

Stroboscopic examination of the larynx

By

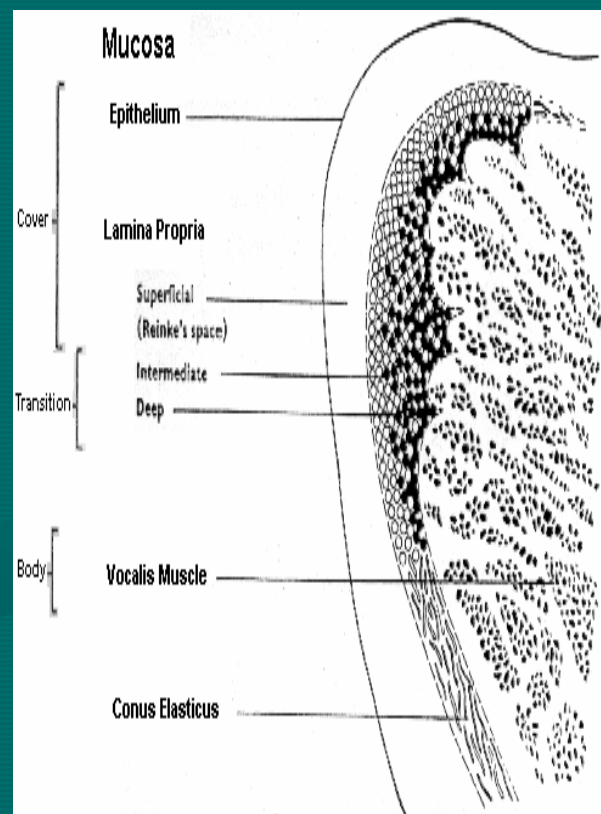
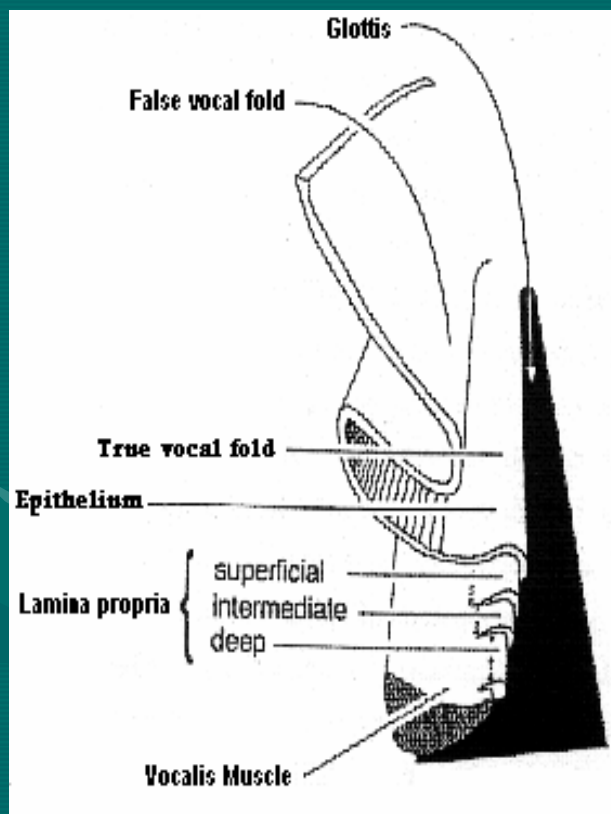
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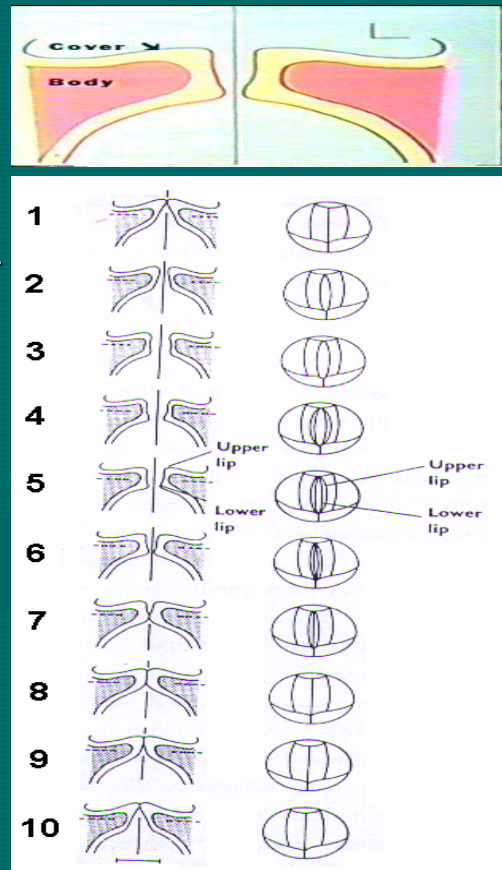
Structure Of The Vocal Fold



Normal Vibratory Cycle Of The Vocal Fold

One cycle of the V.F. vibration is divided into three phases:

- **Opening phase:** The V.F. is blown upward on the whole by the increasing P_{sub} , and the undulating wave moves on the m.m. from the lower part to the upper part. A puff of air is released as the V.Fs. are separated.
- **Closing phase:** After the width of the glottis reaches a maximum, elastic recoil and aerodynamic forces draw the V.Fs. toward the midline and the glottis begins to be closed by the protruding lower lip.
- **Closed phase:** The upper lip moves inward and the closure of the glottis becomes firm. The folds remain approximated for a brief portion of the cycle. P_{sub} builds up again and the next cycle begins.



Pre-requisites of normal voice production

- 1) Normal range of movement of the vocal folds.
- 2) Normal mobility of mucosa on deep layers.
- 3) Optimal coaptation of vocal folds' edges.
- 4) Optimal motor force at glottic closure.
- 5) Optimal pulmonary support.
- 6) Optimal timing of the glottic closure in relation to the onset of the phonatory expiration.
- 7) Optimal muscular tuning of vocal fold tension (int. & ext.).

(Kotby, 1986)

Diagnosis of Voice Disorders

I - Elementary Diagnostic Procedures :

- (A) Patient's interview .
- (B) Auditory Perceptual Assessment (APA).
- (C) Visual impression of the voice source: (Laryngeal examination)
 - 1 . External laryngeal examination .
 - 2 . Elementary visual impression (indirect laryngoscopy).

II - Clinical Diagnostic Aids :

- (A) Augmentation and documentation of the glottic picture:
 - Video recording (video laryngo-stroboscopy):
- (B) Voice recording.

III - Additional Instrumental Measures :

- (A) Aerodynamic Measures .
- (B) Acoustic analysis .
- (C) Voice Range Profile (Phonetogram) .
- (D) Radiological studies .
- (E) Electroglottography (EGG) .
- (F) Electromyography (EMG) .

(Kotby, 1995)

Stroboscopic examination of the larynx

Stroboscopic examination of the larynx

• Rationale of stroboscopic light:

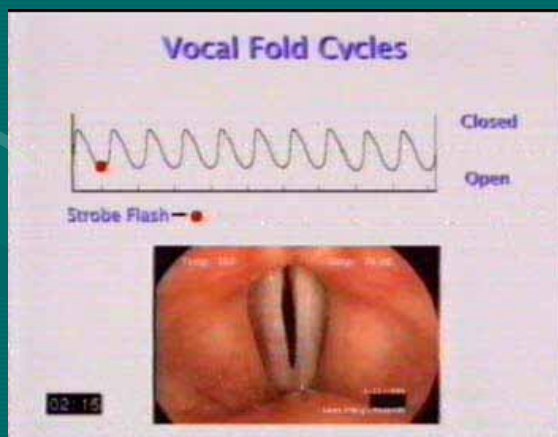
- Talbot's law states that once an image is presented to the eye, it persists on the retina for 0.2 sec. (1/5 cycle/sec.).
- A rapidly rotating or vibrating object can not be seen if the speed of repetition of movements exceeds 5 per sec.
- Since the V.Fs. are very rapidly rotating (100-300 Hz), the eyes fuse the image of successive cycles . So that the V.Fs. seen during phonation in continuous light of an ordinary lamp (50 cycles/sec) seem to be standstill and blurred.
- If the flashes of light are triggered after the onset of the vibratory cycle by a fixed time interval, the adjacent phases of several vibratory cycles will be illuminated successively.



Stroboscopic examination of the larynx

• Rationale of stroboscopic light: (cont.)

- The perceived stroboscopic motion of the vocal fold is an optical illusion created by fusing multiple points of several successive vibratory cycles. This motion is referred to as the glottic wave.



Stroboscopic examination of the larynx

• Rationale of stroboscopic light: (cont.)

- If the flashes of light are exactly equal to and in phase with the vocal fold vibratory cycles the folds will appear motionless.



Stroboscopic examination of the larynx

STROBOSCOPIC FEATURES:

- Amplitude Of Vibration.
- Mucosal Wave.
- Symmetry.
- Periodicity.
- Glottic Closure Patterns:
 - Phase of glottic closure.
 - Configuration of glottic closure.
- Non-Vibrating Portions.
- Ventricular vibrations. **(Bless et al., 1987)**

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(1) Amplitude of Vibration:

■ Definition:

Is the extent of movement of the muscular body of the vocal fold in the horizontal plane.

- **In normal habitual phonatory conditions** the extent of the horizontal excursion of the VF approximates one half the width of the visible part of the VF.

■ Normally the amplitude of vibration:-

- Decreases with raising the pitch of phonation.
- Increases with increasing the loudness of phonation.



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(1) Amplitude of Vibration: (cont.)

The four point rating scale for the amplitude of vibration:

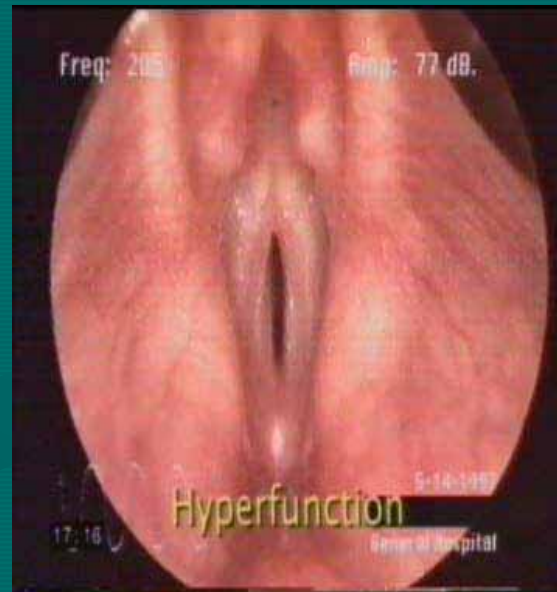
- **0** = No observable horizontal excursions.
- **1** = Diminished amplitude of Vibration.
- **2** = Normal amplitude of Vibration.
- **3** = Greater amplitude of Vibration.



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(1) Amplitude of Vibration: (cont.)

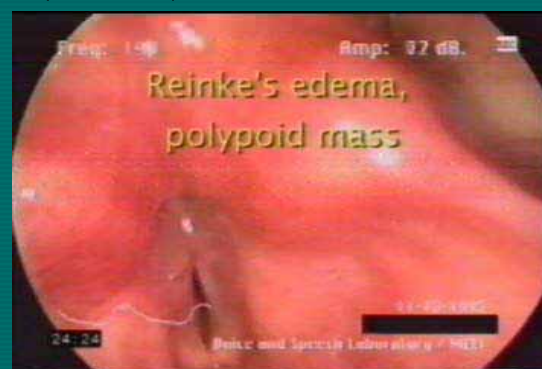
- The amplitude of vibration is affected by VF stiffness and subglottal pressure.
- Pathological conditions leading to decreased amplitude of vibration:
 - Increased VF stiffness e.g. Sulcus Vocalis
 - Tight glottic closure patterns e.g. hyperfunctional dysphonia.



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(1) Amplitude of Vibration: (cont.)

- Pathological conditions leading to increased amplitude of vibration:
 - Increased Psub e.g. Reinke's oedema (where patient needs larger Psub to put the bulky yet pliable VF into vibration).
 - Decreased Laryngeal muscle tone e.g. VF paresis (where VFs display large excursions as a flag fluttering in the wind).



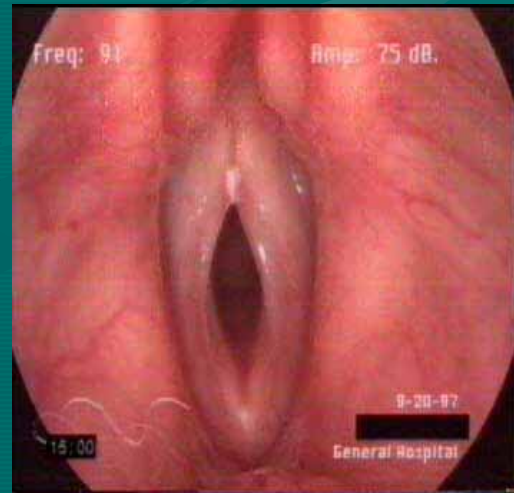
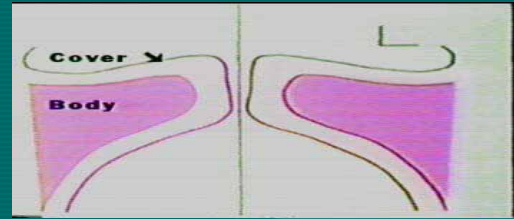
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2- Mucosal Wave:

- **Definition:**

Is the wave motion of the mucosal cover traveling along both the vertical and horizontal planes of the vocal fold.

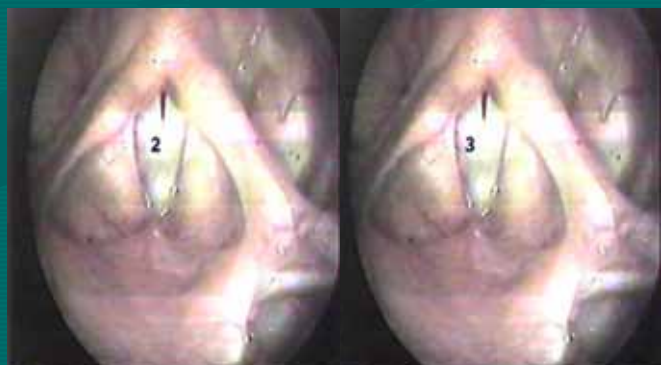
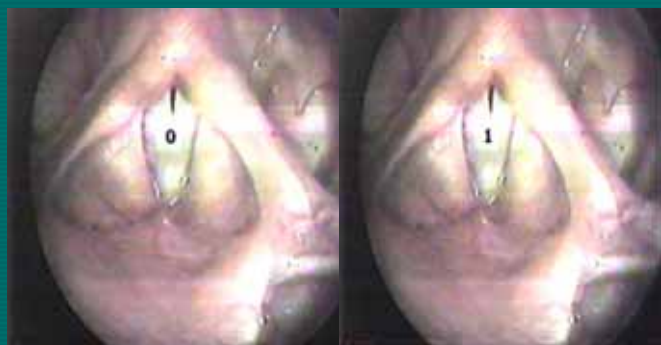
- **In normal habitual phonatory conditions** the mucosal wave travels across the vertical plane of the vocal fold then rolls laterally across at least 50% of the width of visible part of the vocal fold.
- **It is affected by** the pliability of the covering mucosa and the presence of the natural difference in the mechanical properties between the pliable mucosal cover and stiffer muscular core.



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2- Mucosal Wave: (cont.)

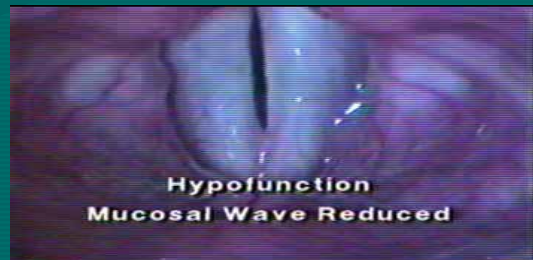
- **Normally the mucosal wave:**
 - Decreases with raising the pitch of phonation.
 - Increases with increasing the loudness of phonation.
- **The four point rating scale for the mucosal wave:**
 - 0** = No observable traveling wave
 - 1** = Restricted mucosal wave
 - 2** = Normal mucosal wave
 - 3** = Greater mucosal wave in which the traveling wave moves from the glottal margin to the most lateral portion of the vocal fold.



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2- Mucosal Wave: (cont.)

- Pathological conditions leading to decreased mucosal waves:
 - * Increased stiffness of the VF due to:
 - (a) Structural changes in the mucosa (cover) e.g.
 - Polypoid degeneration.
 - Sulcus vocalis.
 - V.F. dysplasia.
 - (b) Increased muscle tension (body) leading to tight glottic closure patterns e.g. hyperfunctional dysphonia (long closed phase).
 - * Decreased muscle tension (body) leading to weak glottic closure patterns e.g. hypofunctional dysphonia (long open phase and short closed phase).



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2- Mucosal Wave: (cont.)

- Pathological conditions leading to loss of mucosal waves (stroboscopic fixation) as in:
 - Any infiltrative process that fixes the mobile mucosa to the deeper structure e.g. malignant neoplasm of the V. Fs.
 - Vocal fold scarring.
 - Rec. Lx. nerve paralysis lesions (where vocalis muscle loses its natural tone and the VF body becomes as flaccid as the covering mucosa)



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2- Mucosal Wave: (cont.)

- Pathological conditions leading to increased mucosal wave are usually associated with:
 - increased Psub as in Reinke's oedema.

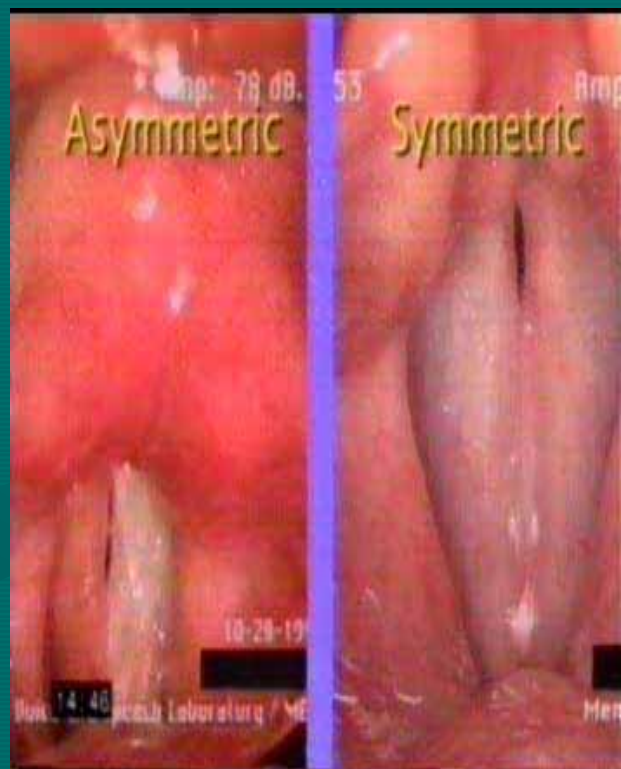


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3- Symmetry:

- **Definition:**

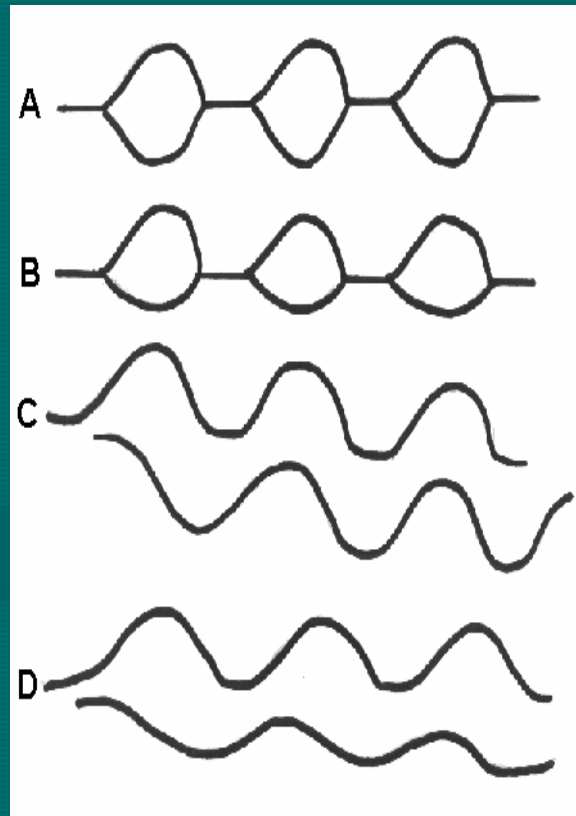
Is the degree to which the V.Fs provide mirror images to one another during vibration both in **Timing (phase)** and in the **Extent of the horizontal excursion (amplitude)**.
- In all normal phonatory conditions whether habitual or extremes of pitch or loudness:
 - The timing of both V.Fs opening and closing patterns is equal.
 - The extent of the horizontal excursion of both V.Fs is equal.



Stroboscopic examination of the larynx

3- Symmetry: (cont.)

- **Graph A** displays **the normal amplitude and timing patterns** of both VFs. The upper graph represents the RVF movement during the opening, closing and closed phase of the glottal cycle. The lower graph represents the LVF movement during the opening, closing and closed phases of the same glottic cycle.
- **Graph B** displays **asymmetry in amplitude** where the range of the LVF excursion is less than that of the RVF.
- **Graph C** displays **asymmetry in phase** where the RVF is closing while the LVF is opening.
- **Graph D** displays **asymmetry both in phase and amplitude**.



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3- Symmetry: (cont.)

- **Asymmetry in phase or amplitude between both V.Fs. is caused by induced differences in the mechanical properties between both VFs as in:**
 - Laryngeal lesions affecting mass, tension or shape of VF.
 - Neurological lesions affecting neuromuscular control of VF.
 - Functional conditions affecting laryngeal muscle tension.



Asymmetry in amplitude



Asymmetry in phase

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4. Periodicity:

- **Definition:**

Is the degree of regularity of successive apparent glottal cycles during vibration.

Aperiodicity between successive glottal cycles can be either in amplitude or in timing or in both.

- In order to evaluate this parameter we shift to the "in phase" modum of the stroboscope unit where the light flashes are executed at the same frequency of the VF vibrations.
- In all normal phonatory conditions with periodic successive glottal cycles this will lead to repeated illumination of the same phase of the glottal cycle resulting in a clear static laryngeal image at that certain phase of the cycle.



Locked (periodic) mode in fully adducted position

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4. Periodicity:

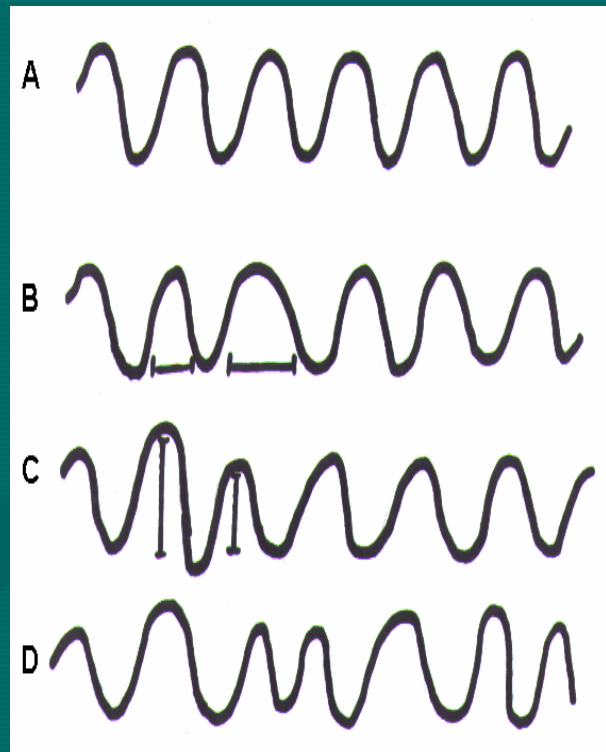
- In cases with irregular successive glottal cycles (Aperiodicity) the flashes will not coincide with the same phase of the glottal cycle. This will result in a hazy shivering laryngeal image.



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4. Periodicity: (cont.)

- **Graph A** displays the glottal waveform of **normal periodic vibrations** where successive glottal cycles are uniform in amplitude and timing.
- **Graph B** displays **aperiodicity in timing** between successive glottal cycles.
- **Graph C** displays **aperiodicity in amplitude** between successive glottal cycles.
- **Graph D** displays **total aperiodicity** in timing and Amplitude.



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4. Periodicity: (cont.)

- **Aperiodicity is caused by disturbance in the balance between the mechanical properties of the VFs and the applied aerodynamic forces. This may be due to:**
 - ✓ Inadequate expiratory air during phonation.
 - ✓ Disrupted laryngeal muscle tension.
 - ✓ Imbalance of neuromuscular control of the larynx.
 - ✓ Disturbed mechanical properties of the VFs.

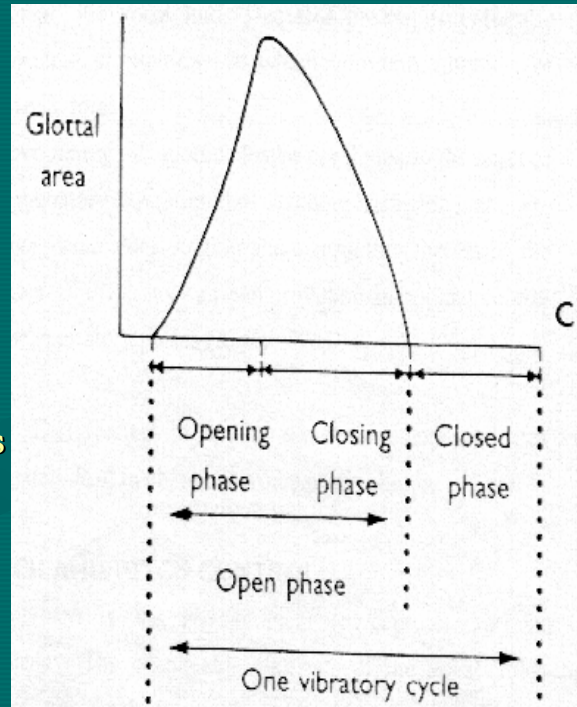


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5. Glottic Closure Patterns:

(A) Phase of glottic Closure:

- **Definition:**
Is the average timing of the closed phase in relation to the whole glottic cycle.
- **In normal habitual phonatory conditions** the timing of the opening phase, closing phase and, closed phase are nearly identical.
- **The opening phase predominates** with raising the pitch of phonation and with decreasing the loudness of phonation.
- **On the other hand, the closed phase predominates** with raising the loudness of phonation.

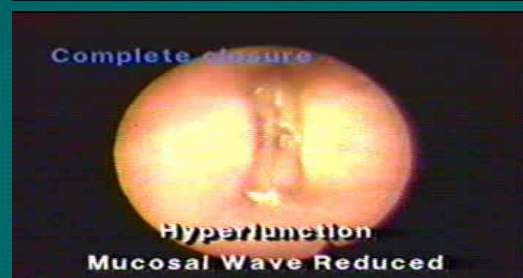
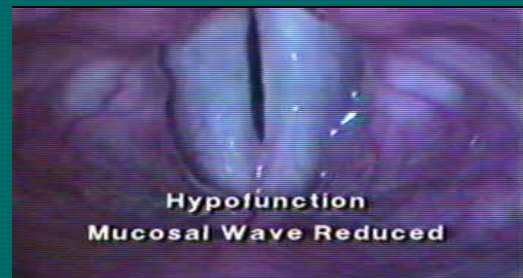


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5. Glottic Closure Patterns:(cont.)

(A) Phase of glottic Closure:(cont.)

- **Pathological conditions** leading to **predominance of the opening phase** during habitual phonation are usually associated with decreased laryngeal muscle tension as in hypofunctional dysphonia.
- **Pathological conditions** leading to **predominance of the closing phase** during habitual phonation are usually associated with increased glottal resistance as in cases of hyperfunctional dysphonia.



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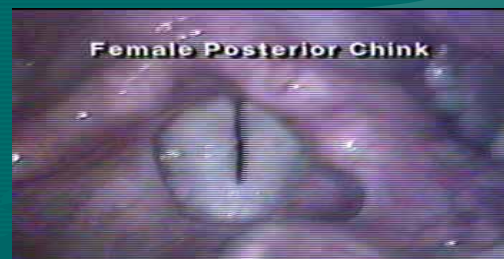
5. Glottic Closure Patterns:(cont.)

(B) Configuration of glottic Closure:

- **Definition:**

This is the shape of the glottis at maximum closure under stroboscopic light.

- **In normal habitual phonation** there is complete closure along the vocal fold edges in males and closure along the vibrating edges with a small triangular posterior chink in females.



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5. Glottic Closure Patterns:(cont.)

(B) Configuration of glottic Closure:

- Abnormal closure patterns may be seen associated with different pathological conditions such as :-
 - * **The hour-glass shape phonatory gap** that may be seen with vocal fold nodules.
 - * **The slit shape phonatory gap** that may be seen in in patients with hyperfunctional dysphonia.

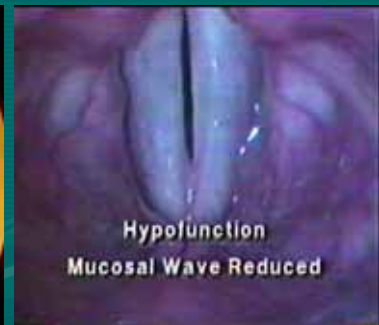


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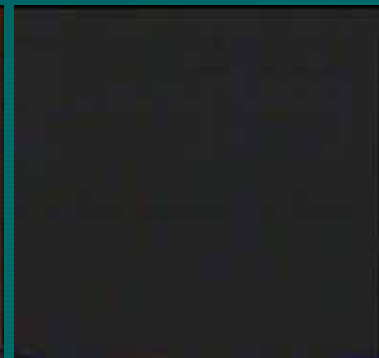
5. Glottic Closure Patterns:(cont.)

(B) Configuration of glottic Closure:(cont.)

* The oval shape phonatory gap that may be seen in patients with hypofunctional dysphonia.



* Irregular phonatory gap as in cancer larynx.



* No closure as in bilateral V.Fs. paralysis.

Stroboscopic examination of the larynx

6-Non-Vibrating Portions:

- Describing the site, extent and persistence of adynamic segments of the vocal folds during vibration.
- This may be due to:-
 - Laryngeal Scarring.
 - Dysplastic Patches.
 - Mucosal Fixation.



7-Ventricular vibrations:

Describing whether unilateral or bilateral and whether or not sharing in phonation.



Value of Video-Laryngostroboscopy

- Detect early stages of cancer and determine the degree of cancerous infiltration.
- Differentiate functional and subtle structural abnormalities of the larynx.
- Determine the changes not visible to the unaided eye such as:
 - Non-vibrating segments of the vocal fold.
 - Changes in stiffness resulting from laryngeal carcinoma, papilloma, or scar tissue.
- The onset of any improvement can be observed in patients with vocal fold paralysis earlier and with greater accuracy than with the eye or ear.
- Pre- and post-treatment comparisons (restoration of the symmetry of the vibrator).

Disadvantages of Video-Laryngostroboscopy

- Does not offer a continuous registration of successive vibratory cycles.
- Difficult to visualize irregular vibrations.



Thank You