DENTAL MEDICINE

Clinical occlusion analysis versus semi-adjustable articulator and virtual articulator occlusion analysis

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Abstract

Background and aims. Identifying the optimal method for occlusion analysis by comparing examination sensitivity of the static and dynamic occlusion using three systems: clinical occlusion analysis, semi-adjustable articulator and virtual articulator (3Shape, Denmark) occlusion analysis.

Methods. The occlusion analysis of sixteen patients was performed using the three systems. In order to analyze the number of concordant and discordant points and trajectories, the clinical method was compared to the semi-adjustable articulator and to the computerized method.

Results. The greatest correspondence was obtained by comparing the clinical and the articulator methods, having a success rate of 85.25%, versus the clinical and the computerized method with a success rate of 73.25%. The propulsion registered the highest discrepancies: 35% in case of the semi-adjustable articulator comparison and 62% in case of the virtual articulator comparison.

Conclusions. The semi-adjustable articulator was superior in static and dynamic occlusion analysis compared to the virtual articulator. The analysis of the dynamic occlusion is the most problematic due to its dependency on the individual anatomy of the glenoid fossa which cannot be exactly reproduced by any articulator.

Keywords: occlusion analysis, semi-adjustable articulator, 3Shape

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Background and aims

Nowadays, occlusal analysis has gained more attention among specialists, due to the indispensable necessity of adapting intra-oral restorations according to functional and biologic principles [1,2]. Without an in-depth analysis of occlusal contacts, the risk of iatrogenic occurrences rises exponentially. Currently there are a number of methods of performing a complex and detailed occlusal analysis. Although many practitioners use mechanic articulators in obtaining prosthodontic restorations [3-6], computerized diagnostic methods are gradually but definitively entering the dental field to a greater degree every day [7,8]. Numerous comparative studies between different occlusion analysis methods have been performed, often obtaining contradictory results. Thus, a consensus regarding an ideal diagnostic method is not yet to be found in literature [9-13]. The aims of this study were to compare three different occlusal analysis methods that are currently being used in the daily practice, to identify the most accurate method and to observe if a single method is enough for obtaining precision.

Methods

The static and dynamic occlusion of sixteen subjects, 4th year Dental Medicine students, aged between 22-25 years, were analyzed using the three different methods. Static occlusion was analyzed by the means of the maximum intercuspation and dynamic occlusion by the analysis of propulsion and left and right lateral movements. The inclusion criteria were: stable occlusion, with multiple occlusal contacts in the frontal and lateral areas; at least 12 dental units on each arch (excepting the third molar); no ongoing orthodontic treatment; no extensive prosthodontic treatment; healthy periodontium; no other diseases. The exclusion criteria were: frontal or lateral open bite, extensive edentulous spaces, more than two missing dental units, with or without prosthodontic restorations; ongoing orthodontic treatment; anterior crossbite; extensive prosthodontic treatment; periodontal pathology (tooth mobility, periodontal pockets, periodontitis); temporomandibular disorders (joint or muscle involvement).

The first analysis method was the clinical occlusion analysis, using intra-oral blue and red 200 μm-thick occlusion paper (Bausch, Germany).

The second method implied using the semi-adjustable articulator Bio-Art A7 Plus together with the Elite face bow (Bio-Art). Stone casts were mounted and occlusion analysis was performed using blue and red 200 μm-thick occlusion paper (Bausch, Germany).

The third method was performed using the virtual articulator Bio-Art A7 Plus and intra-oral scanning with the 3Shape TRIOS® scanning system and virtual casts. The clinical occlusion analysis was performed by applying blue 200 μm-thick articulating paper on the mandibular arch and points in maximum intercuspation were marked. Red articulating paper was used for registering the propulsion and lateral movements paths and also active and passive interferences. Data was recorded by taking photographs of the dental arches (Figure 1, 2).

Figure 1. Contacts in left lateral movement on the upper arch.

Figure 2. Contacts in left lateral movement on the lower arch.

For the second analysis method, impressions were taken using alginate (Cream alginate, Cavex), in standard perforated metallic trays. Casts were poured immediately using class IV hard cast (Class IV Hinriplast, Ernst Hinrichs) and mounted using the semi-adjustable articulator Bio-Art A7 Plus (which is of Arcon-type). The Elite face bow was used (Bio-Art). Stents (Spofa Dental) was used for marking teeth impressions on the occlusal fork. Propulsion was performed and occlusion wax was used for registering the eccentric movement for programming the sagittal condylar inclination. Left and right lateral movements were performed and occlusion keys were used for programming the Bennett angles. After casts mounting and articulator programming, occlusion paper was used for recording the occlusal points and paths (Figure 3,4).

Figure 3. Upper arch paths during left lateral movement using the semi-adjustable articulator.

Figure 4. Lower arch paths during left lateral movement using the semi-adjustable articulator.

The third analysis method used intra-oral scanning and virtual casts. For correct arch setting, the maximum intercuspation (MI) was scanned as a reference position. The programming of the virtual articulator Bio-Art A7 Plus in the 3Shape system was performed using the registered values obtained using the semi-adjustable articulator. MI position and the movement paths were digitalized (Figure 5,6).

All obtained points and movements using the three methods were individually compared. Correlation between clinical analysis and semi-adjustable articulator, as well as between clinical analysis and virtual articulator for each parameter was calculated: the anterior areas, the lateral areas and also overall.

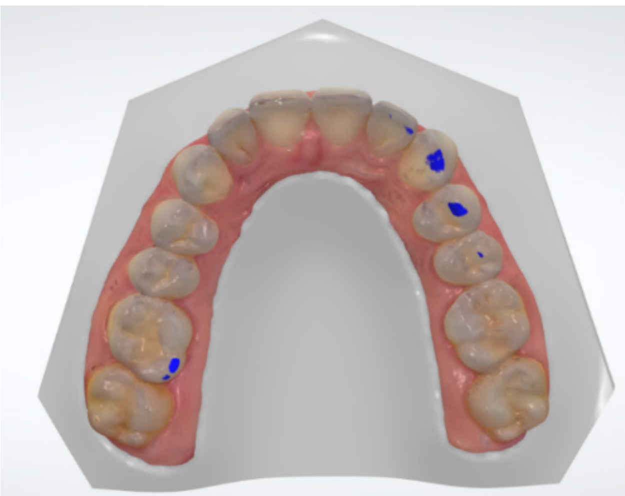

Figure 5. Left lateral movement on the upper arch using the virtual articulator.

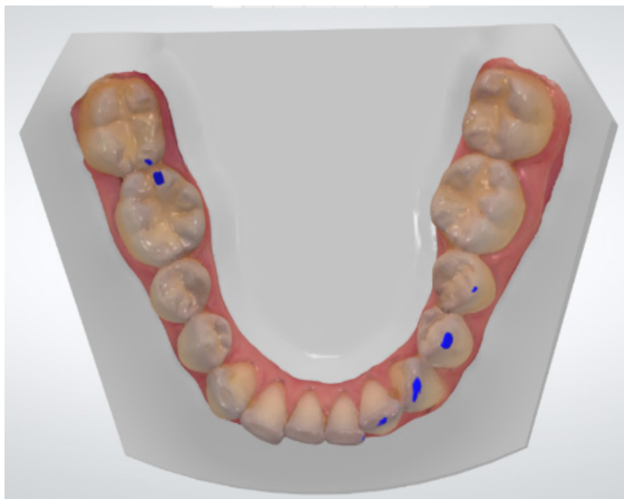

Figure 6. Left lateral movement on the lower arch using the virtual articulator.

Table I. Comparison between the semi-adjustable articulator and clinical status on teeth groups.

Frontal			Lateral		
	Concordance	Disparity		Concordance	Disparity
Maximum intercuspation	280	50	Maximum intercuspation	1002	201
Propulsion	234	30	Propulsion	43	23
Right lateral movement	95	17	Left lateral movement	110	26
Left lateral movement	94	13	Right lateral movement	148	46

Table II. Comparison between the virtual articulator and clinical status on teeth groups.

Frontal			Lateral		
	Concordance	Disparity		Concordance	Disparity
Maximum intercuspation	271	59	Maximum intercuspation	1033	155
Propulsion	208	32	Propulsion	35	57
Right lateral movement	94	18	Left lateral movement	68	69
Left lateral movement	84	27	Right lateral movement	118	62

Table III. Comparison between the semi-adjustable articulator and the virtual articulator with the clinical situation, globally.

Semi-adjustable articulator			Virtual articulator		
	Concordance	Disparity		Concordance	Disparity
Maximum intercuspation	1280	251	Maximum intercuspation	1304	214
Propulsion	277	53	Propulsion	243	89
Right lateral movement	205	43	Left lateral movement	162	87
Left lateral movement	242	59	Right lateral movement	202	89

Results

Comparison of the points and trajectories between clinical analysis and semi-adjustable articulator in maximum intercuspation, propulsion, left and right lateral movements are presented in table I. Comparison between the clinical analysis and the virtual articulator is displayed in table II. Overall outcome between both articulators and clinical status is presented in table III.

When evaluating the anterior and lateral movements, teeth involved into the movement, and passive sides were taken into consideration (possible premature contacts or interferences, respectively). The movements were globally assessed (guiding teeth or interfering teeth were considered).

Our data suggest that the maximum intercuspation position is most precisely represented in case of the both articulators compared to the clinical situation, when comparing teeth groups, with a mean success rate of 84%. Conversely, the dynamic occlusion shows errors in identifying passive interferences, especially in the propulsive movement (errors up to 62% for the virtual articulator). The most discrepancies between the clinical situation and the semi-adjustable articulator were encountered during propulsion in the posterior area (35%, table I). The greatest discrepancies occurred when comparing the virtual articulator with the clinical situation, on teeth groups, in the posterior area during propulsion (65%, table II). Globally, the greatest discrepancies were found during the left lateral movement, both for the semi-adjustable articulator (20%), as well as for the virtual articulator (31%). A great difference between the two articulators during lateral movements was encountered: 31-35% for the virtual articulator and 17-20% for the semi-adjustable one. Altogether, the parameters examined using the semi-adjustable articulator overlapped in a percentage of 82.75% with the clinical situation. Alternatively, the virtual articulator showed a lower success rate in correct detection of the parameters, namely of only 73.25%.

Discussion

The most trustworthy values have been encountered for the maximum intercuspation position, a static relation, for both articulator types. The differences with the clinical situation can be explained in the literature due to the periodontal resilience [14] or due the number of roots. In a clinical situation in which an associated periodontal disease could be encountered, a degree of apical and marginal inflammation should also be considered as a contributing factor. The significantly greater differences obtained during the frontal and lateral movements, when using the semi-adjustable articulator, when compared to the maximum intercuspation position, can be explained by the dependence upon the individual anatomy of the slopes of the articular tubercle and of the condyles. Articulators cannot precisely render the anatomy of the area, nor can they reproduce the individual anatomy of each patient, which can lead to errors that cannot be completely eliminated by any method [13]. Besides, the Bio-Art A7 Plus articulator has a fixed, non-adjustable inter-condyle distance of 110 mm, which can modify the course of the lateral movements. Another directly influencing factor is the clinician's or technician's experience, who mounts the casts using the semi-adjustable articulator. The differences when using the virtual articulator emerge prevailingly during dynamic occlusion, which can be due to the lack of a virtual face bow. These drawbacks can be solved by scanning the dental arches and combining them together with a cone beam computed tomography (CBCT). This way the arches could be correctly three-dimensionally oriented in the virtual articulator. However, the ALARA principle must be respected [15].

Caro et al., studying the clinical occlusion analysis versus the occlusion obtained using the semi-adjustable articulator by means of two methods (occlusion impressions or axiography), concluded that using axiography is a more precise way of determining dynamic occlusion (propulsion, lateral movement) [16]. Mounting the casts using the semi-adjustable articulator using occlusion impressions had a lower reproducibility rate [17].

Contrary to our results, DeLong et al., when comparing the computerized method to the clinical one [18], respectively to the semi-adjustable articulator [19], showed the supremacy of the computerized one.

Solaberrieta et al., compared the occlusal contacts on stone casts with those obtained using three different software programmes after scanning the casts. The authors found that the contact points acquired using virtual casts had higher accuracy compared to those on stone casts, depending widely upon the used software [20]. These data could indicate the fact that the differences encountered in our study could be the result of an interdependency between the limits of the software and the limits of the practitioner.

Regarding the 3Shape system, Lee et al., determined the accuracy of the occlusal contact areas between stone casts mounted in an articulator and virtual scans obtained with the 3Shape system. The authors concluded that computerized occlusal analysis can be used for diagnostic purposes, but the software limitations have to be considered for clinical use, as well as the scanning technique which must be developed [21].

Conclusions

Overall, the semi-adjustable articulator is a useful tool for occlusal analysis, but the practitioner must strictly adhere to the usage protocol and cast mounting. Although this study revealed great differences compared to the semi-adjustable articulator, the occlusal analysis using the virtual articulator embodies the future of dentistry, therefore software improvements regarding data transfer are mandatory.

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