Estimates of pathological Vocal Fold amplitude derived from Highspeed films: A tool for efficacious intervention

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Difference in stiffness

• A difference in stiffness of the vocal folds was measured when comparing a trained with a infected voice user.

• The objective was to evaluate the method based on software reproduction of the vocal fold movements, that is included in -Glottis Analysis Tools- from Erlangen Germany based on high speed films of the vocal folds.
The formula for stiffness

\[ \text{Stiffness} = \frac{\max_{t \leq T_i}(s(t))}{A_i} \]

Where \( T_i \) is the duration of \( i^{th} \) cycle in milliseconds (ms), \( A_i \) is the dynamic range (max-min) for \( i^{th} \) cycle and \( s(t) \) is the magnitude of the 1\textsuperscript{st} derivative of considered signal for \( i^{th} \) cycle (\( t \leq T_i \)).
High speed film and phonovibrogram

Phonovibrogram of a contest winning female, showing the regularity of single movements of the right and left vocal folds 42 cycles
High speed film and phonovibrogram

Phonovibrogram of a 59 years old male with short time extreme dysphonia due to a heavy acute laryngitis, the pathology cannot be captured with acoustical measures alone. 16 cycles
High speed film and phonovibrogram

The regulation of the single movement presenting the area of the phonovibrogram of a contest winning female
High speed film and phonovibrogram

Irregularity of the single area measurements are seen of the 59 years old male with acute laryngitis
Trajectories 50% of a contest winning female, left and right vocal folds
Trajectories 50% of a 59 years old male with short time acute laryngitis
Glottal Area Waveform cycles of a contest winning female, right/left vocal fold
Glottal Area Waveform cycles of a 59 years old male with extreme dysphonia
Calculated results for the signals of Glottal Area Waveform and Glottal Trajectories—statistically significant differences of standard deviations are seen - p< 0,0001

From a contest winning female

From a 59 years old male with extreme dysphonia due to a heavy acute laryngitis
The data analysis shows the female singer listed as "Singer observation", as well as an average of 12 hoarse patients from an voice data material listed as "Group average", hold up against the man with acute laryngitis (\_A001(SegFr_7-356)) listed as "Observation". The table shows an Amplitude-Symmetry deviation between the singer and the male with acute laryngitis due to dysphonia and occasional diplophonia as a result of an acute laryngitis A significant difference in Amplitude – Symmetry-Index is also seen (p<0.0001).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Source</th>
<th>Person</th>
<th>Laryngitis observation</th>
<th>Group average</th>
<th>Singer observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude-Symmetry</td>
<td>[Traj-50%]</td>
<td>_A001(SegFr_7-356)</td>
<td>15796.53</td>
<td>1317.43</td>
<td>0.95</td>
</tr>
<tr>
<td>Amplitude-Symmetry-Index</td>
<td>[Traj-50%]</td>
<td>_A001(SegFr_7-356)</td>
<td>0.30</td>
<td>0.71</td>
<td>0.86</td>
</tr>
</tbody>
</table>
The graph shows the discrepancy between the male patient with dysphonia (\texttt{\_A001(SegFr\_7-356)}) of the parameter amplitude symmetry –Traj 50% compared with the whole group (consisting of 12 patients claiming of chronic hoarseness).
Overtone analysis is another promising software

A Sygyt Software Ltd. presentation showing a normal female voice compared with a female voice of a singer where the upper register is weakened
Conclusions

- Till now we have seen a difference between high quality voices and other voices and in this study we presented a quantified measure of the vocal fold stiffness calculated from individual vocal fold cycles as well as average measures.
- It is our impression that the system - Glottis Analysis Tools - stiffness calculations can be used clinically to differentiate between high and low quality voices, as well as pathology.
- In the future, stiffness measures might be used to determine the treatment effect in voice pathology together with overtone analyses.
• Find the slides on: http://www.mpedersen.org

Thank you for your attention!
References


