

ORIGINAL ARTICLE

The resonance tube method in voice therapy: Description and practical implementations

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Abstract

Phonation into glass tubes, keeping the free end of the tube in water, has been a frequently used voice therapy method in Finland for more than four decades. These so-called resonance tubes, introduced by Professor Sovijärvi in the 1960s, are used in different ways depending on the patient's diagnosis and the goal of the voice therapy. In this paper, some of the most common ways of using the tube are presented.

Key words: *Acoustic impedance, resonance tube, voice exercise*

Introduction

Several methods used in voice therapy involve partial occlusion of the vocal tract in order to create acoustic impedance. Recent reviews by Bele (1) and Titze (2) show that there has been an increasing interest in exploring the effects of such methods. Some of them include phonation into different kinds of tubes or straws. The Finnish so-called 'resonance tube method' is mentioned in several articles (e.g. (1–4)). There are no recent detailed published reports of how the method is used in the treatment of persons with voice disorders in languages other than Finnish (5), except for a brief description in the proceedings from the 5th Nordic Congress of Logopedics and Phoniatrics in Helsinki 2000 (6). Finnish speech therapists find the method effective for the treatment of different kinds of voice disorders.

Unfortunately, no evidence-based research of the effectiveness of this method has been performed. The intent of this paper is merely to describe the resonance tube method and to present some examples of how it can be used in various ways depending on the voice disorder and the aims of the therapy.

The resonance tube—a brief history

Phonation into resonance tubes made of glass has been used in voice therapy in Finland since the 1960s. The method has also been used by normal-voiced persons such as singers for vocal care. It was introduced by Professor Antti Sovijärvi at the Department of Phonetics at the University of Helsinki, the department where also speech therapists were trained at that time.

Sovijärvi used the resonance tube as a part of his voice therapy and treated about 700 voice patients with good results (7). He was at first interested in testing different kinds of glass tubes in the voice therapy of children who had rhinolalia aperta (hypernasality), but he soon started to use the tubes also with adult singers who had voice problems (8). He tried out different kinds of glass tubes with various lengths and diameters. Based on his studies of X-ray pictures of the tracheal bifurcation he came to the conclusion that the thickness of the glass should be 1 mm and that the inner diameter should be 8 mm for children and 9 mm for adults. The length of the tube was 24–25 cm for children and 26–28 cm for adults, which was the length from the tracheal

bifurcation to the teeth (8). Sovijärvi chose the length of the tube in relation to how he, by palpation, felt the larynx sinking during the phonation of a lengthened /b/ into the tube (7). The length of the most suitable tube for a patient corresponded with the voice category, so that a 26 cm long tube corresponded to the soprano and tenor voices, 27 cm to mezzo-soprano and baritone voices and 28 cm to alto and bass voices (7,8).

The resonance tube was kept about 1 mm in between the teeth, the lips rounded so that no air would leak from the mouth, and the free end was kept either below the surface of water in a bowl or in the air as an extension of the vocal tract. Sovijärvi pointed out that the water bowl should be kept in a position that enabled a good body posture for phonation. It should also be big enough for the patient not to feel afraid that the water would run over the edge of the bowl (7). The patient phonated the logatomes (nonsense words) /jibbi/, /jobboo/, /jybby/ with the /bb/ phase lengthened so that the laryngeal depressor had more time to react (9). The purpose of /j/ was to eliminate a hard glottal attack (7). Additionally, the articulatory configuration of /j/ (the contact of the dorsum of the tongue with the anterior part of the palate) widened the lower part of the pharynx and brought the epiglottis to a more upright position (10). The exercise should be carried out several times a day for about 2 minutes each time, and the treatment periods varied from 2 to 6 months (9).

According to Sovijärvi (10), the positive outcomes of the resonance tube method were due to the efficient lowering of the larynx and the firming of the vibration of the vocal folds. When the free end of the tube was kept in water, the water bubbled during the phonation and he thought that the vibration from the bubbling was reflected in the glottis, having a densing effect. Sovijärvi not only used the resonance tubes in the treatment of professional singers and patients who experienced phonasthenia (vocal fatigue), but he also treated patients with vocal nodules and vocal fold paralysis (10,11).

The resonance tube method in voice therapy for some groups of patients

The authors of this paper have been using the resonance tube method in voice therapy for different groups of patients for more than three decades. As with other voice training methods, speech therapists often make modifications to suit the goals of the therapy and the problems of the patient. The descriptions below are based on the guidelines of Professor Sovijärvi, with some modifications based on clinical experience and practice. The

main principle in the tube exercise is that the patient phonates a vowel-like sound into the tube keeping the free end of the tube in water. This will change the magnitude of the input impedance of the vocal tract, and the amount of impedance change is controlled by the depth of the submersion of the tube (4).

The resonance tube method is suitable for the therapy of most voice disorders. The focus is on phonation, breathing and posture. When performing the exercise correctly, the muscles involved in voice production are in balance and enhance economical voice production. The tube can be used in different ways in different phases of the therapy depending on the specific problems and short-time goals. The aim is often to achieve a normal, well functioning voice. Working with patients with neurological disorders, such as Parkinson's disease, the goal might be to delay the deterioration of the quality or strength of the voice.

Sometimes the resonance tube method might be the only method used but usually the patients also do other voice exercises. The voice therapy almost always includes information on voice ergonomics, which comprises all actions that facilitate verbal communication and issues usually referred to as vocal hygiene (12,13).

In clinical practice today, it is seldom possible to offer very long voice therapy periods. When the patient is treated, for example, for vocal hyper- or hypofunction, ventricular voice, chronic laryngitis or vocal nodules, the voice therapy period usually lasts for about 2 months, with about two appointments during the 3 first weeks. In total, the speech therapist has scheduled 8–12 appointments and at least one appointment for a control after the therapy period has ended. Depending on the aetiology and the severity of the disorder, the voice therapy period can be longer.

The length of the tube

Sovijärvi thought that the length of the tube should be chosen according to the voice category of the patient and the lowering of the larynx during the tube phonation (7,8). The glass tubes that Sovijärvi designed are still in frequent use. It is common, however, that patients do not know their voice category. Additionally, the patient's voice quality is often so deviant at the beginning of the therapy period that it is impossible to determine the normal voice category. A main principle for Finnish speech therapists is to choose the tube that best enhances the lowering of the larynx during the phonation of a lengthened /b/ into the tube.

Body posture

It is important that the patient feels comfortable and relaxed when performing the resonance tube exercise. The bowl of water should be kept on a table and not in the hand, and the chair should be adjusted according to the height of the patient in order to enable a relaxed posture. The patient keeps the tube in the hand between the thumb and the fingers, and the bowl should be kept in a position that does not force the patient to bend the neck and lower the chin but to support a good body posture for phonation. Thus, the use of a drinking glass or a bottle is not appropriate.

Starting the resonance tube exercise

As described above, Sovijärvi used the logatomes /jibbii/, /jobboo/, /jybbyy/ for the tube exercise. Today it is common that the speech therapists merely advise patients to phonate a vowel-like sound into the tube (the prolonged /bb/ phase), using their habitual speaking pitch and volume. Patients are often more motivated to do the exercise this way because of the strong vibration they feel in their throat during the phonation. Additionally, many patients find it easier to do the exercise when they do not have to 'say' anything. Most patients find it easy to phonate into the tube and they usually do the exercise correctly merely by imitating the speech therapist. The patient keeps the free end of the tube 1–2 cm under the surface of water (Figure 1). This exercise is used for patients who have for example hyper- or hypofunctional voice, ventricular voice, chronic laryngitis, and vocal nodules. At the beginning of the voice therapy period, the patient uses an almost monotonous voice at least for the first week of

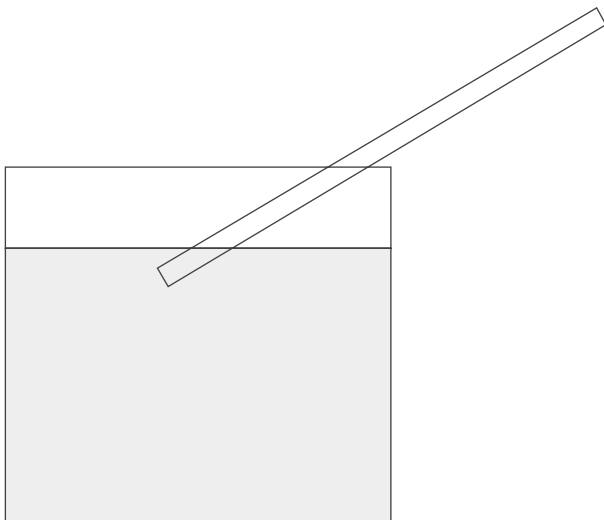


Figure 1. The end of the tube is about 1–2 cm under the surface of the water.

training. Gradually, the patient starts to use more varied intonation such as glides and simple intervals in a glissando mode. The patient is asked to keep the phonation stable and to follow a normal and comfortable breathing pattern in all exercises.

The resonance tube exercise is practised in the voice clinic until both the speech therapist and the patient feel confident that the patient is doing it correctly, without effort. After that, usually on the first or second therapy appointment, the patient is given the tube for home exercises. Every patient receives detailed written instructions on how to use the tube at home, such as how long every training session should last and how many training sessions there should be a day. When the patient takes the tube home, an appointment is usually scheduled for within 2 days. Even if the exercise has been practised with the speech therapist, some patients may forget the instructions, especially at the beginning of the voice therapy period. The most common mistake is that the patient forgets to phonate and merely blows air into the tube. The bubbles are seen in the water but no tone of voice is heard. When this occurs, the patient is asked to phonate into the tube when keeping the free end in the air, following the speech therapist's example. When the patient understands the idea of phonating into the tube, 'making the sound', the free end of the tube is submerged. Sometimes it is advantageous to record the exercise on a tape or on a CD to help the patient remember how the exercise should be performed. Other ordinary mistakes are that the patient has an improper body posture when training at home or that the patient forgets to breathe and becomes exhausted. Some patients might use a pitch which is too high or too low, or they keep the tube too deep under the surface of the water, which can be harmful because the impedance becomes too great and makes the phonation forceful. Phonating into the tube requires concentration, at least when patients first start to do the exercise. Some patients have difficulties concentrating and some have auditory perception problems, which hinder them from learning to do the exercises correctly. Some patients with asthma might feel that the resonance tube exercise provokes coughing. In such cases, the method is not suitable. However, patients usually find the exercises easy to perform, and problems rarely arise.

Sometimes patients who have breathy voices, for example due to a functional voice disorders, ask 'What do you mean by breathy?' They simply seem to have difficulties in hearing that feature in their own voice production. In these cases, the resonance tube can be used so that the patient keeps the end of the tube only about 1 mm under the surface of the water (Figure 2) or does not keep it in the water at

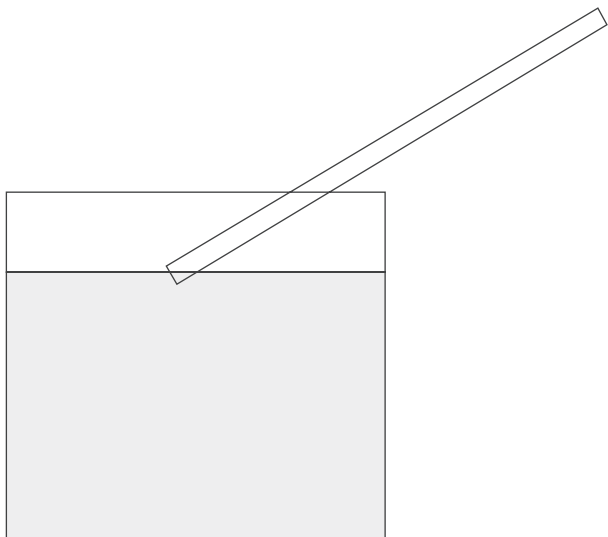


Figure 2. The end of the tube is about 1 mm under the surface of the water.

all. Phonating into the tube strengthens the auditory feedback, and most patients realize the difference between breathy and normal voice during this kind of tube phonation.

If the patient suffers from incomplete vocal fold closure, for example due to recurrent laryngeal nerve palsy, the resonance tube can be used so that the tube is kept 5–15 cm below the surface of the water (Figure 3). In this exercise, it is of particular importance that the phonation is extremely short, as in the pushing exercises. The patient carries out the exercise about 10 times a day, with 5–15 short phonations on every training session. The patient is given exact instructions according to the diagnosis, the laryngeal status, and the degree of breathiness. This exercise is forceful and the patient might feel that the larynx becomes tense or tires. Frequently

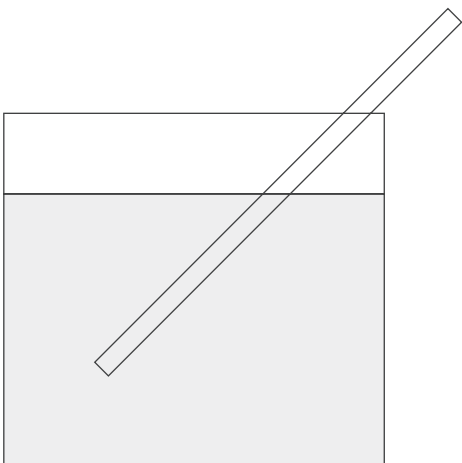


Figure 3. The end of the tube is about 15 cm under the surface of the water.

the patient finds it relaxing to phonate into the tube keeping it 1–2 cm below the surface of the water (as described above) after the ‘tube-pushing’ exercise.

The sensations of the patient

During the performance of the resonance tube exercises, the patients usually feel distinct vibrations and backpressure in the larynx, even if the phonation is unforced. They also feel a sensation of vibration and resonance in the face and sometimes in the chest. This is very motivating; the patients feel ‘that something is actually happening’. Most patients find the vibrations relaxing, like a ‘massage’. If the sensation of backpressure is too strong or uncomfortable for the patient, the tube is pulled closer to the surface of the water.

Some patients might have negative sensations when they first start to use the resonance tube. It is therefore important to inform them of this beforehand so that they do not get worried and stop doing the exercises. Such sensations include a feeling of dryness or too much mucus in the throat, a sensation of tickling in the throat or a need to clear the throat. The speech therapist can advise the patient to drink water after (or during) the training session. The negative sensations generally disappear within 2 days, when the patients become accustomed to performing the exercises. If the sensations persist, which is very unusual, the speech therapist chooses other voice therapy methods.

The patient should under no circumstances feel pain during the exercise. If the patient suffers from laryngitis and feels pain when phonating into the tube, the exercises should be postponed until the laryngitis is less severe (e.g. after having medicated for reflux). When the patient suffers from an upper respiratory tract infection and phonating into the tube feels painful or provokes a cough, the tube should not be used. It is important that the speech therapist keeps informed of possible negative sensations during the whole therapy period. Usually the subjective sensations of the patients are reliable and the speech therapist makes changes in the therapy programme accordingly.

Sometimes voice patients seem to overstress the control of their voice production or feel very anxious performing voice exercises. These patients often feel confident when they use the resonance tube. The bubbling of the water can be felt as an effective ‘masking’ of the voice, which might be advantageous, at least in the beginning of the voice therapy period. Additionally, patients often feel comfortable having a device for training.

The home training programme

The home training programme is intensive. At least during the first 1 or 2 weeks, the patient performs the tube exercises 10–12 times a day for about 1 minute each time. After this, the patient can carry out the tube exercise for about 4–5 minutes, five to six times a day. Gradually, the patient is instructed to vary the tube exercises so that the free end of the tube is kept in the water and in the air in turns, and to use more intonation, ‘humming’ simple tunes or intervals. When the free end of the tube is kept in the air it is easy for the patient to monitor the vocal production. The patient can also add vowels to the /bb/, for example /jibbii/, /abba/, /ebbe/, et cetera. Usually, the patient also has other voice exercises to do at home. If the patient is working, it can often be arranged for the patient to have short breaks for performing the exercises. If the patient has a severe voice disorder and is working in a vocally demanding occupation, it is often necessary for the patient to be on sick-leave for at least 2 weeks when the voice therapy starts.

The home training programme is updated at every voice therapy session. When the voice therapy period ends, the patient is usually given a personal home training programme. This includes the voice exercises and voice ergonomic advice which the speech therapist considers the most beneficial for the patient. The patient might be given the instruction ‘Do this exercise/these exercises those days that you feel that your voice is strained or tired’ or ‘Always do these exercises after a vocally demanding activity’. Patients often ask whether they should continue with the resonance tube exercises ‘for ever’ but generally that is not necessary. However, it feels good for the patients to have a familiar and easy method for voice training and many patients, especially professional voice users, have reported that they continue to use the resonance tube from time to time.

Summary

Finnish speech therapists have found the resonance tube to be a functional tool in the treatment of various voice disorders, some of them mentioned in this paper. A schematic presentation of how the resonance tube can be used is presented in Table I. This is not intended to be seen as a ‘manual’, but merely to give some suggestions of how the tube can be used in voice therapy. As pointed out above, each patient receives personal instructions and a personally adjusted training programme. The instructions change depending on the progress of the patient and the goals of the therapy.

Discussion

When using the resonance tube exercises with the free end of the tube in water, the impedance can easily be manipulated according to the purposes of the exercise. Complications can occur, however. Bele (1) reports that phonating into tubes can be problematic because it can ‘kill’ phonation if the resistance of the vocal tract is excessive, which might happen if a tube is very narrow, extremely long, or is kept very deep in the water. This is also the experience of the authors of this paper. Additionally, if the diameter of the tube is very large and the tube is very long, the phonation might be effortful for the patient. During the last decade, tubes made of silicon or similar materials have been used for voice training. These tubes can be bought (per meter) in hardware stores. A new phenomenon is that some patients who come to voice therapy have bought a piece of silicone tube because they have ‘read in a magazine or on a web site’ or ‘heard from someone’ that phonating into tubes with the free end in the water is good for the voice. Sometimes these tubes have been very long and/or have had a very large or a very small diameter, which makes phonating into them forceful, especially when holding the free end very deep in the water. This kind of voice production might be harmful for someone who has vocal nodules, for example. It is essential that persons with possible voice disorders undergo a medical examination by a phoniatrician or a laryngologist before starting the voice therapy. The speech therapist can ensure that the patients use tubes that are appropriate for the purpose of the voice therapy and give exact instructions for the exercises.

One disadvantage with tubes made of soft-walled materials is that they seem to absorb the sound, which makes the auditory feedback blurred. Some patients also think that they do not feel the resonance as intensely when phonating into a silicone tube as when using a glass tube. One benefit with tubes made of soft materials is that they do not break as easily as glass tubes. Even if the resonance tubes used today are made usually of laboratory glass, they are more fragile than soft-walled tubes. Tubes made of soft materials might be suitable when there are reasons to believe that a tube of glass might easily break, as in the case of patients who suffer from neurological diseases affecting the cerebellum causing ataxia and patients with Parkinson’s disease tremor. When the speech therapist decides to use a soft-walled tube with a patient, the length and the diameter should be selected to suit the goals of the voice therapy.

Table I. Some examples of how the resonance tube method can be used.

Diagnosis	Position of the tube under the surface of the water	Goals
Hyperfunctional voice, vocal nodules	1–2 cm. Keeping the tube at this depth allows an effective but still relaxed phonation.	Relaxation of the muscles of the larynx, improved vocal economy.
Hypofunctional voice, incomplete vocal fold closure	1–2 cm. For some patients 5–15 cm (short phonation). Keeping the tube deep in the water forces the vocal folds to adduct very effectively.	Depending on the diagnosis and laryngeal status: relaxation of the muscles of the larynx, efficient voice production, activating of the laryngeal muscles. Compensation, like a pushing exercise.

Speech therapists have a responsibility to ensure that their treatment is effective, not only to their patients but also to the health care system, which often is paying for their services. This has led to an increased need to evaluate voice therapy methods. Unfortunately, there does not seem to be any detailed documentation of Sovijärvi's research or of the results of his treatment method. The lack of evidence-based research has made it difficult to make the method known outside Finland, where it has become a tradition. A series of studies initiated by Laukkanen (14) have investigated the effects of phonation into different kind of tubes. According to the results of one of these studies (3), the phonation into the resonance tube improved the vocal function of the subjects at the middle frequencies of the speech range. Laukkanen suggests that the reason for the improvement might be that the subjects found a better phonatory balance phonating into the tube and/or a favourable acoustic-mechanical feedback in the vocal source-tract interaction. The subjects in the studies by Laukkanen (14) had healthy voices and they kept the free end of the resonance tube in the air.

Voice therapy methods involving a semi-occluded vocal tract can have a positive effect on the voice because they enhance a more efficient and economic voice production (2). So far, there have been no studies evaluating the effectiveness of the resonance tube method in voice therapy. In a study evaluating the effectiveness of voice therapy in small groups for students with voice disorders, the resonance tube was used as the main method, and the outcome of the therapy was positive (13). However, the purpose of that study was to evaluate voice therapy arranged in groups, not a specific method, and some other voice training methods were also used. It would be of interest to evaluate the effectiveness of the resonance tube exercises in voice therapy with different groups of patients in controlled clinical trials. Additionally, the scientific basis of the possible effects of phonating into tubes with the free end kept in water should be explored.

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