

Relationship between the Korean Version of the Sniffin' Stick Test and the T&T Olfactometer in the Korean Population

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Objectives. The Korean version of the Sniffin' stick (KVSS) test is widely used in Korea to evaluate olfactory function. However, its validity and reliability have not been studied well. In this study, the authors administered the KVSS and the T&T olfactometer test to evaluate olfactory function and to establish relationships between these two test measures.

Methods. Two hundred and eleven patients participated in this prospective randomized study. One hundred and nine patients with no olfactory symptoms and 102 patients with decreased olfaction participated. All participants were underwent KVSS II and T&T olfactometer testing.

Results. The mean recognition threshold of the T&T olfactometer was -1.8 ± 0.9 for patients with normal olfaction and 4.0 ± 2.6 for patients with decreased olfaction. The mean Threshold-Discrimination-Identification score of the KVSS II was 30.0 ± 3.8 for patients with normal olfaction and 15.9 ± 7.1 for patients with decreased olfaction. Correlation coefficient between the two tests was significantly high ($r_s = -0.725, P < 0.01$).

Conclusion. The KVSS and T&T olfactometry test are both reliable tests of olfactory function and their results are well correlated with each other.

Key Words. Korean version of Sniffin' stick test, T&T olfactometer

INTRODUCTION

Olfactory dysfunction is a common disease entity in Otorhinolaryngologic clinics. The incidence of olfactory dysfunction is increasing due to recent increases in industrial accidents, allergic rhinitis, and an aging population (1, 2). It is important to evaluate patients using an olfactory function test that precisely reflects functional state (3). Several tests are commercially available. The

University of Pennsylvania Smell Identification test (UPSIT) and the Connecticut Chemosensory Clinical Research Center (CCCRC) test were developed in the USA (4-6) and the T&T olfactometer was developed in Japan (7). The T&T olfactometer was developed by Toyota and Takagi in 1987 and it establishes detection and recognition thresholds for each of five odorants (β -phenyl ethyl alcohol, methyl cyclopentenolone, iso-valeric acid, γ -undecalactone, and scatole).

In Korea, the Korean version of the Sniffin' stick (KVSS) test was developed by Hong et al. (8) in 1999. The KVSS test is a based on a modified type of Sniffin' stick and all of the odors used in this test are familiar to Koreans. KVSS I is a rapid screening test with an eight-odor identification test, whereas KVSS II offers a more extensive test of olfactory deficits. It consists of three different sets, namely, threshold, discrimination and identification (8).

In this study, we aimed to assess the clinical validity and the

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reliability of KVSS II as compared with the T&T olfactometer test.

MATERIALS AND METHODS

Subjects

Two hundred and eleven patients who visited the Department of Otorhinolaryngology–Head and Neck Surgery, Korea University Guro Hospital from January 2010 to January 2011 were included in this study. One hundred and nine patients with normal olfaction-related activities, such as cooking, detecting spoiled foods, eating and others, and one hundred two patients with decreased olfaction-related activities participated in this study. The normal olfactory group consisted of sixty-six men and forty-three women (mean age, 37.16 ± 17.21). The decreased olfactory group consisted of sixty-two men and forty women (mean age, 44.84 ± 13.33) (Table 1).

Informed consent was obtained from all subjects before study participation and the study was approved by the Institutional Review Board of Korea University Hospital (MD1111).

Test procedures

All 211 patients were underwent KVSS II and T&T olfactometer testing. Tests were administered in random order. To allow time for clearance of any retained odorants, ten minute rest period was allowed between the two tests.

KVSS II

The olfactory threshold test, odor discriminatory test, and odor identification test were performed in order with a three minute interval between tests. The threshold was defined as the concentration at which n-butanol (highest concentration 4%, 1:2 serial dilutions to 16 steps) was correctly identified four times in a row. For discriminatory testing, triplets of odorants (two are identical, one different) were presented and subjects were asked to choose the odd odorant. The identification test involved 16 odors familiar to Koreans. The sums of the three tests are presented as Threshold-Discrimination-Identification (TDI) score. Total scores of 0 to 20 are defined as ‘anosmia’, 20.25 to 27 as ‘hyposmia’, and 27.25 to 48 as ‘normosmia’. This criteria was used based on previous work (9).

Table 1. Patient demographics

	Normal olfaction	Decreased olfaction	P-value
Male/Female	66/43	62/40	
Mean age (years)	37.2	44.8	
Mean T&T olfactometer score	-1.8 ± 0.9	4.0 ± 2.6	<0.01
Mean KVSS II score	30.0 ± 3.8	15.9 ± 7.1	<0.01

KVSS: Korean version of the Sniffin' stick.

The T&T olfactometer test

This test consisted of five odorants: β -phenyl ethyl alcohol, methyl cyclopentenolone, iso-valeric acid, γ -undecalactone, and scatol, and determines the detection and recognition thresholds for each stimulus. Stimuli were presented in seven (methyl cyclopentenolone) or eight (all other odorants) log 10 serial dilutions. For each odorant, an ascending series of concentrations was presented, with the examiner moistening the tip of a strip of paper with the stimulus before sampling by the subject. The detection threshold was defined as the lowest odorant concentration detected by a subject, whereas the recognition threshold was defined as the lowest concentration at which the odor could be identified (7, 10). A recognition threshold of 5.6 to 5.8 was defined as ‘anosmia’, 1.1 to 5.5 as ‘hyposmia’, and -2 to 1.0 as ‘normosmia’, as Japanese Olfactory Test Committee agreed to use this criteria (7).

Statistical analysis

Data were analyzed using SPSS ver. 13.0 (SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test was used to verify distribution normality. Correlations were assessed using Spearman's rank correlation coefficients. ANOVA was used to compare means between groups. The McNemar test was used to confirm the two tests diagnosed same categories.

RESULTS

Comparison of the thresholds of subjective symptoms

The mean T&T detection threshold score for the 109 normal olfactory patients was -1.8 ± 0.9 and the mean score of the 102 patients with subjective decreased olfaction was 4.0 ± 2.6 ($P < 0.01$). The mean TDI score of KVSS II for the normal olfactory patients was 30.0 ± 3.8 and the mean score for the patients with subjective decreased olfaction was 15.9 ± 7.1 ($P < 0.01$) (Table 1).

Comparisons of the thresholds by olfactory groups

When degree of olfaction was based on the KVSS II, the mean T&T recognition threshold score was -1.6 ± 1.1 for normosmia, 0 ± 2.03 for hyposmia, and 5.4 ± 1.5 for anosmia ($P < 0.01$), and

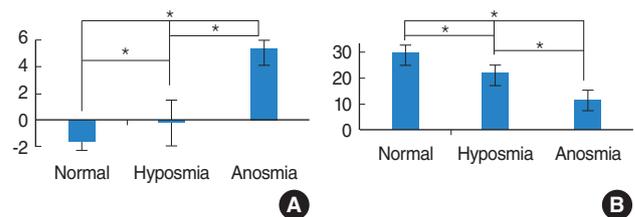


Fig. 1. Comparison of mean T&T olfactometer scores of normal, hyposmia, and anosmia groups based on Korean version of the Sniffin' stick (KVSS) II (A). Comparison of the mean KVSS II scores of these three groups based on T&T olfactometer (B). The mean scores in these three groups were significantly different ($*P < 0.01$).

Table 2. Comparison of the two olfactory function tests by diagnostic categories demonstrating that diagnoses were almost identical

		KVSS II TDI score			Total
		≥27.25	20.25 ≤ score ≤ 27	≤20	
T&T olfactometer recognition score	≤1	102	14	4	120
	1.1 ≤ score ≤ 5.5	2	30	4	36
	≥5.6	0	0	55	55
Total		104	44	63	211

KVSS: Korean version of the Sniffin' stick; TDI: Threshold-Discrimination-Identification.

when degree of olfaction was based on T&T olfactometer results, the mean T.D.I. score of KVSS II was 29.6 ± 4.2 for normosmia, 21.9 ± 5.3 for hyposmia, and 11.4 ± 3.3 for anosmia ($P < 0.01$) (Fig. 1).

Correlations between T&T olfactometer and KVSS II scores

Test results were not normally distributed, and thus, Spearman's rank correlation test was used to evaluate correlations between the two tests. A significant correlation was found between the recognition threshold score of the T&T olfactometer and the TDI score of the KVSS II ($r_s = 0.725, P < 0.01$). Furthermore, a significant correlation was found between the detection threshold score of the T&T olfactometer and the threshold score of the KVSS II ($r_s = 0.661, P < 0.01$) and between the recognition threshold score of the T&T olfactometer and the identification score of the KVSS II ($r_s = 0.575, P < 0.01$) (Fig. 2).

Diagnostic categories by T&T olfactometer and KVSS II scores

The diagnostic levels of olfactory function determined by both tests for all 211 subjects tested are shown in Table 2. For 89% of patients, the diagnostic categories assigned by the two tests were nearly identical ($P = 0.017$), but in 11% of subjects results differ by more than one category.

DISCUSSION

A variety of electrophysiologic and psychophysical techniques are currently used to measure olfactory function. Some of the more widely used tests are UPSIT, Cross-Cultural Smell Identification Test (CC-SIT), CCCRC test, and the T&T olfactometer (8).

Previous studies have examined correlations between olfactory functions as determined by different test measures. Some studies have also examined the KVSS test or the T&T olfactometer. Cho et al. (9) administered the KVSS test and the CC-SIT test to 380 subjects. They reported that a correlation coefficient between the CC-SIT and the KVSS I of 0.720 ($P < 0.01$) and between CC-SIT and KVSS II total scores of 0.714 ($P < 0.01$). Kondo et al. (10) administered the UPSIT and the T&T olfactometer test to 167 subjects, and reported a correlation coefficient between the UPSIT and the T&T olfactometer of 0.698 ($P < 0.01$).

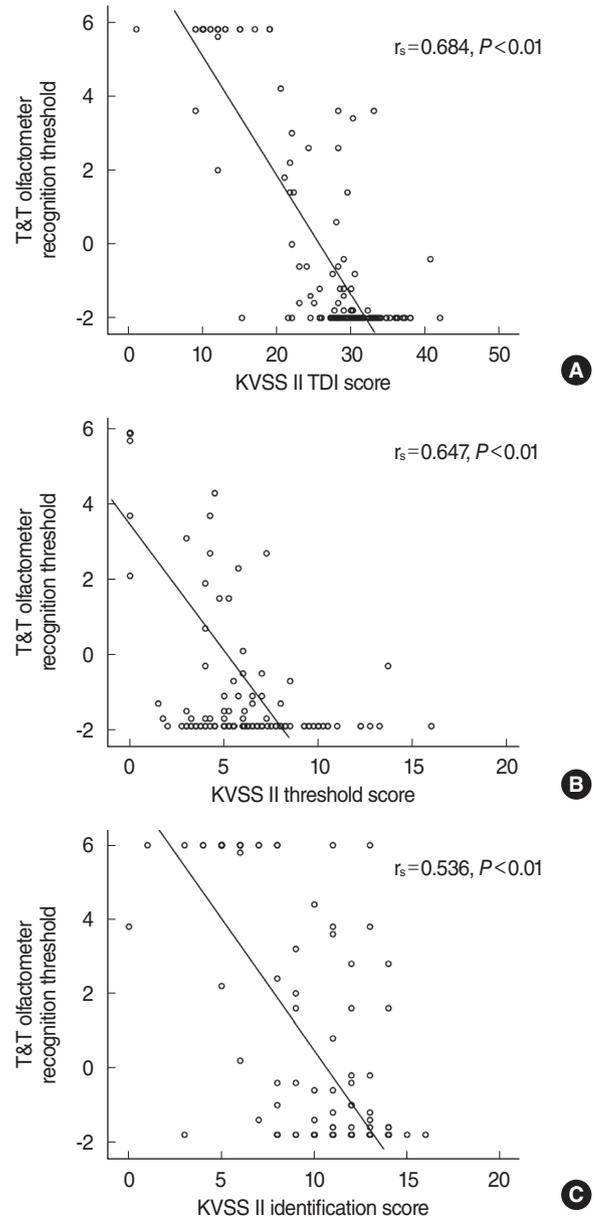


Fig. 2. Correlations between Threshold-Discrimination-Identification (TDI) scores of the Korean version of the Sniffin' stick (KVSS) II and recognition thresholds by T&T olfactometry (A), between threshold scores of the KVSS II and detection thresholds by T&T olfactometry (B), and between identification scores of the KVSS II and recognition thresholds by T&T olfactometry (C). All three correlations were found to be significant.

In the present study, we compared two methods of testing olfaction in Korea, the KVSS II test and the T&T olfactometer test. Both of the tests detected a significant difference between the normal and decreased olfaction groups ($P < 0.01$). The correlation between the T&T olfactometer test and the KVSS II was also high, and the diagnostic categories assigned by the two tests were almost identical ($P = 0.017$).

In the present study, the correlation between the T&T olfactometer and KVSS II tests in the mid-range (hyposmia) group was weaker than those between the two extreme range (anosmia and normal) groups. Tsukatani et al. (11) reported in their comparative study of the Jet Stream olfactometer and CCCRC tests that when hyposmia was compared at three levels (mild, moderate, and severe), JSO, and CCCRC test results were in agreement only 22% of the time. In the present study, correlation coefficients (r_s) were -0.535 and -0.132 in the hyposmia group by KVSS II and by T&T olfactometer testing, respectively.

Although the T&T olfactometer test, which was introduced in 1975, is a standard olfactory function test in Japan, it has several major limitations, as follows; unpleasant smells are used that contaminate the test environment, and thus, the test often requires expensive ventilation facilities (e.g., a chemical hood). Furthermore, it lacks forced-choice response alternatives, which leads to response variations (12-14).

The KVSS was developed to remedy shortcomings of other olfactory function tests and to adopt odorants familiar to Koreans (8). The odorants used are synthetic fragrances can be used for a long time. Furthermore, the KVSS test evaluates olfactory function accurately because results are calculated by summing of three parameters (8).

In conclusion, the present study demonstrates that the KVSS differentiates decreased olfaction and normal groups, and that KVSS and T&T olfactometer test results are well correlated. Although continuous revision is required to determine the best olfactory test for Koreans, the present comparative study shows that the KVSS test is both valid and reliable.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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