



**Mette Pedersen**

**High Speed Films for  
Evaluation of Reflux to  
Help Popular Rock  
Singers**

# The Presenter



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# Abstract

## *Objective*

The objective of the study was to evaluate the use of high speed films to quantify reflux induced swelling in the larynx. This was to help singers with mostly normal functioning of the vocal cords. Our previous Cochrane review did not show an advantage of proton-pump inhibitors to lifestyle correction alone.

# Abstract continued

- *Material and methods*
- It is known that mucus can be regurgitated to the larynx due to reflux. High speed films from Wolf Ltd. Produce 8000 pictures during a period of two seconds. On high speed films, mucus appeared in the larynx during a period of 0,2 seconds, after which there only was a slight oedema on the arytenoids region. Especially rock singers tend to have problems with reflux due to different positions when they sing. Two films are shown of rock singers with reflux at the time of diagnosis, and a few days after the treatment had begun.

# Abstract continued

- We have attempted to make video score evaluations of the abnormality of the arytenoids region, shown on the high speed films, of patients with reflux. In a previous study it was shown that acoustical measures were different when scores were abnormal. In this (first) randomised controlled study we compared abnormal visual scores of the arytenoids on high speed films of a group of patients, before and after treatment for laryngeal reflux,. The patient were divided into three groups receiving either:
  - 1)lifestyle guidance and no other related medication
  - 2)lifestyle guidance and 40mg esomeprazole
  - 3)lifestyle guidance combined with 40mg esomeprazole and alginate.

# Abstract continued

- *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 in singers.

On high speed recordings of the larynx, inter-arytenoids oedema was evaluated and was found to be the basic objective finding in patients with reflux to the larynx. If the reflux is discovered early and lifestyle changes are made, the influence on a singing career is probably minimal.

- References:

- **(1) 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*

# Abstract – Cochrane review

- 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 – Cochrane review

## 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.

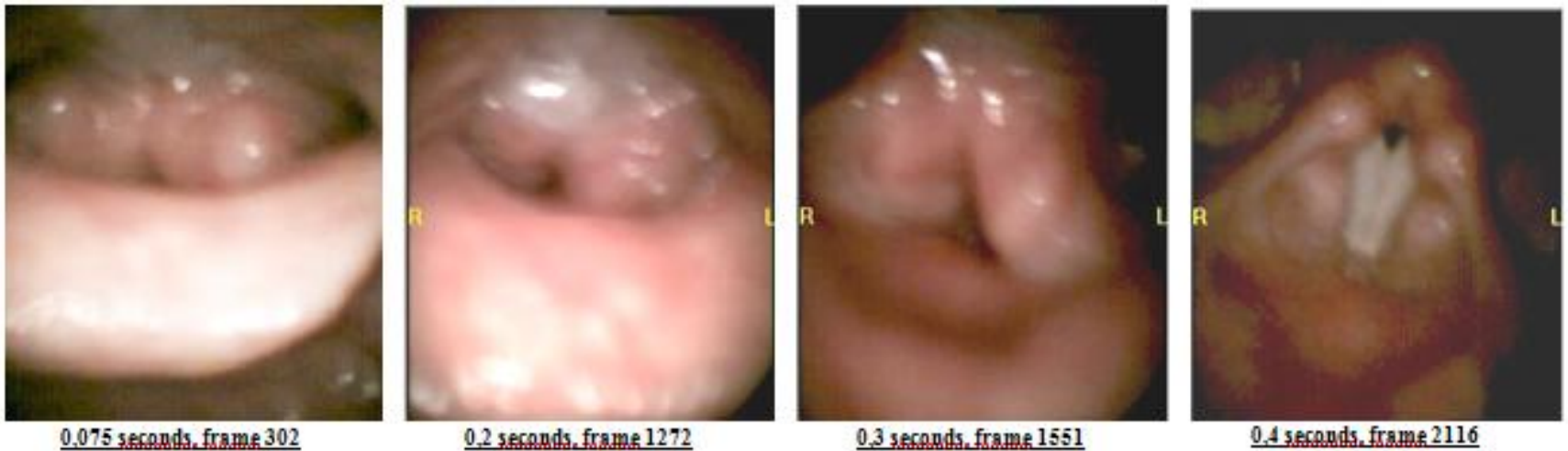


# Reflux flow

- Reflux flow during 0.2 seconds of acid and mucus passage overview and film

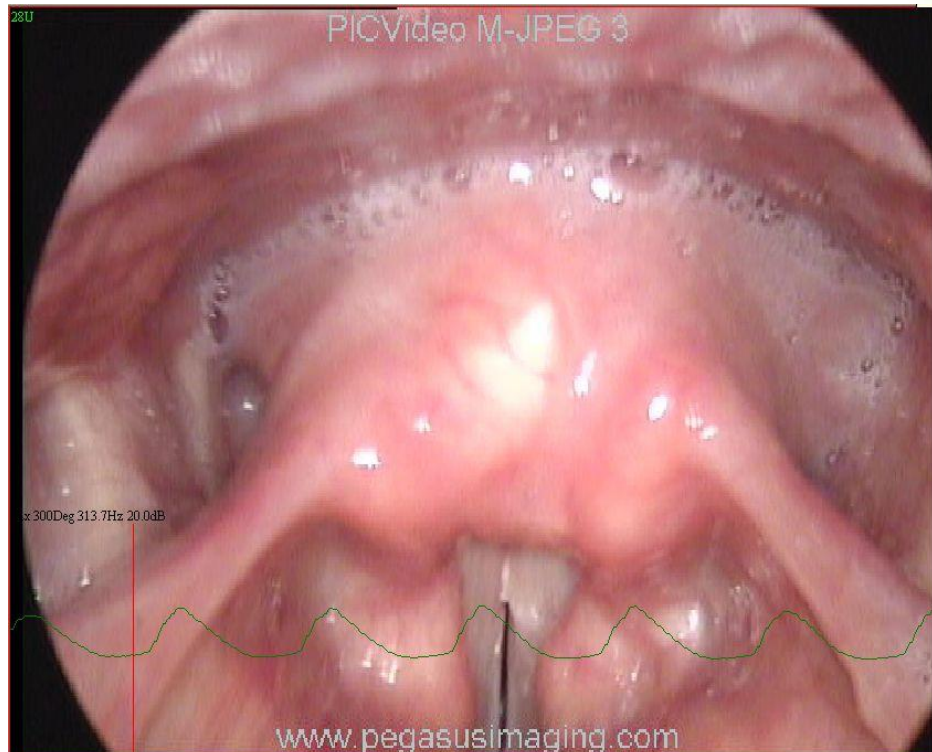


# Appearance of Mucus



**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.

- Videostroboscopy presented as an average of 6 electroglottographic curves



# Example – before treatment

- Example of a rocksinger, who won the Danish Grand Prix Awards. High speed films with segmentation including open phases in front, center and rear parts of the vocal cords before treatment of reflux
- Before treatment

Define Main Axis: [(120/80)|(116/139)]

Define ROI: [(96/78)|(145/139)]

Direction: [→]

Start

Delete Analysis

- Delete analysis in actual frame
- Delete analysis between cursors
- Delete complete analysis

Segmentation Monitor

- Threshold: 57
- Mask Scale: 15

Trajectories:  Main axis,  Rear,  Center,  Front, Area

Open Quotient: 0.60 (Rear), 0.52 (Center), 0.40 (Front), 0.59 (Area)

# Example – after treatment

The screenshot displays a medical software interface. On the left is a video window showing a surgical site with 'R' and 'L' markers. Below it are playback controls and a frame counter showing '31 Frame N'. To the right of the video are control panels for 'Define Main Axis' (coordinates: (170/44)|(160/97)), 'Define ROI' (coordinates: (140/44)|(187/102)), and a 'Direction' button. Below these is a 'Start' button with a gear icon. Further right is a 'Segmentation Monitor' panel with 'Threshold' set to 47 and 'Mask Scale' set to 15. Below the segmentation monitor is a small inset image showing the segmented view. At the bottom, a 'Delete Analysis' panel contains three buttons: 'Delete analysis in actual frame', 'Delete analysis between cursors', and 'Delete complete analysis'. At the very bottom is a data table:

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 high speed films of the singer, two and four days after treatment of a esophageal hernia with Proton-Pump Inhibitors.

Before



2 days after



4 days after



# Arytenoid oedema scores

- (MAVEBA 2007)

## A:

arytenoids	mean		mean		mean				
shape 1	jitter%	Std Dev	shimmer%	Std Dev	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	frequency		loudness						
shape 1	variation%	Std Dev	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.

# Arytenoid oedema scores

- (MAVEBA 2007)

**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.)	
shape	1. examination	Std Dev	2. examination	Std Dev	N 1 <sup>st</sup> 32/ 2nd.25
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	1.examination	Std Dev	2. examination	Std Dev	N 1 <sup>st</sup> 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 1 <sup>st</sup> 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 ppt.)		(shape 1 1 pt.)		

## 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.



# Grading of oedema of arytenoids



Fig. 1A

Score 1



Fig. 1B

Score 3



Fig. 1C

Score 5

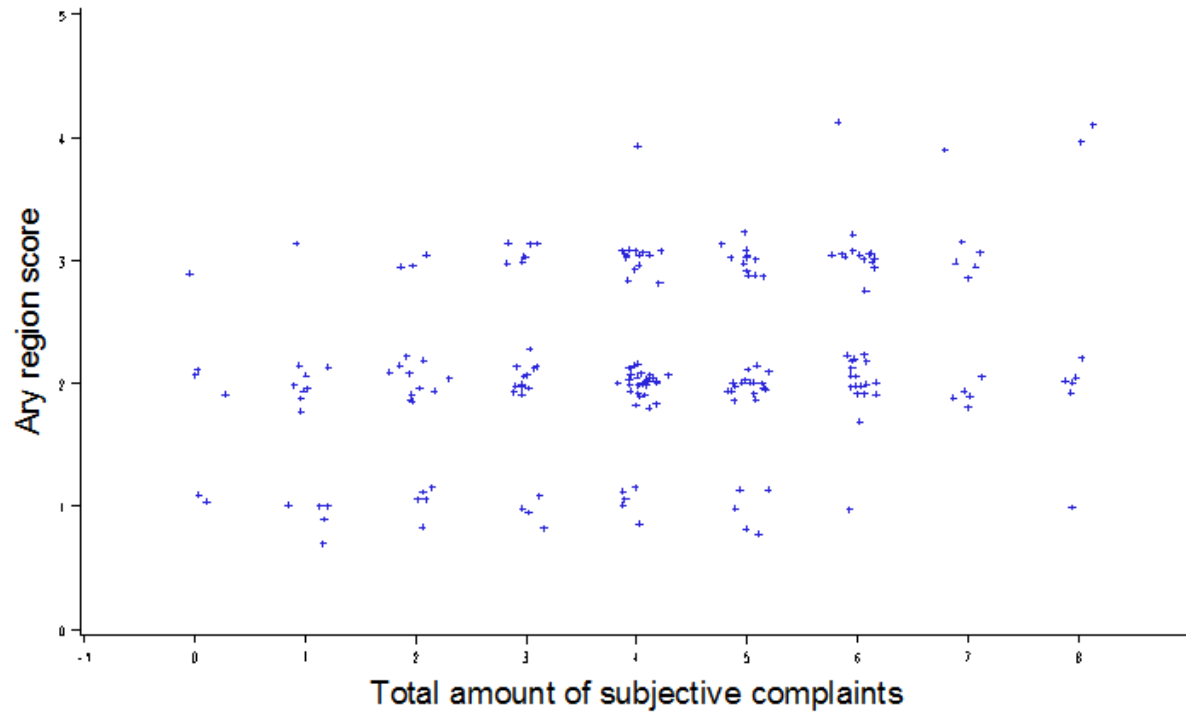
- Visual scores calculation before and 2 weeks after treatment of laryngopharyngeal reflux complaints

**Table 3:** The number of patients of the 5 inter-arytenoid grades for the three groups of Lifestyle, added proton inhibitor (PPI), and added PPI and alginate. The mean grade in each group, range and standard deviation for each group are presented.

	<u>First consultation</u>			<u>Second consultation</u>			<u>Third consultation</u>		
	<u>Lifestyle</u>	<u>Lifestyle + PPI</u>	<u>Lifestyle + PPI + Alginate</u>	<u>Lifestyle</u>	<u>Lifestyle + PPI</u>	<u>Lifestyle + PPI + Alginate</u>	<u>Lifestyle</u>	<u>Lifestyle + PPI</u>	<u>Lifestyle + PPI + Alginate</u>
<b>Oedema of the inter-arytenoid region</b>	<u>Number of patients</u>			<u>Number of patients</u>			<u>Number of patients</u>		
<i>Grade 1</i>	0	0	0	9	8	11	13	13	13
<i>Grade 2</i>	35	29	35	35	29	40	23	21	28
<i>Grade 3</i>	34	33	41	18	17	19	9	9	13
<i>Grade 4</i>	8	8	13	3	2	0	1	0	0
<i>Grade 5</i>	1	0	0	0	0	0	0	0	0
<b>N</b>	78	70	89	65	56	70	46	43	54
<b>Mean grade</b>	2.68	2.70	2.75	2.23	2.23	2.11	1.96	1.91	2.00
<b>SD</b>	0.712	0.667	0.695	0.745	0.738	0.649	0.759	0.718	0.700
<b>Range</b>	2-5	2-4	2-4	1-4	1-4	1-3	1-4	1-3	1-3
<b>Difference to Lifestyle treatment (LS) means [95% CI]</b>					-0.03 [-0.25; 0.20]	-0.14 [-0.35; 0.07]			
<b>p value (#)</b>					0.81	0.20			

(#) Two sided test comparison to Lifestyle treatment group in a statistical model including baseline as covariate and treatment group as fixed effect. (CI = confidence interval)

Figure 2: Scatter plot of the total amounts of subjective complaints (abscissa) versus oedema of the inter-arytenoid region, week 2 (ordinate)



Data are jittered (added noise) to show all data points  
Spearman correlation: 0.280 [95%CI: (0.149;0.410)]

# Sample size consideration

- A total of 49 patients were needed in each group to obtain a power of 90% **in a two-group, one-sided, t-test** to detect a difference of 20% under the assumption that the true difference was 5% and that the standard deviation was 25%. Based on this general consideration and taking into account possible drop out and evaluation of multiple endpoints, a total of 237 patients were randomized in the study.

- No evidence was found for a difference between lifestyle correction and proton-pump inhibitor in this randomised controlled trial.
- The trial was based on our Cochrane Review where no evidence was found for PPI treatment, the patient populations of previous publications being too small.

# 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

# Conclusion

- The artists must have the diagnosis of gastroesophageal hernia/reflux verified by inspection and grading (small – moderate or total opening).
- More quantitative measures are needed.
- It is noted that the artists accept lifestyle correction as basic



# The problem is...

- 1. When rock singers make maneuvers in singing that provokes reflux
- 2. When they are ill with cough, acid reflux cannot be avoided. Prophylactic advice is optional, but in these cases proton-pump inhibitors (and eventually alginate) are mandatory.

- A lifetime success is not destroyed, even when the gastroesophageal hernia/reflux is maximal. The artist has to be conscious of where the voice is weakened and only use the tones that do function.

Thanks to the audience and all my  
students

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