Summary in English

Introduction

Nasal congestion is an important symptom of several diseases of the upper respiratory tract. Nasal congestion may also affect personal well-being and quality of life. Furthermore, as the nasal mucosa is the first part of the airways in contact with the environment, objective evaluation of nasal congestion or nasal patency is important. When assessing fit-for-duty status of a soldier, it is necessary to have an objective picture about nasal ventilation. The level of nasal congestion may be evaluated by determining nasal volume. Nasal volume depends on anatomical structure and thickness of nasal mucous membrane. If we can measure nasal volume, we can assess the character and degree of those factors causing nasal congestion. The method of acoustic rhinometry meets these requirements.

The importance of appropriate nasal ventilation is based on the unity of airways and specifics of military service. Complaints, caused by inefficient nasal ventilation may result in unexpected patho-physiological consequences. Most of allergic airway diseases are –directly, or indirectly- associated with disturbed nasal ventilation. Patients` subjective complaints frequently cannot be explained by the picture received during Oto-rhino-laryngological examination, and at the same time, it is not rare that a seemingly completely blocked airway causes no complaints. Because of high variability of the individual nasal picture and subjective symptoms, it is difficult to set up an evaluation system that can objectively assess diseases, and at the same time can serve as a universal reference system.

Most of the methods used for assessment of the nasal status are subjective; therefore it is good news to have a tool –acoustic rhinometer- that can provide an objective assessment on nasal ventilation.

Acoustic rhinometry is a new diagnostic method in clinical practice, which makes objective nasal diagnostics easier and faster. Its use makes differential diagnosis easier in patients with chronic diseases and provides a tool to control treatment effectiveness.

Methodology

Acoustic rhinometry is a simple, fast, painless and minimally invasive, objective rhinological method that is well repeatable. It helps to obtain reliable information about the anterior, critically resistant segment of the nasal cavity. Nasal cross section can be shown as a function of distance, and this function gives a numerical value of the volume, which serves as a base to calculate nasal volume.

This method gives additional information in diagnostics of several nasal diseases providing an accurate nasal picture. There are more than 500 articles published on the nasal use of this technique that indicates a growing interest towards this method. This might be explained by the need from physicians, patients and authorities to assure correct diagnosis and objectively document treatment outcomes.

Verifications on the use of acoustic reflection technique in the nasal cavity have proved good correlation between area-distance functions using acoustic rhinometry and other methods (like CT, MRI). Acoustic rhinometry is used for clinical and physiological examination of nasal ventilation in several nasal centrums as a verified, but not routinely applied method. Its parameters are well documented in regard with nasal cycles, body posture, effect of different medications, nasal provocation, local cooling of skin, whole body temperature changes and dimensions of cadaver noses. In clinical practice most of the time it is used in diagnostics of volume blockage situations caused by structure or mucous membrane, and also in postoperative treatment evaluation.

Several parameters of the nasal cavity can be measured objectively: the volume of air reaching lungs through nasal cavities (measuring nasal peak flow), resistance of nasal cavity anatomical structures towards the inflowing air (rhinomanometry), thickness of the mucous membrane (rhinostereometry, MR), and the effective cross section and volume of the nasal cavity (acoustic rhinometry). Data received through subjective examination methods (symptoms` score value, visual analogue scale, nasal endoscopy) are contradictory several times; nevertheless they provide important information in analysis of nasal ventilation.

Though theoretical assumptions were not proved entirely, acoustic rhinometry in most cases provides accurate results, at least regarding the first 5-6 cm part of the nasal cavity. In rear parts of the nasal cavity and in the epipharynx, differences were found mainly due to 'sound loss' to the paranasal sinuses. Due to the working groups that use the equipment available in the market, a considerable amount of literature report is available now.

Standard operating procedures, and calibration checks as well as training of operators will enhance the accuracy and reproducibility of results. Since mucous membrane thickness shows considerable variability and is influenced easily by several factors, a standardized measuring method (that includes also an acclimatization period) can improve measurement quality. Guidance was elaborated concerning the system usage and method applicability in order to receive optimal examination results.

In summary, verification of use of the acoustic reflection technique in nasal cavity, that is verification of acoustic rhinometry proved that area-distance functions can be obtained and can also be reproduced with satisfactory accuracy (5–10%) using the present technique.

The equipment needs further verification and improvement in order to receive better results also from the rear parts of nasal cavity and epipharynx. Inherit part of this process is the review and improvement of existing guidelines. Despite of the wide use of acoustic rhinometry in rhinology, we still need comprehensive studies or meta-analysis in order to determine normal values of the average population, and also to determine those limits within which these values can be analyzed in individuals. These limits are not necessarily capable of dividing the examinees into two groups, as healthy individuals and patients, since the feeling of nasal congestion depends not only on sizes of nasal cavity, but on other factors as well.

Different factors, like receptors of pressure, temperature, pain, and others, like rhinorrhea also influence the feeling of nasal ventilation. Even relatively low level of correlation between objective and subjective evaluations cannot endorse abandonment of objective tests in diagnostics and evaluation of treatment effectiveness.

It was shown using acoustic rhinometry that mucous membrane of allergic people is keener to get thicker than that of non-allergic people, and that their histamine sensitivity is also higher. In allergic people acoustic rhinometry is used to

determine the level of hyper sensibility. Several variations of mucous membrane thickness was verified in allergic patients compared to non-allergic people. These facts and also the fact that nasal steroid treatment in non-allergic environment decreased mucous membrane thickness have proved that there is an inflammation and hypersensitivity present in the mucous membrane of allergic patients without the presence of allergen. Allergen provoked inflammation in patients with allergic rhinitis changes the nasal volume.

Several aspects of nasal hype reactivity, especially its connection to asthma and its influence on performance still needs to be studied.

Based on literature data it can be stated that acoustic rhinometry has proved its value as a method used in upper airway diagnostics, in research and in evaluation of treatment results. Accuracy and reproducibility of measurement data depend on standardized measurement method, on calibrations performed before use, and on skills and training of examiners.

During my research I have performed two clinical studies using acoustic rhinometry.

In the first study I have analyzed changes of the mucous membrane in hypobaric-hypoxic and hypobaric-hyperoxic environment.

During my second study I have examined the effectiveness and usefulness of acoustic rhinometry in setting the diagnosis in patients with chronic nasal congestion.

Results

It was proved in several clinical studies that acoustic rhinometry is a useful method in measuring volume changes in the first 6cm part of nasal cavity. Using this method I have analyzed the influence of hypobaric hypoxia (that is still a serious flight safety risk factor) on thickness variability of the mucous membrane in a complex test setting.

I have revealed that in hypobaric hypoxic conditions the mucous membrane is getting so thick that it considerably blocks nasal ventilation. During hypobaric hypoxic conditions temporary deficiency of hearing and balance function may occur due to considerable thickness of the mucous membrane.

Oxygen inhalation (normobaric hyperoxic conditions) resulted in relief of nasal ventilation.

The hypoxic condition appears as a potential brain vasodilator and puts under alarm the central element of regulation. In the tested flight crew members (who are acclimatized individuals) the saturation showed no alteration from normal levels. Based on this I conclude that local processes participating in regulation of mucous membrane vessels play the decisive role in decrease of nasal ventilation. A hypobaric condition directly influences structures of the mucous membrane through mechanoreceptors, so generating local processes. At the same time, mainly in non-acclimatized individuals we cannot ignore the influence of hypoxic condition, which depends on height and endurance, or on adaptation capability and also on external factors like physical workload or acceleration.

A disorder in local regulation processes (like histamine release, or axon-reflex mechanism) results in neurogenic inflammation and in hyper reactivity of the nasal mucous membrane, which leads to swelling of lower nasal conchae and causes decrease in nasal volume. Due to the underlying patho-physiological processes the chance for effective pressure equalization in nasal sinuses and middle ear is worsened. All these may lead to tympanic cavity hemorrhage, reduction of hearing and headache. Close vicinity of the vestibular apparatus may lead also to vestibular symptoms and barotraumas, which may cause acute inability.

Epidemiological studies have revealed that a major part of military personnel is suffering from chronic disorder of nasal ventilation. My specific aeromedical physiology study has proved that nasal volume of flight crew personnel that is not suffering from nasal ventilation problems considerably reduces in a hypobaric hypoxic environment. This leads us to the conclusion that a flight crew member suffering from „rhinitis” in extreme conditions might have far worse symptoms because of blocked nasal ventilation.

In order to reduce to the possible minimum disorders of hearing, pain and vestibular function caused in flight crew personnel during flight in hypobaric hypoxic conditions we have to screen and describe their nasal status during predeployment medical examinations as accurately as possible.

Based on results coming from my second study I have determined the ratio of functional or organic nasal ventilation disorders among those suffering from chronic blockage of nasal ventilation. My study has proved the usefulness of this method in revealing the functional or organic reasons causing nasal airway blockage in patients with long term nasal ventilation problems. It was easy to individually evaluate and

determine reactiveness of the mucous membrane, or to reveal anatomical stricture of either half of the nose.

Based on my test results I was able to make recommendation on which particular treatment method to use in individual patients.

Discussion

When determining fitness for military duty it is extremely important to have a clear picture on the nature of nasal blockage. The use of this method in revealing nasal patency during medical screening examinations allows depicting other diagnostic examinations to be used more selectively.

Test results help us to localize and describe nasal stricture more accurately and objectively, so indication of conservative treatment or the operative approach is more reliable, results of the operation are easier to evaluate and follow on with minimum costs involved.

This method is a great help in setting up nasal diagnosis during medical screenings, especially when determining fitness for special duties. Before performing barochamber tests, also acoustic rhinometry is advisable to do beside airway allergologic and ear-nose-throat examinations, taking into consideration the large number of patients with rhinitis, and to avoid unpredictable possible later complications.

This method –being a useful tool in determining status of the nasal mucous membrane and in objective evaluation of nasal patency- has its own place and is to be introduced in military medical screenings.