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The Voice Foundation´s 36th Annual Symposium

Care of the Professional Voice

May 29 – June 3, 2007

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The clinical use of long time averaged spectrograms (LTAS).

Mette (Fog) Pedersen MD and Rune Sterling, Music College Student

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Abstract

In the larynx the arytenoid regions, and not only the vocal cords are often severely affected by infection, allergy and reflux.
We have earlier measured the glottis closure% and standards deviations with laryngograms (glottograms), jitter% and shimmer% by infection, allergy and reflux in relation to a grading of abnormal videostroboscopies of the larynx (hardware and software by Laryngograph, Ltd.).
In this study we try to implement results of 373 long time averaged spectrograms (LTAS) of reading: The North win and the Sun, and intonation of an /ah/ for 4 seconds in a supplementary statistical setting in relation to the earlier results. The second aspect focuses on LTAS before and after treatment. Pattern recognition and not only formants might be an option in the future.

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In the larynx the arytenoid regions, and not only the vocal cords are often severely affected by infection, allergy and reflux

The idea to include the description of the arytenoids as a routine in videostroboscopies (combined with glottography) was based on our Cochrane review on laryngo-pharyngeal reflux. The normal larynx has score 1, the grading of abnormality is suggested up to 5.

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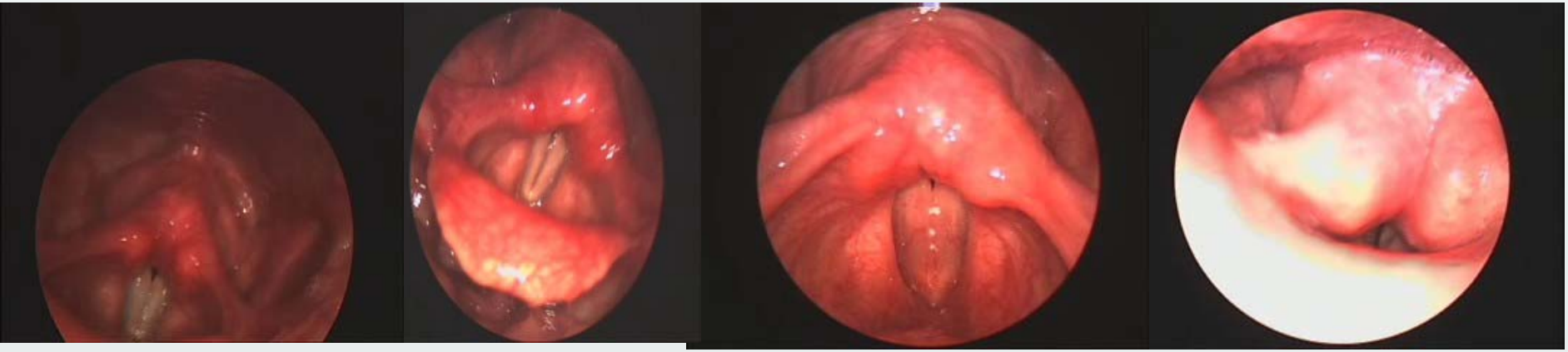
Ary 2-5

2 ⟷ 5



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We have earlier measured the glottis closure% and standards deviations with laryngograms (glottograms), jitter% and shimmer% by infection, allergy and reflux in relation to a grading 1-5 of abnormal videostroboscopies of the larynx (hardware and software by Laryngograph, Ltd.).

A and B.Description of frequency, loudness and glottis closure variation with a sustained tone and by reading of a **standard text**: the North win and the sun at the same time on the same population.

arytenoids shape 1 5	mean jitter%	Std Dev	mean shimmer%	Std Dev	mean Qx%	Std Dev	N	Comments
1	1,0	1,0	9,2	6,5	47,1	6,5	35	Wilcoxon test:
2	3,4	8,1	7,6	5,3	45,6	14,8	70	common
3	2,6	6,0	7,8	4,9	45,8	11,5	128	mean values
4	5,6	15,4	8,7	7,5	44,6	13,0	129	for jitter% and
5	4,5	7,2	11,8	16,6	47,9	7,9	11	shimmer%
statistics	-	-	-	-	significant difference between at least 2 groups for Qx% (p<0,05)			

B:

arytenoids shape 1 5	frequency variation%	Std Dev	loudness variation%	Std Dev	Qx%	Std Dev	N	Wilcoxon test:
1	9,0	6,9	15,4	5,1	48,7	5,0	35	Equality
2	13,2	11,9	16,8	6,8	44,7	13,8	70	cannot be rejected
3	12,1	11,4	16,0	4,7	46,4	10,5	128	
4	12,0	10,1	16,4	5,6	46,1	11,7	129	
5	13,8	14,1	18,2	7,8	46,8	4,8	11	

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Groups of consecutive digitized videostroboscopies evaluated by 2 – 3 observers on the spot, and voice analysis at the same time of normal controls: arytenoids shape grade 1, without laryngeal complaints versus: abnormal clients with laryngeal complaints, arytenoids shape grade 2 – 5, measured with SPEAD by the firm Laryngograph ltd.
A: **sustained tone /ah/. B**: reading of a **standard text:** the North wind and the sun.

A:

arytenoids shape	mean jitter%	Std Dev	mean shimmer%	Std Dev	mean Qx%	Std Dev	N	Comments
1	1	1	9,2	6,5	47,1	6,5	35	
shape 2 – 5	4	10,5	8,2	6,6	45,3	12,7	338	
statistics	-	-	-	-				

significant difference for Qx% and standard deviations between normal and abnormal measures, Welch ANOVA p<0,0001

B:

arytenoids shape	frequency variation%	Std Dev	loudness variation%	Std Dev	Qx%	Std Dev	N	normals SD
1	9	6,9	15,4	5,1	48,7	6,5	35	for frequency variation <6,9 abnormal> 11,1
shape 2 – 5	12,3	11,1	16,4	5,6	46,0	11,4	338	
statistics	p 0,03 *		-		p 0,011 *			normals SD for Qx% <6,5 abnormals >11.4

*p as given (Wilcoxon test)

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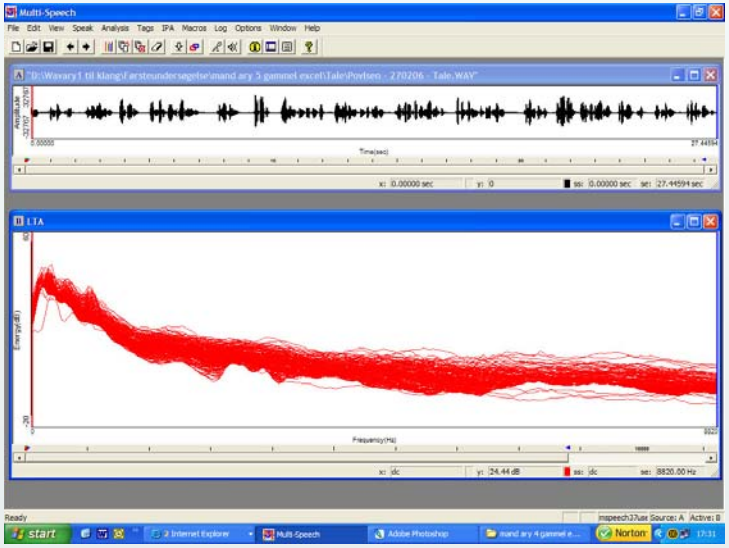
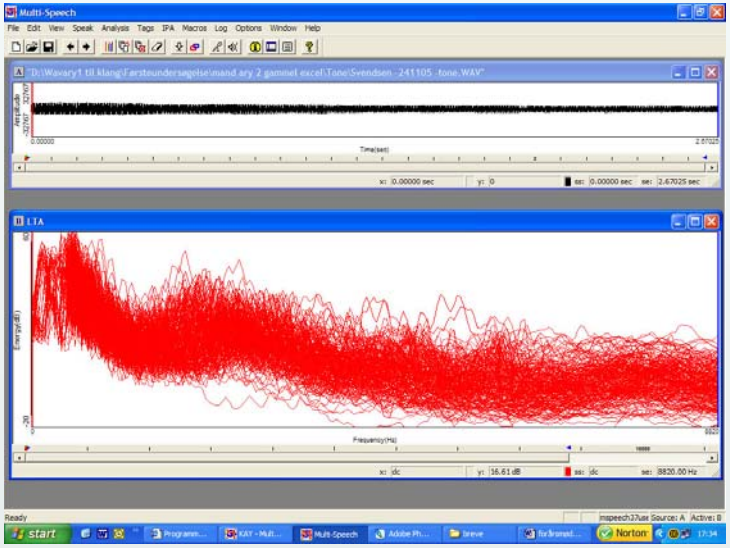
During all of the time of the referred prospective study we looked at the Average spectrum, in the setup (SPEAD, by Laryngograph): There were very clear differences with the FFT analysis up to 10.000 Hz

LTAS arytenoids 2-5
220 women + men - text



LTAS arytenoids 2-5
220 women + men - tone



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The North wind and the sun as a text, was recorded, stored and analysed.

We used LTAS (MDVP) for calculation.

Neither Average spectrum (SPEAD) or LPC (SPEAD) delivered the desired numerical data.

Average Spectrum delivered no numerical data.
LPC delivered some numerical data, but were not an accurate way of measuring spoken text.

LTAS not only was a more accurate way of measuring spoken text, it also provided detailed numerical data, that we were able to extract to Excel. We could use the tables made in Excel for statistical analysis. This was done in SAS JMP.

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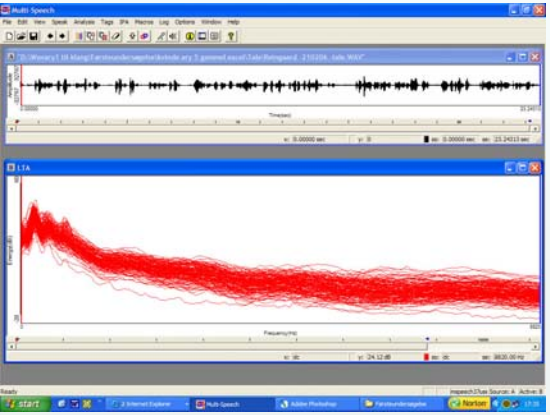
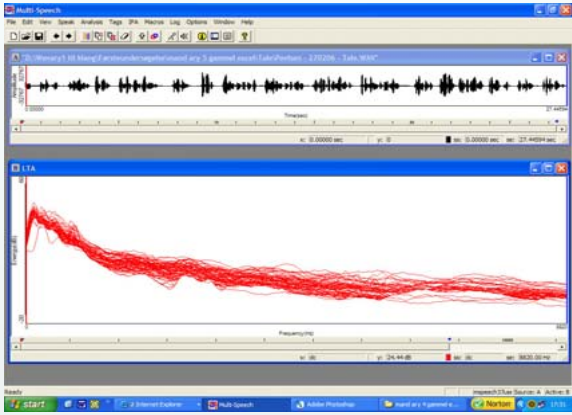
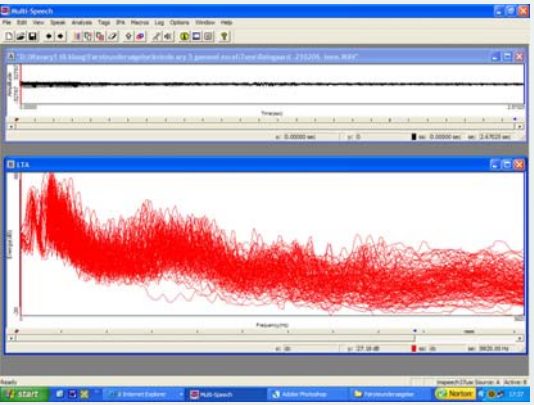
The referred LTAS spectra of combined males and females of ary 2-5 showed interesting abnormalities for text as well as tone. The difference between males and females are shown for the groups of spoken text and sustained tone from 0-10.000 Hz



LTAS ary 2-5 – 144 women text

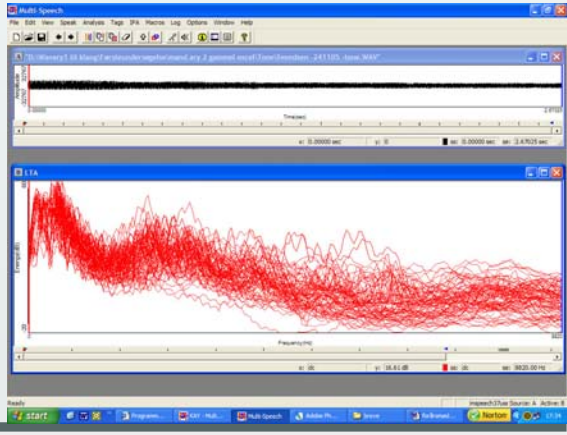
LTAS ary 2-5 – 76 men text





LTAS ary 2-5 - 144 women tone

LTAS ary 2-5 – 77 men tone



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The LTAS is off course affected by pauses etc.

But the human resonance area modelled e.g. by Jaromir Horácek is very uniform even in the to sexes.

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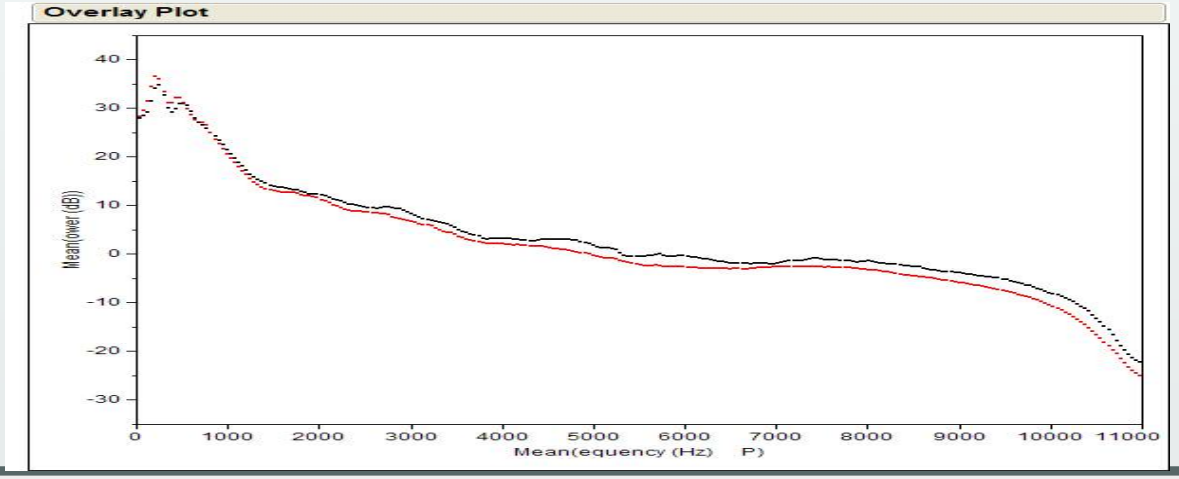
Here are the pathological cases defined by the online video stroboscopy, classified by the oedema of the arytenoids 2-5 versus control group arytenoids 1 from 0 -10.000 Hz.

A weighted average was made for each group on all the harmonics in SAS JMP, the black line represents the normal ones and the red represents the swollen arytenoids



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The total amounts of subjects was 239 with 373 measurements,

there was no significant difference between the normal and pathological groups in the area of 0-10.000 Hz (speech) neither with Log-Rank nor with Wilcoxon test using product-limit survival fit by SAS JMP.

Calculation was made for 0 – 5.000 Hz, there was still no significant difference (speech).

And this was also the case for the area between 2.500 – 4.000 Hz for (speech).

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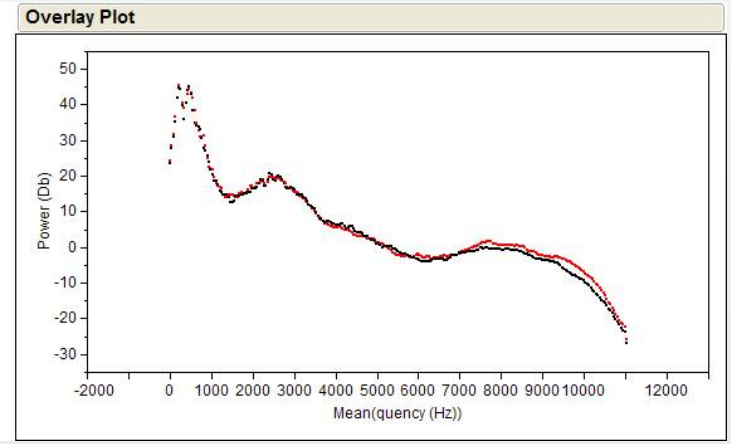
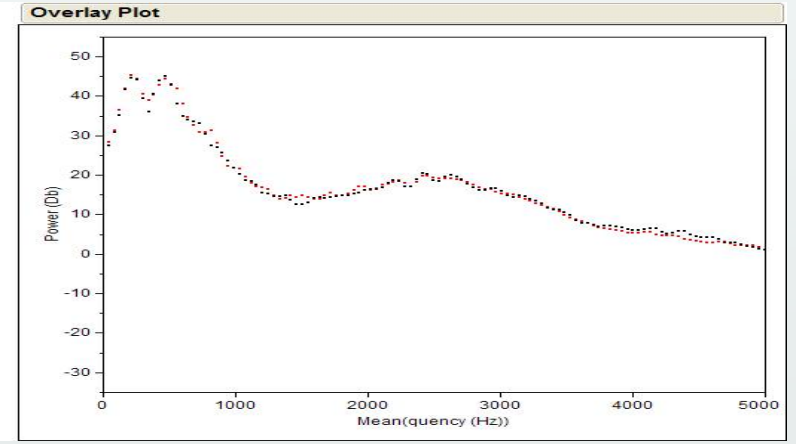
A comparison was made of sustained tones with an interval of two weeks,

of the arytenoids pathological group 2-4, from 0 – 10.000 Hz,

without significance before and after some treatment, this is also the case if you draw the a line between 0 – 5.000 Hz,

the red line represents the later group examination after 14 days.





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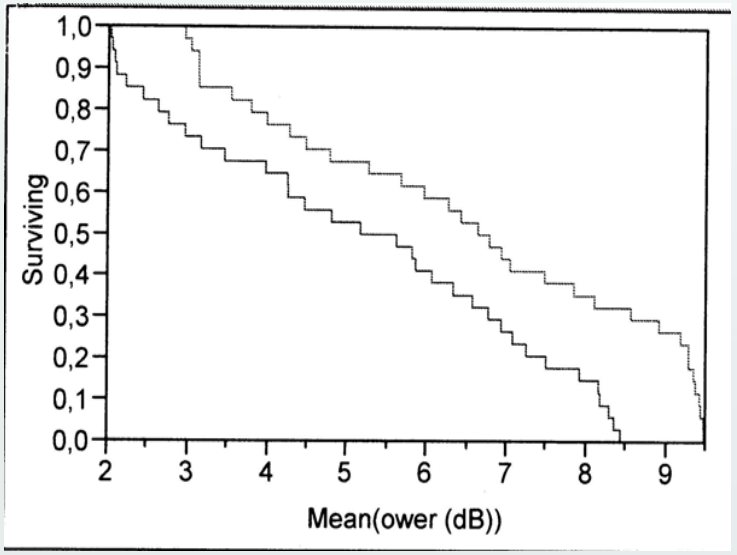
What was interesting was that on the group with sustained tones, the area between 2.500 – 4.000 showed significant difference before and after 14 days with Wilcoxon test (0,0153) and Log-Rank (0,0025)

Tests Between Groups

Test	ChiSquare	DF	Prob>ChiSq
Log Rank	9,1651	1	0,0025*
Wilcoxon	5,8763	1	0,0153*



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Discussion

It makes good sense in a historical connection, that the range of the singing formant part of the spectrum is better defined after reduction of the oedema of the arytenoids.

This is an aspect that is correspondent with modelling, e.g. Jaromir Horácek focuses on the resonance area before and after tonsillectomy.

So we suggest that in the future prospective controlled analysis of LTAS is made of the sustained tone at least in the area from 2500-4000 Hz.

The observation time after treatment must be longer.

The role of high speed films and high speed kymography can be elucidated with online combination with SPEAD/MDVP

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Conclusion

There was found significant difference
between patients before and after treatment –
in the range of 2500-4000Hz
with an interval of fourteen days –
with swollen arytenoids,
comparing the first and the second
examination using a sustained tone /ah/ for
four seconds.

The product-limit survival fit showed a
Log-Rank p <0,0025* Wilcoxon p <0,0153*

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