Image-directed stereotaxy applicated to cochlear nucleus localization in the adult macaque monkey brainstem

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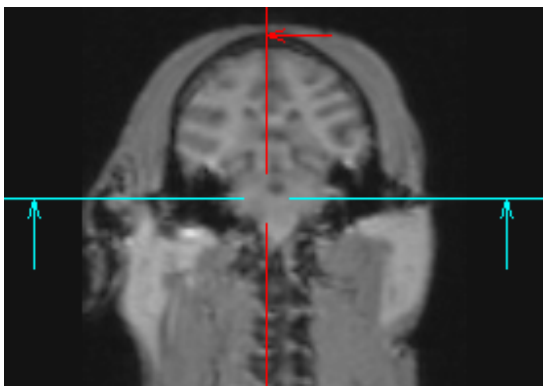
Introduction

Because we plan to record near field evoked potentials from the cochlear nucleus of the macaque monkey to establish the properties of adaptation in response to acoustic and electric stimulation of the cochlea, we need to determine stereotaxic coordinates of this structure to position a chronic electrode. However, considering the small size of this nucleus and the fact that the classical stereotaxic approach is limited by the great inter-individual variability in craniofacial morphology of Macaca fascicularis, we decided to use noninvasive imaging techniques and to translate image coordinates to stereotaxic coordinates. Then, MR-image fusion with CT will be used in order to handle distortion secondary to magnetic field warping and susceptibility artefacts in MRI

AIM:

Performing MRI directed to the brainstem of Macaca fascicularis and delineation of the cochlear nuclear complex (CNC) with an estimated mean volume of about 8mm^3

Monkey *Macaca fascicularis* in 3T-MRI



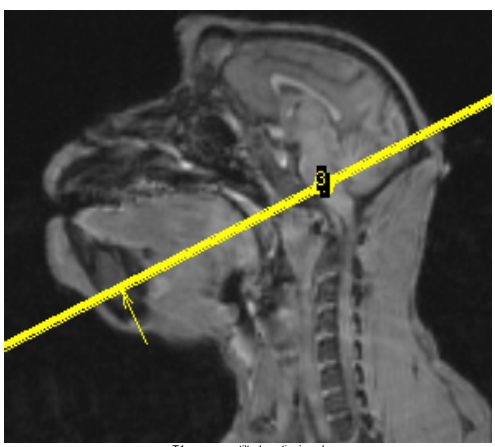
T1_mpr_cor

Methods

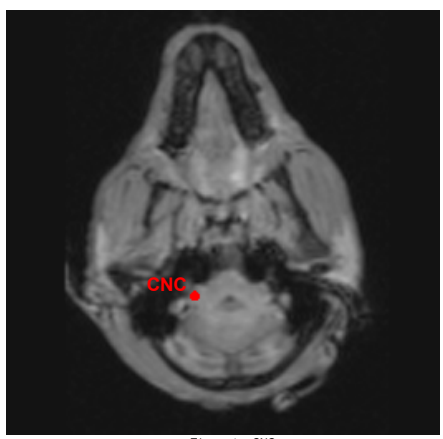
- **Model:** Adult Macaca fascicularis monkey (n=1, M=6kg)
  Anaesthesia: ketamine 5mg/kg, medetomidine 0.1mg/kg, atropine 0.05mg/kg.

- **MRI:** 3 T-system (Siemens, Sonata Vision syngo MR 2004A, Erlangen, Germany)
  - MPR T1-weighted sequences with standard head coil, 192 slices, slice thickness 1mm, 512 matrix, TR 2000ms, TE 3.42ms, TI 710ms, flip angle 15°
  - TIRM T1-weighted sequences with eight-channel head coil, slice thickness 2mm, reconstruction 0.5mm, 512 matrix, TR 10000ms, TE 85ms, TI 150ms, flip angle 145°

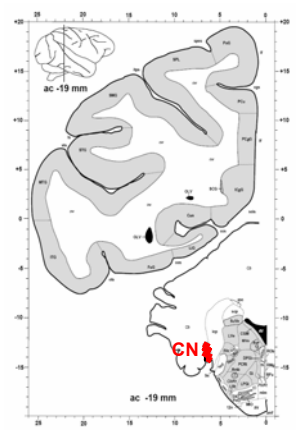
  and in addition:
  - TSE hyper T2-weighted sequences, slice thickness 2mm, 512 matrix
  - TSE hyper T2-weighted sequences, slice thickness 2mm, 1024 matrix
  - TSE hyper T2-weighted sequences, slice thickness 4mm, 1024 matrix
  - TSE 3D ns T2-weighted sequences, variable flip angles
  - TIRM dark-fluid T2-weighted sequences, 512 matrix
  - CISS-sequences 3D, resolution 0.4x0.2x0.4mm



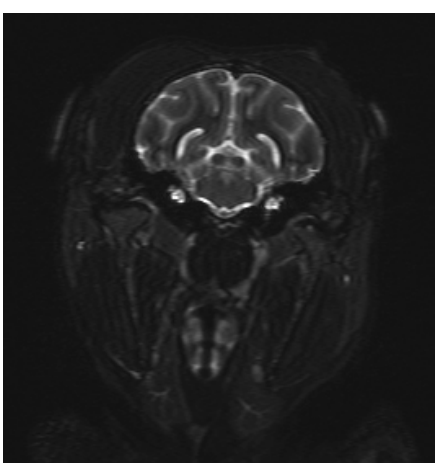
T1_mpr_sag, tilted sectioning plane



T1_mpr_tra, CNC r



Coronal section of the brain of the Macaca fascicularis from the Template Atlas by Martin RF and Bowden DM, 2000



T1_tirm_cor

Analysis and results

- Reported noncontrast human anatomic landmarks for CNC-localization:
  vestibulocochlear nerve root entry zone, cerebellar flocculus, bulge of the CNC into the lateral recess of the fourth ventricle, foramen of Luschka
- Empirical variation of MRI pulse sequences and time constants and delineation of the macaque CNC
  → MPR T1-weighted sequences providing best contrast in the representation of the cochlear nucleus area
  For inclusion of the entire CNC on MPR axial sections use of 3D reconstruction and sectioning in a plane tilted about 30-40° ventrally to the commonly used canthomeatal plane
  → TIRM T1-sequences showing cochlear nucleus area and entering fibers of the cochlear portion of the vestibulocochlear nerve
  → CISS-sequences for definition of anatomical landmarks such as the VIIIth and IXth cranial nerves entering brainstem

Conclusion

By choosing clinically uncommon MRI parameters we succeeded in delineating the CNC in the macaque brainstem for stereotaxically performed positioning of chronic recording electrodes in the near future.