Magnetic Resonance Images of Human Laryngeal Cartilage; MRI from Selbie, et al.

Eric J. Hunter [1,2,3,4], and Scott L. Thomson [1,5]

[1] National Center for Voice and Speech, The University of Utah
Salt Lake City, UT

[2] Department of Bioengineering, The University of Utah
Salt Lake City, UT

[3] Division of Otolaryngology – Head and Neck Surgery, University of Utah School of Medicine
Salt Lake City, UT

[4] Department of Communication Sciences and Disorders, College of Health, The University of Utah
Salt Lake City, UT

[5] Department of Mechanical Engineering, Brigham Young University,
Provo, UT

Abstract

Magnetic Resonance Images 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 on how to view the images. Download updates to this memo can be downloaded at http://www.vocalfolds.org.

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, which requires accurate dimensions of all structures of the larynx. Particularly important is dimensions of those structures which describe function in mechanical terms (e.g., laryngeal muscle orientation, cartilage length/width, and joint size/range).

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 was to present these images with enough detail that other researchers could use the results in a more accessible format than normal scientific journal articles.

2. Source of the Data

The MRI images of five human larynge were obtained directly from W. Scott Selbie, 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 laryngea. The second paper combined those two with three more scans. From Selbie, et al (2002):

"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, representing the 5 layrngeal MRI samples (Table 1). It is unknown which files are for which of the laryngea (if they can be deciphered, edits can be made to the wiki identifying them). Each folder has a set of individual MRI slice images, with a text file with dimension information (_dimensions). While it is not known which folder goes with which sample, 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

Table 1. Folder name an 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

Reading the files can be done using a simple set of scripts in MATLAB. The following list of commands will read the series of 128 scans from a folder and display them in order:

```matlab
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 and, using grayscale 'thresholding' techniques, used to identify and extract three-dimensional representations cartilages. The results can be then saved in a variety of CAD geometryies, like IGES.

4. Analysis and Modification

[this section left for future modification and analysis of the images, if any]

Literature

W. S. Selbie, L. Zhang, W. S. Levine, and C. L. Ludlow. Using joint geometry to determine the motion of the cricoarytenoid joint. J.Acoust.Soc.Am. 103 (2):1115-1127, 1998.

W. S. Selbie, S. L. Gewalt, and C. L. Ludlow. Developing an anatomical model of the human laryngeal cartilages from magnetic resonance imaging. J.Acoust.Soc.Am. 112 (3 Pt 1):1077-1090, 2002.

Acknowledgements

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, and hosted by the National Center for Voice and Speech). The scripts, images, model and text enclosed in this

memo and accompanying this memo are open to use by the public as a service of the NRLD. 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 to this document, the NRLD, and the source of the original data. We also ask the users to consider contacting 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 (March 2011)-- original raw data files and ability to read them.