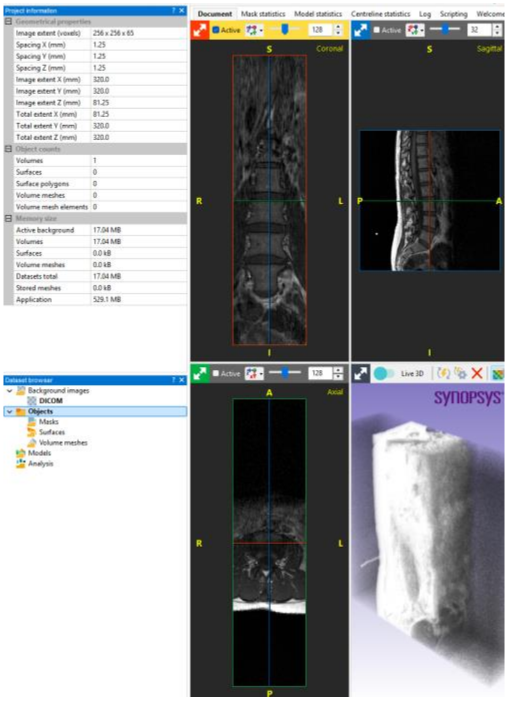
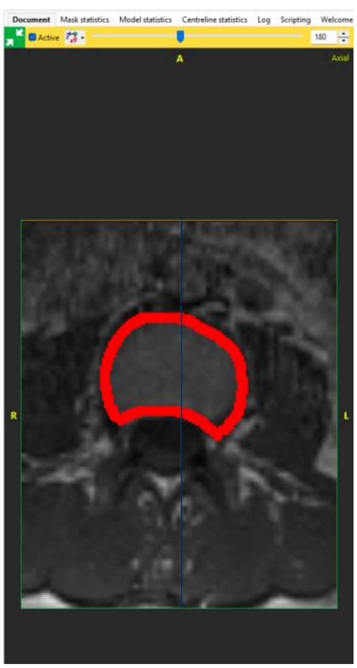
1. **Third Lumbar Body Segmentation from MRI Date using Simpleware**

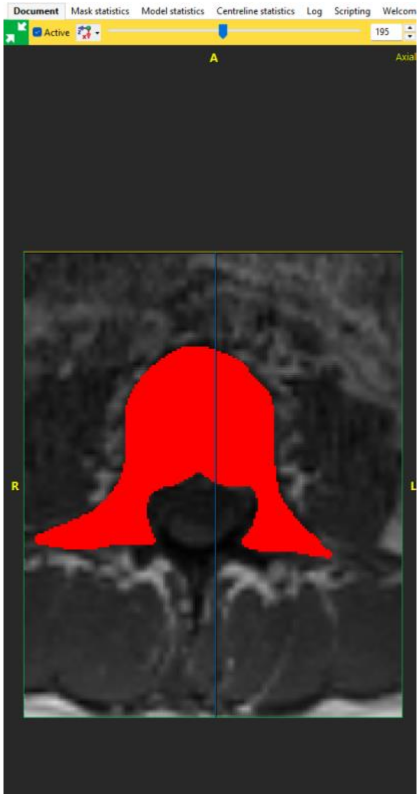
A. <u>3D Wrap Tool</u>



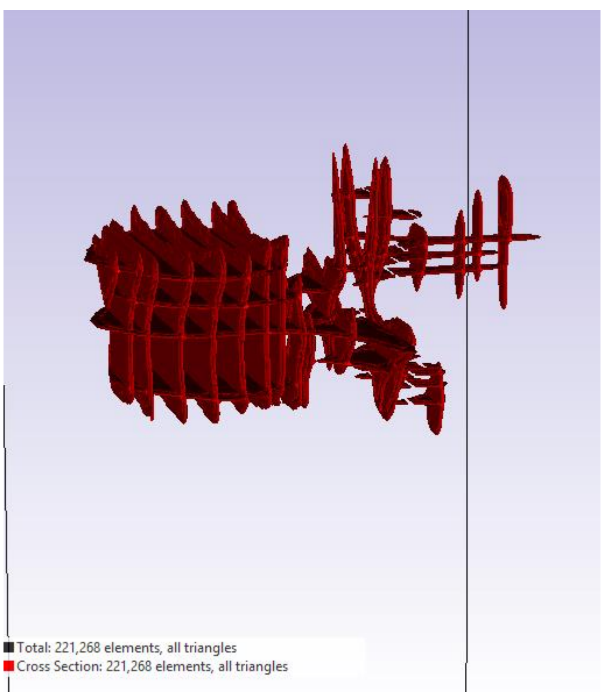
i. Initial MRI dataset view in Simpleware from the DICOM file available from the Simpleware tutorial page.



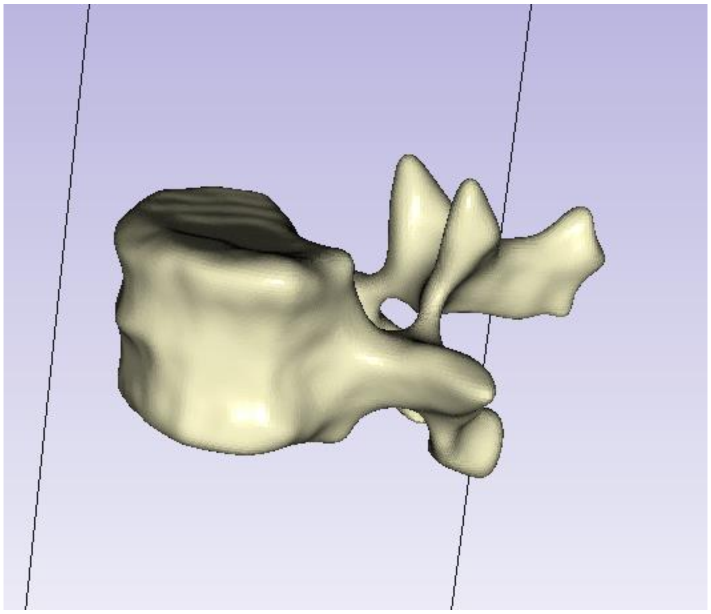
ii. Contour outline for a XZ slice of the L3 vertebral body using Simpleware's manual Paint Tool.



iii. Filled contour from previously selected outline after the use of the Mask Flood Fill Tool.

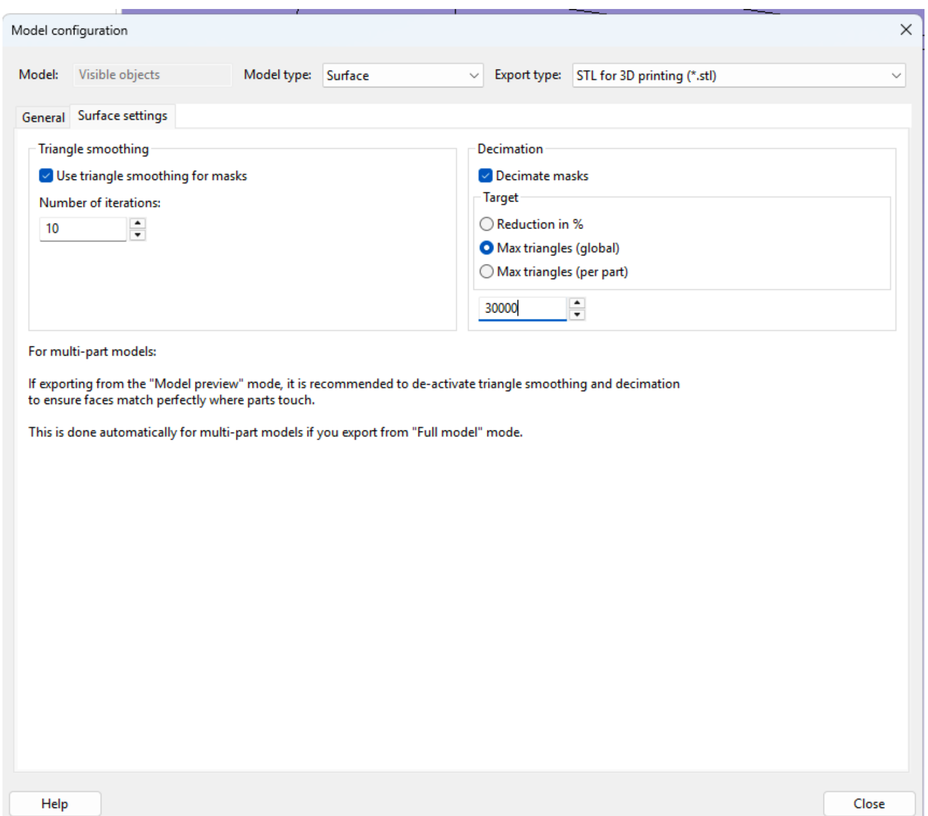


iv. Final filled contours taken from the three intersecting anatomic planes, showing the segmentations made before the 3D Wrap tool is used.

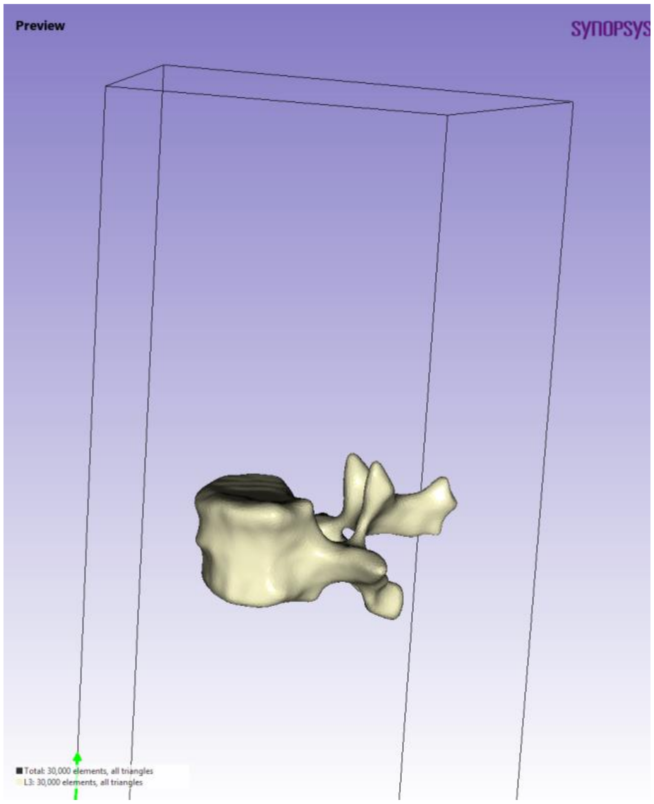


v. 3D view of the final smoothed mask after using the 3D Wrap tool and changing the color to 'bone.'

B. <u>Lumbar Vertebrae surface .STL data</u>

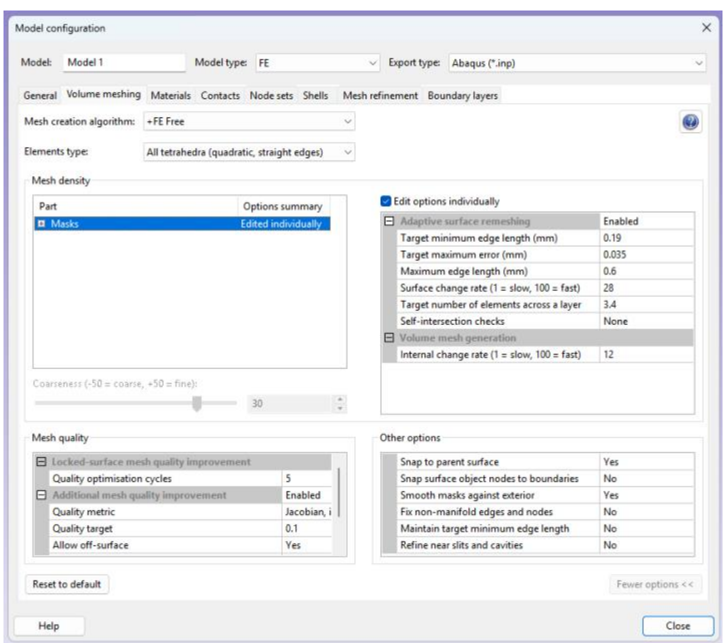


i. Set-up for .STL model with a maximum of 30,000 triangles (globally).

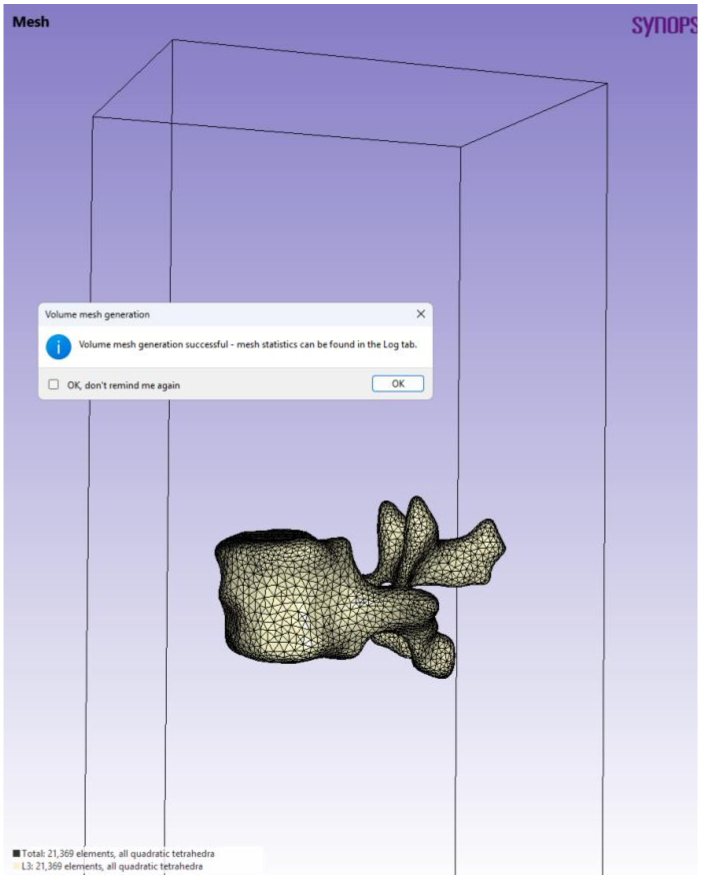


ii. Final .STL model from Simpleware with confirmed 30,000 triangle count.

C. <u>Volumetric Fine Element Model (.INP)</u>

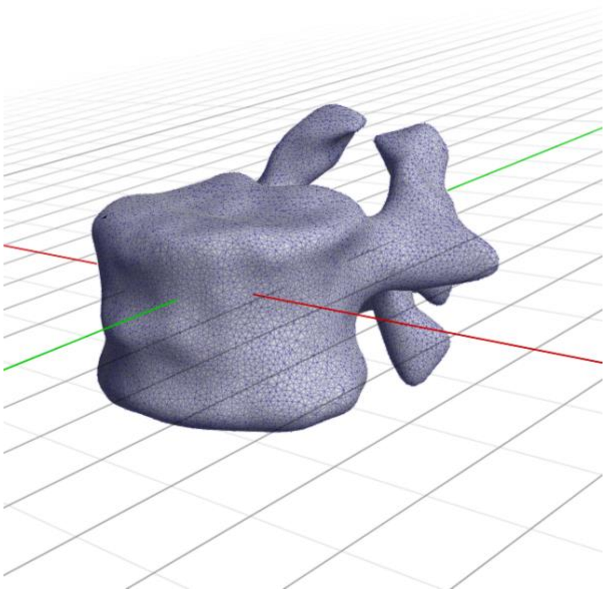


i. Finite element model set-up with a mesh coarseness of -30.

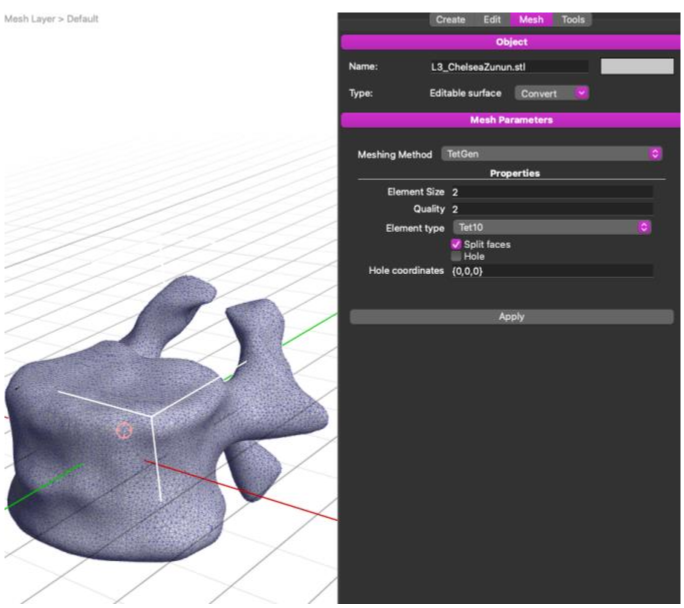


ii. Final volumetric finite element model from Simpleware with a total 21,369 10-node tetrahedral elements.

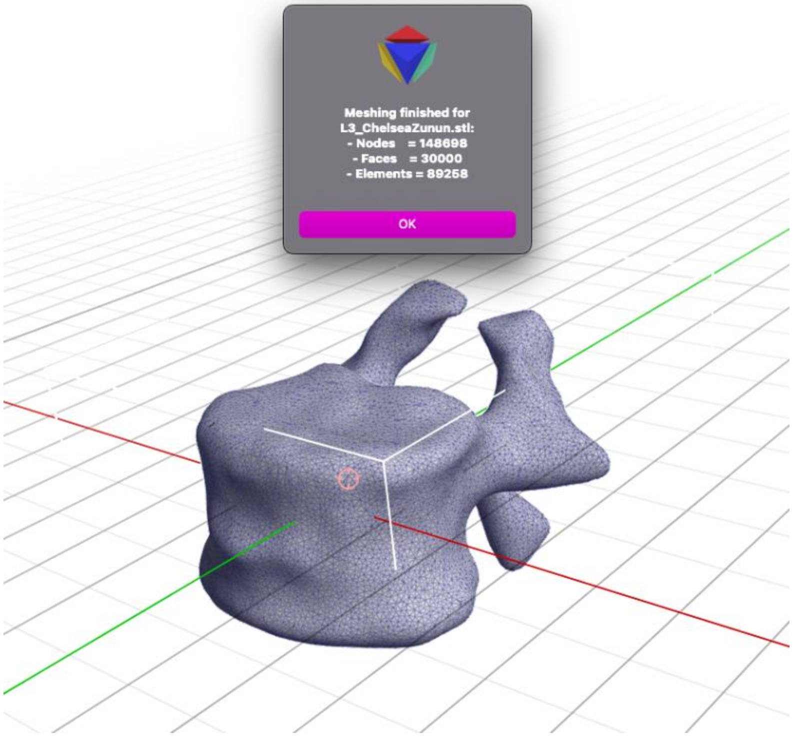
2. Import and Mesh the Lumbar .STL model in FEBio



i. Imported .STL model in FEBio

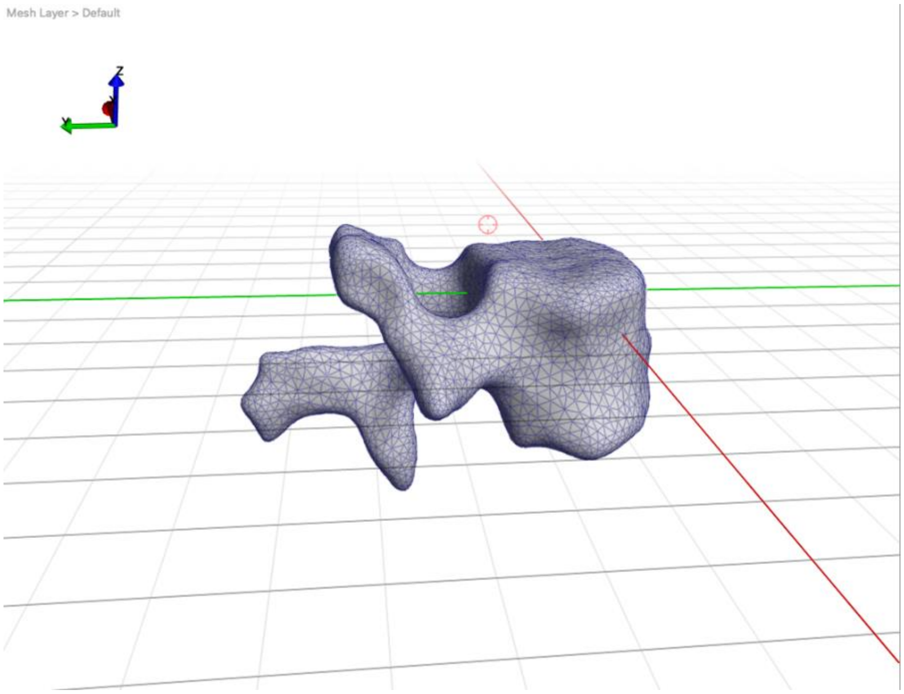


ii. Meshing set-up using Tetgen as the meshing method and Tet10 elements with element quality and size set to 2.

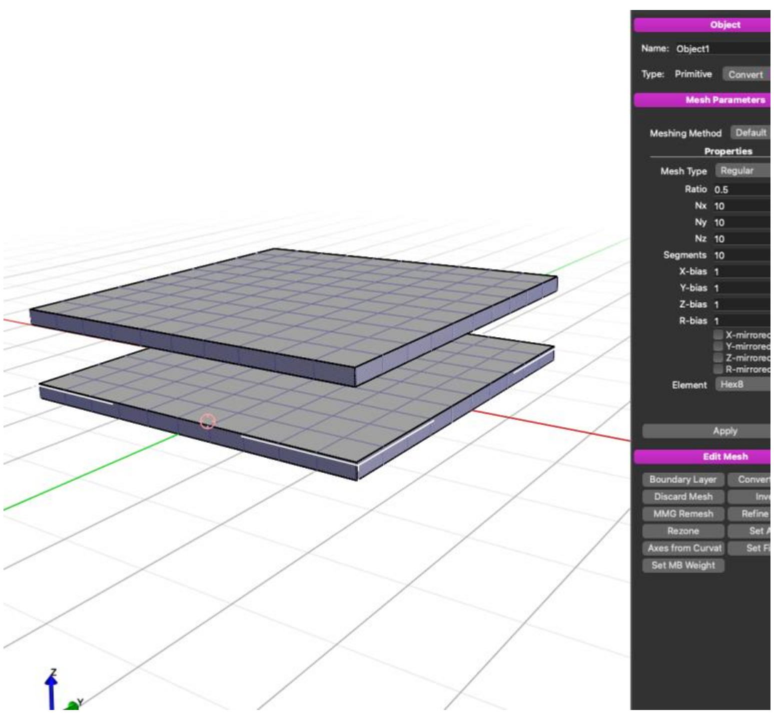


iii. Successful meshing for .STL model, resulting in a mesh with 148698 nodes and 89258 elements.

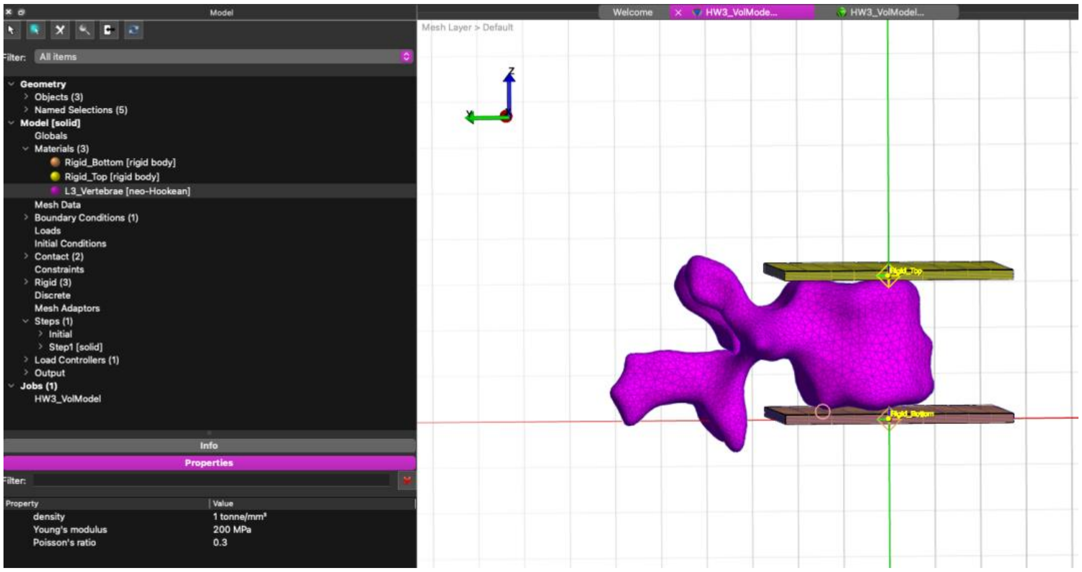
3. **Import the Volumetric model into FEBio and simulate compression of the L3 vertebral body.**



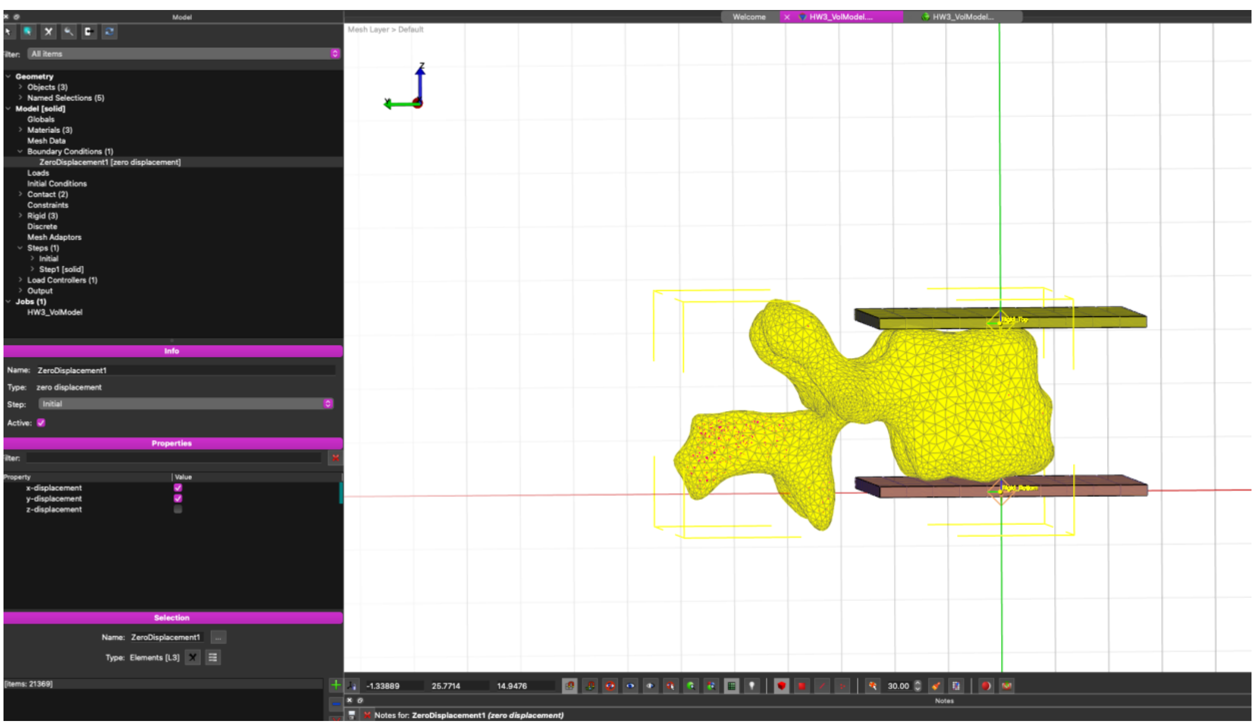
i. The FE vertebrae in FEBio environment after importing the .INP file.



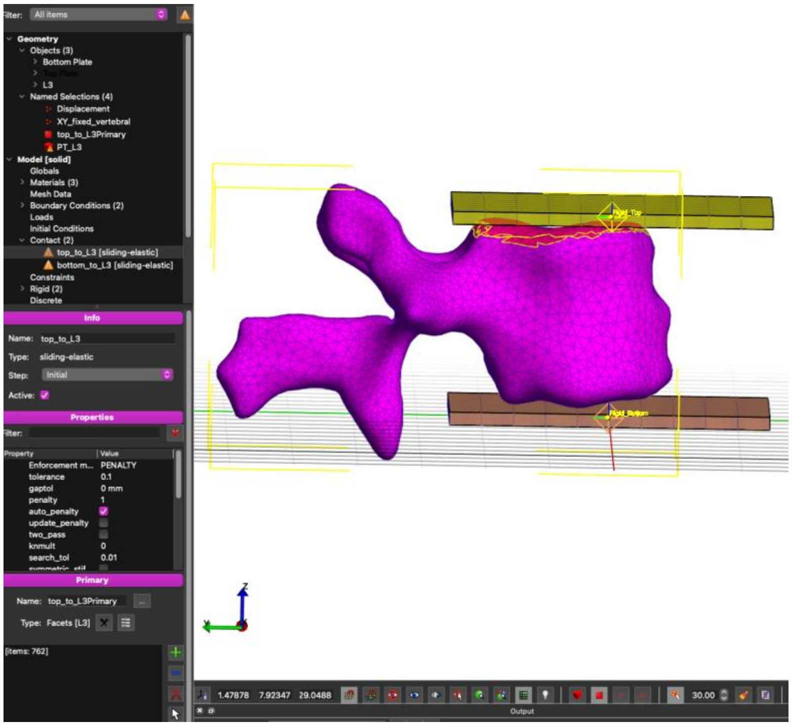
ii. Meshed compression top and bottom plates each constructed from box primitive geometry with the dimensions 50x50x2 mm.



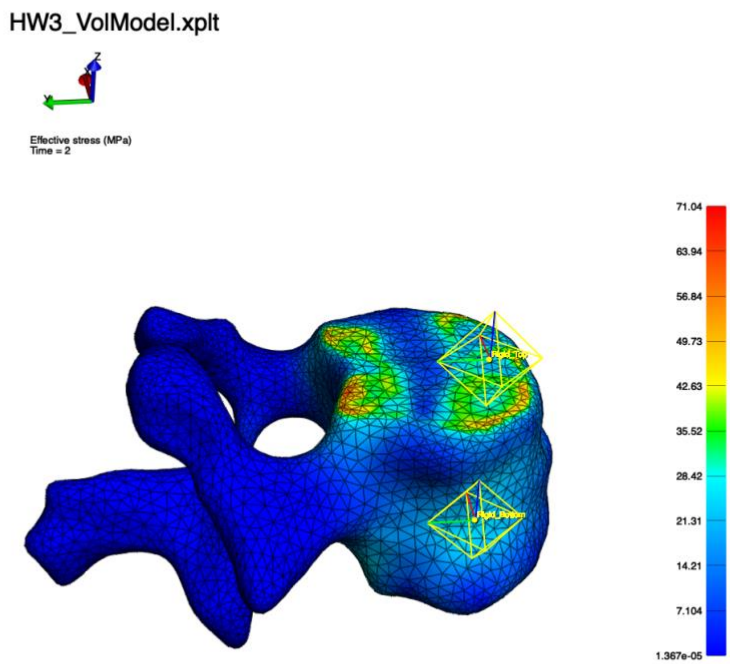
iii. Meshed vertebral body and plate with their assigned material properties, where the plates are rigid materials while the vertebral body is modeled as a Neo-Hookean elastic model (E=200 MPa and v = 0.3).



iv. For non-rigid materials (vertebral body), a nodal boundary condition for zero displacement has been set to fix X- and Y- in place, leaving Z- as the only free direction for the body to move.



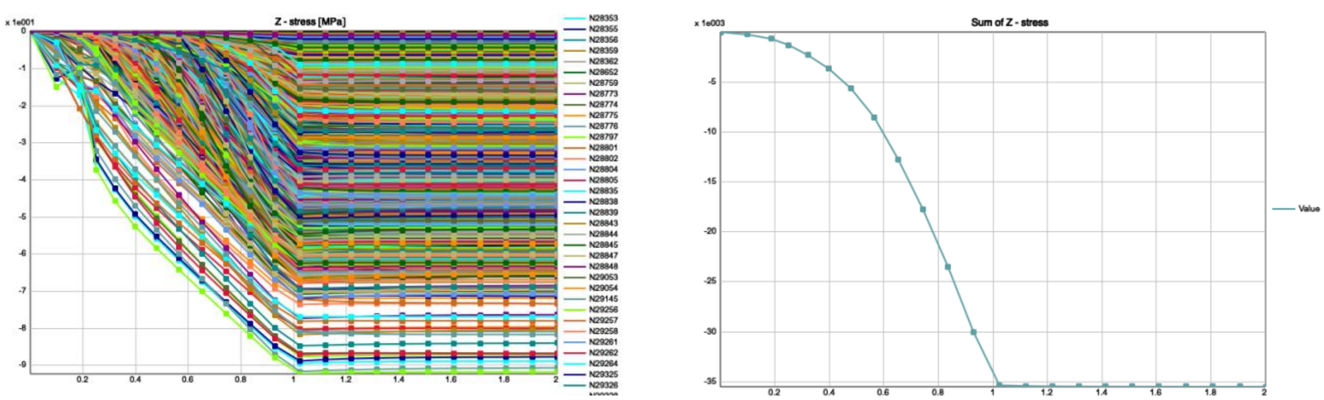
v. Sliding-elastic contact interface between the vertebral body as the primary surface (highlighted in red) and the bottom of the rigid top plate.



vi. Effective stress contours of the vertebral body in MPa, shown from the top with the compression plates hidden for easy visualization.

```
........................ augmentation # 1
 sliding interface # 25
                        CURRENT        REQUIRED
    D multiplier :    2.675240e-03   1.000000e-01
    maximum gap  :    6.622828e-03        ***
 sliding interface # 26
                        CURRENT        REQUIRED
    D multiplier :    1.387347e-03   2.000000e-01
    maximum gap  :    7.890044e-03        ***

convergence summary
    number of iterations   : 5
    number of reformations : 0

------- converged at time : 2


 N O N L I N E A R   I T E R A T I O N   I N F O R M A T I O N

    Number of time steps completed .................... : 22

    Total number of equilibrium iterations ............ : 158

    Average number of equilibrium iterations .......... : 7.18182

    Total number of right hand evaluations ............ : 237

    Total number of stiffness reformations ............ : 158

 L I N E A R   S O L V E R   S T A T S

    Total calls to linear solver ........ : 173

    Avg iterations per solve ............ : 1

    Time in linear solver: 0:01:25

 Elapsed time : 0:02:06

 T I M I N G   I N F O R M A T I O N

    Input time ...................... : 0:00:00 (0.140909 sec)

    Initialization time ............. : 0:00:00 (0.124303 sec)

    Solve time ...................... : 0:02:06 (125.541 sec)

       IO-time (plot, dmp, data) .... : 0:00:01 (0.53635 sec)

       reforming stiffness .......... : 0:00:12 (11.7968 sec)

       evaluating stiffness ......... : 0:00:17 (17.2859 sec)

       evaluating residual .......... : 0:00:04 (4.26317 sec)

       model update ................. : 0:00:03 (3.37329 sec)

       QN updates ................... : 0:00:00 (4.1188e-05 sec)

       time in linear solver ........ : 0:01:25 (84.8258 sec)

    Total elapsed time .............. : 0:02:06 (125.819 sec)

 N O R M A L   T E R M I N A T I O N
```

vii. Log file results after FEBio analysis.



viii. Outputted graphs of z_stress of the vertebrae top surface getting compressed by plate on top, with the left picture representing z_stress in every selected node while the right picture is the sum of z_stress.