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ORIGINAL ARTICLE

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Variations in soft facial tissue by using the interocclusal stabilization splint: 3D stereophotogrammetry

Variações de tecido mole facial com o uso de placa interoclusal: estereofotogrametria 3D

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ABSTRACT

Objective: To analyze variations in soft facial tissue by using the interocclusal stabilization splint (ISS) through the 3D stereophotogrammetry technique in a group of young women with temporomandibular disorder (TMD). **Material and Methods:** 20 females between 20 and 60 years of age (39.3 ± 12.5) and TMD diagnosis based on the criteria of the RDC/TMD, received treatment with ISS. Reference points were marked on the face and photos were performed twice using the Vectra (M3–Canfield®): with and without ISS. In the 3D images the following variables were measured: area of the cheeks and lips (cm^3), linear labial distances (Ls-Cph, Cph-Ch, Li-Ch, Ls-Li, Ch-Ch), lower third of the face (Sn-Me), height of the upper lip (Sn-Ls)/lower (Li-Me) and the angles C-Sn-Ls, N-Sn-Pg and Li-Sl-Pg. The data were analyzed in a descriptive manner, the times with and without ISS were compared using the t-test and the Pearson's correlation was employed in order to correlate the ISS thickness with the facial measurements (5% significance). **Results:** A statistically significant difference was found only for the variables of the lip area ($p = 0.01$) and Ls-Li ($p = 0.006$) in comparison with/without ISS. No correlation was found between the ISS thickness and the lip area for both face sides, right ($p = 0.7$; $r = 0.07$) and left ($p = 0.9$; $r = -0.001$). **Conclusion:** The use of interocclusal stabilization splint does not provide large changes in facial morphology, with the exception of the lip area and height.

KEYWORDS

Dental occlusion; Occlusal splint; Photogrammetry; 3-Dimensional image.

RESUMO

Objective: Analisar as variações de tecido mole facial durante o uso de placa interoclusal estabilizadora (POE) por meio da técnica de estereofotogrametria 3D em um grupo de mulheres jovens com disfunção temporomandibular (DTM). **Material e Métodos:** 20 pacientes do gênero feminino, com idade entre 20 e 60 anos (39,3 ± 12,5) e diagnóstico de DTM com base nos critérios do RDC/TMD, receberam tratamento com POE. Foram então demarcados pontos de referência na face e realizada tomada fotográfica por meio do aparelho Vectra (M3–Canfield®) em dois momentos: com e sem placa. Nas imagens 3D foram mensuradas as seguintes variáveis: área das bochechas e dos lábios (cm^3), distâncias labiais lineares (Ls-Cph, Cph-Ch, Li-Ch, Ls-Li, Ch-Ch), terço inferior da face (Sn-Me), altura do lábio superior (Sn-Ls) e inferior (Li-Me); e os ângulos C-Sn-Ls, N-Sn-Pg e Li-Sl-Pg. Os dados foram analisados de forma descritiva, os momentos com e sem placa foram comparados por meio do Teste T-Student, foi também empregado o Teste de Correlação de Pearson, a fim de correlacionar a espessura da placa com as medidas faciais obtidas (significância 5%). **Resultados:** Foi encontrada diferença estatística apenas para as variáveis área do lábio ($p = 0,01$) e Ls-Li ($p = 0,006$) na comparação com/sem placa. Não foi encontrada correlação entre a espessura da placa e a área do lábio para ambos os lados da face, direito ($p = 0,7$; $r = 0,07$) e esquerdo ($p = 0,9$; $r = -0,001$). **Conclusão:** A utilização da placa oclusal não gera grandes alterações na morfologia facial, com exceção da área e altura de lábios.

PALAVRAS-CHAVE

Oclusão dentária; Placa oclusal; Fotogrametria; Imagem tridimensional.

INTRODUCTION

The quantitative analysis of the face is a tool for evaluating changes observed in an individual over time, or the variations of different individuals, allowing the planning and monitoring of various therapeutic modalities and verification of the results obtained. The scientific and technological advances, techniques such as laser scanning, MRI, ultrasound, scan for contact and stereophotogrammetry, they have become important tools in the diagnostic process, especially the face, because they are considered non-invasive analysis methods [1-3].

For a craniofacial analysis to be reliable, the accuracy and validity of the method used are indispensable, whatever the technique used for this reason [2,4-7]. Among the new facial analysis modalities, the stereophotogrammetry technique has excelled. The 3D image acquisition system and facial sculptor Vectra M3 (Canfield Scientific, Fairfield, NJ) consists of two capsules including three cameras (one color and two black and white) and a projector in each capsule. The system captures images in two dimensions of the individual's face and reconstructs them three-dimensionally. These 3D images can be processed, analyzed, manipulated and measured [1,7]. The possibility of handling the 3D image in different directions (front, side, inferior-superior, superior-inferior) allows several types of analysis of soft tissue are performed, among them we can highlight the measurement of linear distances, angles and areas.

In the dental area, the treatment modality used for temporomandibular disorders (TMD) is the interocclusal stabilization splint (ISS), which simulates an ideal occlusion and favors the relation condyle-fossa, reducing the symptoms. There is some controversy in the literature regarding the use of the ISS and its actual effect on TMD symptoms. Klasser and Greene pointed out that, considering all available data (pros and cons), the use of ISS in the management of localized masticatory myalgia, arthralgia or both is sufficiently supported by evidence in the literature [8]. The use of the device is easy to manufacture and install, and its action mechanism is the interruption of the precedent occlusal scheme and modification of the mandibular position [9]. In this sense, many types of splints were developed by therapeutic purpose for the TMD, among them the Michigan ISS is the most widely used and studied.

The effects of the ISS over the chewing muscles were also demonstrated in studies involving electromyography. Shan and Yun observed a decrease of electromyographic activity in the group with ISS, in comparison with the control group [10]. Nascimento et al. observed a reduction of signs and symptoms of TMD after the use of ISS for 60 days mainly in patients with severe symptoms [11]. Therefore, the ISS remains an excellent therapeutic option for patients with TMD, especially in the presence of myofascial pain in the masticatory muscles and bruxism. The use of ISS also involves adapting the stomatognathic system to a "foreign body", which in early stages can lead to aesthetic and functional changes such as changes in speech and excessive production of saliva, leading to discomfort for the patients.

Therefore, the aim of this study was to analyze the variations of facial soft tissue by using interocclusal stabilization splint through 3D stereophotogrammetry technique (M3 Vectra - Canfield®) in a group of young women with temporomandibular disorder.

MATERIALS AND METHOD

Study design

Interventional and cross-sectional study.

Research participants

A group of 20 volunteers with signs and symptoms of TMD were recruited for this study, the age ranged between 20 and 60 years, with a mean of 39.3 ± 12.5 years. Only women

were included in the study with a minimum of 26 teeth in their mouth and a TMD diagnosis established by the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) [12]. Were excluded individuals who had missing teeth, patients with central or peripheral neurological disorders, history of tumors, and trauma in the region of the head / neck and/or plastic or orthognathic surgery. Were also excluded patients who were in orthodontic treatment, users of partial or total dental prothesis. The Ethics Committee of the School of Dentistry of Ribeirão Preto (FORP/USP) approved this study, according to the protocol 08874612.3.0000.5419.

Procedures performed

The participants were submitted to a clinical dental care performed by dental surgeon trained and calibrated, with the objective to evaluate the overall oral condition. The RDC/TMD protocol was then applied for the establishment of the TMD diagnosis and began the process of making the ISS in accordance with the occlusal surface specificity of each patient. After the molding with irreversible hydrocolloid (alginate), the models obtained were mounted on a semi-adjustable articulator (Bioart®, São Carlos, São Paulo, Brazil). After the assembly process is began waxing the Michigan ISS with the canine guide. The models with the waxed plate were sent to the prosthesis laboratory of the School of Dentistry of Ribeirão Preto (FORP-USP) for the process of inclusion in acrylic resin and subsequent adjustments and installation.

The thickness of the ISS was measured with the aid of a proportional caliper and conforms to the recommended in the literature, around 3 mm. After this first step, the patient was positioned sitting with a headband, in order to ward off hair and ensure better visualization of the face the skin was cleaned with sterile gauze soaked in 70% alcohol, in order to remove any impurities, oiliness and makeup. Reference points were marked on the facial surface of the participants using black eyeliner (Boticário®, São José dos Pinhais, Paraná, Brazil), previously established by Ferrario et al. and Sforza et al. described below [13,14]:

1. Reference Points of the middle line: Tr, Trichion; N, Nasion; Prn, Pronasale; C, Columela; Sn, Subnasale; Ls, Labiale Superius; Sto, Stomion; Li, Labiale Inferius; Sl, Sublabiale; Gn, Gnation; Pg, Pogonion; Me, Menton. (Figure 1)

2. Bilateral reference points (right and left): Ftr and Ftl, Frontotemporale; Cphr and Cphl, Crista Philtri; Chr and Chl, Cheilion; Tr and Tl, Tragus; Gor and Gol, Gonion; Zyr and Zyl, Zygion; Chkr and Chkl, Cheek (Figure 2).

The images were performed in two moments: without ISS - with the patient in Maximum Habitual Intercuspation (MHI) (dental occlusion) and with ISS – with the patient in occlusion on the ISS. In the 3D image, the cheek areas were measured bilaterally in cm3, between the points T, Zy, Chk, Ch, Ng, and Go (Figure 3). The lip areas bilaterally (Ls, Cph, Ch, Li Sto) (Figura 4), three distances above the lip (Ls-Cph and Cph-Ch); sum between these two distances), distance of lower lip (Li-Ch), distance from the lip midline (Ls-Li). In addition to three linear measurements of the lips, comprising the upper lip (Sn-Ls) the lower lip (Li-Me), and measure the length of the lips (Ch right-Ch Left). The measurements were inspected for the lower third (Sn-Me) and measurements of the following angles: nasolabial (C-Sn-Ls), convexity angle of facial soft tissue profile without the nose (N-Sn-Pg), mentolabial angle (Li-Ps-Pg).

The data obtained were analyzed by means of descriptive statistics, in order to establish the average and standard deviation of linear distances, angles and areas, in addition to the Shapiro-Wilk Normality Test and Student's T-Test for data confrontation at times with and without the interocclusal plate. The Pearson's Correlation Test was also employed, in order to correlate the thickness of the plate with the facial measures obtained, in which a 5% significance level (Bioestat 5.0).

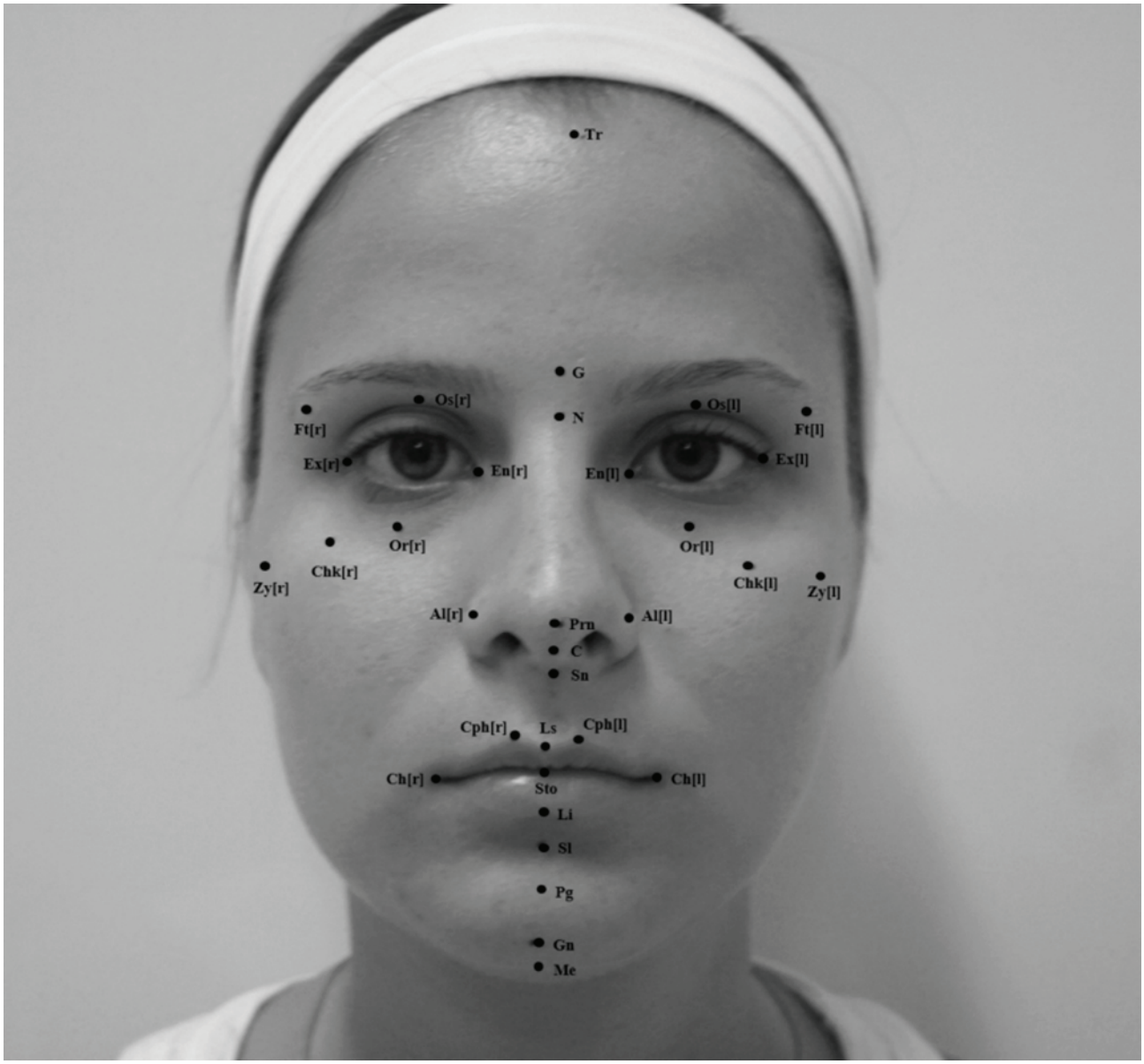


Figure 1 - Reference Points marked in the middle line, area of the eyes, cheeks, nose and lips: front view.

Figure 2 - Reference Points marked bilaterally in the face in the region of the eyes, nose, lips and ears: side view.

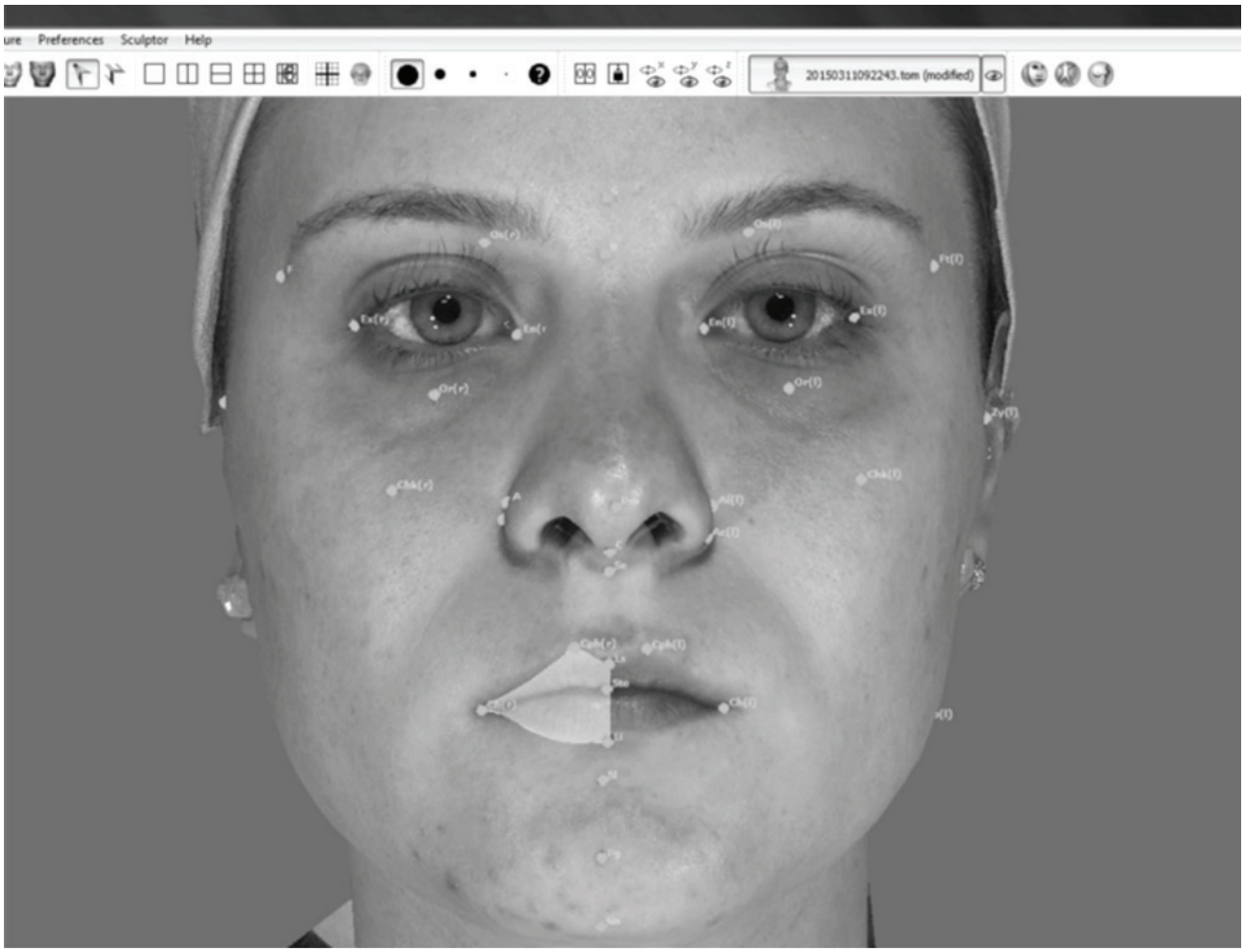


Figure 3 - Cheek areas (cm³), between the points T, Zy, Chk, Ch, Gn, Go.

Figure 4 - Lip area right side, between the points Ls, Cph, Ch, Li and Sto.

RESULTS

The mean values and standard deviation of bilateral variables are presented in Table 1 for the moments with and without ISS. They were compared for both sides' variations in facial morphology between MHI (without the ISS in position) and the ISS in position. There was a statistically significant difference only for the lip area ($p = 0.01$) for both sides, for the other variables assessed no significant difference was observed ($p > 0.05$).

The distances obtained from the mean line and the angles evaluated are shown in Table 2 (mean and standard deviation). In comparison with and without ISS there was a significant difference only for the distance Ls-Li ($p = 0.006$), which represents the height of the lip. It is important to point out that no difference was observed in the lower third of the face, both for Sn-Me ($p = 0.08$), as well as for Sn-Ls ($p = 0.37$) and Li-Me ($p = 0.88$). There was also no change in the length of the lip, since the p-value for Chr –Chl was 0.75, as well as for the facial angles C-Sn ($p = 0.4$), N-Sn-Pg ($p = 0.09$) and Li-Sl-Pg ($p = 0.20$).

Related with the thickness of the ISS, the anterior region showed higher value when compared to regions of molars right and left (Graph 1), and the average value of the thickness of the ISS was 3.3 (±1). The right and left sides were quite close, 3 (± 1.3) and 3.1 (± 0.9).

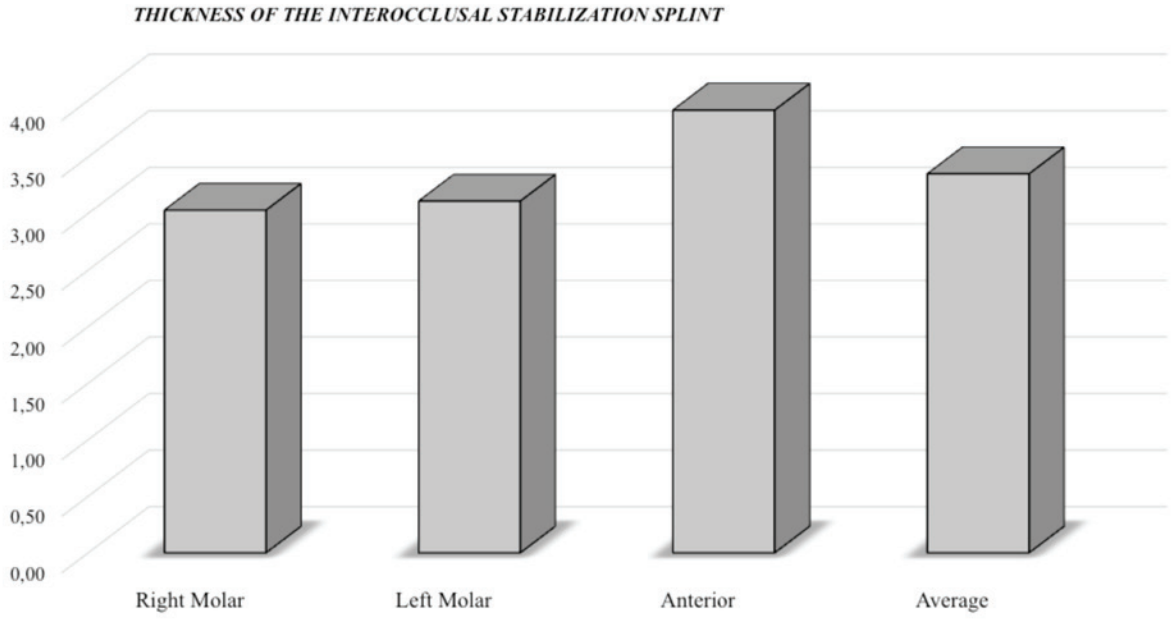
Table 1 - Average and standard deviation of the cheek area, lip area, Ls-Cph, Cph-Ch , Ls-Ch and Ch-Li for left and right sides and statistical comparison of moments with/without ISS - t test ($p < 0.05$).

	Without ISS		With ISS		P-value	
	Right	Left	Right	Left	Right	Left
Cheek area	58.1 (±7.4)	56.7 (±7.2)	57.1 (±6.5)	55.9 (±6.8)	0.65	0.72
Lip area	2.9 (±0.6)	2.8 (±0.5)	3.5 (±0.6)	3.4 (±0.7)	0.01*	0.01*
Ls-Cph	5.8 (±1.1)	6.2 (±0.8)	5.7 (±1.2)	6.1 (±0.8)	0.72	0.78
Cph-Ch	27.2 (±2.4)	26.4 (±2.6)	26.9 (±3)	26.2 (±3)	0.74	0.8
Ls-Ch	33.1 (±2.3)	32.6 (±2.4)	32.7 (±3)	36.1 (±3)	0.62	0.08
Ch-Li	28.9 (±2.8)	28.7 (±2.8)	28.9 (±3)	28.5 (±2.9)	0.98	0.81

Table 2 - Average and standard deviation of linear measurements Ls-Li, Sn-Me, Sn-Ls, Li-Me, Ch-Ch and angular measurements C-Sn-Ls, N-Sn-Pg, Li-Ps-Pg and statistical comparison of moments with/without ISS - t test ($p < 0.05$)

	Without ISS	With ISS	P-value
Ls-Li	14.5 (±2.7)	17 (±2.8)	0.006*
Sn-Me	65.1 (±4.5)	67.8 (±)	0.08
Sn-Ls	15.9 (±2.6)	16.6 (±2.3)	0.37
Li-Me	36.1 (±3.8)	36.3 (±4.5)	0.88
Ch_d-Ch_e	49.3 (±4)	48.9 (±4.3)	0.75
C-Sn-Ls	106.8 (±8.2)	108.6 (±6.6)	0.4
N-Sn-Pg	163.5 (±6.2)	160.4 (±5.6)	0.09
Li-Sl-Pg	143.6 (±13)	138.6 (±12)	0.20

Graph 1 - Average measurements of interocclusal stabilization splint thickness in occlusal regions of right molar, left molar and anterior (mm).



No correlation was found between the thickness of the ISS and the area of the lip to the sides of the face, right ($p = 0.7$; $r = 0.07$) and left ($p = 0.9$; $r = -0.001$), whereas the area of the lip was a variable that showed statistical significance in the comparison between the times with and without ISS, this variation cannot be attributed to the ISS thickness to the posterior region. There was also no correlation between the average thickness of the ISS and the extent of the lower third of the face ($p = 0.8$; $r = 0.04$), indicating to the maintenance of the vertical dimension (Table 3).

Table 3 - Average and standard deviation of linear measurements Ls-Li, Sn-Me, Sn-Ls, Li-Me, Ch-Ch and angular measurements C-Sn-Ls, N-Sn-Pg, Li-Ps-Pg and statistical comparison of moments with/without ISS - t test ($p < 0.05$)

	Right Side	Left Side	Anterior	Average
ISS Thickness	3 (±1.3)	3.1 (±0.9)	3.9 (±1.4)	3.3 (±1)
Lip area	3.5 (±0.6)	3.3 (±0.7)	_	_
Lower Third of the face	_	_	_	67.2 (±4.7)
P-value	0.7 (r=0.07)	0.9 (r=-0.001)		0.8 (r = 0.04)

DISCUSSION

The stereophotogrammetry is the system of three-dimensional image more promising for accurate diagnoses and evaluations of the face. The development of three-dimensional models of the face was one of the ways to overcome the limitations of traditional methods of soft tissue evaluations. For both, the method with the highest clinical applicability is currently digital stereophotogrammetry. The rapid acquisition of images, the accuracy, and the non-invasive are the advantages found in the system employed in this study VECTRA M3 [15]. This technology is capable of improving the assessment and quantification of therapies in the treatment of TMD. Thus, it is possible to install an ISS and assess whether there have been changes during and after the use of the same, as regards the facial measures and the aesthetic aspect of the patient.

Knowledge of the occlusion is of paramount importance for many areas in Dentistry, among which stand out the oral rehabilitation, restorative dentistry, orthodontics and functional orthopedics of the jaws. The majority of the analyses that are carried out for plans dental interventions are based on images of hard tissues (x-rays, computed tomography, cephalometries). However, it is important to point out also the importance of evaluating the soft tissue, because this represents the facial appearance of each individual.

The ISS, regardless of the type has three effects: modify the vertical dimension by changing the resting length of the fibers of the masticatory muscles, changes the spatial relationship between the condyles and the joint cavity, effects on proprioception and posture of the head and neck. It is critical; therefore deduce that the objective of the treatment directed to one of the effects will involve the other two. The ISS will always have an impact on the three effects. The control of these effects is the key to the success of the treatment [16].

With the mandible in the physiological rest position, there is a vertical space between the occlusal surface of the maxillary and mandibular teeth is called, functional free space (FFS), which ranges from 0.5 to 5.4 mm in the dentate and 1.10 to 5.2 mm in edentulous patients [17]. It is extremely important to accurately determine the vertical dimension of rest (VDR) because it is through it that we find the measure of the vertical occlusion dimension (VOD) approximate the patient by subtracting the value of the FFS, but the great difficulty is precisely the variability of VDR due to the aforementioned factors and the average FFS which is also very variable [18].

Rehabilitative procedures are increasingly used in the dental clinic in order to return the function, aesthetics and comfort to patients. With the increase of the complexity of the cases, the aspects related to the restoration of the occlusion of the patient need to be observed, among them the VOD restoration, defined as the vertical distance between two points, one in the maxilla and mandible, when occlusal surfaces are in contact [19].

For that there is a change in the VOD, is by a decrease or increase, some aspects should be initially observed, such as loss of containment back, tooth wear, phonetic evaluation with the use of sounds wheezing, distance interocclusal and the facial appearance [20]. The decrease in the VOD can be related mainly to the wear or absence of dental elements, and its increase by making poorly executed prosthetic work [18]. The damage caused by these changes are diverse and generally relate to aesthetic problems, dental phonetic, swallowing, muscle and joint in the periodontal and postural [21]. Among the methods of determining the VOD, the most commonly used are the metric, the phonetic and the facial proportions, being that they all have limitations; and should be used to reduce the possibility of errors.

One way to minimize the limitations of two-dimensional analysis of the soft tissues of the face is the digital stereophotogrammetry. The analysis of three-dimensional stereophotogrammetry models can be made by means of linear measurements, angular, volume or area and/or comparison of points of reference patterns or of the face. The quality of the results of the study in question will be better; the more relevant points are addressed in a model [22,23]. In this study, linear measurements, angle and area were addressed.

However, there is a need for further studies with long-term follow-up; the protocols for the assessment of facial asymmetries in TMD patients are in the majority, carried out by means of the cephalometric evaluation, which enables one to view, measurement and analysis only of hard tissue. The facial analysis through stereophotogrammetry has been used recently, not exposing the subject to harmful radiation, in addition to promote the evaluation of soft tissues of the face.

CONCLUSION

The use of the ISS does not generate large changes in facial morphology, with the exception of the area and height of lips, being that these changes cannot be attributed to the thickness of the occlusal ISS direction. Most likely, they are related in the thickness direction vestibular-palatal in the anterior region of the ISS, although more facial analysis studies are needed to confirm these findings.

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