Pedersen M The clinical use of long time average spectrograms (LTAS). XVI Annual PVSF/UCLA Voice Conference Los Angeles 2007

Pedersen M (2007). The clinical use of long time average spectrograms (LTAS). *XVIth Annual PVSF/UCLA Voice Conference, Los Angeles.*

The clinical use of long time average spectrograms (LTAS)

Mette Pedersen MD Ear-Nose-Throat specialist PhD and Rune Sterling, student of music

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Abstract

In the study we contrasted the results of long time average spectrum analysis (LTAS) of continuous speech reading and of four second sustained phonation by dysphonic patients diagnosed as having infections, allergic and reflux dysphonia. The resultant data were contrasted with laryngografic glottis closure measures and with video-stroboscopies of the larynx. Supplementing stroboscopic observations with acoustic measurements gives a more realistic clinical evidence based evaluation of dysphonia.

Pedersen M, Yousaf U. (2006) Videostroboscopic expert evaluation of the larynx with running objective voice measurement at the same time gives more secure results than videos alone. Japan. The 5th International Conference on Voice Physiology and Biomechanics: Ed. Society of vocal fold physiology and biomechanics p. 110-113.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Introduction

The problem with long time average spectra has always been the quantitative statistical aspects.

It is well known that there are levels of evidence for clinical research:

Level A randomized control trials / meta-analysis.

Level B well designed none randomized clinical trials: clinical cohort studies, case-control studies with non biased selection of study participant and consistent findings.

Level C consensus/expert opinion.

We have tried to make a case-control study of patients vs. a normal control group and a cohort study of patients before and after treatment.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Material

336 videostroboscopies were group related to oedema of the arytenoids region in a case-control study with or without small benign changes of the vocal cords.

The first group included a normal control group with 35 clients.

Four groups with laryngeal complaints were described with more and more extensive oedema of the arytenoids region in all 301 patients.

77 patients with laryngeal complaints were examined before and after treatment in a cohort study.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

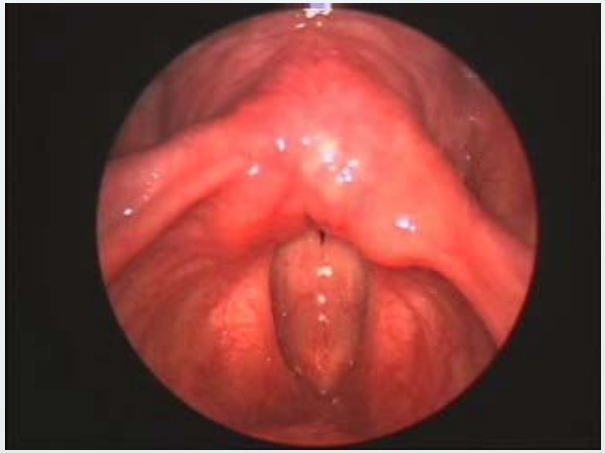
Arytenoid regions with more and more extensive swelling

Group 1 a normal control group

Group 2 slight oedema

Group 3 moderate oedema

Group 4 extensive oedema



Group 5 oedema covering most of the vocal cords

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Method:

Long Time Average Spectrograms (LTAS)

The LTAS were analysed on a standard text (“the North Wind and the Sun”)

and sustained tone /a/ for four seconds.

The problem was to point out the maximal intensities in pathology especially related to formants.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Method:

Long Time Average Spectrograms (LTAS)

Therefore the measurements taken from a Multi Dimensional Voice Profile system (Laryngograph Ltd.London) were placed in an Excel sheet.

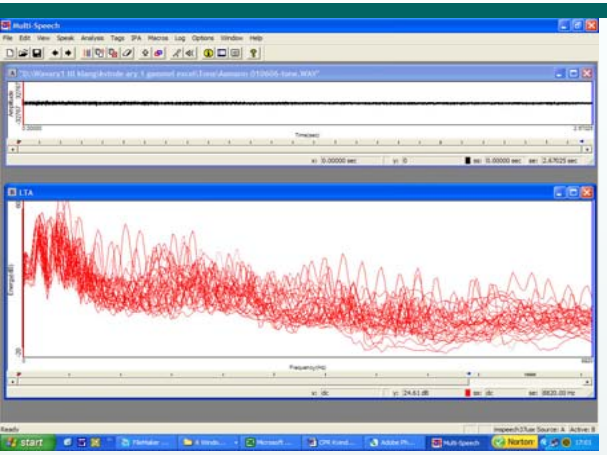
The curves were extracted from individual sheets, harmonics were measured individually on a Multi Dimensional Voice Profile system (Key Elemetrics,US) and compared up to 12.000Hz.

The statistics were based on SAS JMP (survival analysis) of the big amounts of data. The next dia shows the curves of 301 patients with a visual score of deviant arytenoids region from of 2-5 compared to normal.

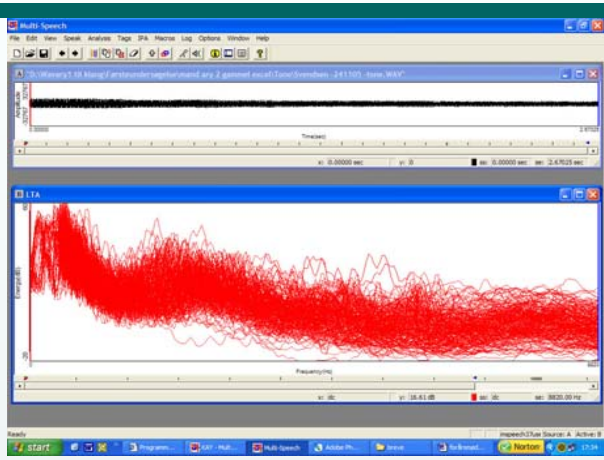
The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

The visual score graded 1(normal) in videostroboscopies and abnormal arytenoids cartilage region visual score graded 2-5 related to LTAS

Sustained tone

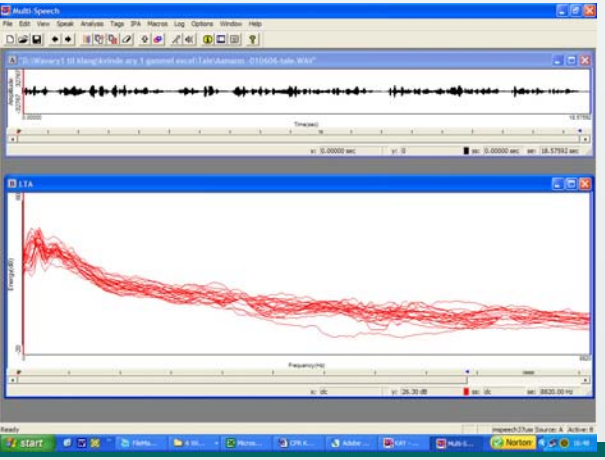


Grade 1

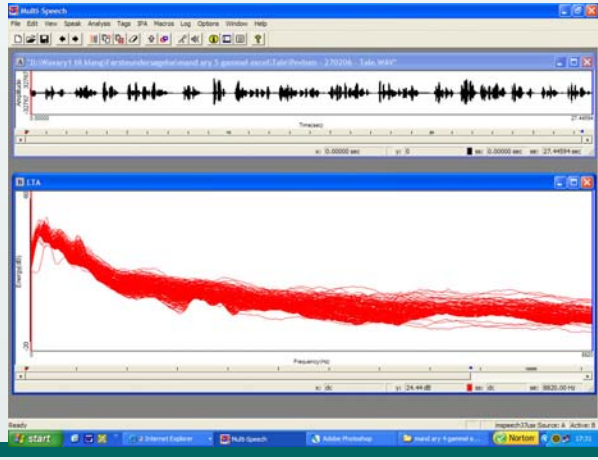


Grade 2-5

Reading



Grade 1



Grade 2-5

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Method:

The closure of the vocal chords (Qx%)

Qx% was measured with the Multi Dimensional Voice Profile system by Laryngograph Ltd. during reading a standard text (“The North Wind and the Sun”) and during intonation of a sustained tone (/a/) for four seconds.

SAS institute statistical analysis was used with ANOVA and paired t-test.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Method:

Qx%, measured of patients before and after medical treatment of allergies, infections and reflux dysphonia

77 patients with laryngeal complaints were examined before and after treatment in a cohort study.

The study only included the videostroboscopy group graded 2-4 with the Multi Dimensional Voice Profile system by Laryngograph Ltd. London.

Allergies were diagnosed by medical history and tests of inhalation allergens, other allergies and intolerance.

Infections were diagnosed with swabs and blood examinations.

Reflux patients were diagnosed with oesophagoscopy and gastroscopy

Treatment included steroids inhalors (without lactose), anti-histamines, antibiotics, acid pump inhibitors, environment corrections including diet and others.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Results:

LTAS in clinical use

Statistics were made on:

- The prospective case-control study using a normal control group of 35 clients with normal arytenoids cartilage area,

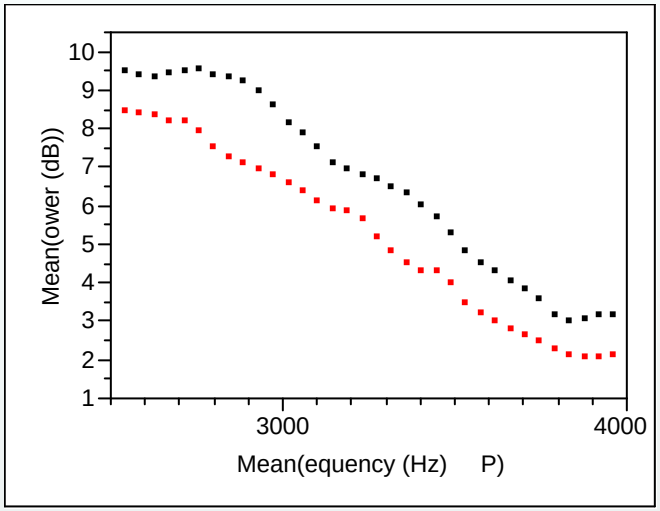
  and

- The 301 patients with laryngeal complaints and a swollen arytenoids cartilage area +/- small benign changes of the vocal chords.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

LTAS in a normal control group with arytenoids cartilage score 1 vs. abnormal patients with arytenoids cartilage score 2-5 showed a significant difference between 2500-4000Hz for reading a standard text, but not for sustained tone

Product-Limit Survival Fit
Survival Plot
1 vs. 2-5
for the overlay plot of **2.500–4.000Hz** for text.



Product-Limit Survival Fit
Survival Plot

1
2-5

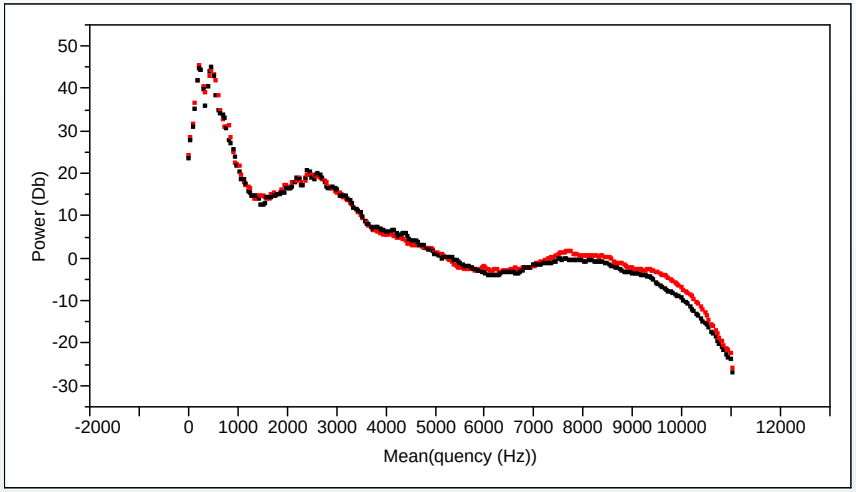
LTAS in a normal control group with arytenoids cartilage score 1 vs. abnormal patients with arytenoids cartilage score 2-5, statistical difference was found for Log-Rank as well as Wilcoxon test in the frequency area 2500-4000 for text.

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

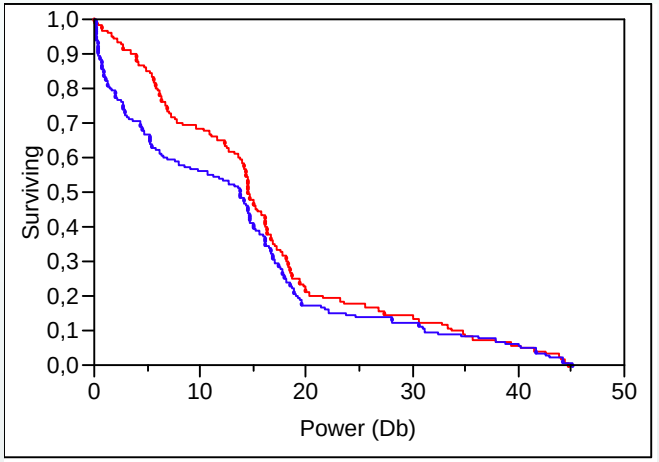
The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

LTAS Product-Limit Survival Fit, Survival Plot group 2-4 before and after treatment showed a significant difference, reading a standard text and sustained tone

Overlay Plot group 2-4 before and after treatment.



LTAS. Product-Limit Survival Fit Survival Plot group 2-4 before and after treatment showed a significant change of intensity level after treatment.



Tests between groups of score 2-4 of the arytenoids cartilage region by reading a standard text before and after treatment

Test	ChiSquare	DF	Prob>ChiSq
Log-Rank	1,6061	1	0,2050
Wilcoxon	5,3489	1	0,0207

Sustain tone (without curve)

Test	ChiSquare	DF	Prob>ChiSq
Log-Rank	1,3753	1	0,2409
Wilcoxon	4,5101	1	0,0337

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Groups of consecutive digitized videostroboscopies evaluated by 2-3 observers on the spot, and voice analysis at the same time of normal controls: measured with Spead (MDVP) by the firm Laryngograph

A:

arytenoids shape 1	mean jitter%	Std Dev	mean shimmer%	Std Dev	mean Qx%	Std Dev	N	Comments
	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			

A: **sustained tone /ah/.**
B: reading of a **standard text:** the North wind and the sun.

B:

arytenoids shape 1	frequency variation%	Std Dev	loudness variation%	Std Dev	Qx%	Std Dev	N	normals SD
	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)

Normal clients with arytenoids cartilage region shape grade1, without laryngeal complaints versus: abnormal clients with laryngeal complaints, arytenoids cartilage region shape grade 2-5.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

77 patients with examinations before and after treatment

Intonation of a sustained tone /ah/.

arytenoids abnormality (shape 5 1 pt.) (shape 5 3 ptt.)

shape 4	1. examination	Std Dev	2. examination	Std Dev	N 1st 32/ 2nd.25
mean jitter%	5.7	17.9	1,1	1,1	
mean shimmer%	7,4	5,2	6,8	3,7	
mean Qx%	43,7	14,4	48,1	6,1	
shape 3	1.examination	Std Dev	2. examination	Std Dev	N 1st 26/ 2nd30
mean jitter%	3,8	8,7	1,6	3,0	
mean shimmer%	7,4	3,9	7,3	3,6	
mean Qx%	42,3	14,5	48,1	7,1	
shape 2	1.examination	Std Dev	2. examination	Std Dev	N 1st 16/ 2nd18
mean jitter%	4,9	11,1	2,2	3,3	
mean shimmer%	4,9	8,7	1,6	3,1	
mean Qx%	45,4	7,5	50,3	9,2	
	(shape 1 2 ptt.)		(shape 1 1 pt).		

statistics

For Tone, no significant change was found of jitter% and shimmer% with paired t-test.

For Qx% there was a significant better closure of the glottis of 4,6% (43,8% to 48,4%) with a significance of 0,0008 with paired t-test.

(not shown)

For the reading of a standard text the regularity frequency% was reduced with 1,98% (p= 0,053), the regularity of loudness% with 1,7% (p=0,004) and the Qx% was better with a change of 2,56% (p=0.044) analysed with paired t-tests.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Discussion

The clinical use of long time average spectrograms (LTAS) and Qx% is documented in a prospective case-control study.
Evidence based level B

It was also documented in a prospective cohort study related to medical treatment of pathological changes of the larynx including the arytenoid regions – not only the vocal cords.
Evidence based level B

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Discussion

For LTAS in a normal control group with arytenoids cartilage region grade 1 vs. patients with laryngeal complaints and arytenoids cartilage region grade 2-5, a difference was found for Log-Rank as well as Wilcoxon test in the frequency area 2500-4000 for reading of a text.

For LTAS Product-Limit Survival Fit Survival Plot the group with laryngeal complaints, grade 2-4 by video-stroboscopy before and after treatment showed a significant change of intensity level after treatment for reading of a text and a sustained tone

.

Discussion

Significant difference for Qx% and standard deviations between normal and abnormal measures was found, Welch ANOVA p<0,0001 for sustained tone.

The normal group SD for Qx% was <6,5 and for the abnormal patients >11.4 for reading of a standard text

p 0,011 (*p as given with Wilcoxon test).

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Conclusion

- With acoustical tools supplementing videostroboscopy it is now possible to make quantitative evidence based documentation of treatment of voice disorders.

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org

Thanks to the audience

- And to
- Kasper Munck, SAS Statistics Institute,
- Assistents
- Christian Larsen
- Daniel Feddersen
- Shahzleen Rajan
- Julie Pedersen
- Anders Jønsson

The Medical Center, Ear, Nose, Throat and Voice Unit. Østergade 18. DK-1100 Copenhagen Denmark
e-mail: m.f.pedersen@dadlnet.dk, url: www.mpedersen.org