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ORIGINAL ARTICLE

Videokymography assessment of vocal fold vibration before and after hydration

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Key words: larynx, hydration, voice, kymography.

Summary

Keeping the body hydrated is one of the factors that contribute to organic and functional laryngeal health, especially for professional voice users. Hydration is considered an important factor for the prevention and treatment of dysphonias. There is no objective evaluation that quantifies water present in the vocal fold tissue. Aim: To evaluate changes in vocal folds investigated through videokymography after internal and external hydration of voice professionals. Study design: Clinical prospective. Material and Method: We assessed six male professional voice users after leaving the workplace (six hours) and without having drunk water for the past four hours. We conducted ENT evaluation, comprising the first laryngeal assessment with laryngoscopy with and without stroboscopic and videokymography. These people were submitted to external and internal laryngeal hydration. They drank two glasses of hydrating solution with electrolytes, Passion Fruit Flavor (total of 300 ml), at room temperature, and external hydration with inhalation of saline solution at 0.9% during 10 minutes. Using videokymography we evaluated the time of open and closed phases during phonation, defining a quotient between these two parameters. Results: We found five subjects with reduced or increased quotient. Conclusion: Videokymography was able to detect differences at the vibrating characteristics of vocal folds before and after hydration.

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INTRODUCTION

Maintaining your body hydrated is a factor that contributes to both the organic and functional health of the larynx, especially in voice professional users. Dehydration contributes to the development of dysphonias and vocal performance worsening; hydration procedures are considered important in the prevention and treatment of dysphonias [1].

Hydration in professional voice users is an important habit of vocal hygiene to maintain vocal quality [2].

The definition of hydrating, according to the Brazilian Portuguese Dictionary Aurelio is: "1. Convert into hydrate; 2. Treat with water; 3. Combine with water; 4. Treat (the skin) with a substance that conveys natural moisture or prevent dryness". Many researchers have been involved in studying this process of laryngeal hydration and its effects.

In a case study, the authors detected reduction of level of dysphonia and phonation instability, in addition to reduction of feeling of discomfort, immediate after hydration procedures were employed. Such data, however, are subjective and it is difficult to confirm that improvement resulted from the hydration process[3].

Some of the effects of laryngeal hydration in the vocal fold mucosa assessed through laryngoscopy with optical fiber are: accumulation of secretion, increase in viscosity and excessive brightness, which may lead to more complicated cases of atrophic line (simulating sulcus) and reduction of mucosa wave mobility [4,5].

As to hydration procedures, in research studies the authors used two types of approaches: internal hydration (intake of water or electrolytes) and external hydration (inhalation of water or sterile solution) [1,6,7].

The use of solutions with electrolytes (sterile solution and hydration liquids for athletes) is referred as an efficient way to hydrate the larynx both internally and externally [6], observed in the visual assessment of reduction of dehydration signals. Such effect over the body can be physiologically explained since water can only enter the internal medium in an active form, using the sodium-potassium pump, followed by electrolyte flow. In general, when we drink only water, little amounts are retained in the body, inducing aqueous enuresis that may debilitate even further sodium reserves, a fact that is widely known by physicians who take care of their patients with dehydration using electrolyte and glucose solutions, which is the most effective form of hydrating a subject.

The hydration status of a subject is assessed by the inspection of the oral and conjuctival mucosa and the skin. The larynx can be visually assessed using laryngostroboscopy, but it will not show its level of dehydration.

Current resources used in research studies on level of laryngeal hydration are based on clinical criteria that may subjectively induce responses, and there are no reports of the use of methods that can assess them objectively. It is difficult to generate criteria to record, confirm and measure the hydration status in the vocal folds and in subjects.

The assessment of tissue and blood osmolarity is an objective method to assess the conditions of hydration and it would be used for such confirmation if it were not an invasive and difficult to apply exam, since there are many factors that interfere in this measurement.

Hydrated mucosa presents further flexibility, increase of contact during the closed phase of vocal production and reduction of glottic opening time in the open phase [1]. However, using only visual observation methods, such as stroboscopy, it is not possible to define objective criteria for hydration measurement.

Videokymography is a method for laryngeal assessment [8, 9] conducted in real time, in which isolated movements in the horizontal line of images and mucosa wave are summed up, representing the vocal fold vibration in a specific point (simulating a section), but it is not widely used owing to cost and difficulty to conduct it [10].

This method objectively assesses and can reproduce all types of irregularities of mucosa wave vibration regardless of vocal quality and degree of affection [11].

In view of the possible use of videokymography as an objective procedures to assess mucosa wave, and knowing of the modifications resultant from hydration, we believe that it is a useful method to assess the vibration conditions before and after hydration.

OBJECTIVE

The objective of the present study was to assess the modifications of mucosa wave vibration pattern after internal and external hydration using videokymography in professional voice users, after a period of vocal use without hydration.

METHOD

The present study gathered 6 male subjects and mean age of 32 years (aged between 28 and 36 years) who had been working at least for one year as professional voice users for a period of 6 working hours a day in an environment with artificial refrigeration, controlled temperature and humidity.

The choice for male population was due to the fact that we wanted to eliminate other hormonal factors that could interfere in laryngeal conditions.

All subjects were aware of the procedures to be conducted to assess laryngeal pre and post-hydration conditions.

In Table 4, we can find the description of the diagnostic hypothesis (ENT, referring to structural conditions of vocal fold cover mucosa).

Before the assessment, the healthy subjects (without having used any type of systemic medication) were instructed to follow some guidelines for the exam, such as remain in the workplace, not to take coffee, alcoholic drinks and diet products, and not to take liquids 4 hours before the assessment with the Otorhinolaryngologist.

On the assessment day, relative air temperature in the workplace of the subjects ranged from 19 to 21 degrees and relative air humidity was between 40 and 50%.

Exams were conducted right after the work shift (respecting commute time required for them to go from work to the assessment center, which was approximately 60 minutes).

Subjects were submitted to laryngological assessment conducted by the Otorhinolaryngologist using computed equipment with digital image, brand Key, Laryngoscope Machida 70°, 7mm, coupled video camera Panasonic KS 5152 and source Key Electronics model 4914, with halogen and stroboscopic light.

Subjects, without hydration, were assessed by the Otorhinolaryngologist first using the above described equipment and the images were stored in DVDs. Next, we used videokymography with Laryngoscope Optomic 90º coupled to halogen white light source (Richards), without topical anesthesia, owing to its action in the quality of mucus and ciliar movement of trachea.

During the conduction of the laryngeal stroboscopic exam, vocal emission intensity (decibel meter RadioShack) and frequency were recorded and pre and post-hydration parameters were maintained for image recording.

For the videokymography exam, subjects produced sustained vowel /i/ in habitual emission.

Right after the first laryngeal assessment, laryngoscopy with stroboscopy and videokymography, subjects drank 2 glasses of aqueous solution with electrolytes (total of 300 ml), at room temperature, and next they were submitted to external laryngeal hydration with inhalation of saline solution at 0.9% during 10 minutes.

After one hour from the first laryngeal assessment, laryngoscopy exams with stroboscopy and videokymography were repeated.

Images obtained by videokymography were registered and assessed frame by frame, selected, frozen and printed. Each sample was assessed isolated, considering frequency (Hz) and intensity (dB), and not taking into account vocal quality of subjects.

An Otorhinolaryngologist and two speech therapists assessed the frozen images. We used the quotient: time in the open phase/time in the closed phase, comparing pre and post-hydration results in the same subject. To extract measures, we used a ruler in millimeters.

RESULTS

From the comparative analysis between pre and post-hydration conditions we noticed that five subjects (80%) presented reduced time of open phase/time of closed phase and one subject (20%) had increased time.

Table 1. Comparison of pre and post-hydration quotient open phase time/closed phase time.

Subjects	Pre-hydration (open/closed phase proportion)	Post-hydration (open/closed phase proportion)	Open/closed phase proportion pre and post-hydration
1	1. 00	1. 66	increased
2	1. 42	0. 90	decreased
3	1. 26	1. 07	decreased
4	1. 31	0. 41	decreased
5	1. 19	0. 58	decreased
6	3. 1	1. 75	decreased

Variation of intensity in production of sustained vowel /i/ after hydration ranged from 4 to 7 Hz.

Table 2. Comparison of intensity measures pre and post-hydration.

Subjects	dB Pre-Hydration	Variation range	dB Post-Hydration	Variation range(dB)
1	Not measured	___	Not measured	_____
2	75 – 89	14	78 – 85	7
3	71 – 85	14	75 – 82	7
4	70 – 75	5	74 – 78	4
5	71 – 82	9	73 – 80	7
6	70 – 80	10	73 – 79	6

Table 3. Comparison of fundamental frequency pre and post-hydration.

Subjects	Pre-hydration (Fo)	Post-hydration (Fo)	Range of frequency
1	170 Hz	172 Hz	2 Hz
2	127 Hz	136 Hz	9 Hz
3	129 Hz	120 Hz	9 Hz
4	107 Hz	110 Hz	3 Hz
5	93 Hz	100 Hz	7 Hz
6	123 Hz	110 Hz	13 Hz

Table 4. ENT Diagnosis (laryngeal assessment conducted by laryngoscopy and stroboscopy).

Subjects	OtorhinolaryngologicalDiagnosis
1	Left vocal fold pocket sulcus and contralateral reaction
2	Right vocal fold scar and laryngitis
3	Left vocal fold pocket sulcus with retention cysts
4	No abnormal findings
5	Right vocal fold major stria sulcus and vestibular fold constriction
6	Fibrin crusts on vocal folds

The variation of fundamental frequency in producing sustained vowel /i/ after hydration ranged from 2 to 13 Hz. Upon analyzing these variations, we can see that in 60% of the studied subjects there was increase of frequency and in 40% there was reduction of frequency.

DISCUSSION

Maintaining appropriate hydration is very important for vocal performance, especially in professionals that use voice as an instrument of work.

Studies have reported that laryngeal hydration applied to excised canine larynges showed subglottic pressure thresholds with significant reduction, which could lead to more comfortable and less harmful vocal emission [1,12,13].

In a case study, the authors detected reduction of level of dysphonia and phonation instability, in addition to reduction of feeling of discomfort, immediately after hydration procedures were employed [6].

Fujita and Ferreira (1999) observed reduction of dehydration signals after internal and external hydration under laryngoscopic and stroboscopic visualization. The authors pointed out with the subjective analysis that increase in viscosity and brightness of vocal folds suggested signals of dehydration and that hydration with saline solution associated with two glasses of aqueous solution with electrolytes favored hydration of vocal folds.

Different methods to assess laryngeal mucosa can be used together with laryngoscopy, such as videomyography, stroboscopy, electroglottography, high-speed camera and stroboscopic X rays.

Upon using stroboscopy and traditional laryngoscopy we could observe that after quick hydration there were the following signs: reduction of the appearance of viscosity of the mucus and bright vocal folds, and increase in amplitude of vocal fold mucosa wave vibration [6].

All signals above described are very subjective and can lead to disagreement in diagnosis, given that they do not represent an objective form of assessment of the hydration status of the vocal fold mucosa.

We chose videokymography because it is a type of ultra-fast filming that allows real-time objective assessment of closed and open phase of one vibration cycle, and in addition, it may show vocal fold vibration pattern [8, 11, 14], an aspect that may be affected with hydration procedures.

In the recording of videokymography waves, we can observe and measure the open and closed phases of one cycle and can express these measures as a quotient, for occasional mistakes to be corrected [14]. In hydrated mucosa, the cycle takes longer in the closed phase, since amplitude of the excursion is increased because there is more flexibility [15].

It is quite difficult to assess the hydration status of subjects if we do not know their habits, workplace, amount of liquid intake and use of drugs.

The studied sample required clinical support because it was formed by professional voice users that worked in a situation of high vocal demand for 6 hours, exposed to noisy environment, controlled air humidity and temperature.

Most of the sample presented affections of vocal fold cover mucosa (Table 4), because they were professional voice users and, in view of any abnormalities, they were expected to be assessed and treated. Despite the fact that minimum structural alterations are not related with environmental factors, they are more frequent among professional voice users, because others that have such difficulties normally do not look for medical support. Maybe this is the reason why our sample had most of the subjects with some kind of lesion.

We know that some of these lesions may affect mucosa wave vibration pattern. We highlight that the analysis was conducted intra-subject, that is, the same larynx before and after hydration.

All subjects in the study presented signs of laryngeal dehydration (increase in mucus viscosity, excessive mucous brightness, accumulation of secretion, and some had atrophic line). Upon using pre and post-hydration images of the same subject, we managed to assess the analyzed factor. However, we would like to point out that environmental and vocal demand provided unfavorable conditions for hydration. After the work shift all subjects had one hour of vocal rest, while they were going to the medical center, and in this period they did not use their voices professionally. This period of time may have excluded from the assessment the effect of muscle contraction.

Similarly to what was described by Verdolini-Marston et al. (1994), laryngeal hydration favored reduction of vocal fold viscosity when assessed only by stroboscopy, and it is an extremely subjective signal. With videokymography, we could record changes in amplitude of mucosa excursion and observe that, in addition to individual reports of more comfortable vocal emission, we found increase in the closed phase of vibration cycle.

We are going to carry on with the study with videokymography as an objective method to assess vocal fold mucosa vibration status after hydration, using a larger sample without vocal trauma in order to study the hydration of vocal fold mucosa.

CONCLUSION

1. Videokymography proved to be an objective method of assessment to check abnormalities to vocal fold mucosa wave vibration after internal and external hydration.
2. We observed reduction in the quotient open phase time/ closed phase time after hydration.

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