Purpose:
Curative radiation for oral cavity, oropharyngeal, hypopharyngeal and nasopharyngeal cancers can injure the vocal cords which can adversely affect speech and quality of life. Vocal cords are difficult to image with conventional MRI, CT or ultrasound. Currently, no imaging technique is available in the clinic to visualize and evaluate such injury. The purpose of this study is to develop a dynamic ultrasound technology to quantify radiation-induced vocal cord injury.

Methods:
Eight healthy volunteers and five post-radiation patients were enrolled under IRB approval. Each participant was scanned using a clinical ultrasound scanner (Sonix Touch) with a 14-MHz linear array transducer. The ultrasound probe was placed in the transverse plane approximately parallel to the vocal fold's mucosal wave propagation. Each participant was asked to phonate the vowel sound “a” and sustain the phonation for 5 seconds while 315 dynamic (consecutive) ultrasound images of the vocal fold were recorded. Vocal cord vibration patterns were obtained through these consecutive images. Vibration frequency and 2-D dimensions were computed to measure vocal cord performance.

Results:
The vocal cords were clearly visualized using dynamic ultrasound in all participants. Vocal cord vibration patterns of the healthy volunteers revealed smooth sinusoidal wave propagation. In contrast, the patterns of post-radiation vocal cords presented irregular wave propagation. M-mode videos parallel and vertical to vocal cord vibration direction were generated. The vocal cord vibration pattern was most disrupted in the patient with clinically-identifiedvocal cord injury. Aliased frequency estimated from M-mode video could be used to distinguish damaged vocal cord injury from normal vocal cord.

Conclusions:
In the effort to develop a noninvasive imaging technique for evaluating vocal cord injury post radiotherapy, we identified dynamic ultrasound as a promising tool. Ultrasound is safe, simple, and cost-effective. This study demonstrated its feasibility in imaging the vocal cords and quantifying the vocal cord condition.

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