# ADVANCED VOICE ASSESSMENT.

## *A prospective case-control study of jitter%, shimmer% and Qx%, glottis closure cohesion factor (Spead by Laryngograph Ltd.) and Long Time Average Spectra*

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## 1. Introduction

It was suggested at the □uropean Oto-□hino-Laryngology conference 2007 in Vienna that voice analysis is empiric and that clinical voice treatment is not evidence based!! In the Cochrane Handbook [1] advice for evaluation of quality of research was made: □roups are made of the quality in 3 levels: **Level A (randomized controlled trial/meta-analysis):** High-quality randomized controlled trial (□C□) that considers all important outcomes. High-quality meta-analysis (quantitative systematic review) using comprehensive search strategies. **Level B (other evidence):** A well-designed, non randomized clinical trial. A non quantitative systematic review with appropriate search strategies and well-substantiated conclusions, includes lower quality □C□s, clinical cohort studies and case-controlled studies with non biased selection of study participants and consistent findings. Other evidence, such as high-quality, historical, uncontrolled studies, or well-designed epidemiological studies with compelling findings, is also included. **Level C (consensus / expert opinion):** Consensus viewpoint or expert opinion.

□he purpose of this categorization is that good studies can be structured in meta-analysis to affirm the results as it is done in e.g. cancer and cardiology research.

In our two Cochrane reviews on vocal nodules [2] and laryngo-pharyngeal reflux [3] no clinical evidence based studies were found neither for the treatment of vocal nodules nor laryngo-pharyngeal reflux. In the review of vocal nodules 659 papers were evaluated, and in the review of laryngo-pharyngeal reflux 302 papers. □he problem most commonly found, was lack of a clear baseline for inclusion in the studies, and, lack of unanimous objective visual and acoustic criteria.

□herefore we have in a **part one** of this prospective case-control study [4] first, tried to make a defined baseline of a complaint of a non-functioning larynx, second, to standardize simple object visual demands for larynx mucosa including the vocal cords but based on oedema of the arytenoids, third, to evaluate the measures of jitter percent, shimmer percent in relation to the closed phase percent of the vocal cords. □vidence of pathological parameters were defined for sustained tons as well as the reading of a standard text, □able 1, difference was also found from before to after treatment, □able 2, treatment as ealier discribed [5]

As **part two** we used the same patients material, for all with sufficient data, in the same prospective controlled case-controlled setup, for two still more advanced objective throat function analysis: the Cohesion Factor of irregularity as defined in the Spead program by Laryngograph Ltd. illucidating kymographic aspects and Long □ime Averaging Spectrum (L□AS).

## Method

I. Inclusion criteria were a. subjective complaints of a non-functioning larynx combined with b. a professional assessment and visual score grouping the patients by swelling in the arytenoids +/- pathological vocal cords. Patients without swelling of the arytenoids and with normal vocal cords were rated normal, score 1 by visual inspection. Patients with swelling rated from 2 to 5 were abnormal. □here are individual variations but a normal video-stroboscopy includes a normal surface of the arytenoids without oedema and a normal shape, as well as normal colour and movement at stroboscopy of the vocal cords and all the rest of the mucosa of the larynx. Fig. 1A, normal, score 1, and Fig. 1□ and C, abnormal scores (score 3 and 5 presented).

II. □he parameter: the closed phase of the vocal cords defines the exact point where the vocal cords meet in the synchro-nized glottography with stroboscopy [6]. □his is difficult to see, if there is oedema of the arytenoids or of the whole larynx mucosa. □he closure of the vocal cords (Qx%) and the fundamental frequency (Fx%) can under those circumstances be compromised even if the vocal cords themselves have movement. □he whole larynx can be affected due to infections, allergy, reflux and misuse etc. [5]. □esting binary equal movements of the vocal cords related to the total amount of movements gives a Cohesion Factor of irregualrity (Spead by Laryngograph Ltd.) for Qx% and Fx% analyzed for a sustained tone for 4 seconds and reading of a standard text (“the north win and the sun”). Fig. 2. □he abnormality degrees of the arytenoids with visual scores of 4 is shown before and after treatment.

III. □he clinical use of harmonics including formants was empiric in pathology till now. □his patient material analysed for the cohesion factor was also analysed for Long □ime Average spectrograms (L□AS), for a sustained tone /a/ for 4 seconds and a standard text (“the north win and the sun”). □he problem was to point out the maximal intensities in pathology especially related to formants, and the change related to treatment.

Fig. 3a shows the normal L□AS during reading the north win and the sun, of 35 persons with normal larynx, score 1,

*Models and analysis of vocal emissions for biomedical applications: 5th international workshop: December 13-15, 2007: Firenze, Italy*, ed. by C. Manfredi,
ISBN 978 88-8453-673-3 (print) ISBN 978-88-8453-674-7 (online)

including normal arytenoids, the measurement taken from Spead by Laryngograph Ltd. and placed in an Excel sheet. The curves where extracted from individual sheets, harmonics where measured individually on Multi Dimensional Voice Profile system by Key Elemetrics and compared up to 12.000Hz.

The statistics where based on SAS JMP (survival analysis) of the huge amounts of data. 3b shows the curves of 301 patients with a visual score of deviant arytenoids form of 2-5.

## Results

Table 3 shows the cohesion factor of Qx%, statistical analyses: Cohesion factor % for 35 normals and 301 abnormals as defined by oedema of the arytenoids and related pathological mucosa**.**

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

Analysis of Long Time Average Spectrograms (LTAS) showed no overall difference between the pathological video - stroboscopies Overlay Plot and the normals, but for the area between 2500 and 4000 Hz Table 4.

## Discussion

It has been shown that jitter% and the closed phase % Qx of the vocal cords are better and evidence based, in a prospective case-control study and in a prospective cohort study, related to medical treatment of pathological changes of the larynx including the arytenoid regions, - not only of the vocal cords.

A differentiation can be made of whether the primary tone generator (including the arytenoids, the mucosa and the vocal cords) or the more coordination related factors of sound making should be focused upon in medical treatment. The cohesion % is significantly better in tone and text after treatment. In the LTAS the area of 2500 to 4000 Hz has a significantly higher value in dB after treatment when reading a standard text.

It was earlier shown that phonetograms are better after medical treatment [5]. So now we have evidence based measurements for the future treatment of voice disorders.

## Conclusion

**The new parameter, the Irregularity % or cohesion factor between all measured signals -and pairs of successive vocal cycles that fall into the same analysis bin in the histogram, has been presented as evidence based in a clinical setting in a prospective case – control study, and a cohort study before and after treatment. Normal values and values after treatment are given. On the same material the LTAS in the area of 2500-4000 Hz has been shown to be of evidence based value in a clinical setting in the case – control study as well as the cohort study before and after treatment, - with higher intensity values in normals and after treatment**

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[6].Pedersen M (Fog) Electroglottography compared with synchronized stroboscopy in normal persons. *Folia phoniatr* 1977 *29:191-200*

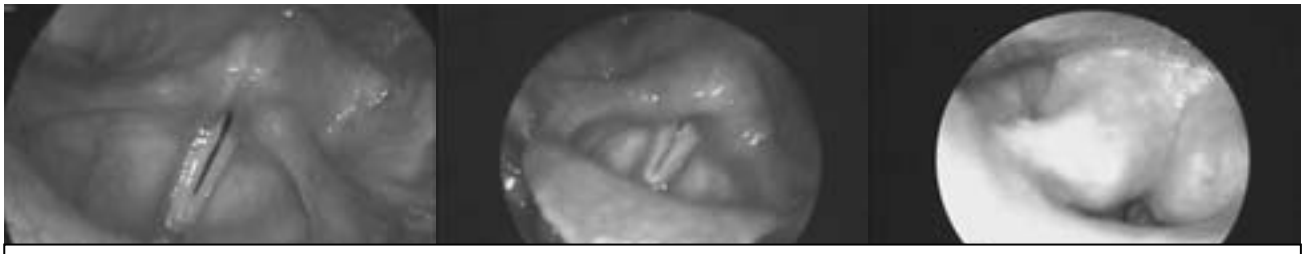


Fig. 1A Score 1 | Fig. 1B Score 3 | Fig. 1C Score 5

**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 | | | |

**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)

**Table 1**
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 grade1, without laryngeal complaints versus: abnormal clients with laryngeal complaints, arytenoids shape grade 2-5, measured with SPEAD by the firm Laryngograph ltd.

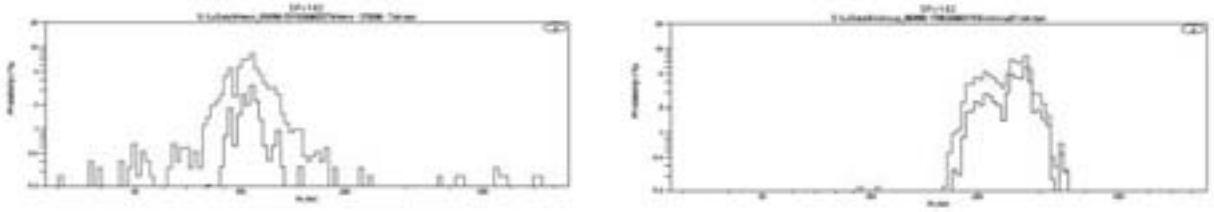
**A**: **sustained tone /ah/.**
**B**: reading of a **standard text:** the North wind and the sun.

**A:** 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 (shape 1 2 ptt.) | 7,5 | 50,3 (shape 1 1 pt). | 9,2 | |

**Table 2.**
**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.
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.

Arytenoids score 4, Fx % cohesion factor before treatment after treatment



Arytenoids score 4, Qx % cohesion factor before treatment after treatment

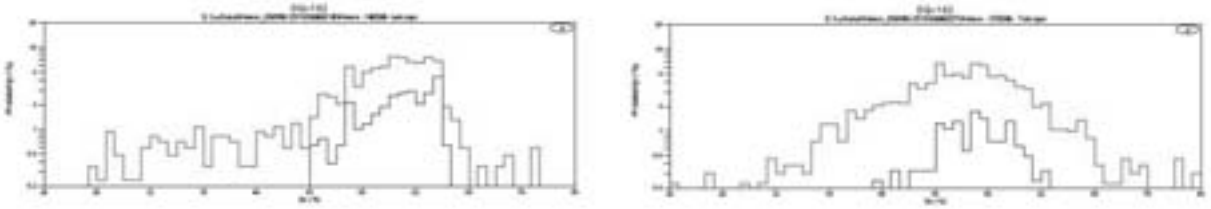
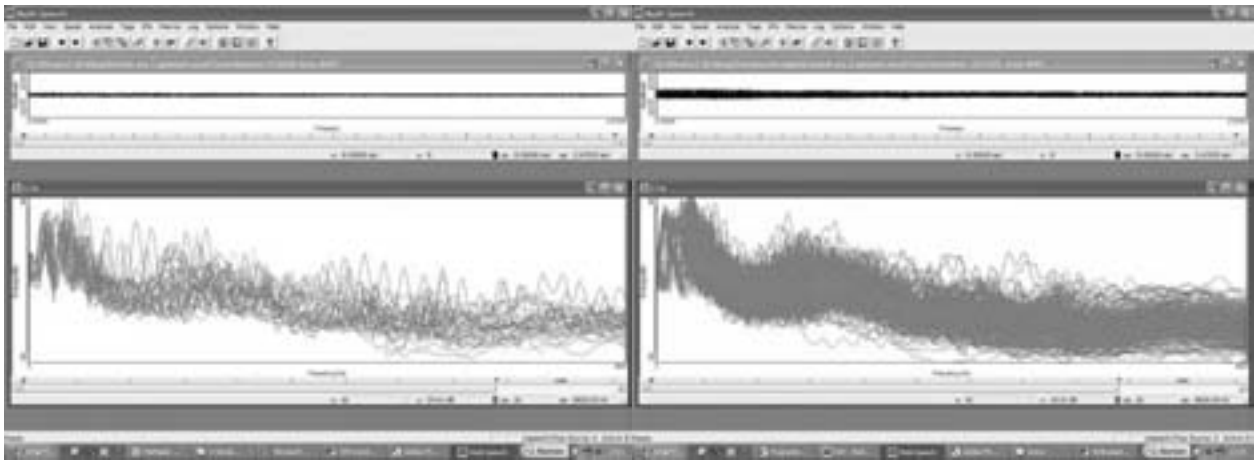


Fig. 2

**Fig. 3a shows the normals visual score 1 related to LTAS and 3b the abnormal arytenoids visual score 2-5 related to LTAS**



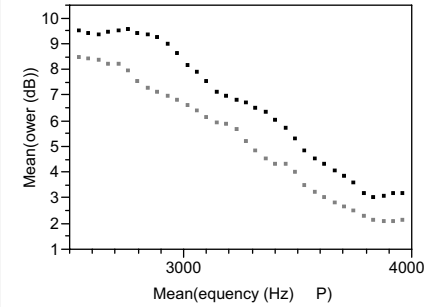
| | Sustained tone Qx% | Reading of a text Qx% | |
|---|---|---|---|
| Arytenoid 1 | 19 (12-26) range | 35 (30-40) **p 0,042* | ← |
| Arytenoids 2-5 | 18 (15-20) range | 41 (39-42) *difference* | |
| | **Sustained tone Fx%** | **Reading of a text Fx%** | |
| Arytenoids 1 | 1,9 (1-6) range | 13 (8-19) **p ,03* | ← |
| Arytenoids 2-5 | 5,3 (3,7-5,8) range | 19(18-21) *difference* | |

| | Sustained tone Qx% | Reading of a text Qx% | |
|---|---|---|---|
| before | 17 (12-22) range | 44 (40-48) *p*0,015* | ← |
| after | 14 (9-19) range | 37 (33-41) *difference* | |
| | **Sustained tone Fx%** | **Reading of a text Fx%** | |
| before | 4.5 (1.8-7.2) | 22 (19-26) | |
| after | 3 (0.3-5.7) | 17 ( 14-22) | |

Cohesion factor before and after treatment arytenoids score 2-4

**Table 3. Cohesion factors for Qx% and Fx%**

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




**Product-Limit Survival Fit**

**Survival Plot**

1 —
2-5 —

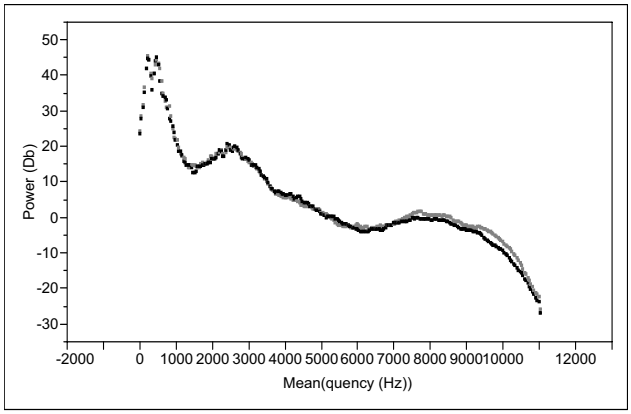
**Tests Between Groups 1 and 2-5 arytenoids reading of a standard text showed a significant difference.**

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

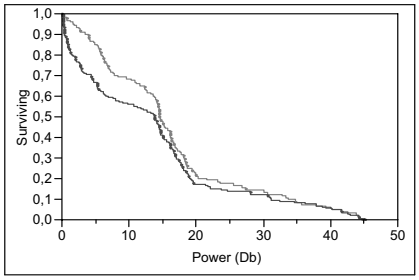
**Table 4. LTAS in normals with arytenoids score 1 vs abnormals with arytenoids score 2-5**

**Table 5. LTAS Product-Limit Survival Fit Survival Plot group 2-4 before and after treatment showed a significant difference**

**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 difference**




Tests Between Groups of score 2-4 of the arytenoides
By reading of 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 | ← |