

# Using Cross Sectional Imaging to 3D Print A Negative Space Model of the Pterygopalatine Fossa



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## Introduction

The pterygopalatine fossa is one of the most complex anatomical regions to understand. It is poorly visualised in cadaveric dissection and most textbooks rely on schematic depictions. Three dimensional (3D) printing is a form of additive manufacturing - data representing a digital object is exported to a specialised printer that builds up consecutive layers of a chosen material to produce a 3D object<sup>1</sup>. By combining this technology with open-source medical image processing software, we produced an anatomically accurate 3D model of the pterygopalatine fossa (PPF) using data from a head CT scan.

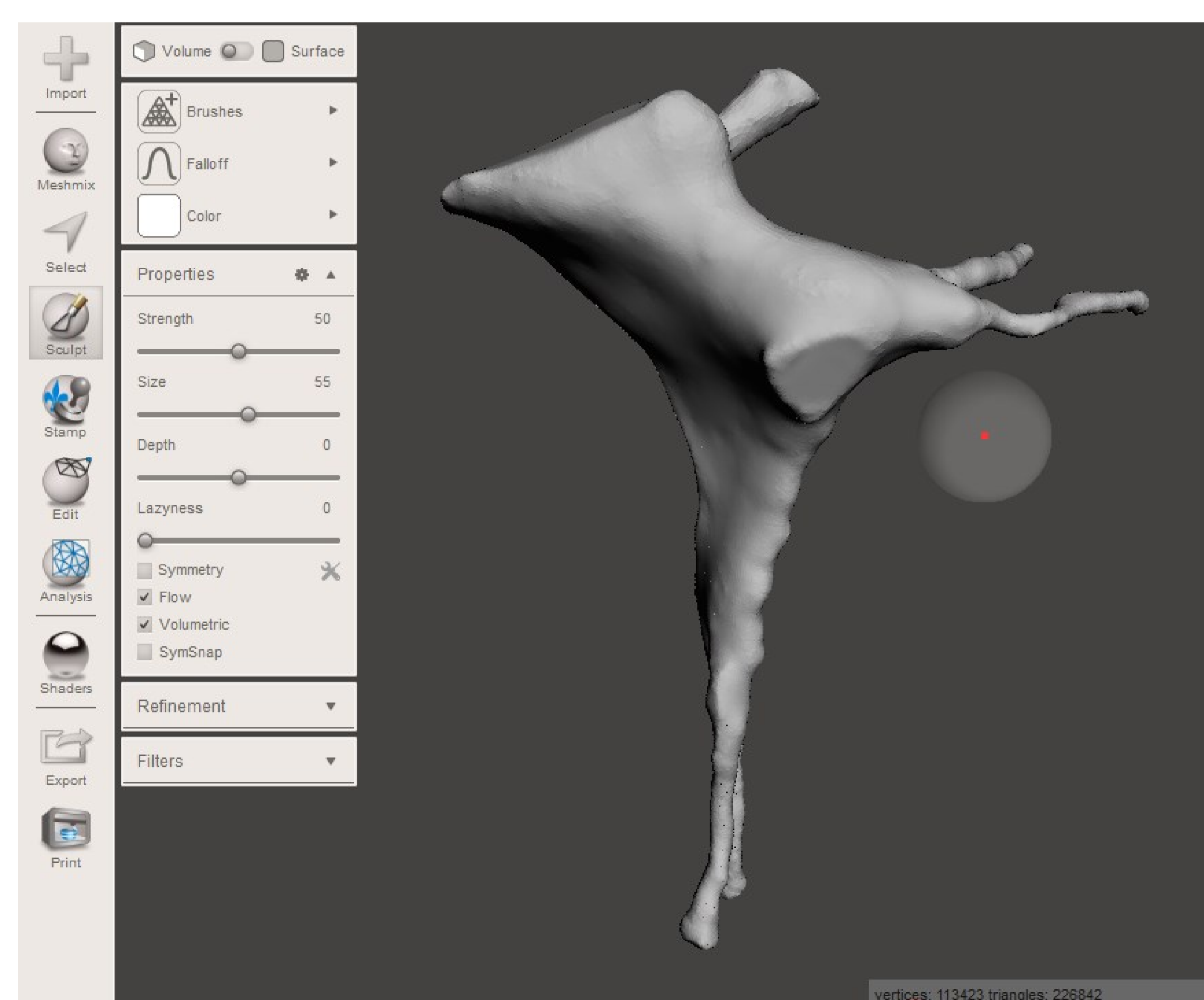


Figure 2 Screenshot showing the process of render smoothing in *Meshmixer*.

## Results and Discussion

The completed model (Figure 3) enables the user to appreciate the true shape of the PPF. As this is a negative space representation, the foramina were painted grey to represent the passages into the PPF. The white area represents the bony walls of the fossa. The volume of PLA used for each model was calculated to cost £0.13.

We feel this model would be particularly useful for postgraduates in ENT, ophthalmology and neurosurgery, as it provides a novel approach to understanding this enigmatic anatomical structure.

## References

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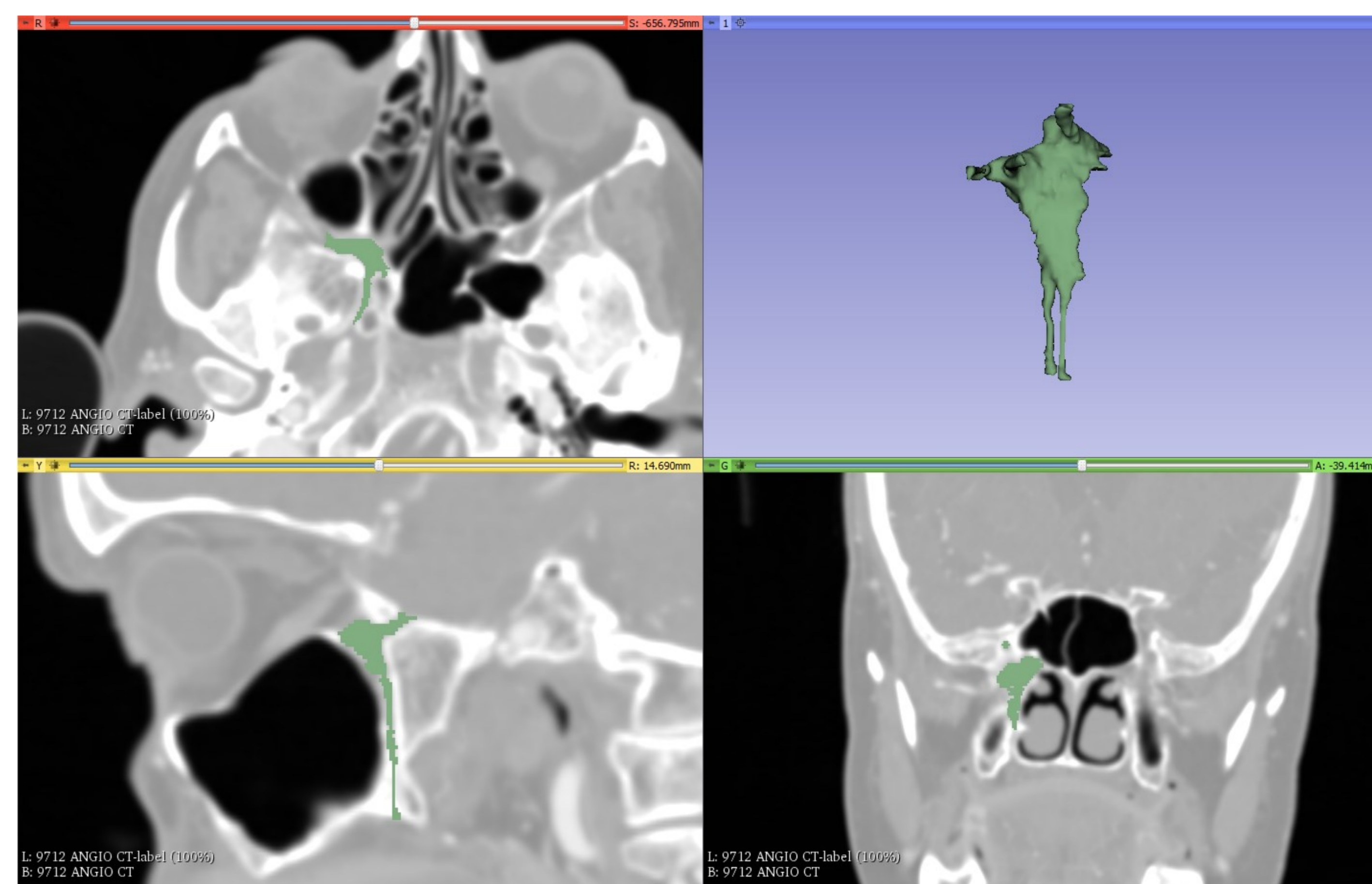


Figure 1 Screenshot showing manual segmentation in *3D Slicer*. The PPF was highlighted in each axial slice in order to produce a 3D volume render of the space (top right).

## Methods

*3D Slicer* is an open-source software platform used to handle DICOM (Digital Imaging and Communications in Medicine) images<sup>2</sup>. After loading a sample head CT series into *3D slicer*, the *Editor Module* was used to map out the non-bony space occupied by the PPF. One operator performed manual segmentation by using the draw tool to highlight all of the pixels of the space in each consecutive axial CT slice. A 3D volume render was then produced (Figure 1).

The 3D render was exported to *Meshmixer* – a free software platform for editing digital 3D objects. This was used to smooth rough edges on the model and enhance definition of the foramina and fissures (Figure 2). The scale of the render was increased to 2:1.

The 3D render was subsequently converted into a G-code file using *Slic3r Prusa Edition*, another free software platform. This provides instructions to the printer conveying the nozzle speed and directions needed to construct the model. A bespoke stand was designed in *Blender* – a 3D modelling suite. The model was 3D printed using a *Prusa i3 MK2* printer. The material used was polylactic acid (PLA) – a biodegradable thermoplastic polyester<sup>3</sup>.

After printing, the model was sanded prior to finishing with acrylic paint. A colour coded key was produced to supplement learning.



Figure 3 The completed model mounted on the bespoke stand.



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