Assessment of Articulation for Children with Cleft Palate

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Introduction

The purpose of this project was to describe the articulation abilities of a sample of children with clefts from western Denmark. This particular sample was selected for study because identification information for all children born with clefts in this area was available. In addition, the influence of surgeon variability was controlled since one surgeon had performed all surgical procedures.

POPULATION AND SAMPLE STUDIED. The records of all patients born in the western section of Denmark in 1963 and 1964 with a cleft of the lip and palate or a cleft of the palate were reviewed. Patients who were deceased, no longer living in the area, or who exhibited multiple congenital anomalies so severe that they could not be tested, i.e. severe brain damage, were excluded from the study. The available sample consisted of 123 patients of which 108 were examined during the year of study. The fifteen patients who were not included failed to keep appointments with the examiner. Table 1 presents the sex and type of cleft for all 123 patients and the 108 patients studied. By comparing the two sets of data it can be seen that the sample studied was highly similar to the total population, i.e. the two groups differed no more than 3% when comparisons were made on either sex or cleft type. The sample studied is also comparable to samples previously reported by Fogh-Andersen (*2*) and Wells (*13*) and approaches the theoretical distribution for general cleft type of one-third cleft palates and two-thirds lip and palate. The sample studied ranged in age from 69 months to 96 months with a mean age of 84 months (S.D. of 6.67 months) and contained 64 males (59.3%) and 44 females (40.7%).

SURGERY. One surgeon performed all the lip and palatal procedures of the sample studied. The unilateral cleft of the lip and palate involving the alveolar ridge was routinely repaired with the Tennison procedure and vomerine flap. When the alveolar ridge was intact the unilateral cleft was repaired with the Tennison procedure but no vomerine flap was done. A bilateral cleft of the lip was repaired in a two-staged Blair-Brown procedure.

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TABLE 1. Sex and type of cleft palate for 123 subjects born in the western section of Denmark in 1963–64 and sex and type of cleft for 108 subjects reported in this study. No subjects with cleft lip only were included.

	male				*female*				*total*			
	population		*sample*		*population*		*sample*		*population*		*sample*	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Unilateral lip and palate												
left	22	17.9	22	20.3	9	7.3	8	7.4	31	25.2	30	27.8
right	12	9.8	11	10.2	7	5.7	6	5.6	19	15.5	17	15.7
total	34	27.7	33	30.5	16	13.0	14	13.0	50	40.7	47	43.8
bilateral lip and palate												
complete	16	13.0	16	14.8	6	4.9	6	5.6	22	17.9	22	20.4
incomplete	8	8.2	5	4.6	3	2.4	3	2.8	11	8.9	8	7.4
total	24	21.2	21	19.4	9	7.3	9	8.4	33	26.8	30	27.8
palate only	14	11.4	10	9.3	26	21.1	21	19.4	40	32.5	31	28.7
total	72	58.5	64	59.3	51	41.5	44	40.7	123	100.0	108	100.0

For 76 subjects the lip was repaired at a mean age of 2.4 months (range from 1 to 4 months). Of these subjects, 30 had the first stage of the bilateral lip repair, eight had the Tennison without the vomerine flap, and 39 had the Tennison and vomerine flap. For the 30 subjects requiring the second-stage lip repair, the mean age of surgery was 4.4 months (range from 3 to 6 months).

The V to Y Wardill palatoplasty was done at a mean age of 24.6 months (with a range of 18 to 66 months). However, 99 of the 108 subjects had the palatoplasty done between 23 and 26 months of age. The cleft width, which was evaluated by the surgeon at the time of surgery, ranged from 5 mm to 15 mm, with a mean of 8.9 mm.

Ninety-five of the 108 subjects had no further palatal surgery. Of the remaining 13, two had fistulae repair, two had fistulae repair and a sulcoplasty, three had a sulcoplasty, one had a tonsillectomy, three had adenoidectomies, and one had a pharyngeal flap.

OBSERVATIONS. The examinations made at the time of observation included evaluation of the oral mechanism, velopharyngeal competency, and articulation. This particular paper reports the study of articulation.

ARTICULATION. Articulation skills of subjects were evaluated by articulation tests and ratings of conversational speech. A 99 item articulation test in Danish was developed and a complete description is presented in another publication (*12*). This test was constructed to include all items in the Danish Pressure Articulation Test (*1*) and common Danish blends in the articulation test developed by Kirsten and Kurt Kristensen (*3*). An

effort was made to match items with the Iowa Pressure Articulation Test and the articulation test from the University of Iowa Cleft Palate Research Program, since comparison of articulation skills of the two samples was planned. This test was administered to each subject as well as to a group of non-cleft children (*12*) and to a group of subjects with cleft of the lip only. All three groups were of comparable age. From this test six sub-test scores were obtained.

Samples of connected speech were elicited from each subject and, as with the articulation tests, tape recordings were made. At the time of observation, each subject's connected speech was rated for severity of articulation defectiveness on a seven point equal-appearing-interval scale, where a rating of one indicates normal articulation, a rating of four indicates moderately defective articulation, and a rating of seven indicates severely defective articulation. Later, samples of conversation were edited from the tapes and rated by the investigator and other judges.

Reliability of Articulation Ratings. Three methods were used to evaluate the investigator's reliability for judging articulation defectiveness on test and from connected speech.

While at the Statens Institut for Talelidende, the investigator and a native speech pathologist in charge of cleft palate treatment at the Institut independently scored tape-recorded Danish Pressure Articulation Tests for ten randomly selected cleft palate subjects. Each of the judges rated 760 elements and the precentage of agreement between the two was 95%.

To obtain a second measure of reliability, the investigator rated the constructed tapes of conversational speech samples one year after the data had been collected and compared these ratings with those made by him (live) at the time of observation. Eighty-one percent of the subjects received the same rating or were within one interval of the original rating, while 17% were within two intervals.

The third method of determining reliability involved the use of the judgments of a native Danish-speaking layman. She had little previous knowledge of cleft palate and was asked only to rate the speech as normal or not normal. The percent of agreement between this native speaker and the investigator was 94%. On 5% of the subjects, the layman judged subjects as normal and the investigator did not, whereas on 6% the converse was found.

Articulation Test Results. As can be observed in Table 2, when the cleft lip and palate subjects were compared on several articulation subtests with both normal Danish children and Danish children with only cleft of the lip, the experimental group achieved significantly lower articulation scores (.001). The results of sub-tests 1, 3 and 6, which were particularly weighted with pressure sounds, demonstrated that cleft subjects were 30 to 40% poorer than their normal peers. Correlations of articulation test scores with severity ratings of articulation defectiveness

TABLE 2. Articulation test results for cleft palate subjects, normal subjects, and cleft lip subjects. Test 1 includes items on the Danish Pressure Articulation Test. Test 2 includes all elements in the Danish Pressure Articulation Test and Test 3 excludes all non-pressure elements in the Danish Pressure Articulation Test. Test 4 includes test one and Danish blends and is comparable to the Iowa Articulation research protocol. Test 5 includes all elements in test four, and Test 6 includes items equivalent to the Iowa Pressure Articulation Test. The cleft palate subjects were significantly poorer (.001) on all articulation tests when they were compared to normal and cleft lip subjects.

test	*articulation test*	*108 clefts (% correct)*	*31 normals (% correct)*	*20 lips only (% correct)*
1	44 Item Danish Pressure Articulation Test	44.52	81.66	73.58
2	76 Element Danish Pressure Articulation Test	60.09	88.87	83.28
3	51 Element Articulation Test excluding all non-pressure elements	43.55	84.56	76.68
4	99 Item Articulation Test	49.22	77.80	73.83
5	152 Element Articulation Test	60.31	83.95	81.22
6	43 Item Articulation Test	38.13	72.76	70.07

(range from .70 to .73) demonstrated essentially no differences among the sub-tests. It is interesting to note that cleft lip only subjects achieved scores two to eight percent lower than their normal peers.

ARTICULATION ERRORS (TYPE, MANNER AND PLACE). The 152 element articulation test (Test 5) was used in comparing types of errors among the three groups of subjects. As is demonstrated in Table 3, cleft palate subjects exhibited approximately 5% more oral distortions than normals,

TABLE 3. Percent of correct responses and percent of various types of errors on the 152 element articulation test (Test 5) for 108 cleft palate subjects, 31 normal subjects, and 20 cleft lip subjects.

responses	*108 cleft palates %*	*31 normals %*	*20 cleft lips %*
correct	60.31	83.95	81.22
mild oral distortion	3.10	3.18	3.78
moderate oral distortion	6.98	3.59	5.98
severe oral distortion	2.38	.75	1.62
any degree of oral distortion	12.47	7.53	11.39
mild nasal distortion	4.48	.17	.00
moderate nasal distortion	5.67	.02	.00
severe nasal distortion	2.73	.00	.00
any degree of nasal distortion	12.89	.19	.00
substitution	5.57	5.02	4.09
sub-nasal	.87	.00	.00
sub-glottals	1.01	.08	.10
omissions	8.48	3.44	3.41

and approximately 13% more nasal distortions. The cleft palate group also exhibited more glottals (1%) and omissions (5%) than the normal group. The cleft lip only group was highly similar to the normal group with the exception of exhibiting more oral distortions (4%).

When manner of production categories were considered, cleft palate subjects acheived the highest percentage of correct production on nasals (95%), followed by glides (91%), plosives (57%), and fricatives (34%). When considering place of production, the rank order in accuracy was as follows: lingua-velar (78%), bilabial (75%), lingua-alveolar (52%), labial-dental (46%), and lingua-dental (46%). Voiced plosives were correct more often than their cognates, while the converse was true for fricatives. Phonemes that were produced less than 50% of the time as tested on the articulation test were as follows: s, ʃ, v, t, and ð.

CLEFT TYPE (ARTICULATION SCORES). Numerous investigators have reported differences in articulation skill when various subgroups of cleft individuals are compared (*4*). In this study, subjects were first categorized into three groups: bilateral cleft lip and palate, unilateral cleft lip and palate, and cleft of the palate only. Scores on the 44 item (Test 1) and 76 element (Test 2) articulation tests were compared and are presented in Table 4. As can be seen, the palate only group achieved the highest scores, followed by the bilateral and unilateral groups respectively. The differences in articulation were not significant (.01) for the three groups on any of the tests.

The palate only group was then divided into categories of complete cleft of the hard and soft palate and cleft of the soft palate only. As is demonstrated in Table 4, subjects with a cleft of the soft palate achieved higher scores, but the difference was not significant. It is difficult to determine whether differences might indeed exist because of the small number of subjects in the cleft of the soft palate only sample. As Moll (*4*) indicates, speech has been judged as normal for a greater percentage of patients with cleft of the soft palate than those with clefts which also involve the hard palate. Contrary to the results in this study, Moll (*4*)

TABLE 4. Comparison of articulation scores on the 44 Item (Test 1) and the 76 Element (Test 2) Danish Pressure Articulation Tests when cleft type is considered.

group	*N*	*mean percent correct*	
		44 items	*76 elements*
bilateral lip and palate	30	45.6	60.9
unilateral lip and palate	47	40.7	57.5
palate only	31	50.8	64.2
complete cleft palate	22	48.0	62.0
cleft of soft palate	8	58.0	69.0
submucous cleft	1	45.0	53.0

TABLE 5. Estimate of velopharyngeal closure when cleft type is considered.

type of cleft	*group 1 achieves closure*	*group 2 marginal closure*	*group 3 no closure*
palate only $N = 31$	54.9%	29.1%	16.1%
unilateral lip and palate $N = 47$	40.5%	49.0%	10.6%
bilateral lip and palate $N = 30$	53.3%	40.0%	6.7%
total group $N = 108$	48.1%	40.7%	11.1%

reports that unilateral cleft subjects achieve normal speech more often than bilateral subjects. This difference, as demonstrated in Table 5, may be attributed to the fact that, in this sample, 53.3% of the bilateral cleft subjects were judged to achieve velopharyngeal competence, while only 40.5% of the unilateral subjects were rated as competent (*10*).

OTHER VARIABLES. *Width of palate.* Since cleft width in all probability contributes to palatal function, the relationship between the surgeon's evaluation of the cleft width before surgery and severity ratings of articulation was investigated. Although the correlation coefficient was significantly different from zero (.002 level), the strength of the relationship was low ($r = .28$). Further comparison of cleft width with scores achieved on the 44 item and 76 element articulation tests indicated correlations of .21 and .23 respectively which were significant at the .01 level of confidence. Therefore, it appears that subjects with more narrow clefts can be expected to achieve better articulation skills. Because of the low correlations, however, it is obvious that other variables also contribute significantly to articulation skills.

It seems apparent that other factors such as palatal length and pharyngeal depth and width, as well as movement of the pharyngeal area, are all contributory factors to velopharyngeal competence and that further study is needed to determine the relative values of the various attributes in predicting the success of surgical management.

Presence of a fistula. When the oral mechanism was evaluated, 47% of the subjects exhibited oral nasal fistulae, usually occurring at the juncture of the premaxilla and the maxilla. Since information concerning the effect of fistulae on articulation is sparse, comparisons between subjects who exhibited fistulae and those who did not were made. Subjects with fistulae achieved poorer articulation scores and more severe ratings of articulation defectiveness than subjects without fistulae. Although no significant difference was obtained between any of the comparisons, the lack of significant differences is probably related to the fact that the fistula group achieved better velopharyngeal competency as determined by phonation of /u/ on lateral x-ray.

Dentition. Little research information has been reported concerning the effects of dental deviations on articulation of speakers with cleft palates

(7); however, it has been generally assumed that severe malocclusion and/or open bite can affect articulation and, clinically, reference is often made to this effect. Therefore, the effect of dental deviations on articulation was evaluated by the use of a five point equal-appearing-interval scale, where a rating of one indicated no dental deviations which should influence articulation, a rating of three indicated dental deviations present which might influence articulation, and a rating of five indicating dental deviations which adversely affect articulation. For 30 of the subjects it appeared that dentition had no adverse effect on articulation, while for 69 subjects it was felt that dentition could influence articulation to a mild to moderate degree, and for nine subjects it appeared that dentition did adversely affect speech. Comparison of the data of normal subjects and subjects with cleft of the lip only indicated that the latter group exhibited more oral distortions (4%). It is highly possible that as cleft severity increases, dental deviations increase and contribute even more to articulation defectiveness.

Velopharyngeal closure. As would be expected, the most discriminating aspect in articulation among cleft palate speakers appears to be the adequacy of velopharyngeal competency. When subjects were rated on adequacy of velopharyngeal closure by the investigator (*10*), the 52 subjects rated as competent produced 57% of the items correctly on the Danish Pressure Articulation Test, whereas the marginal group ($N = 44$) produced 38% correctly and the incompetent group ($N = 12$) produced only 14%. On all articulation tests, approximately 20 percentage points separated each of the three groups.

Conversational speech. The correlations of severity of articulation defectiveness with scores achieved on articulation tests ranged from .70 to .73 and are highly similar to those reported by Moll (*4*). It is of interest that the specific tests, some of which consisted of a large number of pressure elements, did not demonstrate any differences in the strength of relationship to judged severity. Severity of articulation ratings for the total group were also significantly related (.001) to measures of velopharyngeal competency (*10*), as were all articulation tests; however, articulation test scores are more strongly related to severity of articulation and severity of nasality than to other velopharyngeal competency measures (*10*).

Discussion

Two basic problems in cleft research are heterogeneity of the population (*5*) and variability in treatment procedures. The sample collected was felt to be representative of the population and optimally controlled in surgical treatment procedures. Therefore, the articulation data were collected to compare with similar data being collected on the Iowa Longitudinal Research Study as well as to describe the articulation of a non-English speaking group.

Although the articulation scores achieved by the Danish cleft subjects appeared poor when they were compared to their normal peers, comparison with a matched group of cleft subjects from Iowa indicated that the two groups differed less than 8% on articulation tests (*11*).

The results also indicated that types of errors and types of manner of production errors were highly similar to the results of numerous reports (*4, 6, 13*) which describe the articulation of English speaking children with clefts. It appears, however, that perhaps more nasal distortions occurred in the sample studied than would be expected and that such errors could be related to the high incidence of oral-nasal fistulae found in this group.

Although it has been well documented in the literature that adequacy of velopharyngeal closure is the most important factor in acquiring normal articulation for individuals with cleft palate, adequate velopharyngeal closure does not insure good articulation. Therefore, severity of articulation defectiveness and scores achieved on articulation tests are influenced by learned behavior as well as by other factors (*8*). Certainly, subjects who achieve velopharyngeal closure usually perform at higher levels of articulation proficiency than subjects with velopharyngeal incompetence. However, as was demonstrated in a companion study (*9*) subjects who achieved closure and may in addition have received speech therapy were still not as proficient in articulation skills as their normal peers.

The factors which contribute to the articulation defectiveness of subjects with cleft palate who achieve velopharyngeal competency are not well understood, yet if rehabilitation is to improve further documentation of contributing variables such as dentition, palatal and pharyngeal structure, and presence of fistulae are needed.

Summary

In this investigation, a sample of 108 Danish children born with cleft palate were examined to determine their adequacy of articulation. When subjects were compared on articulation tests to their normal peers and to children with cleft of the lip only, they were significantly retarded in articulation skills. Cleft subjects typically exhibited more oral distortions, nasal distortions, and omissions on plosive and fricative phonemes than did their normal peers; however, the patterns of their articulation skills were highly similar to data previously reported in the literature for American children with clefts.

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