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Visual Evaluation of Curvilinear Reformatting for Peeling Off the Skullcap in MRI-T1 volumes

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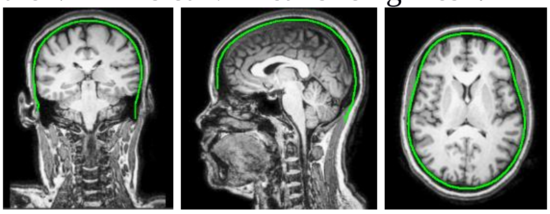
Introduction: Due to the complexity of the brain's structure, the curvilinear multiplanar reformatting (CMPR) tool is more suitable than the conventional multiplanar reformatting (MPR) for exposing subtle cortical lesions. Since it re-slices the brain almost parallel to the dura-mater membrane, we hypothesize that the technique is also suitable for unveiling spatial relationships between the vascular and the cortical cerebral structures if the blood vessels are visible. In this work we present a series of tests we conducted with use of an in-house developed software VMTK [2] for evaluating this novel application of curvilinear reformatting.

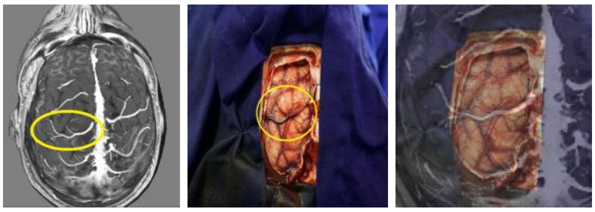
Materials and Methods: We used two groups of T1-weighted magnetic resonance imaging (T1wMRI) scans. The first group consists of 511 T1wMRI volumes of female and male subjects, without contrast, ranging from 11 to 80 years of age for assessing the slicing quality. And the second group of 6 T1-weighted fat-suppressed gadolinium-contrast enhanced magnetic resonance imaging (GAD-T1wMRI) volumes of operated patients for comparing the preoperative view of vascular and cortical spatial relations provided by the CMPR and the neurosurgeon's intraoperative view. All T1wMR sequences (voxel size = 1 x 1 x 1 mm^3, no gap, TR = 7 ms, TE = 3.2 ms, flip angle = 8, matrix = 240 x 240; FOV = 240 x 240; resolution = 180 x 240 x 240) were acquired in a 3T MRI scanner (Philips Medical Systems, Best, The Netherlands) in the Clinics Hospital. For evaluating the slicing quality, we visually checked the geometry of the slicing mesh with respect to the brain. For assessing its usefulness in surgery, we manually overlap the photos taken during surgery and the preoperative cropped volumes generated with VMTK.

Results: For each T1wMR volume its intersection with the slicing mesh was drawn per coronal, sagittal and axial slice, as illustrated in Figure 1. Note that the slicing mesh keeps a certain distance from the cortical surface. The intraoperative photo and the image generated with VMTK shown in Figure 2 demonstrate that the anatomical structures around the cortex have not been removed with the VMTK's curvilinear slicing mesh.



(a) (b) (c)

Figure 1: The intersection of the slicing mesh in green with: (a) coronal, (b) sagittal and (c) axial slices.



(a) (b) (c)

Figure 2: (a) Preoperative volume generated with VMTK, (b) intraoperative photo and (c) their overlay.

Discussion: Despite the shallow depression of temporal fossa, filled with temporalis muscle and fatty tissues, the CMPR implemented in VMTK provided a good visualization of cortical vascular anatomy. It showed to be invariant to gender and ages.

Conclusion: The results showed that the CMPR implemented in VMTK can be applied both in the diagnosis of subtle cortical lesions and in the surgical planning.

References: [1] doi: 10.1007/978-3-319-67552-7_1. [2] VMTK: Visual Manipulation Toolkit for NeuroImages.http://www.dca.fee.unicamp.br/projects/mtk/wu_loos_voltoline_rubianes/index.html.