Development of a standardized method for radiation therapy contouring of the piriform cortex

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INTRODUCTION

For medically intractable temporal lobe epilepsy (TLE), Level I evidence has established the superiority of anterior temporal lobectomy (ATL) over either continued medical management alone or stereotactic radiosurgery (SRS) in achieving durable seizure freedom (1-2). Recent work has indicated that the piriform cortex, a structure not included in traditional operative nor radiosurgical volumes, plays a key role in TLE and that inclusion of this structure in operative resection can increase the likelihood of seizure freedom (3). For TLE patients who are not operative candidates, this structure provides a potential SRS target. Presently, there exists no methodology for radiation treatment planning delineation of the piriform cortex.

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METHODS

Using noncontrast head computed tomography (CT) and brain magnetic resonance imaging (MRI), a standardized methodology for delineating the piriform cortex was created. To simulate patients undergoing linear accelerator (LINAC) SRS, contours were created from images of previously treated patients having undergone LINAC SRS whose lesions did not anatomically distort the primary olfactory cortex (4-5). Contours for LINAC SRS were designed from fusion of noncontrast CT and T1-weighted noncontrast MRI with 0.1 centimeter (cm) axial slice thickness. To simulate patients undergoing Gamma Knife stereotactic radiosurgery (GKRS), contours were created from the Leksell stereotactic frame-based 0.1 cm axial slice thickness T1 and T2 3D fast spoiled gradient echo (FSPGR) images of patients having undergone previous GKRS for pathology not distorting the primary olfactory cortex.

CONTOURING

The piriform cortex was contoured eight separate times from four patients (two LINAC SRS, two GKRS). Contouring for LINAC SRS originated within one cm anterior to the anterior commissure, rostromedial to the amygdala, inferior to the putamen, inferolateral to the globus pallidus, and inferomedial to the claustrum, terminating posteriorly at the level of the anterior commissure (Figure 1). The frontal lobe and temporal lobe portions of the piriform cortex (lateral to the olfactory tubercle and periamygdaloid complex, respectively) encompassing the lateral aspect of the middle cerebral artery were reliably contoured, best visualized on coronal imaging (Figure 1). These same anatomic landmarks were successfully used for GKRS contouring. The slightly greater targeting accuracy of GKRS, obviating the need for placing the 0.2 cm margin typically administered to account for LINAC SRS geometric errors (6), may potentially be of clinical significance in treating TLE.

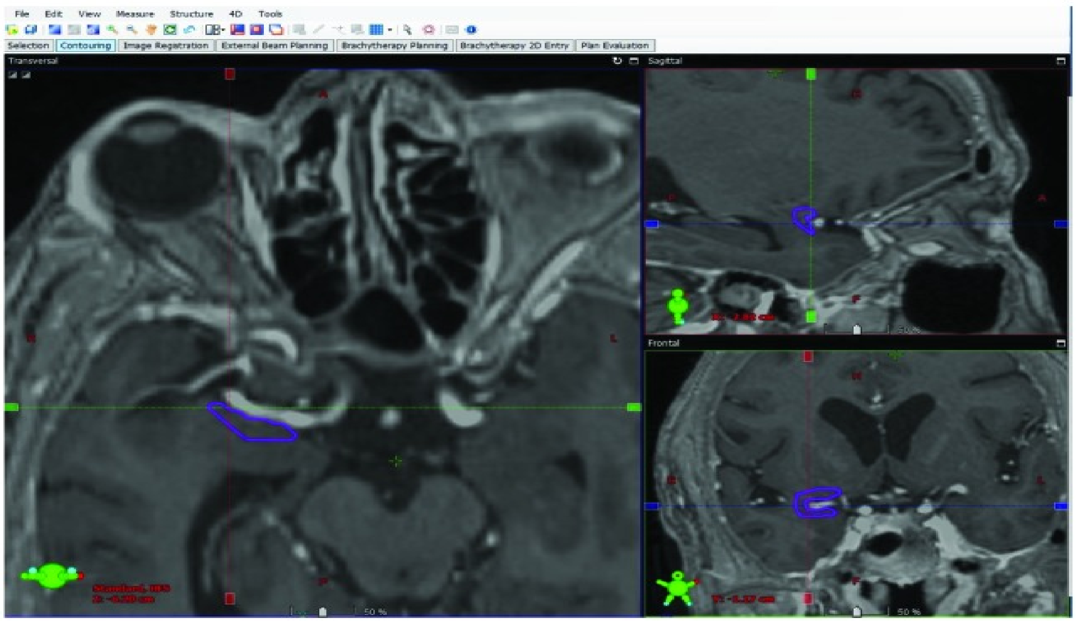

Figure 1

Contour from fused noncontrast head CT/T1-weighted brain MRI for simulated linear accelerator stereotactic radiosurgery demonstrating the right piriform cortex on axial, sagittal and coronal images.

Further investigation is warranted to determine the safety and efficacy of piriform cortex SRS for TLE, particularly since SRS underdosing of the traditional TLE target (parahippocampal gyrus, amydgala, and anterior 2 cm of the hippocampus) has resulted in fatal consequences from failure to achieve seizure control (7). Given the established 52% three-year Engel Class I outcome (seizure-freedom without medication) rate of SRS for TLE from Level I evidence, it is plausible that adding the piriform cortex to the traditional TLE SRS volume increases the rate of Engel Class I outcomes towards the

78% three-year rate associated with ATL, or can be used in patients previously having undergone ATL who have not achieved Engel Class I outcomes and are no longer surgical candidates (2).

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