SVA was 79 degrees on the right (range, 11–110) and 137 degrees on the left (range, 56–172). There was a statistically significant correlation between both the left and the right SVA and fluoroscopy time per vessel (Pearson's Correlation, *P*=0.04 and *P*=0.023, respectively). The mean SVA on the left was 133 degrees when using one catheter and 104 degrees on the right when using 2 catheters. The mean SVA when using two catheters was 100 degrees on the right and 133 degrees on the left. The mean SVA on the left when using 3 catheters was 56 degrees. There was no statistical difference between the SVA on either the right or left side, respectively, and the number of catheters used (Kruskal-Wallis, *P*=0.07 and *P*=0.18). The mean SVA on the left and right for cases that required conversion to femoral access was 56 and 91 degrees, compared to 140 degrees and 77 degrees when not requiring conversion to femoral access, respectively (Mann Whitney U, *P*=0.54 and *P*=0.07). The average SVA on the

left was 143, 138, and 124 degrees and 81, 76, and 54 degrees on the left for grades 1–3 on the operator rating scale of difficulty without statistical correlation found between groups (Kruskal-Wallis, *P*=0.68 [right], and *P*=0.26 [left])

Innominate Aortic Angle (IAA)

The average innominate aortic was 109 degrees (range, 45–167). There was no correlation between the IAA fluoroscopy time per vessel (*P*=0.9). The IAA was 109 degrees when using 1 catheter, 104 degrees when using 2 catheters, and 140 degrees when using 3 catheters (Mann-Whitney U, *P*=0.23). The IAA mean was 119 degrees on cases requiring conversion to femoral access, compared to 109 degrees on cases not requiring conversion to femoral access (Mann Whitney U, *P*=0.67). The mean IAA was 111, 116, 69, and 119 degrees with no statistical difference between mean angle and operator rating of difficulty found (Kruskal Wallis, *P*=0.14).