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## The Distribution and Severity of Tremor in Speech Structures of Persons with Vocal Tremor

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Vocal tremor is a disorder affecting one's ability to produce speech clearly. This tremor can arise from movements of structures in various parts of the body, including the muscles of the thorax, abdomen, neck, and head. In this study, we assessed tremor within these various regions and compared that to the severity of the speech difficulty each individual experienced. We found that people with tremor affecting multiple regions of the body were more likely to have severe voice tremor. This was the first study to examine tremor across multiple regions and relate that to the severity of the voice tremor.

### The Distribution and Severity of Tremor in Speech Structures of Persons with Vocal Tremor

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**Summary: Background.** Vocal tremor may be associated with cyclic oscillations in the pulmonary, laryngeal, velopharyngeal, or oral regions.

**Objectives.** This study aimed to correlate the overall severity of vocal tremor with the distribution and severity of tremor in structures involved.

**Methods.** Endoscopic and clinical examinations were completed on 20 adults with vocal tremor and two age-matched controls during sustained phonation. Two judges rated the severity of vocal tremor and the severity of tremor affecting each of 13 structures.

**Results.** Participants with *mild vocal tremor* typically presented with tremor in three laryngeal structures, *moderate vocal tremor* in five structures (laryngeal and another region), and *severe vocal tremor* in eight structures affecting all regions. The severity of tremor was lowest (mean = 1.2 out of 3) in persons with mild vocal tremor and greater in persons with moderate (mean = 1.5) and severe vocal tremor (mean = 1.4). Laryngeal structures were most frequently (95%) and severely (1.7 out of 3) affected, followed by velopharynx (40% occurrence, 1.3 severity), pulmonary (40% occurrence, 1.1 severity), and oral (40% occurrence, 1.0 severity) regions. Regression analyses indicated tremor severity of the supraglottic structures, and vertical laryngeal movement contributed most to vocal tremor severity during sustained phonation ( $r = 0.77$ ,  $F = 16.17$ ,  $P < 0.0001$ ). A strong positive correlation ( $r = 0.72$ ) was found between the Tremor Index and the severity of the *vocal tremor* during sustained phonation.

**Conclusion.** It is useful to obtain a wide endoscopic view of the larynx to visualize tremor, which is rarely isolated to the true vocal folds alone.

**Key Words:** Vocal tremor–Tremor severity–Tremor index–Endoscopy–Clinical tremor examination.

#### INTRODUCTION

Vocal tremor is a neurological disorder that affects approximately half a million people in the United States.<sup>1,2</sup> Vocal tremor is characterized by low frequency, 4–8 Hz, nearly periodic modulations in pitch, loudness, or voicing.<sup>3</sup> This tremor can have a major impact on an individual's daily life. Those with severe tremor may experience complete voice breaks, which can limit intelligibility,<sup>3,4</sup> but vocal tremor can also limit social interaction for individuals,<sup>5</sup> regardless of the severity level.

Vocal tremor can be treated with laryngeal botulinum toxin injection.<sup>6–10</sup> According to the literature, about 75% of persons benefit from these injections. Although it is commonly understood that persons with vocal tremor may have tremor that affects muscles of the pulmonary, laryngeal, velopharyngeal, and/or oral subsystems,<sup>11</sup> botulinum toxin injections generally target laryngeal (and more specifically the thyroarytenoid) muscles. It may be that the variable response to the injections is related to differences in the extent and severity of the tremor.

There has not been a study examining the distribution and severity of tremor across all four subsystems of the speech mechanism in persons with vocal tremor. However, many studies

have examined particular muscles or structures in persons with vocal tremor in an attempt to determine which parts of the speech mechanism are affected by tremor.<sup>12–17</sup> A review of these studies provides some very useful insight into how tremor might present throughout the speech mechanism.

#### Distribution (spread) of tremor in speech structures

##### Pulmonary structures

Best estimates of pulmonary tremor indicate a rate of occurrence of approximately 30% in persons with vocal tremor and suggest that tremor affects both inspiratory and expiratory muscles. Tremor was found in 29% (2/7) of participants in a study using RespiTrace.<sup>18</sup> Higher incidence rates were reported in other studies; however, these studies had one to three subjects and the subjects may have been selected based on suspicion of pulmonary tremor rather than randomly selected persons with vocal tremor. Using fluoroscopy, investigators identified tremor in the diaphragm in five of six individuals with vocal tremor.<sup>19,20</sup> Needle electromyography (EMG) was used to identify tremor in two of three individuals in the sternocleidomastoid,<sup>20</sup> two of four individuals in the pectoralis major,<sup>20</sup> and three individuals in the rectus abdominis.<sup>20</sup> EMG of the external intercostals, completed in a single participant, did not show tremor activity.<sup>4</sup>

##### Laryngeal structures

Vocal tremor associated with laryngeal abnormality has been found in approximately 80% of study participants, affecting a variety of intrinsic laryngeal muscles. Using laryngoscopy, tremor of the true vocal folds was observed in 79% (110 of 140 individuals) of study participants.<sup>15,17,18,21,22</sup> Using needle EMG, tremor was identified in the cricothyroid muscle in 74% (23 of 31) of

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