3D-Printed Paediatric Temporal Bones as an Alternative Tool for Otological Training

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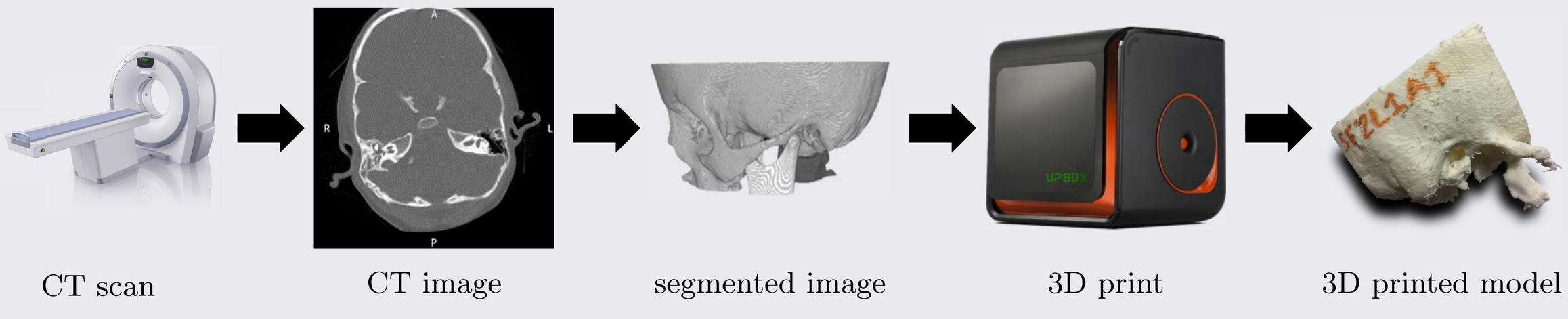

CT scan | CT image | segmented image | 3D print | 3D printed model

Figure 1: There are several steps required to get from the initial CT scan to the final replica as illustrated here.

1 Objectives

Temporal bone dissection is an essential part of otological surgical training. Ideal preoperative preparation should allow the surgeon to undertake the actual operative procedure in a simulated manner. Ethical reasons prevent the use of cadaveric paediatric temporal bones and diseased temporal bones harbour different anatomy to most models or healthy specimens. The use of 3D printed models based on high resolution computed tomography (HRCT) scans has already being trialled for adults, but may be of greater benefit for paediatric cases.

2 Methods

Non-identifiable HRCT scans of paediatric temporal bones were segmented and converted into surface representations using open source software and self-made algorithms (Fig. 1). Several 3D prints of paediatric temporal bones were created, mounted in modelling clay and drilled by ENT surgeons using an electric drill as shown in Fig. 2.

3 Results

3D printing of paediatric temporal bones has proved both economical and anatomically faithful. Use of HRCT scans allow specific cases to be selected for printing. The 3D printed models enabled cortical mastoidectomy to be undertaken but lacked sufficient resolution of the inner ear and facial nerve. With a price of £16, the cost of the bones is much lower than that of traditional plastic cast models (see Fig. 3).

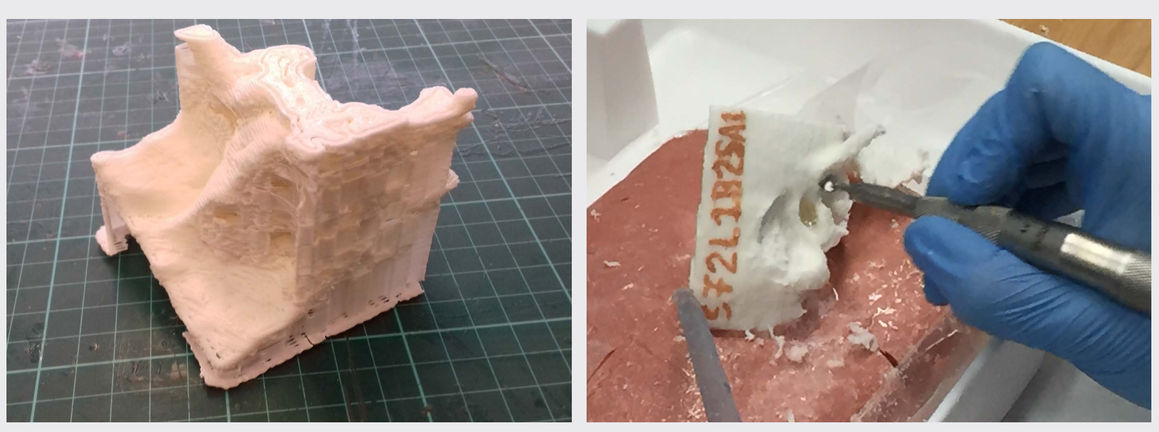

Figure 2: Left: Printed bone with support material coming off the printer. Right: Drilling of the bones for evaluation.

3D print
£16–40
high resemblance

plastic casted
£60
generic

cadaveric
£600
accurate anatomy

Figure 3: Comparison of different available training methods. Models created by additive manufacturing can provide high anatomic accuracy at competitive pricing.

4 Conclusion

Further anatomical delineation of 3D printed temporal bones from HRCT images will provide the opportunity for improved paediatric temporal bone surgical training. It will also provide preoperative simulation opportunities in cases with challenging anatomy. Selection of appropriate materials potentially offers improved haptics.

5 Future Work

Further research in alternative segmentation and additive manufacturing methods will lead to improved temporal bone models. The use of augmented reality (AR) to analyse 3D models and potential re-use of the 3D models in AR teaching is of future interest to us.

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