The influence of arm position on the geometric features of the Brachial Artery and Basilic Vein

N. Aristokleous1, S. Matthew1, S. Gandy2, E. Kokkalis1, L.D. Browne3, S.P. Broderick3, M.T. Walsh3, J.G. Houston1

1Department of Cardiovascular and Diabetes Medicine, School of Medicine, University of Dundee, Dundee, 2Medical Physics, NHS Tayside, Ninewells Hospital and Medical School, Dundee, UK. 3CABER, Department of Mechanical, Aeronautical and Biomedical Engineering, and Materials and Surface Science Institute, University of Limerick, IRL

INTRODUCTION
• It is estimated that over 2 million patients worldwide have ESRD and this number continues to grow at a constant rate of ~7% per annum [1,2].
• The brachial artery (BA) and basilic vein (BV) are commonly used to construct an autogenous arteriovenous fistulae (AVF) for haemodialysis as AVFs offer excellent long term patency [3].
• This study presents work in progress aimed at assessing the effect of vessel geometry on haemodynamics.
• The present study investigates if changes in arm position alters the geometry of these structures.

METHODS
• A group of six healthy male and female volunteers (mean age and range 32.7y, 27-45y) were scanned in a 3T-MRI scanner (Siemens MAGNETOM-Trio) in two arm positions: a) supine with arm by side, b) prone with the arm held in a partial flex above the head.
• 3D surface models were constructed from the anatomical images using a semi-automated segmentation technique performed with ITK-Snap (PICSL, USA). Further image processing and calculations were performed using VMTK (Orobix, Italy) [4]. Statistical analysis performed using R (R Core Team, Austria).
• Specific geometric parameters such as: Bifurcation, Basilic, and Planarity angles, Curvature, Tortuosity and Area Ratios were calculated (Fig. 1A).

RESULTS
• Fig. 1 (B, C) presents the qualitative changes for the Brachial Artery and Basilic Vein, respectively.
• Table 1 presents the quantitative changes for all measured geometric features.
• Fig. 2 shows in more detail the individual results for each volunteer’s Bifurcation and Basilic Angle.

DISCUSSION
• Earlier studies [5] on other vessels indicated that geometric changes alter the haemodynamic field within vessels.
• Results for BV showed a notable reduction in the BA (23.7%) and the Basilic Angle (16.9%). This trend was consistent for the five out of six cases.
• The percentage change for curvature and tortuosity was 11.5% and 17.7% respectively. The corresponding results for BA were found to be 19.3% and 47.2%. The area ratio shows insignificant changes for both structures (5% and 3%). Furthermore, the Wilcoxon signed-rank test was used for the comparisons between the positions. p-values indicated significance only for the bifurcation angle (p<0.05).
• Further studies however are warranted to evaluate the effect of arm position on haemodynamics and if these changes impact on AVF maturation.

ACKNOWLEDGEMENT

REFERENCES

TAKE-HOME MESSAGE
Position impacts on BA and BV geometry which in turn may alter the blood flow field. These findings require further investigation to identify if correlations exist between geometry and haemodynamic risk factors.