Influence of Glottal Closure Configuration on Vocal Efficacy in Young Normal-speaking Women

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Summary: Posterior closure insufficiency of the glottis is often mentioned in connection with permanent voice disorders. Recently published studies have revealed that an incomplete closure of the glottis can be found also in normal-speaking voices, especially in women. However, the effect of glottal closure configuration on vocal efficacy is not sufficiently clarified. The purpose of this study was to determine the effect of glottal closure configuration on singing and speaking voice characteristics. Overall, 520 young female normal-speaking subjects were examined by videostroboscopy for different phonation conditions in the combination of soft, loud, low, and/or high phonation and by voice range profile measurements. According to the videostroboscopic analysis, the subjects were subdivided into four groups: complete closure of the vocal folds already in soft phonation (group 1), closure of the vocal fold with increasing intensity (group 2), persistent closure insufficiencies despite increasing intensity (group 3), and hourglass-shaped closure in subjects with vocal nodules (group 4). Subjects in which the glottal closure could not be evaluated sufficiently were subclassified into group 5 (missing values). Selected criteria of the singing and speaking voice were evaluated and statistically processed according to the mentioned subclassification. Group 1 reached significantly the highest sound pressure levels ($\text{SPL}_{\text{max}}$) for the singing voice as well as for the shouting voice. Group 3 showed a limited capacity to increase the intensity of the singing and speaking voice. The results gathered in this study objectify the relationship of insufficient glottal closure and reduced vocal capabilities. As long as no conclusive data on long-term consequences of insufficient glottal closure are available, a prophylactic improvement of the laryngeal situation especially in female professional voice users by voice therapy should be recommended.

Key Words: Glottal closure—Insufficient glottal closure—Glottal gap—Stroboscopy— Videostroboscopy—Voice range profile measurement—Vocal efficacy—Euphonia—Female voice.
INTRODUCTION

Otorhinolaryngological examinations for evaluating the vocal status in prospective professional voice users are common in daily clinical work. The interpretation of vocal fold closure with regard to its influence on the voice efficacy is still based on subjective clinical experience. Young women with an incomplete glottal closure while phonation were often sent to a phoniatric and logopedic department for further diagnostics and therapy.

In general, the closure of the vocal folds can be described following standard protocols, which may vary, however, in minor aspects. The following criteria for the glottal configuration are usually included: complete or incomplete closure, location of the glottal chink (anterior, middle, posterior), or typical “hourglass” closure.

A high incidence of incomplete closure of the vocal folds has been found in different female age groups. The duration of closure in female subjects becomes shorter with increasing age, whereas male subjects with increased age showed a more closed glottal configuration. Further, the authors observed increased duration of closure with increasing sound intensity and decreasing frequency consistent with findings from other studies.

Experience shows that a posterior chink can occur in both normal-speaking and dysphonic voices. The presence of a posterior glottal chink (PGC), which is mostly regarded as pathological, is a possible etiopathological factor of functional dysphonia. Several studies were performed investigating not only the glottal closure, but also the relationship with selected voice quality parameters. Södersten et al. examined the perceived breathiness due to the configuration of glottal closure during phonation in 9 female normal speaking subjects and later in a more comprehensive study in 17 healthy middle aged women. A posterior triangular chink was the predominant pattern of closure in most women investigated. Most voices were rated as slightly breathy with an increased perceived breathiness in decreased loudness and a less complete glottal closure. The studies revealed a higher frequency of PGC in younger women. Due to the small number of examined subjects, it is questionable whether these findings can be used as normative data.

Currently, there are little objective standard data available concerning the interpretation of the relationship between individual glottal closure behavior and its possible influence on vocal capabilities.

For investigation of vocal capabilities, several methods are used. One of the most favorable investigations of vocal capacity in normal voices and in dysphonia is the voice range profile (VRP). This profile is a means of mapping the physiological limits of the vocal mechanisms in terms of vocal intensity at given fundamental frequencies.

To clarify, if an incomplete closure of the vocal folds ought to be regarded as a contraindication for being successful in a voice-intensive profession or as a risk factor for developing a future professional dysphonia, comprehensive investigations of young women ought to be performed.

For this reason, the goal of the present study was to:

- examine changes in glottal closure of young normal-speaking women as a function of pitch and loudness.
- examine changes in glottal closure as a function of vocal style, ie, speaking vs. singing, using VRP.
- investigate the relationship between the glottal closure configuration and voice capabilities.
- provide data for a future normative database on characteristics of normal-speaking voices.

MATERIAL AND METHODS

Subjects

Between 1998 and 2000, 546 normal-speaking young female subjects in the age from 17 to 41 years (mean 20.7 years) have been examined. Overall, 398 subjects (72.9%) who intended to become a logopedist were referred to our department for a comprehensive vocal evaluation, including videostroboscopy in the course of medical aptitude tests. The other 148 subjects (27.1%) were prospective teachers at the beginning of their training. All subjects participated as volunteers and had no history of any clinically relevant voice complaint at the date of examination.

Methods

Measurements

All women underwent a videostroboscopic examination of the larynx and a voice range profile...
measurement under the instruction of experienced assessors. Due to the known influence of pitch and intensity on stroboscopic parameters, the recordings were performed on all subjects for sustained vowels at four different phonation conditions: low-soft, low-loud, high-soft, and high-loud. The low pitch was in the area of fundamental frequency of the comfortable speaking voice, whereas the high tone was at least a fifth higher. Each subject was asked to phonate for 3 seconds. The pitch for soft and loud phonation should be at the same frequency level.

For videostroboscopy, the following instruments were used: rigid endoscope 90°, endostroboscope unit type 5052, videocassette recorder SVO 9500 MDP Sony, color video monitor model PVM 1443 MD, and CCD endocam 5501 D (Wolf, Vienna, Austria). This equipment records the sound pressure using the dB(A)-scale. Topical anesthesia was necessary only in five cases. Special emphasis was placed on an upright head position and a relaxed posture of the tongue. None of the subjects complained about the test procedure.

The measurements of the singing and speaking voice range profiles were performed according to the standardization proposed by the Union of European Phoniatricians. A head microphone was used considering a noise level <40 dB(A) in the examination room. With the help of voice range profile software 84Phonomat (Homoth, Hamburg, Germany) the fundamental frequency (F0) and the sound pressure level (SPL) were determined in real time.

The speaking voice was measured for three phonation conditions at different intensity levels: from the normal speaking voice to the shouting voice. The frequency and intensity levels for all three phonations were measured while counting from 21 to 30.

The measurements for the singing voice were performed while phonating a sustained /a/, at first at minimum intensity level (piano) and afterward as loud as possible (forte). Starting from 232 Hz, the frequency and intensity levels of the scale were measured until the limits of the vocal range in descending and ascending respective order.

The measured values were put in a two-dimensional-diagram with frequency on the x-axis and the corresponding sound pressure level on the y-axis.

**Videostroboscopic evaluation**

The evaluation of videostroboscopic recordings was focused on the shape of glottal closure under consideration of different phonation conditions. A complete glottal closure was assumed when the visible glottis was completely closed. A visible chink in the intercartilaginous or intermembranous part was evaluated as a posterior glottal chink (PGC).

Subjects with a complete closure already in soft phonation were subclassified into group 1, subjects with a complete glottal closure after an intensity increasing into group 2, and subjects with a persistent posterior gap into group 3. Group 4 contained all women with an hourglass closure due to vocal nodules.

In this study, no effort was made to quantify the visible length and area of the PGC.

In 26 subjects (5.9%), no proper videostroboscopic analysis of the four phonation conditions of the vocal fold could be executed either due to anatomic laryngeal reasons (n = 21) or due to strong feeling to retch (n = 5). Thus, the results of 520 young women were given.

**Evaluation of the voice range profiles**

Nine frequencies of the singing voice range profile were taken into consideration for analysis: 196 Hz, 220 Hz, 262 Hz, 330 Hz, 392 Hz, 440 Hz, 524 Hz, 660 Hz, and 784 Hz. For all frequencies, selected parameters were determined:

- sound pressure level of the maximum loud singing voice (SPL max) in Hertz
- sound pressure level of the minimum soft singing voice (SPL min) in Hertz
- frequency range of the singing voice from the lowest to the highest tone in semitones

The ability to reach at least 90-dB(A) level was evaluated for the maximum sound pressure level of the singing voice.

Following a suggestion for quantifying of the VRP area, an additional parameter was introduced: the sum of dynamic ranges at the nine selected frequencies (in dB(A)).

The speaking voice range profile measurement allowed the evaluation of several further parameters:

- SPL and frequency level of the comfortable speaking voice
Table 1 summarizes the videostroboscopic observations of the glottal closure shape. The predominant pattern was an incomplete glottal closure as a visible posterior triangular gap in soft phonation with a complete closure for loud phonation at the same frequency level (group 2). It occurred in 41.3% of the tested subjects. Only 12.5% of the young women examined showed a complete closure of the vocal folds at soft phonation (group 1).

Almost one third of all subjects exhibited an incomplete glottal closure in the posterior part of the vocal folds (group 3) for soft and loud phonation. The length of the PGC seemed to be related to the loudness level. An incomplete closure was typically seen when a tone was produced in very high pitches.

Forty-five (45) subjects (8.6%) exhibited typical phonation associated laryngeal alterations (vocal nodules), of which 22 subjects (4.2%) with beginning voice nodules and in soft phonation visible hourglass type glottis showed a complete closure of the vocal folds with increasing intensity. The hourglass glottis was visible during both soft and loud phonation for the remaining 23 experimentees (4.4%) with vocal nodules (group 4). Subjects in which the glottal closure could not be evaluated sufficiently were subclassified into group 5 (missing values).

Explorative data analysis of voice range profile measurements

The results of the measurements of the singing and the speaking voice range profiles are demonstrated in Tables 2 and 3. The values show a great intersubject variability.

The comparison of our test results with values recommended as references for a normal voice revealed that only 80% (n = 416) could reach a frequency range of the singing voice of minimum 24 semitones. Only 352 women (67.7%) could fulfill the request of proposed standard minimum SPL of 90 dB(A) for loudest singing, whereas 168 women (32.3%) showed maximum sound pressure levels lower than 90 dB(A).

Similar results were gathered for the speaking voice parameters (Table 3). The SPL values for the shouting voice varied between 71 dB(A) and 110 dB(A). Overall, 448 subjects (86.2%) reached maximum SPL more than 90 dB(A). However, 72 subjects (13.8%) had to be classified as constitutionally weaker voices with SPLs lower 90 dB(A) during shouting.

Statistical analysis

In Figure 1(A–D), the minimum and maximum SPL (mean and ±SEM) for soft and loud singing of the nine selected frequencies were put together according to the four types of glottal closure. The
TABLE 2. Explorative Data Analysis of Singing Voice Characteristics without Consideration of Glottal Closure Characteristics

<table>
<thead>
<tr>
<th>parameter</th>
<th>number of subjects</th>
<th>mean</th>
<th>minimum value</th>
<th>maximum value</th>
<th>± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>frequency range (in ST)</td>
<td>520</td>
<td>28</td>
<td>13</td>
<td>40</td>
<td>5.35</td>
</tr>
<tr>
<td>SPL max (in dB(A))</td>
<td>196 Hz</td>
<td>504</td>
<td>77</td>
<td>49</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>220 Hz</td>
<td>519</td>
<td>81</td>
<td>57</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>262 Hz</td>
<td>520</td>
<td>84</td>
<td>61</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>330 Hz</td>
<td>520</td>
<td>86</td>
<td>66</td>
<td>105</td>
</tr>
<tr>
<td></td>
<td>392 Hz</td>
<td>519</td>
<td>89</td>
<td>68</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>440 Hz</td>
<td>516</td>
<td>90</td>
<td>73</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>524 Hz</td>
<td>484</td>
<td>90</td>
<td>59</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>660 Hz</td>
<td>420</td>
<td>92</td>
<td>63</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>784 Hz</td>
<td>318</td>
<td>93</td>
<td>66</td>
<td>193</td>
</tr>
<tr>
<td>SPL min (in dB(A))</td>
<td>196 Hz</td>
<td>507</td>
<td>52</td>
<td>41</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>220 Hz</td>
<td>519</td>
<td>53</td>
<td>42</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>262 Hz</td>
<td>520</td>
<td>55</td>
<td>43</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>330 Hz</td>
<td>520</td>
<td>57</td>
<td>44</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>392 Hz</td>
<td>519</td>
<td>60</td>
<td>43</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>440 Hz</td>
<td>516</td>
<td>62</td>
<td>49</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>524 Hz</td>
<td>483</td>
<td>65</td>
<td>48</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>660 Hz</td>
<td>423</td>
<td>70</td>
<td>52</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>784 Hz</td>
<td>314</td>
<td>75</td>
<td>54</td>
<td>100</td>
</tr>
<tr>
<td>sum of dynamic ranges at the selected frequencies (in dB(A))</td>
<td>520</td>
<td>230</td>
<td>40</td>
<td>458</td>
<td>72.00</td>
</tr>
</tbody>
</table>

SD = standard deviation; ST = semitone.

curves of the soft singing voice proved no relevant differences for all groups. The profiles for the loud singing revealed lesser maximum SPL values related to larger glottal insufficiencies. The comparison for the groups exhibited smaller values for group 3. The maximum sound pressure levels differed significantly ($P < 0.009$), except those at the frequencies 262 Hz ($P = 0.135$) and 330 Hz ($P = 0.105$).

According to prevailing opinions and recommendations, SPL$_{\text{max}}$ values of minimum 90 dB(A) were regarded as standard for the loud singing voice and for the shouting voice. Figure 2 shows the portion of the so-called constitutionally weak voices with SPL$_{\text{max}}$ smaller than 90 dB(A) (vocal hypofunction) for the four groups. It can easily be seen that subjects with a persistent PGC tend to have constitutionally

TABLE 3. Explorative Data Analysis of Speaking Voice Characteristics without Consideration of Glottal Closure Behavior

<table>
<thead>
<tr>
<th>parameter</th>
<th>mean</th>
<th>minimum value</th>
<th>maximum value</th>
<th>± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>F0 of comfortable speaking voice (in Hz)</td>
<td>217</td>
<td>165</td>
<td>294</td>
<td>20.18</td>
</tr>
<tr>
<td>SPL of comfortable speaking voice (in dB(A))</td>
<td>56</td>
<td>46</td>
<td>68</td>
<td>3.92</td>
</tr>
<tr>
<td>F0 of shouting voice (in Hz)</td>
<td>388</td>
<td>175</td>
<td>588</td>
<td>20.18</td>
</tr>
<tr>
<td>SPL of shouting voice (in dB(A))</td>
<td>93</td>
<td>71</td>
<td>110</td>
<td>7.12</td>
</tr>
<tr>
<td>frequency range (in ST)</td>
<td>10</td>
<td>1</td>
<td>19</td>
<td>3.36</td>
</tr>
<tr>
<td>dynamic range of speaking voice (in dB(A))</td>
<td>37</td>
<td>8</td>
<td>57</td>
<td>7.58</td>
</tr>
<tr>
<td>distance of comfortable speaking voice to the</td>
<td>4</td>
<td>1</td>
<td>10</td>
<td>2.02</td>
</tr>
<tr>
<td>deepest singing tone (in ST)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>voice index (in ST per dB(A))</td>
<td>3.67</td>
<td>0.89</td>
<td>30.00</td>
<td>2.32</td>
</tr>
</tbody>
</table>
weaker vocal reserves. 40.1% of them did not reach the standard SPL_{max}-level with loud singing. In contrast, only 25% of group 1 did not reach the 90-dB(A) level for the loud singing voice. Similar results were found regarding the speaking voice. Only 9.4% or 9.6% of the subjects of group 1 and 2, respectively, did not reach the 90-dB(A) level for the shouting voice. Further, 7.4% of group 4 showed sound

*Figure 1.* Singing voice profile—piano and forte curves under consideration of the glottal closure behavior for the analyzed frequencies: (A) complete glottal closure while soft and loud phonation ("complete"), (B) complete glottal closure in low phonation if intensity increases ("intensity increase").
pressure levels below 90 dB(A). In group 3, however, 20.4% of the women had values below 90 dB(A).

The results are also reflected in the calculation of the sum of the dynamic ranges of all nine frequencies of the singing profile measurement (Figure 3). Group 3 reached significantly the smallest values of the dynamic ranges ($P = 0.047$).

For evaluation of the speaking voice range profile, the comfortable speaking voice was examined first.
No significant differences were seen neither for the fundamental frequency nor for the SPL. However, the interval from the fundamental frequency of the comfortable speaking voice to the lowest reached frequency of the singing voice in the subjects tested was significantly \( P = 0.009 \) one semitone higher for groups 1, 2, and 4 compared to group 3 (Figure 4).

Pitch and SPL\(_{\text{max}}\) were also determined for the shouting voice and analyzed statistically (Figures 5 and 6). Group 3 showed significantly lower values \( P = 0.0002 \) in comparison to the other groups with respect to the reached fundamental frequency and SPL\(_{\text{max}}\). Women with insufficient glottal closure reached lower pitches when shouting \( P = 0.007 \), which is in accordance with the observations made regarding the ability to increase intensity. Despite the fact that the mean value with 92 dB(A) is in the range of the normal voice constitution, 20.4\% of the subjects with an PGC showed values below the 90-dB(A) level. Taking the dynamic range of the speaking voice into consideration as per Fig. 7, it can be seen that group 3 showed a significantly limited increase of the speaking voice \( P = 0.005 \). The highest SPL values and the widest dynamic range could be seen both in subjects who had a complete glottal closure during soft and loud phonation and in subjects with an “hourglass” closure, respectively.

Voice index (ratio of dynamic range of speaking voice in decibels to frequency range in semitones) showed no significant difference between the four groups with an average value of 4 dB(A) per semitone. Subjects with a PCG (group 3) exhibited a tendency for larger voice indices [4.6 dB(A) per semitone].

**DISCUSSION**

Information on vocal structures and function can be acquired in several ways. Videostroboscopic analysis is currently the preferred method for evaluating the status of vibratory capabilities of the larynx and has proven particular evidence in professional voice users.\(^{17-20}\) Gathering information on normal dynamic aspects of the glottis during phonation is essential to determine fundamental principles and mechanisms of voice production and to formulate criteria that can be used to detect potential risk factors of glottal functions and abnormal laryngeal appearances. Videostroboscopy allows a accurate
evaluation of the vocal function and, in particular, the glottal closure.\textsuperscript{1,2,17–21} The type, completeness, and duration of vocal folds closure showed gender- and age-specific characteristics.\textsuperscript{2,5,7,13} Due to the known effects of intensity and pitch on glottal vibrations, videostroboscopy was performed on four phonation conditions in combination of soft, loud, low, and high phonation.

**FIGURE 3.** Sum of dynamic ranges of all selected nine frequencies of singing profile: mean and standard error of mean (±SEM) according to the distinguished glottal closure configurations.

**FIGURE 4.** Distance of comfortable pitch to the lowest tone of singing voice: mean and ±SEM according to the type of glottal closure.
Recent investigations provide evidence that PGC occur commonly in normal young female speakers.\textsuperscript{3,6,7} Young speakers should demonstrate PGC significantly more frequently than elderly women. Södersten et al. reported on posterior triangular gaps observed in 61\% of the judged phonations (10 of the 16 subjects).\textsuperscript{6} Lundy et al observed an incomplete glottal closure in 84.1\% of the singing students...
as well. However, no information could be gathered from the literature on whether a PGC in young women should be regarded as a potential risk factor of a future occupational voice disorder or considered in careers guidance.

The aim of the present study was to objectify the influence of glottal closure configuration on vocal capability in young normal-speaking women. Therefore, four types of glottal closure were subclassified (groups 1 to 4). Only a small number of subjects showed a complete closure in soft and loud phonation (group 1). An incomplete closure was diagnosed in 76.2% of all subjects investigated during soft phonation (groups 2 and 3). When increasing the intensity, still 34.9% of the population (group 3) had an incomplete closure.

The voice range profile measurement was used for evaluation of the vocal capabilities regarding the different configurations of glottal closure. This method has been demonstrated to be a very reliable and effective tool that can be used with confidence in research and clinical practice. The expanding use of VRP software in clinical practice is an excellent possibility to get more practical information regarding vocal capabilities for evaluation of the so-called voice constitution. As known, the VRP measurement represents the output of the entire phonatory mechanism and not only laryngeal functions. Results presented in our study indicate that there are significant differences among women examined with regard to the consequences of the glottal closure on the vocal constitution.

For subjects with an insufficient glottal closure (group 3), a high percentage was observed to produce SPL maximum values below 90 dB(A). Approximately 40% of this group did not reach the 90-dB(A) level for the singing voice and 20% did not reach this standard level for the speaking voice. The comparably small increase in frequency from the comfortable speaking level up to the shouting voice can therefore be regarded as a physiological phenomenon. The gradient of the curve of the speaking voice range profile (voice index) was used as a criterion for physiological evaluation of voice. Under physiological aspects, a larger gradient appears to be desirable. The analysis revealed that subjects with a PGC (group 3) had the tendency to have larger gradients. This may be due to an attempt to compensate for the weaker voice constitution.

As can be seen from the results, the glottal closure configuration has no influence on the pitch and loudness of the comfortable speaking voice and on the soft singing voice.

**FIGURE 7.** Dynamic range between comfortable speaking and shouting voices: mean and standard error of mean (±SEM) according to the type of glottal closure.
GLOTTAL CLOSURE CONFIGURATION ON VOCAL EFFICACY

There are only a few studies published concerning possible consequences on the vocal efficacy, mainly dealing with voice sound and transglottal flow measurements. Södersten and Lindestad found in most of the subjects investigated slightly breathy voices with an increased perceived breathiness in decreased loudness and a less complete glottal closure. Wendler reported that the incomplete glottal closure is the only quantitative stroboscopic parameter that can be related to a specific perceptual impression, heard as breathiness. The impression of breathiness seems to require a minimal glottal width of ~1 mm. Small glottal chinks, in the order of 0.5 mm, may have no influence on the voice sound. Hirano proposed an incomplete closure in the intercartilaginous portion of the vocal fold to be considered as a symptom of normal variance. Adductory forces, comprising myoelastic-aerodynamic factors, determine the pattern of the vibratory cycle. Vocal fold dysfunction has been investigated in several studies. It is possible that the high incidence of posterior chink in young women may be unrelated to physiological ability to achieve closure. Perhaps less forceful contraction of the interarytenoid muscles is adopted by young women as an economic measure or as a means to accomplish a particular vocal quality aim, such as slightly breathy voice quality in terms of an attractive appeal.

So far there is no common agreement on whether an incomplete glottal closure in young women is a normal finding. It is not known if an incomplete closure is of potential risk for the development of future functional voice disorders. Finally, physicians must be careful not to misinterpret deviating stroboscopic findings as pathological when the patients have no voice complaints.

It might be hypothesized that a PGC is a potential risk factor for developing functional voice disorders as the results of compensatory muscle hypertension, muscle misuse, and maladaptive behavior.

Our studies on abnormal laryngeal findings in vocally asymptomatic young persons revealed a surprisingly high incidence of phonation-associated laryngeal alterations. Similar observations were made in healthy singers as well. Elias et al found an incidence of 58% “abnormal” findings as six clinical entities using strobovideolaryngoscopy performed upon 65 healthy, asymptomatic professional singers revealed. It has to be considered that these women had not experienced yet any longtime vocal strain. The question of whether PGC may induce additional vocal stress to compensate the reduced vocal efficacy should be investigated in further studies.

As long as no conclusive data on long-term consequences of insufficient glottal are available, a prophylactic improvement of the laryngeal situation especially in female professional voice users by voice therapy should be recommended.

Moreover, videostroboscopy as well as VRP measurements are recommended in voice-intensive profession as a general routine for assessing glottal closure patterns and vocal efficacy on the basis of selected objective data.

To provide insight into the development of occupational voice disorders, longitudinal studies are warranted. Because of the fact, demonstrated by our data, that at the onset of a voice-intensive profession a subclinical proportion of young women already demonstrates the clinical voice deterioration, we will perform such examinations within a longitudinal study setting.

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