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T-SCAN III POST-ORTHODONTIC TREATMENT OCCLUSAL ANALYSIS IN EXTRACTION CASES

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ABSTRACT

Aim: The aim of this study was to measure the occlusal parameters of orthodontically treated cases with premolar extraction (experimental group) and compared the result with the measures of non-orthodontic normal occlusion subjects using T-Scan III system.

Subjects and methods: The study included 48 participant 32 female and 16 males with age ranging from 17 to 28 years, divided into two groups; experimental group included 24 patients (16 females and 8 males) who finished their orthodontic treatment which included extraction of permanent first premolars teeth and control group which included 27 untreated participants (15 females and 9 males) had class I molar and canine relation with normal anterior and posterior overjet and overbite. T-Scan III occlusal analysis were performed for both groups in centric occlusion. Force distribution on right and left sides and presence of interferences were assessed.

Results: The results showed the presence of significant force distribution imbalances and premature contacts in experimental group when measured by the T-Scan technology. These force imbalances and interferences may act as a causative factor in post-orthodontic treatment instability, periodontitis, NCCL, appearance of TMD signs and symptoms and negatively affect the masticatory function.

INTRODUCTION

Occlusal relationship between maxillary and mandibular arches is one of the most important relations in the human body that affects growth, speech, esthetics, self-confidence and socialization. Simply it can be described by its two main aspects; static occlusion and functional occlusion (dynamic).

Static occlusion in orthodontics was established early based on the work of Angle followed by the work of Andrews, while functional aspects of occlusion were presented later by Roth who gave an attention to the importance of this occlusion aspect as a fundamental issue for orthodontic treatment completion. Occlusion also has an impact on

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orofacial muscles contraction and the well-being of temporo-mandibular joint (TMJ) and its surrounded structures such as ligaments and nerves. All these components in turn have an influence on the post orthodontic retention, stability and the function of the masticatory system.

Evaluation of occlusal quality in orthodontics is mostly inspected visually by; stone dental casts, articulating paper marks and feeling feedback of the patient. Most of the traditional occlusal indication methods are subjective, inaccurate, unreliable and may give false marks due to reasons associated with thickness, strength, physical properties resulting in distortion and false positive marks.

The evolution of Computerized digital occlusion analysis (T-Scan III®) offers dramatic diagnostic improvements over the traditional methods as it records the full arch contacts and multiple pinpoint locations of force intensity either in 2-D or in 3-D that cannot be washed away. The massive occlusal modifications in the; teeth contacts and position, and the inter-arch relationship after extraction of premolars and orthodontic treatment create a reasonable doubt around their effect on the occlusion and accordingly the stability of the orthodontic treatment and masticatory system coordination.

Aim of the study:

The aim of this study was to evaluate the occlusal analysis in extraction cases post-orthodontic treatment using T-Scan III; and compare it with normal cases.

MATERIAL AND METHODS

The ethics committee at the Faculty of Dentistry Ain-Shams University approved the study design after reviewing the study protocol. This study was a part of a Master's degree in orthodontics, Faculty of Dentistry, Ain -Shams University. No financial conflicts of interest were declared. The study was self-funded by the principle investigator.

Forty-eight patients participated in this study (32 females and 16 males), with the mean age of (17- 28 years). They were obtained from Ain-Shams University. They were divided into 2 groups, each group 24 individuals. **Group (A)** experimental group iincluded 24 patients (16 females and 8 males) from the outpatient clinic of the orthodontic department - Faculty of Dentistry - Ain Shams University who finished their orthodontic treatment which included extraction of permanent first premolars teeth, and **group (B)** control group Included 24 participants (15 females and 9 males) had class 1 molar and canine relation, normal overjet and overbite.

Study procedure

- Orthodontic patients who finished their finishing stage of treatment and volunteers with normal occlusion were evaluated according to inclusion and exclusion criteria.
- Participants who met the eligibility criteria were invited to participate in this study.
- Participants who agreed to participate were given a full detailed explanation of the study before any procedure.
- An informed consent was signed by the participants before their enrollment in the study in which the aim of the study and the methodology were clearly described.
- For experimental group the records were taken after debonding within two weeks.

1. All T-Scan® recordings were made with subjects sitting upright in the dental chair.
2. Mesio-distal width of upper central was measured using periodontal probe, as this help in customizing the graphical dental arch in T Scan software, which contributes to good occlusal arch mapping during Participants trained to make the mandibular movement before record had been started. They were instructed to occlude in maximum intercuspation.

3. The recording sensor is inserted intra-orally between the dental arches so that the central mark is positioned between the central incisors of the patient.

Fig. (1) T-scan III Handle connected to a computer by USB cable.

The following measurements were recorded:

1. Bilateral force distribution percentage.
2. Individual tooth force percentages.

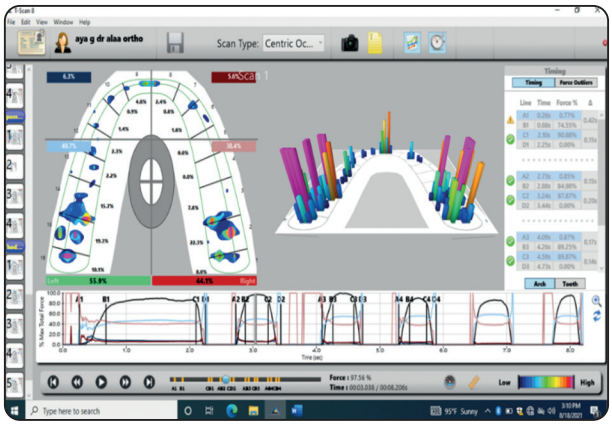

Fig. (2). T-scan® multi bite record for centric occlusion.

Data were collected and tabulated in excel sheet (Microsoft excel sheet 2010) for statistical analysis and comparing the study data with the control one.

Categorical data were presented as frequency and percentage values and were analyzed using Fisher's exact test followed by multiple pairwise comparisons utilizing z-test with Bonferroni correction. Numerical data were presented as mean and standard deviation (SD) values. They were explored for normality by checking the data distribution, and using Shapiro-Wilk test. Parametric data were analyzed using independent t-test. Non parametric data were analyzed using Mann-Whitney U test. The significance level was set at $p \leq 0.05$. Statistical analysis was performed with R statistical analysis software version 4.1.1 for Windows[1].

RESULTS

Centric Occlusion

1- Bilateral force distribution:

Mean, Standard deviation (SD) values of bilateral force distribution for different groups were presented in table (I) and figure (3).

For the heavy force side, results of **independent t-test** showed that experimental group had a significantly higher value than the control ($p<0.001$), while for the light force side, test results showed that the control group had significantly higher value ($p<0.001$).

TABLE (I) Mean, Standard deviation (SD) values and results of independent t-test of bilateral force distribution.

Side	Bilateral force distribution (mean±SD)		p-value
	Experimental	Control	
Heavy	59.02±5.67	52.67±1.09	**<0.001***
Light	40.98±5.67	47.33±1.09	**<0.001***

; significant (p ≤ 0.05), ns; non-significant (p>0.05)

1 R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Individual teeth force distribution:

Mean, Standard deviation (SD) values of individual teeth force distribution for different groups were presented in table II) and figure (4)

Results of **independent t-test** showed that for incisors and molars, experimental group had significantly higher force than the control group ($p<0.05$). For the premolars, control group had significantly higher value ($p<0.001$). For the canines, the difference between both groups was not statistically significant ($p=0.854$).

TABLE (II): Mean, Standard deviation (SD) values and results of independent t-test of individual teeth force distribution

Tooth	Individual teeth force distribution (mean±SD)		p-value
	Experimental	Control	
Incisors	9.72±6.2	6.52±4.02	**0.042***
Canines	5.38±2.82	5.21±3.39	**0.854ns**
Premolars	10.94±1.49	23.27±6.39	**<0.001***
Molars	72.09±7.90	62.52±9.31	**<0.001***

; significant ($p \leq 0.05$), ns; non-significant ($p>0.05$)

DISCUSSION

Symmetry of force distribution on right and left sides during closure in centric occlusion is considered a healthy sign in most of the subjects with normal occlusion as the occlusal forces spread equally between both sides. In the present study the bilateral force distribution was significantly different between the experimental and the control groups.

Force distribution on the right and left sides for control group was symmetrical which is in agreement with **Trpevska et al**,[1] **Koos B et al**[2] and **Qadeer et al**[3] who reported that the bilateral symmetry in force distribution was predominant in subjects with normal occlusion. For the experimental group there were asymmetry in the force distribution on the right and left side. This is in agreement with **Cohn et al**[4] who reported the presence of a moderate force imbalance in his study providing a rationale for occlusal balancing adjustment procedures during the stage of retention.

The result of experimental group in our study was different from the results of **Trpevska et al**,[5] **Koos B et al**[6] and **Qadeer et al**[7]. They found bilateral force distribution symmetry in the orthodontic group. This difference in the result between the experimental groups may be due to the difference in the criteria of the experimental sample.

In this study, the asymmetrical bilateral force distribution in centric occlusion of experimental group may have resulted from the presence of prematurity on the side of increased force and this was confirmed by the previously mentioned increase in occlusion time during closure in centric occlusion.

Uneven occlusal forces distribution between both sides of the mandible result in the difference in the level of activity of the masticatory muscles between both sides. This may enhance disorders in the temporomandibular joint.[8,9]

The force vector during mandibular closure in centric relation is perpendicular to the teeth occlusal surfaces. This type of force is highly tolerated by the posterior teeth but less tolerated by anteriors. Individual tooth force distribution in centric occlusion normally increases gradually from anterior to posterior teeth reaching the peak in the molar area as the occlusal surface area increases and attains the capacity to sustain high occlusal forces. As the forces are distributed evenly on the teeth surfaces according to the occlusal surface area, this will aid in the stability of the occlusion and maintain the masticatory system performance.

In the present study, there was a significant increase in incisors and molars force distribution in the experimental group compared to the control

group. This difference between both groups in the force distribution increased more in the molar region.

This result is in agreement with, **Qadeer et al**[3] who found that the force percentage on second molar was significantly increased in the orthodontic group compared to the non-orthodontic group, owing this to the high prevalence of interference in second molar among orthodontic patients. This may be due to the unengaged second molar in the orthodontic treatment.

From the above-mentioned results, we can deduce that after premolar extraction and orthodontic space closure, occlusal load in the premolar region redistributes on the dental arch anteriorly and posteriorly but most of the load moves to the molar region.

Uneven force distribution on the occlusal surfaces of the teeth lead to increase the occlusal load on specific teeth more than the rest which may affect their periodontium and hence, decrease their occlusal stability.[10,11]

CONCLUSION

Based on the result of this study it can be concluded that:

1- T-Scan III is a valuable tool for assessment of occlusion and detection of occlusal imbalances and interferences which can't be detected by the naked eye or another method of occlusal detectors.

2- T-Scan occlusal analysis of orthodontic treated cases with premolar extraction when compared with that of normal untreated subjects showed increase in the incidence of premature contacts in centric occlusion that leads to increased occlusion time (OT) and uneven force distribution on right and left sides.

3- Engagement of second molars in the orthodontic treatment is an important issue to avoid its interference and may aid in decreasing contact prematurity of first molars.

RECOMMENDATION

1- T-Scan III analysis for finishing orthodontic treatment before appliance removal is highly recommended to help in obtaining a precise case finishing and the best orthodontic end result that will promote satisfactory long-term stability and stomatognathic balance.

2- Repeating T-Scan after a period of time post treatment may change the result as the settling of occlusion may occur.

3- T-Scan guided occlusal adjustment procedures should be taken into consideration to minimize occlusal imbalances, remove premature contacts, correct balancing side interferences and shorten disocclusion time.

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