High-speed films of the larynx

Filming the motion of the vocal folds during phonation is a considerable technical challenge.
Since the frequency of vibration in normal speaking voice is around 100Hz for men and 200 Hz for women, frame rates of 2000Hz or more are necessary to capture the time course of individual vibratory cycles. The films shown here were made using a special high-speed digital film system developed in Erlangen.

Film clips are shown for 4 subjects. Each film is shown first as an overview, and than as detail of a small section. The overview version shows only every second frame and has somewhat reduced image quality.

One of the main points to look for in the film is the surface movement of the vocal folds during vibration, and to try and imagine in this view from above how the vocal folds would look from the front, in particular how the relative motion of the top and bottom edges of the vocal folds looks.

Credits: The films were made at the Abteilung für Phoniatrie, Uni Erlangen (Prof. U. Eysoldt)

List of the film clips, with comments

Film 1419 Overview Female speaker 3703.7 frames/s	Soft onset of phonation. At the start of the film the vocal folds are abducted for respiration. Adduction then starts at about 50 ms. Note that the vocal folds start to vibrate (at about 120ms) before adduction is complete. i.e for the first few cycles they vibrate without forming a firm closure. This would be characteristic of what is called breathy phonation. For this speaker an audio signal is also available, which confirms this impression. Note that this speaker leaves a very slight gap open between the arytenoids even after completion of adduction. This is quite common and perfectly normal. Although the changes in the vertical orientation of the vocal folds are not so easy to see in this example, nonetheless the good image quality gives a good impression of the displacements occuring on the surface of the vocal folds, with their gelatine-like consistency.
Film 1419 Detail	The detail view shows a few cycles of fully developed phonation.

Film 0124 Overview
Male speaker
1922 frames/s

Unlike in the previous example the vocal folds adduct completely before phonation starts. Notice how the adduction in the region of the false vocal folds relaxes somewhat just before vocal folds start to vibrate. Initially, vibration is just in the anterior part of the glottis, but spreads over the first couple of cycles to include the whole length.

It is easier in this example than in the previous one to see the changes in vertical orientation of the vocal folds over the course of each vibratory cycle.

Film 0124 Detail

Again, the detail view shows fully developed phonation

Film 0125 Overview
Male speaker
1922 frames/s

Similar to previous example, but with an even “harder” onset. During the first 200ms strong adduction takes place, then for the next 100ms little change occurs, the view of the true vocal folds being considerably obscured by the strong adduction of the false vocal folds. Then following relaxation of the false vocal folds over about the following 70ms phonation starts. Thus, both this example and the previous one have glottal stops preceding phonation onset.

Film 0125 Detail

Again, fully developed phonation.

Film 1404 Overview
Female Speaker
Paresis of right recurrent laryngeal nerve.
3636.5 frames/s

This example shows the pattern of vibration in the presence of paresis of the recurrent laryngeal nerve. This affects the innervation all laryngeal muscles except the cricothyroid, and thus means that the tension in the affected vocal fold cannot be regulated properly, and that it also cannot be properly adducted (or abducted). The two vocal folds thus effectively try to vibrate at different frequencies, which means that a clear division of the glottal vibratory cycle into open and closed phases cannot be achieved. In a severe case such as this almost no sound production is possible, but note that even under such unfavourable conditions some vibration does occur.

Film 1404 Detail

The detailed film shows a striking consequence of the difference in the vibratory properties of the two vocal folds: phases occur where both vocal folds are tending to move in the same direction.