Original Research Article

Irregularity Index With Gender Differences Using (Exocad) System

Nidhal Hussein Ghaib[1]   Haraa Sabah Mohammed-Salih[1]   Hayder Saed Al-Atabi[2]
Ahmed Ismaiel Alali[1]
[1]College of Dentistry, University of Baghdad, Baghdad, IRAQ
[2]College of Dentistry, University of Al-Muthanna, Sammawa, IRAQ

E-mail:haidarsaeed@yahoo.com

Abstract

This study was conducted to detect the greater amount of anterior crowding whether in the upper or lower dental arch in either male or female in different malocclusion using exocad system on digital model.

Sample of 30 subjects (15 male, 15 female) with age range (14-18) years old, study model for each subject for upper and lower arch scanned by using MeditIdentica Blue Scanners after Exocad software used to measure intermolar (IMD), intercanine (ICD) and little's irregularity index (LII) in present study.

Shows wide range of variation in IMD, ICD and LII, female sample shows wider arch in molar and canine region in cl III malocclusion at both upper and lower dental arches (49.45mm and 45.63mm respectively), whereas male data showed greater IMD found in CLI malocclusion (56.54mm) in the upper arch. Results indicating LII in female group with CLI malocclusion severe anterior crowding was found in the lower arch (13.13mm), whereas the least amount of anterior crowding was found in the upper arch of CLII malocclusion (3.59 mm), while in the lower arch well aligned anterior teeth with minimal crowding was found in CLIII malocclusion (3.14mm), with highly significant differences between groups for both dental arches (P < 0.01). In male group, the results of LII were different as the most anterior crowding was found in CLII malocclusion in both upper and lower dental arches (11.7mm and 9.36mm respectively), whereas the minimal anterior crowding was found in CLIII in the lower and upper dental arches (3.74mm and 8.57mm respectively), with significant differences (P < 0.01).

Finding establish that the crooking of incisors its dominant character in female male group in the mandibular arch with the CL I malocclusion, while In male group severe crowding exist in the maxillary arch of CL II malocclusion patients.

Key Words: Exocad, Irregularities Index; Lower arch crowding.

مقياس عدم التناغم بين الجنسين باستخدام جهاز نظام السكنر

الخلاصة

أجريت هذه الدراسة لتحديد أكبر كمية من الازدحام الأمامي سواء في الجزء العلوي أو السفلي إما ذكرا أو أنثى في مختلف سوء الإطباق.

تضمنت الدراسة من 30 عينة من الاشخاص (15 ذكرا، 15 أنثى) بالفئة العمرية (14–18) سنة، تم اجراء مسح ضوئي لقوالب الفك العلوي والسفلي لكل الاشخاص باستخدام MeditIdentica Blue Scanners و برنامج Exocad المستخدمة لقياس المتغيرات في الدراسة الحالية.

بينت الدراسة وجود اختلافات واسعة في IMD, ICD and LII وكانت عينة الإناث أوسع في منطقة الأرحاء في cl III من سوء الإطباق على حد سواء في الفك العلوي والسفلي (mm 49.45 و mm45.63على التوالي). ولم تكن هناك فوارق ملحوظة في الفك العلوي بين CL I, CL II and) (CL III في حين كان هناك فرق كبير في الفك السفلي في جميع انواع سوء الإطباق.

كان الازدحام في القواطع من اكثر الصفات المشتركة في مجموعة الإناث في الفك السفلي في سوء الإطباق CL I، بينما في مجموعة الذكور كان الازدحام شديد جدا في الفك العلوي من مرضى سوء الإطباق CL II .

الكلمات المفتاحية: Exocad، معامل التشوهات، الازدحام في الفك السفلي.

Introduction

Nowadays, the big improvement in technology like the invention of digital dental models. Digital program permit the handling and measurement of digital models in three dimensions of space. A several articles clarify that the uses of computerized dental models in interpretation of patient maocclusios were statistically none significant in regards to conventional method of plaster models analysis[1,8]. The advantages of computerized models for orthodontic problems may be neglected if the validity, efficiency and ease of linear and angular measurements of occlusal character with digital models were not comparable to those related to plaster models, the usual "gold standard" used daily in the dental practice [9].

There are three ways at present to generate digital casts: from scans of casts poured up from impressions or from laser scans of impressions or directly from intraoral scanner. Accurate measurements can be done on a virtual dental cast, produced from scan of casts poured up from impressions. This works reasonably well for transverse, anteroposterior and vertical dimensions. The resulted digital scans can be used for measuring different orthodontic parameters such as intercanine distance, intermolar distance, overjet, overbite and little's irregularity index and other parameters in any direction (anteroposterior, transverse and vertical planes) which can be visualized and measured precisely [10].

Computer software solution providers throughout the use EXOCAD software as a basic frame for their solutions because of its ease of use and shortened learning curve, thus allow dentist, dental laboratories and technicians to decrease training price and increase productivity. Its open-architecture CAD software platform allows it to seamlessly coordinate with other digital solutions, including CAD and CAM [11].

According to Russel A.L. an scale has defined as a numerical value prescribing the relative state of whole population on a graded scale with clear upper and lower borders, which is designed to allow and facilitate comparison with other populations classified by similar criteria and methods [12].

Occlusal scales were used primarily as epidemiological tools to rank or differentiate the occlusion. A huge number of occlusal indices appeared in the 1950s and 1960s to help in epidemiological evaluations. High standard occlusal indexes suppose to be reliable and valid. Validity means determination of treatment need [13]. Among all the scales, Little's irregularity index (Little's, 1975) 14 is the simplest way and not requires special maneuvers to conduct the index. The irregularity index is a form of occlusal index used to evaluate the amount of incisors crowding of permanent dentition in upper or lower dental arches. Their use decrease the subjectivity linked to the diagnosis, results and difficulty assessment of orthodontic treatment. It can also provide us the extent of post treatment relapse of incisor crowding of orthodontic cases [15, 16].

Diagnostic measurements have traditionally been made on plaster dental casts. Now, 3-dimensional digital dental models with Exocad software system was used in the present study aims to detect the greater amount of anterior crowding whether in the upper or lower dental arch in either male or female in each malocclusion dental classes, (i.e: CL I, II and III). Exocad system used to realize in which dental classes, the wider molar and canine region exist for both genders.

Materials and Methods

Samples

After initial examination of a total 78 subjects, the sample consisted in the present study was 30 subjects, (15 male and 15 female), with age range of (14-18 years old), attending to Al-Baladyat specialized dental center/Ministry of Health, for orthodontic treatment. Subject selection criteria included:

1. Physically and mentally healthy subjects without history of congenital or

developmental disturbances due to syndromes or hormonal disturbance which could affect their growth.

2. No previous history of trauma or injury to the face and/or the hand middle finger region.

3. full set of upper and lower permanent teeth except wisdom.

4. Good oral hygiene and healthy gingival tissues.

5. intact anterior teeth.

6. No pervious orthodontic treatment.

7. No supernumerary or missing teeth (except third molars).

8. No wearing of anterior teeth.

The total sample selected were divided into two main groups 15 male and 15 female , within each group the sample consisted of three equals groups (5 in each group) according to dental malocclusion classes into CL I, CL II and CL III.

Methods

Patients seated on dental chair to established upper and lower impressions were taken as a routine procedure by Ortho Technology DuraLock®PLUS Impression Tray using LascodMillenium alginate impression material, pouring of impression

was done within 15 minutes as a maximum limit and let it to set for at least 30 minutes. A set of accurate upper and lower study models was prepared and checked out for any voids or bubbles of plaster.

The study model for each patient was scanned by using Medit Identica Blue Scanners and once the scanning was completed, a Medit Exocad software system used to measure the assessed variables in the present study including :

Little's Irregularity Index (LII):

Each linear displacement between the 5 anatomic contact points (A, B, C, D, and E) of the anterior teeth was measured as shown in (Fig. 1: A, in maxillary and B, in the mandibular arch). LII comprises the 5 linear displacements added up in millimeters (mm), which represents the amount of crowding in the anterior teeth. Scoring is given for each patient cast according to LII as follow:

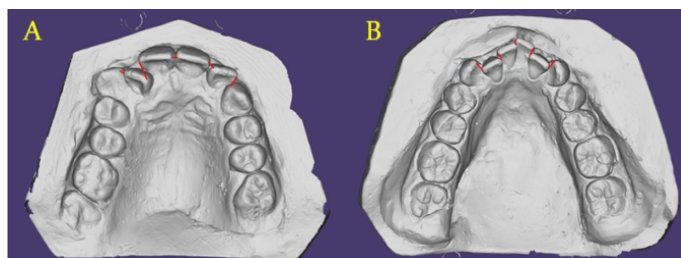|	
0	Perfect alignments
1-3	Minimal irregularity
4-6	Moderate irregularity
7-9	Severe irregularity
<10	Very severe irregularity

Figure 1: Little's Irregularity Index: sum of five displacements for: [A: Upper and B: Lower Arch].

Intercanine Distance (ICD)

Distance from the cusp tip of the canines in (mm) of maxillary and mandibular dental arches in the horizontal

occlusal plane, (Fig.2: A, in maxillary and B, in the mandibular arch).
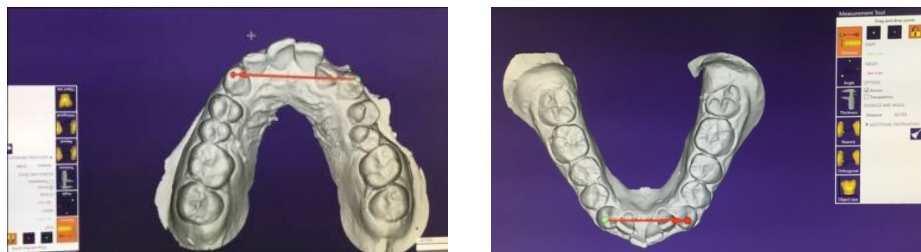

Figure 2: Digital ICD measurements in (mm),using Exocad system A, in maxillary arch and B, in the mandibular

mandibular dental arches in the horizontal occlusal plane, (Fig.3: A, in maxillary and B, in the mandibular arch).

Intermolar Distance (IMD)

Distance from the mesiobucall cusp tip of the first molars in (mm) of maxillary and
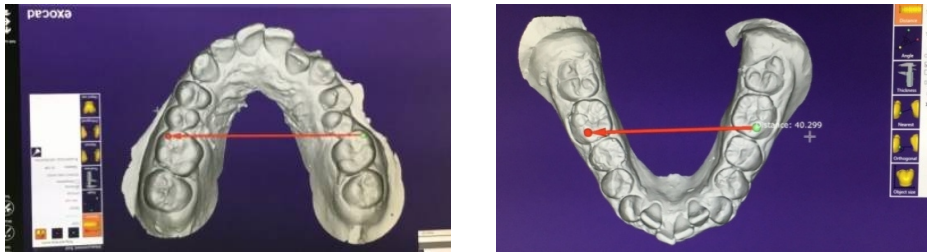

Figure 3: Digital IMD measurements in (mm),using Exocad system A, in maxillary arch and B, in the mandibular arch.

Readings on both digital scanning of study models were taken twice at an time frame of two days by two examiners and the findings were averaged for intra and inter-examiner reliability. The experts were blunt in relation to which group the cast belonged to in order to went down the bias.

Statistical Analysis

The collected data was analyzed on (SPSS version 21, Windows 2010). The descriptive analysis including mean and standard deviation (SD). Inferential statistics including (ANOVA) with F-test and Student t-test were used. The level of significance was set at $P<0.05$ (S) with $P>0.05$ is Non Significant (NS) and $P<0.01$ Highly Significant (HS).

Results

In the present study, the studied groups mainly composed of gender differences with different dental classes in order to detect the correlation between anterior crowding with each dental class in sex distribution, (Fig. 4) showed that all subjects sample was healthy with normal body weight and height in relation to their ages.

Descriptive statistic for digital variables including IMD, ICD and LII showed a wide range of variation in male and female in each dental malocclusion group, as in Table (1). In female sample the wider arch width

in molar region was shown in CL III malocclusion at both upper and lower dental arches (49.45mm and 45.63mm respectively), however it was a non-significant difference in the upper arch between (CL I, CL II and CL III) ($P>0.05$), while it was significant in the lower arch as compared between malocclusion dental classes ($P < 0.05$). Also the higher ICD was found in CL III malocclusion in both upper and lower dental arches (35.04mm and 30.48mm respectively). Highly significant difference was found between groups in the lower arch ($P< 0.01$) and significant difference in the upper dental arch ($P < 0.05$), as in (Fig. 5).

In male group different results were appeared, as the greater IMD was found in CLI malocclusion (56.54mm) in the upper arch, while in the lower arch it was found in CLIII malocclusion (51.1mm), and there was a higher significant difference between groups for both dental arches ($P< 0.01$), as shown in (Fig. 6). The same results were found indicating the ICD as the wider canine region in the upper arch in CLI malocclusion (38.59mm) and in the lower arch was found in CL III malocclusion (33.11mm), with highly significant differences between groups for both dental arches ($P< 0.01$).

The results indicating the LII with the sex distribution showed unpredictable difference between them in each

malocclusion groups (i.e.: CLI, CLII and CLIII). As in female group with CLI malocclusion the anterior crowding was found in the upper arch (6.98mm) with nearly doubled in the lower arch (13.13mm), whereas the least amount of anterior crowding was found in the upper arch of CLII malocclusion (3.59mm), while in the lower arch well aligned anterior teeth with minimal crowding was found in CLIII malocclusion (3.14mm), with highly significant differences between groups for both dental arches (P< 0.01), as shown in table (2).

In male group, the results of LII were different as the most anterior crowding was found in CLII malocclusion in both upper and lower dental arches (11.7mm and 9.36mm respectively), whereas the minimal anterior crowding was found in CLIII in the lower and upper dental arches (3.74mm and 8.57mm respectively), with a significant difference in the upper dental arch (P < 0.05) and highly significant differences between groups in the lower dental arch (P< 0.01), as shown in table (2).

T-test for digital variables was used to compare between male and female for each dental malocclusion classes and to show if there is any significant differences between genders on the results of IMD, ICD and LII. In CLI malocclusion there are highly significant differences between male and female in the amount of anterior crowding and the width of canine and molar regions (P< 0.01). IMD and ICD in both upper and lower dental arches in male are more than that in female, as well as for LII in the upper dental arch only, whereas LII in the lower dental arch in female greater than that in male, as shown in table (3).

In CLII malocclusion, the IMD of both dental arches in female is slightly more than that in male (with non-significant difference, P>0.05), whereas for the ICD the results are vice versa (with significant difference, P < 0.05) as well as the amount of anterior crowding (i.e. LII) of both dental arches in male are greater than female (with highly significant differences, P< 0.01), as shown in table (4).

In CLIII malocclusion the results showed gender differences for each dental arch. The IMD and ICD of the upper dental arch in female are greater than that in male (with highly significant differences, P<0.01), whereas in the lower dental arch they are more in male than in female (with significant difference, P < 0.05). The LII of both upper and lower dental arches are more in male than in female, however; it is significant in the upper dental arch (P < 0.05) and non-significant difference in the lower dental arch (P>0.05), as shown in table (5).

Discussion

Many literatures carried out with Class I malocclusion, in this study, the other classes CLII and CLIII with gender differences were evaluated in order to detect the presence of anterior crowding with its correlation to dental arch width anteriorly and posteriorly (i.e. ICD and IMD) in each dental class and its maximum prevalence in relation to the male and female groups to make a positive decision on treatment plan and expect the tendency of post treatment relapse.

The average age of subjects were (14-18 years) for male and female because at this age range all the permanent anteriors and posterior teeth are fully erupted to the line of occlusion and this was important in order to get a clear and valid assessments of the prevalence and distribution behavior of incisors crooking in the presence of all of the permanent teeth.

In the last years, most of studies concerning the CLII were based on the comparisons between the most accurate methods for assessment of anterior crowding and all of these studies conclude that the digital method is more accurate than that manual in its measurements, however; with non-significant differences than the manual method. A previous study determined whether anterior crowding and linear measurements taken from computerized models from cone beam computed tomography (CBCT) images were comparable to the traditional method of digital study models (OrthoCAD) by

impressions, the results shows CBCT digital models are as accurate as OrthoCAD digital models in making linear measurements for over-jet, overbite, and crowding measurements [17]. Another study assessed the incisor irregularity on photocopied images as an substitute to the usual direct method of assessment on dental casts. The results clarify that the incisor irregularity on photocopied images limits the vertical mistake that can occur in old method and wraps up that it is a reliable diagnostic tool which can be considered in our daily diagnostic methods [18]. Therefore, in the present study, the assessment of incisors irregularity and other transverse measurements like (Intercanine width and Intermolar distance) on digitally scanned picture of dental casts can be one of the methods as an substitute to direct measurement on dental casts. For the evaluation of incisor irregularity by direct method on dental casts, measurements suppose to be taken parallel to occlusal plane, which is not usually precise as three dimensional measurements do occur. While on digital images these mistakes are nullified because of measurements along a single plane. Also it is suitable to preserve records in the form of photocopies as compared to dental casts. ExoCAD system was used for its accurate measuring method providing complete examination of the dental cast in all planes of space without any vertical mistakes or image distortion could occur and with very easy and simple technique.

Crooking of permanent teeth is an unaesthetic distinguishable character of most malocclusions. It might be either primary, happens during early mixed period of dentition as a result of genetic irregularity of tooth size and jaw size due to eruption of large mesiodistal width of permanent incisors in place of small mesiodistal width of deciduous incisors or secondary, appearing in teenager as a result of continuous growth of the mandible which grows beyond the anterio-posterior growth limit of maxilla as a result of cephalocaudal growth gradient [19].

In the present study, severe anterior crowding was occur in the mandibular arch of CL I female patient than in male, with the maximum reduction in both anterior and posterior arch width (i.e. ICD and IMD respectively), this could be attributed to the skeletal maturity of female group earlier than that in male as well as the age range 14-18 years exhibits the highest frequency of incisors crooking between the age groups, this is in accordance with Madhusudhan and Mahobia [20]. The crooking in the anterior teeth went up during growth particularly in the mandible [21]. The role of wisdoms in lower incisor crooking has in doubts for a several years. The wisdom teeth not included in the inclusion criteria of this paper because there is no sense demonstrates these teeth really play a role in anterior crowding [22-24]. Only one theory commonly stated that "the third molars creating space to erupt by causing anterior teeth to crowd" [25]. There are several factors affect the prevalence of mandibular crowding in female subject since she is more dependent on vegetable food habit, soft diet and refined food habit which might have lead to lower anterior segment crowding than that in male subject. Thus, the results underline the orthodontist attention should be given to the mandibular anterior crowding, because these teeth have more possibility to relapse post-treatment so careful attention should be taken in treatment plan for female patient with very severe mandibular anterior crowding in CL I malocclusion at this chronological age also it is better to use a fixed retainer instead of a removable retainer [26].

Whereas, a very minimal irregularity was showed in female group with the CL III malocclusion in the mandibular dental arch in relation with increase in ICD and IMD values however, it isn't significant than in male. This is due to the fact that in CL III malocclusion if caused by protrusion of mandibular jaw will result in increase in the arch width in both anterior and posterior region resulting in anterior teeth will be arranged in a well aligned position with a minimal crowding [10] , in association with

the reduction in maxillary arch width resulting in that this irregularity occur towards moderate –severe level in the maxillary arch in male group than in female with significant reduction in the arch width anteriorly and posteriorly. This could be attributed to the earlier skeletal growth in female than male even at the same chronological age as showed in the results of skeletal maturity in the present study. Therefore orthodontic treatment during adolescence with skeletal discrepancies is to take the advantage of the patient's growth change; therefore, prediction of both the time and amount of active growth, especially in the craniofacial complex would be useful to ensure successful outcome in the treatment of dentofacial deformities.

Surprisingly, also very severe irregularity of anterior region was shown in male group with CLII malocclusion in the maxillary arch and with a non-significant difference than female in the mandibular arch however; reduction in arch width occur in the mandibular arch as compared between groups thus resulting in small lower arch with nearly severe crowding and as a result the anterior maxillary region exhibit very severe crowding in order to accommodate the reduction in the lower arch, therefore early treatment of CL II male patient must be considered to avoid such crowding however; further mandibular growth may be occur in male group when they reach to the maximum growth spurt.

Conclusions

The conclusions that can be drawn from this study are:

1- The higher prevalence of crowding of one or more incisors was a common feature in the female group in the mandibular arch with the CL I malocclusion.

2- In male group severe crowding exist in the maxillary arch of CL II malocclusion patients.

3- In female group, the widest arch anteriorly and posteriorly occur in maxillary and mandibular arches in CLIII malocclusion, whereas the narrowest one in the mandibular arch in CLI malocclusion.

4- In male group, the widest maxillary arch anteriorly and posteriorly occur in CLI malocclusion and in the mandibular arch occur in CLIII malocclusion whereas the narrowest one in the maxillary arch in CLIII malocclusion anteriorly.

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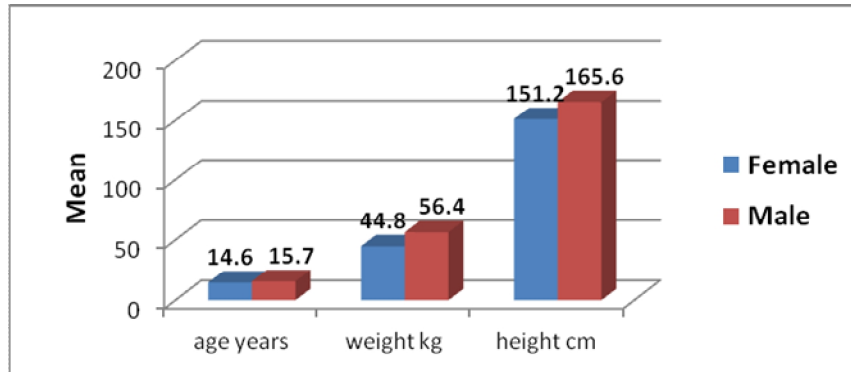
Figure 4: Bar chart to show the gender distribution of the sample for physical characters, (Age, Weight and Height).

Table 1: Discriptive statistic for digital variables of each dental arch for each dental malocclusion classes of both genders

| Gender	Groups	Statistic	I.M. distance , mm		I.C. distance , mm		Little's index , mm	
			max.arch	mand.arch	max.arch	mand.arch	max.arch	mand.arch
Female	CL I	Mean	48.35	41.64	32.08	23.29	6.98	13.13
		SD	0.983	1.303	0.838	0.982	0.509	0.677
	CL II	Mean	47.81	42.27	31.92	25.91	3.59	6.26
		SD	1.108	0.978	1.651	1.249	1.179	0.755
	CL III	Mean	49.45	45.63	35.04	30.48	6.14	3.14
		SD	1.749	2.178	1.398	1.427	0.976	0.882
Male	CL I	Mean	56.54	47.22	38.59	29.32	9.62	5.87
		SD	1.385	1.155	1.34	0.764	1.556	0.48
	CL II	Mean	46.8	42.06	35.35	27.93	11.7	9.36
		SD	2.027	1.403	1.382	0.563	1.928	0.667
	CL III	Mean	42.97	51.1	26.43	33.11	8.57	3.74
		SD	1.155	0.911	0.82	1.298	1.796	0.554
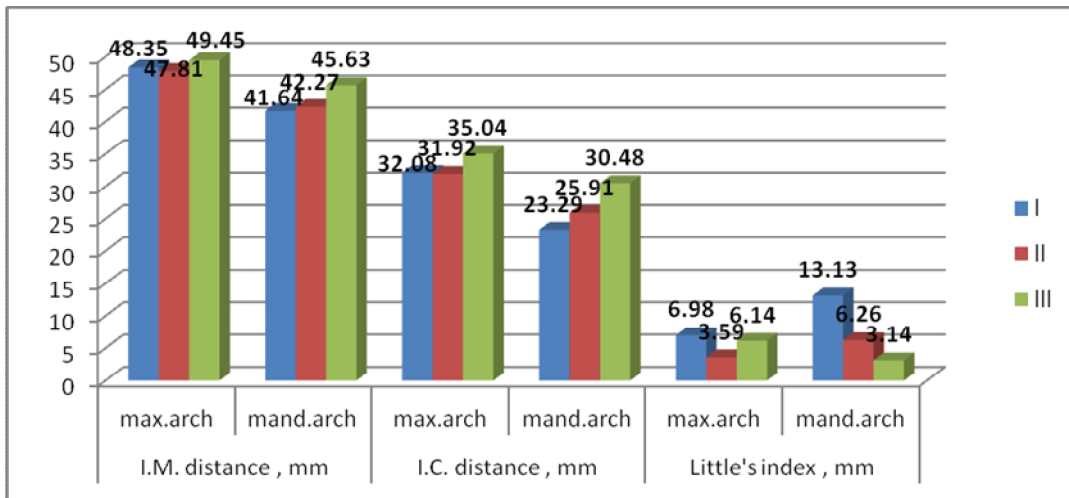
Figure 5: Bar chart show the distribution of digital variables in maxillary and mandibular dental arches in female group
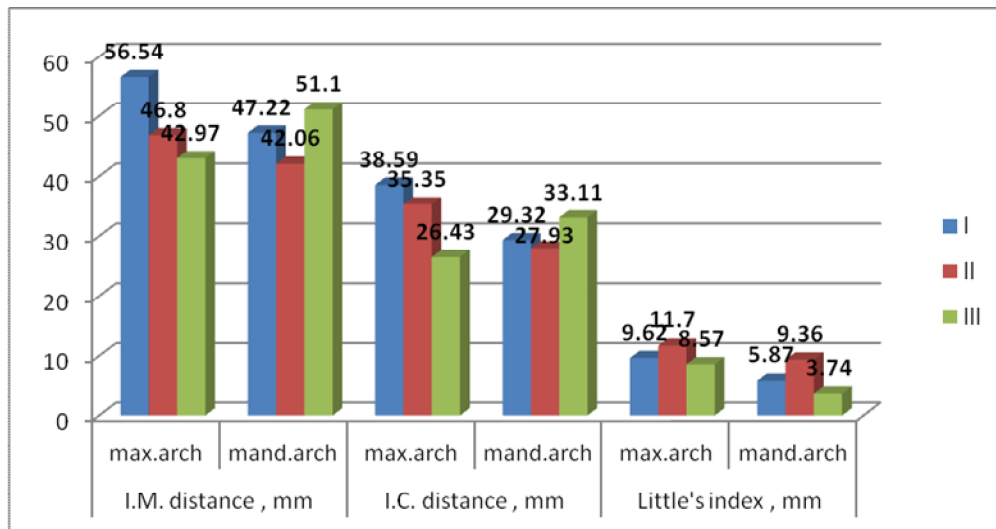

Figure 6: Bar chart show the distribution of digital variables in maxillary and mandibular dental arches in male group

Table 2: ANOVA with F-test to show the significant differences between dental malocclusion classes for each gender group

Gender	Groups	Statistic	I.M. distance , mm		I.C. distance , mm		Little's index , mm	
			max.arch	mand.arch	max.arch	mand.arch	max.arch	mand.arch
Female	l,ll,lll	F-test	1.983	9.339	8.613	43.53	17.885	216.6
		P-value	0.18 NS	0.004 S	0.005 S	P<0.01 HS	P<0.01 HS	P<0.01 HS
Male	l,ll,lll	F-test	99.671	74.527	135.6	41.733	4.056	122.9
		P-value	P<0.01 HS	P<0.01 HS	P<0.01 HS	P<0.01 HS	0.045 S	P<0.01 HS

*P<0.05 Significant, **P>0.05 Non significant, ***P<0.01 High significant.

Table 3: Gender differences of digital variables using T-test between male and female of CL I malocclusion group

Group	Digital variables	Dental arch	t-test	P-value	Sig
CL I	IMD (mm)	max.arch	-10.778	.000	HS
		mand.arch	-7.160	.000	HS
	ICD (mm)	max.arch	-9.213	.000	HS
		mand.arch	-10.827	.000	HS
	LII (mm)	max.arch	-3.613	.007	S
		mand.arch	19.571	.000	HS

*P<0.05 Significant ,**P>0.05 Non-significant, ***P<0.01 High significant.

Table 4: Gender differences of digital variables using T-test between male and female of CL II malocclusion group

Group	Digital variables	Dental arch	t-test	P-value	Sig
CL II	IMD (mm)	max.arch	.979	.356	NS
		mand.arch	.274	.791	NS
	ICD (mm)	max.arch	-3.559	.007	S
		mand.arch	-3.291	.011	S
	LII (mm)	max.arch	-8.016	.000	HS
		mand.arch	-6.873	.000	HS

*P<0.05 Significant, **P>0.05 Non-significant, ***P<0.01 High significant.

Table 5: Gender differences of digital variables using T-test between male and female of CLIII malocclusion group

Group	Digital variables	Dental arch	t-test	P-value	Sig
CL III	IMD (mm)	max.arch	6.905	.000	HS
		mand.arch	-5.174	.001	S
	ICD (mm)	max.arch	11.871	.000	HS
		mand.arch	-3.048	.016	S
	LII (mm)	max.arch	-2.662	.029	S
		mand.arch	-1.270	.240	NS

*P<0.05 Significant, **P>0.05 Non-significant, ***P<0.01 High significant.