

Olfaction in rhinology – methods of assessing the sense of smell*

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SUMMARY

Olfactory disorders frequently occur in rhinological disease. Different subjective and objective test methods are available to assess the sense of olfaction. Among the subjective methods, screening tests and threshold measurements are commonly used to quantify hyposmia or anosmia. Qualitative methods are available using discrimination and identification tests. Objective methods are used in research and in some medicolegal situations. Objective tests include olfactory evoked potentials, functional Magnetic Resonance Imaging and functional Positron Emission Tomography.

The measurement of the sense of smell helps to assess the whole spectrum of the effects of nasal disease. This is especially important before rhinological surgery, because a non-detected smell disorder in patients with rhinological disease is common. The assessment of a pre-existing hyposmia or anosmia helps to avoid a postoperative claim that this was caused by surgery. A variety of validated screening tests for olfaction is available and they are a useful tool to document whether a patient is able to smell.

Key words: anosmia, assessment of olfaction, hyposmia, sense of smell, sinus surgery, threshold level

INTRODUCTION

Olfaction disorders are often not taken seriously because they are viewed as affecting the “lower senses” – those involved with the emotional life – instead of the “higher senses” that serve the intellect⁽¹⁾. “Sense of smell? ... I never gave it a thought” – you don’t normally give it a thought but when you lose it – it is like being struck blind or deaf. Anosmia may not be the disaster in humans that it would be for the majority of the animals but we must realize that it can be a very traumatic condition with a profound impact on our social life⁽²⁾. Smell is a sense whose value seems to be only appreciated after it is lost. The sense of smell also plays an important role in our interaction with the environment and therefore it can have a direct influence on human behaviour⁽³⁾ and can lead to a significant decrease in quality of life. In evaluating a patient who may have a possible olfactory disorder – “hyposmia”, the clinician has several tools at his disposal. The patient’s history, physical exam and olfactory testing as well as testing the taste are all relevant. With this, most of the information for the etiology of the possible hyposmia can be obtained. Furthermore blood tests and diagnostic radiology have an important role in the diagnosis of a smell disorder.

Since the sense of olfaction can differentiate between thousands of different odorants, it is impossible to assess the whole sensory system with a few simple tests. Depending on the information that is needed, specific tests can be used to mea-

sure certain facets of the olfactory system. In rhinology, the **quantitative** assessment of smell is important because hyposmia or anosmia due to conductive olfactory loss is a frequent symptom of rhinological diseases such as allergic rhinitis or chronic rhinosinusitis⁽⁴⁻⁸⁾. Qualitative disorders, the so-called dysosmias (for example cacosmia or parosmia), are much more difficult to measure. Nevertheless, specific tests for the assessment of **qualitative** disorders have also been developed.

As in audiology, most tests are dependent on patient compliance (“subjective” methods). For the assessment of the non-compliant patients and for scientific research, objective test methods are needed. These commonly measure changes in the central nervous system provoked by olfactory stimulants.

CLINICAL OLFACTORY TESTING

Taste and Smell

Taste and smell are independent but it is often difficult to split between them with the patients’ history alone. Patients with smell and/or taste deficits initially often complain of gustatory problems. For example, after a head injury a patient might report that a favorite tomato sauce no longer “tastes” right. However, rather than experiencing a problem with taste per se, this patient is more likely experiencing an alteration in flavor perception.

Because pure taste disorders are very rare, a simple **taste test** can be performed beforehand to rule out this specific diagno-

Table 1. Types of taste impairment.

Hypogeusia	diminished taste
Dysgeusia	distorted taste
Aliguesia	altered taste
Phantogeusia	persistent abnormal taste
Ageusia	total loss of taste

sis. By the use of liquids that stimulate the sense of taste for salty, sweet, sour and bitter flavours a patient's inability to detect one or more flavours is identified. Loss or impairment of taste can occur in various degrees (Table 1).

Subjective test methods

Subjective test methods are frequently used to assess olfaction because they can be done quickly and easily in a compliant patient. Several simple chemosensory tests can be done in the primary care office, but in a specialized ENT setup today a validated screening test with a printed form for documentation should be used at all cost. In the last decade a few validated screening test for olfaction have been developed worldwide and they can be used with the physician or self-administered by the patient alone. To obtain an overview of the many different tests available, three different *categories* can be defined (Table 2).

Table 2. Subjective test methods to assess the sense of smell.

Test method	Definition
Screening tests of olfaction	Fast evaluation whether or not there is a smell disorder
Quantitative olfaction tests	Tests to quantify an existing smell disorder (Threshold measurement)
Qualitative olfaction tests	Evaluation of qualitative smell disorders

Screening tests of olfaction are designed to detect whether a patient has an impaired sense of smell or not. These tests should be fast, reliable and cheap. A commonly known example is a serie of bottles containing a certain odorant such as coffee, chocolate or perfume to investigate a simple overview. Also each nostril should be tested separately to ascertain whether the problem is unilateral or bilateral – “lateralized screening”.

In recent years, more sophisticated tests have been developed that are both reliable and convenient to use ⁽⁴⁾. The “University of Pennsylvania Smell Identification Test” (UPSIT) or “Smell Identification TestTM” (Sensonics, Inc., P.O. Box 112, Haddon Heights, NJ 08035-0112 USA) is a well-known example. It is a scratch and sniff test with microencapsulated odorants, which is frequently used in the United States ⁽⁹⁾. Other examples are the 12-item “Brief Smell Identification TestTM” (Sensonics, Inc., P.O. Box 112, Haddon Heights, NJ 08035-0112 USA ⁽¹⁰⁾, the Japanese odor stick identification test (OSIT ⁽¹¹⁾), the Scandinavian Odor Identification Test (SOIT, ⁽¹²⁾), and the “Smell Diskettes” for the screening of olfaction (Novimed,

Heimstrasse 46, CH-8953 Dietikon, Switzerland). This test presents 8 odorants in reusable diskettes to the patient (Figure 1) and has also a pictorial representation in a forced multiple-choice manner ⁽¹³⁾. Another example is the “Sniffin’Sticks” test using a pen-like device for odor identification ⁽¹⁴⁾ and finally the latest example a brief three-item smell identification test ⁽¹⁵⁾ that is validated and highly sensitive in identifying olfactory loss in patients with chemosensory complaints.

All the listed test batteries are validated (some with cultural bias) and well documented in the literature and therefore best used today for the first investigation of an olfactory disorder or to document the olfactory function before any kind of nasal surgery. However, with the screening tests one can only distinguish between normal and abnormal smell function. For the further evaluation of a smell dysfunction (Table 2) a quantitative investigation is needed.

Quantitative olfaction tests measure the threshold levels of certain odorants in order to quantify an impaired sense of smell. They are usually more time consuming to perform but are useful to monitor the degree of hyposmia. However, they are unable to determine the cause and provide prognostic information or therapeutic guidance.



Figure 1. Screening test of olfaction: “Smell Diskettes”.

There are many threshold tests available today, most of them using n-butanol as the odorant. The object is to find the weakest concentration of n-butanol that the patient can detect, starting with the weakest dilution. Examples of such extended test kits are the Connecticut Test -“CCCRC threshold test”⁽¹⁶⁾, and the “Sniffin’ Sticks[®] threshold test” (Burghart Medizintechnik, Tinsdaler Weg 175, 22880 Wedel, Germany)⁽¹⁴⁾. The European test of olfactory capabilities - ETOC, a well cross-culturally validated test⁽¹⁷⁾ and the “Smell Threshold Test[™]” (Sensonics, Inc., P.O. Box 112, Haddon Heights, NJ 08035-0112 USA) measure the threshold of phenyl-ethyl-alcohol⁽¹⁸⁾.

These tests measure the olfactory performance and separate anosmics and normosmics and allow an assessment of hyposmia. For every test a different scoring system is used to determine the grade of hyposmia (mild, moderate and severe hyposmia, anosmia).

Another very accurate way of measuring smell thresholds can be done with olfactometers; these machines are designed to present precise concentrations of odorants. An example of an olfactometer that is used to measure the threshold level of vanilla is shown in Figure 2. Just as an audiogram is used to measure the hearing level, this computer-linked device is designed to measure the olfactory threshold for both sides separately. Up till now threshold olfactometers are mainly used in research projects and are not yet available for office use.

Nevertheless these tests all have their limitations, especially when investigating children, people with cognitive impairment or people from different cultural backgrounds. The complexity of some tests, the price for extended smell-kits for threshold measurement and the time-consuming factor deter many doctors from starting to evaluate adequately this specific group of patients and this is therefore still concentrated in specialized centres.

Qualitative tests of olfaction are used to assess a wide range of qualitative smell disorders. These so-called “dysosmias” are difficult to measure because patients with dysosmias find it difficult to describe their altered sense of smell. Nevertheless, specific tests have been designed to assess some of these qualitative disorders. The ability to recognize certain odorants can

Table 3. Types of smell impairment⁽²⁴⁾.

A: Quantitative olfactory dysfunction.	
Normosmia	normal sense of smell
Hyposmia	diminished sense of smell
Hyperosmia	enhanced odor sensitivity
Anosmia	total loss of smell
Specific Anosmia	inability to perceive a certain odor
B: Qualitative olfactory dysfunction.	
Dysasmia	distorted detection of smell
Parosmia	perversion of the sense of smell
Carosmia	inappropriate detection as foul or unpleasant
Phantosmia	hallucination of smell
Heterosmia	inappropriate distinction between odours



Figure 2. Measurement of the threshold level of vanilla with an olfactometer.

be measured by identification tests, and discrimination tests assess the ability to distinguish between different odors. An example of such a test is the already above mentioned “Sniffin’ Sticks[®] extended test battery” which combines quantitative and qualitative measurement^(19,20).

Trigeminal nerve assessment

In addition to olfactory epithelium the nasal mucosa also contains trigeminal nerve endings. They are important in detecting tactile pressure, pain and temperature sensation. Using special odorants with a trigeminal component such as mustard, menthol, capsaicin, vinegar and onion the function can be assessed.

Objective test methods

The objective measurement of the sense of smell is difficult and relies on detecting changes in the central nervous system provoked by olfactory stimulants. It is the only way to assess olfaction in non-compliant patients or malingers. A well-established method is the olfactory evoked potentials^(14,21,22). New techniques include functional imaging (functional Magnetic Resonance Imaging, functional Positron Emission Tomography) which allow the direct visualization of central changes caused by olfactory stimulants. These methods are currently used for scientific research but have the potential to become tools also for clinical routine.

CONCLUSIONS AND PERSPECTIVES

Based on current reports, 1 to 2 percent of the american population below the age of 65 experience an impaired smell to a

significant degree and out of this population more than 200.000 people visit a physician each year to help with smell disorder and related problems (Statistics on Smell, National Institute of Health, 2005). This illustrates the importance of the adequate assessment of smell including the use of smell tests.

Smell disorders are a common finding in patients with rhinological disease⁽⁴⁾. The measurement of the sense of smell helps to assess the whole spectrum of the effects of nasal disease. This is especially important before rhinological surgery, because a non-detected smell disorder may lead to the accusation that impaired olfaction may have been caused by surgery. In a study of patients prior to nasal surgery, 10.3% of patients had an altered sense of smell making it desirable that this is documented in order to avoid postoperative claims that this was caused by surgery⁽²³⁾. Routine preoperative smell tests are therefore an essential step to avoid a postoperative claim that surgery has been responsible for a pre-existing olfactory disorder.

Smell tests also help to provide comparable data in studies to audit the outcome of the treatment of nasal disease. Smell tests also help to focus both the patients' and the surgeons' attention to this aspect of their disease so that it has not been forgotten until it is too late! As we still don't know exactly where we have olfactory epithelium in the nasal mucosa and which areas are therefore at most risk during sinus surgery, the pre- and postoperative workup of the sense of smell is essential to find out how to tailor the surgery to preserve the sense of smell at all cost. The documentation of the smell function over time is also an essential point in the management of the medical treatment as the impairment of smell might be the first sign of a recurrence of the nasal disease and helps to motivate the patient to accept medical treatment in long term.

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