

Morphologies Measurement

Protocol Notes

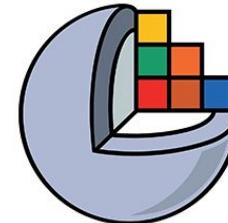
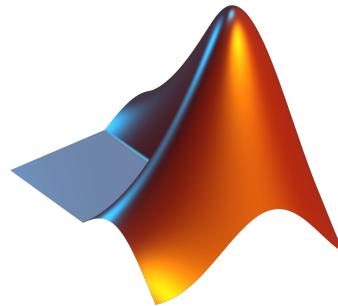
O'Connell Biomechanics Lab

Yousuf + Sylvi

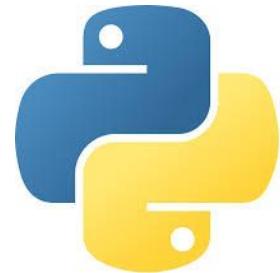
Winter 2025



Last updated: 1/22/2026



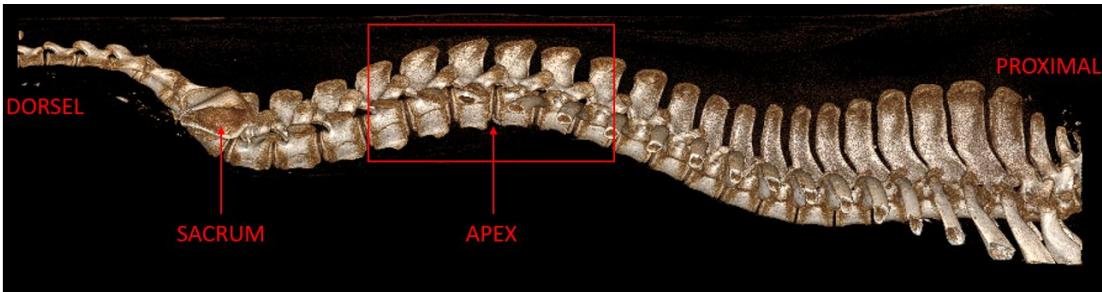
3D Slicer



Berkeley
UNIVERSITY OF CALIFORNIA

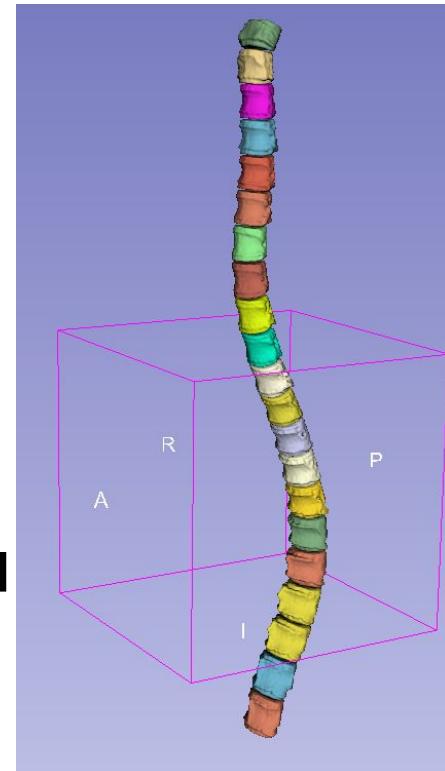
Measurement Protocol Overview

Raw imaging data

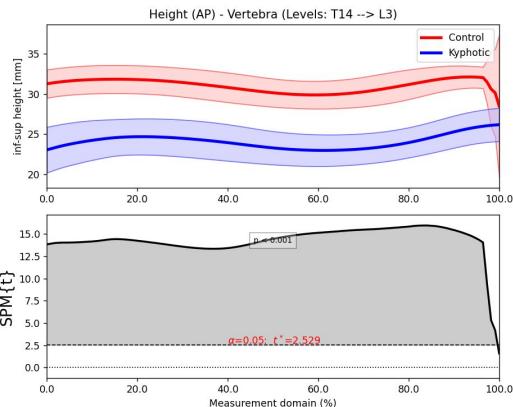


Full spine segmentation^[1]

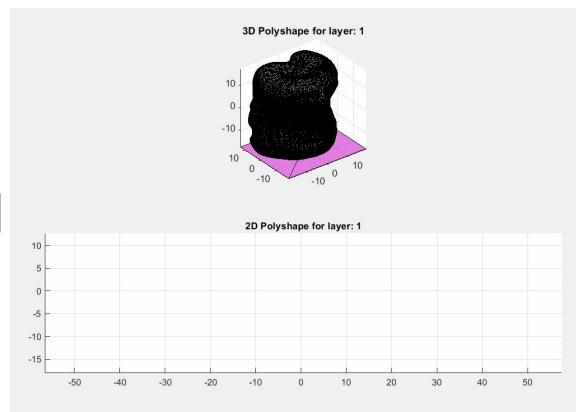
Assumes: 15
thoracic + 6
lumbar levels



Statistical Analysis



(Automated) MATLAB measurements



[1] Manual segmentation protocols [here](#)

Programming Overview

Morphologies Github [here](#)^[1], general pipeline:

*Loading all vertebrae geometry files → disc construction → geometry alignment →
slicer, height, and volume measurements → analysis*

Morphologies

Author: Yousuf Abubakr (yousufabubakr123@berkeley.edu)

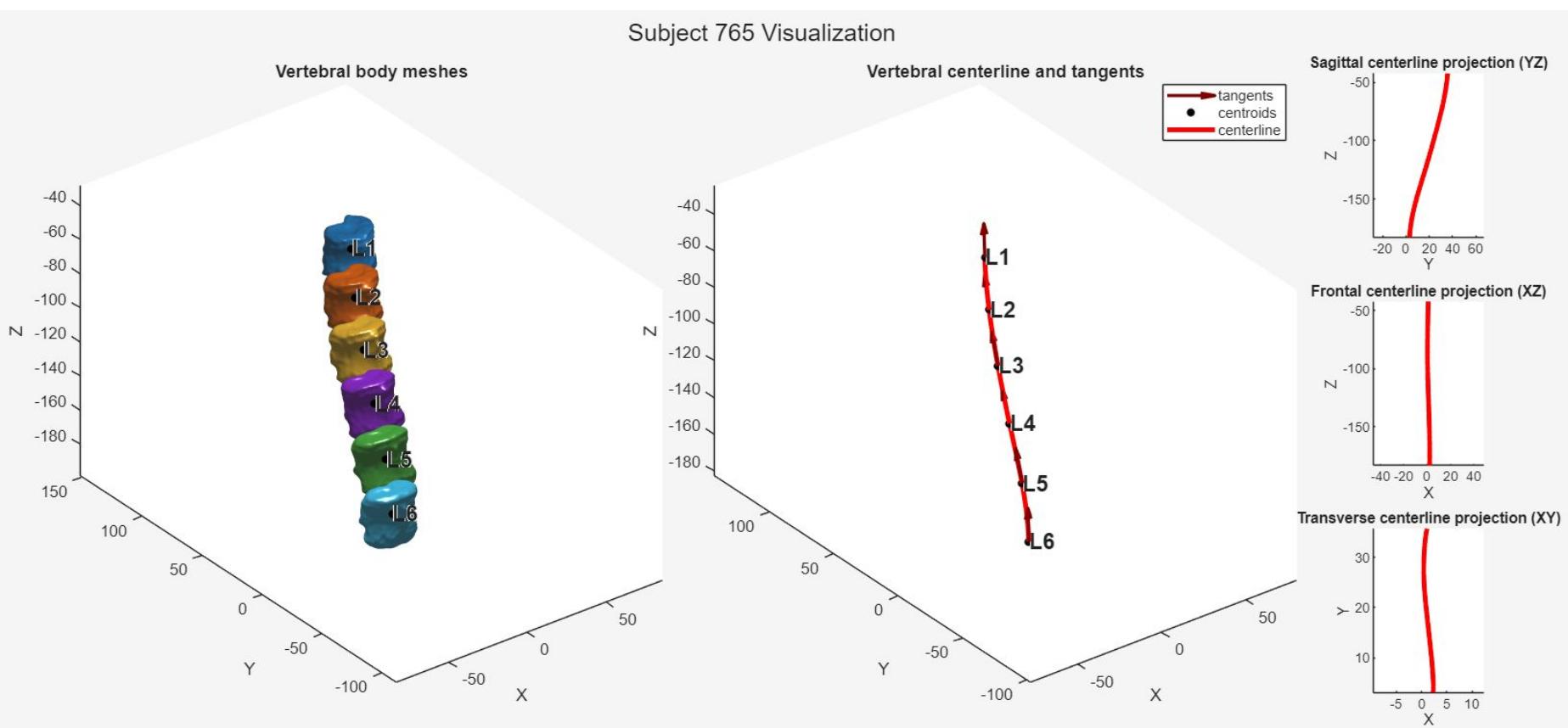
Lab: Grace O'Connell Biomechanics Lab (<https://oconnell.berkeley.edu/>)

Description: A toolkit for processing, analyzing, and visualizing morphological data from medical imaging datasets (e.g., STL meshes, MATLAB measurement files).

[1] Github stats (as of 1/22/2026): total # lines of code = 5,802, total # of words = 25,239, total # of characters = 225,008, total # of MATLAB .m files = 72

MATLAB Program Overview

1.) Loading geometry: *loads vertebral body geometries & computes centerline path and tangents*



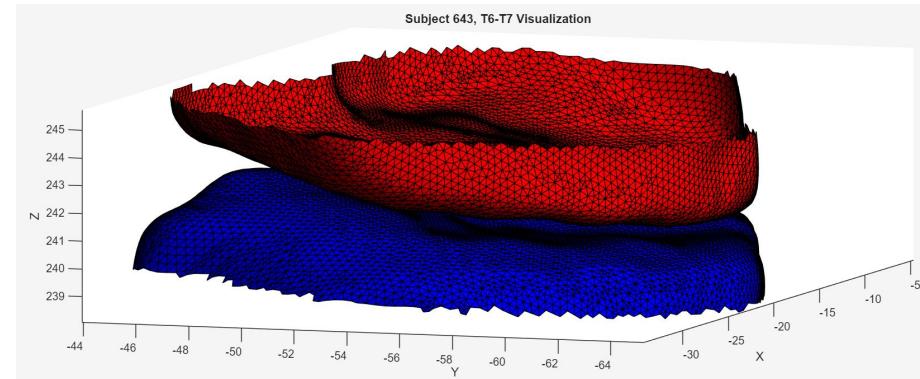
MATLAB Program Overview

2.) Disc construction: *interpolating across vertebral endplates to define and export disc volumes*

Step 1:

Extract triangulation representations of superior + inferior surfaces

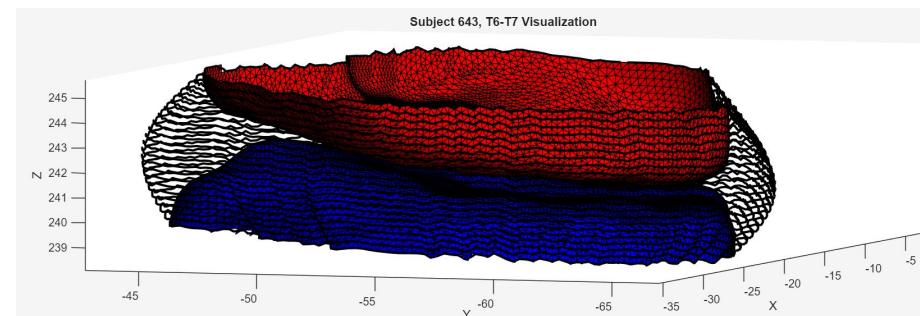
- Red = superior surface of disc
- Blue = inferior surface of disc



Step 2:

*Obtain inferior → superior loft curves
(pictured in black)*

- Associated parameters:
 - # of rings
 - bulge amplitude (default: 2 mm)

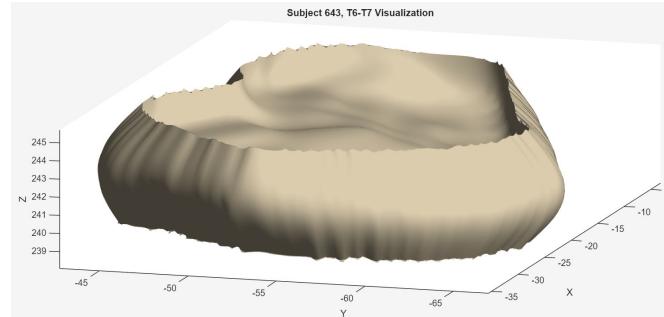


MATLAB Program Overview

2.) Disc construction: *interpolating across vertebral endplates to define and export disc volumes*

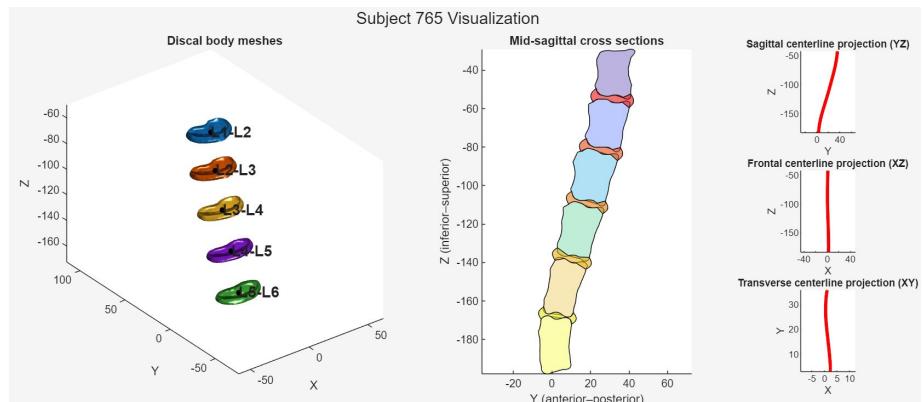
Step 3:

Stitch endplate surfaces to one another to create a full disc triangulation and export to .stl file



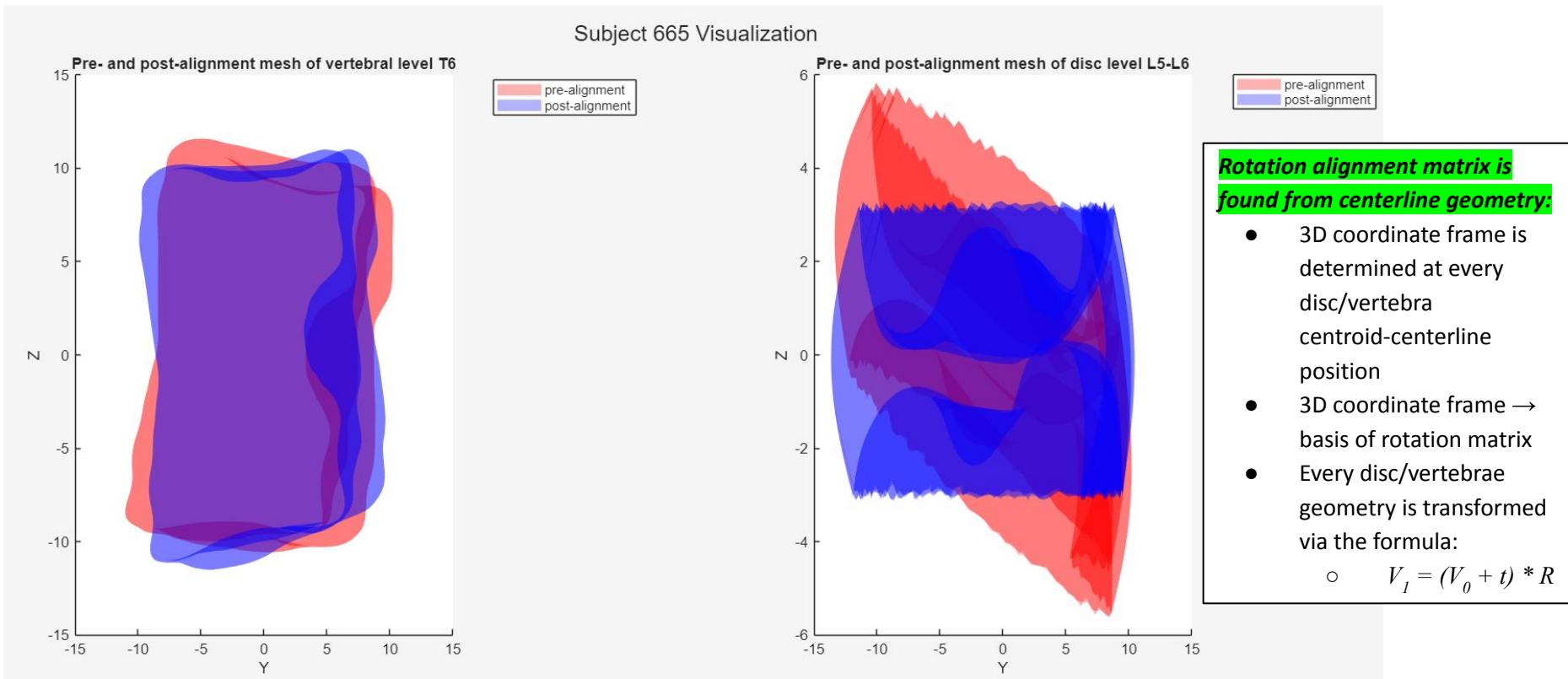
NOTES:

- Water-tightness is NOT guaranteed
- Any further geometry processing and measurement processes are generalized for both vertebra and disc structures



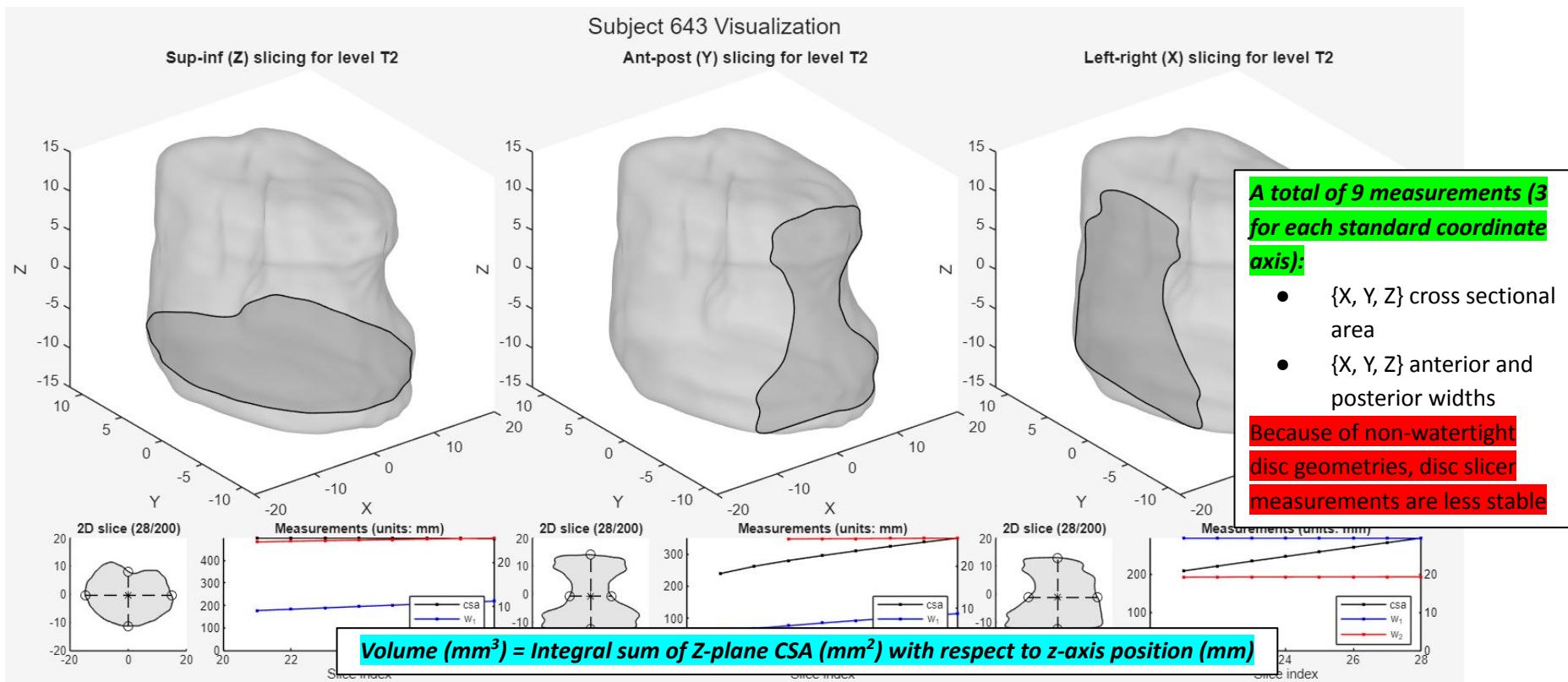
MATLAB Program Overview

3.) Geometry alignment: centerline-based geometry alignment to standard coordinate reference frame



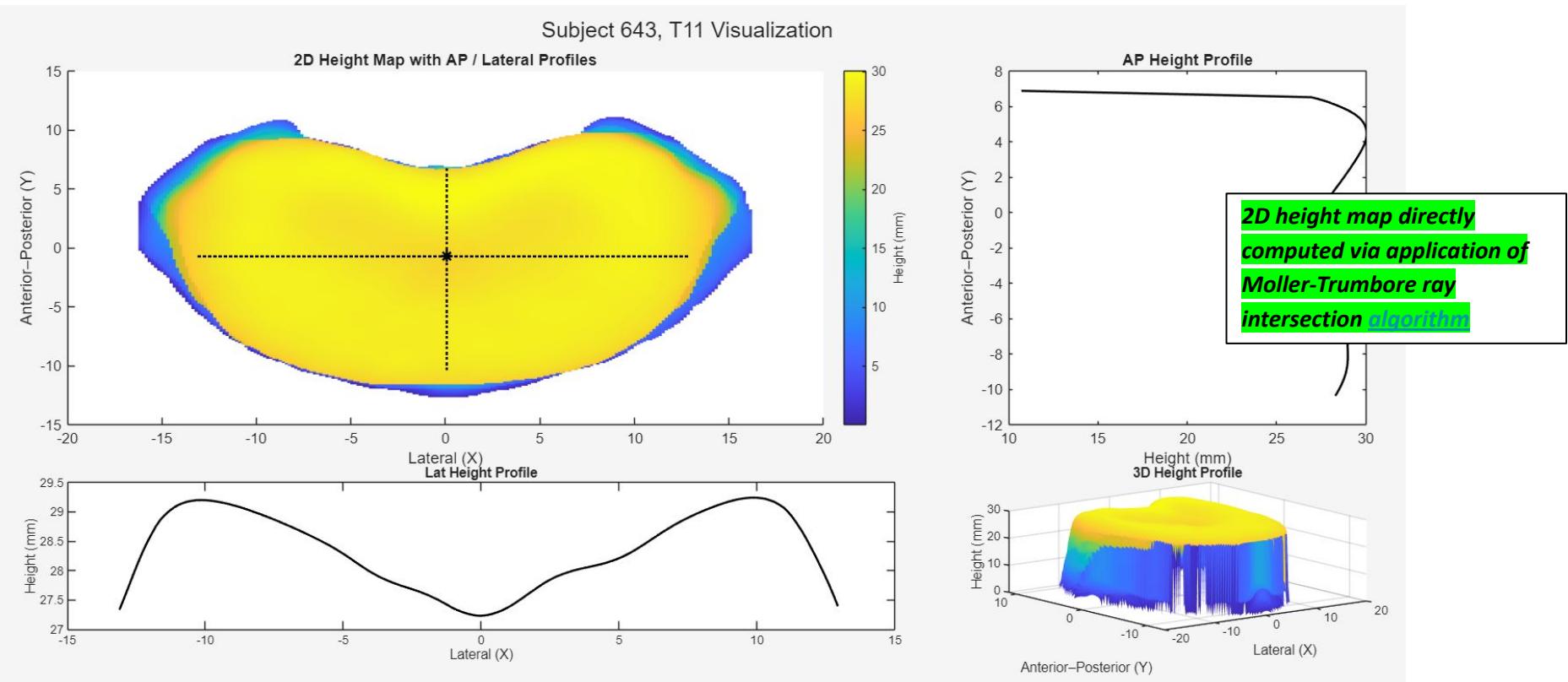
MATLAB Program Overview

4.) Slicer/volume measurements: slicing geometries and measuring CSAs, widths, and volumes



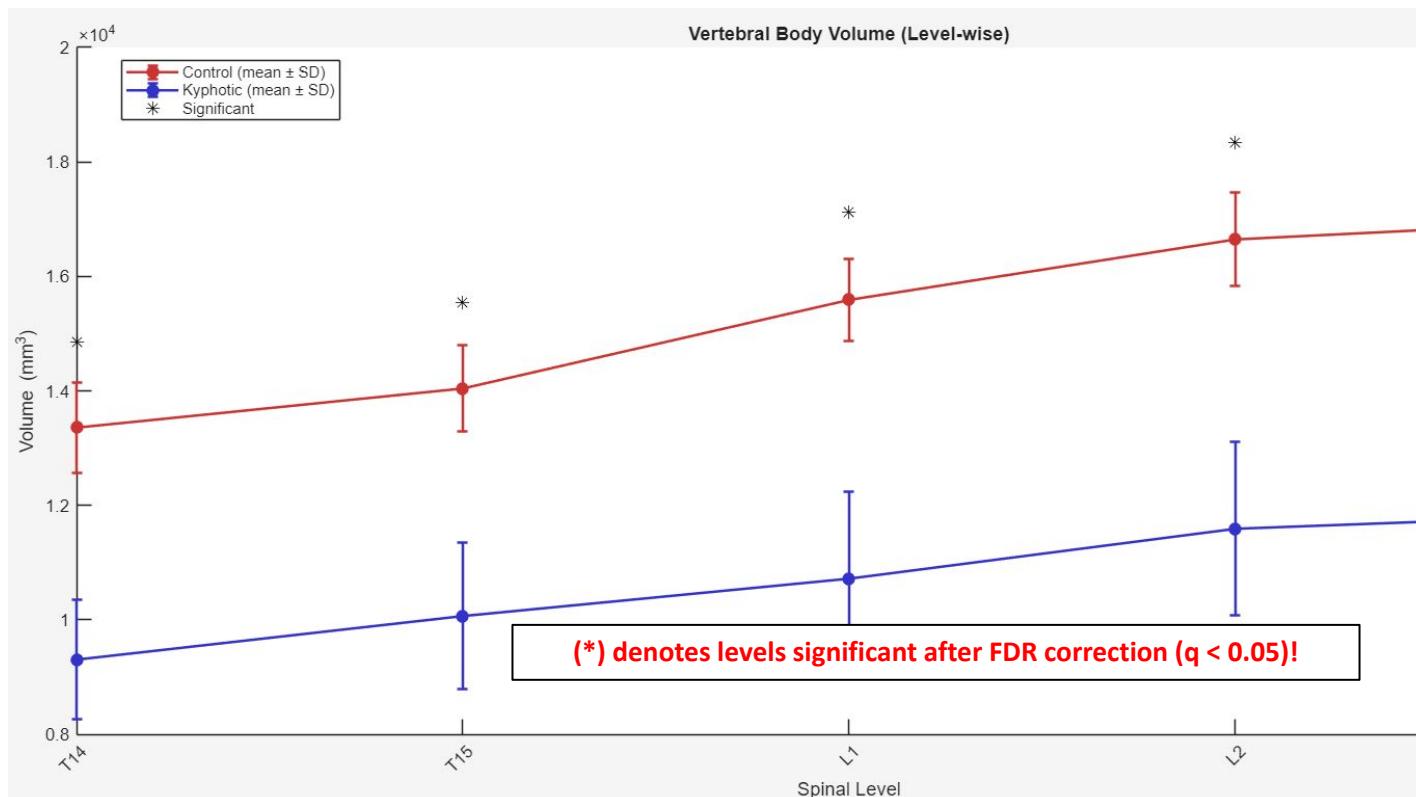
MATLAB Program Overview

4.) Height measurements: measuring 2D height distribution and extracting AP and LAT heights



MATLAB Program Overview

5.) Analysis: computing and visualizing summary statistics across control and kyphotic experimental groups



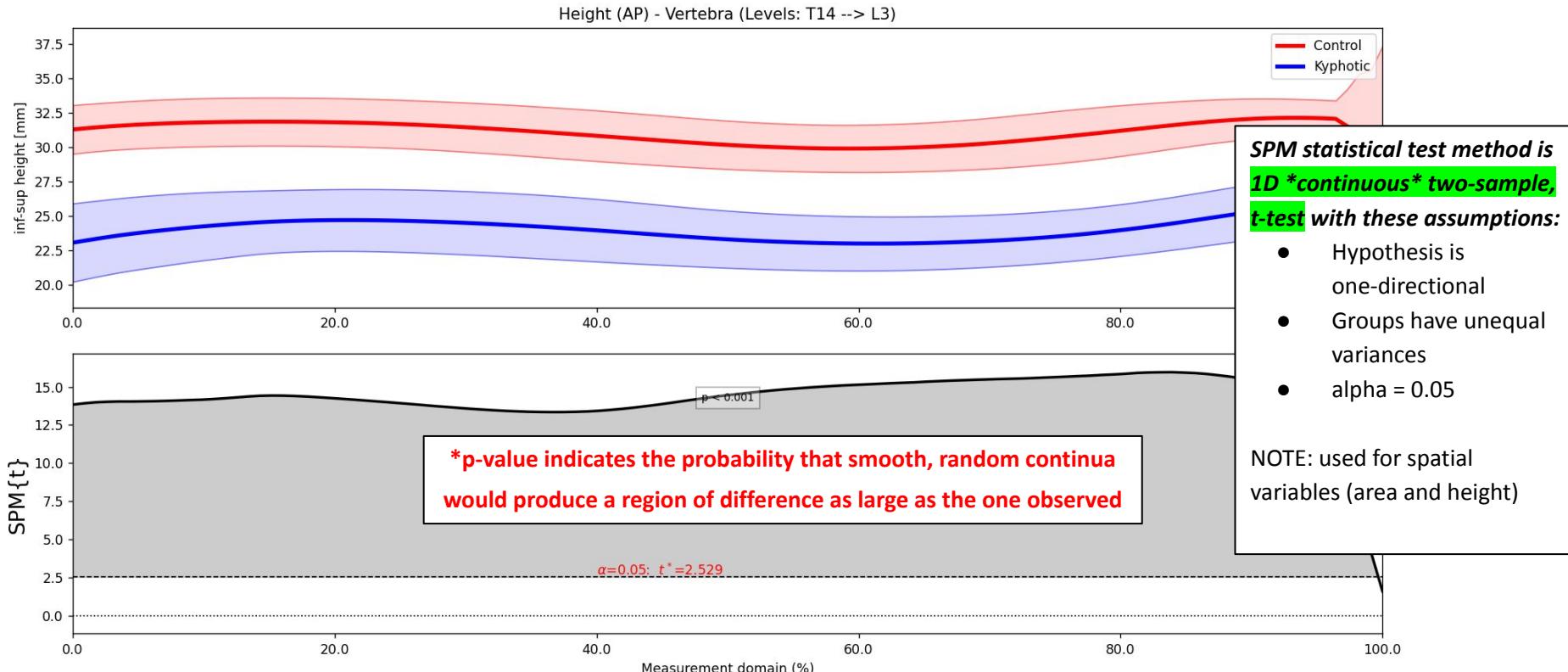
MATLAB statistical test
method is **1D *discrete***
two-sample, t-test with these assumptions:

- Hypothesis is two-directional
- Groups have unequal variances
- $\alpha = 0.05$
- FDR is controlled with [BH procedure](#)

NOTE: used for body variables (volume)

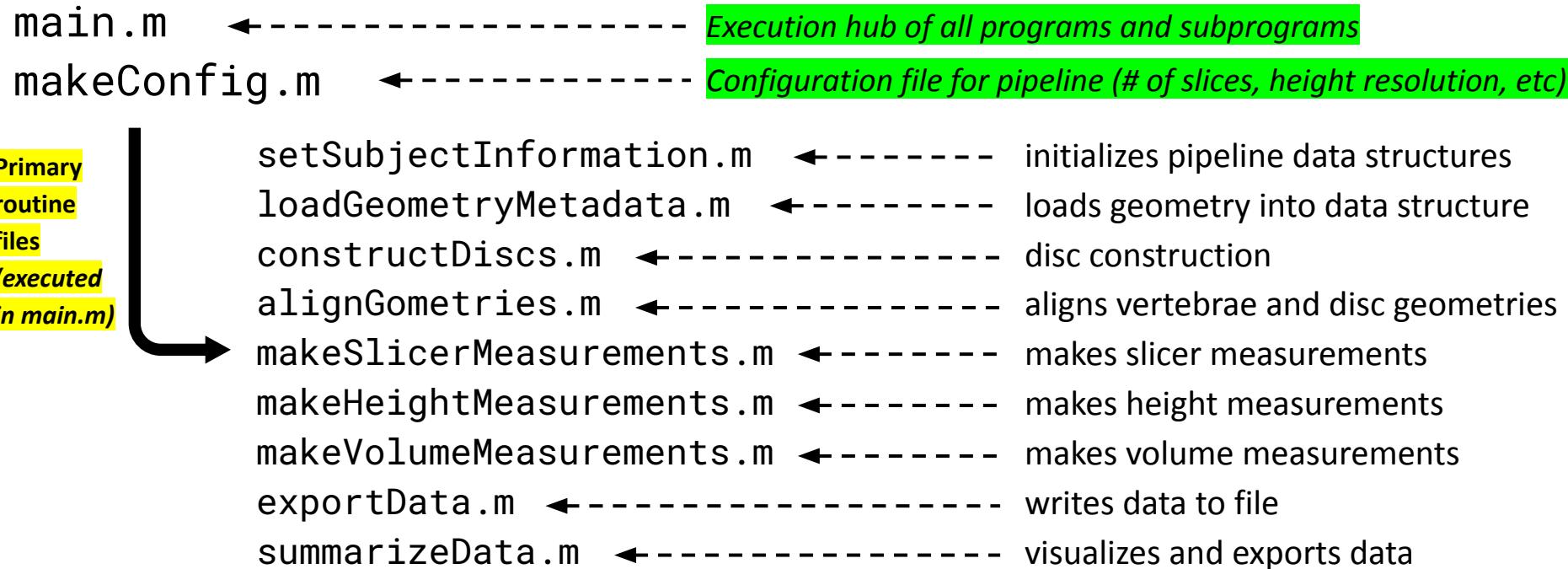
MATLAB Program Overview

5.) Analysis: computing and visualizing summary statistics across control and kyphotic experimental groups



Morphologies Technical Overview

Morphologies source code [here](#), head files:



Morphologies Technical Overview

Morphologies source code [here](#), head files:

main.m ←----- *Execution hub of all programs and subprograms*

makeConfig.m ←----- *Configuration file for pipeline (# of slices, height resolution, etc)*

How to use source code:

1. Set configuration settings in makeConfig.m

a. **IMPORTANT PARAMETERS:**

i. *numSlices, heightResolution, slicerIgnorance, heightIgnorance*

ii. *If pipeline detects any of these config parameters are different from the saved config settings in 'data/raw', the measurements will be rewritten!*

b. *Options for visualization (note: some plots are graphics intensive)*

c. *Disc construction parameters*

d. *Range of levels to be exported for SPM analysis*

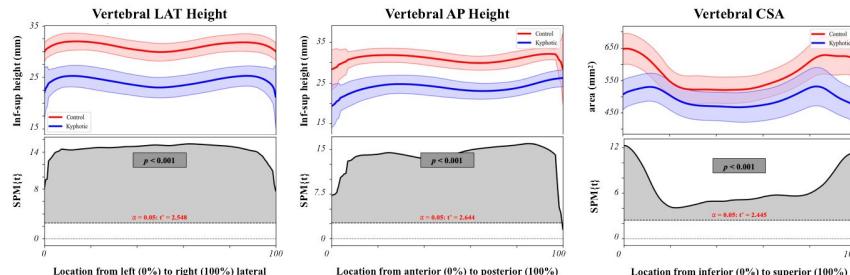
2. Run main.m for MATLAB results and run '[analysis-utils/main.py](#)' for SPM results

Summary of Results from *Morphologies*

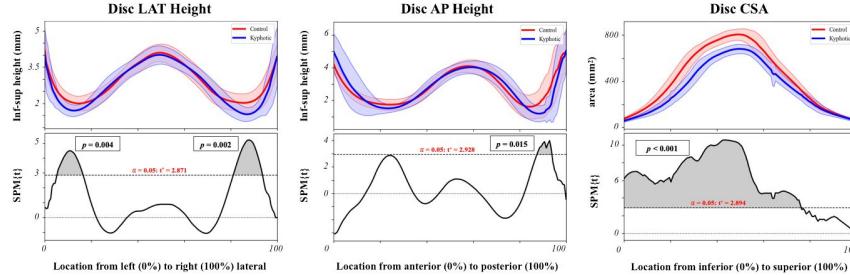
Settings: # of slices = 200, height resolution = 200, slicer & height ignorance = 0.1, **levels exported** = T14 → L3

Spatially-varying measurements

A

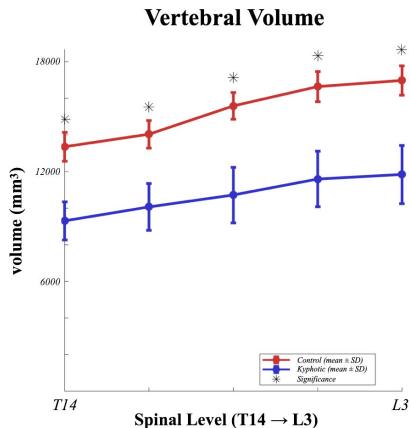


B

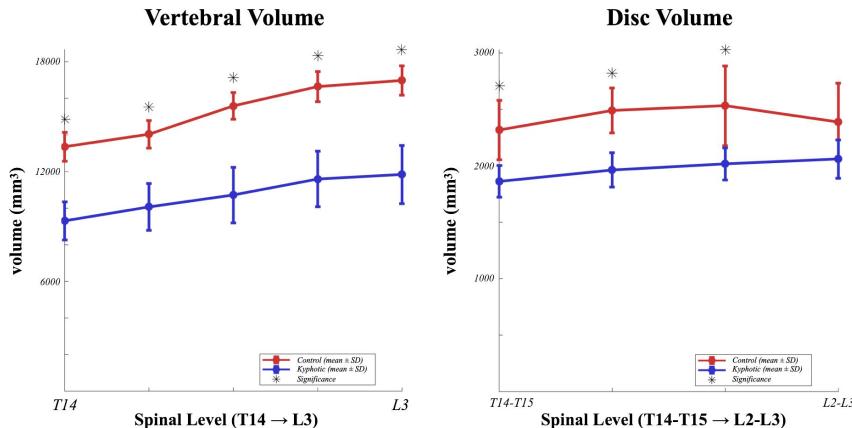


Spine-level scalar measurements

A



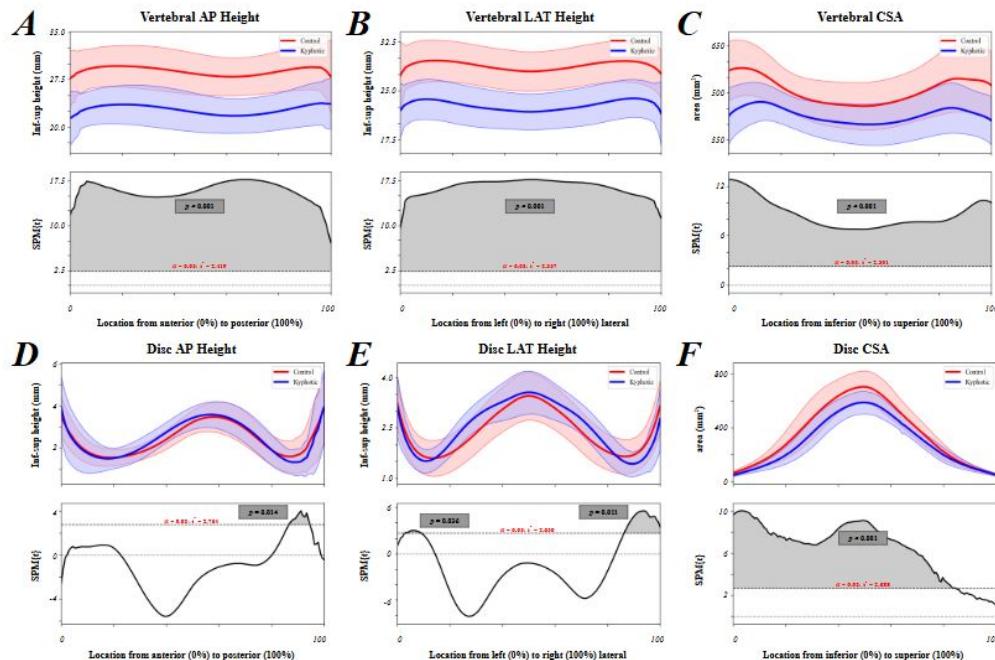
B



Summary of Results from *Morphologies*

Settings: # of slices = 200, height resolution = 200, slicer & height ignorance = 0.1, **levels exported** = T1 → L6

Spatially-varying measurements



Spine-level scalar measurements

