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Evaluating the diagnostic accuracy of Arabic SNAP test for children with hypernasality

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ABSTRACT

Nasometry is a method of measuring the acoustic correlates of resonance through a computer-based instrument called nasometer. High nasalance scores in comparison to normative data suggest hypernasality and/or other nasality disorders, while low scores suggest hyponasality. Normative values of nasalance for Egyptian Arabic speakers were established using the Arabic SNAP (Simplified Nasometric Assessment Procedures) test.

Objectives: to evaluate the diagnostic accuracy of Arabic SNAP test to allow for its use in the differentiation between normal and hypernasal speech in Egyptian Arabic-speaking children.

Methods: Nasalance scores of normal children ($n = 92$) on Arabic SNAP test were compared to those of 30 children with velopharyngeal insufficiency due to cleft palate. Receiver operating characteristic (ROC) curve was used to determine cutoff points with the highest sensitivity and specificity.

Results: Statistically significant differences were found between both groups for all items in nasometric evaluation ($p < 0.05$) except for prolonged/m/sound ($p > 0.05$). Cutoff points were determined and certain items were selected for routine nasometric evaluation.

Conclusion: The Arabic SNAP test is a sensitive and specific tool for evaluation of children with hypernasality and can be used for both diagnosis and follow up of these cases.

1. Introduction

Velopharyngeal Insufficiency (VPI) means that the velum and pharyngeal muscles cannot produce optimal sphincter – like closure between the oro and nasopharynx, which is necessary to have undisturbed respiration, suckling, swallowing, speech and hearing [1]. VPI may be organic or functional, produced by congenital or acquired causes, but most frequently occurs as a result of cleft palate [2].

Hypernasal speech is a major symptom in children with cleft palate abnormalities or with other disorders in which velopharyngeal insufficiency is a problem. Speech evaluation of patients with velopharyngeal dysfunction can be classified into perceptual and objective assessments [3]. Examples of objective assessments include nasometry, aerodynamic assessment, nasoendoscopy, and multi-view video-fluoroscopy [4].

Nasometry is a method of measuring the acoustic correlates of resonance through a computer-based instrument called nasometer. Nasometry testing gives the examiner a nasalance score, which is the percentage of nasal acoustic energy to the total acoustic energy (nasal plus oral) [5]. High scores in comparison to normative data suggest hypernasality, while low scores suggest hyponasality. The nasometer can also be a valuable treatment tool because it provides visual feedback to the patient. Finally, it can be used effectively for pre- and post-treatment comparisons [6].

The establishment of normative nasalance scores for each language is very helpful in cleft palate clinics. Nasalance scores have shown many similarities in different languages, however, variation in norms is present. For this reason, Abou-Elsaad et al. [7] conducted a prospective study on 300 Egyptian Arabic volunteers to collect normative values of nasalance for Egyptian Arabic speakers in different age groups, using Arabic speech samples. The speech samples were based on the MacKay-Kummer SNAP Test-R (Simplified Nasometric Assessment Procedures) [6]. The test was modified to be applicable to the Arabic language (Egyptian dialect). The Arabic SNAP test included 4 subtests, namely; the syllable repetition subtest, sustained sounds subtest, picture-cued subtest, and reading passages subtest. The normative values established by

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Abou-Elsaad et al. [7] could be considered general guidelines and not absolute markers of normal and abnormal resonance.

The objective of this study was to evaluate the diagnostic accuracy of Arabic SNAP test in differentiating between normal and hypernasal speech in Egyptian Arabic speaking children.

2. Subjects and methods

This study was conducted on a sample of 30 children attending the Phoniatric outpatient clinic at Mansoura University hospitals, in the period from March 2013 to January 2014, who proved to have velopharyngeal insufficiency after unsuccessfully repaired cleft palate. All the children were Arabic speakers with northern Egyptian Dialect. They were 16 females (53.3%) and 14 males (46.7%) with their ages ranged between 3 and 9 years (mean = 5.5 1.61 years) and were uttering at least three-word sentences in order to get reliable speech samples. 28 children (93.3%) had VPI after primary repaired cleft palate and 2 children (6.7%) had VPI after secondary repaired cleft palate. None of the children received previous speech therapy. Children with sensorineural hearing loss, mental retardation and syndromic cleft palate were excluded from the study. The study had been approved by the Institutional Research Board (IRB) of Mansoura faculty of medicine, Mansoura, Egypt.

Data of normal children nasalance scores ($n = 92$) in the study by Abou-Elsaad et al. [7] will be used to find out cutoff points. All cases were subjected to history taking, clinical examination, and auditory perceptual assessment (APA) of speech. The latter included reporting on nasality (its type and degree), consonant precision, compensatory articulatory mechanisms (glottal and pharyngeal articulation), facial grimace, audible nasal emission of air and overall intelligibility of speech. All the above elements were graded along a 5-point scale starting with 0 (normal) to 4 (severely affected) [8]. Nasopharyngoscopy was done to assess the velopharyngeal port (VPP) movements while the child was repeating speech tasks including vowels, consonants and automatic speech (counting from 1 to 10). The pattern of closure of VPP whether coronal, sagittal, circular or circular with passavant's ridge was specified. Also the degree of closure was determined. Psychometric evaluation was done using Stanford Binnet intelligence scale "4th Arabic version" [9] for determination of mental age to exclude cases with mental retardation. The Preschool language scale "4th Arabic Version" [10] was done for determination of language age.

The Nasometer II (Model 6400; Kay Elemetric Corporation, Lincoln Park, N.J., USA) was used for the analysis of speech samples. Since the study sample included children in the preschool age, the reading passages subtest test was excluded. All participants were asked to perform the following three speech subtests [7].

The Syllable Repetition Subtest I: This subtest included 16 consonant-vowel syllables of pressure sensitive consonants (plosives, fricatives, or affricates) combined with either the low vowel/a/or the high vowel/i/.

Sustained Sounds Subtest II: This subtest included two sustained vowels and three sustained consonants.

Picture-cued Subtest III: All participants were asked to read a picture-cued sentence list (containing six picture sets). The words in each sentence were chosen to be phonetically homogeneous, focusing on bilabial plosives, lingual-alveolar plosives, velar plosives, sibilant fricatives, velar fricatives (which are added to the original test) and nasals. Average nasalance scores were calculated for the six sentences for each tested consonant category.

The nasometer calculates the nasalance which is the ratio between the nasal acoustic energy and nasal plus oral acoustic energy multiplied by 100 [11]. The mean and standard deviations for the nasalance scores in all speech tasks were calculated.

Statistical analysis: Data was collected, tabulated, and analyzed using SPSS (statistical package for Social Sciences) version 15. Quantitative data was presented as mean and standard deviation. Student *t*-test was used to compare between two groups. *p* value was considered statistically significant if <0.05 and highly significant if <0.01. Receiver operating characteristic (ROC) curve was used to determine cut-off points with highest sensitivity and specificity to differentiate between cases and controls. Non-parametric spearman's rho correlation and wilcoxon Signed Ranks test were used for correlative statistics.

3. Results

The results were classified into:

(A) Comparative statistics.
(B) Sensitivity and specificity of Arabic SNAP test.
(C) Correlative statistics.

3.1. Comparative statistics

Comparison between SNAP test scoring (nasalance score) of normal children ($n = 92$) in Abou-Elsaad et al. [7] study and SNAP test scoring (nasalance score) of VPI patients ($n = 30$) are summarized in (Table 1). Statistically significant differences were found for all items in nasometric evaluation ($p < 0.05$) except for prolonged/m/sound ($p > 0.05$).

Table 1
Comparison between SNAP test scoring of normal children and SNAP test scoring of VPI patient (mean ± SD).

	Variables	Normal[a] Mean ± SD	Abnormal Mean ± SD	t	p
Syllable repitition subtest	ba,ba, ba	8 ± 2	26.97 ± 13.56	7.545	<0.001
	ta, ta, ta	8 ± 2	26.43 ± 15.16	6.329	<0.001
	ka, ka, ka	9 ± 3	26.53 ± 14.95	5.916	<0.001
	sa, sa, sa	9.±4	29.17 ± 15.83	6.644	<0.001
	ʃa, ʃa, ʃa	9 ± 5	28.13 ± 16.02	6.210	<0.001
	xa, xa, xa	10 ± 5	25.50 ± 13.92	4.480	<0.001
	pi, pi, pi	17 ± 7	36.60 ± 21.72	4.919	<0.001
	ti, ti, ti	19 ± 9	36.87 ± 24.90	3.961	<0.001
	ki, ki, ki	20 ± 10	34.33 ± 23.35	3.390	0.002
	si, si, si	17 ± 8	44.13 ± 24.31	6.131	<0.001
	ʃi, ʃi, ʃi	13 ± 7	40.60 ± 23.72	6.276	<0.001
	xi, xi, xi	15 ± 6	41.43 ± 22.52	6.693	<0.001
	ma, ma, ma	58 ± 13	48.90 ± 10.55	−4.113	<0.001
	na, na, na	61 ± 8	52.37 ± 12.41	−4.026	<0.001
	mi, mi, .mi	80 ± 5	62.13 ± 14.61	−6.942	<0.001
	ni,ni, ni	81 ± 6	65.40 ± 12.08	−7.067	<0.001
Prolonged sounds subtest	Prolonged/a/	8 ± 2	26.03 ± 14.44	6.736	<0.001
	Prolonged/i/	20 ± 15	41.73 ± 23.15	5.046	<0.001
	Prolonged/s/	0	83.47 ± 23.66	19.326	<0.001
	Prolonged/x/	0	66.53 ± 31.39	11.610	<0.001
	Prolonged/m/	92 ± 3	88.80 ± 17.73	−1.011	0.320
Picture cued subtest	Bilabial Plosives	14 ± 8	35.03 ± 19.30	6.020	<0.001
	Lingual Alveolar Plosives	15 ± 8	35.03 ± 19.70	5.585	<0.001
	Velar Plosives	11 ± 9	32.80 ± 16.58	6.995	<0.001
	Velar fricatives	14 ± 8	34.37 ± 17.37	6.368	<0.001
	Sibilant Fricatives	14 ± 6	39.83 ± 17.85	7.938	<0.001
	Nasals	40 ± 13	49.93 ± 13.71	4.120	<0.001

Student *t*-test.
[a] Normal data from Abou-Elsaad et al. [7].