3D printing for craniosynostosis

Craniosynostosis treatment, including cranial vault remodeling, fronto-orbital advancement (FOA), and endoscopic suturectomy, requires practical experience with complex anatomy and tools. The infrequent exposure to complex neurosurgical procedures such as these during residency limits extraoperative training. Lack of cadaveric teaching tools given the pediatric nature of synostosis compounds this challenge. The authors sought to create lifelike 3D printed models based on actual cases of craniosynostosis in infants and incorporate them into a practical course for endoscopic and open correction. The authors hypothesized that this training tool would increase extraoperative facility and familiarity with cranial vault reconstruction to better prepare surgeons for in vivo procedures.

The authors utilized representative craniosynostosis patient scans to create 3D printed models of the calvaria, soft tissues, and cranial contents. Two annual courses implementing these models were held, and surveys were completed by participants (n = 18, 5 attending physicians, 4 fellows, 9 residents) on the day of the course. These participants were surveyed during the course and 1 year later to assess the impact of this training tool. A comparable cohort of trainees who did not participate in the course (n = 11) was also surveyed at the time of the 1-year follow-up to assess their preparation and confidence with performing craniosynostosis surgeries.

RESULTS: An iterative process using multiple materials and the various printing parameters was used to create representative models. Participants performed all major surgical steps, and we quantified the fidelity and utility of the model through surveys. All attendees reported that the model was a valuable training tool for open reconstruction (n = 18/18 [100%]) and endoscopic suturectomy (n = 17/18 [94%]). In the first year, 83% of course participants (n = 14/17) agreed or strongly agreed that the skin and bone materials were realistic and appropriately detailed; the second year, 100% (n = 16/16) agreed or strongly agreed that the skin material was realistic and appropriately detailed, and 88% (n = 14/16) agreed or strongly agreed that the bone material was realistic and appropriately detailed. All participants responded that they would use the models for their own personal training and the training of residents and fellows in their programs.

The authors have developed realistic 3D printed models of craniosynostosis including soft tissues that allow for surgical practice simulation. The use of these models in surgical simulation provides a level of preparedness that exceeds what currently exists through traditional resident training experience. Employing practical modules using such models as part of a standardized resident curriculum is a logical evolution in neurosurgical education and training [1)].

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Cheng D, Yuan M, Perera I, O'Connor A, Evins AI, Imahiyerobo T, Souweidane M, Hoffman C. Developing a 3D composite training model for cranial remodeling. J Neurosurg Pediatr. 2019 Sep 20:1-10. doi: 10.3171/2019.6.PEDS18773. [Epub ahead of print] PubMed PMID: 31629320.