Available online at www.sciencedirect.com
ScienceDirect
American Journal of OTOLARYNGOLOGY
American Journal of Otolaryngology–Head and Neck Medicine and Surgery 28 (2007) 388–391
www.elsevier.com/locate/amjoto

The standard clinical smell testing protocol of the National Center for Diabetes, Endocrinology and Genetics in Amman, Jordan: JOR test

Azmi T. Ahmad, MD[a], Mousa Abu Jbara, MD[a], Dana Hiyasat, MD[a], Anwar Bateiha, MD[b], Kamel M. Ajlouni, MD[a,*]

[a]*Division of Endocrinology and Metabolism, National Center for Diabetes, Endocrinology and Genetics, Amman, Jordan*
[b]*University of Science and Technology, Irbid, Jordan*

Received 22 September 2006

Abstract

Objective: The aim of this study was the development of a simple clinical smell test that can be applied in Jordan and its validation against one of the standard tests, the University of Pennsylvania Smell Test (UPSIT, Sensonics Inc, Haddon Heights, NJ).
Design: A prospective validation study of a locally designed smell test was done.
Setting: The study was conducted at the National Center for Diabetes, Endocrinology and Metabolism in Amman, Jordan.
Participants: Fifty subjects were recruited to participate in this study. Twenty-five were normal healthy individuals, and 25 were patients with Kallmann syndrome.
Intervention and main outcome measures: All 50 participants underwent 2 tests, the UPSIT and the locally designed test (JOR test).The scores of all patients in both tests were compared. Test-retest reliability was determined in the same 50 subjects. All patients completed the study.
Results: Subjects who scored within normal limits on the UPSIT scored 8 to 10 on the JOR test, and people who were abnormal on the UPSIT scored between 0 and 5 on the JOR test. The correlation between the scores of both tests was almost perfect ($r = 0.984$, $P = .000$). When both tests were classified as normal and abnormal, there was a complete agreement (κ statistic = 1). Both sensitivity and specificity were 100%.
Conclusion: Given its highly significant correspondence to the UPSIT and the odor thresholds of Jordanians, our test proved valid and useful as a cross-cultural clinical test of olfactory function. In addition, it is an inexpensive, rapid test. Unfortunately, the data lacked persons with moderate impairment of smell. Therefore, the new test may not be used to assess this category of patients.

1. Introduction

Smell and taste are chemical senses with which an individual senses the environment for diverse information [1]. The nasal mucosa in the roof of each nostril contains the sensory olfactory epithelium, which is made up of about 10 million receptor cells [1]. Each cell possesses a terminal enlargement (knob) that projects above the epithelial surface and contains 8 to 20 olfactory cilia [1]. The olfactory cilia are nonmotile and contain the smell receptors [1]. Neurons from the lateral olfactory tract project to the amygdala, septal nuclei, prepyriform cortex, the entorhinal cortex, hippocampus, and the subiculum, which form the limbic system, an ancient region of the brain concerned with motivation, emotion, and specific kinds of memory [1]. Projections are also sent to the thalamus and then to the frontal cortex for recognition with forward and backward connections between these brain centers [1].

The manifestations of Kallmann syndrome include anosmia (an impairment in the sense of smell due to hypoplasia or absence of the olfactory bulbs and tracts), and

* Corresponding author. National Center for Diabetes, Endocrinology and Genetics, Amman 11942, Jordan. Tel.: +962 65353374; fax: +962 65356670.
E-mail address: ajlouni@ju.edu.jo (K.M. Ajlouni).

0196-0709/$ – see front matter © 2007 Published by Elsevier Inc.
doi:10.1016/j.amjoto.2006.11.009

hypogonadotrophic hypogonadism due to deficiency in gonadotropin-releasing hormone (GnRH) [2]. Recent studies demonstrate that neurons that synthesize GnRH originate embryologically in the olfactory tissues and migrate to the forebrain along the olfactory nerve pathway, but fail to do so in Kallmann syndrome [3]. Clinical assessment of smell can be difficult to perform precisely, unless standardized references are adopted. The Connecticut Chemosensory Clinical Research Center Test [4] and the University of Pennsylvania Clinical Smell and Taste Research Center Test are the standard for clinical assessment of smell [5]. More recently developed and less demanding testing methods are validated against these 2 tests [6]. In our practice, we are faced with cross-cultural difficulties of identifying odors that are not commonly encountered by the Jordanian population, examples of which are the smells of beer and whiskey. Thus, we developed a simple clinical test of smell that can be applied to the Middle East (including Jordan) and validated it against one of the standard tests, the University of Pennsylvania Smell Test (UPSIT, Sensonics Inc, Haddon Heights, NJ) [7]. The test is designed to be applicable to all the different socioeconomic levels and to be concordant with the social culture.

2. Materials and methods

Fifty subjects were recruited to participate in this study, 25 of whom were healthy university students with no known diseases, and 25 were hyposmic or anosmic patients with the clinical diagnosis of Kallmann syndrome. Healthy subjects were excluded if they had an inflammatory process including rhinitis, nasal polyps, traumatic anatomic abnormality such as deviated septum, an endocrine disturbance that affects the olfactory function such as hypothyroidism and diabetes mellitus, and a history of brain surgery or the use of medications or compounds that may alter smell sensitivity, including alcohol and nicotine. The diagnostic criteria for Kallmann syndrome are the presence of anosmia or hyposmia with clinical signs and symptoms of hypogonadism and a testosterone level of less than 100 ng/dL among males 16 years and older and estradiol level less than 20 pg/dL among adult females, together with low basal gonadotropin level [8,9].

All 50 participants underwent 2 tests, the UPSIT and a locally designed test (JOR test), which is the subject of this report. In the locally designed test, olfaction was assessed by using 10 odors that can be easily identified by individuals from all social classes of the population. These 10 odors are cinnamon, coffee, chamomile, thyme, soap, oriental perfume, tobacco, lemon, banana, and cardamom. The specific odoriferous substance was approximated to the nostrils while the patient had his eyes closed, and then the patient was asked to name the olfactory stimulus. The identification of 8 of 10 odors is considered normal smell appreciation.

At the same time, the patient's smell function was assessed by the UPSIT, which is a standardized microencapsulated 40 odorant test in a "scratch and sniff" format with 4 response alternatives accompanying each odor. The test was applied in an outpatient clinic to all subjects. The scores were compared against sex- and age-related normal standards, and the results were analyzed. A score ranging from 35 to 40 in males and from 34 to 40 in females is considered as a normal smell appreciation. Complete anosmia is identified for a score between 6 and 18, which can be achieved by chance on guessing. A score between 19 and 25 is considered as severe hyposmia, between 26 and 30 as moderate microsmia, and between 31 and 34 as mild hyposmia. The test has been validated and the manual gives a standardized operating procedure. The reference values have been derived from recorded reference ranges for the UPSIT test. In both tests, the subject must provide a response even if no odor is perceived. Test-retest reliability was determined by repeating the JOR test in the same 50 subjects.

3. Statistical analysis

We correlated the scores on both tests and obtained the Pearson's correlation coefficient. The κ statistic was also obtained as a measure of agreement after the UPSIT was dichotomized into normal (score ≥ 35) and abnormal (score <35) and the new test was dichotomized into normal (score ≥ 8) and abnormal (score <8). To further assess the validity of the new test, we used the UPSIT as a gold standard and obtained both the sensitivity and

Table 1
People with normal smell

Number	Age	Sex	Score of UPSIT smell test	Score of JOR smell test
1	23	M	36/40	9/10
2	22	M	37/40	10/10
3	20	F	36/40	9/10
4	21	F	37/40	10/10
5	21	F	36/40	10/10
6	22	F	37/40	10/10
7	27	M	36/40	10/10
8	30	M	35/40	9/10
9	32	M	37/40	10/10
10	22	M	36/40	10/10
11	21	M	38/40	9/10
12	20	M	36/40	9/10
13	21	F	38/40	10/10
14	22	F	38/40	9/10
15	26	M	36/40	8/10
16	24	M	37/40	8/10
17	22	M	36/40	9/10
18	25	M	37/40	10/10
19	23	F	36/40	8/10
20	28	F	38/40	10/10
21	24	F	36/40	9/10
22	26	M	38/40	9/10
23	28	F	39/40	10/10
24	33	F	37/40	10/10
25	28	F	38/40	10/10

Table 2
People with abnormal smell

Number	Age	Sex	Score of UPSIT smell test	Score of JOR smell test
1	46	M	10/40	3/10
2	16	M	8/40	0/10
3	27	M	7/40	0/10
4	20	M	7/40	1/10
5	20	M	10/40	2/10
6	19	M	8/40	0/10
7	16	M	7/40	0/10
8	17	M	6/40	0/10
9	20	M	20/40	4/10
10	19	M	25/40	5/10
11	22	M	10/40	1/10
12	20	M	7/40	2/10
13	37	M	15/40	2/10
14	23	F	12/40	2/10
15	24	F	6/40	0/10
16	18	F	8/40	2/10
17	19	F	22/40	4/10
18	20	F	24/40	4/10
19	30	F	14/40	2/10
20	20	M	8/40	0/10
21	22	M	6/40	0/10
22	14	M	7/40	1/10
23	9	M	8/40	0/10
24	8	M	6/40	1/10
25	8	M	7/40	0/10

specificity of the new test. The reliability of the new test was also assessed by using the κ statistic.

4. Results

The correlation between the identification test and the new test was highly significant ($r = 0.984$, $P = .000$). People who were normal on the UPSIT test scored 8 to 10 on the JOR test (Table 1), and people who were abnormal on the UPSIT test scored between 0 and 5 on the JOR test (Table 2).

The UPSIT test was dichotomized into normal (score ≥ 35) and abnormal (score <35). The new test was also dichotomized into normal (score ≥ 8) and abnormal (score <8). Using these cutoff points, the JOR test agreed perfectly with the UPSIT test ($\kappa = 1$). Both sensitivity and specificity were also 100%. All individuals who had normal smell appreciation identified on the UPSIT (scored >35) had a score above 8 in the locally designed test. Those who were defined as having complete anosmia on the UPSIT (scored <10) had scores less than 3 in the locally designed test. Subjects who were classified as hyposmic on the UPSIT (score between 19 and 34), scored between 4 and 7 in the locally designed test. Test-retest reliability was perfect ($\kappa = 1$).

5. Discussion

Proper and accurate clinical assessment of a person's olfactory ability can be difficult to perform if no standardized references are adopted [10]. The UPSIT is a readily available and widely used clinical test of olfaction. Numerous studies have demonstrated its reliability and validity as a measure of olfactory function [7]. It is used most effectively to assess the olfactory ability of adults with normal intellectual function. Problems of interpretation can arise, however, when it is used in individuals from diverse cultural or linguistic backgrounds [11]. In support of this hypothesis, Takagi [12] suggested that the poorer performance of native Japanese on the UPSIT was due to a lack of familiarity with some odors and odor names rather than insensitivity to the odors.

Attempts have been made to develop smell identification tests in languages other than English [13] and to simplify the UPSIT [14], so that it is more appropriate across cultures [15]. Therefore, we chose to create our own odor-identification test that can be simple to perform among Jordanians, and at the same time avoid any cultural bias due to test odorants that may be unfamiliar to the Jordanian population.

Our locally designed test was developed to be a simple, inexpensive, and rapid method for the assessment of olfactory function. The test was completed in approximately 5.0 minutes (including instructions) using the protocol described in this report. Given its good reliability and correspondence to the UPSIT and odor thresholds in the Jordanian population, our test proved its validity and usefulness as a cross-cultural clinical test of olfactory function.

Unfortunately, our data lacked persons with moderate impairment of smell; therefore, until the validity of the test among this group is established, it cannot be used to assess this category of patients.

Our locally designed test proved its validity in assessing smell ability in healthy persons as well as in patients with severe hyposmia and anosmia, but its ability to detect moderate degrees of impairment could not be evaluated.

References

[1] Kratskin IL, Belluzzi O. Anatomy and neurochemistry of the olfactory bulb. In: Doty RL, editor. Handbook of olfaction and gustation. New York: Marcel Dekker; 2003. p. 139-64.
[2] Hu Y, Tanriverdi F, MacColl GS, et al. Kallmann syndrome: molecular pathogenesis. Int J Biochem Cell Biol 2003;35:1157-62.
[3] Soussi-Yanicostas N, de Castro F, Julliard AK, et al. Anosmin-1, defective in the X-linked form of Kallmann syndrome, promotes axonal branch formation from olfactory bulb output neurons. Cell 2002;19:217-28.
[4] Frank RA, Dulay MF, Gesteland RC. Assessment of the sniff magnitude test as a clinical test of olfactory function. Physiol Behav 2003;78:195-204.
[5] Doty RL. Studies of human olfaction from the University of Pennsylvania Smell and Taste Center. Chem Senses 1997;22:565-86.
[6] Lehrner JP, Gluck J, Laska M. Odor identification, consistency of label use, olfactory threshold and their relationships to odor memory over the human lifespan. Chem Senses 1999;24:337-46.
[7] Doty RL, Shaman P, Dann M. Development of the University of Pennsylvania Smell Identification Test: a standardized microencapsulated test of olfactory function. Physiol Behav 1984;32:489-502.
[8] Hu Y, Tanriverdi F, MacColl GS, et al. Kallmann syndrome: molecular pathogenesis. Int J Biochem Cell Biol 2003;35:1157-62.

[9] Abujbara MA, Hamamy HA, Jarrah NS, et al. Clinical and inheritance profiles of Kallmann syndrome in Jordan. Reprod Health 2004; 24(1):5 [Available at: http://www.reproductive-health-journal.com/content/1/1/5].

[10] Tsukatani T, Reiter ER, Miwa T, et al. Comparison of diagnostic findings using different olfactory test methods. Laryngoscope 2005; 115:1114-7.

[11] Frank RA, Dulay MF, Niergarth KA, et al. A comparison of the sniff magnitude test and the University of Pennsylvania Smell Identification Test in children and nonnative English speakers. Physiol Behav 2004; 81:475-80.

[12] Takagi SF. A standardized olfactometer in Japan. A review over ten years. Ann N Y Acad Sci 1987;510:113-8.

[13] Kobayashi M, Saito S, Kobayakawa T, et al. Cross-cultural comparison of data using the odor stick identification test for Japanese (OSIT-J). Chem Senses 2006;31:335-42.

[14] Konnerth CG, Hummel T, Rosenheim K, et al. Screening of olfactory function using a 4 minute odor identification test. Chem Senses 2001; 26:1088.

[15] Doty RL, Marcus A, Lee WW. Development of the 12-item Cross-cultural Smell Identification Test (CC-SIT). Laryngoscope 1996; 106:353-6.