

## Observing the female middle register using EGG wavegrams

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The choice of singing register and the degree of vocal fold adduction are two concepts that are not easily discriminated by inexperienced singers. This is particularly true for the mid range (pitch C4 – C5) of untrained female singers, where sounds are often produced in either (a) fully adducted chest register or (b) breathy falsetto register. An adducted falsetto register, which is the desired sound source function of classical singing above a pitch of D4 is often not observed in untrained females.

As an underlying physiological principle, vocal fold adduction can be separately controlled by (a) *cartilaginous adduction*, i.e. the adduction of the posterior glottis via the arytenoids (controlled by the singer with the degree of “breathiness” / ”pressedness”); and by (b) *membranous medialization* through vocal fold bulging (controlled by the choice of vocal register, i.e. chest vs. falsetto).[1] The electroglottographic (EGG) signal is well suited to detect changes in both membranous medialization (i.e. registers)[2] and cartilaginous adduction[3] in singing.

In this study, the EGG wavegram[4], a novel method for displaying and analyzing EGG signals was used as a real-time feedback tool in the voice studio. In the context of singing exercises and instructions designed for this purpose, it was employed to help amateur female singers to understand and to better control the wide range of adductory settings (cartilaginous adduction vs. membranous medialization) in their middle range.

Wavegram data reveals distinct differences between abducted and adducted falsetto register for each individual. The observed differences established themselves as (a) presence/absence of vocal fold contact; (b) degree of irregularities reflected in the EGG signal to noise ratio; (c) absence/presence of DEGG double peaks. The results suggest that subjects can learn to increase cartilaginous adduction in their falsetto register using real time EGG wavegram feedback.

[1] C. T. Herbst, et al., "Membranous and cartilaginous vocal fold adduction in singing," J Acoust Soc Am, vol. accepted, 2011.

[2] N. Henrich, et al., "Glottal open quotient in singing: Measurements and correlation with laryngeal mechanisms, vocal intensity, and fundamental frequency," J. Acoust. Soc. Am., vol. 117, pp. 1417-1430, 2005.

[3] C. T. Herbst, et al., "Using Electroglottographic Real-Time Feedback to Control Posterior Glottal Adduction during Phonation," J. Voice, vol. 24, pp. 72-85, 2010.

[4] C. T. Herbst, et al., "Electroglottographic wavegrams: a technique for visualizing vocal fold dynamics noninvasively," J Acoust Soc Am, vol. 128, pp. 3070-8, Nov 2010.