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Persuading Factors for Tooth Extraction Decision in Treatment of Class 1 Maloclusion among Orthodontists in Sulaimani City

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Abstract: *The extraction rate in orthodontics varies throughout the years. While the extraction decision is easily made or excluded in clear-cut cases, it still remains controversial what makes an orthodontist decide to extract in borderline cases.*

The aim of this retrospective study are to identify the percentage of extraction cases in a sample group of Class I malocclusions and to clarify which variables contributed most to the extraction decision.

Seventy class I malocclusion cases were selected from Shorsh Dental Center and in three private orthodontic offices. Fifty three of these patients were female and seventeen male. The mean age was 19.7 (standard deviation (SD) 5.5) for the non-extraction group and 18.2(SD5.3) for the extraction group.

The extensive series of 17 linear and angular measurements derived from the cephalometric analysis and 6 measurements from the dental cast, along with the variables of age and gender.

The percentage of the patients treated with premolar extractions was 44.2%. The results showed that the variables of lower lip to E-plane, crowding, and overjet, U1-L1, L1-NB accounted most for the decision to extract at a very significant level.

In sample of 70 Class I patients, the extraction rate was 44.2%. The most important measurements when the orthodontist decides extractions in Class I cases are lower lip to E-plane, crowding, overjet, L1-NB and U1-L1. In clinical orthodontic practice, the findings facilitate treatment by providing evidence-based treatment predictors for Class I malocclusions.

Keywords : *Class 1 malocclusion, Extraction, orthodontic diagnosis*

I. Introduction

A malocclusion is defined as an irregularity of the teeth or a mal-relationship of the dental arches beyond the accepted range of normal[1]. Malocclusion is common in modern society[2]. If untreated, maloccluded teeth can cause psychosocial problems related to impaired dentofacial aesthetics, disturbances of oral function, such as mastication, swallowing, and speech, and greater susceptibility to trauma and periodontal disease[1]. Although malocclusion is not life threatening[3]. It can be considered as a public health problem due to its high prevalence, prevention and treatment possibilities[4]. The etiology of malocclusion may be genetically determined factors, environmental factors or more commonly a combination of both inherited and environmental factors acting together[5].There are various local factors such as adverse oral habits, anomalies in number, form and developmental position of teeth can cause malocclusion[6]

In class1 malocclusion a common condition often exists: discrepancy between tooth size and arch size. Orthodontics is primarily concerned with lack of arch space within the alveolus, and there currently are two primary treatments to resolve tooth size versus arch size discrepancy (TSASD). The first involves the extraction of teeth to gain the space needed for tooth alignment. The second relies on arch expansion to gain the space needed for correction[7]. Extraction rate in orthodontics shows strong variations depending on the decade and socioeconomic factors. In the 1950s, 10% of the cases were treated with extractions whereas in the following decade, the percentage climbed up to 50% until the 1980s when it dropped to the contemporary number of 30%[8-12].

Premolar extraction is a common treatment option for tooth size versus arch size discrepancy because it provides space for subsequent correction. Controversy not only lies with which teeth should be extracted, but also the consequences of space closure. According to extraction opponents, closing extraction spaces reduces the radius of the dental arch [13], negatively impacts facial esthetics[14], and promotes airway deficiency. Through “careless” retraction of the maxilla, the mandibular arch is forced to fit into a maxillary arch that is too small, which decreases airway volume, increases parafunction, increases the risk of temporomandibular disorder (TMD), and increases chances of obstructive sleep apnea[15].

In diagnosing and treatment planning a case, the orthodontist examines a series of variables that lead him to his final decision. These variables are the measurements of the cephalometric analysis and the models along with the age and sex of the patient. Other factors like periodontal condition, restorations, and congenitally missing or extracted teeth also have an impact on the decision. After taking all of the above factors into consideration, the treatment plan is established and the need for or not for extractions is justified[16,17].

The knowledge of the variables which account for favoring one therapeutic approach over the other will help expedite the decision making and will serve to establish treatment predictors. The numerical value of these variables will also be a valuable tool when diagnosing a Class I case. In order to identify which variables have an impact on the orthodontist's decision whether to extract or not, it is necessary to know in which characteristics patients treated in one way tend to differ from those treated in another way. The characteristics of the patient that lead a clinician to a given treatment decision are known as confounding variables. Discriminant analysis is the ideal statistical multivariate technique that deals simultaneously with large numbers of confounding variables[18,19].

II. Methodology

The sample was 70 patients (males & females) with Class I malocclusion selected from Shorsh Teaching Dental Center/ orthodontic clinic and three private orthodontic offices. It was decided to gather records from Shorsh Teaching Dental Center where there is a substantial number of different supervisors and residents and also from three different private offices in order to eliminate selection or proficiency bias attempting thus to reflect contemporary treatment philosophy regarding extraction treatment of Class I malocclusions.

The following criteria of sample selection were considered:

1. Bilateral angle class I molar relationship with a full complement of teeth (excluding the third molars) who presented with a Class I dental and skeletal malocclusion.
2. Age ranged between (14 -25) years.
3. No history of any cleft, dentofacial deformity, or syndrome, and they are not receiving any previous orthodontic treatment.

Data- recording sheet has been prepared containing: name, age, gender, extraction and non-extraction.

Cast measurements was done by using digital caliper gauge (Measures up to 100mm; 0.01mm resolution), in-credible pencil ,ruler including : Overbite, Overjet, Midline shift and Crowding.

All cephalometric radiographs used in this study were obtained by a single operator and in a single machine (Digital cephalometric x ray system Pax 400c-Vatech)and they were taken in natural head position. The cephalometric analyses performed by using special software (AutoCAD 2013) and the cephalometric measurements are illustered in "Table 1 "[19].

The lateral cephalometric x- imported to the personal computer with the use of AutoCAD software program 2013. Then the magnification correction was done in reference to the attached L-shaped ruler (Nasion holder) which is scaled shown in lateral cephalometric radiograph , so that the real measurements were obtained .After that land marks were identified in the profile views, then(angular and linear) measurements were conducted accordingly .

The parameters used in the study were taken from Steiner, Downs, Mcnarama, Jaraback, Rickets, Wit analysis. Overall 17measurments including 8 linear, 9 angular were used.

Sixteen landmarks were identified, it was performed on the personal laptop with software AutoCAD 2013. Points were located on a computer screen and not traced on acetate.The following alphabetical listing of the cephalometric landmarks used in this study .As shown in Figure (1): Sella (s), Nasion (n), Anterior point on the frontonasal suture, Point (A), Point (B), Anterior nasal spine (ANS), Posterior nasal spine (PNA), Menton (Me), Gonion (Go), Pogonion, Porion (po), Orbitale (or), Pronasale (prn), U1 tip, U1 apex, L1tip, and L1 apex as" Fig.1".

Nine angular measurements were taken as shown in (Fig.2) : SNA (Sella–Nasion–A Point), SNB (Sella-Nasion-B point), ANB, U1-SN, U1-NA, L1-NB, FMIA , IMPA, U1-LI (interincisal angle) as " Fig. 2"

Eight Linear measurements were taken: AO-BO (Wits appraisal) , N-ANS (Upper anterior facial height) ' ANS-Me (Lower anterior facial height), N-Me (Total anterior facial height), U1-NA (mm), L1-NB (mm), L1-A Pg (mm), LL-E-plane (mm)"Fig.3"

To test the reliability of the methods that were used in this study including anthrometric landmark identification and cephalometric procedure, intra- examiner, inter-examiner, and manual calibration procedure were done. Acetate paper was taped over ten radiographs, all the cephalogram were traced by single operator on acetate tracing paper with 5H pencil and landmarks commonly used to assess dentofacial relationships will be identified with the 5H pencil using the Frankfort plane as the horizontal reference plane. The midpoint of bilateral structures and double images was chosen by construction. Measurements were obtained using a ruler and protractor.

III. Results

Table 2, shows the mean age of male and female in extraction group and non extraction group. The mean± SD age of male in extraction group was 14.4 ± 2.3 years while in non-extraction group was 21.7 ± 6.5 years, the difference was statistically significant (P< 0.05) and the mean± SD age of female in extraction group was 18.3 ± 4.9 years while in non-extraction group was 19.2 ± 5.2 years, the difference was statistically non significant .Whereas ,The mean± SD between the age (male and female) of extraction group and the age (male and female) of non-extraction group was not statistically significant (P> 0.05) .

Statistical analyses revealed that the mean ± SD of SNA, SNB, ANB, U1-SN, U1-NA, FMIA, IMPA, and overbite were not statistically different between extraction group and non-extraction group as shown in Table (2).

The mean ± SD of L1-NB of extraction group was 30.5 ± 4.3 and L1-NB of non-extraction group was 28.1 ± 3.1, the difference was statistically significant (P<0.05), Table 2 and Figure 1. The mean ± SD of U1-L1 of extraction group was 121.1 ± 8.7 and of U1-L1 of non-extraction group was 126.1 ± 9.2, the difference was statistically significant (P< 0.05), “Table 3” .

The mean ± SD of U1-NA, WITS, N-ME, N-ANS, ANS-ME, were not statistically different between extraction group and non-extraction group (Table 2). The mean ± SD of L1-NB(mm) of extraction group was 5.4± 1.6 and of L1-NB of non-extraction group was 4.4±1.5, the difference was statistically significant (P< 0.01), “Table 3”

The mean ± SD of L1-APg of extraction group was 3.5 ± 1.2 and of L1-A Pg of non-extraction group was 2.8 ± 1.0, the difference was statistically significant (P< 0.05).

The mean ± SD of over jet of extraction group was 3.03 ± 0.92 and of over jet of non-extraction group was 3.48 ± 0.73, the difference was statistically significant (P< 0.05), Table 3 and Fig 8. The mean ± SD of LL-E-plane of extraction group was 2.27 ± 0.81 and of LL-E-plane of non-extraction group was 2.61 ± 0.59, the difference was also statistically significant (P< 0.05), “ Fig. 9”.

Midline deviation of extraction group and non-extraction group was also nearly similar .The percentage of upper and lower crowding was 86.7% in extraction group and 63.3% in non-extraction group. The relationship between type of crowding and extraction and non extraction status was statistically significant, P< 0.05 “Table 5 and Figure 10”.

“Table 4” shows the gender distribution between extraction group and non-extraction group was nearly similar. The number and percentage in extraction group was 31 (44.3) but in non- extraction group was(55.7). Outcome of multivariate logistic regression analysis showed that there was an association between crowding, over jet, L1-NB, U1-L1, and LL-E-plane and extraction decision. LL-E-plane increased the probability of extraction 2.5 times, P<0.05. Crowding increased occurrence of extraction about 2.3 times, P<0.05. Over jet increased the occurrence of extraction to 1.9 times, P<0.05. U1-L1 increased the probability of extraction to 1.7 times, P<0.05. L1-NB increased occurrence of extraction1.5 to 1times, P<0.05 (Table 6).

IV. Discussion

In orthodontics, extractions have been traditionally highly debated and their percentage has displayed considerable variation throughout the years depending on treatment trends and other various factors. In the present study, in overall seventy patients with class I malocclusions the number and percentage of the patients treated with premolar extractions was (31) 44.3%.

According to the study carried out by Proffit at the University of North Carolina in the 1950s, only 10% of the cases were treated with four first premolar extractions [20] . The following decade, the percentage attained its peak with 50% and remained there until the 1980s when it started decreasing [21-25]. The decrease in extraction rates was attributed to the lack of evidence in the literature regarding treatment stability after extractions, as well as to the non-evidence -based theory of extraction association to TMJ dysfunction. Numerous studies suggest that biotechnology innovations along with the tendency for fuller lips bring the extraction rate up to 30%, hence reaching the level of the early 1990s [15].Konstantonis et al.carried out study in 2013 for 542 Class I patients treated in a university graduate program and in five private orthodontic offices result showed the extraction rate was 26.8% . Thus extraction decision in orthodontics shows strong variations depending on the decade and socioeconomic factors [19].Orthodontists traditionally follow a specific diagnostic process which helps them gain confidence into decision making. Parts of this process are the cephalometric analysis, the study of diagnostic dental casts and the consideration of other parameters such as age and gender. The decision seems easier to make when addressing a clear - cut rather than a borderline case.

In borderline cases, we tried to quantify clinicians' favorite parameters, according to which his decision about extractions is made.

The logistic regression analysis incorporated five variables that were unique in their ability to discriminate between the two different treatment approaches.
The first variable was the measurement of lower lip to E -plane which is an indication of the patient's profile.

This widely used measurement which is the distance of the lower lip to the E-plane as suggested by Ricketts still remains a very prevalent tool when diagnosing a case [26].

When the lips show inadequate projection, the orthodontist is quite reluctant to extract, but when they exceed the E-plane, extractions are easier to decide. This result came to verify the importance facial aesthetics have for the vast majority of orthodontists upon treatment planning [15,19,26,27].

The second most important variable was crowding. Indeed, the clinicians base a big part of their treatment decision on crowding .This variable was found to be of paramount importance in similar studies conducted by Baumrind et al, Luppanapornlarp et al , Konstantonis D,and Dhiman et al [15,19, 27-29].However in the present study the crowding was not measured in millimeters since the number of extracted unit was not specified in the extraction sample comparison in addition to the limited sample size beside, whatever there will be crowding the orthodontist will consider the amount of crowding as a significant variable in extraction decision.

Furthermore, the overjet was found to be the third important variable which could possibly lead to an extraction decision in Class I cases constitutes an indication of teeth and soft tissue projection, thus playing an important role in balanced dental and facial aesthetics. Excessive overjet is usually noted in dentoalveolar bimaxillary protrusion cases which they are routinely addressed with removal of four first premolars.

Another variable which could possibly lead to an extract ion decision is U1 L1 (interincisal angle) which is the angle between long axis of upper and lower incisors as suggested by Stenier

The variable of U1-L1 is an indication of Upper -lower incisor relationship. The inter incisal angle affect long term stability after treatment.

In the nonextraction group, because of the proclination of the mandibular and maxillary incisors, the interincisal angle decreased significantly with treatment, after that increases in interincisal angles.

In the extraction group, the interincisal angle significant increased with treatment and stayed stable [15,19,27]. L1-NB(mm) was found to be important variable which could possibly lead to an extraction decision .which is the distance of the lower incisor to the NB by Stenier. The variable of L1 NB is an indication of the Lower incisor position and inclination which is important for the 45 stability oftreatment[30].Brodie studied non – extraction orthodontic patients, and Cole studied extraction patients; both concluded that the axial inclination of teeth disturbed by orthodontic treatment tends to return to pretreatment conditions [31-32].

Weinber gand Sadowsky reported that the protrusion of mandibular incisors can predispose them to relapse [31]. On the other hand, Freitas et al reported that final mandibular incisor inclination and linear protrusion do not influence crowding relapse [34]. Schulaf et al reported that the mandibular incisor anteroposterior position relative to various cephalometric values had no relationship to post retention crowding of mandibular incisors [35] .It is interesting that most of the variables represent linear measurements routinely obtained by the orthodontist upon clinical examination. Without use of cephalometric radiographs the measurements including the amount and position of the lips in relation to the face can also be estimated upon clinical screening, yet clinical appraisals were included in the present study. Surprisingly, the orientation of the lower incisor to the basal bone or the face as appraised in various angles like IMPA, FMIA was not included into the discriminatin g variables. In similar studies,the lower incisor angle was found to be an important variable with the ability to discriminate between the two treatment modalities [27-29].

As it is clear that extraction will absolutely affect the profile of the patient moreover recent trends contribute the successful orthodontic treatment with the well balanced soft tissue relation other than stability and occlusion of the teeth.

There are probably other popular measurements of morphological characteristics on which clinicians base their treatment decision, but these five were detected by the analysis as the most important ones when deciding extractions. These findings apply to the sample they were derived from which was 70 patients and will possibly vary if the research is repeated in different populations treated by other orthodontists. The equation derived from the logistic regression analysis is a useful adjunct to consult when in doubt regarding extractions in Class I cases.

V. Conclusions

In a sample of 70 Class I patients treated in Sulaimani Governorate, the extraction rate was 44.3%. According to the logistic regression analysis, when deciding extractions to address Class I cases, the orthodontist mainly considers the measurements of lower lip to E-plane, crowding, and overjet, U1-L1, L1-NB. The employment of a simple mathematical model which includes five ‘key’ orthodontic measurements provides a quick way of assigning treatment type regarding extractions in Class I malocclusions.

Table 1. Cephalometric measurements, Normal value, and Characteristics.

N.O	Variable	Normal value	Characteristics
1	SNA(Steiner)	80°	Maxillary position
2	SNB(Steiner)	82°	Mandibular position
3	ANB(Steiner)	2°	Maxillo-mandibular relationship
4	U1-SN(Steiner)	103	Upper incisor inclination
5	U1-NA(Steiner)	22°	Upper incisor inclination
6	FMIA(Tweed)	65°	Lower incisor inclination in relation to FH
7	IMPA(Tweed)	90°	Lower incisor inclination in relation to MP
8	L1-NB(Steiner)	25°	Lower incisor inclination in relation to NB
9	U1-L1(Down)	130°	Upper-lower incisor relationship
10	U1-NA(Steiner)	4mm	Upper incisor position and inclination
11	L1-NB(Steiner)	4mm	Lower incisor position and inclination
12	L1-A Pg(Ricketts)	0-2 mm	Lower incisor position
13	Wits apprasial(Wit's)	(0)mm	Maxillo-mandibular relationship
14	N-Me(BjrokJarabak's)	(105-120)mm	Total face height
15	N-ANS	(50-55)mm	Upper face height
16	ANS-Me (Ncnamara)	(60-65)mm	Lower face height
17	LL-E-plane(Ricketts)	2mm	Lower lip protrusion

Table 2. Age distribution of extraction and non-extraction groups according to gender.

Gender	**Age of extraction group** Mean ± SD	**Age of non-extraction group** Mean ± SD	**P value**
Male	14.4 ± 2.3	21.7 ± 6.5	0.029
Female	18.3 ± 4.9	19.2 ± 5.2	0.534

Table 3. Descriptive statistics.

Variable	**Extraction (No.= 31) Mean ± SD**	**Non-extraction (No.= 39) Mean ± SD**	**P value**
SNB°	77.6 ± 2.5	77.8 ± 3.5	0.763
ANB°	3.0 ± 1.7	2.8 ± 1.6	0.636
U1-SN°	106 ± 6.1	104 ± 5.3	0.151
U1-NA°	25.1 ± 6.6	23.8 ± 5.9	0.364
FMIA°	55.8 ± 7.9	58.7 ± 5.8	0.091
IMPA°	97.5 ± 5.1	96.0 ± 6.7	0.294
L1-NB°	30.5 ±4.3	28.1 ±3.1	0.042
U1-L1°	121.1 ± 8.7	126.1 ± 9.2	0.022
U1-NA(mm)	5.3 ± 2.0	5.1 ± 1.6	0.642
L1-NB (mm)	5.4 ± 1.6	4.4 ± 1.5	0.009
L1-A Pg (mm)	3.5 ± 1.2	2.8 ± 1.0	0.039
WITS (mm)	1.7 ± 1.1	2.1 ± 1.8	0.284
N-Me (mm)	93.4 ± 6.3	93.6 ± 5.9	0.885
N-ANS (mm)	41.1 ± 2.3	41.8 ± 2.7	0.249
ANS-Me(mm)	53.1 ± 4.2	53.6 ± 4.6	0.637
Over bite (mm)	2.8 ± 1.4	2.9 ± 1.8	0.797
Over jet (mm)	3.03 ± 0.92	3.48 ± 0.73	0.023
LL-E-plane (mm)	2.27 ± 0.81	2.61 ± 0.59	0.043
Age (**year)**	18.2 ± 5.3	19.7 ±5.5	0.259

Table 4. Association of gender to extraction and non-extraction groups .

Variable		Extraction (No.= 31)No. (%)	Non-extraction (No.= 39) No. (%)	P value
Gender	Male	5 (16.1)	12 (30.8)	0.156
	Female	26 (83.9)	27 (69.2)	
Total		31(44.2)	39 (55.7)	

Table 5. Descriptive statistics.

Crowding	None	1 (3.2)	9 (23.1)	0.018
	upper	3 (9.7)	7 (17.9)	
	lower	1 (3.2)	4 (10.3)	
	Upper & lower	26 (83.9)	19 (48.7)	
Midline deviation	None	5 (16.1)	6 (15.4)	0.382
	Upper	3 (9.7)	5 (12.8)	
	Lower	12 (38.7)	21 (53.8)	
	Upper &lower	11 (35.5)	7 (17.9)	

Table 6. Outcomes of multivariate binary logistic regression analysis: factors affecting extraction decision.

Factors affecting extraction decision	P value	Odds ratio	95% CI	
			Lower	Upper
LL-E-plane (mm)	0.010	2.5	1.5	3.9
Crowding	0.036	2.3	1.3	3.8
Over jet	0.025	1.9	1.1	3.4
U1-L1^0	0.042	1.7	1.2	3.8
L1-NB (mm)	0.048	1.5	1.0	2.6

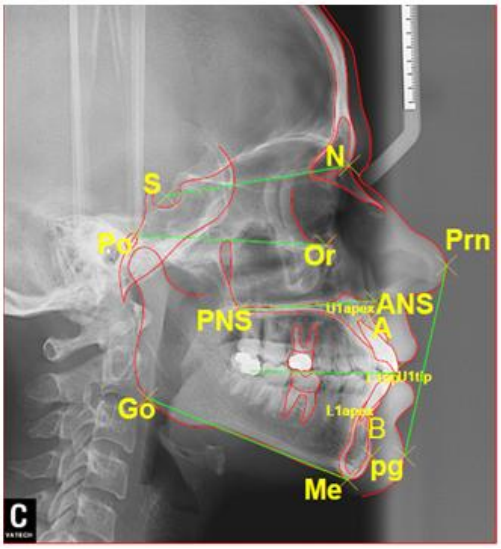

Figure 1. Reference planes on cephalometric radiograph

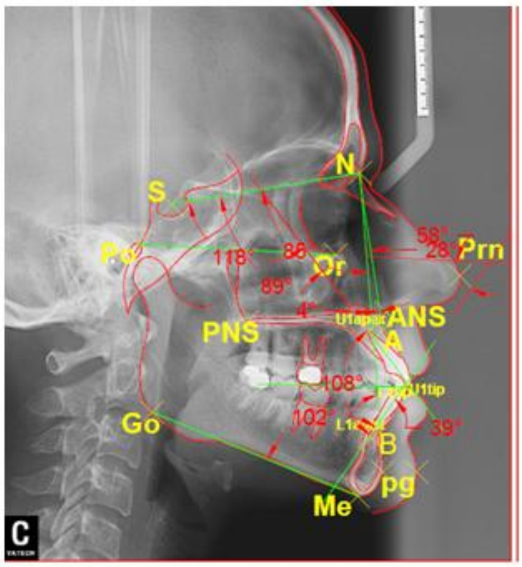

Figure 2. Linear measurements on cephalometric radiograph

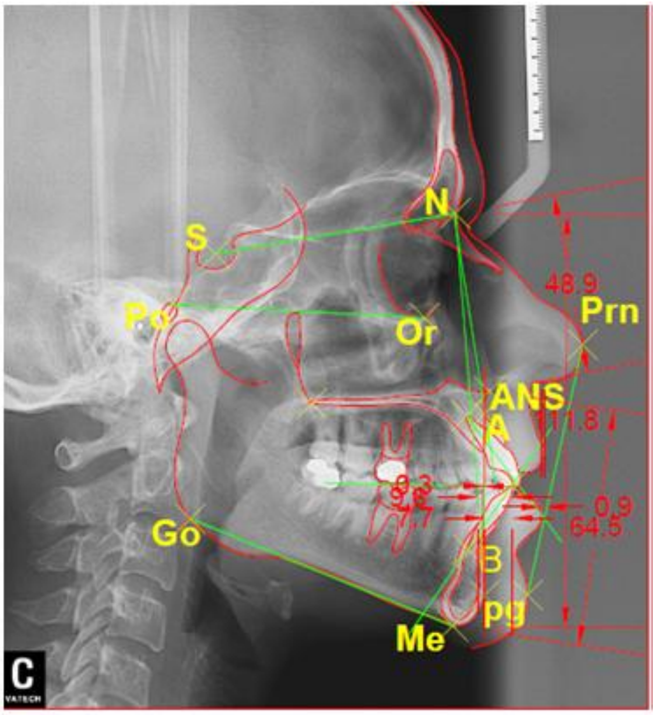

Figure 3. Angular measurements in cephalometric radiograph

Figure 4. Mean L1-NB° in extraction group and non-extraction group.

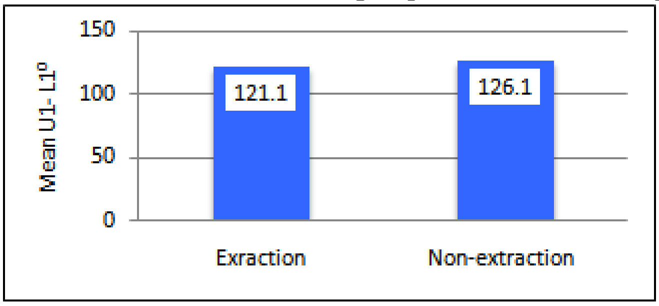

Figure 5. Mean U1-L1 in extraction group and non-extraction group.

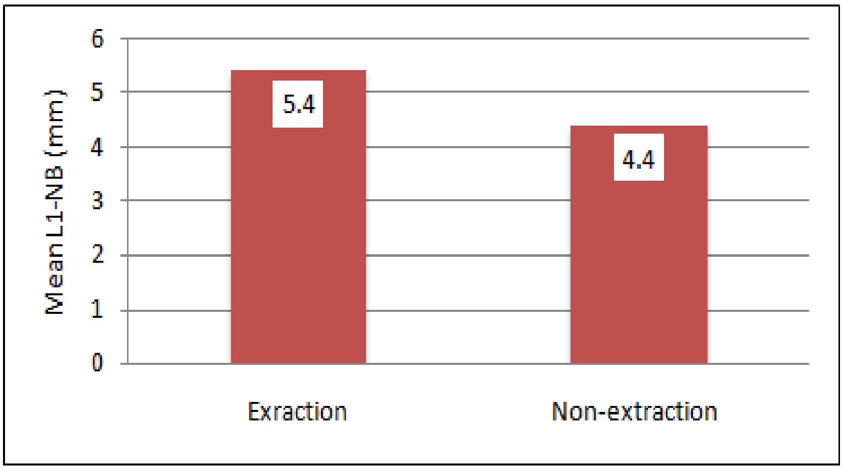

Figure 6. Mean L1-NB(mm) in extraction group and non-extraction group.

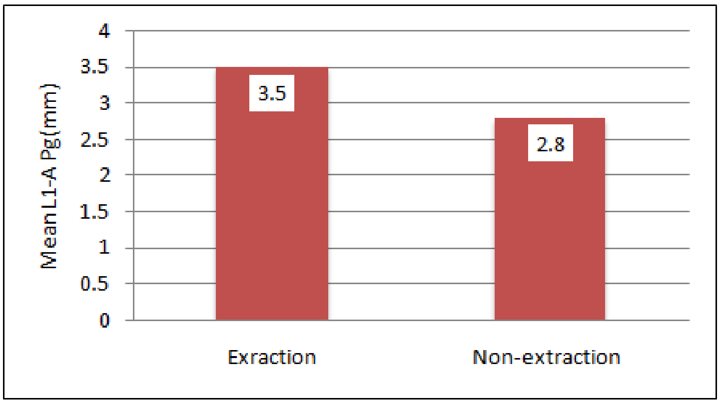

Figure 7. Mean L1-A Pg in extraction group and non-extraction group.

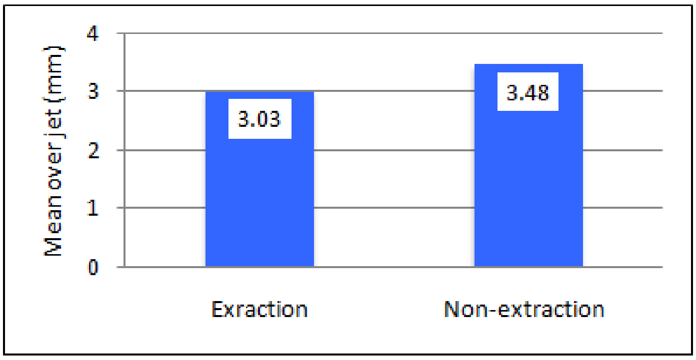

Figure 8. Mean over jet in extraction group and non-extraction group.

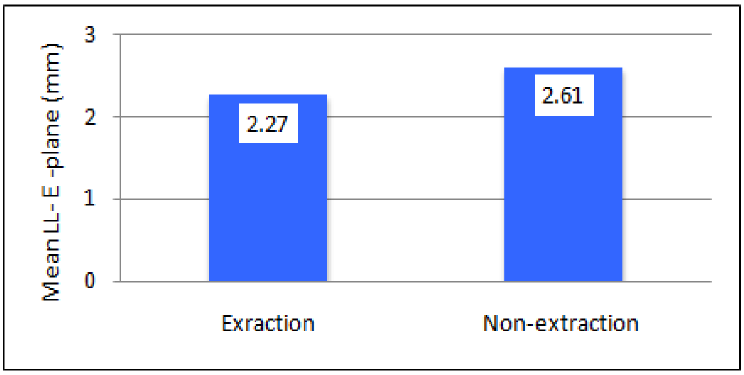

Figure 9. Mean LL-E-plane in extraction group and non-extraction group.

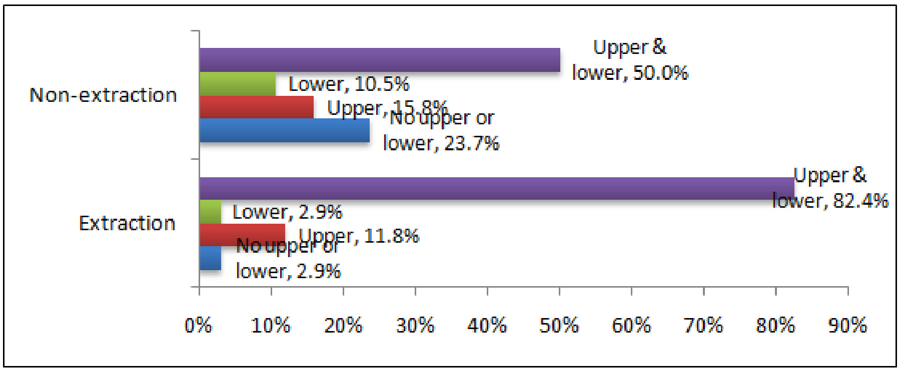

Figure 10. Crowding in extraction group and non-extraction group.

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