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Three-Dimensional Printing the Intra- and Extra-cranial Segments of the Cranial Nerves Utilizing High-Resolution MRI and CT Co-Registration.

Cristian Gragnaniello MD, PhD, MSurg, MAdvSurg; Anam Salman MD; Ramin Javan MD

Introduction

Cranial nerves in their extra-cranial portions are difficult to study, given the intricate anatomy and technical difficulties in their visualization except when abnormal. In this study, we employed multiple imaging techniques to help outline the course of the cranial nerves in their intra- and extra-cranial segments. Coupled with 3D printing, this may allow for better understanding of their course as well as to help with preoperative planning of approaches to lesions involving these structures.

Methods

Skull base CT images of 0.6 mm thickness in bone kernel along with multiple high-resolution MRI sequences of the same skull base were imported as DICOM in Materialise Mimics and subsequently co-regsitered. The MRI sequences include axial SSFP images of the skull base acquired in 0.8 mm thickness. MR Neurography images of the entire head were acquired with 0.9 mm thickness and -0.45 gap, generating thin slices that are 3D isotropic. Additionally, axial T1 post-contrast 3D FSPGR images were also obtained. In Materialise Mimics, the 'Nerve Tracing' tool was utilized with 2 mm radius to create the intra- and extra-cranial segments by tracing the course either through actual visualization or using neural

Learning Objectives

The reader should be able to understand the course of cranial nerves involved in pathological processes and modify their surgical strategy accordingly.

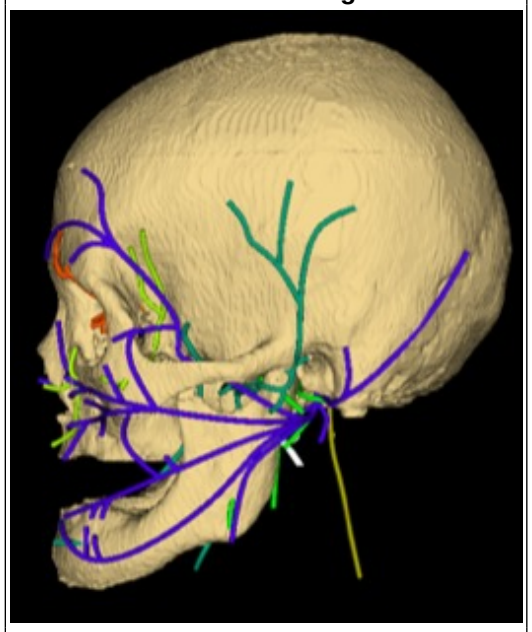
Conclusions

The complex neuroanatomy of the cranial nerves may better be understood and depicted using advanced 3D printed models. This technique may also be of great use for the preoperative planning where delineation can impact the choice of surgical approach as well as improve outcomes.

Results

An accurate 3D printed model of the cranial nerves that includes the cisternal segments and parts of their extra cranial segments, whether visible on imaging or deduced through known landmarks, was successfully created with polyamide material.

STL rendering



STL rendering of extra-cranial portion of the nerves.

3D print

3D printed polyamide model.

References

Javan R, Davidson D, Javan A. "Nerves of Steel: a Low-Cost Method for 3D Printing the Cranial Nerves." J Digit Imaging. 2017 Feb 21. doi: 10.1007/s10278-017-9951-z.