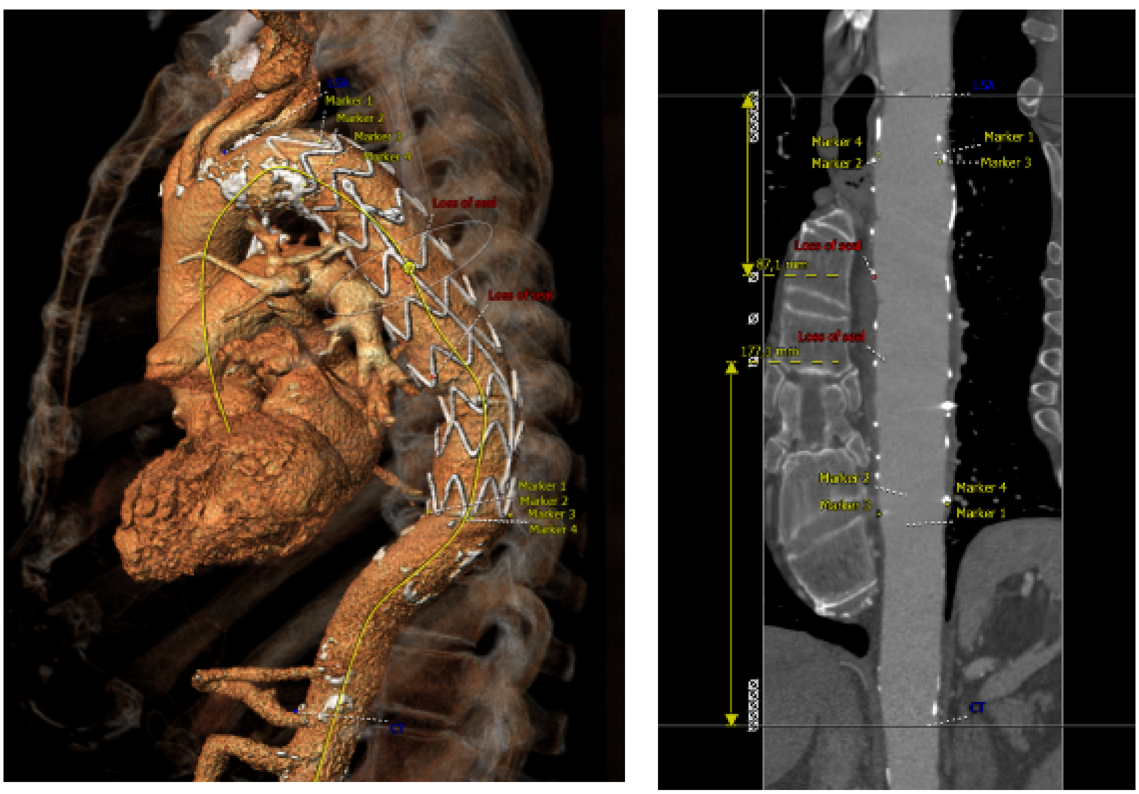
A New Methodology to Determine Apposition, Dilatation, and Position of Endografts in the Descending Thoracic Aorta After Endovascular Thoracic Aortic Repair Kim van Noort et al. *J Endovasc Ther.* 2019;26(X)

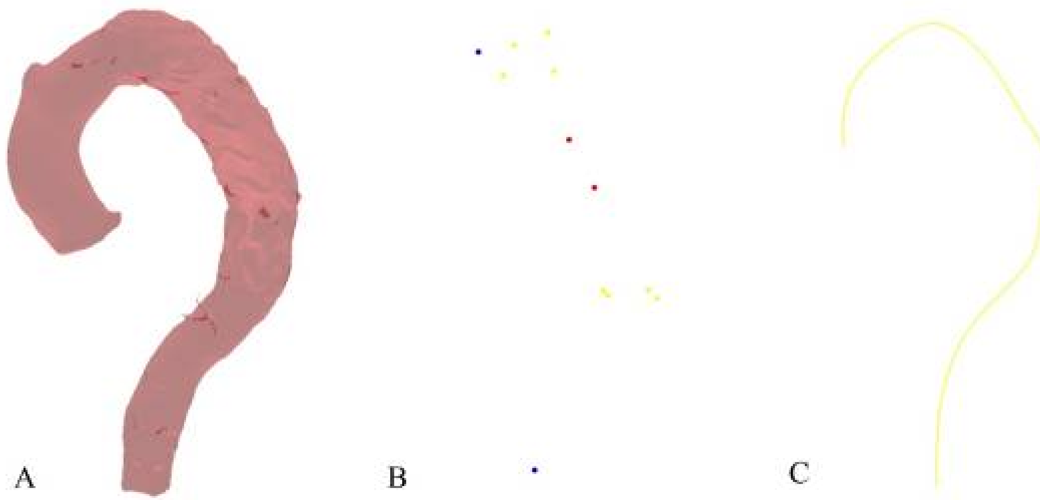
Supplement A: Technical Steps for the Vascular Image Analysis (VIA) Software for Thoracic Endovascular Aortic Repair.

First, measurements were performed in a 3Mensio Vascular workstation (version 9.1; Pie Medical, Maastricht, the Netherlands). A center lumen line (CLL) was semi- to automatically drawn through the flow lumen of the aorta between the ascending aorta and the abdominal aorta distal to the celiac trunk (CT). Three-dimensional (3D) coordinates were obtained of the distal left subclavian artery (LSA) orifice, proximal CT orifice, and locations of the proximal and distal necks or apposition ends. Four coordinate markers were positioned circumferentially on the proximal and distal ends of the endograft fabric on the postoperative computed tomography angiography (CTA) scans (Supplement A Figure 1).



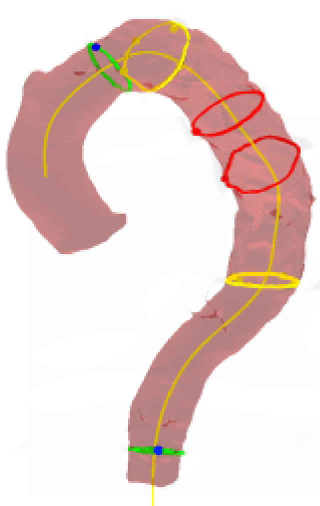
Supplement A Figure 1. Measurements are performed in 3Mensio. (Left) A centerline is semi- to automatically drawn though the lumen to produce the 3D reconstruction (Right). The 3D coordinates of the LSA, CT, endograft fabric markers, and proximal and distal ends of the apposition are measured, as well as diameters and lengths.

Second, the coordinates, CLL, and a mesh of the aortic flow lumen were exported from 3Mensio into the VIA software (Supplement A Figure 2).



Supplement A Figure 2. (A) Exported mesh, (B) coordinates, and (C) the CLL of the thoracic aorta in Figure 1. Exported coordinates are the LSA and CT (blue dots), the markers of the endograft fabric (yellow dots), and the proximal and distal positions where 360° apposition with the aortic wall is lost (red dots).

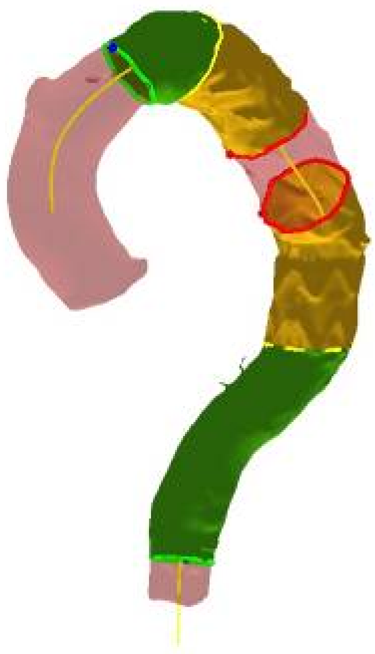
Third, the circumferential boundaries were determined with the use of the mesh and CLL. The LSA circumference was marked by calculating a plane through the LSA coordinate orthogonally to the CLL. This intersection of the plane with the mesh was then marked as LSA circumferences. This was also performed for the CT circumference and the loss of apposition circumferences. The circumference of the endograft fabric was calculated as the plane through the endograft fabric coordinates and the intersection with the aortic mesh (Supplement A Figure 3).



Supplement A Figure 3. Boundaries of the surfaces were determined with the use of the mesh, CLL, and coordinates. Green circumferences are the proximal and distal neck boundaries. Yellow circumferences are the proximal and distal ends of the endograft fabric. Red circumferences are the positions were the 360° apposition with the aortic wall is lost.

The surfaces over the mesh between different circumferences could be calculated. Figure 4 shows the available apposition surfaces and the endograft apposition surfaces both proximal and distal. Every coordinate in the mesh was marked if it was positioned between certain circumferences. The mesh was built up of faces. With the selected coordinates belonging to the faces, the surface could be calculated in mm^2. The surface containing n faces with each having 3 vertices is calculated as:

$$Surface = \sum_{k=1}^{n} 0.5 * \|(face(k,2) - (face(k,1)) * (face(k,3) - face(k,1))\| \qquad (1)$$

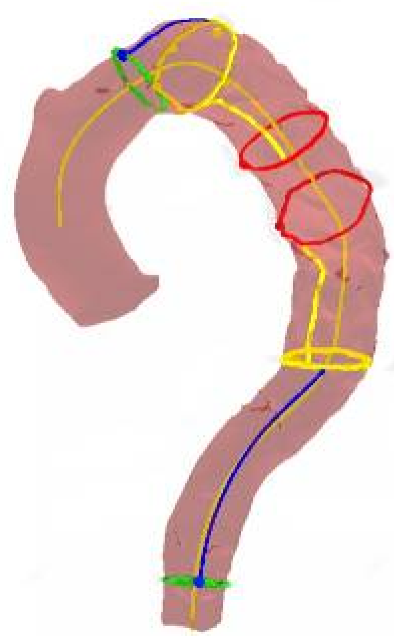


Supplement A Figure 4. Surfaces between the calculated boundaries. Green surface is the available apposition surface and is situated between the boundaries of the arteries (LSA and CT) and between the position where apposition of the endograft is lost (red circumferences). For the apposition surface (yellow surface), the boundaries are defined as the circumferential endograft fabric (yellow circumferences) and the circumference where the 360° apposition is lost (red circumferences).

To reduce the calculation time, not all coordinates of the mesh were selected. Only the coordinates within a certain range (ie, 5, 10, or 20 cm) from the circumferences were selected and judged if they were positioned between the circumferences. This could manually be adjusted if surfaces became too large.

To cope with the large angulation, the directional vectors for calculation of the surfaces were adjusted. In endovascular aneurysm repair, the calculations were performed from top to bottom between selected circumferences. Therefore, the direction of calculation was performed from top to bottom. In TEVAR these circumferences were not necessary above each other; therefore, directional vectors were adjusted.

The endograft inflow and outflow diameters were calculated as the diameter of the circumference of the intersection between the plane of the endograft markers and the aortic mesh. For determination of the position parameters, the distances over the mesh between the LSA/CT and endograft fabric (shortest fabric distances) and the distance over the mesh between the endograft fabric and 360° loss of apposition circumference (shortest apposition length) were calculated (Figure 5). Due to the large angulation, the absolute shortest distances were not necessarily the logical distances. Therefore, the shortest distances in the direction of the CLL were calculated.



Supplement A Figure 5. Lengths over the aortic mesh in the direction of the CLL were calculated between boundaries. The blue lines are the shortest fabric distance, which is the distance that could have been used for apposition but was not used. The yellow lines are the shortest apposition lengths, which are the proximal and distal lengths of the endograft that have apposition with the aortic wall.