LETTERS TO THE EDITOR

Does Recurrent Laryngeal Nerve Stimulation at 30 Hz Produce Vocal Cord Abduction?*

To the Editor:

This letter is in response to an article which appeared in OTOLARYNGOL HEAD NECK SURG 1986;95:152-7, entitled "Transcutaneous electrical stimulation of the recurrent laryngeal nerve," by I. Sanders et al. In this article, the authors reported that vocal cord abduction occurred when the recurrent laryngeal nerve was transcutaneously stimulated at a constant current of 10.0 mA, 1.0 msec pulse duration, 30 Hz stimulus frequency, 1.0 sec stimulus train. They also reported that (in one animal) vocal cord abduction occurred when the recurrent laryngeal nerve was surgically dissected and directly stimulated by use of the same stimulus parameters.

The UCLA-Wadsworth Veterans Administration Laryngeal Physiology Laboratory is presently investigating various aspects of phonation by use of an in vivo canine model of the larynx. We routinely apply direct electrical stimulation to the recurrent and superior laryngeal nerves in our preparations, but have never observed Dr. Sanders' findings in regard to vocal cord abduction at 30 Hz. This discrepancy prompted us to repeat *their* experiment in *our* laboratory. In three animals, direct electrical stimulation of the recurrent laryngeal nerve—with the use of the previously mentioned stimulus parameters—did *not* produce vocal cord abduction. Instead, stimulation at 30 Hz was observed to produce a medial twitching of the vocal cord. As the stimulus frequency was gradually increased to 70 Hz or more, fusion of this medial twitching into vocal cord adduction was observed. Thus, the observed rate of twitching and degree of adduction were proportional to the stimulus frequency applied to the recurrent nerve. However, recurrent nerve stimulation at 30 Hz, while the electrode simultaneously touched the adjacent strap muscles, caused the larynx to be polled inferolaterally, which produced a small but noticeable rotation of the cord outward. Since the authors did not specifically mention that the recurrent laryngeal nerve was electrically insulated from the surrounding tissue, it is possible that they misinterpreted the contraction of the strap muscles and the resulting outward rotation of the vocal cord as abduction. It should be noted that increasing the stimulus frequency to the recurrent nerve to 70 Hz or higher induced vocal cord adduction, even though the adjacent strap muscles were also activated.

One additional point: the authors stimulated the recurrent nerve at the onset of inspiration, when the cords normally abduct and the adductory fibers are believed to be inhibited. Thus, stimulation at the onset of inspiration may have contributed to the false impression that the cords were abducting as a result of the electrical stimulation parameters. We agree with the authors' statement that a simple non-invasive technique for control of the glottic aperture would be of benefit to otolaryngologists and other medical personnel. In our laboratory, numerous permutations in electrical stimulus parameters to the recurrent nerve have been tested, but cord abduction has been achieved only after intralaryngeal sectioning of the recurrent nerve adductory fibers. In brief, the results reported by Sanders et al. concerning cord abduction at 30 Hz stimulus frequency may have been artifact related to their experimental design. The results from an additional laboratory in regard to this matter should be reported.

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THE AUTHOR'S REPLY

The frequency-dependent response of canine vocal cords to direct stimulation of the recurrent laryngeal nerve (RLN) has been previously documented by numerous investigators. As referenced in my paper, Nakamura demonstrated that vocal cord abduction occurs at 20 Hz and adduction at 40 Hz.[1] Sato and Ogura[2] published a series of photographs that showed abduction at 30 Hz and then progressive adduction at higher frequencies. As stated by Rice[3]: "Abduction occurs at frequencies below 30 per second whereas adduction occurs at greater frequencies and becomes maximal at approximately 80 per second." Furthermore, the phenomenon is presented as fact in a prominent ENT textbook.[3] The results of our study concur with those of previous investigators, and we have extended the application of this phenomenon to include transcutaneous stimulation as well as direct.

Certain other points raised in the above letter require clarification. Not one but all six dogs that were transcutaneously stimulated subsequently underwent direct stimulation of the RLN. When stimulating directly, strap muscle excitation was prevented by use of insulated electrodes. These muscles were observed directly while the stimulus was applied, and were found to neither contract nor displace the larynx. In addition, although observations were standardized by application of current at the onset of inspiration, stimulation at any other time during the respiratory cycle yielded nearly identical results. Furthermore, the small (<1 mm) excursion observed during inspiration is clearly distinguishable from the much larger (>3 mm) excursion noted upon stimulation at 30 Hz. Lastly, in a subsequent study that we have conducted in monkeys, unequivocal vocal cord abduction was again found at low frequencies by use of either transcutaneous or direct stimulation.[5]

I encourage other investigators to experiment in this area and would be happy to forward a videotape detailing the technique and results of these experiments.

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*For convenience, Dr. Berke's original letter (first run in June 1987) has been reprinted with Dr. Sanders' response.