

Assessment of the vertical dimension of the glottic wave: Its clinical value

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Introduction:

Superior to clinical laryngo-stroboscopy in areas of voice diagnostics, high speed films are able to capture 4000 or more images per second of the larynx. Data are acquired with a high-speed camera recording in real-time during phonation of a vowel. A rigid endoscope (90° optic, 9-mm diameter) is placed into the oropharynx coupled to a high-speed camera, flexible endoscopes can also be used (Figure 1).

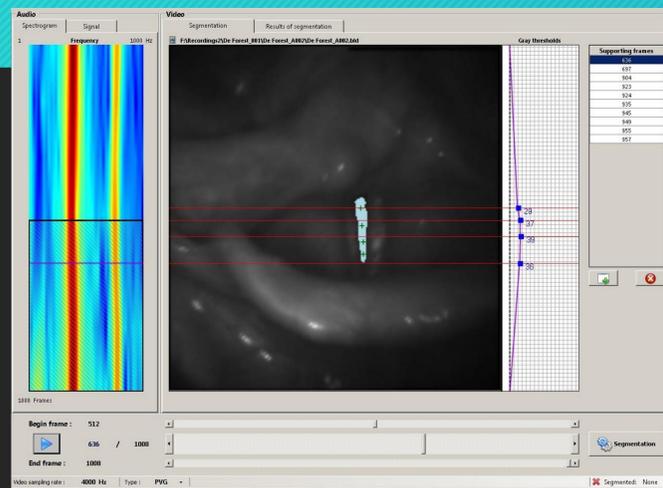


Figure 1) The Richard Wolf Ltd HRES Endocam 5562 setup

Figure 2) shows the imported recording and the segmentation in Glottis Analysis Tools (M Döllinger). The possibilities are many to ensure an accurate segmentation: varying black/white balance and segmentation area during the length of the film are just some of them.

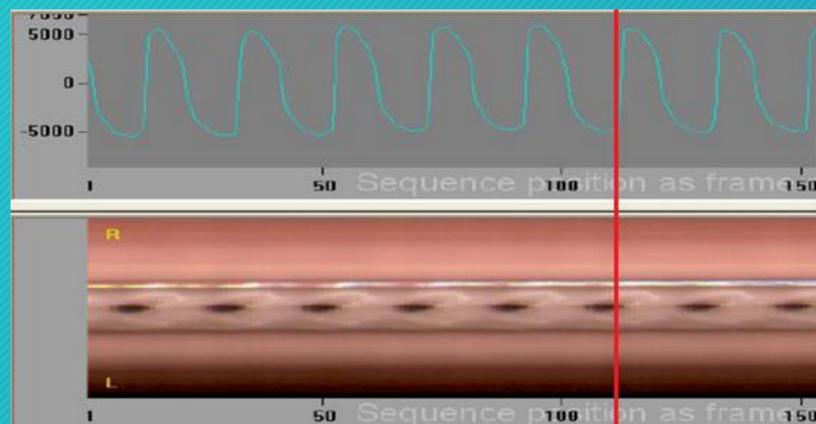


Figure 3 - Accordance between Kymography and Electroglottography for VF activity

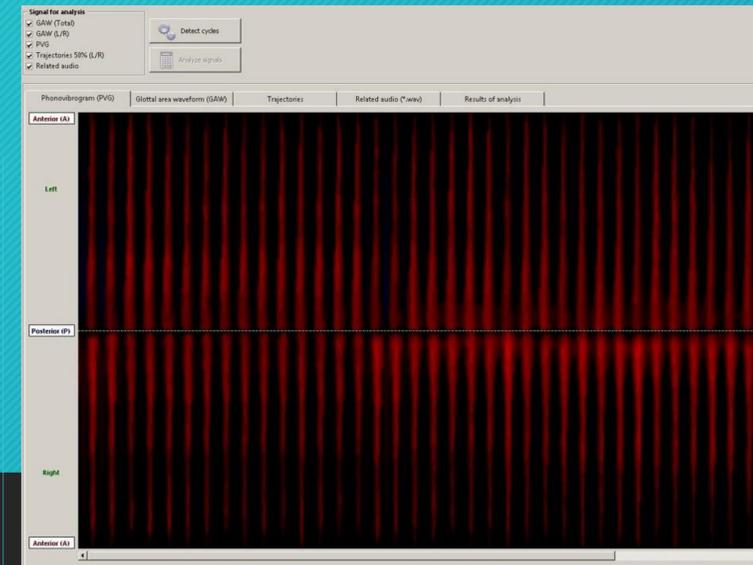


Figure 4) High speed films and phonovibrograms
Phonovibrogram of a contest winning female, showing the regularity of single movement of the right and left vocal folds

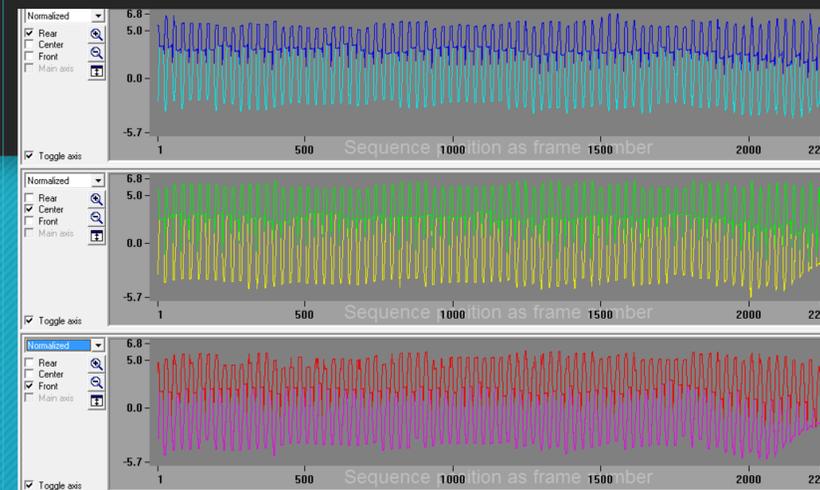


Figure 5 - Segmentation of a normal functioning voice - male: right and left vocal cord presented in front, centre and rear parts (of the stored recording). There is a software possibility to zoom in and out for greater detail in both axes.

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Range	Average	Lowest	Highest	S.D.	Normative values in our clinic, measured on 18 females and 12 males (aged 20-40 years) of high-speed films, sustained tone (/a/) for two seconds. Open quotient between the vocal cords in: - Front - Middle - Rear - Area calculations
Open quotient front					
Male	0,45	0,14	0,92	0,32	
Female	0,48	0,37	1,0	0,49	
Open quotient centre					
Male	0,51	0,09	1,0	0,27	
Female	0,58	0,12	1,0	0,29	
Open quotient rear					
Male	0,59	0,07	0,99	0,32	
Female	0,48	0,00	1,0	0,31	
Area between vocal cords					
Male	0,60	0,04	1,0	0,43	
Female	0,68	0,13	1,0	0,30	

Table1- The quantitative open quotients for a normal voice, based on high-speed frames up to 8000 frames /2 s.

Methods:

The objective in this study was to evaluate the method based on software reproduction of the vocal fold movements, that is included in - Glottis Analysis Tools - used together with high speed films. Here differences in stiffness of the vocal folds can be measured (Figure 2).

Results:

We present a quantified measure of the vocal fold stiffness calculated from individual vocal fold cycles with average measures, standard deviations - and minimum and maximum values (Table 2).

			[MEAN]	[STD]	[MIN]	[MAX]
Stiffness	[GAW]		0,38	0,02	0,333	0,413
Stiffness	[GAW]	[Left]	0,391	0,024	0,338	0,432
Stiffness	[GAW]	[Right]	0,395	0,024	0,352	0,451
Stiffness	[Traj-50%]	[Left]	0,483	0,043	0,371	0,625
Stiffness	[Traj-50%]	[Right]	0,486	0,029	0,392	0,513

Table 2) Calculated measures for the signals of Glottal Area Waveform and Glottal Trajectories - note the standard deviations of the mean which was 0,38 out of 42 measured cycles

Discussion/Conclusion:

It is our impression that the system -" Glottis Analysis Tools" stiffness calculations can be used clinically. In the future, stiffness might be used to determine the treatment effect in voice pathology.

References:

1) Pedersen, M., Eeg, M., Jønsson, A., Mahmood, S., 2015. Chapter 8. Working with Wolf Ltd. HRES Endocam 5562 analytic system for high-speed recordings.