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ORIGINAL RESEARCH

Evaluation of Occlusal Contacts among Different Groups of Malocclusion using 3D Digital Models

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ABSTRACT

Objectives: (1) To evaluate the applicability of using 3D digital models in the assessment of the magnitude of occlusal contacts by measuring occlusal contact surface areas (OCSAs) and 3D mesh points in 'contact' (OCMPs) in a sample of orthodontic patients; (2) To detect any sex differences in the magnitude of occlusal contacts in all malocclusion groups; (3) To detect inter-group differences; (4) To assess possible correlations between occlusal contacts and other dental characteristics.

Materials and methods: Study casts of 120 malocclusion patients were selected and divided into 4 groups (class I division 1, class II division 1, class II division 2, class III) with equal numbers for both sexes. 3D digital models were produced using O3DM™ technology. Occlusal contacts were quantified using two methods of measuring.

Results: (1) No significant sexual differences were detected for OCMPs (mesh points) and OCSAs (mm^2) in all groups. (2) There were statistically significant differences among malocclusion groups for OCMPs and OCSAs ($p < 0.001$). Tukey's HSD post-hoc tests showed that class III patients had significantly less occlusal contacts than other malocclusion groups. (3) Stepwise multiple regression equations showed that overjet, lower arch width and overbite could explain approximately 19.5% of the total variance of OCSAs and OCMPs.

Conclusion: Sexual differences in occlusal contacts were not detected. Class I division 1 patients had the highest amount of occlusal contacts among all groups of malocclusion. Overjet, overbite and lower dental arch width were best predictors of occlusal contacts in the current sample.

Keywords: 3D digital models, Malocclusion, Occlusal contacts, 3D mesh points, Correlation, Stepwise regression analysis.

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INTRODUCTION

Mastication is one of the important functions of the oral system that is subject to change during orthodontic therapy. Characteristics of the oral system, like dentition, jaw muscle activity, bite force and salivary flow rate, influence the masticatory process. Dentition and bite force have been shown as the key determinants of masticatory performance.[1] Teeth are important in the masticatory system since they form the occlusal platform where food particles are fragmented. This fragmentation depends on the total occlusal area and thus on the number of teeth.[2]

The variation in masticatory performance may be related to many different dental factors, such as the number of teeth present,[3] number of occluding tooth contacts,[4] the number of occluding pairs of teeth,[5,6] the total occlusal surface,[7] the occlusal contact area.[8-10] In a study on the influence of occlusal factors on the masticatory performance in 32 young dentate subjects, it was found that masticatory performance was most highly correlated with the occlusal area of the posterior teeth ($r = 0.55$, $p < 0.01$).[7] An even more important factor controlling the masticatory performance of people with natural teeth proved to be the amount of occlusal contact area of molar and premolar teeth, which is on average one-fifth of the total occlusal surface.[11]

The anatomic aspects are usually centered around occlusal contacts, malocclusion, alignment of teeth, overbite and overjet, the arrangement and relationship of the teeth within and between the arches and the relationship of the teeth to the osseous structures.[12] Few studies have evaluated the previous variables and their relationship with occlusal contacts. Owens et al demonstrated a increasing area of occlusal contact or very-near contact from a class III malocclusion group, through a class II group, a class I group to the most occlusal contact in subjects with good occlusion.[8] This was also supported by Jang et al who measured differences in occlusal contact areas between class II and I molar relationships,[13] but these two studies did not evaluate the possible differences between class II division 1 and division 2 malocclusions and the sample size in Owens study was very small (only six cases in the class III group).

Assessment of the magnitude of occlusal contacts has been first approached by using articulating paper, shim stocks, occlusal waxes or silicone impressions, but these methods have not proved their efficacy in reproducing occlusal contacts accurately.[10,14,15] Several 3D imaging systems of study models have been available to be used for producing 3D digital models of patient's teeth.[16] The reproducibility, validity and reliability of employing 3D digital study models been evaluated and have been deemed satisfactory.[17,18] One study evaluated surface areas of occlusal contacts by locating regions of intersection between the 3D upper dental mesh and the corresponding lower one in the posterior segments (i.e. premolars and molars) for each patient.[13] Several programs allow the orthodontist to identify the magnitude and extent of occlusal contact by eyeballing what is called the 'occlusogram'. Recently, a 3D viewing program (O3DM™) has added a functionality to convert the occlusogram into numerical values amenable to statistical analysis. The exported values represent the number of mesh vertices (points) which are in very close proximity (e.g. 0.0-0.4 mm) with the opposing mesh at the occlusal surfaces of upper and lower teeth.

Reviewing the literature reveals a paucity of research evaluating occlusal contacts between malocclusion groups using 3D digital models. Furthermore, the possible relationships between occlusal contacts and other dental characteristics have not been yet evaluated well. So, the objectives of the current study were fourfold: (1) To evaluate the applicability of using 3D digital models in the assessment of the magnitude of occlusal contacts by measuring occlusal contact areas and mesh points in very close proximity in a sample of referred orthodontic patients at a teaching hospital in Syria; (2) To detect any sex differences in the magnitude of occlusal contact between females and males in all malocclusion groups; (3) To compare the magnitude of occlusal contact of the four groups of malocclusion; (4) To detect any possible correlation between dental arch characteristics and the magnitude of occlusal contacts and to build a regression equation that would employ highly correlated factors.

MATERIALS AND METHODS

Estimation of Sample Size

Sample size calculation was undertaken using Minitab® 16 (Minitab Inc, State College, PA, USA). It was found that 112 patients should be recruited to meet our assumptions (28 in each group; Figure 1).

STUDY DESIGN

This was an observational, cross-sectional study for descriptive and analytical purposes and our target population was Syrian referred orthodontics patients with different types of malocclusion.

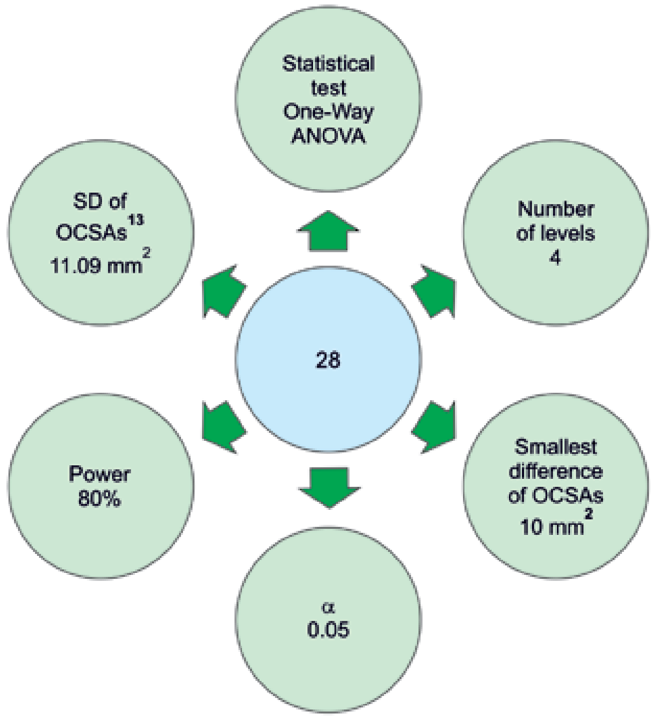


Fig. 1: Sample size estimation with its six assumptions. SD indicates standard deviation; OCSAs, occlusal contact surface areas

Sample Recruitment

This research project was approved by the Ethics Committee (UBDS 1875-2012 PG) and was funded by the University of Al-Baath Postgraduate Research Budget. Disproportionate multi-stratified random sampling with respect to sex and malocclusion class was employed. Study models were obtained by checking 1327 records of patients who visited the Department of Orthodontics at University Al-Baath Dental School (from June 2010 to April 2012). The study sample consisted of 120 malocclusion patients divided into 4 groups (class I division I, class II division 1, class II division 2 and class III). Each group consisted of 30 patients (15 males, 15 females). Baseline sample characteristics are given in Table 1. Study models were included according to the following criteria:

1. The ANB skeletal and clinical Angel classification[19] were employed to construct the groups:
   - Class I division 1 group: (1) bilateral class I molar and canine relationship. (2) Mild to moderate anterior crowding on one arch or both (up to 5 mm tooth-size arch-length discrepancy) (3) ANB from 0 to 4°.
   - Class II division 1 group: (1) bilateral half-unit class II molar and canine relationship or more. (2) Proclination of upper front teeth with overjet ≥ 5 mm. (3) ANB greater than 4°.
   - Class II division 2 group: (1) bilateral half-unit class II molar and canine relationship or more. (2) Retro-

clination of upper incisors at least of the two central incisors. (3) ANB greater than 4°.
- Class III group: (1) bilateral half-unit class III molar and canine relationship or more. (2) ANB less than 0°.

2. Complete permanent dentition and all teeth fully erupted to the occlusal plane. (Excluding third molars).
3. Well-aligned and no tooth crowded out of the arch in posterior regions.
4. Neutral occlusal surfaces of teeth with no caries, restorations, attrition,[20] enamel stripping or dental anomalies.
5. No transverse or vertical posterior discrepancies such as cross bite, scissors bite or open bite.
6. No previous orthodontics or prosthodontic treatment, maxillofacial or plastic surgery.
7. Absence of craniofacial syndromes, cleft lip/palate or previous dentofacial traumas.
8. No signs or symptoms of temporomandibular joint disorder or bruxism.
9. All study models were registered by bite-wax and uniformly trimmed in central occlusion position.

Data acquisition and 3D model analysis: Study models were sent to O3DM™ OrthoLab (Częstochowa, Poland), in which 3D digital models were created using a laser scanning technique (Fig. 2). The accuracy and reproducibility of the created 3D models by this technique (O3DM™) have been tested elsewhere.[17] 3D digital models were downloaded from the company's website to the principal researcher's PC desktop (N. A-R). The magnitude of occlusal contact was evaluated by two methods. In the first method, O3DM™ software Version 3.3.7 was used and its occlusogram chart was employed to extract the number of mesh vertices (points) that are in very close approximation (or 'actual contact') with the opposing mesh, i.e. between 0 and 0.4 mm.[21] The posterior region was extracted from the each upper and lower 3D mesh (2 premolars and 2 molars on each side; Figs 3A to C) and then the average number of mesh points (OCMPs) which lie in the 'actual contact' category (the black and red points in Figs 4A to C) was calculated. In the second method, Rapidform™ XOR3® SP1 V3.1 (INUS Technology Inc. Seoul, Korea) was used. Each O3DM™ model was exported as a stereolithographic model (.stl file) and then imported into Rapidform™ XOR3® software. Regions of intersection between 3D upper and lower meshes (i.e. the occlusal contact surface areas OCSAs) were calculated using a Boolean function embedded in this software.[13] The figures given by the software were divided by 2 to give an estimation of one side of the mouth (Figs 5A to C).

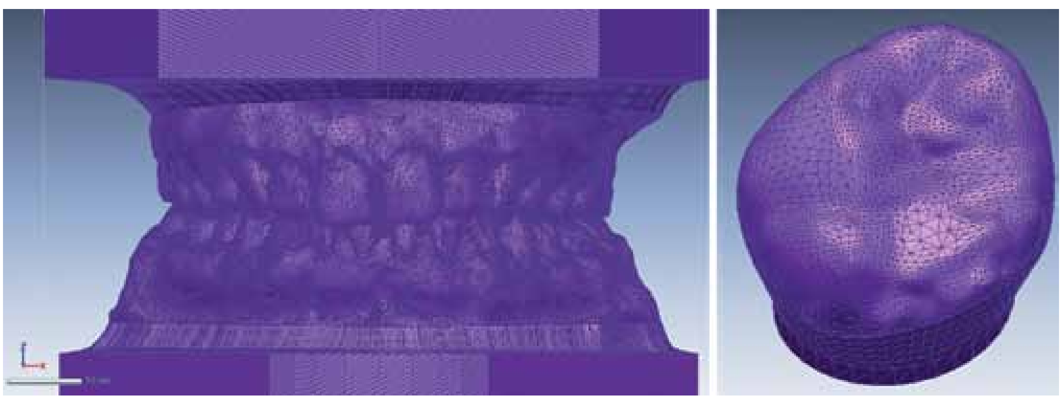
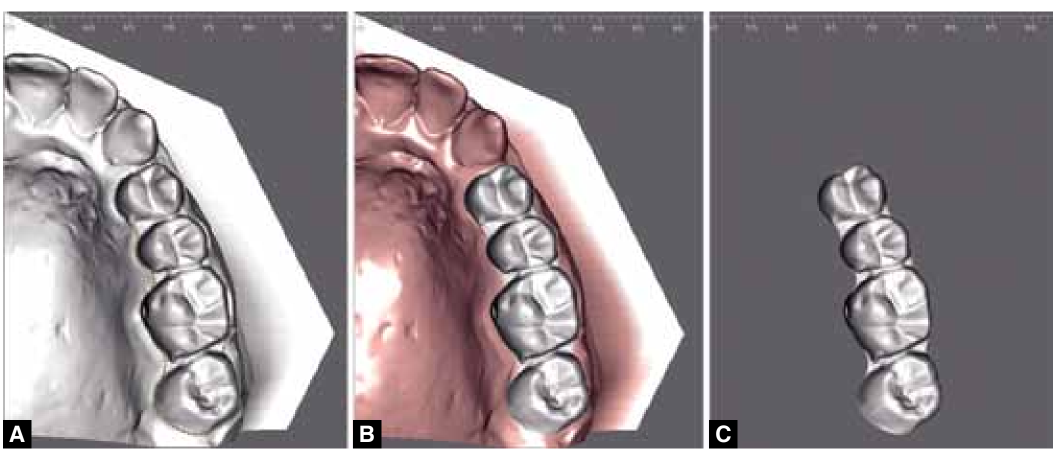
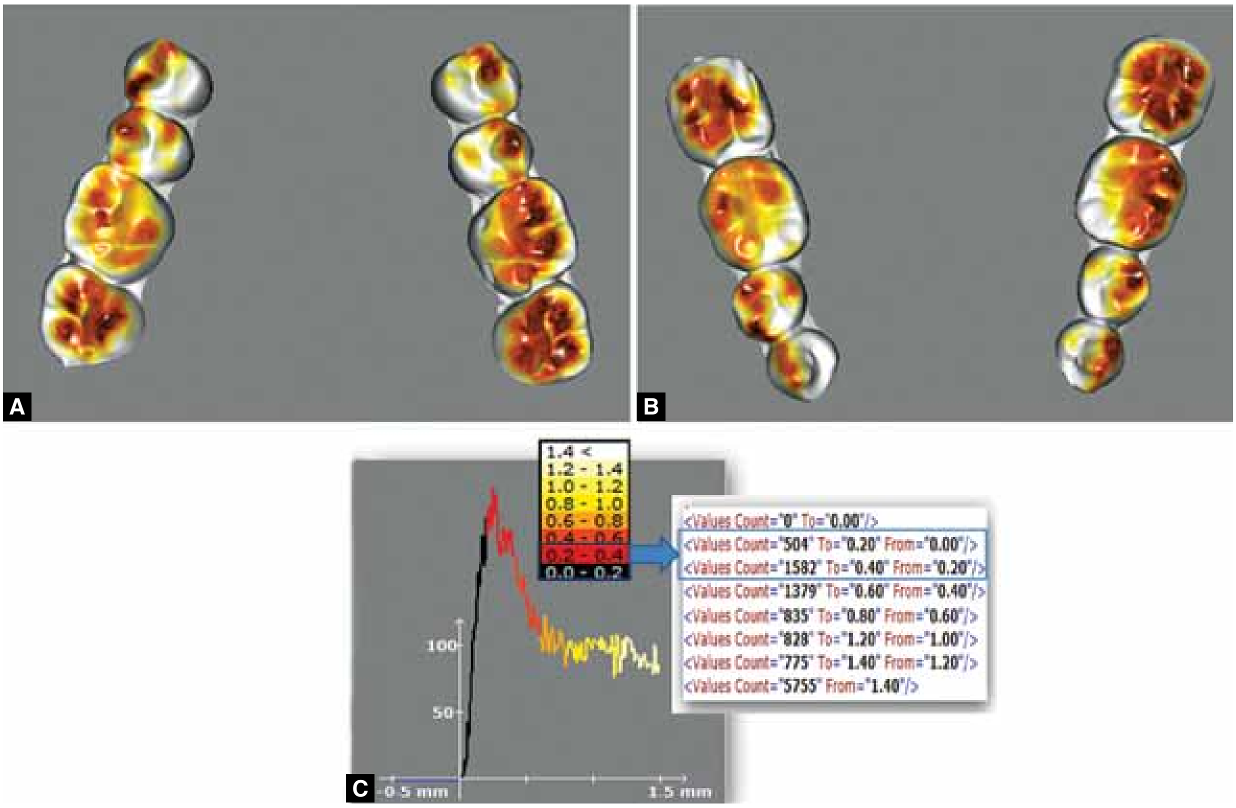


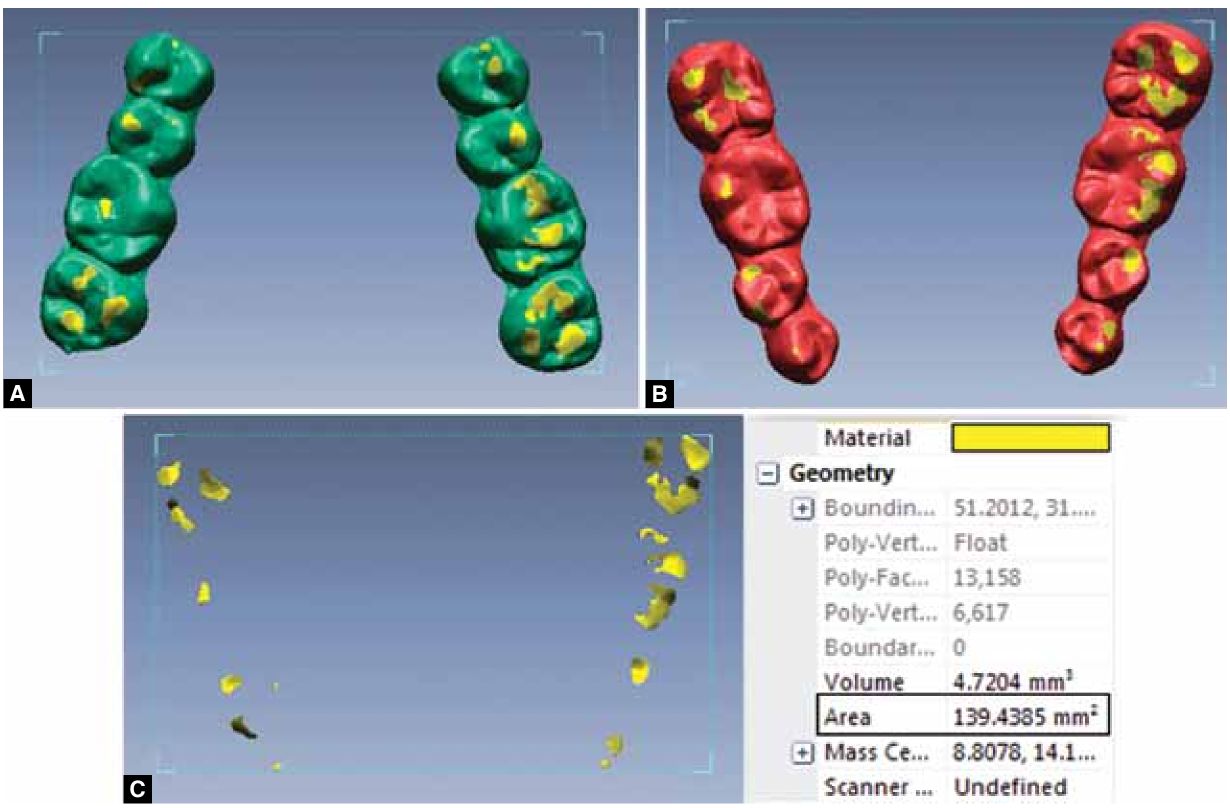
Fig. 2: Close-up screen captures illustrate the density of the 3D digital models used in this study



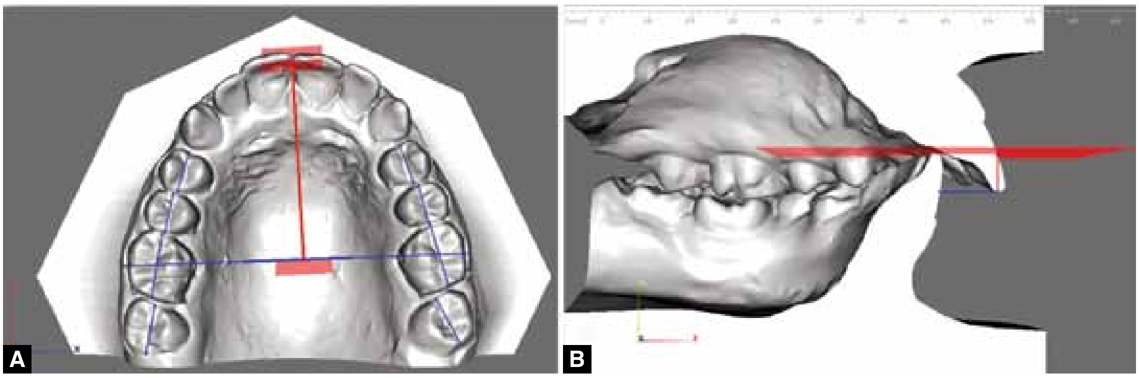
Figs 3A to C: Teeth segmentation in the O3DM™ program. (A) Creation of a cervical contour around the posterior teeth; (B) Extracting these teeth from the upper 3D mesh; (C) the cut segment



Figs 4A to C: 3D digital models evaluated by the O3DM™ program showing the 'Occlusogram' as well as the mesh points chart. Black and red points represent upper and lower mesh vertices in proximity of about 0.00 to 0.4 mm. (A) Upper mesh; (B) Lower mesh; (C) Occlusogram chart which is displayed in the O3DM™ program



Figs 5A to C: 3D digital models evaluated by the Rapidform™ XOR3® program showing the intersection areas (yellow) of the upper and lower meshes. (A) Upper mesh; (B) Lower mesh; (C) Occlusal contact surface areas



Figs 6A to B: Measurements made on the 3D digital models: (A) (1) mesiodistal widths of the eight teeth (in mm) in the upper arch. (2) Arch width (mm): the distance between the mucogingival junctions of the right and left permanent first molars. (3) Arch depth (mm). (B) (4) Overjet (mm), (5) Overbite (mm)

Assessment of correlation was based on several 3D dental arch measurements (Figs 6A and B) which had been previously performed as a part of an MSc research project for the first author (N. A-R). Highly correlated variables were incorporated in a stepwise multiple regression analysis.

Statistical Analysis

All descriptive and inferential statistics were performed using the Minitab® 16 software package. Two-sample t-tests were used to detect sex differences. One-way analysis of variance (ANOVA) was performed to detect significant differences between the malocclusion groups in relation to the outcome variables. Tukey honestly significant difference (HSD) posthoc tests were performed for pairwise comparisons. Pearson's correlation analysis was used to determine correlation coefficients between the occlusal contact variables and dental arch variables. This was followed by a stepwise multiple linear regression analysis to arrive at the best subsets of predictors. Alpha was set at 0.05.

Error of the Method

Segmentation the premolars and molars regions for the calculation of OCSAs and OCMPs were repeated on 20 3D digital models randomly selected after a 3-week interval by the same principal researcher (N. A-R). Paired t-tests showed no systematic error between the two occasions of measuring. The error of the method (according to Dahlberg)[22] ranged from 0.001 mm^2 for OCSAs to 0.26 mm for the upper arch width measurement. Coefficients of reliability (according to Houston)[23] were high among all assessed measurements and ranged from 96.2 to 99.9%.

RESULTS

A high degree of correlation was found between the two methods (OCMPs and OCSAs; $r = 0.942$). Gender differences in each group are shown in Table 2. There was no significant sexual dimorphism in the OCMPs (mesh points) or the OCSAs (mm^2) in all groups. Therefore, the data of both sexes were combined in each group. Statistically significant differences among the malocclusion groups were found for the OCMPs and the OCSAs ($p < 0.001$; Table 3). The OCMPs and OCSAs of class I division 1 group were the largest (2259.4 mesh points ± 1119.3 and 78.42 mm^2 ± 44.25, respectively) while those of class III group were the smallest (78.42 ± 44.25 mesh points and 22.64 mm^2 ± 19.43, respectively). Tukey's HSD pairwise comparisons are presented in Table 4. The difference between class I division 1 and class II division 1 groups was statistically significant for both measures of occlusal contacts (i.e. the OCSAs and the OCMPs). Additionally, pairwise comparisons between class III malocclusion group and the other three groups showed statistically significant differences for both measures of occlusal contacts.

Pearson's correlation coefficients are presented in Table 5. The OCMPs and OCSAs had the largest correlation coefficients with 'overjet' (+0.29 and +0.34, respectively). In addition, statistically significant correlation coefficients were found with 'overbite' (+0.28 for OCMPs and +0.23 for OCSAs) and with 'lower arch width' (–0.27 for OCMPs and –0.26 for OCSAs) variables. The results of the stepwise multiple linear regression analysis are presented in Table 6. The 'overjet' (mm) measurement was able to explain singly 11.82% of the total variance of the OCSAs and 8.95% of the total variance of the OCMPs. The three variables ('overjet', LAW, and 'overbite') together explained approximately 19.5% of the total variance of the OCSAs or the OCMPs.

DISCUSSION

Sophisticated 3D viewing, manipulating and measuring programs have been recently introduced offering the possibility of quantitative assessment of occlusal contacts. Jang et al[13] were probably the first to show a 3D-digital-model-based calculation of inter-occlusal contact surface areas (OCSAs)

Table 1: Baseline sample characteristics

	Class I	*Class II division 1*	*Class II division 2*	*Class III*
Number of patients	30	30	30	30
Age years (Mean ± SD)	19.38 ± 3.82	19.05 ± 4.33	19.96 ± 3.64	19.39 ± 4.08
Skeletal angle ANB (Mean ± SD)	2.46 ± 0.86	4.96 ± 0.33	5.33 ± 0.28	–1.07 ± 0.46
Overjet mm (Mean ± SD)	2.85 ± 1.09	7.29 ± 1.84	3.41 ± 1.30	–3.82 ± 1.21
Overbite mm (Mean ± SD)	3.12 ± 1.05	2.79 ± 2.14	6.13 ± 2.02	1.21 ± 2.16
Anterior crowding mm (Mean ± SD)	3.6 ± 0.7	1.8 ± 0.5	2.1 ± 0.3	1.5 ± 0.5

SD: indicates standard deviation

Table 2: Gender comparisons of OCMPs (mesh points) and OCSAs (mm²) in different malocclusion groups[a]

Malocclusion groups	*Males*		*Females*		*p-value*
	Mean	*SD*	*Mean*	*SD*	
Class I					
OCMPs	2053	1059	2438	1175	0.371
OCSAs	69.90	37.60	85.80	49.40	0.346
Class II division 1					
OCMPs	1601	705	1382	543	0.411
OCSAs	58.90	26.76	54.73	30.14	0.723
Class II division 2					
OCMPs	1797	683	2223	842	0.168
OCSAs	65.57	29.47	73.38	32.16	0.525
Class III					
OCMPs	753	534	736	455	0.936
OCSAs	19.27	16.24	25.73	22.21	0.433
Total malocclusion					
OCMPs	1578	902	1750	1052	0.379
OCSAs	54.38	34.50	61.74	41.36	0.332

[a]OCMPs, indicates occlusal contact mesh points (first method); OCSAs, occlusal contact surface areas (second method); SD, standard deviation

Table 3: One-way ANOVA comparisons of OCMPs (mesh points) and OCSAs (mm²) among different malocclusion groups[a]

Malocclusion groups	*Class I*		*Class II division 1*		*Class II division 2*		*Class III*				*p-value*
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*df*	*F*	
OCMPs	2259.4	1119.3	1482.4	618.2	2026.5	788.2	744.2	482.7	3	17.16	<0.001
OCSAs	78.42	44.25	56.64	28.10	69.77	30.59	22.64	19.43	3	13.87	<0.001

[a]OCMPs: indicates occlusal contact mesh points (first method); OCSAs: occlusal contact surface areas (second method); SD: standard deviation: df, degree of freedom

using Rapidform™ program, whereas the current work is an attempt to transform occlusalgram data (provided by O3DM™ program) into numerical values reflecting mesh points in contact (or semi-contact) as an indicator of the magnitude of occlusal contact in a sample of refereed orthodontic patients.

In the present study, OCSAs were derived from calculations based on Rapidform™ program which has been used widely in the orthodontic literature for landmark-based measurements or superimpositioning purposes[16] or even for surface area[13] or volumetric assessments.[24] Therefore, the Rapidform-based OCSAs method was considered the gold-standard to which OCMPs values were compared. A high correlation coefficient was found between the two methods (r = 0.942) which demonstrated a concurrent criterion validity.[25] When statistically significant differences in the magnitude of occlusal contact were detected between any pair of malocclusion groups employing the OCSA method, similar findings with similar statistical significance were observed with the OCMP method. This confirmed convergent construct validity.[25] Test-retest reliability showed

Table 4: Tukey HSD comparisons of OCMPs (mesh points) and OCSAs (mm²) among different malocclusion groups[a]

Malocclusion groups	*OCMPs*		*OCSAs*	
	Mean difference	*p-value*[b]	*Mean difference*	*p-value*[b]
Class I *vs* class II division 1	–777	0.004**	–21.78	0.045*
Class I *vs* class II division 2	–233	0.715	–8.65	0.763
Class I *vs* class III	–1515	<0.001***	–55.78	<0.001***
Class II division 1 *vs* class II division 2	544.1	0.087	13.13	0.486
Class II division 1 *vs* class III	–738.2	0.012*	–34.00	0.003**
Class II division 2 *vs* class III	–1282	<0.001***	–47.13	<0.001***

[a]OCMPs: indicates occlusal contact mesh points (first method); OCSAs: occlusal contact surface areas (second method); [b]*Significant at $p < 0.05$: **Significant at $p < 0.01$: ***Significant at $p < 0.001$

Table 5: Correlation coefficients between OCMPs (mesh points), OCSAs (mm²) and other variables[a]

Variables	*OCMPs*		*OCSAs*	
	r	*p-value*[b]	*r*	*p-value*[b]
Age	0.129	0.158	0.113	0.175
Mesiodistal width of posterior teeth				
Upper first premolar	0.099	0.325	0.137	0.171
Upper second premolar	0.028	0.784	0.067	0.505
Upper first molar	0.017	0.868	0.091	0.367
Upper second molar	0.050	0.622	0.091	0.365
Lower first premolar	0.048	0.632	0.072	0.472
Lower second premolar	0.095	0.347	0.100	0.314
Lower first molar	0.076	0.453	0.078	0.441
Lower second molar	0.112	0.266	0.123	0.219
Sum of upper posterior teeth	0.056	0.575	0.119	0.234
Sum of lower posterior teeth	0.103	0.304	0.116	0.248
Overbite	0.280	0.005**	0.230	0.021**
Overjet	0.299	0.002**	0.344	<0.001***
Arch dimensions				
Upper arch width (UAW)	0.046	0.647	0.107	0.287
Lower arch width (LAW)	–0.277	0.005**	–0.262	0.008**
Upper arch depth (UAD)	0.043	0.672	0.071	0.478
Lower arch depth (LAD)	–0.046	0.647	–0.018	0.855

[a]OCMPs: indicates occlusal contact mesh points (first method); OCSAs: occlusal contact surface areas (second method); r: Pearson's correlation coefficient; [b]**Significant at $p < 0.01$, ***Significant at $p < 0.001$

that the error of this approach was within the minimal limits. Thus, validity and reliability of the current methodology support its applicability in the assessment of the magnitude of occlusal contacts by measuring occlusal contact mesh points (OCMPs) that lie in very close proximity with the opposing mesh points.

Occlusal contacts are difficult to be compared and contrasted between published papers because of the lack of similarity in the methodology and definition of interocclusal contact areas. Dawson and Arcan's classification of occlusal contact was based on the degree of light penetration into the occlusal wafer giving three possible categories: light contact (up to 40% light penetration), medium, and heavy contact (over 60%).[26] Another classification depended on the thickness or color change of registration materials. Owens et al defined 'actual contacts' as areas of contact with a thickness of the registration wafer equals to or below 50 μm, whereas 'near contacts' areas were defined as those with a thickness greater than 50 μm but less than 0.35 mm.[8] However, Wilding[9] reported that masticatory performance was related to 'intermediate occlusal contact areas' (0.2-0.45 mm interocclusal distance) but not to 'tight occlusal contact areas' (<0.2 mm interocclusal distance). Accordingly, mesh points which lie at 0.00 to 0.40 mm from the opposing 3D

Table 6: Stepwise multiple regression analysis for OCMPs (mesh points) or OCSAs (mm²) as dependent variables employing several candidate independent (predictor) variables[a]

Dependent variable	*Independent variable*	*B*	*SE B*	*t*	*p-value*[b]	R^2
OCMPs[c]	1 (Costant)	1516.7	106.0	14.31	<0.001***	8.95%
	Overjet	64.87	20.80	3.12	0.002**	
	2 (Costant)	5627	1611	3.49	0.001**	14.64%
	Overjet	57.77	20.43	2.83	0.006**	
	LAW	–71.48	27.96	–2.56	0.012*	
	3 (Costant)	5139	1584	3.24	0.002**	19.59%
	Overjet	50.69	20.14	2.52	0.013*	
	LAW	–67.36	27.33	–2.47	0.015*	
	Overbite	77.77	31.84	2.44	0.016*	
OCSAs[d]	1 (Costant)	51.47	4.06	12.68	<0.001***	11.82%
	Overjet	2.90	0.80	3.64	<0.001***	
	2 (Costant)	197.48	62.01	3.18	0.002**	16.56%
	Overjet	2.65	0.79	3.37	0.001**	
	LAW	–2.54	1.08	–2.36	0.020*	
	3 (Costant)	183.30	61.78	2.97	0.004**	19.32%
	Overjet	2.44	0.79	3.11	0.002**	
	LAW	–2.42	1.07	–2.27	0.025*	
	Overbite	2.26	1.24	1.82	0.072	

[a]OCMPs: indicates occlusal contact mesh points (first method); OCSAs: occlusal contact surface areas (second method); LAW: lower arch width; B: unstandardized regression coefficient; SE B: standard error of B; R2: determination coefficient; [b]*Significant at p < .05; **Significant at p < .01, ***Significant at p < .001; [c]The regression equation is OCMPs = 1517 + 64.9 overjet, The regression equation is OCMPs = 5627 + 57.8 overjet – 71.5 LAW, The regression equation is OCMPs = 5139 + 50.7 overjet – 67.4 LAW + 77.8 overbite; [d]The regression equation is OCSAs = 51.5 + 2.90 overjet, The regression equation is OCSAs = 197 + 2.65 overjet – 2.54 LAW, The regression equation is OCSAs = 183 + 2.44 overjet – 2.42 LAW + 2.26 overbite

mesh were chosen in the current study to represent points with 'actual' contacts.

The current findings demonstrate no statistically significant differences in the magnitude of occlusal contact between males and females among the four evaluated malocclusion groups and this result is similar to those of Owens et al.[8] The lack of influence of sex on occlusal contacts does not contrast the findings of Bakke et al who reported higher maximum bite forces for men compared to women which have been thought to have a potential effect in increasing total masticatory performance in males.[27] On the other hand, statistically significant differences in the magnitude of occlusal contact were found among the malocclusion groups ($p < 0.001$; *see* Table 3). Patients with class I division 1 malocclusion had larger occlusal contacts than subjects in other malocclusion groups. This result is in agreement with the two previous studies[8,13] which evaluated occlusal contacts among different malocclusion groups and can be explained by that class I division 1 malocclusion is the closest to normal occlusion with regard to the 3D localization of posterior teeth between the two jaws.

The occlusal contacts of class III subjects were significantly less than those of other malocclusion groups. The antero-posterior relationship of molars seems to result in a loss of the surface area of 2 first lower premolars and 2 second upper molars. It has been shown that about 50% of the variance in the masticatory performance could be explained by the number of occlusal units (or interocclusal contacts).[5] Therefore, orthodontic camouflage would not be able to restore this loss and surgical interventions in class III deformities would be a better option to rehabilitate oral functions, particularly masticatory performance.[28]

Although strict inclusion criteria were employed in the current study, the amount of variation in OCSAs and OCMPs were relatively large in each group (as shown in *see* Tables 2 and 3). A trend of large individual variability in occlusal contacts and masticatory performance has been shown in healthy subjects.[3,5,7,13,29] For instance, Sierpinska et al found that the mean area of the chewing platform was 125.12 ± 46.5 mm^2 in subjects with full dentitions.[30] Despite this large variation, an additional search for factors (or predictor variables) was conducted in two steps (i.e. correlation analysis followed by multiple regression analysis). The current study appears to be the first to evaluate occlusal contact relationships with these variables. It has been reported that the cumulative occlusal contacts decrease as the number of teeth in contact decreases[7,29] and as the platform area of post-canine teeth decreases.[7] Therefore, detection of any possible correlation between mesiodistal widths of posterior teeth and occlusal contact was a concern in the current study. However, this possible correlation was not existing in the current analysis suggesting that other dimensions should be studied such as the buccolingual dimension of posterior teeth.

When multiple regression analysis was employed, the 'overjet' alone explained 11.82% of the total variance of OCSAs and 8.95% of the total variance of OCMPs. The coefficient of determination (R^2) increased to 19.32% OCSAs and to 19.59% for OCMPs when further two variables were added to the equation; the lower arch width and the overbite. However, the current regression equation could not explain the remaining 80.5% of the variability of the magnitude of occlusal contact which keeps the door widely open for future research work to dig into more explanatory variables.

The current study aimed to analyze static inter-digitation surface areas but there was no intention to include other components of the masticatory function (e.g. bite force or muscular activity). Chewing is a very complex oral function intertwined with several different factors;[31] therefore it would beneficial to conduct future research work trying to employ four-dimensional analyses[32] with larger sample sizes and to evaluate measurements of dynamic occlusal force, masticatory muscle strengths, and mandibular movement patterns to obtain a comprehensive picture of the masticatory performance in all different types of malocclusion.

CONCLUSION

Measuring occlusal contact mesh points (OCMPs) that lie in very close proximity with the opposing mesh points is a valid and reliable method in the assessment of the magnitude of occlusal contacts when using 3D digital models.

Statistically significant gender differences in the magnitude of occlusal contacts were not found.

Patients with class I division 1 malocclusion had larger occlusal contacts than subjects in other malocclusion groups while class III had the smallest contacts.

The largest correlation coefficients were found between occlusal contact variables and 'overjet', 'overbite' and 'lower arch width'. All these three variables explained about 19% of the total variance of occlusal contact indices.

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