Applications of Spectral CT for Head and Neck Cancer

By Reza Forghani, MD, PhD, Associate Chief, Department of Radiology, Jewish General Hospital, and Assistant Professor of Radiology, McGill University, Montreal, Canada

Introduction

There are emerging applications of spectral CT in all subspecialties of radiology, including in neuroradiology and head and neck radiology. In head and neck imaging, there are multiple reports suggesting that spectral CT reconstructions may help increase accuracy and diagnostic confidence for determination of tumor extent and invasion of critical organs.[1-5] This is why at the Jewish General Hospital, a tertiary care hospital affiliated with McGill University in Montreal, Canada, spectral CT scans are routinely performed for the evaluation of head and neck cancer patients.

When evaluating hypopharyngeal and laryngeal cancers, accurate detection of the presence or absence of thyroid cartilage invasion can be essential for proper tumor staging and determination of patient management. In this case study we found that the spectral CT reconstructions can help increase diagnostic confidence when evaluating thyroid cartilage invasion.[1,3]

Patient history

A 63-year-old man referred from the head and neck surgery section for a hypopharyngeal and supraglottic mass. Imaging plays an essential role for head and neck cancer patients, enabling evaluation of deep tumor extent and nodal stations that are not accessible by clinical examination and endoscopy alone. At our institution, like many others, CT is the first line imaging technique used for work up of mucosal cancers of the head and neck below the level of the hard palate. However, these scans are performed in spectral CT mode rather than as a conventional single energy CT.

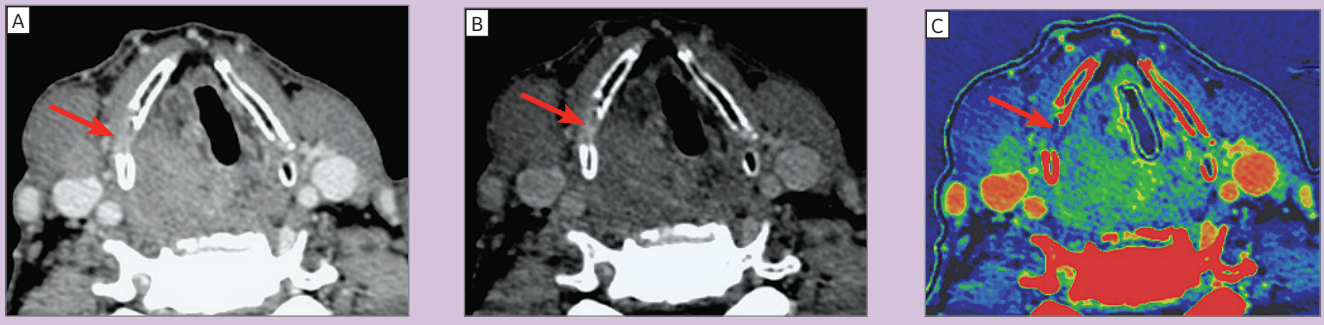

Figure 1. (A) 65 keV virtual monochromatic image similar to a conventional 120 kVp image; (B) 95 keV image; (C) iodine (water) MD image. GSI images depict a hypopharyngeal tumor extending to the larynx. The arrow points to the non-ossified portion of the right thyroid cartilage.

> *"In this case, spectral CT reconstructions using Gemstone Spectral Imaging (GSI) helped to assist in the evaluation of thyroid cartilage by helping distinguish non-ossified thyroid cartilage from the tumor."*
>
> *Dr. Reza Forghani*

Acquisition

kV: 80-140, rapid switching mode
FOV: 50 cm
Rotation speed: 0.6 sec
Slice thickness: 1.25 mm
Pitch: 0.984:1, helical
IV protocol: 80 ml @2 ml/sec, 65 sec delay
GSI protocol: GSI preset 15

Findings

Consistent with the clinical observations, the scan demonstrated a large hypopharyngeal mass extending into the larynx. Part of the tumor approached the thyroid cartilage on the right side. In that location, there was variable ossification of the right thyroid cartilage and this can present a challenge for interpretation because it can have density similar to a tumor. On the conventional CT-equivalent 65 keV image (Figure 1A), note there is a gap in the ossified cartilage with density similar to the tumor (arrow). On the 95 keV virtual monochromatic image (Figure 1B), the attenuation of the tumor is suppressed but with relative preservation of the high attenuation in the thyroid cartilage (arrow), consistent with variable ossification of the cartilage rather than invasion by the tumor. On the iodine (water) image (Figure 1C), the iodine containing tumor approaches but does not extend into the defect (arrow), also consistent with variable ossification rather than tumor invasion.

Discussion

One of the challenges when evaluating thyroid cartilage is the potential for variable ossification (Figure 1A), in which non-ossified parts may be intermixed with ossified parts and the pattern is not predictable. This becomes increasingly difficult when a tumor approaches or abuts the thyroid cartilage, as the attenuation between the lesion and the non-ossified part of the cartilage can be similar in appearance.

In this case, spectral CT reconstructions using Gemstone™ Spectral Imaging (GSI) helped to assist in the evaluation of thyroid cartilage by helping distinguish non-ossified thyroid cartilage from the tumor (Figure 1). In a published study, it was shown that on virtual monochromatic images reconstructed at 95 keV or higher, the density of the non-ossified cartilage is different from that of tumor.[1] The reason for this is that the iodine content of an enhancing tumor is progressively suppressed at higher energies, whereas there is relative preservation of the high attenuation of non-ossified thyroid cartilage on higher energy virtual monochromatic images (Figure 1B). In addition to virtual monochromatic images, iodine overlay maps have also been shown to improve diagnostic accuracy for the evaluation of thyroid cartilage[3] (Figure 1C).

In head and neck imaging, this is one of the clinically useful applications of spectral CT using GSI.

At the Jewish General Hospital, key spectral CT reconstructions are routinely generated and sent to PACS so that they are ready for clinical use in a workflow friendly manner. If needed, additional manipulation of the spectral CT imaging data can be performed on the Advantage Workstation (AW). Depending on the version of the scanner console, the process may be automated. Workflow-friendly integration is a key factor for more widespread implementation of the technology and routine clinical use. ■

References

1. Forghani R, Levental M, Gupta R, et al. Different spectral hounsfield unit curve and high-energy virtual monochromatic image characteristics of squamous cell carcinoma compared with nonossified thyroid cartilage. AJNR Am J Neuroradiol 2015;36:1194-1200.
2. Lam S, Gupta R, Levental M, et al. Optimal Virtual Monochromatic Images for Evaluation of Normal Tissues and Head and Neck Cancer Using Dual-Energy CT. AJNR Am J Neuroradiol 2015;36:1518-1524.
3. Kuno H, Onaya H, Iwata R, et al. Evaluation of cartilage invasion by laryngeal and hypopharyngeal squamous cell carcinoma with dual-energy CT. Radiology 2012;265:488-496.
4. Forghani R. Advanced dual-energy CT for head and neck cancer imaging. Expert review of anticancer therapy 2015:1-13.
5. Lam S, Gupta R, Kelly H, et al. Multiparametric Evaluation of Head and Neck Squamous Cell Carcinoma Using a Single-Source Dual-Energy CT with Fast kVp Switching: State of the Art. Cancers (Basel) 2015;7:2201-2216.