

Abstract for 8th World Congress on Brain Injury:

High speed films as a new tool for diagnosis of neurological disorders, especially when they include voice function

- a prospective cohort study of 55 patients with localized and universal dystonia

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INTRODUCTION / OBJECTIVES

There is nowadays a better understanding of universal and local voice related dystonia.

High speed films of the vocal cords have shown to be a valuable tool in many connections. There is a measure of the distance between the front, middle and rear part of the vocal cords that can be used quantitatively (figure 1).

The real movements of the vocal cords are seen, and with segmentation, marking of the free border of the vocal cords reveals pathological phenomena.

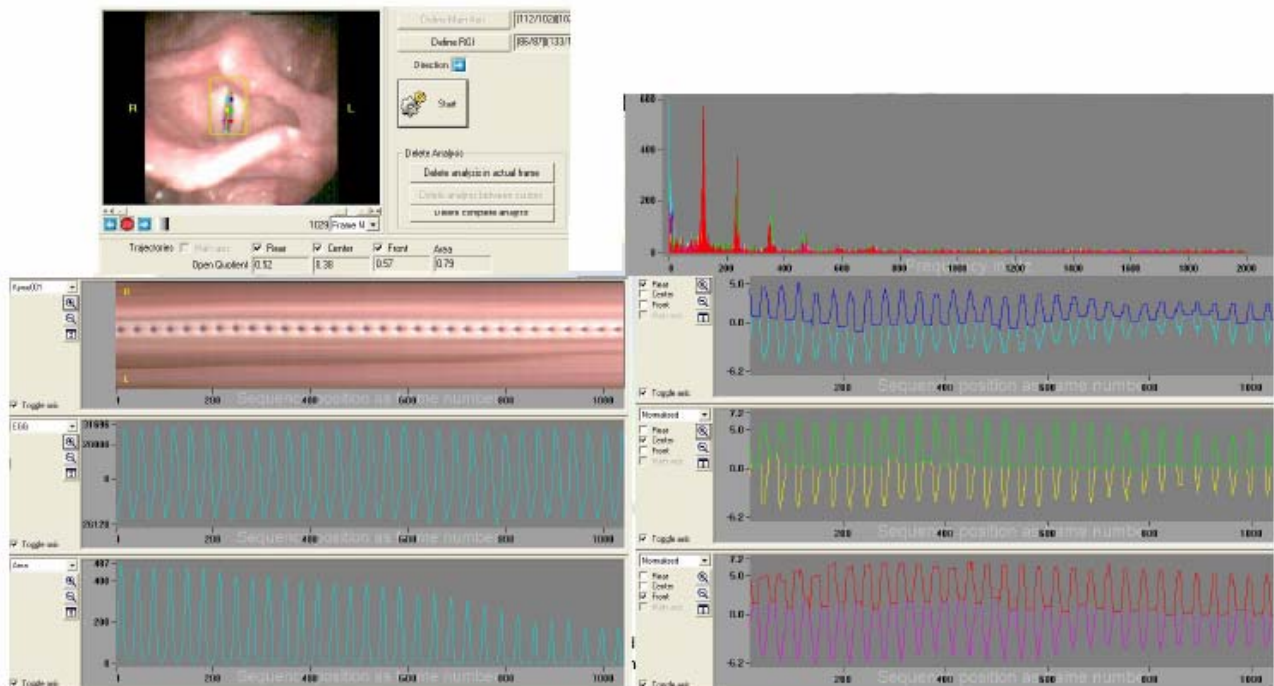


Figure 1: High speed data of a normal male, showing kymographic curve, the electroglottograph (EGG), the area between the vocal cords, the Fast Fourier Transmission (FFT), and the opening phases of the rear, center and front part of the vocal cords.

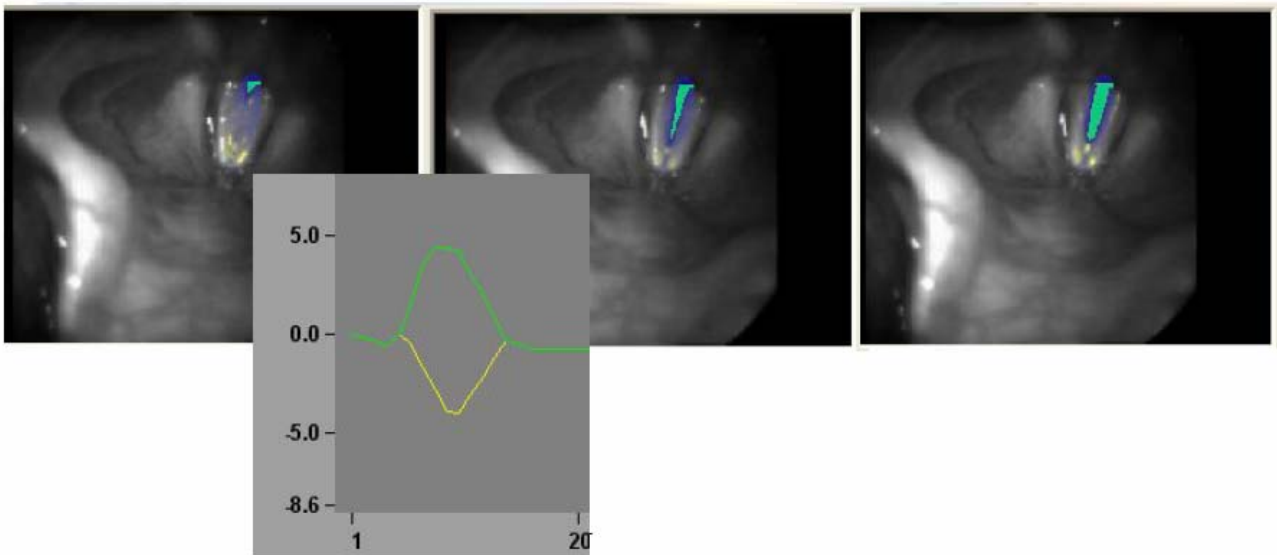


Figure 2: Segmentation is demonstrated by the colour variations seen in the figures. The colour variations show the differences of adduction and abduction of the vocal cords during phonation.

In stroboscopy, there is mostly an average of 4-5 compressed pictures/second of the vocal cords, and due to this, the real movement evaluation compared with EGG and acoustical measures, including the open phases, cannot be made.

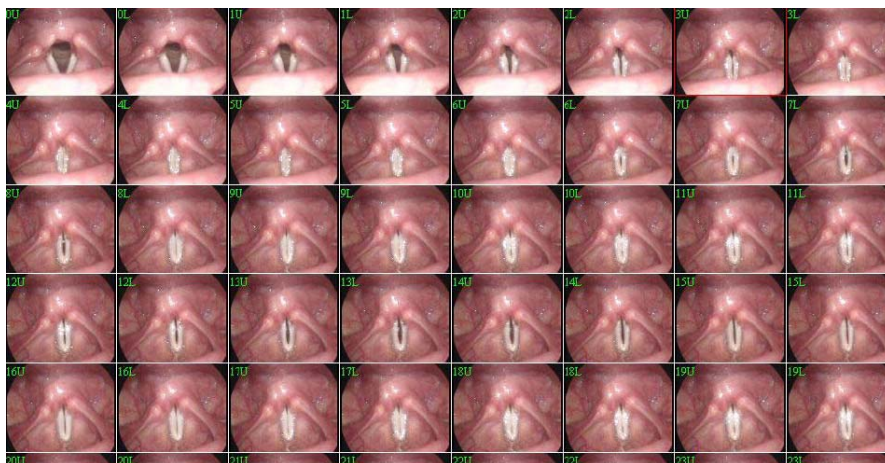


Figure 3: With stroboscopy, front, center and rear parts cannot be well defined.

METHOD and MATERIAL

The routinely made high speed films included on average 1-2 seconds of film with 4000-8000 frames. Segmentation was made with marking of the free edges of the vocal cord. The following modes were analysed (as presented in figure 1):

- 1) kymography
- 2) Electroglottograms (EGG)
- 3) Acoustical curves
- 4) Presentation of the area between the vocal cords
- 5) Fast Fourier Transmission (FFT) up till 2000 Hz.
- 6) Specific presentation of the right and left vocal cords' movement in the front, middle and rear area of the open phases.

A software calculation of distance between the cords was given in the front, middle and rear part of the vocal cords (Wolf Inc). Statistics were made of differences before and after the given treatment (using the SAS statistics).

We have a standard differential diagnosis and treatment for inflammation in the upper airways, with local steroids and supplemented with a strong antihistamine in maximum dose.

The index dystonic patient came into the clinic with throat complaints. She was treated according to the standard treatment for inflammation in the upper airways. The picture below demonstrates the universal dystonic symptoms she was suffering from:



Figure 4: The index patient

The dystonia was surprisingly eliminated completely within 14 days as a result of the treatment.

During a consultation at the first follow up after the dystonia had disappeared, the index patient suddenly experienced a relapse with cramps in the facial area, triggered by irritation of the high speed camera in the larynx region. The patient was immediately given 4-5 inhalations of local steroids, where after the symptoms disappeared. The high speed results are presented below, including the kymography, the electroglottography (EGG), acoustical curve, vocal movement, area calculations between the vocal cords and open quotients in front, center and rear part of the glottis.

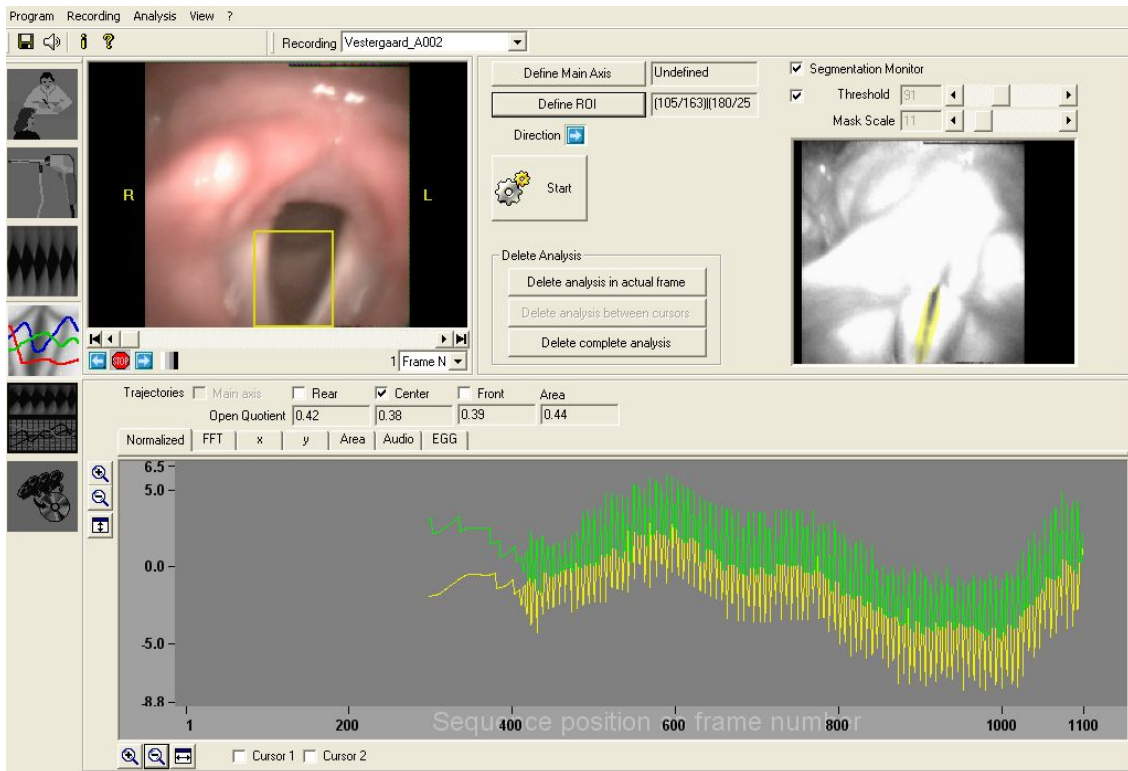


Figure 5: Open quotients in the front, middle and rear parts of the vocal cords, with segmentation while the dystonia still persisted. Notice the reduced open quotients. The curve shows the open quotient of the center part of the vocal cords.

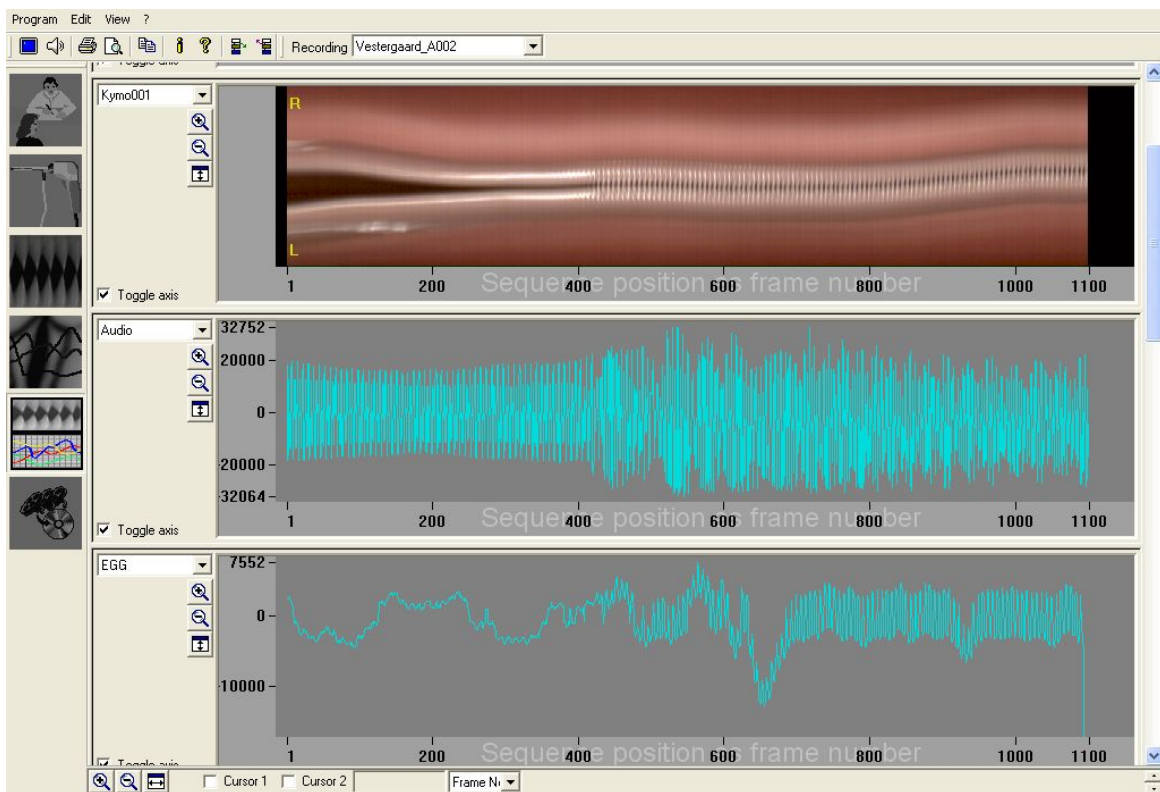


Figure 6: Showing the kymography, acoustical curve and EGG for the index patient while the dystonia still persisted.

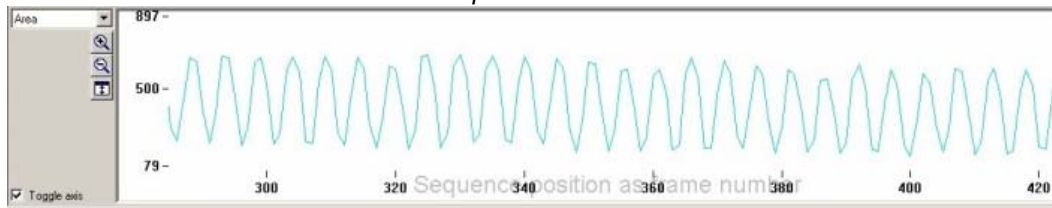


Figure 7: Showing the area while the dystonia still persisted. Notice the sharp closure.

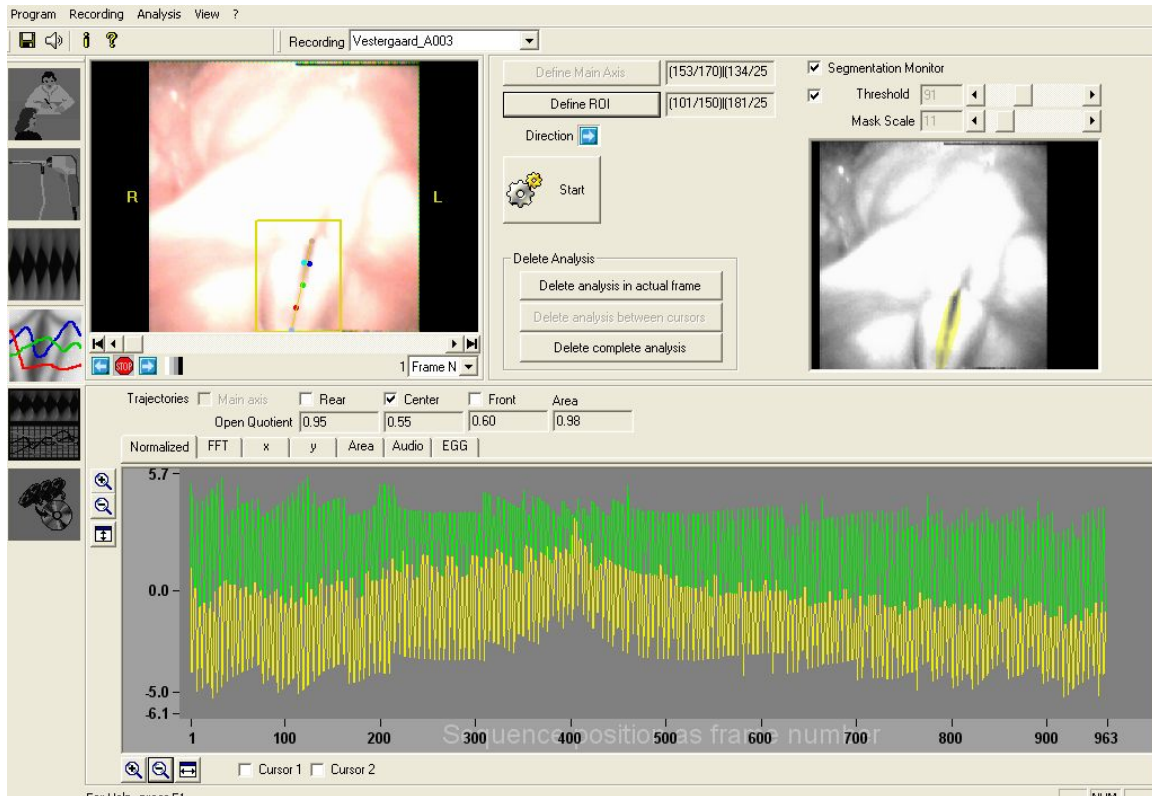


Figure 8: Open quotients in the front, middle and rear parts of the vocal cords, with segmentation after the acute treatment of the dystonia relapse. Notice the higher open quotients compared with figure 5. The curve shows the open quotient of the center part of the vocal cords.

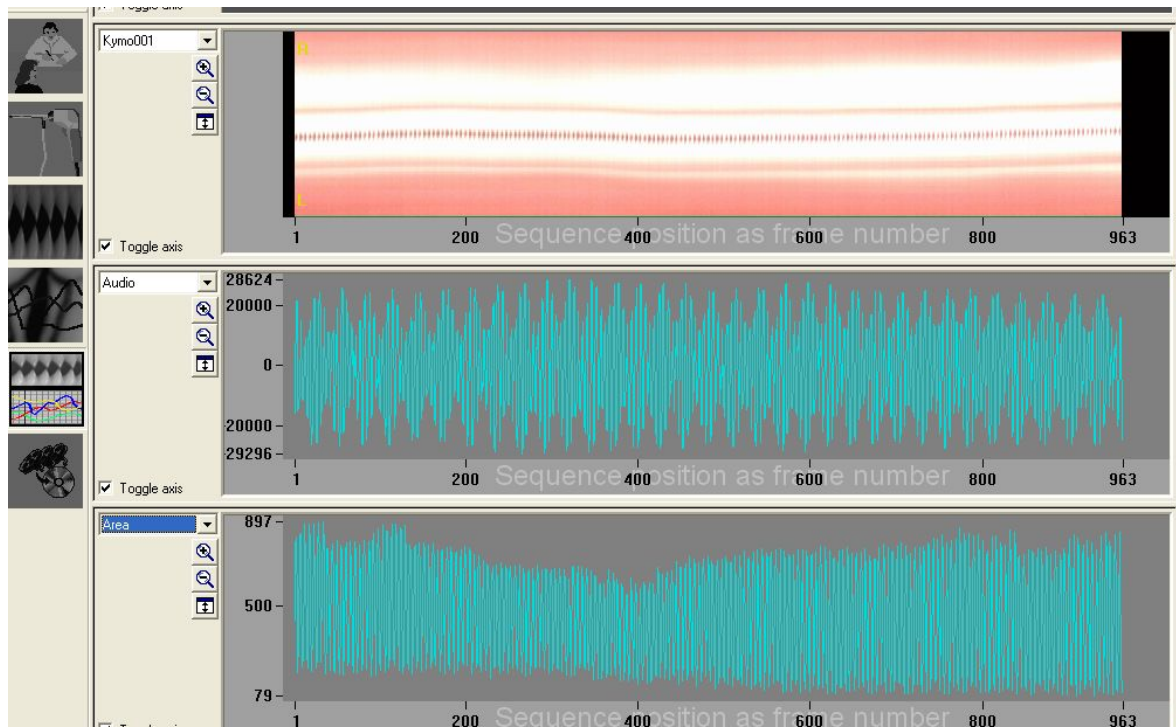


Figure 9: Showing the kymography, acoustical curve and area between the vocal cords for the index patient after the dystonia was treated at the acute relapse.

An example is given of how a dystonic pressed voice can be seen at the kymography:

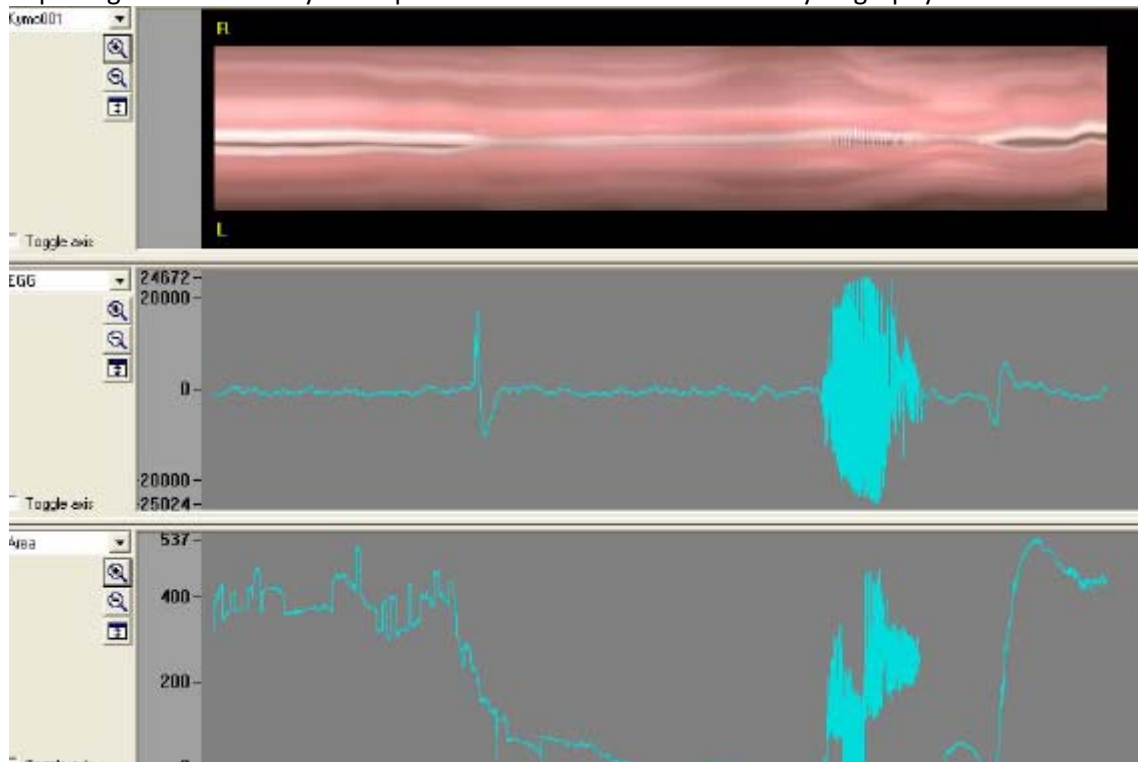


Figure 10: Kymography, EGG and the area between the vocal cords for a pressed voice of a dystonic patient

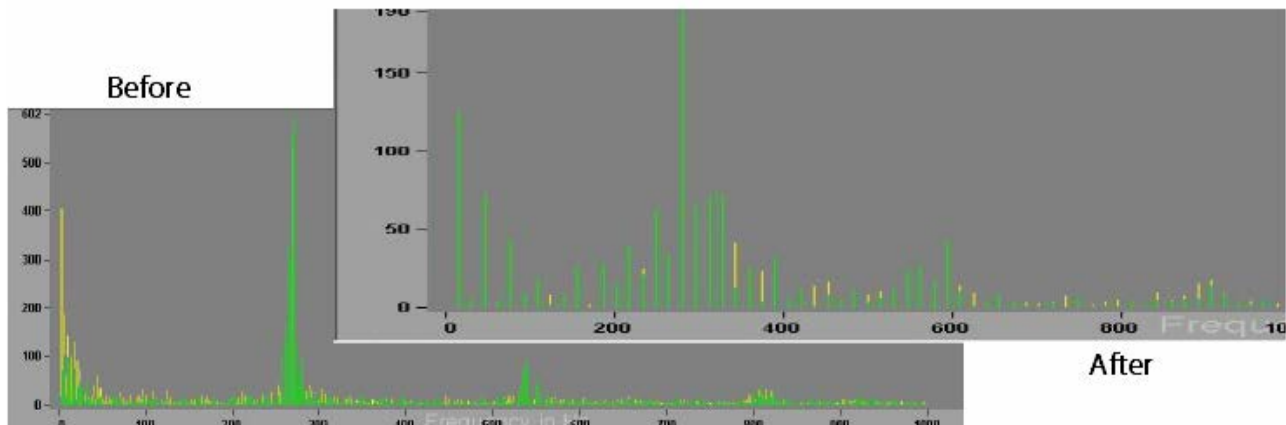


Figure 11: Showing the FFT before and after medical treatment of the pressed voice.

The dystonic patients

Following the surprising results of the index patient, a prospective case control cohort study was carried out. 55 patients with localised and universal dystonia were prospectively referred to the clinic in a period of 8 months, mostly from our co-workers in physiotherapy, even if they have had dystonia for many years. The patients were complaining of all round voice problems. The physiotherapists wanted a systematically overall status of the patients immune systems and eventual treatment of upper airway mucosal problems. The patients were in dystonia training groups already established. Surprisingly, the effect of mucosal treatment of the upper airways was, in many cases that the dystonia was reduced or even disappeared. Therefore, visual scores on dystonia symptoms from 1-100 of the diagnosis and treatment effect of the immune system with local steroids in the pharynx and larynx combined with a strong antihistamine in maximal dosage were graded by the patients. A control group of normal individuals was set up. The dystonic material included 14 males, 41 females of which 12 males and 14 females were in work. 14 males and 36 females received botox treatment. Immune system deficiencies were found in all patients.

RESULTS

The dystonia related changes of voice were seen on the kymography and the EGG, especially when compared with the acoustical curves. We evaluated the well known cycle look of the variance of frequency, which was mostly from 5-20 cycles. In those cases where there was a treatment effect, the "cycle look" disappeared. The open quotients between the vocals cords normalized as measured on normal clients.

In figure 12-16, the visual scores of upper airway, mucosal treatment effect, presented in percentage, of all patients are shown. A relation is also made to symptom duration. In table 1, the calculation is presented of the open phases in the front, center and rear part of the vocal cords, before and after immunological diagnosis and treatment (including local steroids and a strong antihistamine).

Using Nominal Logistic Fit for improvement, a chi square calculation was significant for the treatment effect of the center opening phase between the vocal cords (0,0009).

A calculation has been made, comparing an earlier material with normal patients and the dystonic patients. If the patients are divided in groups as presented, there is a significant difference for the dystonia material of 0,0577 at the center opening phases for the group with 51-75% effect on the visual score.

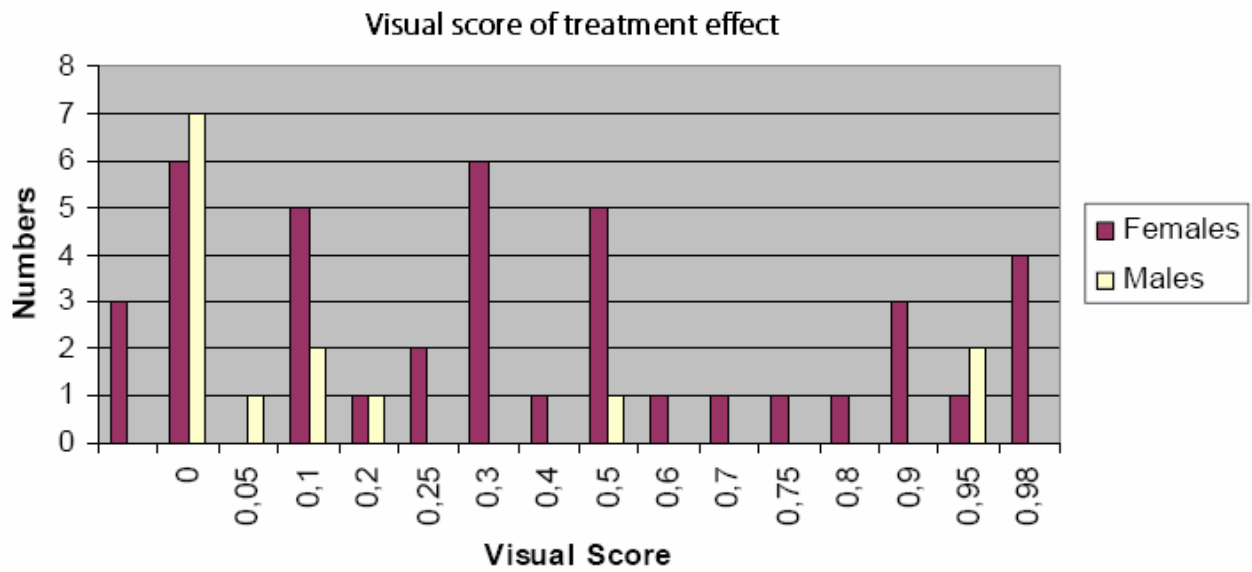


Figure 12: General visual score of treatment in males and females

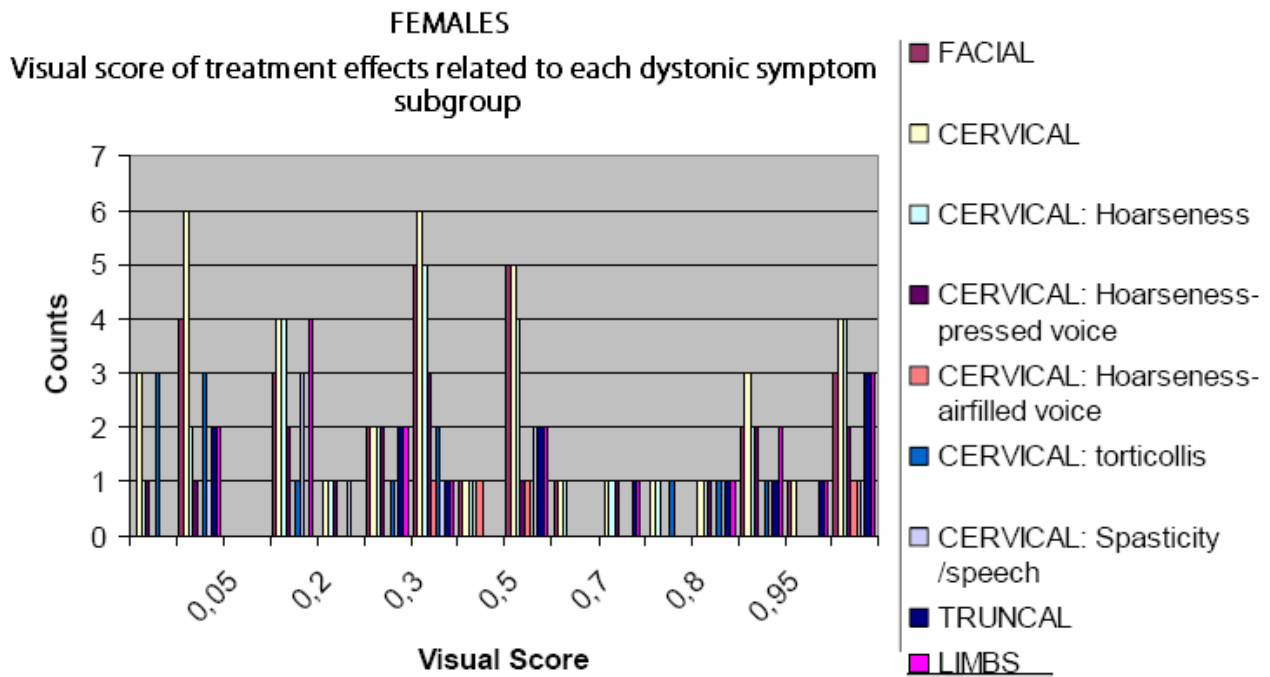


Figure 13: Visual scores of improvement in each dystonia subgroup for females

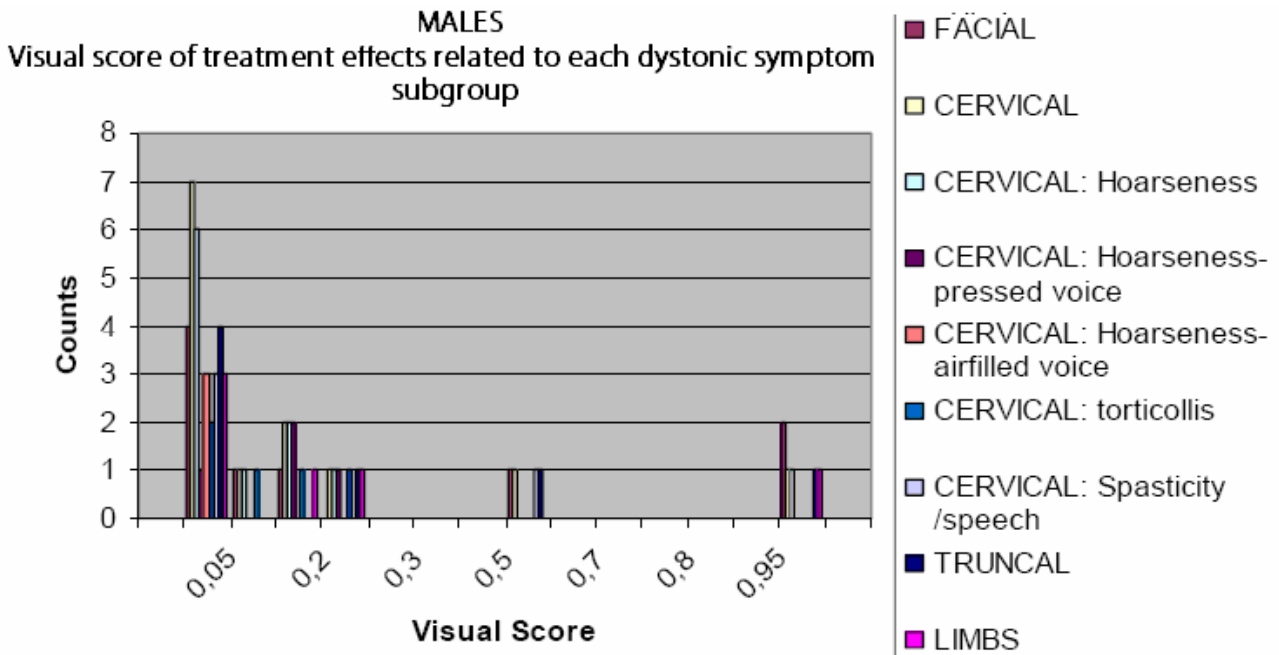


Figure 14: Visual scores of improvement in each dystonia subgroup for males

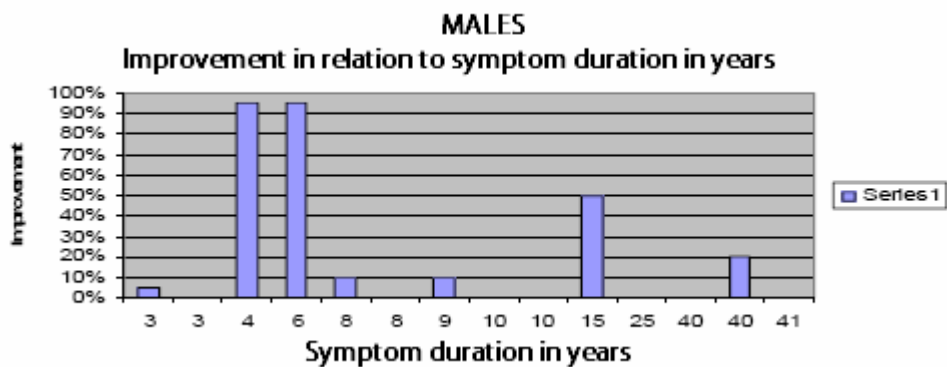


Figure 15: Improvement in relation to symptom duration in years for males,

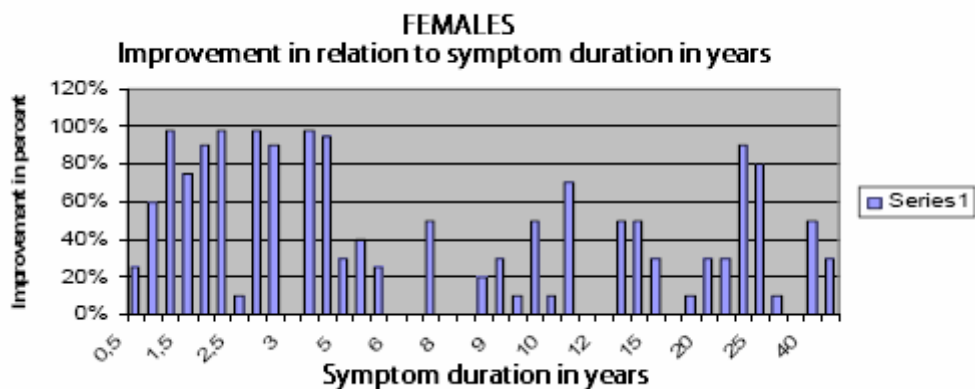


Figure 16: Improvement in relation to symptom duration in years for females

| VISUAL SCORE | BEFORE TREATMENT | | | | AFTER TREATMENT | | | |
|--------------|------------------|--------|------|------|-----------------|--------|------|------|
| | Front | middle | rear | area | Front | middle | rear | area |
| 76-100 | 0,44 | 0,53 | 0,62 | 0,74 | 0,54 | 0,64 | 0,68 | 0,77 |
| 51-75 | 0,69 | 0,51 | 0,43 | 0,74 | 0,81 | 0,69 | 0,72 | 0,89 |
| 26-50 | 0,49 | 0,50 | 0,56 | 0,66 | 0,61 | 0,63 | 0,63 | 0,84 |
| 1-25 | 0,52 | 0,46 | 0,66 | 0,77 | 0,61 | 0,53 | 0,44 | 0,73 |
| 0 | 0,43 | 0,54 | 0,64 | 0,67 | | | | |

Table 1: Showing the opening phases of the front, center, and rear parts of the vocal cords in each group of visual score of treatment

DISCUSSION

The aspect of objective voice measures has been discussed at several conferences (Pedersen 1991, Pedersen and Christensen 1992). Izdebski K (1998) described verbal tests without objective measures to use in spasmodic dysphonia.

A Cochrane review was made in 2006 by Watts and Chad in which the reviewers concluded that “the evidence from randomised controlled trials supporting the effectiveness of botulinum toxin for management of spasmodic dysphonia is deficient”.

Vena et al. 2008 thoroughly described the many effects on the immune system of H1-antihistamines. Pedersen et al. 2008 and 2009 had presentations at the Pacific Voice Symposium on the new treatment possibilities on laryngeal dystonia and related disorders and discussed clinical voice related technologies. A meta-analysis was made of acoustical measurements in 2008 by Maryn et al. concluding that “although acoustic measures are routinely utilized in clinical voice examinations, the results of this meta-analysis suggest that caution is warranted regarding the concurrent validity and thus the clinical utility of many of these measures”.

Hopefully, the new digital quantitative analysis of high speed imaging can be used for clinical evidence (Yuling et. al 2009)

Focusing on the upper airways is traditionally done in singing and the treatment we used could lead to a partial normalization of the vibrato related system. The vibrato is not clearly understood, but it certainly represents an optimal coordination of the motor system in the human body. (DeJonckere et al 1995, Timmermans B et al 2005).

CONCLUSION

With the use of high speed films, many voice related neurological disorders can be more accurately diagnosed. High speed films should therefore be used much more in the field of neurology, at least as a standard of diagnosis of neurological voice disorders. High speed films can also prove to be a useful tool in documenting the effect of treatment.

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