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A study of olfactory testing in patients with rhinological pathology in the ENT clinic*

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SUMMARY

Background: *Despite the common occurrence of rhinological pathology presenting to the ENT clinic, routine testing of olfactory ability is rarely performed.*

Objectives: *The aim of this study was to determine the role of routine olfactory testing.*

Methods: *This was a prospective study conducted in the outpatient clinic of a district general hospital. Patients presenting with rhinological complaints had their olfactory status assessed using the combined olfactory test (COT) before and after rhinological surgery.*

Results: *Eighty patients (56 men, 24 women) had tests completed over a 12-month period. Patients assessed mostly had nasal polyposis, chronic rhinosinusitis or septal deformity. 83% of patients had either a complaint of olfactory disturbance or a COT score of 6 or less, or had both; but correlation between symptoms and scores was poor. Post-operative COT scores showed significant improvement ($p = 0.02$) with post-septoplasty patients showing the most significant improvement as a group ($p = 0.001$).*

Conclusions: *Olfactory disturbance is very common in rhinological pathology and the patient's history alone cannot be relied upon. Simple olfactory assessment, such as with the combined olfactory test, is easy to perform and cheap to use and should be a commonly used resource in the ENT clinic. Formal testing can help to document any pre-existing olfactory loss and any post-operative changes as well as detecting unreported hyposmia.*

Key words: olfaction, sensory thresholds, signs and symptoms

INTRODUCTION

Despite olfactory disturbances being common complaints in the general population with a prevalence of 7% in the USA [(1)] and even as high as 25% in the over 50 age group [(2)], they are often underrated as a minor social inconvenience. A patient reporting hearing loss or with other otological symptoms can expect to be evaluated in the ENT clinic with an audiogram, but the same cannot typically be said of anosmia and hyposmia. This may be in part due to under-reporting of these symptoms by patients but also in part due to a lack of interest amongst Otorhinolaryngologists. Previous studies have demonstrated that olfactory disturbances are more common than we realise with approximately 20% of non-rhinological patients demonstrating hyposmia or anosmia [(3)], and poor correlation between subjective sensation and objective scoring in normal subjects [(4)]. For some individuals a good sense of smell may be crucial to their profession (e.g. perfumer, chef), however, more importantly olfaction can provide important information to an individual when encountering inherent dangers such as hazardous chemicals, fumes from a fire or even unpalatable food. Beyond the practical aspects, patients with olfactory dysfunction can suffer significant psychosocial problems [(5,6)].

There are several validated olfactory tests currently in existence and these include the University of Pennsylvania Smell Identification Test (UPSIT) [(7)], Sniffin' Sticks [(8)], the Barcelona Smell Test (BAST-24) [(9)] and the Japanese odour sticks [(10)]. For the purposes of this study the Combined Olfactory Test was used as this has been validated on a British population. The object of this study was to evaluate the validity of an olfactory test in assessing routine referrals with rhinological problems to the ENT outpatient clinic and at their post-operative follow-up. Ideally all patients who complain of olfactory disturbance and all patients undergoing surgery that may potentially disturb their olfactory ability should be tested.

MATERIALS AND METHODS

Patients

All patients attending the ENT outpatient clinic at the James Paget Hospital with rhinological complaints during a 12-month

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period were tested with the COT. One hundred and seven patients were tested as part of the study and for each patient an audit proforma was completed; the only exclusions were patients under the age of 16 and those who did not wish to undergo the test. A list of symptoms and signs were collected on the study proforma along with the diagnosis made by the doctor in the clinic. Where possible, patients undergoing nasal surgery were tested again on their return to clinic post-operatively; all tests were completed within 12 months of commencing the study. Due to the study being conducted as an audit the only demographic and medical data collected other than rhinological, was the age and sex of the patients.

Olfactory test

As mentioned above, the olfactory test used was the Combined Olfactory Test which has been validated previously in the UK [(11)]. The reasons for using this test, apart from its proven use in British patients, was the low cost and ease of use along with an opportunity to utilise both quantitative and qualitative test formats. The test proceeds in 2 parts: firstly patients are given 10 individual bottles containing different odours and a response sheet containing 4 possible answers for each odour and asked to identify them. Secondly patients are taken through a threshold test in a single ascending staircase two alternative forced choice technique, comparing sterile water against increasing concentrations of 1-butanol until they detect a difference between the 2 bottles. The odours contained in the identification component of the test include baby powder, vinegar, Vicks vaporub™, peppermint oil, peanut butter, Marmite™, motor oil, coffee, chocolate and ammonia. For the purpose of scoring the ammonia is not included and hence there is a maximum score of 9 for the identification test. With nine dilutions of 1-butanol, there is also a possible maximum score of 9. The two scores are then added and divided by two to give the final COT score. Control subjects were not used in this study as the previous validation study already provided a reference point for comparison.

Statistics

Statistical analysis was undetaken using SPSS for Windows software (version 14.0, Chicago, Illanois) to perform paired t-tests for comparison of test results before and after testing, unpaired t-tests between patient groups, Kruskal-Wallis test for the effect of gender and Spearman's rank correlation for the effect of age.

RESULTS

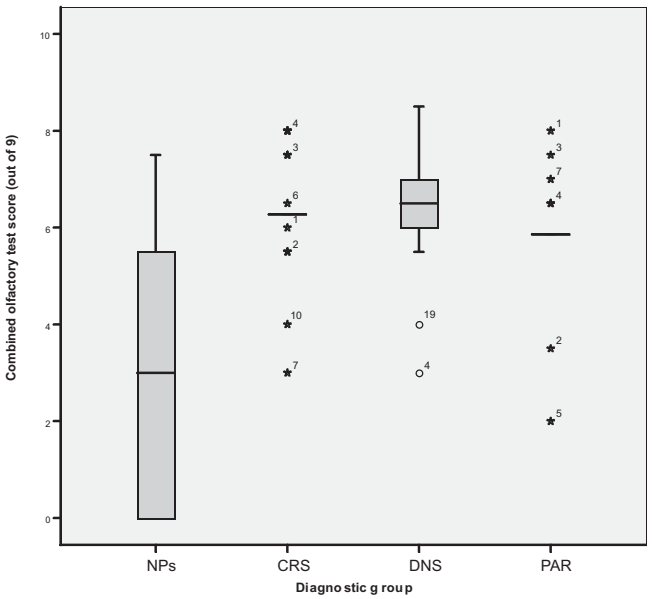
From the original 107 patients included in the study only 80 sets of results were available for analysis (56 male, 24 female) and fell into the following diagnostic groups: chronic rhinosinusitis with nasal polyposis (n=27), chronic rhinosinusitis without nasal polyposis (n=12), septal deviation (n=30), perennial allergic rhinitis (n=7), diagnosis unknown (n=3) and no pathology identified (n=1). Demongraphic data and descriptive statistics are displayed in Table 1. Fifty-one patients underwent rhinological surgery with the intention to have both pre- and post-operative testing; this left twenty-nine patients who did not opt for or were not offered surgical intervention and therefore did not undergo a second test. One patient's pre-operative test result was missing and eight patients failed to attend their post-operative olfactory test. This left 42 patients in whom both pre- and post-operative tests were performed, but 80 patients (79 results available) in whom a "pre-treatment" test result was obtained. Gender had no significant bearing on COT score ($p = 0.47$, Kruskal-Wallis test), but there was a significant reduction in COT scores with age ($p = 0.02$, $r = -0.33$ Spearman's correlation).

Of the patients analysed, 40 patients (50%) actually complained of a reduced olfactory ability as a presenting complaint, as documented on the study proforma. The diagnosis for these patients was chronic rhinosinusitis (CRS) with (n=10) or without (n=9) polyps (NPs), perennial allergic rhinitis (PAR) (n=6), septal deformity (DNS) (n=14) or no discernable pathology (n=1); 2 patients in the whole cohort had insufficient information on the proforma for diagnosis. Testing of patients, however, revealed that 48 (60%) actually had a demonstrable olfactory deficit with a COT score of 6 or less. Conversely, 26 of these patients (33%) did not complain of olfactory disturbance at presentation and of those that did present with a complaint of poor olfactory ability, 17 (21%) had a COT score of greater than 6. This disparity between subjective olfactory ability and actual test result is demonstrated clearly by the Venn diagram in Figure 1, which shows that only 22 patients actually had both a subjective disturbance of alfaction and a low COT score.

Figure 1. Venn diagram illustrating correlation between reported olfactory disturbance and low COT scores (by subject numbers).

Examining the comparison between the main four groups ($n = 75$) of rhinological patients of NPs, CRS, DNS and PAR, showed that the patients with NPs had significantly lower COT scores compared to those presenting with other pathologies ($p<0.001$ for all group comparisons) (Figure 2 and Table 2). (N.B. Only 75 results were available for this comparison due to 3 proformas missing a diagnosis, 1 patient not having any identifiable pathology and 1 patient having a missing result for their pre-operative test.) There was no significant difference between the other groups ($p = 0.29$, 0.51 and 0.10). Breaking down the COT scores into the component parts, the identification test showed a significant difference between the CRS and DNS

Figure 2. Box plots demonstrating pre-treatment COT score by diagnostic group.



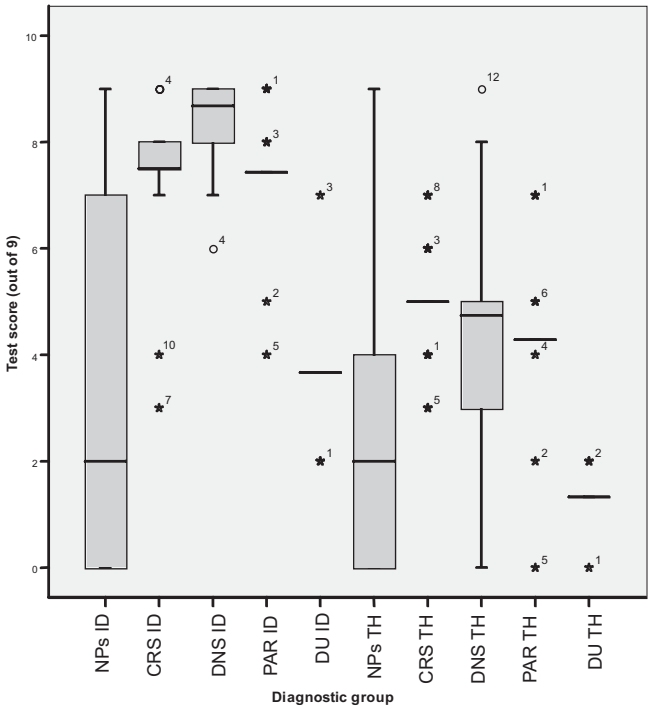
NPs = nasal polyps, CRS = chronic rhinosinusitis, DNS = deviated nasal septum, PAR = perennial allergic rhinitis (NPs vs CRS/DNS/PAR – $p < 0.001$)
* = outlier point, ° = extreme outlier

Table 1. Demographics of subjects by diagnosis, gender and age.

Diagnosis	Number of patients	Mean age in group	Standard deviation	Percentage in group by gender (%)	
				Male	Female
NPs	27	49.7	14.24	74	26
CRS	12	49.1	17.05	64	36
DNS	30	43.3	14.58	67	33
PAR	7	45.1	23.23	86	14
None recorded	3	-	-	-	-
No pathology	1	-	-	-	-
Total	80	47.0	16.49	70	30

NPs = nasal polyps, CRS = chronic rhinosinusitis, DNS = deviated nasal septum, PAR = perennial allergic rhinitis

Figure 3. Box plots demonstrating pre-op identification and threshold test results by diagnostic group.



NPs = nasal polyps, CRS = chronic rhinosinusitis, DNS = deviated nasal septum, PAR = perennial allergic rhinitis, DU = diagnosis unknown, ID = identification score, TH = threshold score. (NPs vs CRS/DNS/PAR – $p < 0.001$).
* = outlier point, ° = extreme outlier

patients and DNS and PAR patients (Figure 3, Table 2) ($p = 0.002$ and <0.001, respectively). The threshold test however did not show any significant differences between the 3 non-polyp groups (Figure 3, Table 2). Comparisons between NPs and all the other groups were significant for both components of the test. Repeating the above comparisons between the groups post-operatively revealed the same statistically significant differences (Table 3).

When comparing the pre- and post-operative COT scores, a significant improvement was seen in COT scores for all patients together (Figure 4, Table 4) ($p = 0.022$). However when broken down into the diagnostic groups, surprisingly, it

Table 2. Comparative p-values pre-treatment by diagnostic group (see also figures 2 and 3).

Pre-op	CRS			Septal deviation			PAR		
	COT	ID	TH	COT	ID	TH	COT	ID	TH
Polyps	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001
CRS	-	-	-	0.29	0.002	0.61	0.57	0.89	0.35
DNS	-	-	-	-	-	-	0.1	< 0.001	0.75

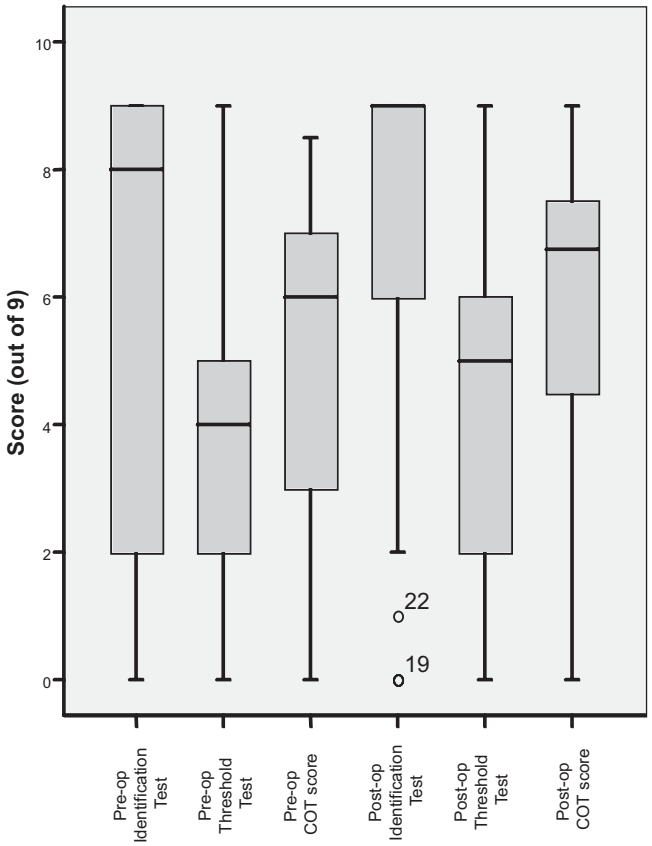
NPs = nasal polyps, CRS = chronic rhinosinusitis, DNS = deviated nasal septum, PAR = perennial allergic rhinitis, COT = combined olfactory test, ID = identification test, TH = threshold test

Table 3. Comparative p-values post-op by diagnostic group.

Post-op	CRS	Septal deviation		PAR					
	COT	ID	TH	COT	ID	TH	COT	ID	TH
Polyps	< 0.001	< 0.001	0.008	< 0.001	< 0.001	0.002	< 0.001	0.004	0.08
CRS	-	-	-	0.69	< 0.001	0.57	0.60	0.63	0.61
DNS	-	-	-	-	-	-	0.07	< 0.001	0.87

NPs = nasal polyps, CRS = chronic rhinosinusitis, DNS = deviated nasal septum, PAR = perennial allergic rhinitis, COT = combined olfactory test, ID = identification test, TH = threshold test

Figure 4. Box plots comparing pre- and post-operative COT and component scores.



* = outlier point, ° = extreme outlier
p = 0.022 (COT), 0.08 (identification), 0.012 (threshold)

Table 4. Overall comparative p-values pre-versus post-op (see also Figure 4).

	p value	Confidence intervals	
Threshold	0.012	-1.38	-0.18
Identification	0.080	-1.40	0.08
COT	0.022	-1.25	-0.09

Table 5. Comparative p-values pre versus post-op by sub-group.

	p value	Confidence intervals	
Polyps	0.150	-3.07	0.53
CRS	0.870	-1.50	1.7
DNS	0.001	-1.00	-0.30
PAR	0.591	-1.72	1.12

was only the DNS patients that showed a significant post-operative improvement (p = 0.001) (Table 5) and this owed more to an improvement in threshold scores.

The responses to ammonia in the identification test showed that 23 patients failed to recognise or respond to this; 13 of these patients had NPs and 2 were "undiagnosed" (Figure 5). One further patient reacted to the ammonia but then refused to identify it on the response sheet. Of these patients that failed to recognise ammonia pre-operatively, 4 with NPs that had post-operative tests continued to be unable to recognise it and six became able to identify it. Overall 6 patients with no pre-operative response to ammonia had a persistent non-response, but there were 9 patients did not attend for a second COT. This however did mean that 8 patients detected ammonia post-operatively that had not done so pre-operatively.

DISCUSSION

The study results have clearly demonstrated that by testing patients for olfactory ability, 66 (83%) had either a subjective olfactory complaint or a deficit found with olfactory testing or both. Thirty-three percent of patients were found to have a previously undetected olfactory deficit. These findings are succinctly demonstrated by the Venn diagram (Figure 1) that also shows only 22 patients had both a subjective olfactory loss and a low COT score. It shows that the majority of the patients in the study had a good reason to undergo the COT, either to confirm their olfactory loss, to reassure them that they had reasonable olfactory function or to identify an unrealised olfactory deficit. This poor correlation between reported symptoms and olfactory test scores has been reported before in specific groups with sino-nasal pathology [12,13] but not for a wider range of pathologies.

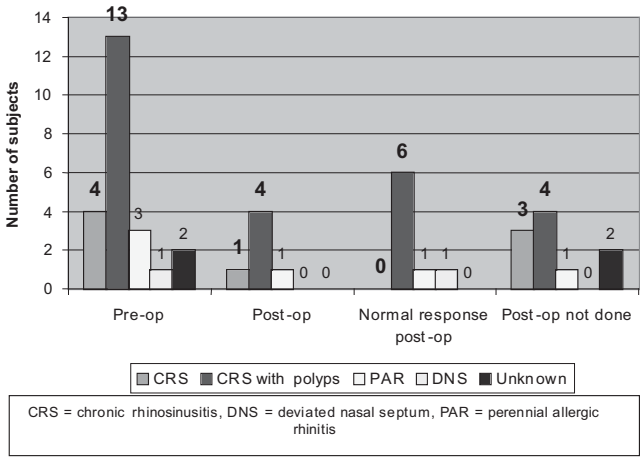


Figure 5. Ammonia non-responses.

Studies that have previously assessed perceived olfactory function have shown that patients with chronic rhinosinusitis appear to be able to correctly assess their level of olfactory function [14] as opposed to elderly people who seem unable to identify that they have impaired olfaction (presbyosmia) [2]. The study however showed poor correlation within the CRS patients but a positive correlation with age and no effect of gender. A recent study by Hummel et al. has suggested that gender differences may become apparent between the ages of 16 and 55 [15]. Another study that looked specifically at the correlation between ratings of olfactory impairment and olfactory function using Sniffin' Sticks found that there was a significant correlation between their rating and the test scores albeit with a wide range of variation between subjects [13]. This study did however differ in that it looked at specific causes of anosmia including post-viral, traumatic and idiopathic. But when healthy normosmic subjects with no rhinological pathology were studied there was poor correlation between perception and test scores [4]. Finally a study looking specifically at patients undergoing endoscopic sinus surgery for CRS also found that 83% of subjects presented with an olfactory deficit compared with 58% who actually complained of an olfactory disturbance [16].

It is probably not surprising that the COT scores showed that patients with nasal polyps had the greatest deficiency because there is mechanical obstruction of the olfactory cleft preventing orthonasal and possibly retronasal olfaction [17,18]. However, it was interesting to note that patients with septal deformity had lower scores for quantitative testing with 1-butanol and yet good scores for identification (Figure 3), with the threshold test scores improving post-operatively. This may reflect an alteration in local airflow to the olfactory cleft that is restored by surgical intervention and has been seen in a similar study before [12] where thresholds were measured in each nostril and post-operative improvements were seen in the previously obstructed side. Localised nasal airflow has been shown to exhibit great variation for which the measurement of peak inspiratory flow rate may be unreliable [4,19,20].

Whilst there are superior tests available for the purposes of olfactory testing such as Sniffin' Sticks [8], the COT provides a quick and cheap means of assessment in the clinic which can be delegated to a nurse practitioner if deemed appropriate. Loss of olfactory ability in the longer term can have negative psychosocial consequences for patients [21], and should be given serious consideration in patients with rhinological complaints. There are also medico-legal implications for patients undergoing surgery and the COT score provides a record of the pre-operative state for comparison and reference post-operatively; thus an olfactory test should be considered in the way an otologist considers an audiogram. Although some would debate the merits of the "rhinological audiogram" due to methodological concerns and that the definitive "olfactogram" has yet to be realised, the importance of this documentation should not be underestimated and this has been underlined by a previous study where olfaction was assessed before and after rhinological surgery [22]. Clearly the universal olfactory test is a long way from realisation, but this does not prevent clinicians from utilising olfactory tests that have been validated on culturally similar populations to provide a record of olfactory function.

The results reported in this paper also provide additional reference data for the COT, which has not been supplemented since the validation studies that were published in 1996 [11]. The reporting of olfactory disturbances cannot be relied upon in the presence of sino-nasal pathology and therefore olfactory testing for all rhinological patients is valid in the outpatient clinic, and should be considered an essential part of the peri-operative management of rhinological conditions.

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