

# Effectiveness of the Semi-Adjustable Articulator Compared to Clinical Examination

## Eficacia del Articulador Semiajustable en Comparación con el Examen Clínico

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**ABSTRACT:** This work aims to verify the effectiveness of the semi-adjustable articulator (SAA) when compared to a clinical examination of samples in individuals comparing the number of occlusal interferences. The research was carried out at FAESA (Integrated University of São Pedro), in which two independent researchers compared occlusal interferences in protrusion and laterality movements in the clinical examination and in models mounted on a semi-adjustable articulator, with carbon from Baush, in 77 patients who attended to the graduation clinic. Data were tabulated and evaluated by the Mann-Whitney statistical test and data normality was verified by the Kolmogorov-Smirnov test. When analyzing the interference of protrusion on central incisors, it was found that the mean was higher for the SAA on clinical examination. As for the right laterality in the canine guides, it was observed that the clinical examination had a higher interference average in relation to the SAA. The same was true for left laterality, where the mean interference was also higher for the clinical examination. That is, by increasing the values of occlusions in the SAA, the values of occlusions in the clinical examination also increase. As central incisor protrusions between the SAA and clinical examination were moderately positive, there was a strong positive relationship for the right sides and a moderate positive relationship for the left sides. It is concluded that a semi-adjustable articulator is an effective tool for the diagnosis and planning of the dentist, due to its ability to simulate mandibular movements. However, such a tool requires prior knowledge for an ideal assembly for treatment success.

**KEY WORDS:** dental articulators, functional laterality, effectiveness.

## INTRODUCTION

The occlusal analysis is based on a therapeutic procedure that proposes, when necessary, changes in dental surfaces, restorations, or prostheses, being one of the essential techniques for stomatognathic diagnosis and prosthesis construction (Jeong *et al.*, 2020). Performing occlusal adjustment during dental appointments is an essential step, as the number of occlusal contacts and occlusal contact areas are

related to the effectiveness of the patient's chewing (Lujan-Climent *et al.*, 2008; Jeong *et al.*). In addition, the presence of premature contact or occlusal interference can induce changes in the masticatory muscles, temporomandibular joint, cementum, periodontal ligament, and alveolar bone, impairing the patient's function (Koh & Robinson, 2004; Ishigaki *et al.*, 2006; Jeong *et al.*).

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For this, the articulator plays a fundamental role in the diagnosis and occlusal analysis and its main purpose is to observe and simulate occlusal relationships, record the axis of rotation of the mandible with the upper and lower teeth (Frankfurt Plan), in order to adapt the esthetics and patient occlusion (Wise, 1982; Hayashi *et al.*, 1994). There are several types of articulators in the dental market. Among them, semi-adjustable (SAA) stands out due to their affordable cost and efficient results. The SAA simulates the beginning and end of the movement of the condyles, in a straight line (Schwartz, 1959; Todescan, 1996). Arcon type articulators, on the other hand, have the condylar elements attached to the lower limb of the instrument, in the same way, that the condyles are attached to the mandible. And to represent the glenoid fossa, the condylar guide is attached to the superior branch of the articulator (Todescan).

In addition to the use of articulators, another viable alternative to perform occlusal analysis and dental relationship in order to rehabilitate a dental group is to evaluate the stomatognathic system through a clinical evaluation (Santos JR, 1998). To assess the stomatognathic system, anamnesis begins by interrogating general clinical manifestations, personal and family history. Then, there is a general physical examination, checking data such as temperature, heart rate, and blood pressure. Then, an inspection of the head and neck is carried out, with palpation of the muscles and lymph nodes. The intraoral examination checks the salivary glands, gums, oral mucosa, teeth, and tongue, in addition, during the intraoral examination, the occlusal relationship of the teeth is analyzed (Campana, 2010).

Knowing this, this work aims to verify the effectiveness of the semi-adjustable articulator when compared to a clinical examination from samples in individuals evaluating the amount of occlusal interference

## MATERIAL AND METHOD

This study is a research approved by the Ethics and Research Committee (ERC) of Faculdades Espírito Santense (FAESA) (number 4.754.054). 77 students from the 5th period of Dentistry participated in this study. There was no need to calculate a sample since in this period there were three classes (5th period) and from these, the occlusions were collected in the clinical and

articulating examination of all, thus characterizing a population with the inclusion and exclusion criteria in force.

**Mounting in an articulator on the patient:** A BioArt A7 plus semi-adjustable Arcon type articulator was used (São Carlos, São Paulo, Brazil). The assembly started with bite registration with a low fusion compound positioned on the fork at three points, so that one point is anterior, located right in the center of the fork, and the other two in the posterior region. When taking the fork to the patient, it was centered with the patient's midline, as the fork was settled on the upper teeth and fixed bi-digitally until the final set of the material. To confirm the purpose of the record, it was checked on the patient's model.

To assemble the facebow, the patient remained seated, keeping the fork in the same position with the thumbs resting against the maxilla. The facebow was positioned together with the attachment on the bite fork shaft so that one attachment butterfly was facing downwards and the other to the side. Then, the facial bow auricles were inserted in the patient's external auditory meatus, to later adapt the nazium rapporteur to the arch's crossbar, centered and supported on the patient's glabella. The three standard bow fastening screws were also properly adjusted. Once this was done, the fork clamping assembly was pushed until it was closest to the lip, and then the vertical shaft and horizontal shaft butterflies were adjusted.

To prepare the articulator, the Bennett angle was adjusted to 15 degrees and the angle of the condyle guide to 30 degrees. With the articulator locked, the facebow was positioned in union with the superior branch of the articulator by means of small pins located on the external face of the condyle guides, fitting into the orifices of the auricles. The front part of the superior branch of the articulator was supported on the crossbar of the arch. Then, the facebow was firmly closed and its central fixation screw tightened, positioning the bow and the upper branch over the lower branch of the articulator.

**Assembly of models in Articulator.** The upper type IV plaster model (dent-mix 4 ASFER, São Caetano do Sul, São Paulo, Brazil) was prepared with retentions and previously hydrated, to be positioned on the fork register. The upper branch of the articulator was lifted to place a portion of plaster on the model and another small amount of plaster on the mounting plate of the upper branch.

The fork and model were fixed in position to prevent any movement. The articulator was closed until the upper branch touched the crossbar of the facial bow, waiting for the final set of the plaster. To assemble the lower model in the articulator, it was necessary to have a record that relates the upper and lower dental arches, according to the Maximum Habitual Intercusation (MHI). The incisal pin was positioned in the superior branch of the articulator, with its tip rounded down so that the superior and inferior branches are parallel, that is, at the zero marks. Then, the articulator was positioned "upside down" on the table to seat the lower model, previously hydrated and with retentions, on the upper model. An elastic band was used to secure the models so that they remain in position during the crystallization of the plaster. In the same way, as described for the upper model, the lower model was also assembled.

All condylar elements were fitted to the condyle guides and the articulator closed until the incisal pin touched the incisal table. Then it was necessary to fix the articulator branches with an elastic band to prevent possible distortions caused by the expansion of the plaster. After setting the plaster, the articulator returned to its normal position (lower branch supported on the laboratory table).

**Occlusal relationship analysis.** Occlusal registration was performed with Miller forceps and Bausch carbon (Dr. Jean Bausch KG/Oskar-Schindler-Str. 4, Germany). The patient seated at 90° performed the movements of protrusion, left laterality, and right

laterality with the carbon in the mouth, the same movements were also reproduced in the models of these same patients that were mounted on the SAA. A comparison of the two methods was recorded by two independent evaluators of each of the 77 patients examined, observing the existence or not of occlusal interference.

## RESULTS

The occlusal interference in the protrusion movement was higher on average for the SAA (mean=2.40, SD ± 2.28) than in the clinical examination (mean=1.91; SD ± 2.03). For the right lateral movement, it was observed that the highest mean of occlusal interference was for the clinical examination (mean=2.06; SD ± 1.93) compared to the SAA (mean = 1.77; SD ± 1.71), and the same occurred for the left lateral movement, where the highest mean of occlusal interference was for the clinical examination (mean = 1.91; SD ± 1.82) compared to the SAA (mean = 1.58; SD ± 1.63) (Table I).

The Kolmogorov-Smirnov test rejected the null hypothesis of normality ( $p < 0.050$ ), so the best technique to be used is the non-parametric one (Table II).

The Mann-Whitney test did not show significant differences ( $p > 0.050$ ) in the medians of the protrusion movements, right and left lateralities between the SAA and the clinical examination (Table III). In Table III this

Table I. Description of occlusal interferences from SAA movements and clinical examination.

		Minimum	Median	Maximum	Average	Standard deviation
Protrusion	SAA	0.00	2.00	11.00	2.40	2.28
	Clinical examination	0.00	1.00	10.00	1.91	2.03
Right laterality	SAA	0.00	1.00	7.00	1.77	1.71
	Clinical examination	0.00	1.00	7.00	2.06	1.93
Left laterality	SAA	0.00	1.00	7.00	1.58	1.63
	Clinical examination	0.00	1.00	9.00	1.91	1.82

Table II. Kolmogorov-Smirnov normality test.

		Statistic	df	p* value
SAA	Protrusion	0.181	77	< 0.001
	Right laterality	0.271	77	< 0.001
	Left laterality	0.250	77	< 0.001
Clinical examination	Protrusion	0.209	77	< 0.001
	Right laterality	0.216	77	< 0.001
	Left laterality	0.237	77	< 0.001

SAA - Semi-adjustable articulator; (df) Degrees of freedom; (\*) Kolmogorov-Smirnov normality test

occurs, so the conclusion is that the medians of the SAA and the clinical examination are similar, that is, the number of occlusal interferences in the SAA is similar to the number of occlusal interferences in the clinical examination. Thus, when relating the movements in the SAA and in the clinical examination, it is affirmed that it was positive, the SAA is effective, its use prior to the clinical examination will provide a basis for occlusal or non-occlusal interferences of the patient in a safe and positive way.

There was a relationship between movements in all comparisons evaluated between the SAA and the clinical examination (Table IV). Thus, there was a moderate positive correlation ( $r = 0.601$ ;  $p < 0.001$ ) of central incisor protrusions between the SAA and the clinical examination (Fig. 1). As for the right laterality relationship, there was a strong positive relationship ( $r = 0.836$ ;  $p < 0.001$ ) (Fig. 2) and for the left laterality there was a moderate positive relationship ( $r = 0.699$ ;  $p < 0.001$ ) (Fig. 3).

Table III. Comparison of medians of protrusion occlusions, right and left lateralities between the SAA and clinical examination.

		Median	p* Value
Protrusion	SAA	2.00	0.179
	Clinical examination	1.00	
Right laterality	SAA	1.00	0.427
	Clinical examination	1.00	
Left laterality	SAA	1.00	0.262
	Clinical examination	1.00	

SAA - Semi-adjustable articulator; (\*) Teste de Mann-Whitney

Table IV. List of protrusion occlusions, right and left lateralities between the SAA and clinical examination.

			Clinical examination		
			Protrusion	Right laterality	Left laterality
SAA	Protrusion	Valor $\rho^*$	0.601 <b>&lt; 0.001</b>		
	Right laterality	Valor $\rho^*$		0.836 <b>&lt; 0.001</b>	
	Left laterality	Valor $\rho^*$			0.699 <b>&lt; 0.001</b>

SAA - Semi-adjustable articulator; ( $\rho$ ) Spearman's correlation (rho)

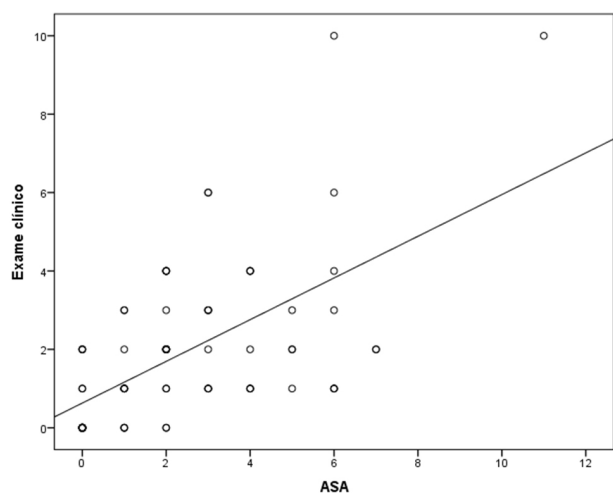


Fig. 1. Correlation of central incisor protrusion occlusions between SAA and clinical examination.

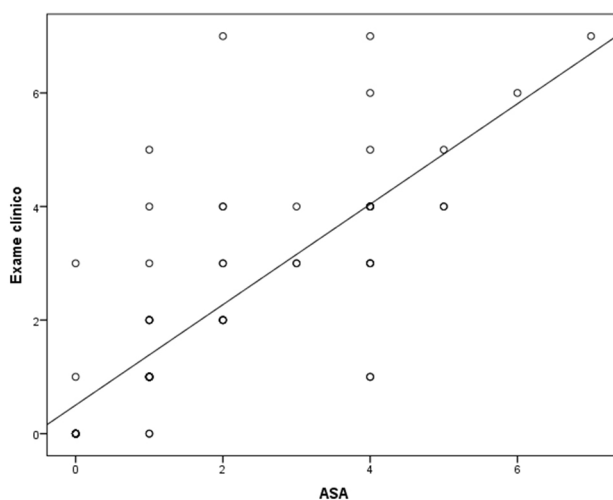
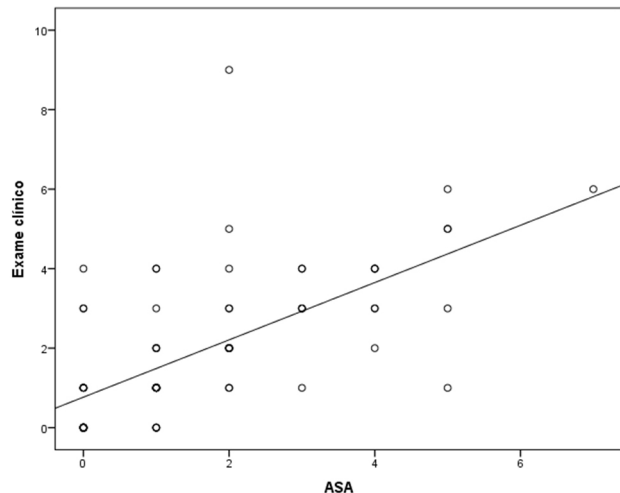


Fig. 2. Correlation of occlusions of the right laterality of the canine guides between the SAA and the clinical examination.



## DISCUSSION

The results of this study showed that there were no statistical differences between the medians of the protrusion and lateral movements (right and left) between the semi-adjustable articulator and the values obtained in the clinical examination, being similar in the number of occlusal interferences. Such results do not corroborate the study by Dos Santos Júnior & Ash Jr. (1998), where they observed that the values recorded from the articulators were in 50 % of the cases higher than the values obtained directly from the patient, which can be explained by the longer intercondylar distance accepted by the SAA.

Currently, digital images obtained from intraoral scanning have been used to analyze the state of occlusal contact. However, the digitization of the entire dental arch requires technical capacity, which when not achieved can lead to errors in obtaining these images, which usually occur due to the presence of accentuated curves, such as in the distal portions of molars and the incisal portions of the anterior teeth. These requirements can lead to light diffraction during intraoral scanning, as described by Lee *et al.* (2018), who concluded that digital occlusal analysis can be used for diagnostic purposes, but software limitations should be considered for clinical use, as well as the scanning technique employed.

What was also reported by Solaberrieta *et al.* (2015), who compared the occlusal contacts of plaster

casts with those obtained using three different software, observed that the occlusal contacts changed according to the software used. Thus, the use of SAA in the identification of occlusal interferences becomes indispensable, and it can be used even before the clinical examination, speeding up the diagnosis.

Given the above data, it is possible to see that the semi-adjustable articulator combined with the clinical examination is an important tool for occlusal analysis, diagnosis, and treatment plan, being able to reproduce protrusion and lateral movements similar to those performed by the patient, which allows performing prosthetic work under biological and functional principles (Amin *et al.*, 2019; Buduru *et al.*, 2020).

It can be concluded that the semi-adjustable articulator is considered an effective instrument when compared to the clinical examination for the diagnosis and dental planning of the patient.

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**RESUMEN:** Este trabajo tuvo como objetivo verificar la efectividad del articulador semi-ajustable (SAA) cuando se compara con un examen clínico de muestras en individuos de acuerdo al número de interfecciones oclusales. La investigación se llevó a cabo en FAESA (Universidad Integrada de São Pedro), en la que dos investigadores independientes compararon las interfecciones oclusales en los movimientos de protrusión y lateralidad en el examen clínico y en modelos montados en un articulador semiajustable, con carbón de Baush, en 77 pacientes que acudieron a la clínica de graduación. Los datos se tabularon y evaluaron mediante la prueba estadística de Mann-Whitney y la normalidad de los datos se verificó mediante la prueba de Kolmogorov-Smirnov. Al analizar la interfección de la protrusión en los incisivos centrales, se encontró que la media era mayor para el SAA en el examen clínico. En cuanto a la lateralidad derecha en las guías caninas, se observó que el examen clínico tuvo un promedio de interfección más alto en relación al SAA. Lo mismo ocurrió con la lateralidad izquierda, donde la interfección media también fue mayor para el examen clínico. Es decir, al aumentar los valores de oclusiones en el SAA, también aumentan los valores de oclusiones en el examen clínico. Como las protuberancias de los incisivos centrales entre el SAA y el examen clínico fueron moderadamente positivas, hubo una fuerte relación positiva para los lados derechos y una relación positiva moderada para los lados izquierdos. Se concluye que un articulador semi-ajus-

table es una herramienta eficaz para el diagnóstico y planificación del odontólogo, debido a su capacidad para simular movimientos mandibulares. Sin embargo, tal herramienta requiere conocimientos previos para un montaje ideal para el éxito del tratamiento.

**PALABRAS CLAVE: articuladores dentales, lateralidad funcional, efectividad.**

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