Automatic Contouring of Vital Swallowing Structures using an Atlas-based Segmentation Method: A Time Saving and Toxicity Assessment

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OBJECTIVES

High doses of radiation to the pharyngeal constrictor and larynx has been associated with long term dysphagia.

In addition, patient with radiation induced dysphagia have been found to have increased thickness of the pharyngeal constrictor muscles.

Properly contouring of these structures on CT is difficult and time consuming.

The purpose of this study is to evaluate the utility of atlas based segmentation (ABS) in time saving in the pretreatment patient and in the assessment of toxicity in the post-treatment patient.

MATERIAL AND METHODS

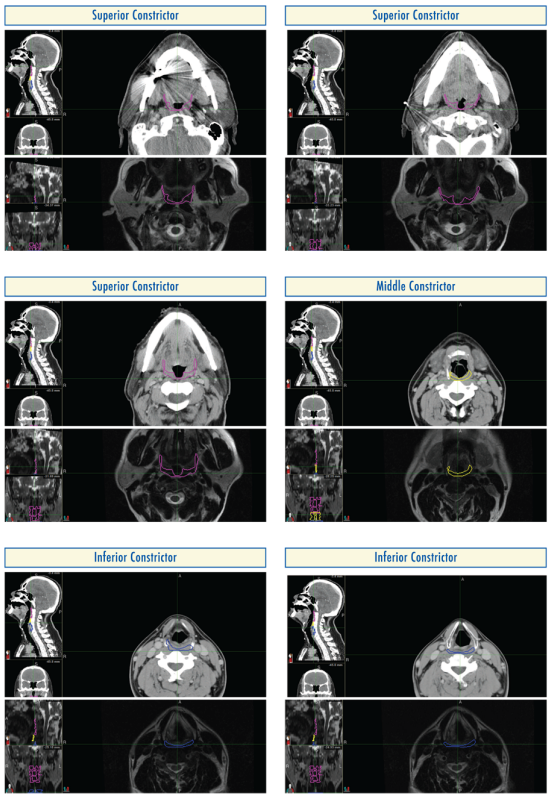
Commercially available software was used for atlas creation and automatic ABS (MIMvista Corp, Cleveland, OH.)

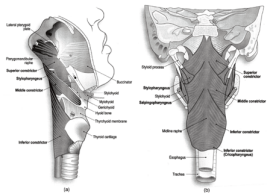
The custom atlas contained a library of 10 patients (8 NPX and 2 Paragangliomas) from fused CT/MRI T2 weighted scans. (see below)

The structures included were: the superior constrictor (SC), middle constrictor (MC), inferior constrictor (IC), larynx and the proximal 1cm of the esophagus were contoured as per Eisbruch et al[1]. *(see diagram[1])*

1. Eisbruch et al. Dysphagia and aspiration after chemoradiotherapy for head-neck cancer: Which anatomic structures are affected and can they be spared by IMRT? IJROBP V60, I 5, 1 December 2004, Pages 1425-1439

CT/MRI FUSION





BRUSH SIZE

In order to expedite and simplify contouring of the pharyngeal constrictor muscles on future CT scans, an analysis of different brush stroke size (3mm, 5mm and 7mm) and the resultant volumes (VBS) where compared with the MRI/CT fusion volume (VMRI).

The 5mm brush stroke was selected. *(See figure below Pink = MRI/CT volume, White = 3mm, Yellow = 5mm, Purple = 7mm) (see Table1)*

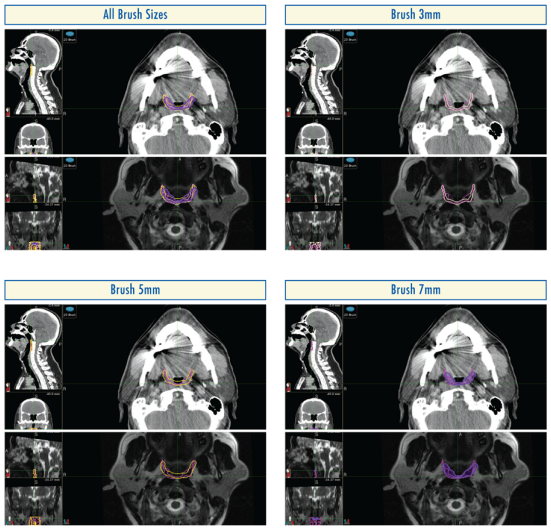


Table 1

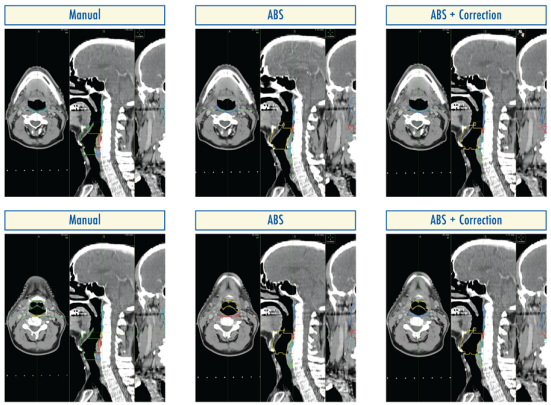
Brush	Overcoverage (V_{BS}-V_{MRI})/(V_{BS})	Undercoverage (V_{MRI}-V_{BS})/(V_{MRI})	Average
3 mm	20%	34%	27%
5 mm	34%	16%	**25%**
7 mm	40%	10%	27%

AUTOMATIC ATLAS BASED SEGMENTATION

11 new patients were then randomly selected for comparison of ABS vs. Manual contouring. For each patient, the best fit atlas subject was automatically selected and contours were deformed on to the CT scan. Each contour was then edited by the author (EL). The same patient was manually contoured by the same author (EL). The time for correction of the automatic contour and the manual contour for each patient was recorded.

RESULTS

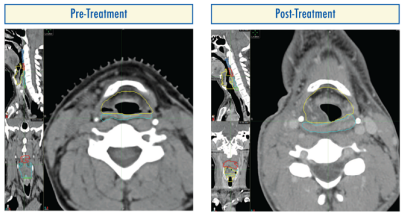
11 pretreatment scans were studied (6 OPX and 5 NPX). ABS resulted in a time reduction in 10 out of 11 patients. *(see below)*



Site	ABS (seconds)	Manual (seconds)
Oropharynx	538.17	599.17
Nasopharynx	347.80	437.20
Average	450.31	524.41

TOXICITY ASSESSMENT

2 patients with known grade 3 pharyngeal toxicity pre and post radiation treatment scans were analyzed. ABS contours were created and corrected, and the total volumes of the structures were measured. *(see below)*



Site	Vol. Change
SC	22%
MC	-4%
IC	11%
Larynx	-1%
Esophagus	25%

CONCLUSION

In the pretreatment patient, ABS afforded a time saving in 10 out of 11 patients.
In the post treatment patient, ABS may be a tool in assessing treatment changes.