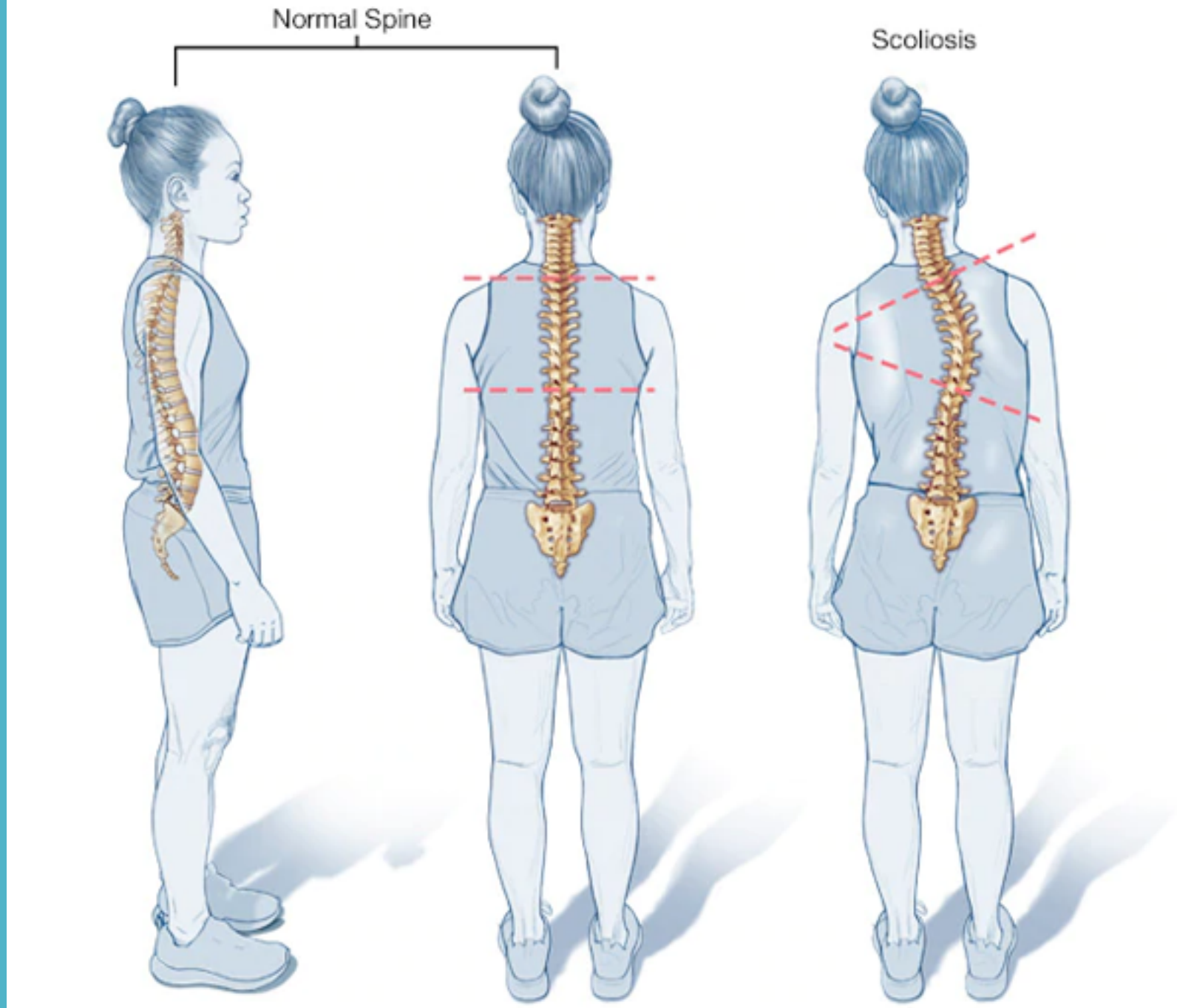
Source: rebeccamcmillandesign.com

Automatic Scoliosis Assessment

Scoliosis: Overview



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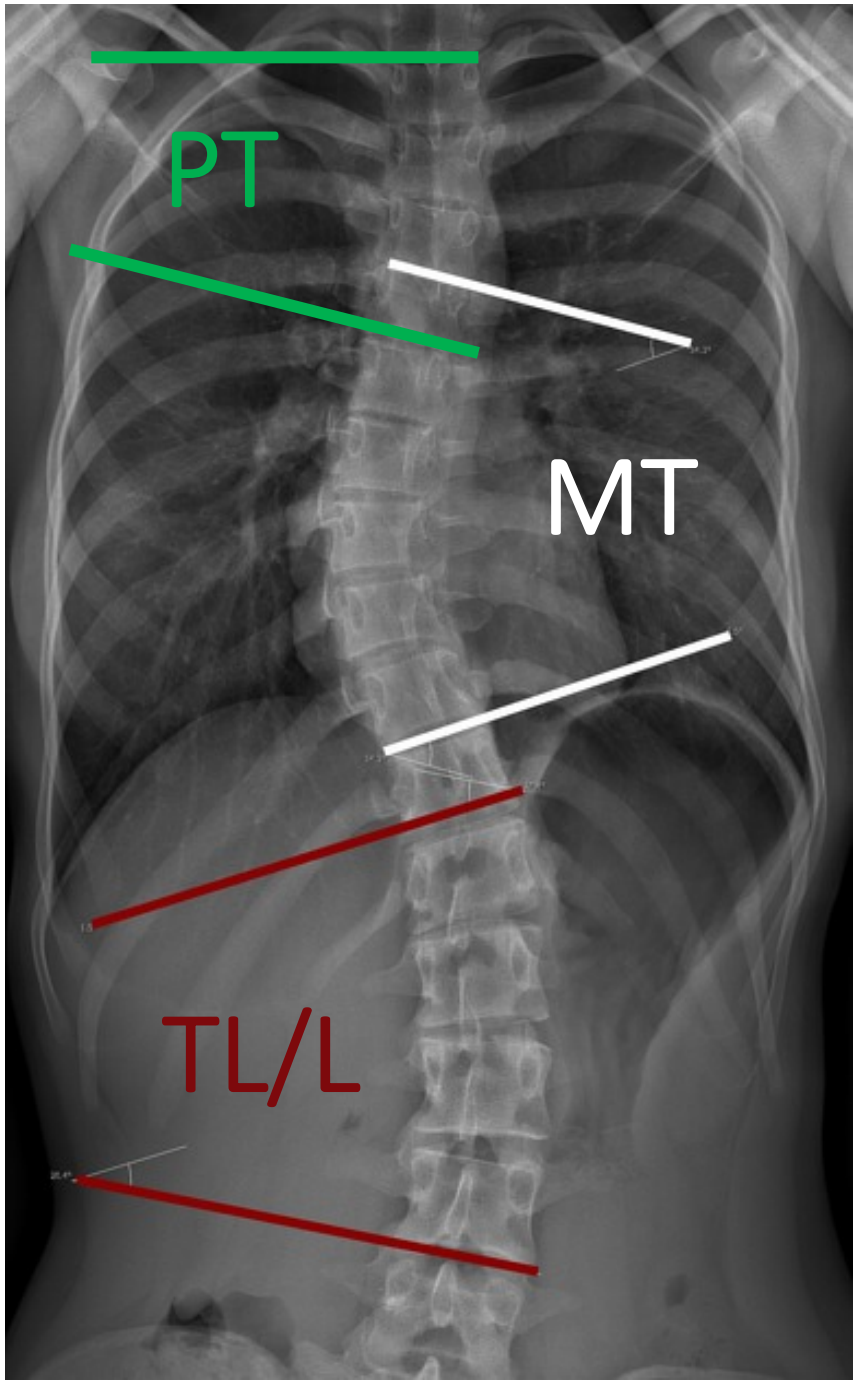
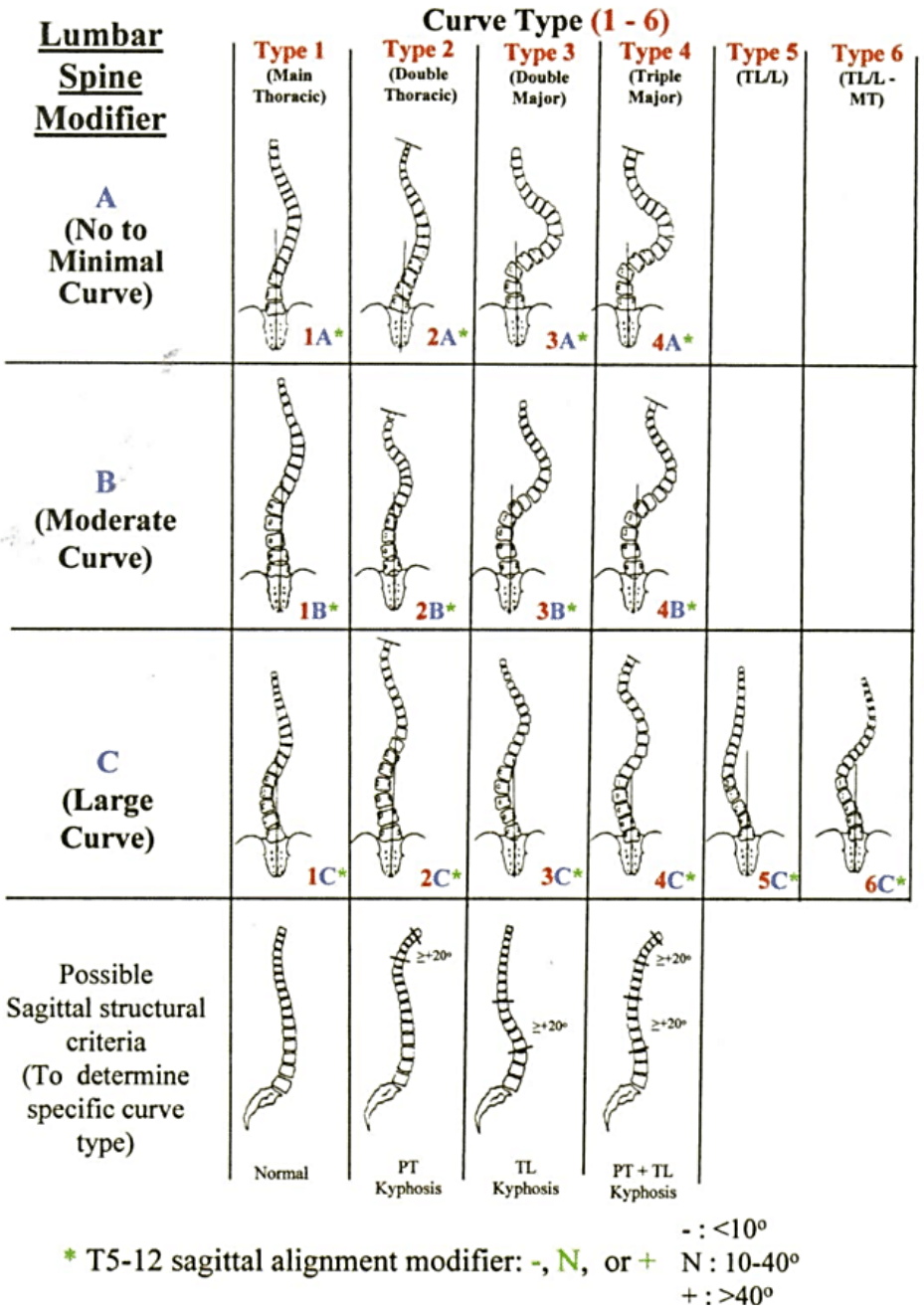
Cobb Angle Measurement



Source: radiopaedia.org

Lenke Classification



Source: [1]

PITFALLS

Accuracy affected by:

- Selection of vertebrae
- Observer bias
- Image quality

High inter and intra-observer variability

(3-5˚ MAD for Cobb Angles [2]-[4])

Time consuming

Team

Academic

Darragh Maguire – Biomedical Engineering

Dr John Healy – Electronic Engineering

Dr Kathleen Curran – Medicine

Clinical

Mr Michael Dodds, Consultant Orthopaedic Surgeon

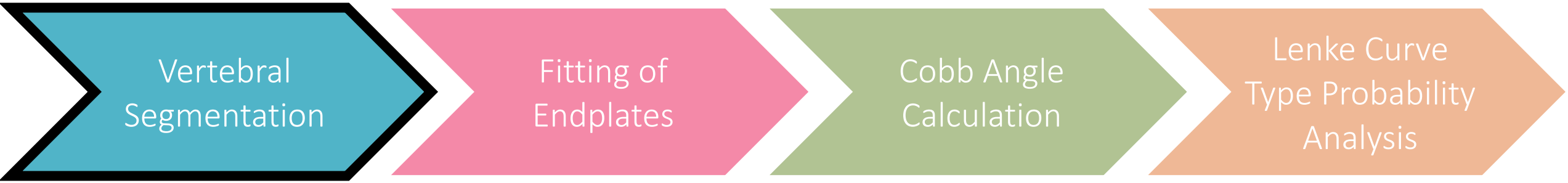
Mr Connor Green, Consultant Orthopaedic Surgeon

Prof Eoin Kavanagh, Consultant Radiologist

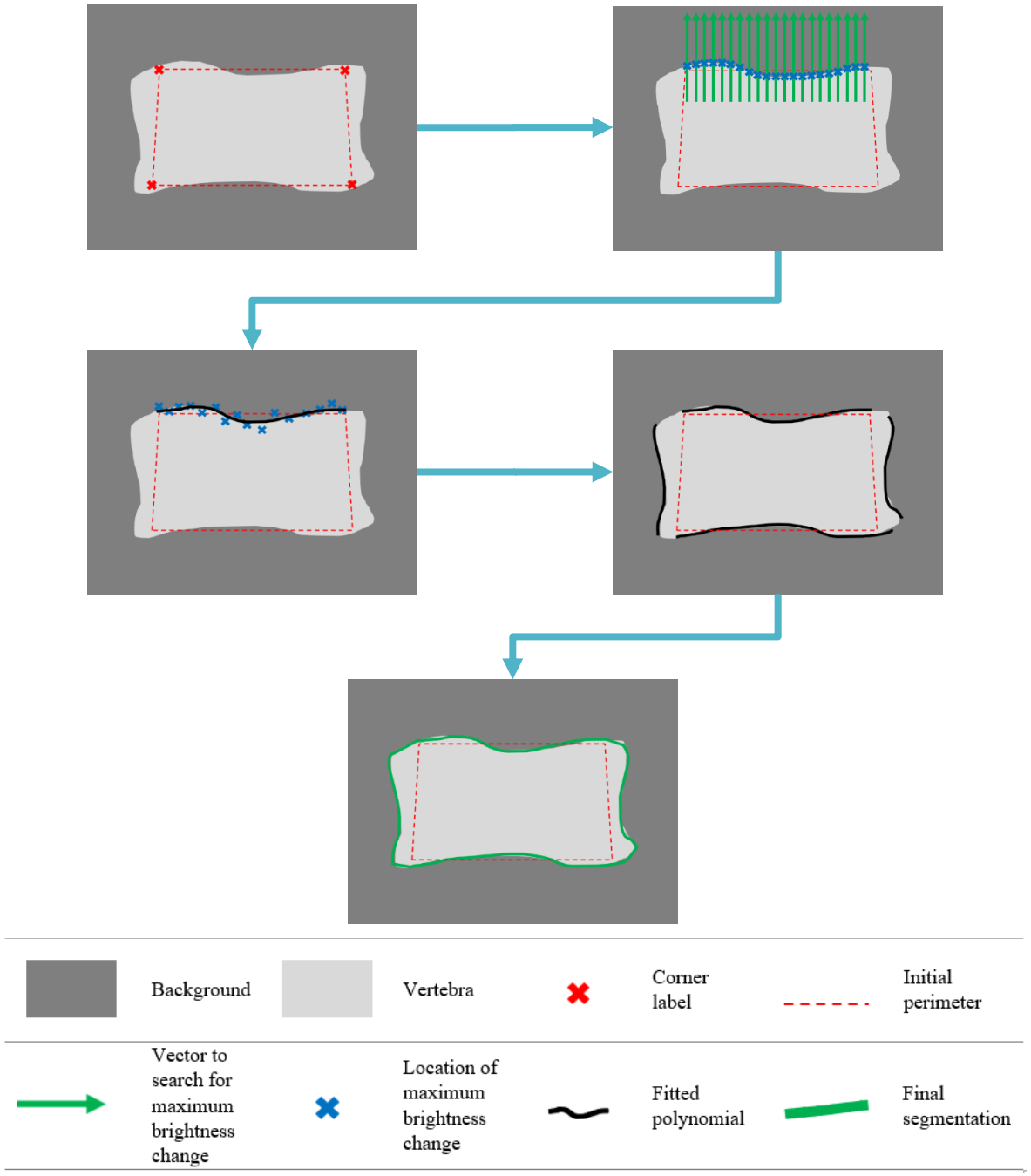
Dr Rosanne-Sara Lynham, Orthopaedic Registrar

Dr Ivan Welaratne, Specialist Registrar in Radiology

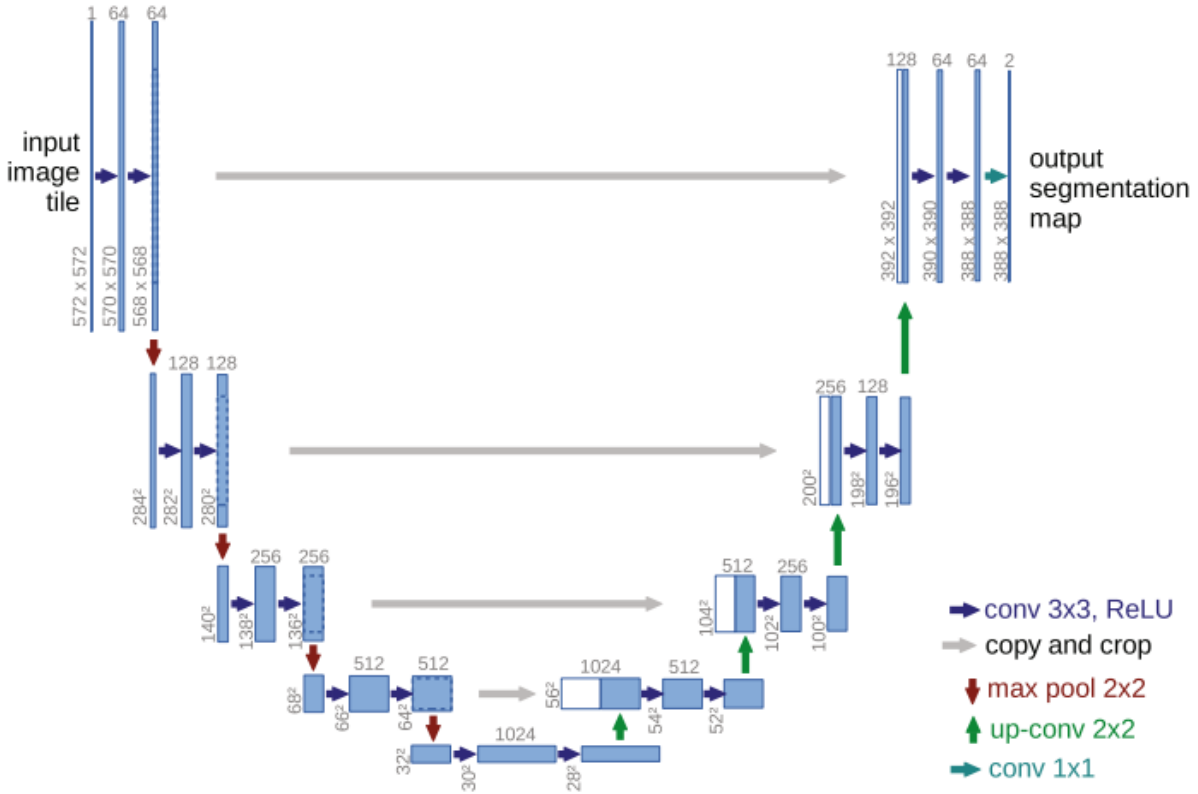
PROPOSED SYSTEM


Vertebral Segmentation
Fitting of Endplates
Cobb Angle Calculation
Lenke Curve Type Probability Analysis

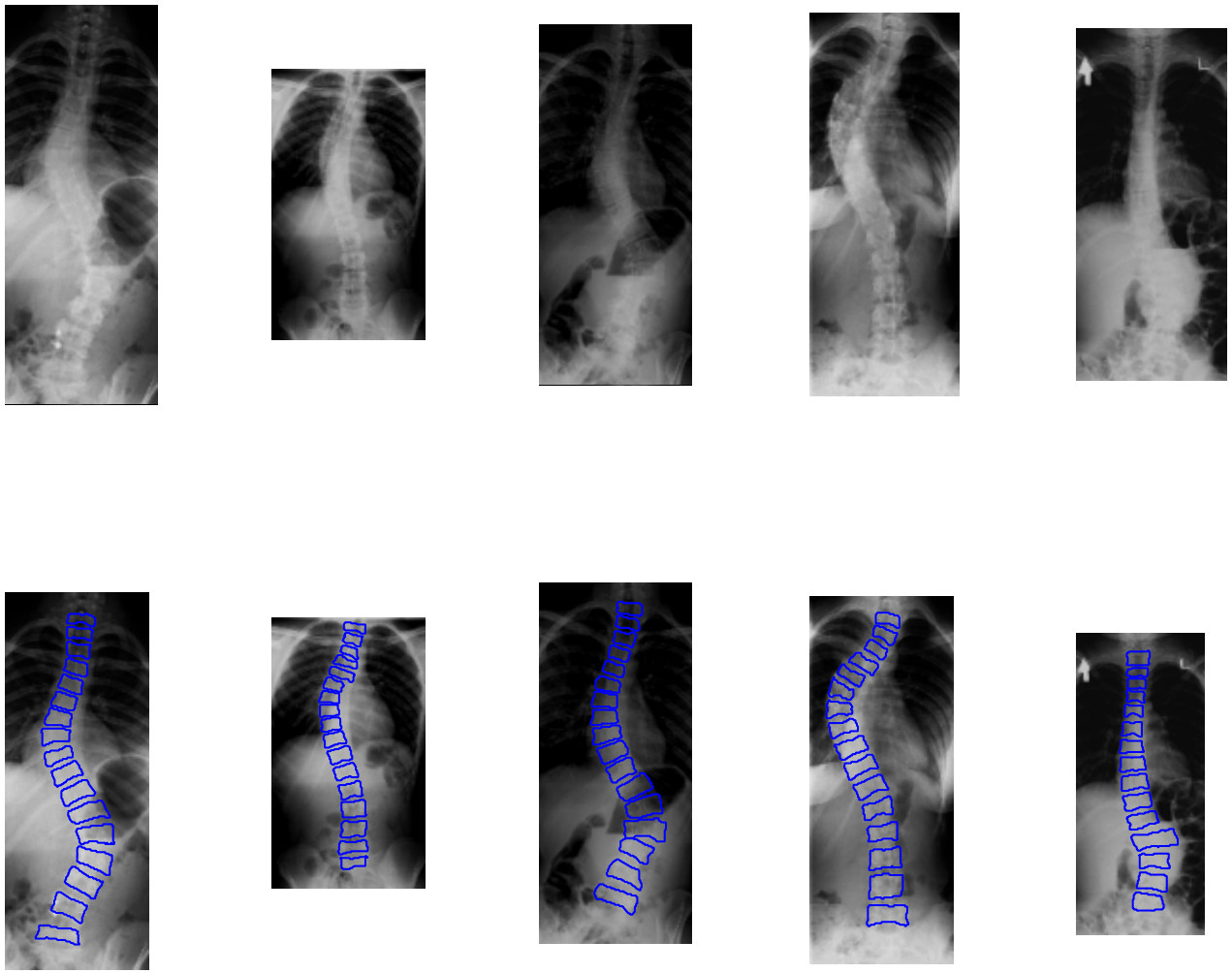
Novel Ground-truth Vertebral Segmentations



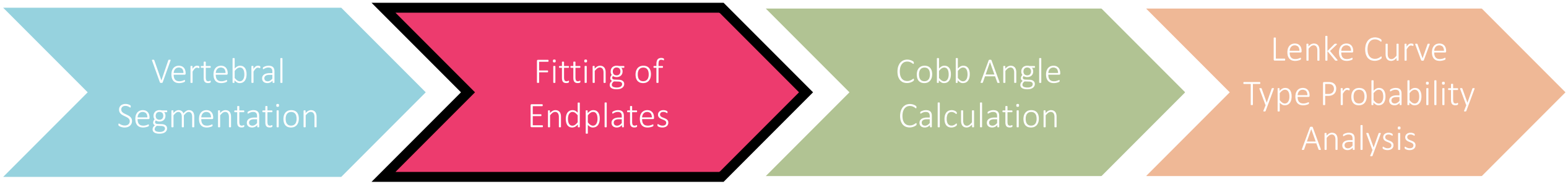
Vertebral Segmentation Network



Random Sample of Images & Corresponding Vertebral Segmentations



Vertebral Segmentation


Vertebral Segmentation
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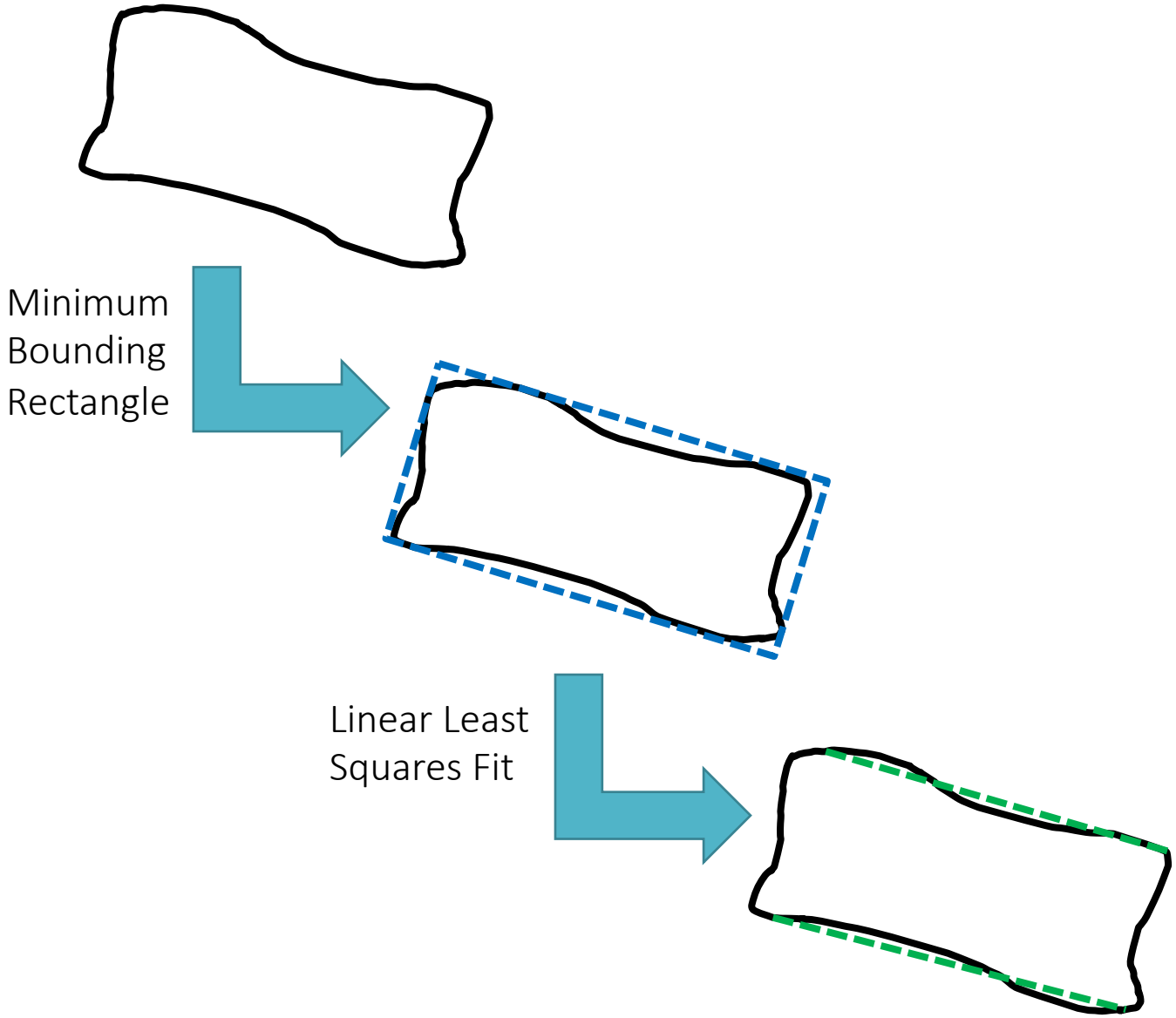
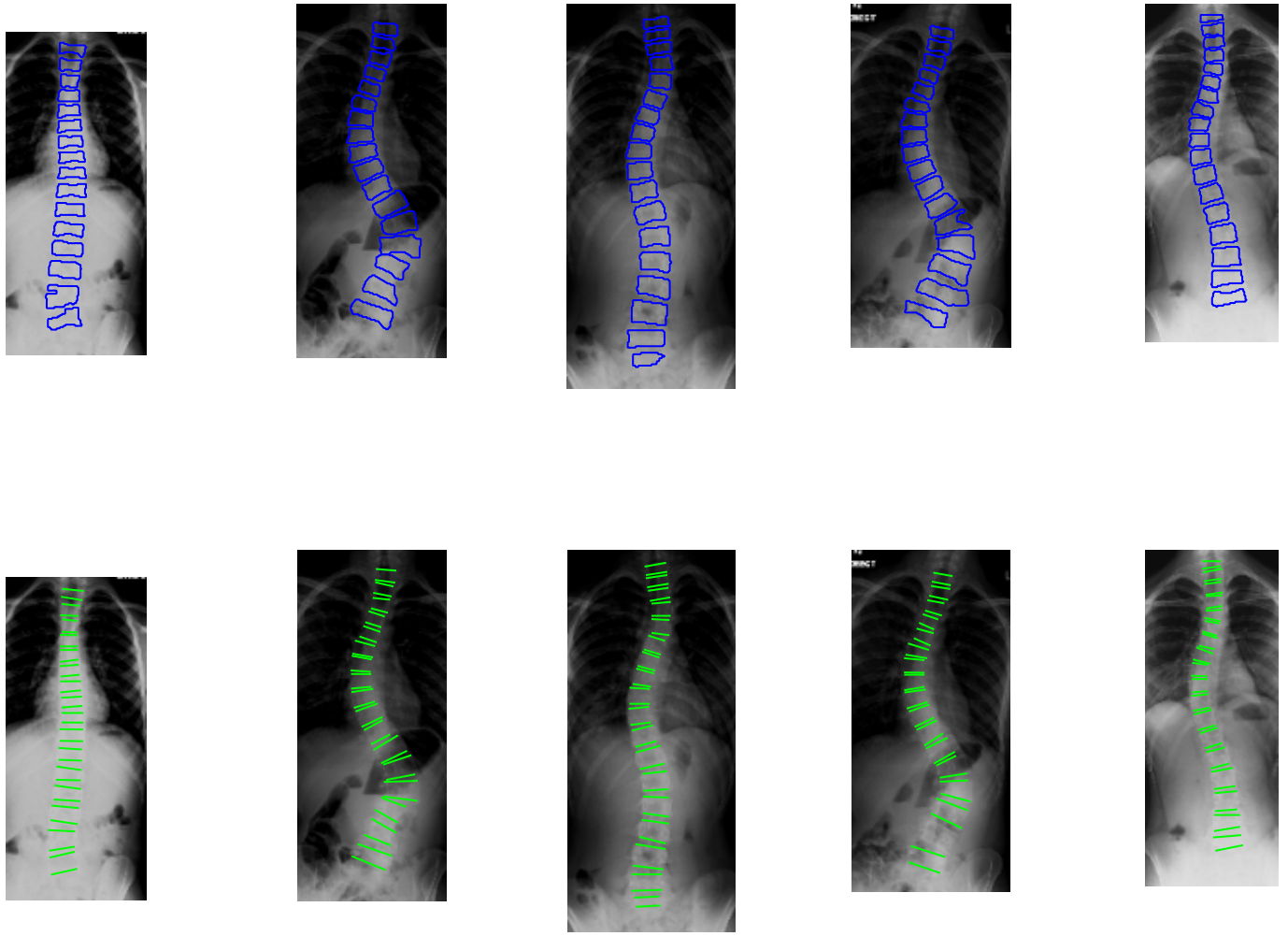
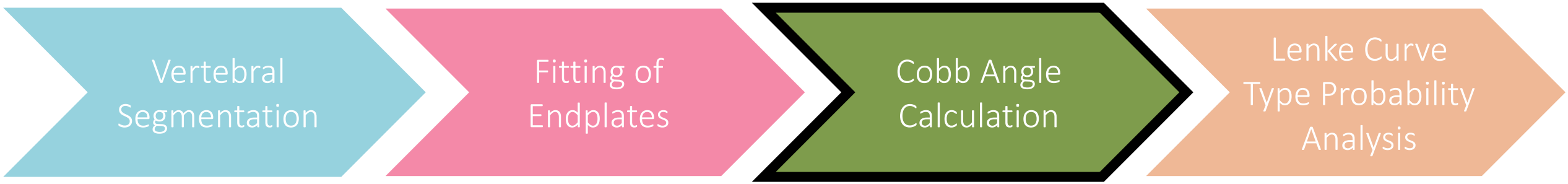
Fitting of Endplates

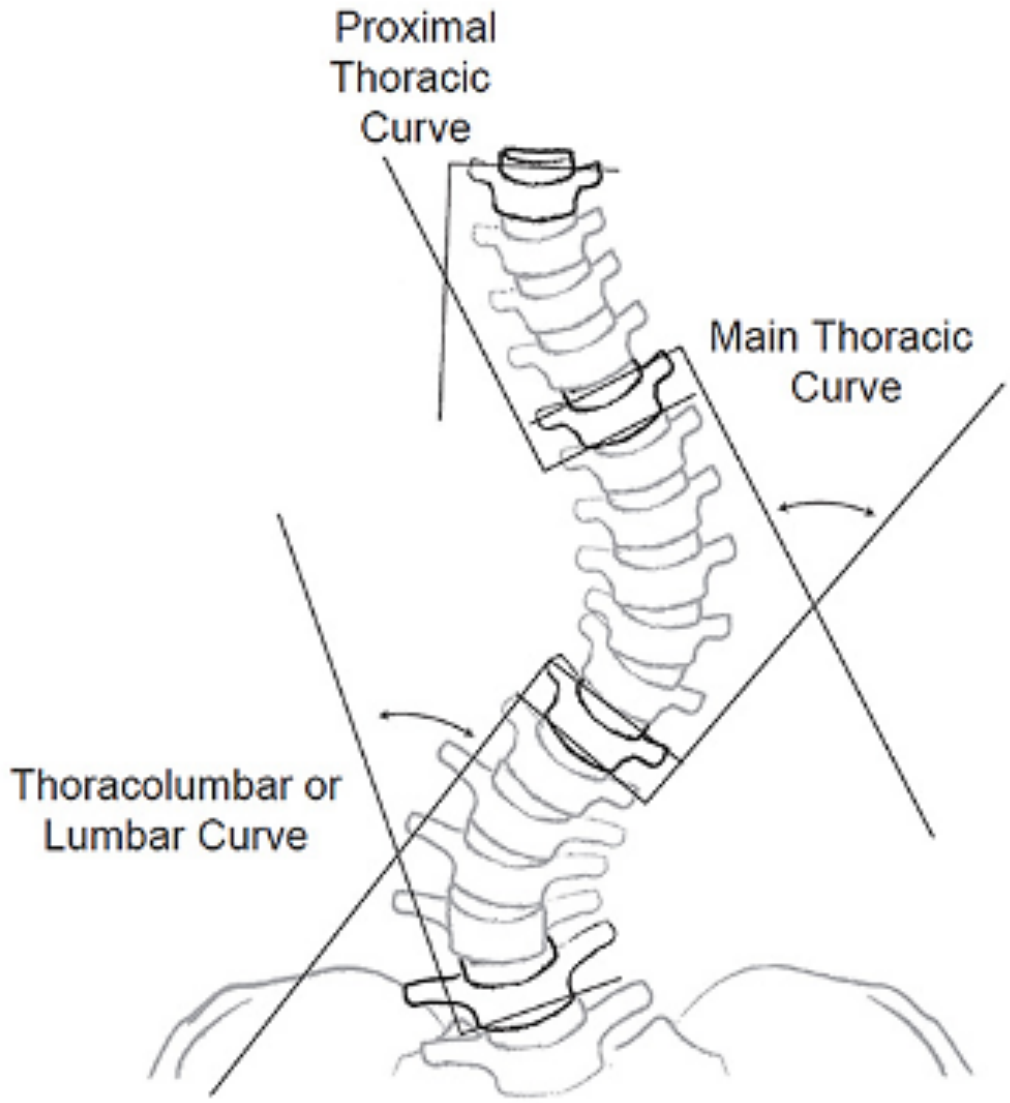


Random Sample of Vertebral Segmentations & Corresponding Fitted Endplates



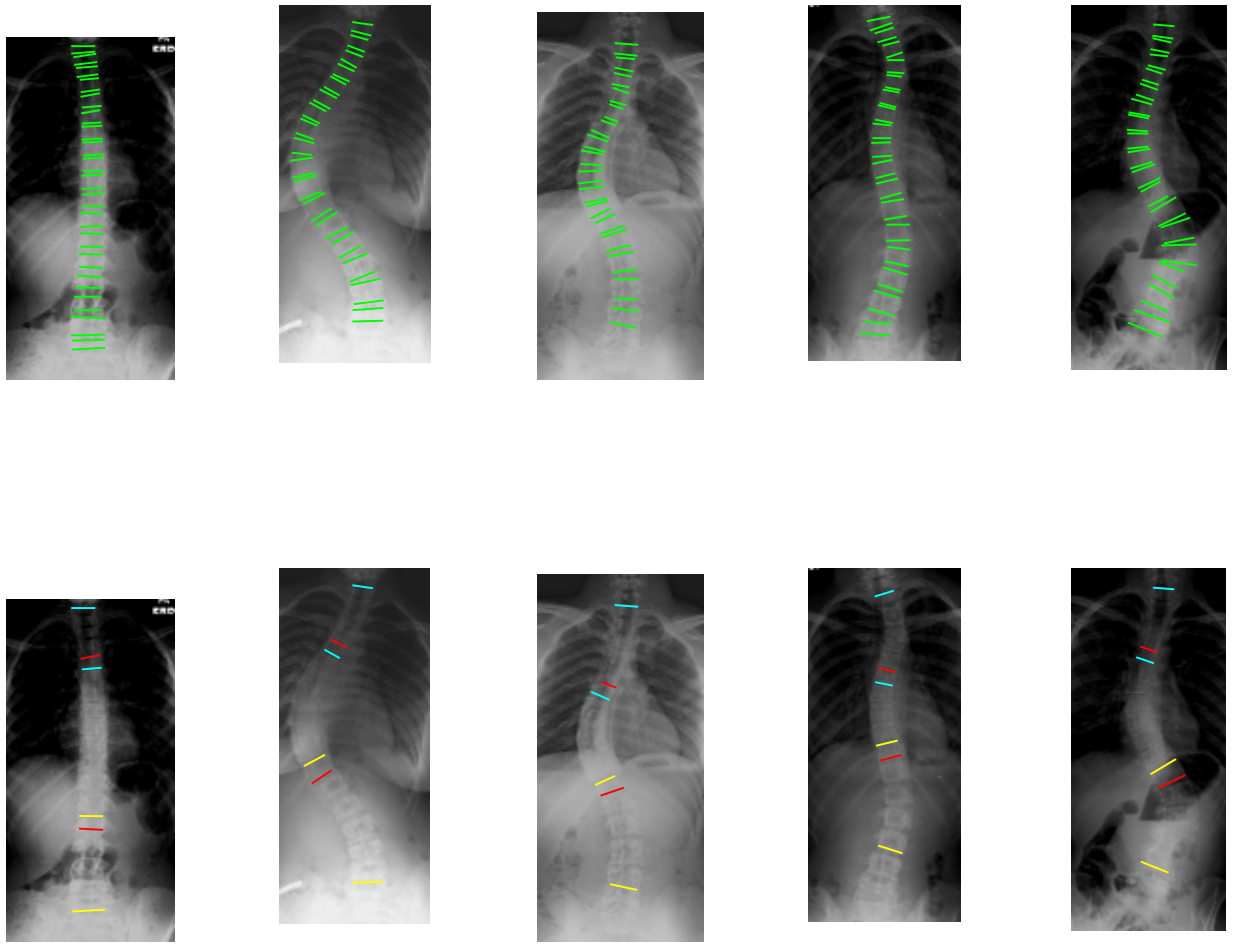

Vertebral Segmentation
Fitting of Endplates
Cobb Angle Calculation
Lenke Curve Type Probability Analysis

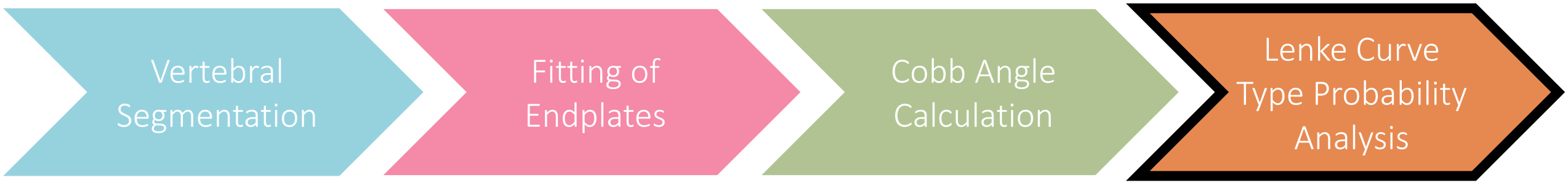
Cobb Angle Calculation



Source: hsg.settingscoliosisstraight.org

Random Sample of Fitted Endplates & Corresponding Cobb Angles




Vertebral Segmentation
Fitting of Endplates
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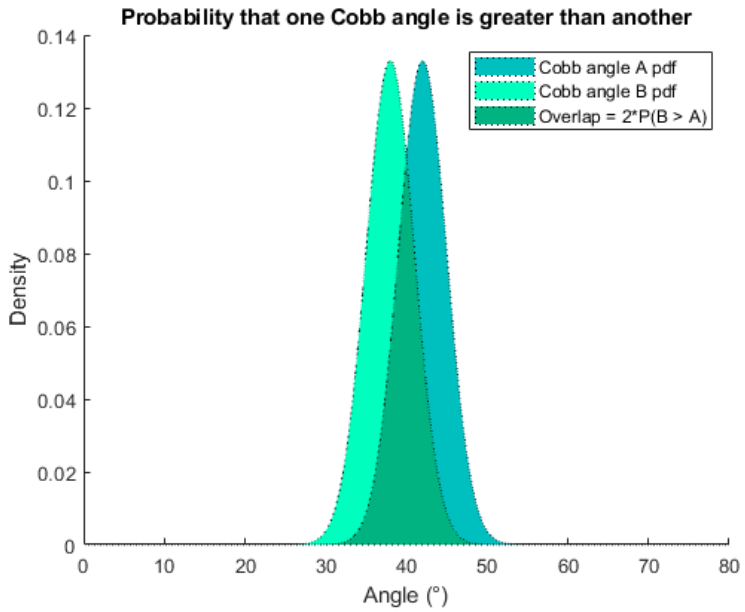
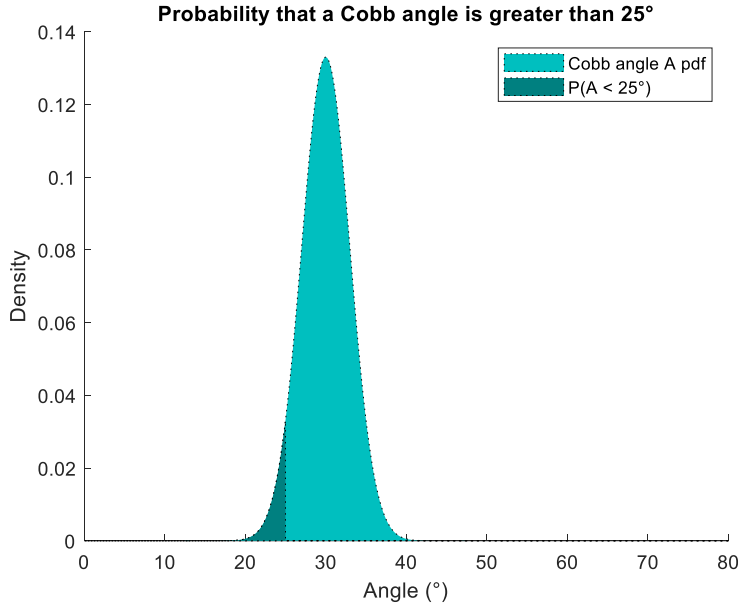
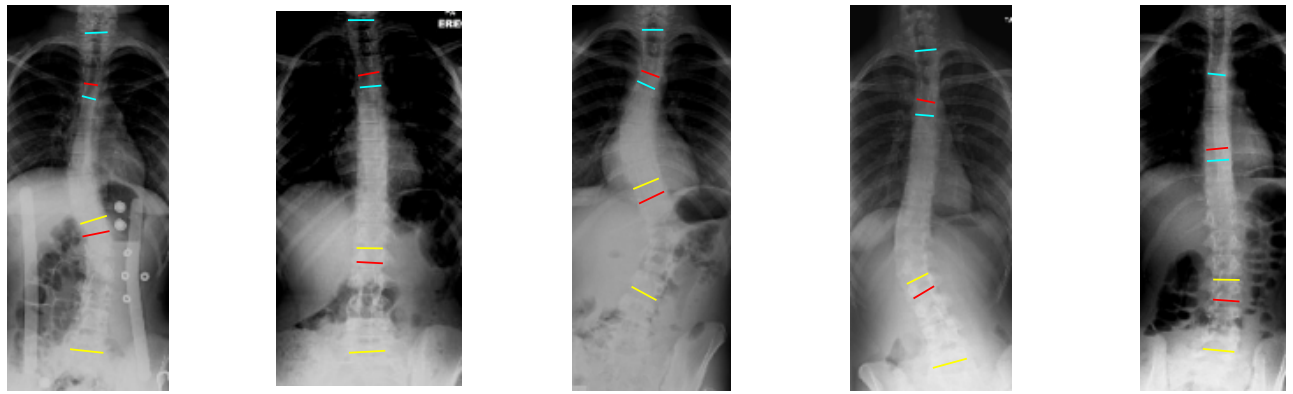
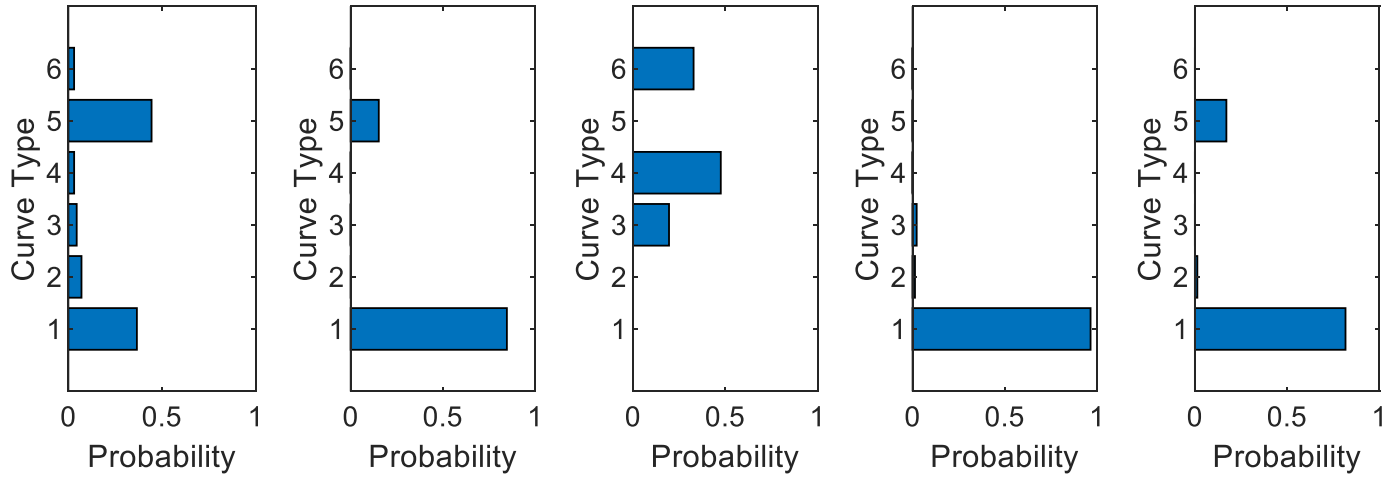
Novel Lenke Curve Type Probability Analysis





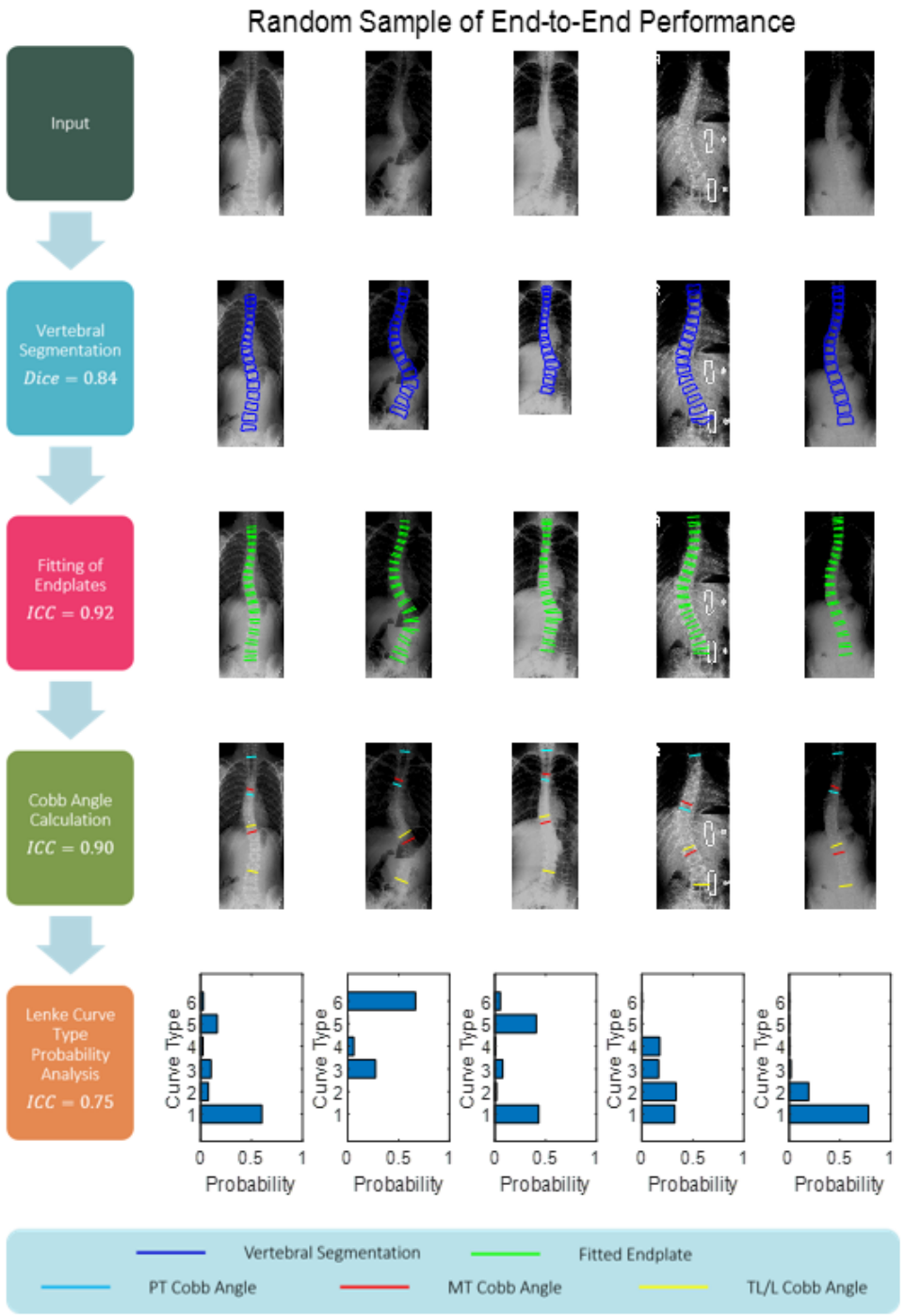
Random Sample of Cobb Angles & Corresponding Lenke Curve Type Probabilities





PT Cobb Angle MT Cobb Angle TL/L Cobb Angle

Overview of Performance



Future Work: Automatic Assessment

Vertebral Segmentation

- Cobb Angle Measurement
- Lenke Curve Type Classification

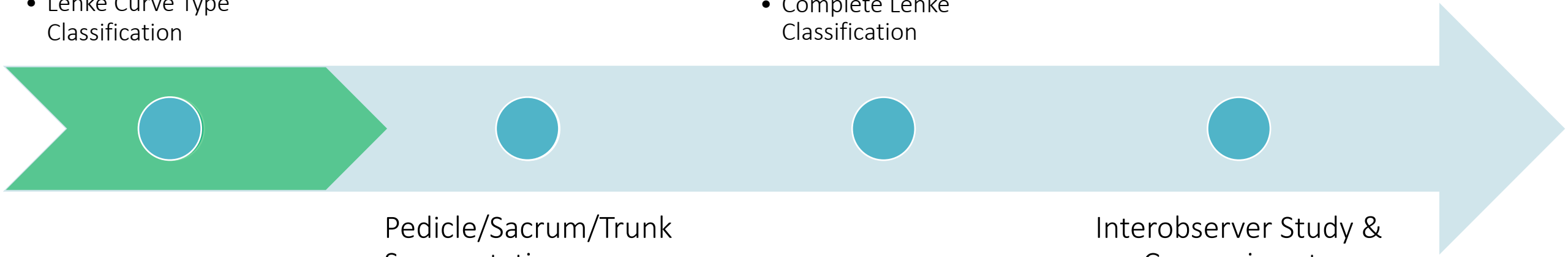
Pedicle/Sacrum/Trunk Segmentation

- Trunk Shift Measurement
- Lenke Lumbar Modifier Assignment

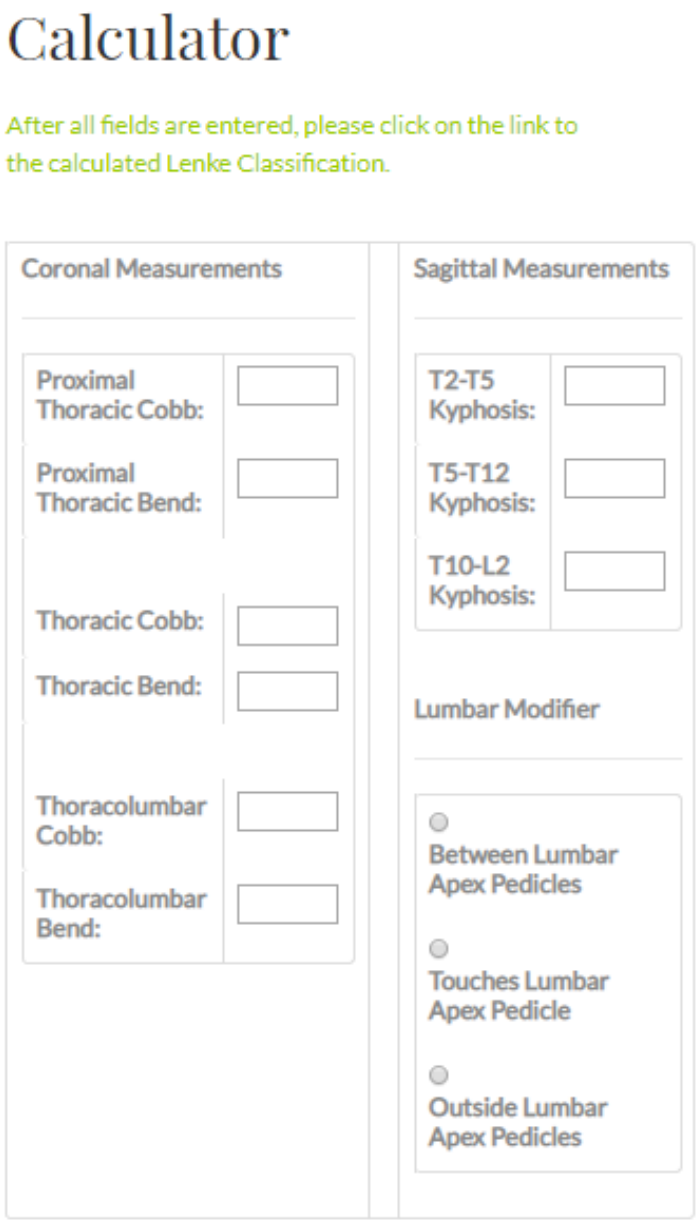
Bending & Sagittal View X-ray Analysis

- Complete Lenke Classification

Interobserver Study & Comparison to Automatic Methods



Lenke Probability Analysis as an Aid to Current Clinical Practice



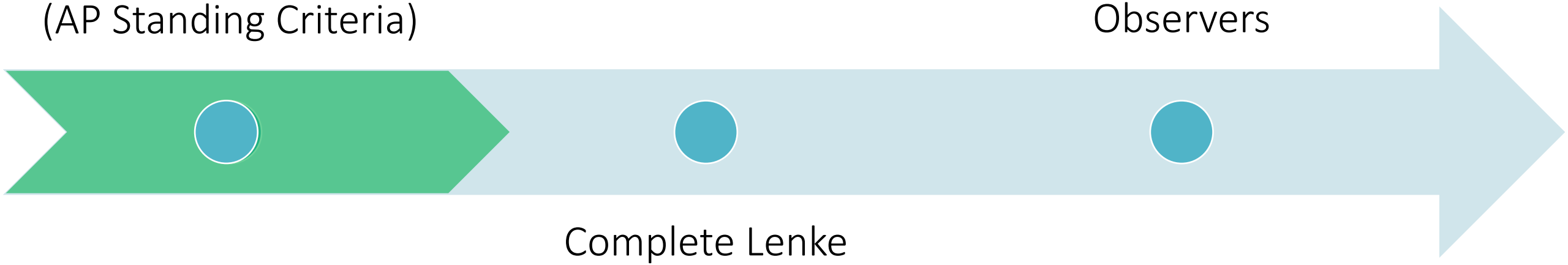
Source: hsg.settingscoliosisstraight.org

Future Work: Lenke Probability Analysis

Lenke Curve Type Probability Analysis (AP Standing Criteria)

Complete Lenke Classification Probability Analysis

Application of Analysis on Cobb Angles Measured by Multiple Observers



Clinical Impact

Automatic Scoliosis Assessment

- Improved clinical workflows

Lenke Probability Analysis

- Prevention of misclassification

Contribution to Future Research

- Journal articles & open-source software

References

[1] L. G. Lenke, R. R. Betz, J. Harms, K. H. Bridwell, and et al, 'Adolescent idiopathic scoliosis: A new classification to determine extent of spinal arthrodesis', *J. Bone Jt. Surg. Am. Vol. Needham*, vol. 83, no. 8, pp. 1169–81, Aug. 2001.

[2] S. Langensiepen *et al.*, 'Measuring procedures to determine the Cobb angle in idiopathic scoliosis: a systematic review', *Eur. Spine J.*, vol. 22, no. 11, pp. 2360–2371, Nov. 2013, doi: 10.1007/s00586-013-2693-9.

[3] M. C. Tanure, A. P. Pinheiro, and A. S. Oliveira, 'Reliability assessment of Cobb angle measurements using manual and digital methods', *Spine J.*, vol. 10, no. 9, pp. 769–774, Sep. 2010, doi: 10.1016/j.spinee.2010.02.020.

[4] R. Lechner, D. Putzer, D. Dammerer, M. Liebensteiner, C. Bach, and M. Thaler, 'Comparison of two- and three-dimensional measurement of the Cobb angle in scoliosis', *Int. Orthop.*, vol. 41, no. 5, pp. 957–962, May 2017, doi: 10.1007/s00264-016-3359-0.

Questions?