ORIGINAL ARTICLE

DOES ORTHODONTICS EXTRACTIONS NEGATIVELY AFFECT THE OCCLUSAL BITE FORCE OF AN INDIVIDUAL - A QUASI-EXPERIMENTAL STUDY

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Background: Orthodontics is said to be that branch of dentistry which takes into consideration the facial growth, dentition development as well as occlusion. It is also concerned with the prevention as well as the rectification of the occlusal anomalies. The aim of this study was to determine the occlusal bite force (OBF) changes during fixed orthodontic treatment up to a period of 9 month in Class I patients treated with extraction and non-extraction treatment protocol. **Methods:** It was a Quasi-experimental study conducted from 13th March 2018 to 20th March 2019 in the orthodontic department on 90 subjects which were divided into a treatment group {extraction (30), non-extraction (30)} and controls (n=30). Bite force was measured with an OBF gauge at 6 different intervals before starting the treatment to the ninth month of the treatment. The changes in OBF were assessed using r-ANOVA test. Post-hoc Bonferroni was used for multiple comparisons in bite force levels at different treatment stages. The mean difference in OBF between treatment groups was evaluated by independent t-test. Significance for all tests was predetermined at *p* value of ≤0.05. **Result:** The mean OBF significantly increased in both the extraction and non-extraction treatment groups ($p<0.001$) in comparison to the controls. The mean change in OBF was comparatively greater in the non-extraction group as opposed to the extraction group, but the difference was not statistically significant ($p=0.468$) **Conclusion:** Orthodontic treatment has a positive effect with a gradual increase in the OBF values in subjects treated with extraction and non-extraction fixed mechano-therapy. This indicates that well-aligned arches can have an impact on the functional occlusion, hence, enhancing the bite force levels.

Keywords: Occlusal Bite Force; Orthodontic Treatment Protocol; Bite Force Gauge

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INTRODUCTION

Orthodontics is said to be that branch of dentistry which takes into consideration the facial growth, dentition development as well as occlusion. It is also concerned with the prevention as well as the rectification of the occlusal anomalies.[1] The primary aim of the orthodontic treatment is to ensure that the three main areas like oral functions, aesthetics as well as the general dental health of a person can be improved.

Out of the various indicators used to evaluate the overall functions of occlusion, Occlusal Bite Force (OBF) is said to be one of the biggest and the most important indicator to help predict the masticatory performance.[2] The primary factors that determine the masticatory function of an individual with a healthy set of dentition are the number, as well as the size of the occlusal contacts.[3] The overall nature of these occlusal contacts determines at least 10 to 20% of the variations in the maximum bite force of different adults.[4]

The bite force is that aspect which provides an indication about the state of the masticatory system. It is a result of actions of the muscles of mastication which are further governed by the cranio-mandibular biomechanics.[4] The evaluation of the bite force of each individual is studied and used widely in dentistry. The magnitude and intensity of bite force helps a clinician understand the mechanics of mastication. This in turn aids in assessing the therapeutic effects of the different prosthetics or orthodontic devices on mastication. Researchers can also guide the reference values of average bite force which can help in conducting studies on understanding the mechanics of different appliances.[5]

There are a number of different factors which can influence the maximal occlusal bite force in any individual. This huge variation in the bite force levels is contingent on a number of different aspects which relate to the anatomical and physiological features of the subjects. In addition to all of these factors, the accuracy of bite force is often influenced by the method with which the bite force is recorded.[6] A reduction in the maximum bite force is said to be associated with a malocclusion.[7–9] The occlusal bite force gets affected by various physiological as well as morphological factors which include aspects like, age, gender, craniofacial morphology, height and body weight, temporomandibular disorders (TMD), periodontal

support, pain, and dental status.[10–22] Comprehensive review of the literature suggests that there are inadequate studies on changes in OBF during orthodontic treatment and further data is required to assess whether orthodontic treatment is a contributing factor in changing the force of mastication. Therefore, the aim of our study is to assess the changes in OBF at different intervals during the course of first nine months of orthodontic treatment. In a previous study, OBF has been shown to increase in the first six months of orthodontic treatment, hence our study will help verify this linear increase with an additional measurement made at ninth month.[23] Over the years, extracting teeth during orthodontic treatment has become a mainstay of treatment providing better stability. Our study is also aimed at determining whether occlusal bite forces improve or worsen in those treated by extraction protocol versus those by non-extraction protocol.

MATERIAL AND METHODS

A quasi experimental, multi-center study was conducted at the department of orthodontics of our institute after approval from the institutional review board (IRB-1008/DUHS/Approval/2018/22) on 90 subjects, mean age 20.10±3.13 years (60 in treatment group, 30 in control group). The sample size was calculated as 26 participants in each group using PASS (version 22) software using the mean values of OBF from a study conducted by Pizolato *et al*[22] with a value of 640.52±254.07 N for control group and 467.91±181.09 N for treatment group with mean difference 172.61N at 95% confidence interval and keeping the power of the study at 80%.[23] Due to patient attrition and the rate of loss to follow up 15% extra of the sample size was taken, hence, the total number of participants in each group were 30. Diagnostic records for all subjects reporting to the orthodontic OPD were obtained. After formulating an ideal treatment plan for the patients, the subjects were randomly selected for the treatment groups on the basis of our inclusion criteria. The treatment group was further divided into two sub-groups. The first subgroup consisted of 30 participants with well aligned arches, proclined upper and lower incisors. These subjects were treated with all first premolar extractions based on their procumbent soft tissue profile. The extractions were carried out initially in the first 3 months. The second subgroup had 30 individuals with mild to moderate crowding and a straight profile treated with non-extraction protocol. A group of 30 individuals having Class I occlusion with well aligned arches consisting of in-house officers was chosen to act as controls.

Subjects included in the treatment group had Angle's class I malocclusion with no previous history of orthodontic treatment, extractions or congenitally missing teeth. None of the subjects in the control group had undergone any orthodontic treatment nor were they undergoing current orthodontic treatment. Subjects with presence of crossbite, multiple restored teeth, temporomandibular joint dysfunction, cranio-mandibular anomalies, muscular or joint disorders, compromised periodontal condition or any prosthetic replacement were excluded from the study.

Occlusal bite force was measured using an occlusal bite force gauge (warm springs, Fremont, California, USA) as shown in Figure-1, the validity of which had already been tested. All the participants signed a written consent form and the procedure was explained to each subject before the recording process began. Each subject was instructed to sit upright in the dental chair in natural head position and asked to bite on the BFG to their full potential without any head movement. BFG was used bilaterally between the molars. A second attempt was made after a rest phase of 15 seconds. A total of five readings were taken and the average value was calculated and recorded. The maximum sampling time was 20 seconds. All force samples were logged as shown in Figure-2. The maximum value was used as the maximum occlusal bite force. Occlusal bite force was measured at five different intervals. The initial reading was recorded prior to the start of the treatment (T0). A 2nd recording was made one week after the placement of orthodontic brackets (T1). The 3rd measurement was made at the first month (T2) and fourth reading at third month, during the orthodontic treatment (T3). The fifth recording was carried out at the sixth month (T4), whereas, the final reading was taken at the ninth month of treatment (T5).

Bite force of 10 random subjects at different intervals from each group were carried out by a second investigator to control the examiner bias. Readings of both the investigators were compared by intra class coefficient (ICC) which showed greater than 0.85 reliability value for the bite force calculated.

The collected data was subjected to statistical analysis using SPSS Version 22 software. Shapiro-Wilk test was used to test the normality of data which showed a normal distribution hence parametric tests were applied. Means and SD's were calculated for the bite force at six different intervals. The changes in occlusal bite force were assessed using Repeated measures ANOVA test. Post-hoc Bonferroni was used for multiple comparisons in bite force levels at different treatment stages. The mean difference in OBF between extraction and non-extraction subjects was evaluated by independent t-test. Significance for all tests was predetermined at p value of ≤ 0.05.

RESULTS

The mean OBF between the treatment and control groups when compared at baseline was statistically

insignificant (*p*=0.371). Similarly, baseline OBF between both the genders for treatment and control group had no significant difference, hence, to increase the power of the study the groups were not stratified based on gender for further analysis (Table-1). Mean OBF in treatment and control groups at different treatment intervals is given in Table-2. Repeated measures ANOVA was applied to compare the changes in OBF between the intervals. The results showed a highly significant increase in OBF in both the extraction and non-extraction groups ($p \leq 0.001$) in comparison to the controls. Hence, it suggests that orthodontic treatment has a positive effect on the OBF. A linear increase in OBF was not evident in the treatment groups, instead a substantial drop in the OBF value is seen at T1 and T2 levels. A gradual increase in OBF is visible from T3 onwards. Table-3 and 4 represents the individual comparisons of OBF after extraction and non-extraction fixed mechano-therapy. This table revealed a highly significant change ($p \leq 0.001$) at each interval; however, it was almost similar for both the treatment groups. The mean change in OBF in subjects treated with extraction and non-extraction mechano-therapy is shown in Table-5. Although the mean change in OBF was comparatively greater in the non-extraction group as opposed to the subjects undergoing extraction treatment, but the difference was not statistically significant ($p = 0.468$). This indicates that extraction of premolars did not affect the OBF vastly.

Table-1: Comparison of mean OBF between males and females before treatment

Variable	Treatment group						Control group		
	Extraction			Non-extraction					
	Male	Female	*p*-alue	Male	Female	*p*-value	Male	Female	*p*-value
OBF	291.98 81.4 N	285.25±38.1 N	0.76	298.21±56.4 N	276.07±35.7 N	0.24	288.6±27.9 N	284.9±41.7 N	0.77

Independent t-test, $p \leq 0.05$

Table-2: Changes in OBF between extraction, non-extraction and control groups

Time Intervals	Treatment Group		Control Group
	Extraction	Non-extraction	
T0	278.32 ± 56.5 N	296.90 ± 57.8 N	286.90 ± 34.4 N
T1	148.84 ± 36.6 N	170.21 ± 41.0 N	286.41 ± 35.2 N
T2	169.32 ± 34.9 N	195.76 ± 42.7 N	287.84 ± 37.1 N
T3	203.52 ± 37.6 N	225.67 ± 50.3 N	288.88 ± 35.2 N
T4	244.35 ± 46.2 N	257.28 ± 51.8 N	288.74 ± 36.0 N
T5	300.75 ± 52.5 N	325.22 ± 50.5 N	287.97 ± 34.8 N
P-value	< 0.000**	< 0.001**	0.364

Repeated measures ANOVA, *$p \leq 0.05$, **$p \leq 0.001$

1 = T0	= Baseline Occlusal Bite Force
2 = T1	= 1 week after
3 = T2	= At the 1st month
4 = T3	= At the 3rd month
5 = T4	= At the 6th month
6 = T5	= At the 9th month

Table-3: Changes in occlusal bite force at different treatment intervals in extraction group

		Mean Difference	Std. Error	Sig.[b]
T0	T1	132.894	8.371	.000*
	T2	111.789	8.240	.000*
	T3	79.050	7.881	.000*
	T4	37.130	5.683	.000*
	T5	-22.173	4.376	.000*
T1	T2	-21.105	4.194	.000*
	T3	-53.844	4.769	.000*
	T4	-95.764	6.279	.000*
	T5	-155.067	7.352	.000*
T2	T3	-32.739	3.411	.000*
	T4	-74.659	5.037	.000*
	T5	-133.962	6.692	.000*
T3	T4	-41.920	3.811	.000*
	T5	-101.223	5.807	.000*
T4	T5	-59.303	3.945	.000*

Repeated measures of ANOVA

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

T0	= Before the start of the treatment.
T1	= 1 week after the placement of orthodontic brackets.
T2	= 1st month of treatment
T3	= At the 3rd month of treatment
T4	= At the 6th month of treatment
T5	= At the 9th month of treatment

Table-4: Changes in occlusal bite force at different treatment intervals in non-extraction group

		Mean Difference	Std. Error	Sig.[b]
T0	T1	126.689	7.390	.000*
	T2	101.134	7.921	.000*
	T3	71.222	10.208	.000*
	T4	39.618	8.068	.001*
	T5	-28.324	6.707	.004*
T1	T2	-25.555	4.915	.000*
	T3	-55.467	7.454	.000*
	T4	-87.071	6.959	.000*
	T5	-155.012	6.346	.000*
T2	T3	-29.912	5.851	.000*
	T4	-61.516	6.049	.000*
	T5	-129.457	6.576	.000*
T3	T4	-31.604	5.274	.000*
	T5	-99.545	6.752	.000*
T4	T5	-67.941	5.668	.000*
Repeated measures of ANOVA				
*. The mean difference is significant at the .05 level.				
b. Adjustment for multiple comparisons: Bonferroni.				
T0	= Before the start of the treatment.			
T1	= 1 week after the placement of orthodontic brackets.			
T2	= 1st month of treatment			
T3	= At the 3rd month of treatment			
T4	= At the 6th month of treatment			
T5	= At the 9th month of treatment			

Table-5: Mean change in occlusal bite force between extraction and non-extraction treatment groups

Variable	Extraction (T0 – T5)	Non-Extraction (T0 – T5)	*p*-value
Occlusal bite force	-22.43±26.8 N	-28.32±35.4 N	0.468
$p \leq 0.05$, independent t-test			
T0 = baseline occlusal bite force			
T5 = at the 9th month			

Figure-1: Bite Force Gauge. Sensor with USB assembly

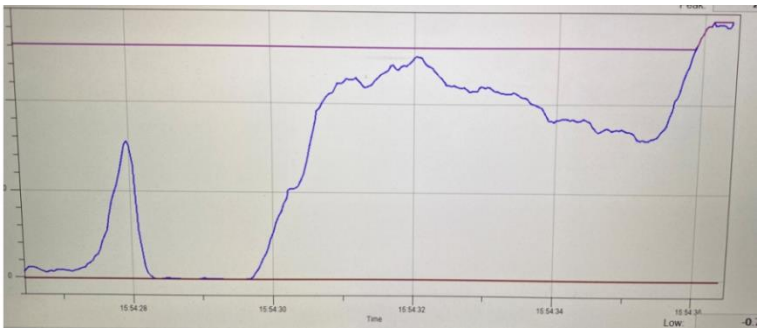

Figure-2: Graph obtained of the measured bite force This is the graph we will obtain when the patient bites. It gives the maximum OBF that is the peak

DISCUSSION

Orthodontics aims at correcting the functional and aesthetic needs of a patient. The functional state of occlusion is primarily assessed by the occlusal bite force of an individual. Coordination of multiple muscles, bones and teeth along with an appropriate number and size of occlusal contacts results in an increased bite force, hence, an improvised masticatory function which is one of the basic roles of the oral cavity.[1,2,4]

Literature survey shows that studies have been carried out to assess the bite force during orthodontic treatment in both adults and children.[7,23] Researchers also observed an increase in bite force after completion of orthodontic treatment in children with unilateral crossbite. On the other hand, Alomari *et al*[23] evaluated the OBF over 6 month's period did not find any significant difference in the bite force of the patient in subjects with a Class I malocclusion. None of the studies has compared the effects of different mechano-therapies on the resultant bite force, therefore, our study is the first to evaluate the effect that extraction treatment has on the bite force. A control group was also used in the current study which was compared with subjects undergoing extraction treatment and non-extraction treatment. Similar bite force at different intervals of controls suggest that orthodontic treatment has an effect on the overall OBF. In agreement with the previous studies, there was no difference in the OBF between the genders.[24-26]

In the current study the maximum OBF was increased in both the extraction and non-extraction cases. The overall difference in T0 and T5 OBF was greater in subjects undergoing non-extraction mechano-therapy which is in accordance with the study conducted by Bakke which showed that an increase in the number of teeth and occlusal contacts increases the overall OBF.[4] In contrast to these findings, a study reported a decrease in OBF after orthognathic surgery. This study showed that pre-surgical procedure causes malalignment because of incisor decompensation, hence, the resultant reduction in OBF.[27] When evaluating the mean OBF difference between the extraction and non-extraction groups, the subjects with premolar extractions had initially a greater drop in the maximum bite force values but the overall change was statistically insignificant.[28] It is suggestive that in the extraction cases premolar are the main pillars of occlusion, which are extracted that provide solid contact points for maximum biting force and functional occlusion. This finding was in contrast to results from other studies which showed that the bite force taken in different areas of oral cavity had no effect on OBF.[6,29–31] Hence, any orthodontic treatment modality in class I subjects tend to increase the maximum OBF.

The immediate reduction in OBF after bracket placement or after extractions could be due to the level and intensity of pain felt at the initial visit or the changes occurring in the occlusal contacts during the treatment. This causes a reflex response in the patient to avoid biting, which in turn lead to a decrease in the biting force.[23] This is in accordance with the observation of Sonnesen *et al*[7] that muscle activity levels and bite force magnitude is strongly associated with occlusal support. The results of current study confirmed those of Thomas *et al*[27] and Alomari and Alhaija[23] who also reported a reduction in OBF during initial stages of orthodontic treatment. Godreich *et al*[10] also observed that adjustments in orthodontic appliance tend to decrease the muscular activity. Besides, some studies displayed an increase in the force after the removal of the fixed appliances, as the patient was able to bite to the maximum level without any hindrance of appliance in the mouth.[10,23,28,29] Hence, these findings indicate the importance of tooth alignment for not only enhancing the aesthetic value of a patient but also positively affecting the masticatory function.

Extraction slightly decreases the biting force; however, still achieves the maximum biting force after few visits indicating that treating a Class I malocclusion by orthodontic treatment will have a positive effect on OBF regardless of the treatment protocol.

Limitations & Recommendations:

The limitation of this study is a small sample size as Class I malocclusion is less prevalent in our population. Hence, a study should be conducted with a larger sample size and on class II and class III malocclusions where the pre-treatment and post-treatment bite force should be compared. Occlusal bite force should be measured during treatment intervals and then at the completion of treatment so as to deduce that which step of treatment has the maximum effect on the overall biting force.

CONCLUSION

The bite force in patients treated with extraction protocol was systematically lower than the mean OBF of patients treated with non-extraction mechano-therapy. The bite force was lowest immediately after bond up although the results successfully displayed an overall increase in the OBF at the ninth month of treatment when compared to the pre-treatment bite values in both the treatment groups.

AUTHORS' CONTRIBUTION

SS: conceived the idea of the study, collected the data and helped to draft the manuscript. AB: Supervised data collection, Helped to draft and edit the manuscript.

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