

Group 21: Robotic Soft Tissue Assessment

Seminar Presentation

"Voice Outcomes Following Treatment of Benign Midmembranous Vocal  
Fold Lesions Using a Nomenclature Paradigm"

by Akbulut et al., 2015

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# Overview

- Project Summary
- Introduction
- Summary of Problem & Key Result
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- Necessary Background
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# Project Summary

- Assess and prove through subjective expert analysis that robotic assisted laryngeal surgery is more effective than mere manual surgery
- Use GALEN robot to assist in the laryngeal cyst removal surgery in animal larynx to mimic real surgery

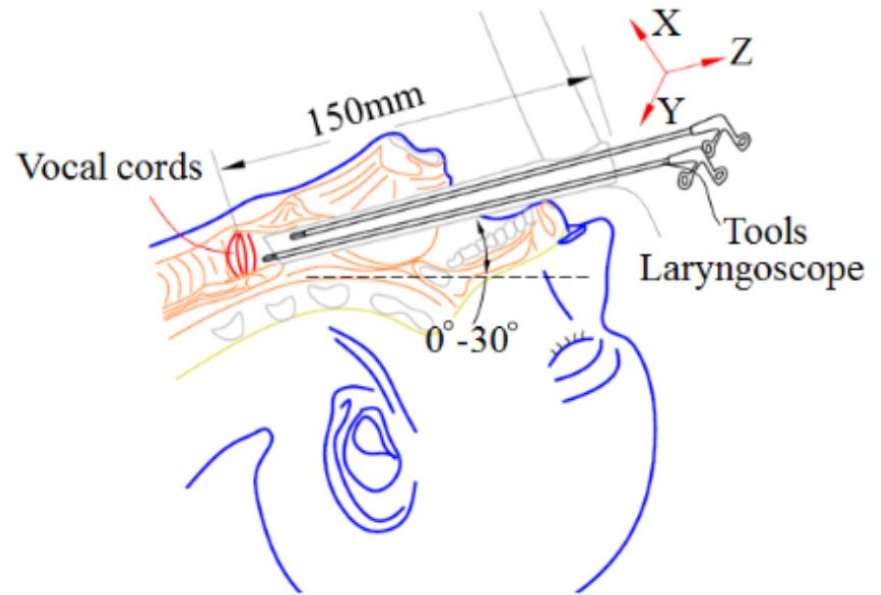


Figure 1: Microlaryngeal Phonosurgery

# Introduction

$$\mathbf{F} = m \mathbf{a}$$

In an inertial reference frame, the vector sum of the forces  $\mathbf{F}$  on an object is equal to the mass  $m$  of that object multiplied by the acceleration  $\mathbf{a}$  of the object.

Standardization can help to maximize compatibility, interoperability, safety, repeatability, or quality.



# Paper Selection

- Concerned with Vocal Cord Lesions
- Standardization of Types of Vocal Cord Lesions
- Draw a parallel between Types of Lesions and Success of Treatment

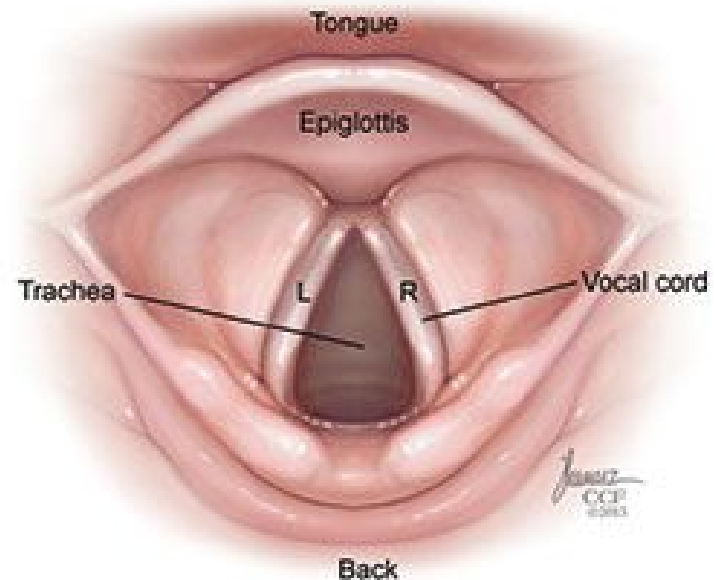


Figure 2: Healthy Vocal Cord Diagram

(Credits: <https://my.clevelandclinic.org/health/articles/vocal-cord-lesions>)

# Summary of Problem

"Benign midmembranous vocal fold lesions (BMVFLs) are common voice disorders, but interpretation of outcomes following treatment is difficult due to the lack of a standardized nomenclature system for these lesions."

For example, Schindler and colleagues reported the results of voice therapy on patients with "Reinke's edema," "vocal fold cyst," and "gelatinous polyp." (Schindler et al., 2013)



# Key Result

The study investigates the outcomes of patients with BMVFLs using a previously validated nomenclature, and provides incidences and outcome results for each diagnosis.

The key result of the paper is producing the first outcomes-based report of BMVFLs using a strictly defined nomenclature system for stratification of lesions.

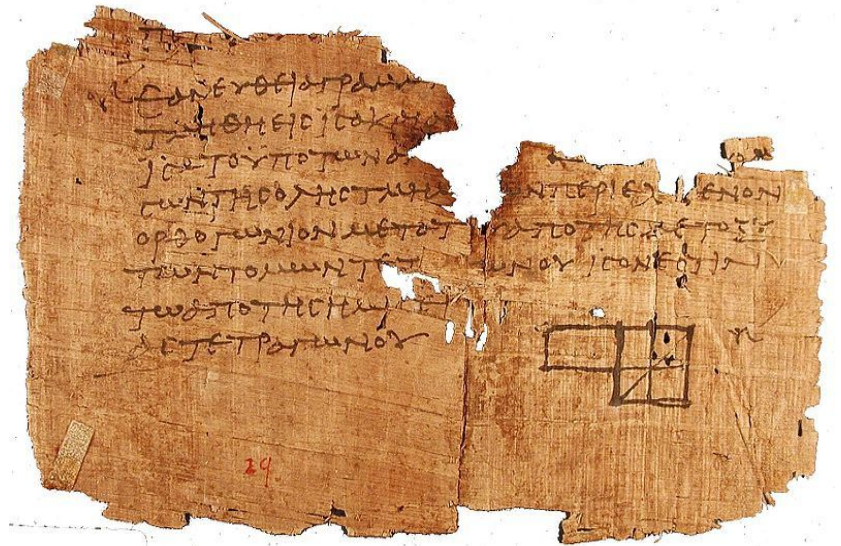


Figure 3: Oxyrhynchus papyrus showing fragment of Euclid's Elements, AD 75-125 (estimated)

(Credits: [http://www.pitt.edu/~jdnorton/teaching/HPS\\_0410/chapters/non\\_Euclid\\_Euclid/index.html](http://www.pitt.edu/~jdnorton/teaching/HPS_0410/chapters/non_Euclid_Euclid/index.html))

# Significance of Key Result

Drawing a parallel between the types of lesions and the outcomes of respective treatments can be beneficial for further analysis and improvement of treatments by third parties.

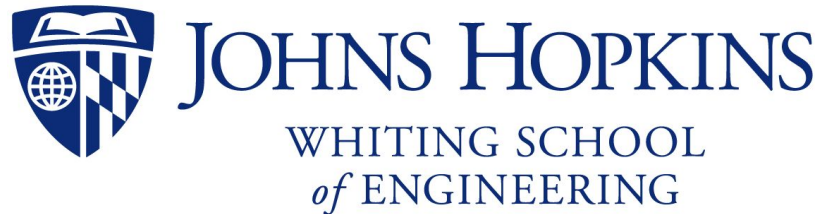


Figure 4: Example Third Party  
Johns Hopkins University Whiting School of Engineering





# Background

9 specific categories  
based on

- stroboscopic findings
- lesion morphology
- lesion size change  
following voice therapy
- and when applicable,  
surgical findings

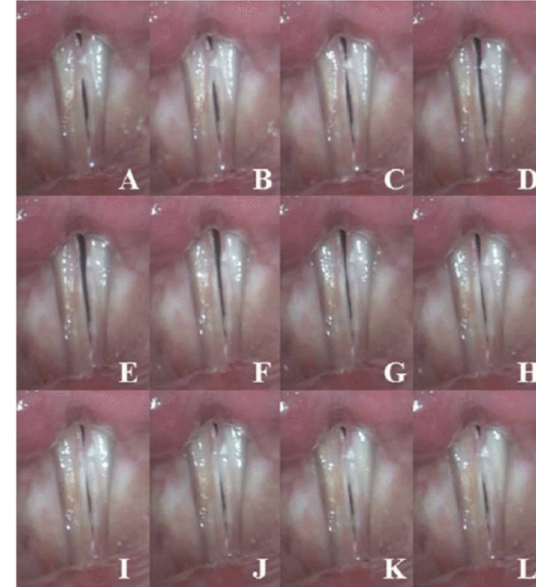


Figure 5: Stroboscopic findings of a representative case. (A–L) show the stroboscopic findings at the first visit: on both sides, there is severe vocal fold atrophy that hardly vibrates.

(Credits:[https://www.researchgate.net/publication/273635173\\_Single\\_Injection\\_of\\_Basic\\_Fibroblast\\_Growth\\_Factor\\_to\\_Treat\\_Severe\\_Vocal\\_Fold\\_Lesions\\_and\\_Vocal\\_Fold\\_Paralysis](https://www.researchgate.net/publication/273635173_Single_Injection_of_Basic_Fibroblast_Growth_Factor_to_Treat_Severe_Vocal_Fold_Lesions_and_Vocal_Fold_Paralysis))

# Background

Type	Definition
Vocal fold nodule	Bilateral, fairly symmetric, normal or mild impairment of mucosal wave, resolve (complete or nearly complete) with voice therapy.
Vocal fold polyp	Unilateral or bilateral, exophytic, gelatinous material that is unorganized in the SE space.
Vocal fold cyst, SE or lig	Encapsulated lesion within the SE or lig location, often associated with reduced mucosal wave, does not resolve with voice therapy.
Fibrous mass, SE or lig	Amorphous fibrous material within the SE or lig location, often associated with reduced mucosal wave, does not resolve with voice therapy.
Reactive vocal fold lesion	Contralateral lesion (SE) to a fibrous mass, cyst, or polyp. Will often resolved or get smaller with voice therapy.
Pseudocyst	Unilateral or bilateral superficial lesion associated with glottal incompetence (e.g., vocal fold scar, vocal fold paresis, vocal fold paralysis). High likelihood of recurrence following surgical removal if associated glottal incompetence is not addressed.
Nonspecific vocal fold lesion	Persistent unilateral or bilateral lesion following voice therapy. Lesion is not treated with surgery given the improved clinical voice function that the patient experiences from voice therapy.

lig = ligamentous; SE = subepithelial.

Table 1: Previously Validated Definitions of Benign Midmembranous Vocal Lesions (Rosen et al., 2012).



# Theory & Experiment

The study included patients that underwent three types of BMVFL treatment as an assessment criteria:

- Voice Therapy Intervention
  - vocal exercises
- Medical Intervention
  - medicinal therapy, behavioural and dietary modifications
- Surgical Intervention
  - microsuspension laryngoscopy with microflap excision.



# Theory & Experiment

Table 2: Incidence of Benign Midmembranous Vocal Fold Lesions and VHI-10 Results of Treatment, N = 224.

	Polyp	FM-lig	FM-SE	cyst-lig	cyst-SE	NSVFL	Nodules	Pseudocyst
No.	69	10	48	10	12	54	19	2
Mean age, yr	43	38	41	47	50	35	40	45
Gender	F = 65%, M = 35%	F = 80%, M = 20%	F = 69%, M = 31%	F = 80%, M = 20%	F = 83%, M = 17%	F = 93%, M = 7%	F = 58%, M = 42%	F = 100%, M = 0%
Incidence	30.8%	4.5%	21.4%	4.5%	5.4%	24.1%	8.5%	0.9%
Pre-VHI-10	22.67	21.2	21.77	21.1	24.17	15	16.79	22
Post-VHI-10	7.91	15.9	9.6	10	7.75	9.54	8.11	7.5
$\Delta$ VHI-10	14.76	5.3	12.17	11.1	16.42	5.46	8.68	
<i>P</i>	.001	.033	.001	.002	.001	.001	.001	
% change	65.1%	25%	55.9%	52.6%	67.9%	36.4%	51.7%	
% with normal VHI-10 post-treatment	64.80%	20%	56.30%	50%	66.70%	58.20%	63.20%	
<p>% change = percentage change of VHI-10 score following treatment (pretreatment – post-treatment/pretreatment); <math>\Delta</math> VHI-10 = delta VHI-10 score (pretreatment VHI-10 – post-treatment VHI-10); Cyst = vocal fold cyst; F = female; FM = fibrous mass;</p> <p>M = male; lig = ligamentous; Nodules = vocal fold nodules; NSVFL = nonspecific vocal fold lesion; Polyp = vocal fold polyp; Post-VHI-10 = post-treatment VHI-10; Pre-VHI-10 = pretreatment VHI-10; SE = subepithelial; VHI-10 = Voice Handicap Index-10.</p>								



# Relevance & Assessment

Useful study to have a stronger impact on the surgeon community if robotic assistance made a significantly higher post-treatment improvement regarding of soft tissue manipulation

Further research could involve using NLP techniques and analysis of past researches and patient databases.



# Conclusions

The existence of a standard form of nomenclature for the types of lesions and their treatment success would be a significant advantage for those who are working on developing novel surgical methods.

One of the key opportunities provided by this study is that fibrous mass–ligamentous (FM-lig) has a substantially lower post-treatment percentage decrease in VHI-10 even after surgery compared to other surgeries. Robotic assistance may prove most useful for this type of lesions.



# References

Akbulut, S., Gartner-Schmidt, J. L., Gillespie, A. I., Young, V. N., Smith, L. J., & Rosen, C. A. (2016). Voice outcomes following treatment of benign midmembranous vocal fold lesions using a nomenclature paradigm. *The Laryngoscope*, 126(2), 415-420.

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