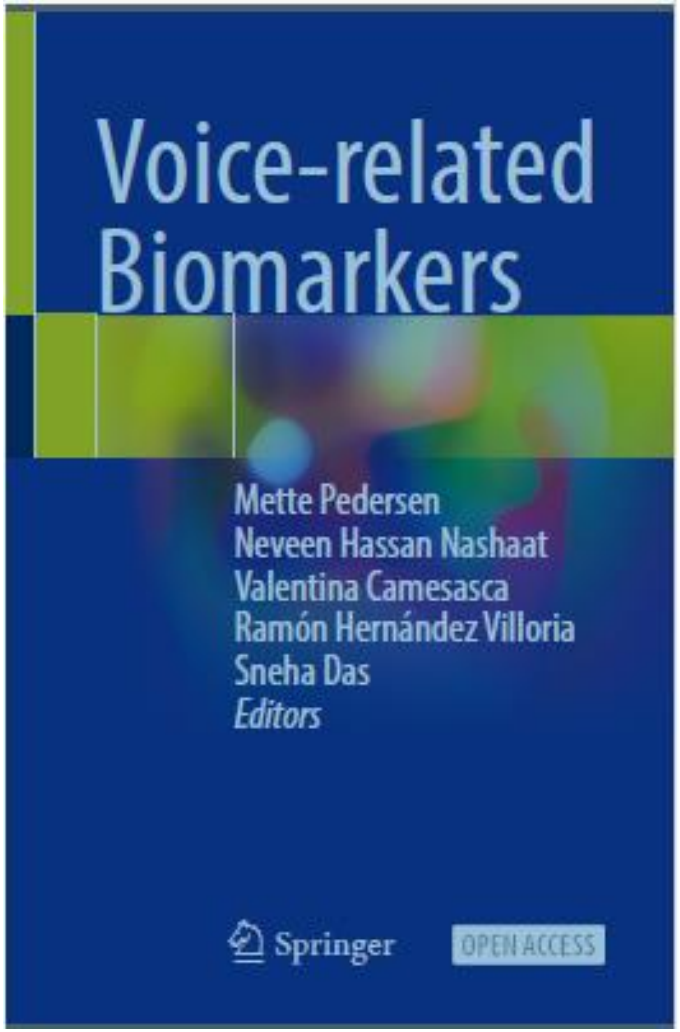
Voice-related Biomarkers and laryngology

From subjective dysphonia to systematic, measurable, repeatable clinical signals

IFOS 2026



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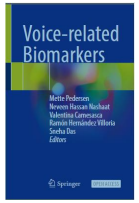
Why voice-related biomarkers matter in laryngology

They make the voice clinically measurable beyond the impression of hoarseness.



Clinical problem

Laryngeal disorders often change vocal fold vibration, closure, mucosa, breath support and patient experience at the same time.

Voice-related Biomarker value

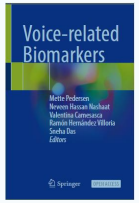
A marker is useful when it is measurable, repeatable, interpretable and linked to a clinical question.

Practical aim

It combines acoustics, aerodynamics, clinician rating, and patient-reported outcome into one workflow.

The multidimensional voice assessment model with patient scales

No single measurement can represent the larynx function.



Symptoms & history → **Perceptual rating** → **Acoustic analysis** → **Maximal Phonation Time Air flow** → **Imaging & tissue evaluation**

Clinical diagnosis

Edema, inflammation, reflux-related change, nodules, scar or functional disorder, tumors, paresis etc.

Treatment monitoring

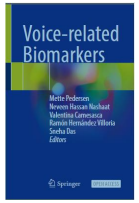
Baseline, intervention, recovery, recurrence and longitudinal progression.

Research & AI

Standardized inputs enable multicentre data, transparent algorithms and validation.

Suggested core voice-related biomarkers

A pragmatic minimum set for the laryngology clinic.

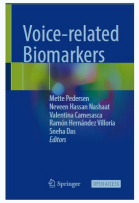


Domain	Example biomarkers	
Patient-reported	Voice handicap index (VHI)/Singing voice handicap index (SVHI)	Impact on daily function, singing and quality of life
Perceptual	GRBAS test / CAPE V	Expert auditory judgement of voice quality.
Acoustical	F0, jitter, shimmer, Harmonics to noise ratio (HNR).	Periodicity, perturbation and noise in the vocal signal
Aerodynamic	Maximum phonation time (MPT), airflow, phonation quotient	Respiratory-laryngeal efficiency and glottal competence.
(Imaging)	Stroboscopy, High-speed video (HSV), Optical coherence tomography (OCT).	Tissue, vibration, closure and layered microstructure

Minimum set: small enough to implement, broad enough to capture function

What a voice-related biomarker must be: definition and glottal function

Three criteria and glottal closure as the central clinical target. (UEP Biomarkers Committee)



Specificity

The measured characteristic must do what it claims. A narrow clinical focus is essential for good specificity.

Effectiveness

A biomarker must make clinical sense. It should help prevent harm or guide management in a clinically meaningful way.

Efficiency

Must be cost-effective in both time and technology. The simpler and more accessible, the better.

Glottal closure: the primary clinical target

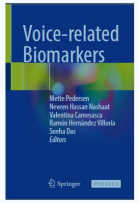
The three core glottal functions are ventilation, phonation, and airway protection. Good glottal closure is essential for both voice and swallowing. A biomarker of glottal function therefore has both a voice and a dysphagia dimension — making it relevant across a wide patient population.

Why this matters: prevalence

Dysphonia: 3–9% of the adult population. Dysphagia: 4%. In Parkinson's disease: up to 80% voice problems. In Alzheimer's: 84–93%. In head and neck oncology: ~40%. Voice-related biomarkers address one of the most prevalent and underdiagnosed symptom clusters in medicine.

Acoustic biomarkers: signal-level information

Useful for screening and follow-up, dependent on recording protocol.



Fundamental frequency

Pitch-related measure. Interpreted in relation to sex, age, task, register and professional voice use.

Jitter

Cycle-to-cycle frequency variation. Can increase with irregular vibration, instability or roughness.

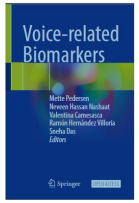
Shimmer

Cycle-to-cycle amplitude variation. Often associated with breathiness, weak closure or unstable phonation.

HNR

Ratio of harmonic structure to noise. Lower values may indicate turbulence or aperiodicity.

CPP, EGG and Voice Range Profile



Complementary tools that overcome the limitations of perturbation measures in severe dysphonia.

Cepstral Peak Prominence (CPP)

Quantifies aperiodicity without cycle boundary detection. Usable in connected speech and severe dysphonia where jitter/shimmer fail. High CPP = periodic signal; low CPP = noisy/aperiodic voice.

Electroglottography (EGG)

Measures vocal fold contact area via impedance signal. Open quotient (OQ) elevated in hypofunctional dysphonia and many benign disorders, e.g., leukoplakia. Can be combined with kymography.

Voice Range Profile (Phonetogram)

Maps dynamic range (F0 vs intensity). Recommended for singing voice complaints and in children's choirs when stroboscopy is negative. Shows detailed and interesting vocal capacity improvements after treatment.

Clinical history alone: 5% diagnostic accuracy

Initial evaluation by endoscopic laryngoscopy raises diagnostic accuracy to 68%. Measures that extend beyond biomarkers are EGG, CPP, and phonetograms; they are not supplementary niceties: they are necessary for adequate clinical accuracy.

Voice-Related Biomarker's book – chapter 10

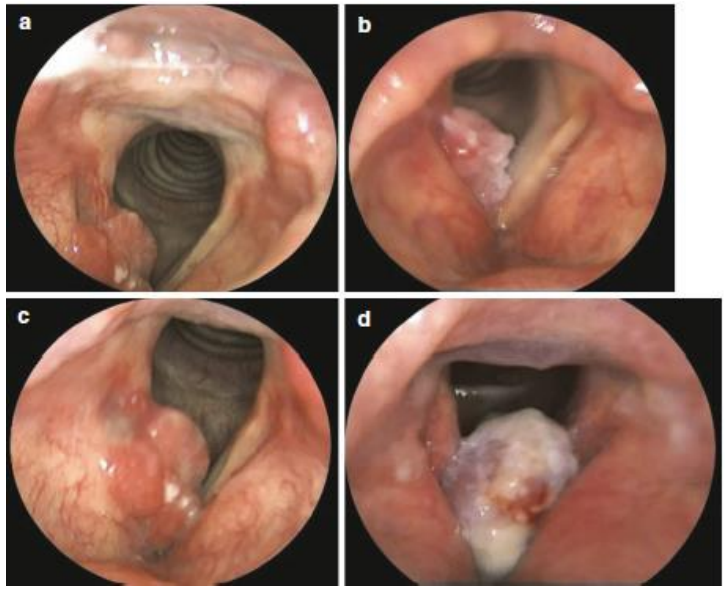


Fig. 10.2 Different shapes of VF mass. Different shapes of VF mass: (**a**) Irregular mass of the anterior half of the right VF; (**b**) Irregular mass of the right VF; (**c**) Irregular mass of the right VF; (**d**) Irregular mass of the left VF

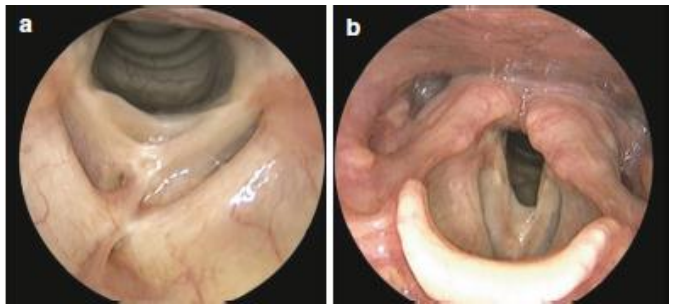


Fig. 10.3 Different shapes of acquired VF web. Different shapes of acquired VF web: (**a**) involving the VF length; (**b**) involving the majority of the VF length

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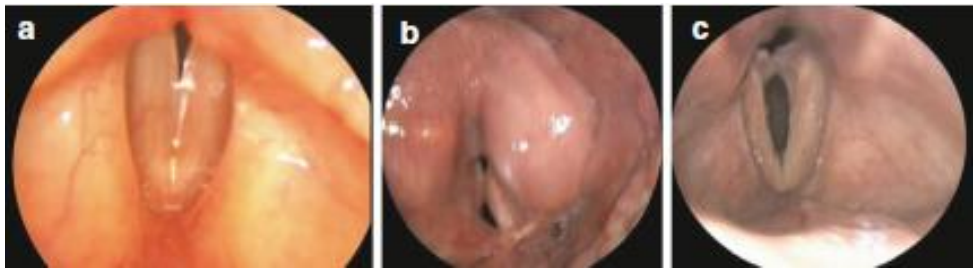


Fig. 10.4 Examples of phonatory gap patterns during phonation. Phonatory gap patterns during phonation: (**a**) posterior glottal gap; (**b**) anterior glottal gap attributed to right VF scar; (**c**) incomplete glottic closure leading to double gap.

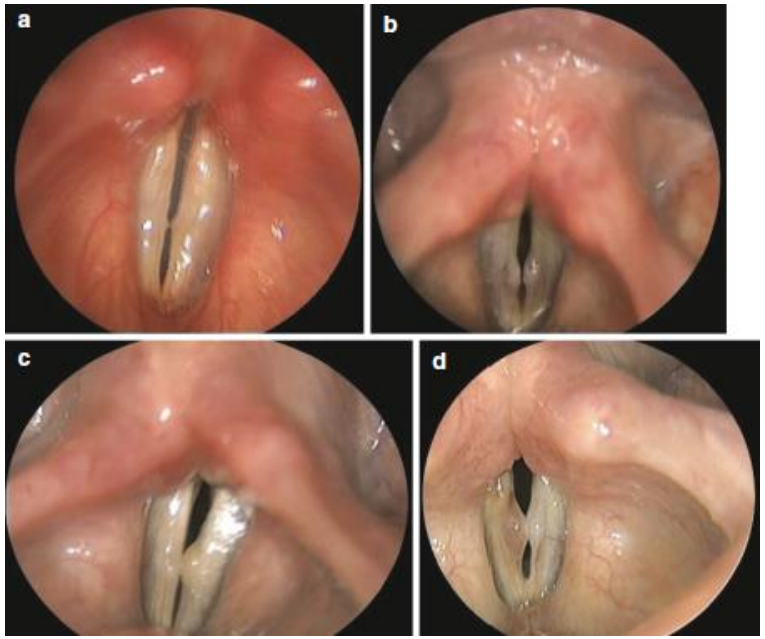


Fig. 10.5 The hourglass glottal gap during phonation, The hourglass glottal gap during phonation: (**a**) Early bilateral VF nodules; (**b**) Bilateral VF nodules; (**c**) Left VF cyst; (**d**) Right VF cyst with left VF reaction.

Voice-Related Biomarker's book – chapter 10

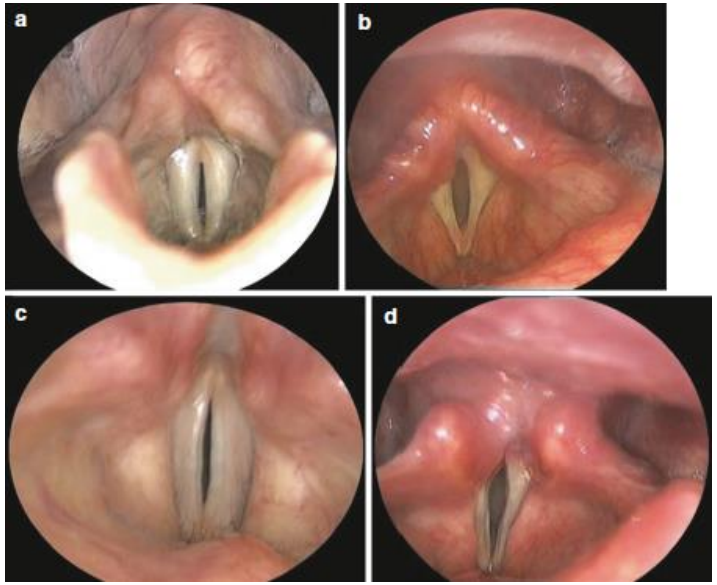


Fig. 10.6 Fusiform glottal gap during phonation. Fusiform glottal gap during phonation with different types of laryngeal pathology: (**a**) Fusiform phonatory gap in a case with early Parkinson's disease; (**b**) Fusiform phonatory gap in a case with advanced Parkinson's disease; (**c**) Fusiform phonatory gap with right VF sulcus vocalis; (**d**) Fusiform phonatory gap with bilateral sulcus vocalis

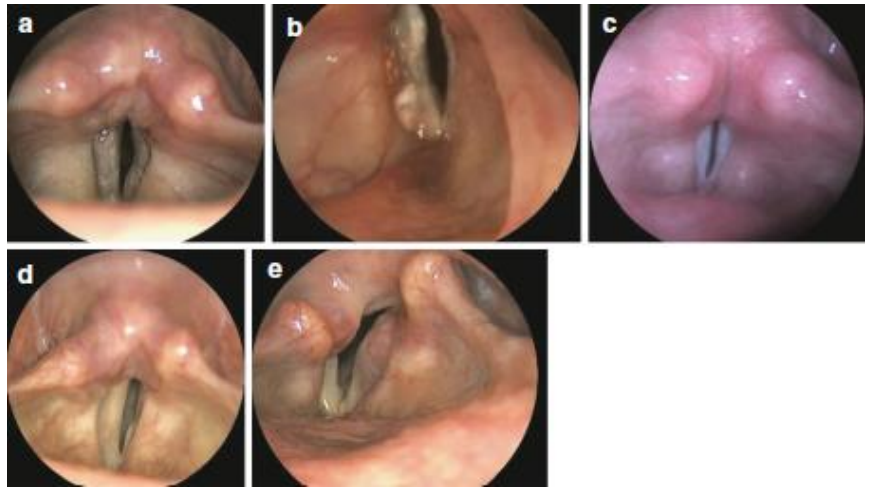
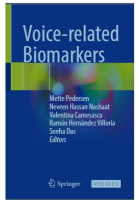


Fig. 10.7 Irregular glottal gap during phonation. Irregular glottal gap during phonation attributed to different laryngeal pathologies: (**a**) Left VF scar; (**b**) Right VF scar; (**c**) Left VF scar; (**d**) Left VF posterior cordectomy; (**e**) Irregular phonatory gap attributed to multiple laryngeal pathologies

What imaging cannot tell us with acoustical measures alone

A biomarker panel prevents over-interpretation of one number.



Patient-reported outcome

VHI/SVHI captures burden, participation and professional consequences that may not match acoustic severity.

Clinician perception

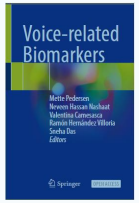
GRBAS or CAPE-V remains clinically meaningful because patients seek help for perceived voice quality.

Aerodynamics

MPT, airflow and phonation efficiency help identify glottal insufficiency, hyperfunction or respiratory limitation.

(Based on Imaging)

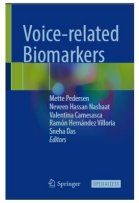
Use of Voice-related Biomarker patterns across laryngeal disorders



Patterns support clinical reasoning; they do not replace expert examination.

Clinical group	Expected biomarker changes	Clinical use
Benign lesions	Higher perturbation/noise, reduced MPT	Baseline and post-treatment monitoring
Vocal fold paresis/paralysis	Breathiness, low HNR, reduced MPT,	Differentiate insufficiency from compensatory hyperfunction
Inflammation/edema/reflux-related change	Lower stability, symptoms fluctuating over time	Track response and recurrence
Scarring/sulcus	Acoustic instability	Document function and counsel expectations
Malignancy/dysplasia	Voice change, suspected tissue abnormality	Biopsy planning and follow-up

Clinical workflow



1. History + VHI → 2. GRBAS/CAPE-V → 3. Standard Recording → 4. MPT/aerodynamics → 5. Endoscopy ± OCT

In the future:

Before treatment

Create a baseline with the same tasks and recording settings.

After treatment

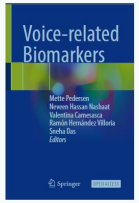
Repeat the same bundle and compare patterns, not isolated values.

Across centres

Use shared protocols to support research and AI validation.

AI and digital biomarkers: promising, but not yet automatic medicine

The next step is transparent clinical validation.



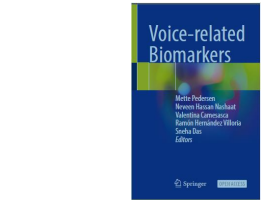
What AI can support

- screening and prioritizing
- change detection over time
- combining biomarkers in a hybrid AI setup
- identifying hidden patterns in large datasets

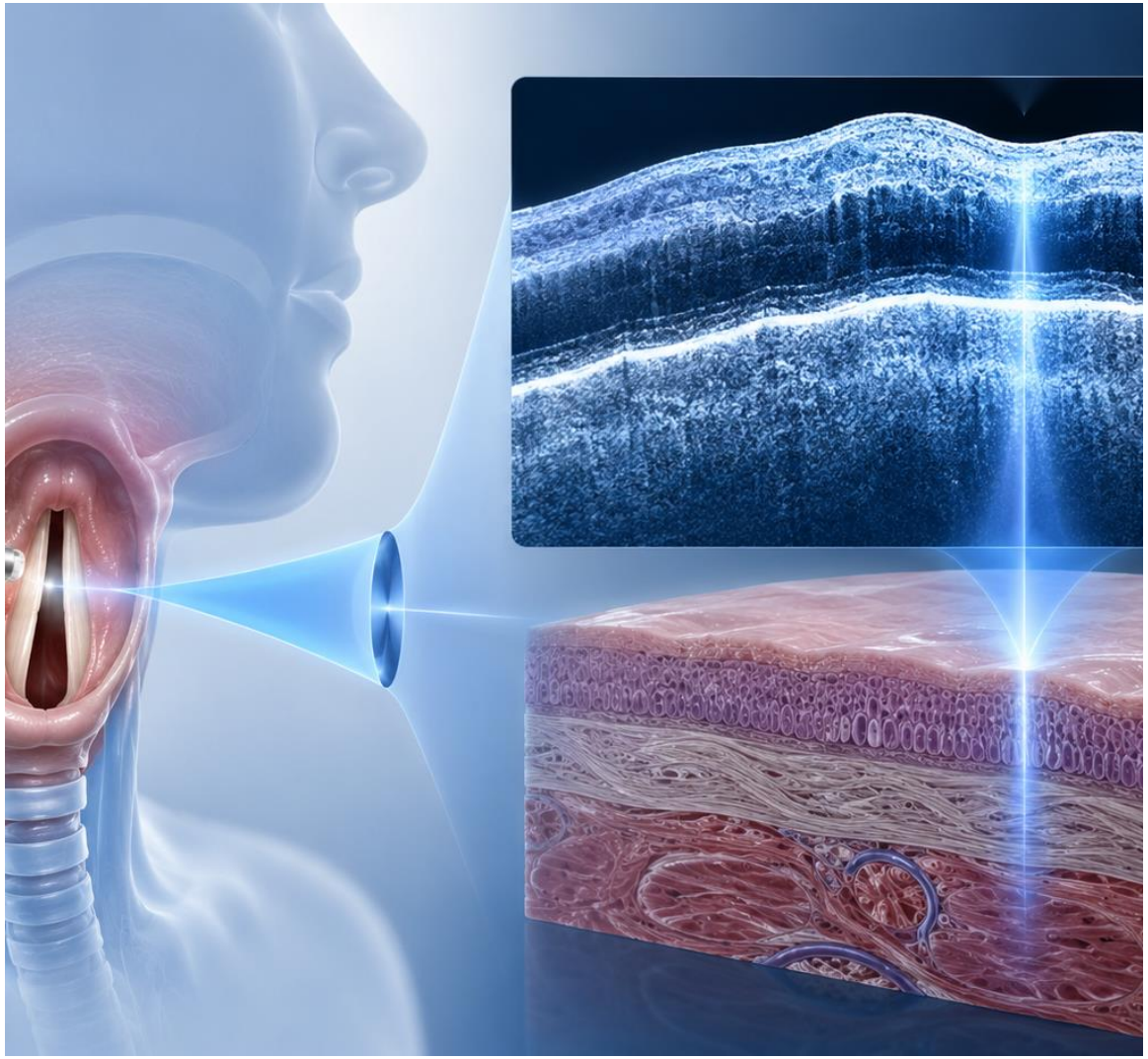
What must be proven

- external validation
- prospective workflow studies
- comparison with expert laryngologist
- bias, explainability and data governance
- clinically meaningful outcomes

Optical coherence tomography: tissue-level future biomarker



OCT adds near-histological, non-invasive information about the vocal fold layers.



Why it matters

Laryngeal disease often begins in tissue architecture before measurement change is specific.

What it can show

Epithelium, lamina propria, scar, edema, lesion depth and microstructural change.

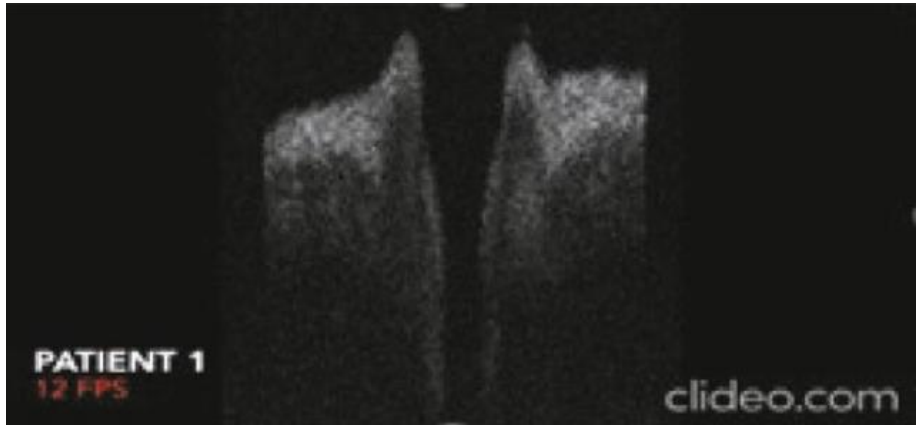
Clinical potential

Optical biopsy, margin guidance, treatment monitoring and early tissue characterization.

Current limitation

Needs practical probes, motion control, normative datasets and validated laryngeal protocols.

Optical coherence tomography: tissue-level future biomarker



During the *resting state*, in males the epithelium state was

106 ± 49 µm, and the lamina propria 367 ± 197 µm

in females, it was 66 ± 24 µm and 595 ± 179 µm respectively.

During phonation in males, the epithelium state was

81 ± 35 µm, and the lamina propria 376 ± 130 µm

in females, it was 79 ± 38 µm and 522 ± 220 µm respectively

Propagation with different amplitudes.

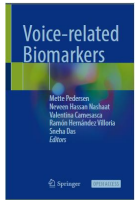
For the X-axis horizontal wave: 30 points were distributed equidistantly along the width of the superior contour of each vocal fold.

For the Y-axis vertical wave: with consecutive phonation over a period of at least 3 s, the vertical mucosal wave can be visualized and measured.

The Green lines visually demarcate the displacement vector between the 30 equidistant points along the superior surface of each segmentation

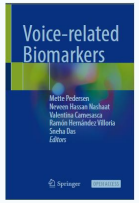
The Yellow and orange lines show two epithelium segmentations from consecutive image frames

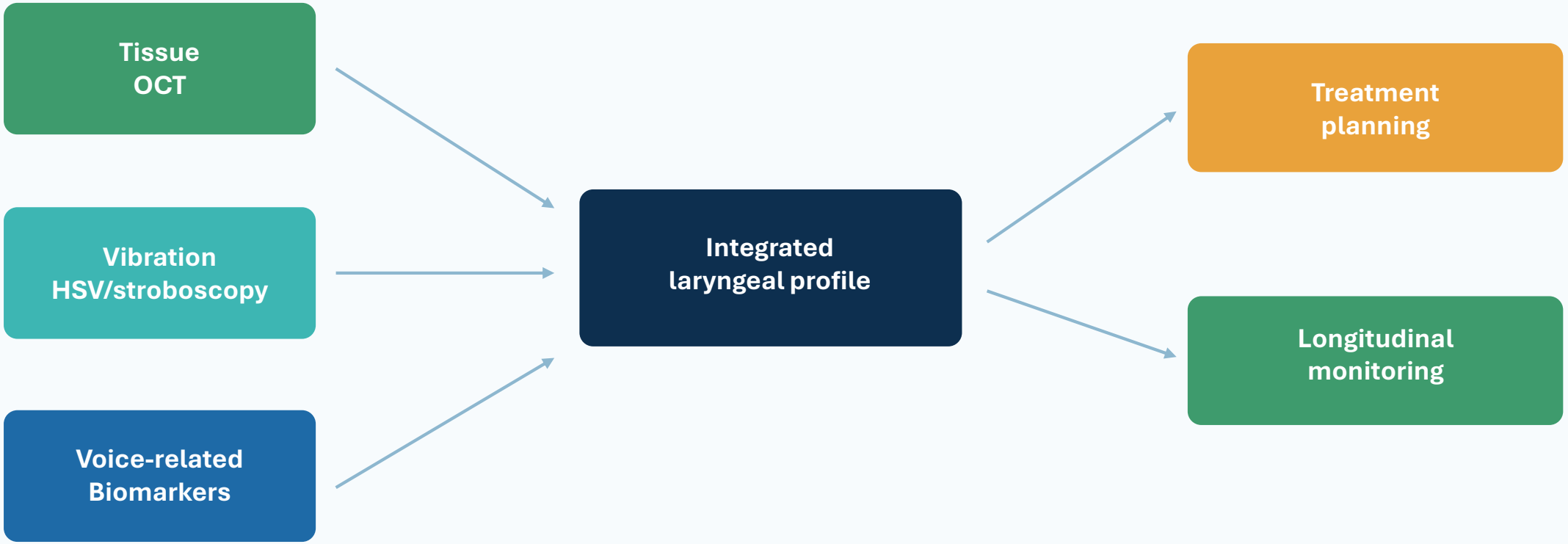
Optical coherence tomography: tissue-level future biomarker



Integrating OCT with voice analysis

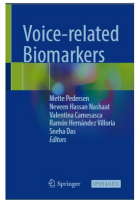
The future is not only “better pictures”, but linked tissue-function data.





OCT becomes most perful when it is linked to the voice signal, patient burden and treatment response.

Data quality



A Voice-related Biomarker is only as good as the protocol behind it.

Recording

microphone, distance, room, SPL, vowel and task

Patient state

hydration, medication, infection, allergy, reflux, fatigue

Task design

sustained vowel, connected speech, singing task, register

Norms

age, sex, language, professional voice use, pathology group

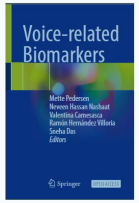
Documentation

same protocol before/after therapy and across centres

For research and reproducibility is a part of the Voice-related Biomarker aspects.

Clinical use in laryngology

Where voice-related biomarkers can change decisions today.



1. Early organisation

Identify whether the dominant pattern suggests, e.g., structural, inflammatory, neurological, functional, or other voice disorder.

2. Pre/post therapy

Quantify change after surgery, voice therapy, reflux/allergy treatment or medication adjustment.

3. Professional voices

Document small changes that are professionally significant for singers, teachers and performers.

4. Safety monitoring

Track hemorrhagic risk, steroid masking, fatigue and return-to-voice decisions.

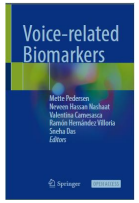
5. Research trials

Use harmonised endpoints for multicentre studies and digital-health validation.

6. Shared language

Create a common vocabulary between laryngologists, phoniatricians, SLPs and singing teachers.

Research agenda for future laryngology

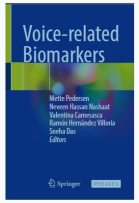


From promising measures to clinically trusted AI tools.

Priority	Why it matters	Deliverable
Common protocol	enables comparable data	international minimum dataset
External validation	prevents overfitting	multicentre benchmark cohorts
Prospective workflow studies	tests real-world clinical value	before/after and decision-impact studies
Tissue Validation	connects tissue to function	validated probe + acquisition standards
AI governance	supports safe clinical use	transparent models and bias checks

The field needs fewer isolated metrics and more validated voice-related biomarker panels.

Three messages: Use Panels, not isolated numbers, Standardise the recording and the task, link voice signal, patient burden, clinician rating and tissue imaging



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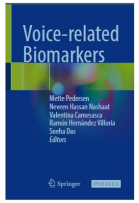

Thank you for listening!