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Magnetic Resonance Images of Human Laryngeal Cartilage: MRI scans from Selbie et al.

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Abstract

Magnetic resonance images (MRIs) of five human laryngeal cartilages were obtained from a previous study (Selbie et al., 1998; Selbie et al., 2002). The images are presented here along with descriptions of how to view the images.

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Keywords: laryngeal cartilage, CAD model, MRI

1. Introduction

Understanding the morphology of the laryngeal framework is a crucial step in mapping laryngeal function. It is also a necessary step toward quantitative biomechanical modeling of voice disorders (Farley & Thomson, 2011; Hunter, Titze, & Alipour, 2004; Titze & Hunter, 2007), which requires accurate dimensions of all structures of the larynx. Particularly important are dimensions of those structures which describe function in mechanical terms (e.g., laryngeal muscle orientation, cartilage length/width, and joint size/range) (Hunter & Titze, 2005; Kim, Hunter, & Titze, 2004; Tayama, Chan, Kaga, & Titze, 2001).

Because of the difficulty in obtaining and performing experiments on the human larynx, Magnetic Resonance Imaging (MRI) has become a useful tool in obtaining anatomical information in both live subjects and donated samples. In the final form, such images can be used to create geometric shapes.

The purpose of this report is to provide the raw images from five human MRI scans of laryngeal cartilages. The goal is to present these images with sufficient detail for future researchers to use the results.

2. Source of the Data

The MRI images of five human larynges were obtained directly from W. Scott Selbie, who is the first author of two papers presenting aspects of laryngeal mechanics and dimensions (Selbie et al., 1998; Selbie et al., 2002). The first paper, studying the mechanics of the cricoarytenoid joint, presented the results of the analysis of two larynges. The second paper also used these two, along with three additional scans. In describing the specimens and data collection, Selbie et al. (2002) states:

> Larynges from four male (65–75 years old), M1–M4, and one female (67 years old), F1, were excised when cadavers, previously rapidly frozen immediately after death, were unfrozen and made available by the Uniformed Services University of the Health Sciences, Department of Anatomy. Two of these larynges, M1 and M2, were used in a previous study of the cricoarytenoid joint (Selbie et al., 1998). Larynges were used only if autopsy records and gross examination revealed no glottal or anatomical abnormalities. The specimens were fixed in 5% formalin, secured rigidly, and oriented axially inside acrylic cylinders. Each cylinder was inserted into a 2.5-in.-i.d. search coil and scanned with a 2.0 Tesla Omega scanner (GE-NMR Instruments, Freemont, California) using a TR of 200 ms and a TE of 6.7 ms. This scanner was selected because it was the best available to us to meet our resolution needs at that time for identifying and segmenting the major cartilages of the human larynx. A 3D Fourier transform acquisition was used to provide isotropic resolution. One larynx, M1, was scanned at a voxel resolution of 256x256 pixels for 128 slices over a field of view of 90x90x45 mm (yielding cubic voxels with 0.35-mm sides), while the other four larynges were scanned at 128x128 pixels for 256 slices over a field of view of 55x55x110 mm (yielding cubic voxels with 0.43-mm sides).
>
> The MRI scans were stored as isotropic three-dimensional matrices of voxel intensities and analyzed using VOXELVIEW–ULTRA (Vital Images, Inc., Fairfield, Iowa) on a Silicon Graphics R4000 Indigo computer. Cartilage, muscle, and airways were distinguished by their contrasting voxel intensities.

3. Data files and unpacking

3.1 Files

Five compressed folders accompany this manuscript, one for each of the 5 layrngeal MRI samples (Table 1). At the present, it is unknown which files represent which larynges (if each can be identified, edits can be made to the wiki). Each folder has a set of individual MRI slice images, along with a text file containing dimension information (`_dimensions`). As the images and folders were handed from the original researcher, it is not known which folder goes with which sample. Nevertheless, folder 18718_8bit has a text file which is of a different format where the file indicates that there are 128 slices; thus M1 maybe 18718_8bit, but likely the two 18000 numbered scans are either M1 or M2. As further information regarding the scans comes available, this report will be updated.

Table 1. Folder name and specimen scan information. The *zsize* and related are from the `_dimensions` text file.

Folder Name	# files	zsize	xsize	ysize	bits/voxel	Specimen
18718_8bit	128					M1/M2
18698_8bit	84	128	256	256	8	M1/M2
19635_8bit	128	128	256	128	8	M3/M4/F1
19636_8bit	128	128	256	128	8	M3/M4/F1
19653_8bit	128	128	256	128	8	M3/M4/F1

3.2 Reading Files

The files containing a series of 128 scans can be read in or as folder and displayed in order using the following list of MATLAB of commands:

```
for n=1:128
   fid = fopen(num2str(n));
   image1=fread(fid, [256 256],'uint8');
   %imshow(image1,[]) % requires image processing toolbox
   image(image1)
   colormap('gray')
   pause(0.2)
end
```

Using commercial MRI (e.g., "Velocity", http://www.v2software.com/) and three-dimensional software packages (“Pro/Engineer”, http://www.ptc.com/), the images can be imported. Then grayscale ‘thresholding’ techniques can be used to identify and extract three-dimensional representations of cartilages. The results can then be saved in a variety of CAD geometries, like IGES.

References

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Use Agreement

The scripts, images and text are open to use by the public as a service and part of the National Resource of Laryngeal Data (supported by the National Institute of Deafness and other Communicative Disorders). However, we ask the reader to respect the time and effort put into this manuscript and research.

If the text, images, or included scripts are used, the user agrees to reference this document, the NRLD, and the source of the original data. We also suggest that the user contact the original contributors of the data and give them the right of refusal to (1) participate on papers using the data and (2) have their supporting project acknowledged. The user agrees to freely share with the NLDR any extension software build on the data contained.

Revisions

1.0 Eric Hunter: Main document: original raw data files and ability to read them (March 2011)
- 1.1 Eric Hunter: slight modifications (April 2011)
- 1.2 Bob Jensen: slight modifications (Sept 2011)

2.0 Laura Hunter: imported into new template, technical writing review (April 2015)