Research Article

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Relationship Between Malocclusion and Fonoarticular Disorders

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Introduction

The authors examined 113 subjects between the ages of 9 and 14 years, 59 males and 54 females, in the town of Santa Maria, state of Rio Grande do Sul, Brazil. Dental/orthodontic assessment revealed that 12 had normal occlusion, and 66 had Class I, 18 had Class II division 1, 7 had Class II division 2, and 10 had Class III malocclusions.

For the analysis of the speech articulatory disorders, the Yavas, Hernadoren & Lamprecht (1992) adapted test was used. A list of words was selected that had all phonemes of the Portuguese language, in all possible positions in the words. A tape recording was utilized for later analysis of the speech sample and a phonetic transcription of the words was done.

Results indicated that the 12 subjects with normal occlusion did not have speech-articulatory disorders; however, there were correlations between malocclusion and articulatory problems. Twenty of the 113 subjects (17.7%) were identified as having malocclusion and articulatory disorders. This study attempted to define possible relationships between malocclusion and fonoarticular disorders.

Review of the Literature

According to Ferraz (1984), for many years researchers have attempted to define the relationship between the presence of malocclusions and anatomical and functional anomalies of the oral cavity.

Fymbo (1957), Coff (1960), Snow (1961), and Bloomer (1971) state that the integrity of the dental arches is important for correct production of speech and that both the upper and lower arch have considerable influence on speech articulation. They have also observed the correlation between malocclusion and articulation. However, Lubit (1967), investigating speech articulatory disorders in 300 patients with orthodontic problems, concluded that malocclusion has little effect on speech ability in general.

Farret et al (1982a), through eletromyographic studies, compared the activity of the mentalis and the lip depressor muscles between normal speakers and individuals who have speech problems. They used phonetically balanced words of the Portuguese language spoken in Brazil. They did not find statistically significant differences in the muscular activity of the two groups during the production of the selected words.

These same researchers (1982b) using the same list of words, observed, through eletromyographic analysis, the activity of the orbicularis oris muscle (upper and lower) in normal individuals and in those that had speech problems. They observed that in people with speech problems the activity of the upper orbicularis muscle is significantly lower than in the normal speakers only in the pronunciation of /mala/ and /kwelu/.

Kessler (1955) studied the relationship between malocclusions and difficulty in the production of speech sounds. In that research, subjects with Class II relationship presented more frequent speech disorders on /s/ and /z/.

In subjects that had openbite, the difficulties were on the phonemes /f, v, p, b, m/ due to the inability to extend the lips sufficiently to produce these sounds. Some cases produce distortion of the phonemes /s/ and /z/ because of the excessive passage of air that can occur in Class II relationships. The author also reported that all of the difficulties mentioned were present in Class III relationships, due to the interference of the jaw in the movements of the lips and tongue.

Vallino & Thompson (1993) compared characteristics of the articulatory distortions made by subjects with Class II associated with openbite and Class III and concluded that the errors occurred mostly in the fricatives /s, z/ and affricate /j/. Problems in the plosive consonants /p, b, t, d/ and nasal /m, n/ occurred with less frequency. It appears that every type of malocclusion can have a specific influence on the nature of the articulatory error.

The study by Ferraz (1980) showed the relationship between openbite and misarticulation of the phonemes /t, d, l, r/. Barrett & Hanson (1974) concluded that (1) anterior openbite also has influence on swallowing and on the production of sibilant sounds /s/ and /z/; (2) overjet can affect bilabial plosives /p, b, m/; and (3) Class III relationship generally involves the labiodental phonemes /f, v/.

The investigation by Fairbanks & Litner (1951) compared the dental conditions of two groups: one with normal speech and the other with articulatory problems. Only openbite was significantly more frequent in the latter group.

Examining a sample of 451 Finland children for the purpose of finding the occurrence of speech articulatory disorders and the possible effects related to age, sex and previous speech therapy, Laine et al (1987) reported

distortions of /s/ in 16% of the subjects, of /r/ in 3% and of /l, n, d/ in 1%. These errors are combined with other articulatory disorders.

The study done by Hale et al (1988) observed the incidence of speech disorders related to oral and facial development and determined that 81% of the subjects preparing to start orthodontic treatment had articulatory disorders, 7.4% had voice problems and 11% presented both speech and voice disorders.

Mocellin (1988) states that the alterations presented by mouth breathers are: facial deformities, malocclusion and speech disorders. He emphasizes the relationship between all the problems mentioned and stresses that treatment needs to include an otorhinolaryngologist, an orthodontist and a speech therapist.

According to Hanson & Barrett (1988), crossbite or openbite in the posterior regions has little effect upon speech, except in cases where lateral lisp occurs. Overjet can affect the speech in many ways. If the patient has a severe incisal labialversion, it is anatomically difficult to occlude the lips for the production of the bilabial stop sounds /p/ and /b/. The Class II relationship with overjet may be one of the main factors responsible for frontal lisp. The speech problems associated with Class III relationship appear to be caused by the malocclusion. If a constriction of the maxillary arch occurs, the tip of the tongue will probably touch the incisors instead of the alveolar point ("spot"). The sounds of /f/ and /v/ may be produced by the upper lip contacting the lower teeth.

Materials and Methods

The purpose of this study is to investigate the interrelationship between speech articulatory disorders and malocclusions associating them with the specific difficulties of the Portuguese language, intending to contribute to preventive and corrective programs in orthodontics and speech therapy areas.

The authors examined 113 subjects between the ages of 9 and 14 years old, 59 male and 54 female, in the city of Santa Maria R.S Brazil. From this sample 66 (68.41%) had malocclusion Class I, 18 (15.93%) had malocclusion Class II division 1, 7 (6.19%) had malocclusion Class II division 2, 10 (8.85%) were Class III and 12 (10.62%) had normal occlusion.

An interview was done with the children to obtain the identification data.

The Yavas, Hernandorena & Lamprecht (1992) adapted test was used to analyze the speech problems of the children. The test consisted of a list of words that contained all of the phonemes of the Portuguese language in all of the positions in the word (initial, medial and final).

The phonemes of the Portuguese language that are formed by velar, labiodental, palatal, bilabial and linguadental contacts were represented by pictures so the children would not be influenced by hearing the examiner produce the phonemes. The authors used a tape recorder with a microphone, so they could analyze the sounds later

and make phonetic transcriptions of the words, to document the absence or presence of speech articulatory disorders.

Occlusion was classified by the criteria established by Angle: Class I, II and III with their respective divisions and subdivisions. The authors also observed the presence of crossbite, openbite, overjet, overbite and crowding.

The statistical method utilized was chi-square with tables of contingency 2x2. For all the analyses, the 5% level was considered statistically significant.

Results

Of the 113 subjects in this study, 93 (82.3%) had normal speech and only 20 (17.7%) had articulatory disorders. Table 1 demonstrates that the incidence of defective speech varies significantly within the different categories of the Angle classification system. None of the 12 children with normal occlusion had articulatory disorders. 8 of the 10 subjects (80%) with Class III malocclusion had articulatory disorders, compared with 10 of the 66 subjects (15.15%) with Class I; 1 of the 18 subjects (5.56%) with Class II div. 1; and 1 of the 7 subjects (14.29%) with Class II, div. 2.

Statistical analysis of the data on gender (Tables 2 and 3) reveal no significant differences between males and females in classification of malocclusion or in articulation proficiency.

Tables 4, 5, and 6 present the data on each individual subject (identified by a letter of the alphabet) with specific information on orthodontic problems (crossbite, openbite, crowding, overjet, and overbite), articulation errors, and gender.

***Editors note: /r̃, š, ž, č, and ĵ/ are phonemes in the Portuguese language not found in the English language.

Discussion

The subjects who presented speech disorders represented 17.70% of the sample. A similar study accomplished by Lain (1987), in children from Finland from 6 to 8 years old, revealed 20% with speech disorders. The children examined by those authors belonged to an age group younger than the sample in the present study. A continuation of incidence studies is encouraged as additional data will further define the role of time in the maturity of the oral-facial musculature in speech production.

In the present study the variable maturity was not considered because all of the subjects were from 9 to 14 years old and "developmentally" would be expected to produce all sounds correctly.

Angle (1907), Case (1921), Strang (1959), and Salzmann (1957) have recognized the association between faulty speech and malocclusion. Kessler (1951) has included malocclusion as one of the causes of speech problems. The same author (1955) has emphasized the

occurrence of speech disorders in malocclusion Class II, III and in cases of anterior openbite. Vallino & Thompson (1993) have agreed with that statement and observed that each type of malocclusion has a specific influence on the nature of the articulatory defect. The studies by Hale, Kellum & Bishop (1988) have examined the incidence of faulty speech. They concluded that 81% of the subjects with malocclusion problems had speech disorders.

Lubit (1967) found results quite different from the above. In his studies he observed that orthodontic problems had little influence on the production of speech.

Bernstein (1954) also demonstrated that speech defects are not related to malocclusion, with the exception of anterior openbite that has a strong relationship with sigmatism (distortion of /s/ and /z/).

The present investigation has found significant relationships between malocclusion and speech disorders. All subjects that had normal occlusion had normal speech. Another finding of this study was that the presence of speech disorders does not vary with the sex of the subjects.

According to Hanson & Barrett (1988), overjet can affect speech in many ways. In the presence of a severe incisal labialversion, the speaker has difficulty occluding the lips to produce the bilabial plosive sounds /p, b, m/. On the contrary, in our sample, this fact did not occur in any case. This can be explained, according to Marchioro (1996) as a compensatory manner in the production of these phonemes. He was able to identify the aspects of compensation by eletromyographic study of the upper lip in subjects with Class II division 1 malocclusion with overjet. According to Marchioro, the upper lip will develop more activity to compensate for the poor activity of the lower lip. Howell (1987) affirms that people with Class II division 1 and overjet, during certain phonemes tend to project the jaw forward in an edge to edge relationship of the incisors, compensating for their abnormal structure and enabling normal speech. In the present study, of the 25 subjects that had Class II relationship, only 2 presented speech articulatory disorders, one had Class II division I relationship and the other had Class II division 2 relationship.

The present study revealed that 6 out of the 10 subjects with Class I malocclusion had errors on /r/; 2 of the 10 had errors on /t, d, n, and l/; 1 had errors only on /s/ and /z/; and 4 had errors on /s, z, š, ž, č, and ĵ/ (Table 4).

It appears that the great number and diversity of cases with speech problems is because of the many problems inherent in Class I malocclusion. Laine et al (1987) have demonstrated that often these speech problems are associated with other additional orthodontic problems such as crossbite, overbite, crowding and spacing which corroborates our studies (Table 4).

Kessler (1955) reports distortions of the sounds /s, z/, in subjects with Class II, due to the excessive passage of the air through the anterior teeth. In spite of the small number of Class II subjects in our study, we found that one of them, (Class II, division 1) has presented sibilant sigmatism in the production of the phonemes /s, z, š, ž, č, ĵ/

, agreeing with the above study. The other member of the Class II division 2 sample misarticulates the phoneme /r/ in clusters (r-blends), due to the incorrect positioning of the tongue, which in this case protruded between the upper and lower incisors. There is a need for further studies with a larger population of Class II subjects. Because of the small sample size in this study, no correlations could be established for Class II malocclusions and articulatory disorders.

Hanson & Barrett (1988) have emphasized that speech problems associated with Class III may be due to the malocclusion. If constriction of the maxillary arch occurs, the tip of the tongue will touch the upper incisors instead of the alveolar ridge, for /t, d, l and n/. Also the /f/ and /v/ sounds may be produced by the upper lip contacting the lower incisors, instead of the upper incisors contacting the lower teeth. These would represent "compensatory techniques" and might be "acoustically correct" but "cosmetically incorrect."

The present study also adds that the subjects with Class III relationship, (Table 6) may present sigmatismus predentalis affecting the phonemes /t, d, n, l/ due to the position of the tongue against the lower incisors; sibilant sigmatismus distorting the fricatives /s, z, š, ž/ and affricates /č, ĵ/ due to the excessive passage of the air flow because of the position of the jaw. When the air space is too large, too much air is allowed to escape and the fricatives are distorted. It also distorts the phoneme /r/ due to the incorrect positioning of the tongue. This last fact occurred in a great number of cases, except in the subjects with Class II relationship that presented sigmatismus predentalis because of protrusion of the tongue. On the other hand, the misarticulation of the phoneme /r/ to /r⁹/r9/ requires a posterior positioning of the tongue and subjects with Class III relationship have difficulties doing that. We suggest that more studies in this area be done in order to clarify further the etiology of this specific speech problem.

Kessler (1955) observed and reported the difficulty in production of the phonemes /f, v, p, b, m, s, z/ in patients with Class III relationship, due to the interference of the projection of the jaw with the movement of the lips and tongue and the dentalized resting tongue posture.

Conclusions

After the evaluation and discussion of the results we concluded that:

- 1) Individuals with normal occlusion did not present articulatory speech problems.
- 2) 17.70% of the subjects in the sample presented consonant errors associated with malocclusion.
- 3) There was a significant relationship between malocclusion and speech disorders in all of the Angle classifications: Class 1 (15.15%), Class II, div. 1 (5.56%), Class II, div.2 (14.27%). However, in Class III, the results were highly significant (80%).

- 4) There was no significant relationship between malocclusion and gender.
- 5) The subjects that had anterior cross bite did not present abnormal speech because of the compensation mechanism of the lower lip in speech sound production.
- 6) A great number of the individuals Class I and Class III presented distortion of the /r/ to /r̃/. This incorrectly pronounced sound did not occur in Class II subjects and this may be due to the difficulty of positioning the tongue posteriorly. More studies should be done to clarify this matter.
- 7) The most frequent speech problem found in subjects with malocclusion Class III was sibilant sigmatismus.
- 8) The subjects with Class I malocclusion had a greater diversity of speech articulatory problems.
- 9) Of the 25 people in the sample with Class II malocclusion, only 2 presented speech problems, probably because of the individual differences in ability to adapt and to compensate for structural changes in speech sound production.

TABLE 1 - Population distribution, according with the Classification of Angle and presence or not of articulatory disorders.

Variable frequency percentage pct. Line pct. Column	Normal occlusion	Class I	Class II div. 1	Class II div. 2	Class III	Total
with	0	10	1	1	8	20
articulatory	0.0%	8.85%	0.88%	0.88%	7.08%	17.70%
disorders	0.0%	50.00%	5.00%	5.00%	40.00%	
	0.0%	15.15%	5.56%	14.29%	80.00%	
with normal	12	56	17	6	2	93
speech	10.62%	49.56%	15.04%	5.31%	1.77%	82.30%
	12.90%	60.22%	18.28%	6.45%	2.15%	
	100.00%	84.85%	94.44%	85.71%	20.00%	
Total						
Frequency	12	66	18	7	10	113
Percentage	10.62%	68.41%	15.93%	6.19%	8.85%	100.00%

TABLE 2 Population distribution, according with the Classification of Angle and presence or not of articulatory disorders in males

Variable frequency percentage Pct line Pct column	normal occlusion	Class I	Class II div. 1	Class II div. 2	Class III	Total
with	0	7	0	0	4	11
articulatory	0.00%	11.86%	0.00%	0.00%	6.78%	18.64%
disorders.	0.00%	63.64%	0.00%	0.00%	36.36%	
	0.00%	21.88%	0.00%	0.00%	66.67%	
with normal	8	25	9	4	2	48
speech	13.56%	42.37%	15.25%	6.78%	3.39%	81.36%
	16.67%	52.08%	18.75%	8.33%	4.17%	
	100.00%	78.13%	100.00%	100.00%	33.33%	
Total						
Frequency	8	32	9	4	6	59
Percentage	13.56%	54.24%	15.25%	6.78%	10.17%	100.00%

TABLE 3 - Population distribution, according with the Classification of Angle and presence or not of articulatory disorders in females

Variable	normal occlusion	Class I	Class II div. 1	Class II div. 2	Class III	Total
frequency						
percentage						
Pct line						
Pct column						
with articulatory disorders.	0	3	1	1	4	9
	0.00%	5.56%	1.85%	1.85%	7.41%	16.67%
	0.00%	33.33%	11.11%	11.11%	44.44%	
	0.00%	8.82%	11.11%	33.33%	100.00%	
with normal speech	4	31	8	2	0	45
	7.41%	57.41%	14.81%	3.70%	0.00%	83.33%
	8.89%	68.89%	17.78%	4.44%	0.00%	
	100.00%	91.18%	88.89%	66.67%	0.00%	
Total frequency	4	34	9	3	4	54
Percentage	7.41%	62.96%	16.67%	5.56%	7.41%	100.00%

TABLE 4 - Occlusion problems related with articulatory disorders in occlusal Class I.

Class I (individuo)	cross bite	open bite	crowding	overjet	over bite	phoneme	Sex
I	Yes	No	Yes	Yes	No	[r]→[r ⁸] distortion	M
J	No	No	Yes	Yes	Yes	[s,z] anterior sigmatism	M
L	No	No	Yes	No	No	[s,z,ʒ,ʒ̃,ʒ̃̃] sibilant sigmatism	M
M	No	No	Yes	No	No	[t,d,n,l,r] anterior sigmatism	M
N	No	No	No	Yes	No	[r]→[r ⁸] distortion [r]→[ɹ] [pr,br] distortion	M
O	No	No	No	No	No	[t,d,n,l,r] anterior sigmatism [s,z,ʒ,ʒ̃,ʒ̃̃] sibilant sigmatism distortion of [r], in the clusters	M
P	No	No	Yes	No	Yes	[r]→[r ⁸] distortion	M
Q	Yes	No	No	No	No	[r]→[r ⁸] distortion distortion of [r] in the clusters	F
R	Yes	Yes	No	No	No	[s,z,ʒ,ʒ̃,ʒ̃̃] sibilant sigmatism	F
S	No	No	Yes	No	No	[s,z,ʒ,ʒ̃,ʒ̃̃] sibilant sigmatism distortion of [r] in the clusters	F

TABLE 5 - Occlusion problems related with articulatory disorders in Class II.

Class II	cross bite	open bite	crowding	overjet	overbite	phonemes	Sex
T (div.1)	No	No	Yes	No	No	[s,z,ʃ,ʒ,ʎ,ʝ] sibilant sigmatism	F
U (div.2)	Yes	No	No	No	No	distortion of [r] in the clusters	F

TABLE 6 - Occlusion problems related with articulatory disorders in Class III.

Class III	cross bite	open bite	Crowding	phonemes	sex
A	No	No	Yes	[t,d,n,l,r,f,v] anterior sigmatism [s,z] sibilant sigmatism	F
B	Yes	No	Yes	[r]→[r ^h] and [r]→[R] distortion	F
C	No	No	No	[s,z,ʃ,ʒ,ʎ,f,v] and [r] sibilant sigmatism	F
D	Yes	No	No	[s,z,ʃ,ʒ,ʎ,ʝ] sibilant sigmatism	F
E	Yes	No	No	distortion of [r], in the clusters.	M
F	Yes	No	Yes	[s,z,ʃ,ʒ,ʎ,f,v] sibilant sigmatism	M
G	Yes	No	No	[s,z,ʃ,ʒ,ʎ,ʝ] and distortion of [r] in the clusters sibilant sigmatism	M
H	No	Yes	No	[s,z,ʃ,ʒ,ʎ,f,v] sibilant sigmatism	M

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