Analysis of the degree of visual acuity in patients with mandibular asymmetry

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Abstract. Recently, there has been a rapprochement between disciplines interested in the functioning of the stomatognathic system and ophthalmological alterations, particularly visual function. There is evidence of the relationship between craniofacial anatomical factors and dysfunctions in TMJ biomechanics. Our work investigates the possible relationship between facial asymmetry of mandibular origin and visual acuity in a young adult population. The sample population consisted of 25 subjects (14 female and 11 male) with mandibular asymmetry diagnosed with the Simões Panorogram and the Planas Masticatory Functional Angle to determine the presence or absence of preferential chewing. Likewise, a Snellen chart and an ocular occlude were used to measure visual acuity. To determine the correlation between preferential chewing and the degree of visual acuity, Spearman's Rho test was used with a 95 % confidence level. The SPSS V.26 statistical program was used. 52 % of the subjects were asymmetrical due to preferential chewing, and 42 % were asymmetric for different reasons. Subjects with unilateral preferential chewing had more excellent visual acuity on the side of asymmetry. Here, we report a positive relationship between subjects who presented asymmetry due to preferential chewing and more excellent ipsilateral visual acuity.

Keywords: visual acuity, mandibular asymmetry, preferential chewing.

1. Introduction

The relationship between the stomatognathic system and the ophthalmic region has been the subject of some research in recent years. A strong association has been found between malocclusion, body posture and the podal system [1]. There is a very close interconnection between alterations in stomatognathic functions and the etiology of ophthalmological problems [2]. Currently, some research has been done in which it has been found that patients with dental-maxillofacial asymmetry present cranial and orbital skeletal vertical asymmetry [3]. In addition,[4] found that mandibular movement patterns are influenced by head support and body postures. Visual, postural, and occlusal disturbances are related, and craniofacial anatomical factors and temporomandibular joint biomechanics have been observed to affect many body systems, including the organ of vision [5]. Furthermore, a possible positive correlation between TMD (temporomandibular) and vision defects emerges. In particular, the most interesting associations were found between functional or skeletal orthognathic disturbances and oculomotor dysfunctions [6]. Chewing is constantly contributing to the changes of facial architecture, where the jaw and orbital cavities provide feedback to each other through physiological signals and stimuli from their embryonic origins and throughout life [7]. Today, it is known that an individual's health assessment cannot be carried out in isolation, focusing only on the predominant ailment or the most evident clinical manifestation. Given the complexity involved in understanding the different health conditions of human beings, we must be able to offer the most comprehensive diagnosis possible and always see a patient's health as a whole. The objective of this work was to determine the existence of an association between mandibular asymmetry and visual acuity.

2. Materials and method

The sample consisted of 25 subjects with mandibular asymmetry. All members signed an informed consent form, keeping the personal data provided confidential and verifying compliance with the ethical principles proposed in the Declaration of Helsinki. Panoramic X-rays were taken with a brand device, on which the mandibular symmetry analysis was performed through the Simões panoramic graph. The Planas Masticatory Functional Angle was clinically analyzed to determine the presence of unilateral mastication. Specialists in the corresponding area carried out the diagnosis to determine mandibular asymmetry due to preferential chewing and the evaluation of visual acuity.

To measure visual acuity, a Snellen chart and an ocular occluder were used, performing the following steps:

1) The subject is placed in the chair to evaluate distance visual acuity. 2) You are asked to occlude the right eye to evaluate the left and vice versa, followed by the evaluation of both eyes. 3) Depending on the visual acuity obtained in the evaluation, whether the pinhole examination was performed (which consists of looking through a small hole that allows determining the presence of any pathology that prevents the possibility of improvement). 4) The close evaluation is performed without correction (without glasses if the subject currently uses them). 5) The close evaluation is done with correction (using the subject's lenses). 6) Evaluate variation between points 5 and 6 results. 7) Preliminary tests are carried out, and the inter-pupillary and naso-pupillary distance (from pupil to nose on both sides) are measured. 8) Ocular motility is evaluated to see if there is any alteration in the muscles involved in eye movements. Through versions (conjugated movements with both eyes) and ductions (monocular, occluding one eye at a time to evaluate the opposite). 9) The Hilbert test is performed to evaluate the retinal reflex and see no deviation. 10) Next, search tests (ability to stay looking at the stimulus provided) and tracking tests (ability to follow the stimulus) are performed. 11) The near point of convergence is made, where an optotype is progressively brought closer to your eyes, and how much they can converge (bring your eyes together) is evaluated. 12) Unilateral and alternating screening is performed, which consists of placing an occluder covering each of the eyes separately, followed by doing it alternately. First from afar and then up close. 13) The pupillary reflexes are evaluated as direct, indirect, and accommodative. The direct one is by throwing a stimulus (light) directly into the eyes of the subject, and the pupillary reaction of miosis and mydriasis is evaluated. Indirectly, the stimulus is directed toward one eye and evaluated by the counterpart's response. Moreover, the accommodative through alternating distant and close stimuli. 14) Keratometry is performed, which is a corneal evaluation. This yields results of the power of keratometry and measures the astigmatism present in this structure and its degree. 15) Retinoscopy is performed. The phoropter and retinoscopic lens will be placed according to the requirements of each case. 16) The retinal reflection is evaluated using the retinoscope, which gives images with shadows and is determined according to these shadows. 17) Subjective tests are performed according to the results obtained in the patient's examination. Through bi-chromatic or maximum positive tests. 18) The "astigmatic clock" or "Jackson's crossed cylinder" test is performed to evaluate astigmatism. The above is obtained using a phoropter and projector. 19) Ocular health is evaluated using a biomicroscope, reviewing each eye's structures (eyebrows, eyelashes, eyelid, conjunctiva, cornea, lacrimal, lens, and anterior chamber). 20) Ophthalmoscopy is performed, either using the indirect ophthalmoscope or the retinograph. Capturing a fundus photograph and viewing the internal structures and their current state. 21) A refractive and pathological diagnosis is given (if

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one exists). 22) The side with greater visual acuity will be determined, right left eye.

Depending on the visual acuity obtained in the first assessment, we determined whether to perform the pinhole examination (which consists of looking through a small hole, which allows us to determine the presence of any pathology that prevents the possibility of improvement).

Statistical analyses were performed for each of the variables. Spearman's Rho correlation coefficient test was conducted to determine whether there is a correlation between the highest degree of visual acuity and the unilateral chewing side. Using SPSS V. 26.0 software, a coincidence level of 95 % was considered.

3. Results

A total of 25 subjects (11 female and 14 male) diagnosed with facial asymmetry were studied, of which 52 % (13) had asymmetry due to preferential mastication and 48 % (12) had asymmetry not due to preferential mastication. Visual acuity was equal in both eyes in subjects who presented incipient preferential mastication, while those who had preferential mastication on one side had greater visual acuity on the preferential mastication side. Of the subjects who presented asymmetry not due to preferential mastication, 9 had equal acuity in both eyes, 2 had greater visual acuity on the side of mandibular deviation, and only 1 had greater visual acuity on the side opposite to the mandibular deviation.

Table 1. Sample distribution.

Total, subjects ($n = 25$)	Asymmetry due to preferred chewing	Asymmetry not due to preferred chewing
Fémale 14 Male 11	13	12
Visual acuity	It is greater on the chewing side	The same in both eyes ($n = 9$) Greater on the side of mandibular deviation ($n = 2$) Grater on the side opposite to the mandibular deviation ($n = 1$)

Spearman's Rho correlation coefficient showed a significant difference ($p = .001$), which indicates a relationship between the presence of greater visual acuity in the eye corresponding to the side of asymmetry and preferential chewing (Tables 2 and 3). No statistical significance was observed ($p = 317$) in the Spearman Rho correlation coefficient (.209) between the greatest visual acuity and the side of asymmetry when the asymmetry is not due to the presence of preferential mastication (Table 4).

Table 2. A correlation can be observed between the greater visual acuity of the right eye in subjects with preferential chewing on that side

Non-parametric correlations				
		Correlations	Mandibular asymmetry side (Preferred chewing side)	Great visual acuity
Rho de Spearman	Mandibular asymmetry towards the right side (Preferred chewing)	Correlation coefficient	1,000	.752**
		Sig. (bilateral)	*	.000
		N	25	25
	Greater visual acuity (right eye)	Correlation coefficient	.752**	1,000
		Sig. (bilateral)	.000	*
		N	25	25
* The correlation is significant at the level 0,01 (bilateral).				

Table 3. Shows the correlation between visual acuity of the left eye and preferential chewing on that side.

Non-parametric correlations				
		Correlations	Mandibular asymmetry side (Preferred chewing side)	Greater visual acuity
Rho de Spearman	Mandibular asymmetry towards the left side (Preferred chewing)	Correlation coefficient	1,000	.707**
		Sig. (bilateral)	*	.000
		N	25	25
	Greater visual acuity (left eye)	Correlation coefficient	.707**	1,000
		Sig. (bilateral)	.000	*
		N	25	25
* The correlation is significant at the level 0,01 (bilateral).				

Table 4. Non-parametric correlations between greater visual acuity and mandibular asymmetry without preferred chewing can be observed

		Correlations	Mandibular asymmetry side (no preferred chewing side)	Greater visual acuity
Rho de Spearman	Mandibular asymmetry side (no preferred chewing)	Correlation coefficient	1,000	.209
		Sig. (bilateral)	*	.317
		N	25	25
	Greater Visual acuity	Correlation coefficient	.209	1,000
		Sig. (bilateral)	.317	*
		N	25	25

4. Discussion

The visual and stomatognathic systems represent fundamental aspects of a healthy individual who can perform essential functions and tasks regularly. Due to their location and being part of the craniofacial complex, anatomical and physiological, they are undisputedly linked and, to a large extent, perform simultaneous functions during everyday actions.

Facial asymmetries can have different characteristics according to their origin. The orbit is the site of many pathologies of diverse etiologies [8]. In a study on skulls in the early medieval period, the researchers looked for the relationship between mastication and the directional asymmetry of the upper facial skeleton. They concluded that the relationship between the upper facial skeleton's directional asymmetry and the mandible's directional asymmetry resulted from the mandible's compensatory and adaptive function [9]. These results coincide with the present study since, in our sample, we found that in subjects with unilateral masticatory asymmetry, said asymmetry is related to the direction of the mandibular asymmetry presented. Nonetheless, it has been observed that various functional or postural lateral preferences seem to be related to the side of preferential mastication [10]. Likewise, a statistically significant correlation between ocular mobility disorders and unilateral crossbite with midline deviation was found [11]. On the other hand, [12] studied the amplitude of the electromyographic activity of the masseter and anterior temporalis muscles during mastication in three groups classified according to their vertical growth pattern. They concluded that the vertical facial pattern influences masticatory performance, mandibular movement during mastication, and the effort of the masticatory muscles required for mastication. The center of force at maximum inter-cuspidation is located mainly on the masticatory side, where periodontal mechanoreceptors are essential in regulating mandibular movements and masticatory forces [13]. A strong correlation has been observed between the center of force and the preferential chewing side [14]. The researchers also reported that the relative effort of both muscles was greater in subjects with a shorter face. This coincides with the present work results, where subjects with unilateral mastication showed a smaller vertical dimension on the masticatory side. Likewise, we agree with a recent study on the relationship between Camper's and Frankfort's reference planes and masticatory performance. In this work, the researchers noted the presence of a positive correlation between the reference planes and masticatory force [15]. On the other hand, some studies have shown the importance of the presence of facial asymmetries concerning some ocular alterations, such as strabismus, eyelid abnormalities, and amblyopia, among others [16], as well as the position of the jaw and head depending on ocular dominance [17]. Meanwhile, no studies have been published in which an association of unilateral masticatory asymmetry with specific alterations such as visual acuity is sought, as is the case in the present study, in which it was observed that a percentage of the subjects belonging to the group with asymmetry not associated with unilateral mastication, showed the infraorbital rim higher on the side of the asymmetry; however, not all the subjects of this group obeyed this behavior. Additionally, the subjects with asymmetry related to unilateral mastication were shown to have a lower orbit on the side of mastication, but the eyeball could be higher. Craniofacial growth is a complex mechanism that requires the interaction and coordination of several genetic, biological, and mechanical phenomena, among others [18]. The eye, along with other structures such as the superficial ectoderm and the forebrain, is an important organizer of craniofacial functions; therefore, more research is needed to understand not only how eye functions influence craniofacial growth but also to determine the relationship between the mechanical part of the eye and some human craniofacial anomalies [19]. On the other hand, it is known that the correct regulation of masticatory force and mandibular movements requires sensory input from periodontal mechanoreceptors, and the absence of these inputs leads to distorted control of masticatory movements.

Recently, Marrese et al. suggested that under specific indentation conditions, the retina perceives mechanical stimulation as a modulation of the visual input [20]. These findings coincide with the present work since patients with unilateral mastication have greater mechanical stimulation on the masticatory side, causing directional asymmetry of the jaw. In addition, this mechanical stimulation is related to greater visual acuity.

The results shown in the present study provide a better understanding of how the consequences of repetitive patterns during mastication can influence craniofacial aspects, particularly the sense of sight. Some studies corroborate this, evidencing the link between the stomatognathic and visual systems, starting with connections established during the embryonic period, as explained by [21]. Among the contributions of Dr. W. A. Simões is the decagon of functional priority, which exposes the undeniable relationship between different body structures during phases of growth, development, and function, impacting throughout the maturation phase and adulthood [22].

From another perspective, there are pathological conditions in which the visual aspect and the jaw are particularly affected. Some studies suggest that dental occlusion influences posture under specific conditions of movement, and causes fatigue and visual deprivation [23]. Certain characteristics have been reported that are part of some syndromes, such as degeneration of the facial nerve, which produces a simultaneous contraction of the orbicularis oculi muscle and the external pterygoid muscles as occurs with the Marin-Amat syndrome [24]. Another case is the Marcus-Gunn phenomenon, where the subject presents involuntary eyelid ptosis when mandibular movements are performed [25]. In the case of cherubism, the presence of facial deformity, malocclusion, alteration in the orbits, and visual disability have also been reported [26]. On the other hand, a study on 44 patients with hemifacial microsomia at the Philadelphia Hospital found that 67 % of the patients showed alterations in the eyes or their annexes. The authors considered these as novel findings since, on the one hand, these characteristics were not considered a part of this syndrome, and on the other, they found these manifestations even when the patients presented mild facial microsomia [27].

In the health area, ocular disorders of visual acuity and field alterations have been studied, and a high frequency of ocular convergence defects was confirmed. Even though a cause-effect relationship cannot be established, the level of evidence allows us to establish a correlation between ocular disorders (myopia, hyperopia, astigmatism, exophoria, and non-physiological gait due to ocular convergence defects), dental occlusion [28] and the mandibular conditions of lateral deviation in the case of asymmetry [29]. Recently, in the area of malocclusions, various studies have been carried out in which an association of the different types of malocclusions in the three planes of space with ocular disorders, such as ocular motility, astigmatism, myopia, and hyperopia, has been found [30]. Meanwhile, previous work carried out on pediatric patients in which a diagnosis of malocclusions was made reported the presence of a correlation between astigmatism and crossbite [31]. Later, a possible correlation between myopia and class II malocclusion was reported [32]; however, few references identify a repetitive pattern that relates both entities, as in the case of mastication. Regarding malocclusion in the vertical sense, [33] conducted a study in 2012 in which they analyzed the different ocular alterations in patients with malocclusion and found that subjects with a deep bite had a significant tendency to show esophoria, while patients with an open bite showed a significantly lower percentage. We agree with [34] that an integrated postural and occlusal approach could optimize the diagnosis and treatment of dental patients. With the results obtained, it is possible to provide more comprehensive treatment to patients who seek our care since, when our diagnosis is made, they can be referred to an ophthalmologic specialist promptly for treatment simultaneously with ours.

5. Conclusions

This preliminary work noted that there may be a relationship between individuals with asymmetry due to preferential chewing; a higher degree of visual acuity could be linked to their chewing side. This potential relationship is not observed in the group whose asymmetry does not arise from preferential chewing. However, a small sample size might influence these results. More research is necessary to substantiate the observations made in this study. Further investigations, increasing the number of cases, and using more accurate auxiliary diagnostic methods, such as CBCT, are essential.

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Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author contributions

Aidé Terán: conceptualization, data curation, formal analysis, investigation, methodology and ophthalmological studies, project administration, resources, supervision, validation, visualization, writing-original draft preparation, writing-review and editing. Amanda Zavala: data curation, investigation, methodology and ophthalmological studies, project administration, validation. Miguel Lloret: data curation, formal analysis, methodology and ophthalmological studies, project administration, resources, supervision, validation, visualization, writing-original draft preparation, writing-review and editing. Sergio Zavala: methodology and ophthalmological studies. Daniela Rubio: software, writing-original draft preparation. Maribel Liñán: software, visualization. Ariana Olamendi: investigation. Carlota García: resources, visualization.

Conflict of interest

The authors declare that they have no conflict of interest.

Ethics statement

The research adhered to all applicable laws and ethics standards. Permission for this investigation was granted by the Autonomous of Querétaro Medicine School Ethics Committee.

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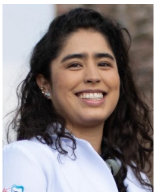

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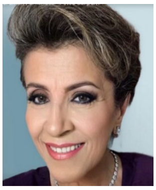

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