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Relation between Dental Malocclusions and Masticatory Performance in Patients with Atypical Swallowing

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ABSTRACT

Introduction: Atypical swallowing can modify the position of the teeth, the relationship and shape of the dental arches, and chewing. **Objective:** To relate chewing performance to dental malocclusions and atypical swallowing in patients from a university in Bogotá, Colombia, 2017-2018.

Material and methods: Cross-sectional descriptive study in 78 subjects with atypical swallowing and dental malocclusions. Masticatory performance was measured following Albert's protocol and the mtp (Median Particle Size) was calculated using a power equation similar to the Rosin-Rammler formula. **Results:** Masticatory performance was not significantly correlated with the types of malocclusions ($p > 0.05$). mtp is higher in class II (6.05) than in class III (5.52) and class I (5.0). **Conclusions:** No significant correlation was found between masticatory performance, type of dentition, and malocclusion in patients with atypical swallowing.

Keywords: atypical swallowing, dental malocclusions, chewing

INTRODUCTION

The components of the stomatognathic system have a coordinated influence on the masticatory process[1]; there must be harmonious contact between the dental arches, allowing better neuromuscular functionality during the mastication process[2]. In mastication, the participation of the teeth is fundamental[3], the anterior or posterior loss or change in the arrangement of the teeth can lead to inefficient mastication. Therefore, researchers such as Freitas *et al.*[4], Velástegui and Salazar[5], and Owens *et al.*[6], argue that the interocclusal contact area and close contact at maximum intercuspidation in patients with malocclusion exert influence on masticatory performance. One of the most important structures in swallowing and mastication is the tongue; its movements are associated with those of the masticatory muscles, helping to stabilize occlusion[7-9].

During swallowing there can be an alteration in the position of the tongue, generating an atypical swallow that will cause myofunctional problems thus affecting chewing[10,11]. The causal relationship between atypical swallowing and malocclusion is controversial. Some authors claim that form depends on function, and others that function tends to exacerbate cases of malocclusion[12,13] However, the functions of chewing and swallowing are intimately linked as they share bone and muscle structures commanded by the central nervous system, which implies a sensorimotor synchrony[2,14].

Orofacial functions involved in vital actions such as breathing, chewing, and swallowing also influence actions of social interaction, emotional communication, facial expression, and appearance[15]. Yamashita *et al.*[16] considered that the chewing pattern may be influenced by dental-skeletal morphology and physical properties of food, which may have a future impact on both chewing efficiency and chewing performance[12,16-19].

Several methods have been used in the weighting of chewing performance[6,20]. One of the most important methods is fractional sieving, a technique to separate the food after being chewed for a certain period, using natural and artificial foods, such as impression silicone. Due to the importance of the mean particle size (X50), to assess chewing performance, authors such as Eberhard *et al.*[21], and Souto-Souza *et al.*[22], have used the Rosin-Rammler equation[17,23] for this purpose. Therefore, this study aimed to relate masticatory performance to dental malocclusions in patients diagnosed with atypical swallowing.

MATERIAL AND METHOD

A cross-sectional descriptive study was conducted on 78 people with atypical swallowing who attended the orthodontic clinics of a private university in Bogota, Colombia, during the years 2018-2019. Patients with complete primary, early mixed, and complete permanent dentition were included; with consent and/or informed consent filled out. Patients with caries or dental mobility, neurological alterations, and craniofacial malformations were excluded. The research was performed following international requirements, the Helsinki Declaration, and was approved by the subcommittee of Bioethics in research of the Universidad Cooperativa de Colombia (N°013-2016).

The probability sampling was based on the prevalence of atypical swallowing in the 2017 population in the clinics; the sample was calculated with SPSS V 10.1 for a reliability level of 95%, error estimate of 5%, and probability of 50%; the sample universe was 400 patients with atypical swallowing diagnosed by a speech and hearing therapist expert in the Payne technique[24,25].

Subsequently, the diagnosis of the type of dentition was made following the guidelines proposed by Björk for the primary dentition[26] and the type of dental malocclusion in the mixed and permanent dentition according to the Angle criteria[27,28]. Afterward, masticatory performance was evaluated and the mean particle size (X50) of the food particles crushed for each patient was determined.

The data collection was performed by three examiners, standardized with an orthodontist with previous research in the area[29]. Subsequently, the three examiners performed the interexaminer calibration of the hardness of the silicone pieces and of the masticatory performance of five patients, applying the Dahlberg reproducibility coefficient for the hardness measurements in Shore units and the determination of the sample weights in grams. Calibration was also verified with Bland-Altman graphs with confidence intervals, resulting in an average of 64.16 (SD ±1.4; 95%CI 63.59 - 64.73) Shore A, considered acceptable.

In the selected patients, chewing performance was determined following the protocol proposed by Albert[30], the crushing of Zetaplus® silicone tablets was measured, known for their resistance to water and saliva absorption, as well as their difficulty in breaking and their adequate consistency for the preparation[31].

The overall process for assessing chewing performance, including tablet making, tablet hardness measurement, weight determination, screening through the meshes, and mathematical determination of the median particle size (mtp) was implemented as described in detail in the manual for the standardization of procedures for the diagnosis of atypical swallowing and chewing performance[29]. For the calculation of mtp a mathematical software was designed based on a power equation equivalent to the Rosin-Rammler formula: $y = aX^b$, where:

X = % of weight retained on each sieve,
Y = Particle size in mm squared,
b = size distribution coefficient,
a = sieve size in mm squared.

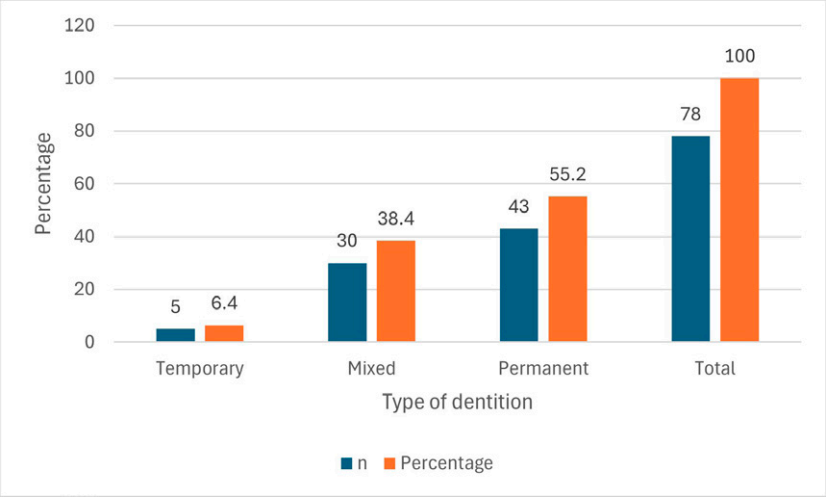
The percentages retained in each sieve whose size is established in square mm were calculated taking as 100% the weight of the sample given to each patient; with those percentages and the size of the sieves, a curve was constructed in which the value corresponding to 50% was interpolated or extrapolated, which is the mtp value defined as the size of a theoretical mesh

that retains 50% of the weight of the sample given to each patient (between 10 and 12 grams); the mtp is equivalent to the 50th percentile of the particle size distribution. A significance level for all purposes of $p < 0.05$ was used.

The variables were subjected to normality tests, using Levene's test ($p > 0.05$); for the comparison of mtp averages by gender, Student's t-test was used and for comparisons by type of dentition and malocclusion, one-way anova and Bonferroni's t-tests were used. Pearson's linear correlation r was used for age and Mantel and Haenszel's (Chi-square MH) for the other correlations.

RESULTS

Seventy-eight patients with atypical swallowing were evaluated, between the ages of five and 40 years, with a predominance of females, 46 (59%). On observing the distribution by type of dentition of the patients with atypical swallowing, it was found that 6.4% presented primary dentition, 38.4% mixed dentition, and 55.2% permanent dentition as can be seen in Graph 1. Concerning dental malocclusion in the primary dentition, 2.5% of the children presented a straight terminal plane, indicative of an adequate molar relationship, 3.8% presented a mesial step (potential class I), and none a distal step.



Graph 1. Distribution by type of dentition of patients with atypical swallowing

As can be seen in Table 1, in the mixed and permanent dentition, class I dental malocclusion (43.7%) was in the first place, followed by class II dental malocclusion (38.5%) and with less frequency class III (11.5%). To establish the masticatory performance in patients with atypical swallowing and dental malocclusion, two of the patients were excluded because they did not perform an adequate trituration of the material by not following the instructions correctly. Therefore, 76 valid data were used for the calculation of the mtp, as can be seen in Table 2. No statistically significant difference was found between the medians or averages of mtp when comparing both genders ($p = 0.62$). However, the median was slightly lower for men than for women (5.6 vs. 5.7 mm^2), that is, slightly more efficient mastication in men.

Table 1. Dental malocclusion by type of dentition

Dentition	Malocclusion	Malocclusion distribution	
		n	%
Temporary	Straight terminal plane	2	2.5
	Distal step	0	0
	Mesial step	3	3.8
Mixed and permanent	Class I	34	43.7
	Class II	30	38.5
	Class III	9	11.5
	Total	78	100

Table 2. Median particle size (mtp) (mm^2)

		Average	SD	95% CI	Median	
Total sample (76)		**5.65**	**0.917**	**5.437-5.857**	**5.7**	
Gender	Female	5.7	0.883		5.75	
	Male	5.6	0.983		5.6	
Type of dentition	1Temporary	Average	SD	Median	Comparison	p
	1Temporary 2 Mixed	5.62	0.6	5.4	1 vs 2	0.79
	1Temporary	5.71	0.85	5.7	1 vs 3	0.98
	3Permanent	5.61	1	5.65	2 vs 3	0.67

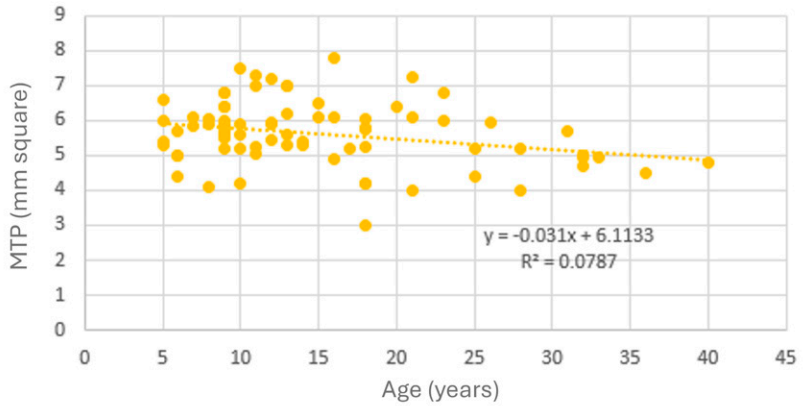
Table footnote: SD: standard deviation, CI: confidence interval.

Graph 2 shows a correlation between age and mtp that is not significant (r= -0.28 for 74 gl corresponds to a p= 0.04) and is negative, which is interpreted to mean that the older the age, the lower the mtp and, consequently, the higher the masticatory efficiency. When linking masticatory performance with the different types of malocclusion, there was no statistically significant relationship (p> 0.05). However, in the mixed and permanent dentition, the medians were similar (5.7 and 5.65 mm^2). Graph 3 shows that mtp is higher in class II (6.05) followed by class III (5.52) and class I (5.4), which suggests that masticatory activity is more efficient in class I and less efficient in class II in this sample.

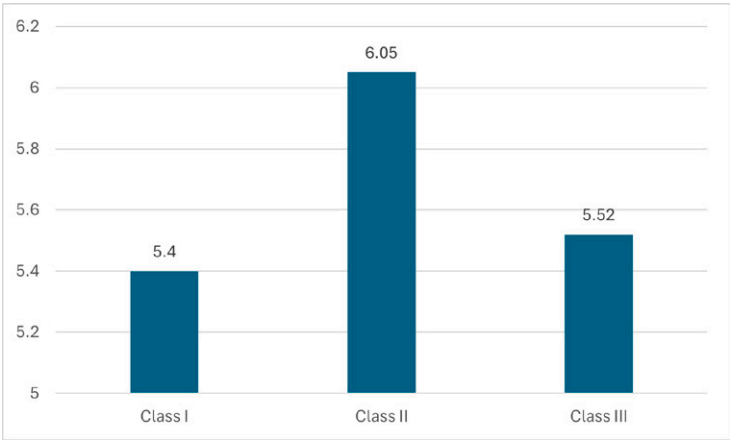
DISCUSSION

Atypical swallowing is one of the most frequent oral habits in the dental office. Its early correction will avoid the deleterious effect on occlusion that depends not only on the force exerted on the oral cavity but also on the time of action[32]; the muscles involved in swallowing are closely related to masticatory function[33,34].

In the present study, we used the protocol proposed by Albert[31], to evaluate chewing performance as in the studies of Toro *et al.*[35], Sánchez Ayala *et al.*[36, 37], Peyron *et al.*[38]. They argue that the chewing of standard foods requires a greater number of chewing cycles over the



Graph 2. Correlation between masticatory performance and age in patients with atypical swallowing



Graph 3. Comparison of MPT medians according to malocclusion classification

years, as individuals adapt to changes in the hardness of foods; given that with age the motor functions of the lips, tongue, cheeks and jaw are affected over time and influence chewing performance[39,40].

Contrary to the above, in this study it was found that the participating patients, despite presenting atypical swallowing and affected masticatory musculature, as found by Begnoni *et al.*[41], masticatory performance improved with age; a situation that may be because the participants were young, with complete dentition, reaching the maximum point of stabilization of masticatory performance; it is important to emphasize that not only age is a factor associated with loss of masticatory performance. Tooth loss, occlusal strength, saliva flow, and oral motor function are also affected and thus influence masticatory performance.

In this study, no significant differences were found in masticatory performance between males and females, like that reported by Sierpinska T, *et al.*[42], who found no influence between masticatory performance and gender. Masticatory performance and swallowing are oral functions that can be altered by parafunctional habits that depend on the motor activity of participating organs such as the teeth, tongue, orofacial musculature, and salivation[36].

CONCLUSIONS

Within the studied population, dental malocclusion does not seem to have a statistically significant impact on the efficiency of the masticatory process in those individuals with atypical swallowing patterns; likewise, the gender variable does not seem to be a determining factor in the variations of the measurement of mtp in the population studied; however, in this context, age could have an inversely proportional influence on the masticatory capacity of the individuals, that is, the older the age, the lower the mtp and, consequently, the greater the masticatory efficiency.

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