The AORTIST Cloud Platform: A Deep Learning-based Clinical Decision Support System for TEVAR

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Conflict Disclosure

I have the following potential conflicts of interest to report:

- Owner of a healthcare company
- Employment in industry
- Consulting
- Stockholder of a healthcare company
- Other(s): ___________________________

- I do not have any potential conflict of interest
Examples of AI Application in Medicine

- AlphaFold: Predict protein structure
- Google DeepMind: Deep learning for OCT
- Aidoc's brain solution
- Zebra's Coronary Calcium Scoring algorithm
- Carewell’s AI-ECG Platform
- IBM Watson for Health
Clinical Pain spot-1

Problems in Aortic Measurement
- insufficient precision for diameter/length

Perpendicular Plane vs Axial Plane

Defects of measurement on axial plane
A: The two intersection points of the intersection plane and aortic wall may be not perpendicular to anterior and posterior aortic wall;
B: If the max diameter is between the convexity and concavity, max diameter is unachievable on axial plane.
Clinical Pain spot-2

Problems in Prognosis of TBAD

-no prediction model for prognosis after TEVAR

Aortic enlargement is the most common complications after TEVAR for TBAD

- Post-TEVAR aortic enlargement
  - Thoracic aortic enlargement
  - Abdominal aortic enlargement
- Distal SINE
- Endoleak
  - type I & type II & type III...
- Retrograde type A aortic dissection
- Aortic-related death

**incidence**

12-mo: 19.7%-41.7%
12-mo: 20.9%-54.2%
2-y: 6.3%-27.3%
23.1% by meta-analysis
2%-16%
24-mo: 8.2%

References:

- J Vasc Surg 2014; 59: 1544-54
- JACC Cardio Intv 2013; 6: 876-82
- J Vasc Surg 2017; 65: 676-85
- J Vasc Surg 2013; 57: 64-71
- J Endovasc Ther 2015; 22: 918-33
- J Cardiovasc Surg 2010; 51:613-32
Clinical Pain spot-3

Patient Management & Data Collection

- Save clinical and imaging information of each patient as a stand-alone cloud storage unit
- Support name, gender, ID editing
- Support patient retrieval, list sortable
- Support automatic follow-up

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<th>Name</th>
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Overview of AORTIST

AORTIST—Artificial intelligence Online Research platform Targeting Individualized aortic Stent-grafting Therapy

- CNN-based Automatic Segmentation
- TEVAR Planning
- Data Collection and Follow-up Management
- Adverse Event Prediction
- Change Course of Aortic Volume
Process of Automatic Segmentation

ROI: entire aorta, true lumen and false lumen

DICOM files → Manual segmentation → Multi-task CNN

3D view of automatic segmentation for entire aorta, true and false lumen

Axial view of the automatic segmentation for entire aorta, true and false lumen
Accuracy Evaluation for Auto Segmentation

- Dice Similarity Coefficient (DSC):
  A statistic used for comparing the similarity of two samples (e.g. manual and automatic seg), ranging between 0 to 1.

- DSC of test sample (15 patients):

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<td>Entire aorta</td>
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<td>True lumen</td>
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<td>0.86</td>
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<td>0.83</td>
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<tr>
<td>False lumen</td>
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<td>0.88</td>
<td>0.89</td>
<td>0.83</td>
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- DSC is more closer to 1, the similarity is more better.
Dissection Analysis of AORTIST

- Automatic tear recognition;
- Mask show or not;
- Toggle button: MPR or MPR-CPR;
- CPR rotation;
- Output diameter along centerline;
- Aortic volume of aorta, true and false lumen
TEVAR Planning Recommendation

- Location of the primary entry tear;
- Anatomic information for each aortic zone, including diameter, length;
- Two endovascular strategies, including location of landing zones and size of stent-graft
Follow-up Management & Data Collection

Patient’s characteristics, follow-up start time, and follow-up questionnaire are editable.

Send questionnaire to patient according to the predesigned time points.
Change Course of Aortic Volume

**Thoracic aortic enlargement**

**Abdominal aortic enlargement**
Radiomics Prediction Model in AORTIST

- ROI
- Feature extraction
- Clinical data
- Training database
- Feature selection and machine learning
- Validation database
- Clinical d. image
- Prediction model
- Case
- Optimal model
- Prediction
Improved Solution for Dissection (V3.0)

Adding arch branches, visceral arteries, and iliacofemoral artery into ROI

AORTIST can provide anatomic information for these branches mentioned above.
Future Solution for AAA (ongoing)
Conclusion

• Medical digital images have the inherent advantages of applying AI;
• Problem-driven AI reduces human errors, makes diagnosis and treatment more accurate and more efficient;
• Preop CTA = surgical plan = prognosis will come true in the near future;
Thank you for your attention
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