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The Effect of Vowels on the Nasalance Values in Kannada Speaking Preschoolers with Repaired Cleft of Lip and Palate

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Abstract: **Nasalance value has been reported to be influenced by age, gender, stimulus type and the language spoken by the individual. Hence the current study was aimed at investigating the nasalance value of 3 to 5 year old native Kannada speaking children with repaired cleft of lip and palate (RCLP) and to compares it with typically developing children (TDC). Twenty children with RCLP were considered for the study who were equally grouped into 3–4 year and 4-5 year old group. Further equal number of age and gender matched TDC children were considered as the control group. Nasalance value for the prolonged phonation of vowels /a/ /i/ and /u/ was collected from each child using Nasometer 6450. The data thus obtained was subjected to appropriate statistical analysis. The nasalence value was compared with in and across groups.The results revealed that vowel /i/ had the highest nasalance value followed by /u/ and /a/ in children with RCLP. However, in the TDC group vowel /i/ had the highest nasalance but naslance of /a/ and /u/ was not statistically significant. The reasons for the same are discussed.**

Keywords: **Kannada Language, nasalance value, vowels.**

I. INTRODUCTION

Normal velopharyngeal mechanism comprises of coordinated movement between soft palate, lateral pharyngeal walls and posterior pharyngeal wall. In certain conditions such as cleft of lip and palate this mechanism can be affected leading to velopharyngeal dysfunction (VPD). Such a dysfunction leads the perception of nasality due to an imbalance in the expiratory airflow and acoustic energy in the oral and nasal cavity. The severity of nasality varies in individuals and is often judged perceptually using various rating scales. However, of late it is being supplemented by objective measures such as nasometry.

Nasometry gives the nasalance value which is the numerical ratio of nasal acoustic energy to the sum of nasal and oral energy and is expressed as percentage. There are various stimulus related factors which are also known to influence nasalance such as the phonetic content and stimulus length [1], [2], [3].

A study was carried to establish revised normative for Simplified Nasometric Assessment Procedures (SNAP) using Nasometer II [4]. The study focussed on improving the diagnostic value of nasometer and to enable administration of Nasometer II easier in children and non-cooperative patients. Typically developing children between 3 to 9 years were considered during the re-norming stage. SNAP-R consisted of four subtests viz., syllable repetition, prolonged sounds, picture cued subtest and reading subtest. establish normative investigated the nasalance of the variety of CV syllabli. The findings of the study revealed that the difference in scores between Nasometer I and Nasometer II was not clinically significant. The study reported that the nasalance value of CV syllabi were highly dependent on the vowel in the CV

combinations. The study reported that syllabi with high front vowel /i/ had higher nasalance value compared to syllabi with low back vowel /a/. The authors reported such a finding could be due to the high tongue position for vowel i/. This position reduces the oral cavity space with a proportional increase in impedance for sound passing through oral cavity. Also transpalatal sound transmission is highest at the velum due to the presence of the soft tissue for vowel /i/ leading to high nasalence value for CV syllable with vowel /i/ compared to other CV combinations.

The effect of stimulus length on nasalance score was investigated [5]. The study consisted of 20 children who were at risk for VPD and five children without any history of communication disorder. The stimuli included a 44 syllable passage and 17 syllable passage, 6 syllable sentences and a 2 syllable word derived from the same passage. Their nasalance value was obtained and compared across stimuli and groups. The findings revealed that longer stimuli have better correlation with nasalance of standard passage whereas short stimuli such as two syllable words were less clinically applicable.

Further a study was conducted to establish the normative nasalance values across stimuli and gender in Malayalam speaking individuals [6]. The study included sixty adults between 18 to 25 years of age. Each individual was made to repeat ten words and ten sentences. Nasometer 6450 was used for stimuli recording such as ten sentences and ten words. The study revealed that there is a significant difference in nasalance value across gender where in females had higher nasalance value than the males. There was significantly higher nasalance value noted for words in both oral and nasal conditions than sentences which was attributed to the phonetic content within the words and sentences.

Another study investigated the derived nasalance measures of nasality for sentences in children with RCLP [7]. The study included 90 children between 4 to 12 years of age. They were divided into group Ia and group Ib which consisted of children with RCLP having mild and moderate to severe hypernasality respectively. Group II consisted of children with normal nasality. The groups were created after perceptual evaluation of hypernasality using four point rating scale. Nasalance score, nasalance distance and ratio for oral and nasal sentences were obtained using Nasometer II. The results revealed that the nasalance value was high for children with moderate to severe hypernasality compare to mild group for nasal sentences than oral sentences. The study thus concluded that derived nasalance measure is reliable measure to evaluate children with CLP.

The nasalance value is also reported to be influenced by various subject related factors such as language of an individual, the dialect spoken also the age and gender of an individual [3], [6], [8], [9], [10]. However there are studies which state that gender and age does not have an effect on the nasalance value [11], [12], [13]. This difference in studies could be due to the variation in number of participants, the age group selected and type of stimuli used.

India with the second largest population in the world has an increase in the incidence of children with CLP [14]. It is also well known that India is linguistically diverse. There are 22 official languages spoken in India and Kannada language is one among them. Review of literature has revealed that language, age and stimulus have an effect on the nasalance value and that there are a handful of studies investigating the influence of the same in Kannada speaking young children with RCLP. Therefore the current study is aimed at investigating the nasalance value of 3 to 5 year Kannada speaking children with RCLP and comparing it with age and gender matched typically developing children.

Objectives:

1. To investigate the nasalance value of vowels across 3 to 4 and 4 to 5 year old TDC.
2. To investigate the nasalance value of vowels across 3 to 4 and 4 to 5 year old children with RCLP.
3. To compare the nasalance value of vowels across age and groups.

II. METHOD

The study included forty children of 3 to 5 year old children who were native Kannada speakers. Among them 20 children were typically developing children (TDC) who were divided into two groups based on their age into 3-4 year old and 4-5 year old groups. These children were selected from "Anganwadi" and preschools in and around Mysore city. Each child in the TDC groups was included only after passing the WHO ten screening test for disability [15]. Also any history of ear infections, hearing loss, other medical ailments were ruled out after interviewing the parents of the children. All children included in the study belonged to mid-high socio economic background based on NIMH socio-economic status scale: Improvised version [16].

The remaining 20 children included in the study were children with RCLP. They were also divided according to age into two groups viz., into 3-4 year old and 4-5 year old groups. They were selected from Unit for Structural and Oro-Facial Anomalies at Department of Clinical services, All India Institute of Speech and Hearing. Any history of hearing loss, ear infections, poor intelligence, syndromes etc were ruled out based on the physicians report. A written consent was obtained from parent of each child before proceeding with the investigation. The study was conducted according to the ethical guidelines of the institute [17]. Following are the steps followed to measure the nasalance value of each child using Nasometer 6450.

Pre-testing:

Calibration of Nasometer 6450 was carried according to the manufacturer instructions each day prior to data collection. Standard clinical procedures were followed to sanitize the head gear of nasometer before evaluating each child.

Instructions:

Each child was made to sit comfortably on a chair inside a quite room. The headgear of Nasometerr was strapped to the head of the child according to the manufacturer specifications. The investigator then demonstrated a prolonged phonation of vowel /a/ at comfortable pitch and loudness after a deep inhalation. The child was then asked to imitate the same. After the investigator was satisfied that the child was able to phonate appropriately, phonation of vowels was recorded using the Nasometer. Three trials of phonation of vowel /a/ was recorded with inter stimulus gap of 3 sec. Similarly, three trials of phonation of vowel /i/ and /u/ were also recorded. The recorded data was saved in the computer which was later analysed.

Analysis:

A three second stable phonation duration was selected by the investigator to obtain the mean nasalance value for each trial of vowel /a/. These were then tabulated and average of the three trials was calculated and noted. Similar steps were followed for vowel /i/ and /u/. The data thus tabulated was analysed using appropriate statistical measures.

III. RESULTS

Nasalance value across age in TDC:

The mean, standard deviation and median of nasalence value in 3 to 4 and 4 to 5 year old TDC are depicted in table 1. It can be noted from table 1 that the nasalance value for the younger 3 to 4 year old group was higher than the older 4-5 year old group for all three vowels. Among the vowels, it was observed that the nasalance for vowel /i/ was the highest followed by /a/ and /u/. However the mean difference between /a/ and /u/ was minimal.

TABLE 1: Mean, SD, and Median of both age groups in RCLP and TDC.

	TDC			
Stimuli	Age	Mean	SD	Median
/a/	3-4	11.59	4.50	10.66
	4-5	6.12	1.96	5.49
/i/	3-4	18.06	4.57	17.99
	4-5	15.56	3.19	14.83
/u/	3-4	11.16	5.41	11.16
	4-5	6.49	2.88	5.33

Nasalance value* across age in children *with RCLP:

The descriptive statistics of nasalence in 3 to 4 and 4 to 5 year old children with RCLP is shown in table 2. It can be noted from table 2 that similar to TDC, the nasalance value of the younger 3-4 year old children with RCLP was higher than the older 4-5 year old children with RCLP. Also the nasalance value of vowel /i/ was highest followed by /u/ and /a/ in both age groups unlike the TDC group.

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TABLE 2: Mean, SD, and Median of both age groups in RCLP and TDC.

		RCLP		
Stimuli	Age	Mean	SD	Median
/a/	3-4	32.09	21.43	28.33
	4-5	25.13	12.81	24.00
/i/	3-4	69.36	21.86	75.66
	4-5	67.72	23.17	67.66
/u/	3-4	58.82	23.39	58.33
	4-5	58.63	12.30	59.33

Nasalance value across groups and ages:

Shapiro-Wilk's test of normality revealed that nasalance value of both TDC and RCLP groups followed normal distribution. Following this mixed ANOVA was done to compare the nasalance value of vowels while considering age and group as between factors. The results revealed a significant difference in the nasalance value between vowels [$F(2,72) = 72.52$, $p<0.01$, Partial Eta square = 0.668]. Conversely, there was no significant difference noted between age groups [$F(1,36)=0.858$, $p>0.05$, Partial Eta square = 0.023].

Following this it was noted that there is interaction effect present between vowel and group [$F(2,72)=39.93$, $p<0.01$, Partial Eta square = 0.526] whereas no interaction effect was noted between vowel and age [$F(2,72) = 0.65$, $p>0.05$, Partial Eta square = 0.018]; group and age [$F(1,36) = 0.02$, $p>0.05$, Partial Eta square = 0.001]; and vowel-group-age [$F(2,72)=0.27$, $p>0.05$, Partial Eta square = 0.008]. Thus it was evident that age as a variable did not have influence on the nasalance value in both TDC and RCLP group.

Later, repeated measure ANOVA was done to compare the vowels within groups. As it was noted in previous steps that age did not have any significant effect on other variables it was excluded during this step. The results of repeated measure ANOVA revealed that there was statistically significant difference in the nasalance value between vowels in both TDC [$F(2,38)=47.67$, $p<0.01$, Partial Eta square=0.715] and RCLP groups [$F(2,38)=58.46$, $P<0.01$, Partial Eta square = 0.755].

Following this Bonferroni's adjusted multiple comparison test was used for pair wise comparison of the three vowels (/a & i/, /a & u/, /i & a/, /i & u/, /u & a/, /u & i/) across TDC and RCLP groups. The test revealed that there was statistically significant difference in nasalance among two pairs of vowels viz., /a & i/ and /a & u/ .However the same was not true with vowel pair /i & u/. In TDC group statistical significant difference was noted between vowel pairs /a & i/ ands /i & u/ and not between /a & u/.

IV. DISCUSSION

There were three important findings from the present study. Firstly, age as a variable was not found to have any significant effect on the nasalance value of all three vowels across TDC and RCLP groups. As there was no significant age gap between the 3-4 year and 4-5 year old age groups, there might not have been any concomitant difference in the oropharyngeal anatomy. Thus leading to similar nasalance values across ages in both TDC and RCLP groups. Previous studies also have reported absence of difference between the nasalance value across children of different age groups as well as in adults [13], [18], [19].

Secondly it was noted that the RCLP group had overall higher nasalance value compared to the TDC group. The findings of the current study support the findings of the previous studies [20], [21]. The children in the RCLP group of the present study had varying degree of cleft which was surgically corrected only after 1.5 years of age. Also none of the children had attended speech therapy post surgery. Thus the age of surgery, varying degree of the cleft pre-surgery and absence of speech rehabilitation might have led to an increase in the nasalance value of children with RCLP.

Thirdly, among all three vowels, vowel /i/ had the highest nasalance value in both TDC and children with RCLP. Results of the present study is in agreement with the previous findings [7], [22], [23]. The inherent high oral air flow resistance during the production of vowel /i/ leads to higher nasalance value in TDC group for vowel /i/. Also due to the advanced

tongue position the vowel /i/ has highest transpalatal acoustic energy transmission compared to remaining vowels [24]. This nasal energy for vowel /i/ increases further in children with RCLP due to the presence of VPD.

Among the remaining vowels, vowel /u/ was found to have higher nasalance value compared to vowel /a/ in children with RCLP. Vowel /a/ being a low vowel has the least oral airflow resistance compared to high back vowel /u/. This variation in the resistance to oral air flow among these two vowels along with the presence of VPD led to higher nasalance for vowel /u/ than /a/ in children with RCLP [24].

However, among the TDC group, nasalance of vowel /a/ and /u/ was not found to be significantly different. This could be due to the influence of language. Contradictory findings have also been reported by various studies. One such study reported that among the non-VPD children considered for the study, nasalance of vowel /i/ was highest followed by /u/ and /a/ [21]. However, another study reported that among /i /, /æ/, /u/, and /a/ vowels, nasalance of /i/ was the highest and /u/ was the lowest [25]. This could be because, nasalance is reported to be influenced by tongue advancement [25]. Thus, it can be speculated that Kannada speaking 3 to 5 year old f TDC children might differ in their tongue placement for vowel /u/ and /a/ leading to a statistically insignificant difference in their nasalance value.

V. CONCLUSION

The study aimed at investigation the influence of age, stimulus type and language on nasalance value in Kannada speaking children with RCLP. The study revealed that among children with RCLP vowel /i/ had the highest nasalance value followed by /u/ and /a/. However, in the TDC group it was observed that vowel /i/ had the highest nasalance. On the other hand nasalance value of vowel /a/ and /u/ was not significantly different in TDC group. This difference was attributed to the variations in tongue advancement for vowels in Kannada language, the difference in oral airflow resistance among vowels and also the transmission of acoustic energy transpalatally.

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