Dual Centerline Modeling of Type B Aortic Dissection: A Novel Method to Identify High Risk Morphologic Features that Predict Aortic Growth.

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Objective.

- Optimal medical therapy (OMT) remains the 1st line therapy for acute uncomplicated type B aortic dissection (AUTBAD). OMT produces excellent short-term outcomes but *has a high rate of failure in the chronic phase*.

- Thoracic endovascular aortic repair has been proposed as an alternative therapy, particularly for patients with "high risk" features. However, current risk stratification relies primarily on the diameters of the aorta and false lumen.

- The objective of this study is to develop ***a comprehensive three dimensional (3D) geometric characterization of TBAD morphologies*** based upon the extraction of separate aortic centerlines for the true lumen (TL) and false lumen (FL) beginning at the largest or dominant intimal tear (DIT).

Methods.

- Twenty-one patients with computed tomography angiographic (CTA) scans from their initial diagnosis of acute uncomplicated TBAD from 2000-2023 were selected from an academic institutional aortic database.
- Patients were divided into two groups based upon the efficacy of OMT in preventing significant aortic growth, defined as increase in aortic diameter by ≥ 1 cm.
- The OMT success (OMT-S) had 14 patients, OMT failure (OMT-F) group had 7 patients.

Methods.

- CTA images were segmented by means of edge detection algorithms and 3D surface models of the aorta from the aortic root to the iliac arteries were extracted.
- Two sets of models were created. The 1st model included the DIT and all fenestrations occurring at the celiac, SMA, renals and iliacs. The 2nd model contained no fenestrations and allowed for a separate analysis of the TL and FL(Fig 1A).
- By digital subtraction of the two models, the DIT was identified and modeled as a 3D surface (blue in Fig 1B).
- From the models, separate TL and FL centerlines were computed running from the aortic root to the left subclavian artery (LSA) and to the iliacs (Fig 1B).

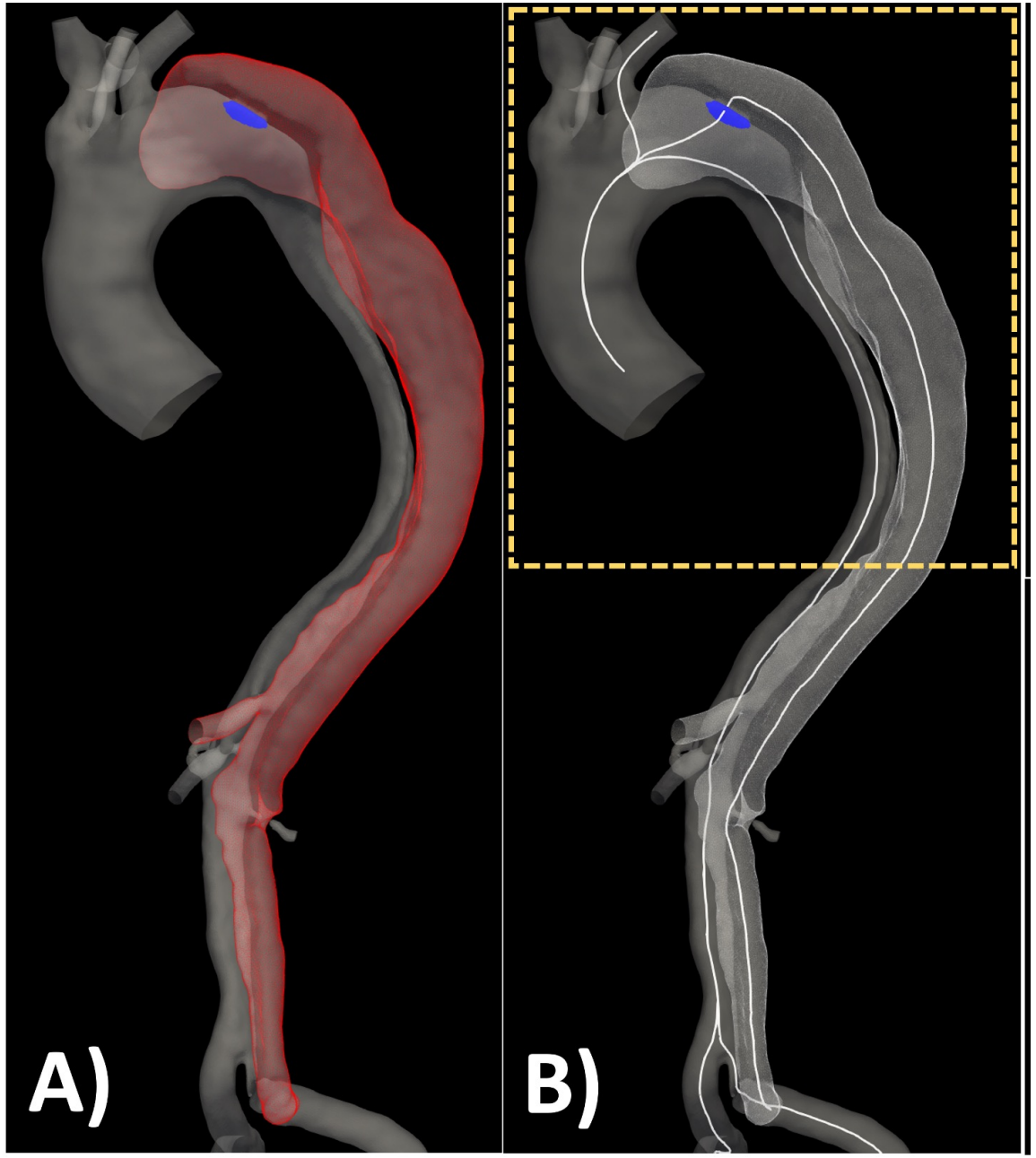

Fig 1 A) 3D TBAD model with TL, FL (red) and DT area (blue); B) centerlines extraction.

Methods.

- Morphologic parameters measured included length, minimum, maximum and mean curvature (Fig 1E), tortuosity, cross sectional areas (CSA, Fig 1D) and cross section shape index (SI, ranging 0 to 1 from elliptical to circular profiles).
- The surface area of the DIT and its distance from the LSA were measured(Fig 1C).
- The DIT location on the TL was classified as inner or outer curve of the TL.
- Averages ± STD were computed for all geometric parameters in the two groups and differences tested (p-value=0.05).

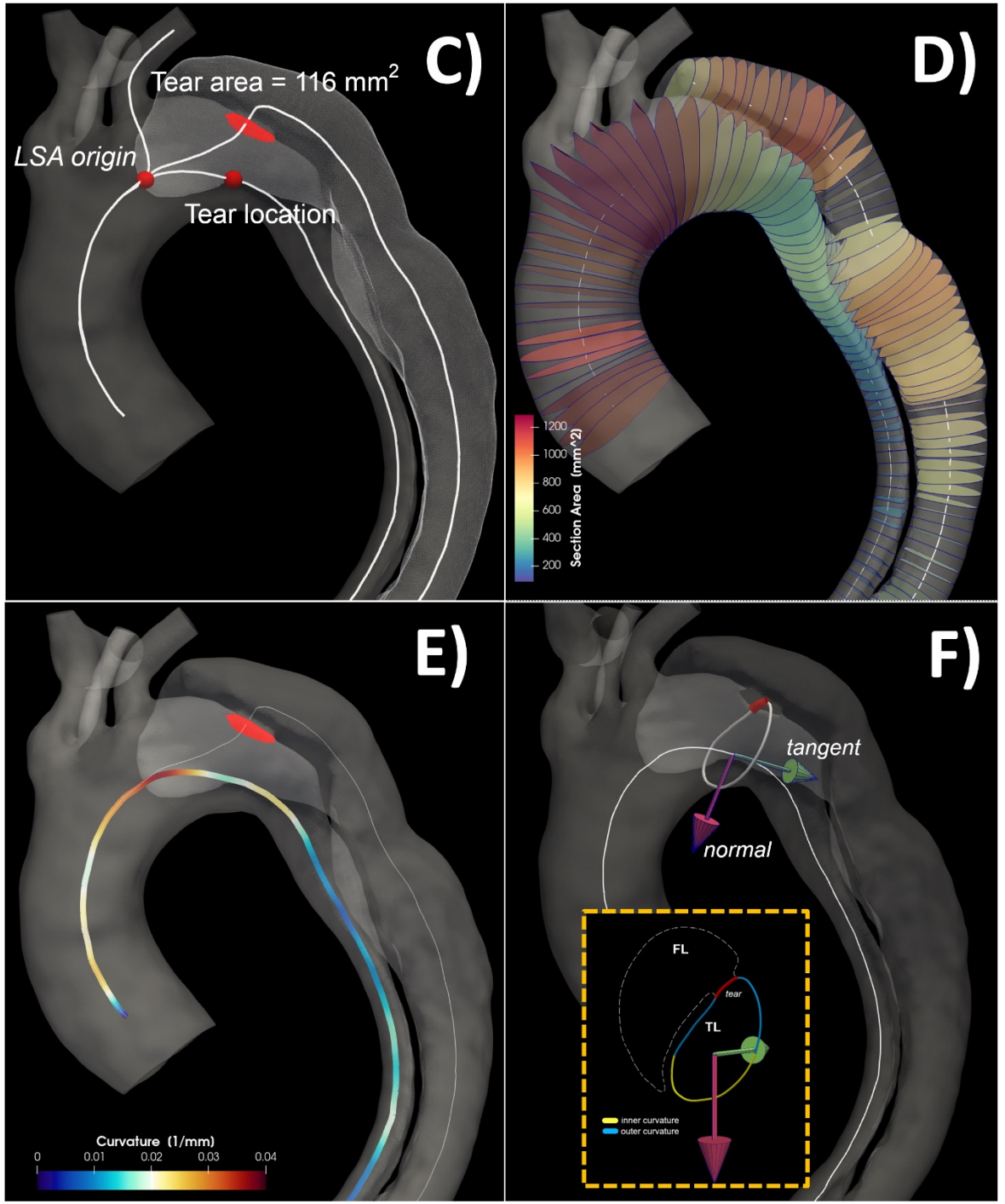

Fig 1 C) identification of LSA origin and DT location on the TL centerline; DT modeling allows direct area quantification; D) cross section areas along TL and FL; E) TL curvature; F) opening of the DT along the inner or outer aspect of TL.

Results.

- There was no difference between the groups in the DIT surface area (OMT-F 391±300mm^2 vs OMT-S 293±350mm^2 , p=NS), distance from LSA (OMT-F 36.1±17.6 mm vs OMT-S56.1±52.3mm, p=NS) or DIT location on the inner/outer curve of the TL (Fig 1G).

- Analysis of TL and FL geometry demonstrated that the OMT-F group had an increase in length (OMT-F 275±22mm vs OMT-S243±21mm, p<0.05) and a smaller shape index (OMT-F 0.26±0.09 vs OMT-S 0.38±0.12, p<0.05) of the descending aorta. There was no difference between the groups in descending aortic curvature.

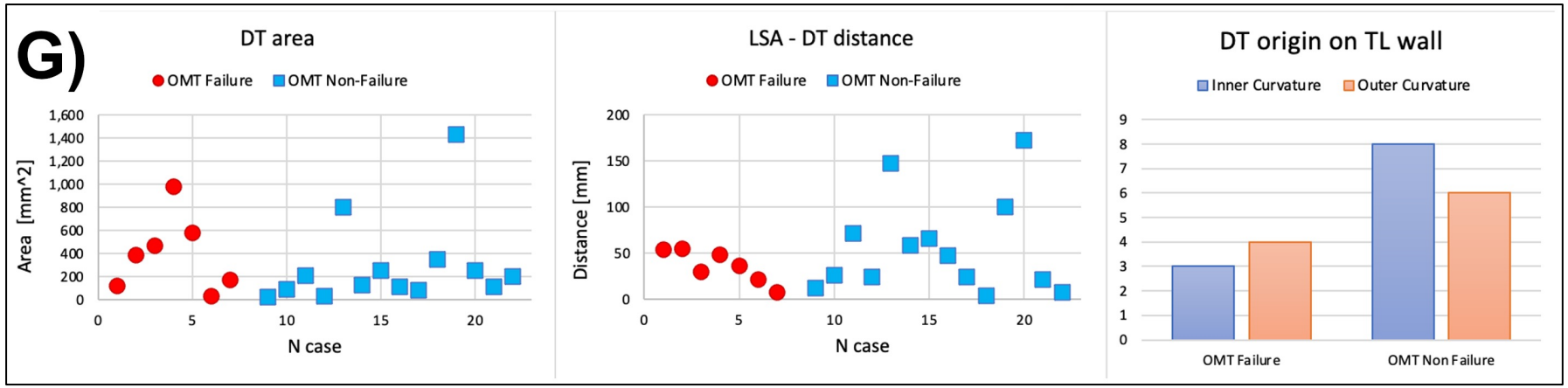

Fig 1 G) plots of DT area, LSA-DT distance and location of DT origin from TL wall for the analyzed cases.

Conclusions.

- These data demonstrate the feasibility for a novel, semi-automated method to perform extensive morphological characterization of the TL, FL and DIT in uncomplicated TBAD.

- Future investigations using this method may identify important morphologic characteristics other than aortic size that may predict an increased risk of aortic growth.