

High speed films for evaluation of laryngeal reflux

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The Presenter

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Materials and Methods

A high-speed film is shown of a case-patient with reflux, where mucus regurgitated to the larynx. The film consists of 8000 pictures during a period of two seconds. Compared to videostroboscopy, the high speed camera is a new possibility to evaluate reflux. Due to this, we have attempted to make video score evaluations of the abnormality of the larynx of each patient represented in the high speed films. In an earlier study it was found that acoustical measures were different when the scores were abnormal.

In this study, we have examined a group of patients before and after treatment for laryngeal reflux. The patients were divided into 3 treatment groups, receiving either:

- lifestyle guidance and no other related medication

- lifestyle guidance and 40mg esomeprazole,

- lifestyle guidance combined with 40mg esomeprazole and alginate.

Results and Conclusion

The high speed film showed statistically significant reduction of the arytenoids oedema. Due to the fact that online evaluation on the larynx on high speed films shows the correct and actual visualization, it is our experience that high speed films are superior to videostroboscopy films for evaluating reflux.

On high speed recordings of the larynx, inter-arytenoids oedema was evaluated and was found to be the basic objective finding in patients with LPR.

References:

Pedersen M, Munck K (2007). A prospective case-control study of jitter%, shimmer% and Qx%, glottis closure cohesion factor (Spead by Laryngograph Ltd.) and Long Time Average Spectra. *Congress report Models and analysis of vocal emissions for biomedical applications(MAVEBA); pages 60-4.*

Hopkins C, Yousaf U, Pedersen M (2005). *Acid reflux treatment for hoarseness. Cochrane Database of systematic Reviews 2006, Issue 1. Art. NO.: CD005054. DOI: 10.1002/14651858.CD005054*

Objective of the study

The objective of the study was to evaluate the use of high speed films to quantify swelling and dysfunction of the larynx due to gastroesophageal hernia

A film example

- A film is shown where acid and mucus from the stomach touches the arytenoid region, and disappears again, without anatomical follows



Mucus appearance



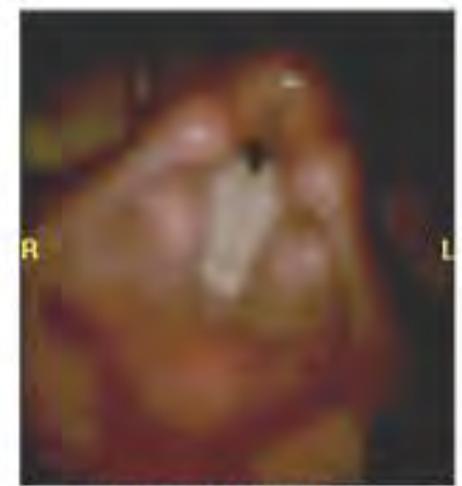
0.075 seconds, frame 302



0.2 seconds, frame 1272



0.3 seconds, frame 1551



0.4 seconds, frame 2116

Figure 1: Frames taken from a high-speed video set on recording 4000 pictures per second. The picture, at frame 1272 shows the appearance of mucus in the larynx, and shortly after (frame 1551) it is reduced. On frame 2116, the mucus has disappeared. The process took a total of 0.2 seconds.

Grading of irritation

- Grading of irritation of the arytenoids into grade 1-5



Fig. 1A

Score 1



Fig. 1B

Score 3

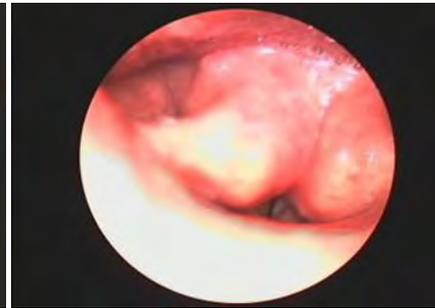


Fig. 1C

Score 5

- The grading was presented at MAVEBA 2007
- Acoustically, a difference was found only between grade 1 and grade 2-5

Tables

A:

arytenoids shape 1	mean jitter%	Std Dev	mean shimmer%	Std Dev	mean Qx%	Std Dev	N	Comments
shape 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 1	frequency variation%	Std Dev	loudness variation%	Std Dev	Qx%	Std Dev	N	comments
shape 1	9,1	11,1	16,4	5,6	46,7	11,4	338	normal 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 ppt.)	
	1. examination	Std Dev	2. examination	Std Dev
shape 4				
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				
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				
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 ppt.)		(shape 1 1 ppt.)	

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.

Difference of MDVP

In the previous prospective cohort study, we showed, both on sustained tones as well as on reading of a text, a difference of MDVP (Laryngograph Ltd.) between a normal arytenoid area and mucosal oedema

The study

- Our Cochrane review on laryngo-pharyngeal reflux showed that the patient populations in the previous publications were too small to detect any differences between treatments. Due to this, a power calculation was made for this study.
- The calculation showed that 49 patients in each group were needed to obtain a power of 90%, showing an effect of lifestyle correction, proton pump inhibitors and alginate.
- A randomised controlled prospective study, with 237 participating patients, was carried out during a period of 2 1/2 years

Abstract

- Background

- Acid reflux is a common problem, and is thought to occur in 4% to 10% of patients presenting to ENT clinics. A recent study of reflux and voice disorders suggests that up to 55% of patients with hoarseness (dysphonia) have laryngopharyngeal reflux. Anti-reflux therapy is often used empirically in treating patients with hoarseness, where no other cause has been identified by examination.

- Objectives

- The aim of the review was to assess the effectiveness of anti-reflux therapy for patients with hoarseness, in the absence of other identifiable causes, regardless of whether or not a definitive diagnosis of laryngopharyngeal and gastro-oesophageal reflux had been made. This was assessed by evaluation of prospective randomised controlled studies that were identified by a systematic review of the literature. Both medical and surgical treatments were evaluated.

- Search strategy

- The Cochrane ENT Group Specialised Register, the Cochrane Central Register of Controlled Trials (CENTRAL) (Cochrane Library Issue 3, 2005), MEDLINE (1966 to 2005), EMBASE (1974 to 2005) and conference proceedings were searched with prespecified terms. The date of the last search was September 2005.

Abstract continued

Selection criteria

- Randomised controlled trials recruiting patients with hoarseness in the absence of other identifiable causes, such as malignancy, cord palsy or nodules, and regardless of whether or not a definitive diagnosis of laryngopharyngeal and gastro-oesophageal reflux has been made.
- Data collection and analysis
- Three reviewers examined the search results and identified studies before deciding which would be included in the review.
- Main results
- 302 potential studies were identified by the search strategy. No trials were identified which met our inclusion criteria. Six randomised controlled trials were identified in which some, but not all patients presented with hoarseness, and were treated with proton pump inhibition. As we could not determine with certainty whether all these patients had hoarseness among the other laryngeal symptoms, these were excluded. However, these studies suggest a significant placebo response, which is comparable to the benefit derived from anti-reflux therapy in some studies. As no trials met our criteria, we are unable to reach any firm conclusions regarding the effectiveness of anti-reflux treatment for hoarseness.
- Authors' conclusions
- There is a need for high quality randomised controlled trials to evaluate the effectiveness of anti-reflux therapy for patients with hoarseness, which may be due to laryngopharyngeal and gastro-oesophageal reflux.

Flowchart 1: Comparison of treatments for laryngo-pharyngeal reflux (LPR)

Trial start

Eligible LPR patients

Requirement for inclusion was symptoms of LPR, with the subjective complaint that “my throat does not function” and inter-arytenoid oedema. The symptom duration was at least 2-4 weeks.

Supplementary inclusion criteria were the presence of two or more of the following subjective complaints:

- Hoarseness or a problem with your voice
- Clearing your throat / excess throat mucous or postnasal drip
- Difficulty swallowing food, liquids, or pills (dysphagia)
- Coughing after you ate or after lying down, troublesome or annoying cough
- Breathing difficulties or choking episodes (larynx spasms and hick ups)
- Sensations of something sticking in your throat or a lump in your throat (globules)
- Heartburn, chest pain, indigestion or stomach acid coming up, pain or burning feeling in the throat

Tests: High speed films, video-stroboscopy, voice analysis including jitter%, shimmer%, electroglottography (EGG) closed phase Qx% on a sustained tone (/ah/) frequency variation%, loudness variation%, electroglottography (EGG) closed phase Qx% on reading of a standard text.

N = number of included

Life style guidance

Life style guidance +
Proton pump inhibitors 1 X 40mg/day.

Life style guidance + Proton pump inhibitors 1 X 40mg/day + Gaviscon 1-2 chewing tablets after the main meal and at bedtime.

Clinical re-examination: high speed films, video-stroboscopy, voice analyses (reading of a standard text + sustained tone on /ah/). Assessment of inter-arytenoid oedema. Asking patients about subjective complaints.

Clinical re-examination and follow-up: high speed films, video-stroboscopy, voice analyses (reading of a standard text + sustained tone on /ah/). Assessment of inter-arytenoid oedema. Asking patients about subjective complaints.

ASSESSMENT OF OUTCOME

Statistical comparison of the outcome of the three groups → formation of a conclusion

14 days

2-3 months



Opening quotients

- A calculation of opening quotients on high speed films was made before treatment and after 14 days, of the front, center and rear of the vocal cords during intonation.

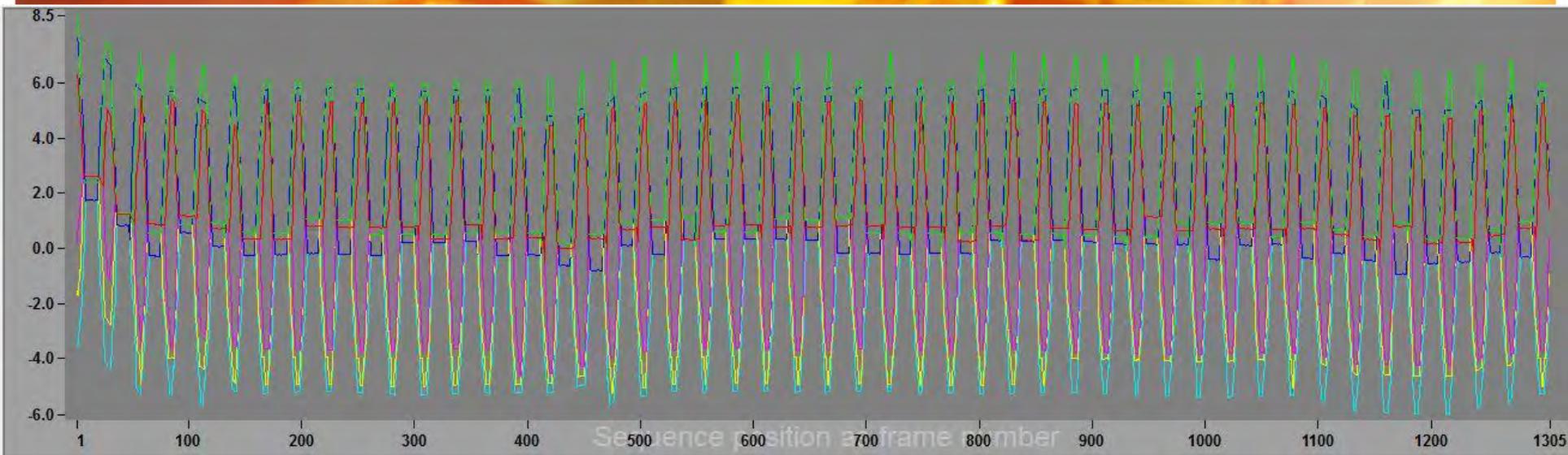
The screenshot shows a software interface for calculating opening quotients. On the left is a video frame of the vocal cords with 'R' and 'L' markers. The central control panel includes fields for 'Define Main Axis' and 'Define ROI', a 'Direction' button, a 'Start' button with a gear icon, and a 'Delete Analysis' section with three options: 'Delete analysis in actual frame', 'Delete analysis between cursors', and 'Delete complete analysis'. On the right, the 'Segmentation Monitor' is active, showing a threshold of 57 and a mask scale of 15, with a corresponding grayscale image of the vocal cords where the opening is highlighted in green. At the bottom, a table displays the calculated opening quotients for different regions.

Trajectories	Main axis	Rear	Center	Front	Area
		0.60	0.52	0.40	0.59

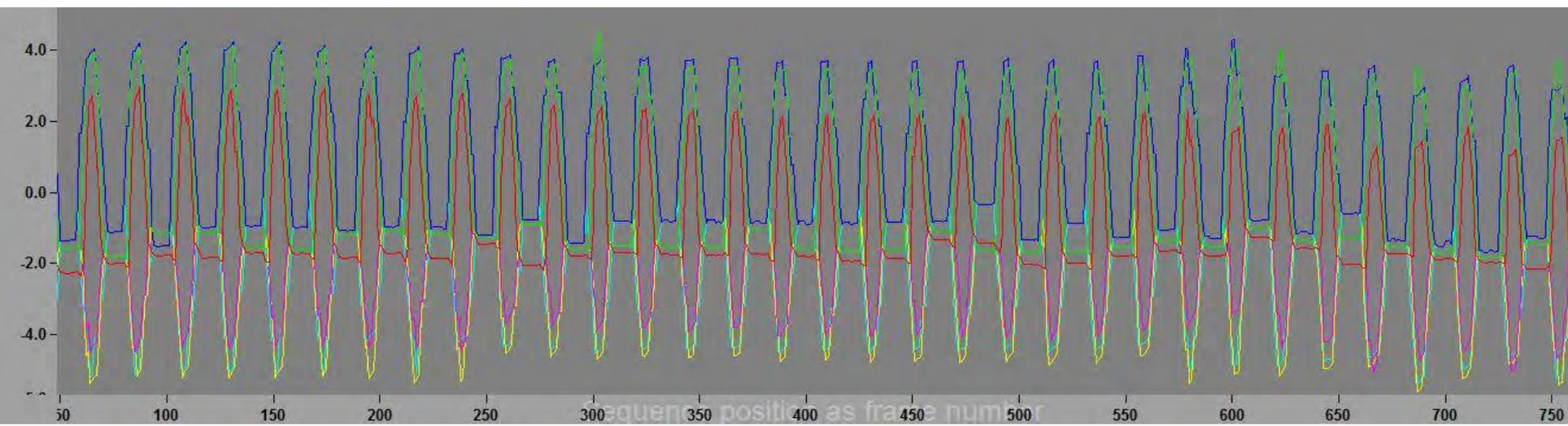


Trajectories	<input type="checkbox"/> Main axis	<input checked="" type="checkbox"/> Rear	<input checked="" type="checkbox"/> Center	<input checked="" type="checkbox"/> Front	Area
Open Quotient	0.57	0.46	0.33	0.58	

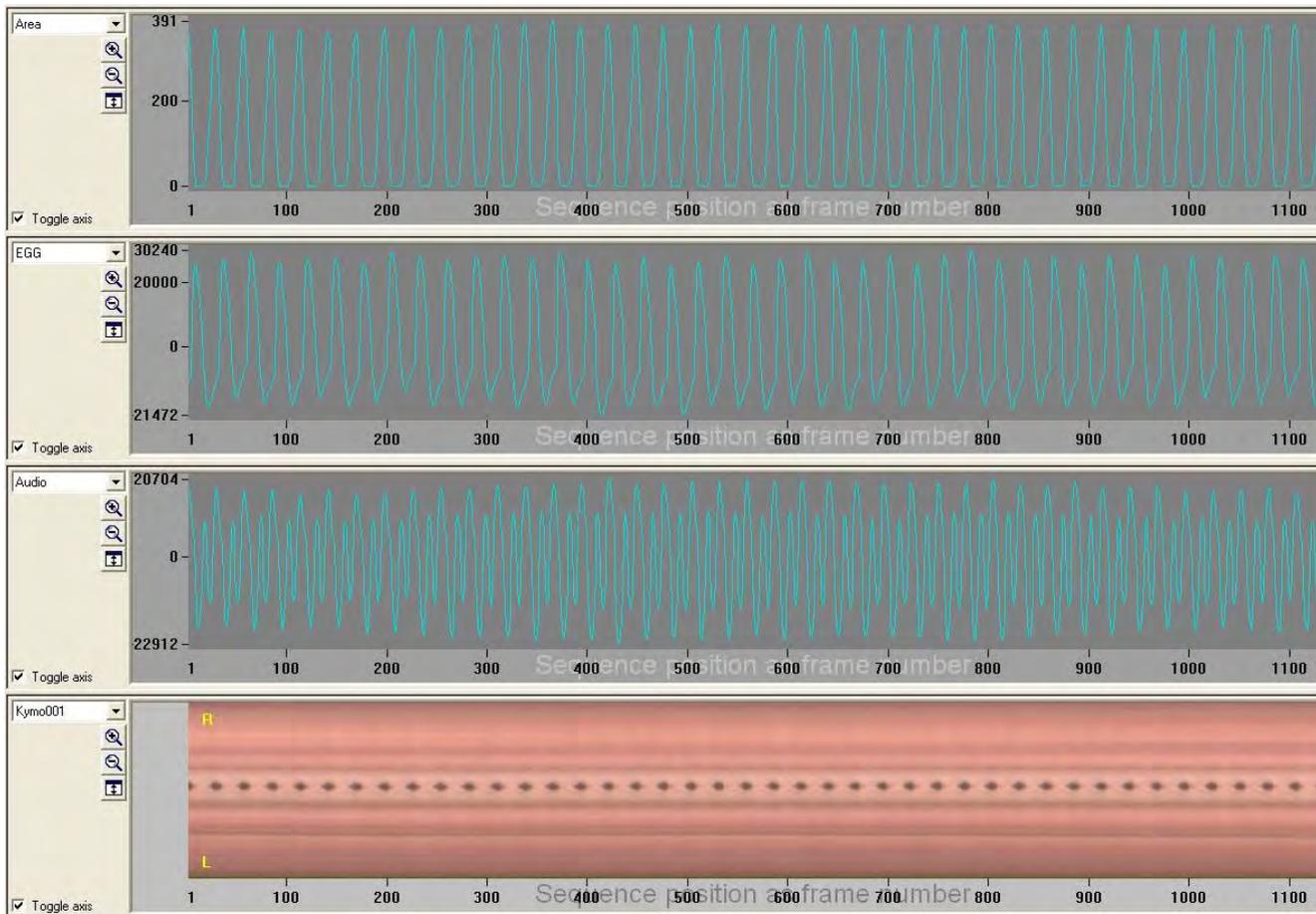
The acoustical and electroglottographical curves, as well as the movement of the right and left vocal cords, in the front, center and rear did not change, but the arytenoid region oedema was reduced after treatment



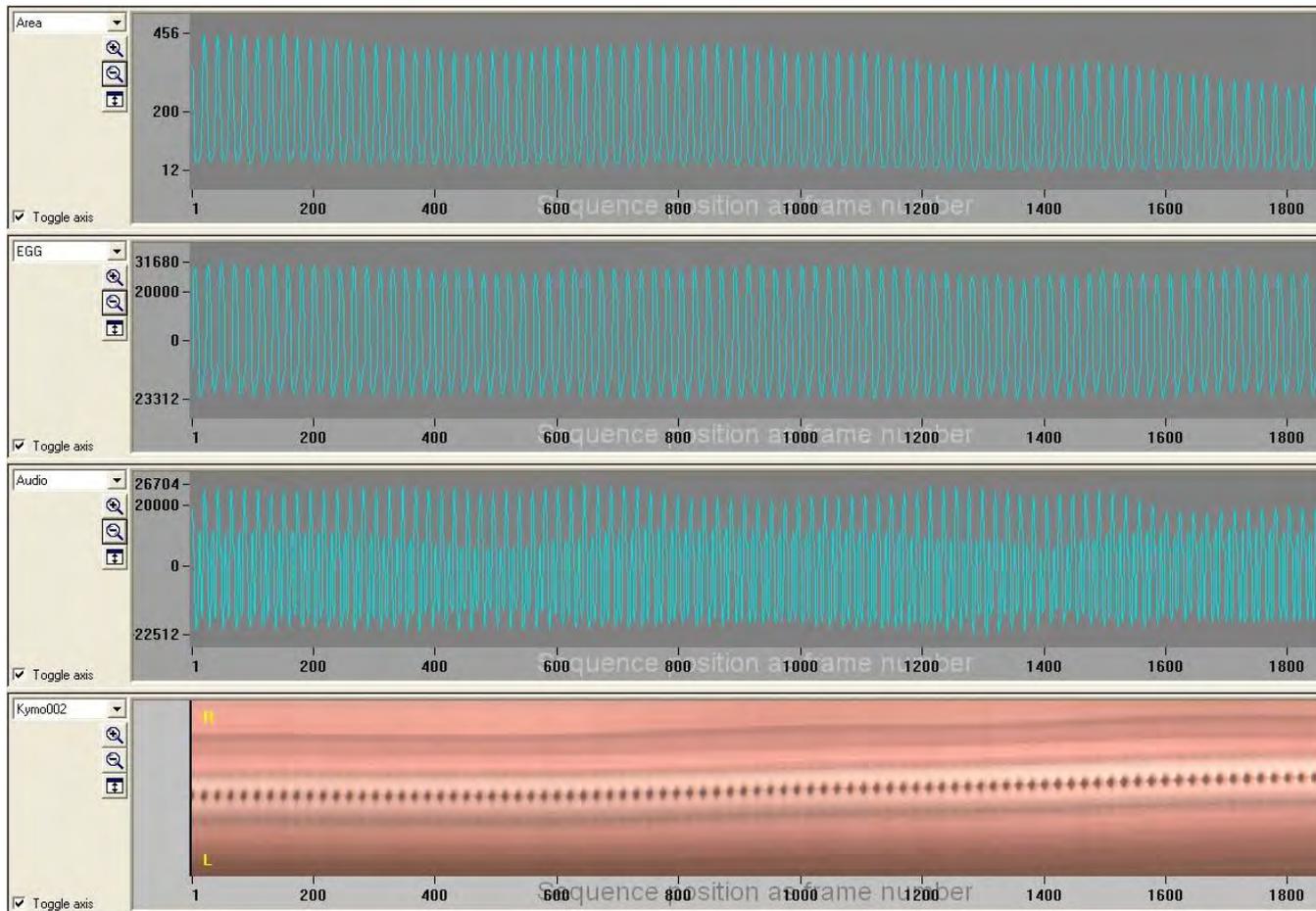
Before and after



Before



After





Define Main Axis: [(155/121)][(143/194)]

Define ROI: [(128/117)][(173/196)]

Direction

Start

Delete Analysis

Delete analysis in actual frame

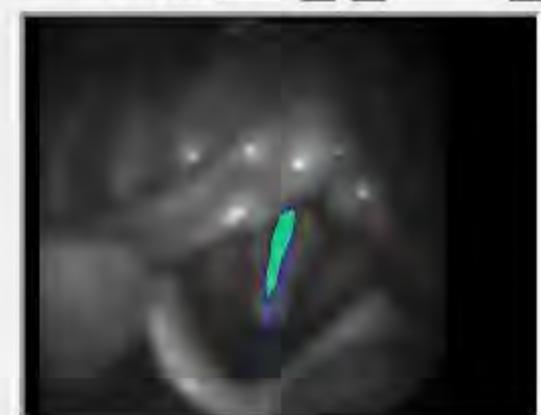
Delete analysis between cursors

Delete complete analysis

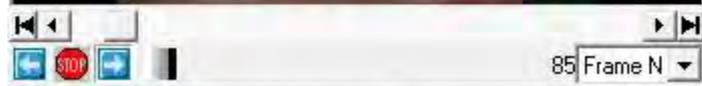
Segmentation Monitor

Threshold: 46

Mask Scale: 10



Trajectories	<input type="checkbox"/> Main axis	<input type="checkbox"/> Rear	<input checked="" type="checkbox"/> Center	<input type="checkbox"/> Front	Area
Open Quotient	1.00	0.69	0.96	1.00	



Define Main Axis: [(107/110)][(103/145)]

Define ROI: [(89/105)][(121/157)]

Direction

Start

Delete Analysis

Delete analysis in actual frame

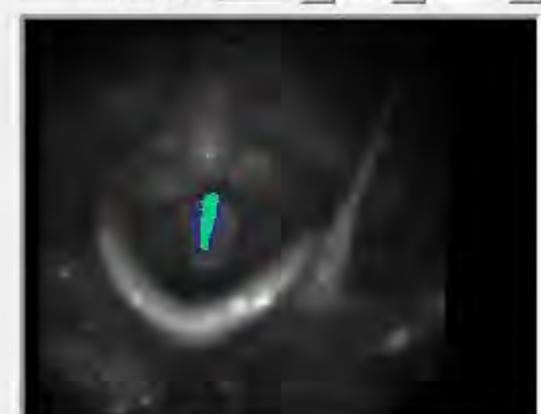
Delete analysis between cursors

Delete complete analysis

Segmentation Monitor

Threshold: 33

Mask Scale: 23



Trajectories	<input type="checkbox"/> Main axis	<input type="checkbox"/> Rear	<input checked="" type="checkbox"/> Center	<input type="checkbox"/> Front	Area
Open Quotient	0.99	0.44	0.29	0.94	

Findings

- Lifestyle advice was found to be the most important factor in order to reduce the subjective complaints of laryngopharyngeal reflux. The effect was also objectively documented with reduction of the oedema of the arytenoid region.
- Lifestyle advice includes instructions on: no smoking, no fatty or smoked food, no caffeine or chocolate, no spicy foods or foods consisting acid, no eating 2-3 hours before bedtime and sleeping with the head positioned 30 degrees up

Discussion

- The randomised controlled prospective study, which was large enough for statistical calculation, showed that evidence-based treatment of laryngopharyngeal reflux involves change of lifestyle.
- This does not mean that pharmacological treatment with proton-pump inhibitors and alginate cannot or should not be used. But especially for rock singers and other singers, our results must be underlined, since many updated singing techniques involve maximum diaphragm movements

Example

- An example is given of an international female jazz singer who came to the clinic 3 years ago with an infection. She returned to this clinic this year, with a gastroeophageal hernia grade 1. Her voice symptoms of voice fatigue and lack of closure between the vocal cords disappeared with lifestyle change supported with proton-pump inhibitors.

Example

The screenshot displays a video analysis software interface. On the left is a video frame of a mouth with a blue trajectory. The video player includes navigation controls and a frame counter showing '408 Frame N'. The main control panel on the right contains the following elements:

- Define Main Axis:**
- Define ROI:**
- Direction:**
- Start:**
- Delete Analysis:**
 -
 -
 -
- Segmentation Monitor:**
 - Segmentation Monitor
 - Threshold:
 - Mask Scale:

At the bottom, a table displays analysis results:

Trajectories	<input type="checkbox"/> Main axis	<input type="checkbox"/> Rear	<input checked="" type="checkbox"/> Center	<input type="checkbox"/> Front	Area
Open Quotient	0.80	0.50	0.28	0.63	

Conclusion

- Based on our randomised controlled study it is seen, that the patient advice for gastroesophageal hernias is optimised with high speed films.
- The patient gets an online impression of where the exact mucosal disorder is located, and an online impression of several functional parametres at the same time