ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 3, Issue – 2, March - 2020, Page No. : 177 - 185

Comparison of Occlusal Bite Force Changes In Extraction and Non-Extraction Fixed Orthodontic Cases- A Prospective Clinical Trial

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Citation of this Article: Dr. Anshul Munjal, Dr. Anshul Singla, Dr. Anil Miglani, "Comparison of Occlusal Bite Force Changes In Extraction and Non-Extraction Fixed Orthodontic Cases- A Prospective Clinical Trial ", IJDSIR- March - 2020, Vol. – 3, Issue -2, P. No. 177 – 185.

Type of Publication: Case Report

Conflicts of Interest: Nil

Abstract

Aim and objectives: To determine and compare occlusal bite force changes during the course of fixed orthodontic treatment in extraction and non-extraction cases at various time intervals.

Materials and methods: The subjects were 90 patients (45 for extraction group and 45 for non-extraction group) between the age 15-30 years with Angle's class I malocclusion. Bite force was measured using strain gauge transducer at different time intervals during the eighteen months of fixed orthodontic treatment.

Results: Post hoc pairwise comparison by Boneferroni test showed that bite force measured at one week after placing fixed orthodontic treatment was significantly less than that measured at other time intervals in both extraction and non-extraction cases. Independent t-test showed bite force increased significantly when measure at fifteen and eighteen months. This was more significant in non-extraction cases.

Conclusions: In both extraction and non-extraction cases, occlusal bite force reduces immediately after separator placement, it reduces to 50% after the end of first week and gradually increases with time and reaches to almost pre-treatment levels within three months.

Keywords: bite force, fixed orthodontic, premolar extraction

Introduction

Mastication is one of the important functions of the stomatognathic system which requires adequate occlusal bite force for proper grinding of food[1]. Bite force results from harmonization of the different components of masticatory apparatus which includes bones, muscles and teeth[2]. Adequate bite force provides a positive stimulus for the normal development of the maxilla and mandible.

Bite force results from the action of jaw elevator muscles which is determined by the central nervous system and feedback from muscle spindles, mechanoreceptors and nociceptors modified by craniomandibular biomechanics[3].

It has been found that occlusal bite force changes because of the orthodontic treatment[4]. The occlusal bite force is found to be low in malocclusions because of deranged occlusal contacts and faulty cusp fossa relationship. However, it increases after orthodontic correction. Pain and discomfort during orthodontic treatment produces a reduction in occlusal bite force, which stabilizes after a few months. While changes in bite forces have been shown to occur during routine orthodontic treatment, there is no clarity whether the change in bite force during and after orthodontic treatment is the same for both extraction and non-extraction cases.

Therefore, the need for this study is to determine and compare occlusal bite force changes during the course of fixed orthodontic treatment in extraction and non-extraction cases at various time intervals.

Materials and Methods

Bite force measuring gauge (figure 1) from Asian Test Equipment's was used for measuring the occlusal bite force.

Inclusion Criteria

- Patient's with Angle's class I malocclusion.
- Good periodontal health.
- No history of prior orthodontic treatment.
- No signs or symptoms of temporomandibular joint dysfunction.
- No posterior crossbites.
- No grossly decayed tooth

Method

- The sample size (n=90) was equally divided into two groups i.e. Group 1 (extraction cases) and Group 2(non-extraction cases)
- Before recording bite force, each subject was instructed to sit upright, look forward without head support and with the Frankfort plane parallel to the floor (figure 2).
- The bite force meter's bite plate was covered with a disposable plastic sleeve to prevent contamination.
- Bite force was measured according to the procedure described by Mountain, 2008[5]. Patients were previously trained to perform their strongest bite over the device.
- Maximum occlusal bite force was measured on both sides in the first permanent molar region.
- Three occlusal bite force measurements were recorded on each side with a 15 seconds rest between each bite.
- The maximum occlusal bite force measurement achieved on each side was recorded.
- The average maximum occlusal bite force was considered as the occlusal bite force for that patient and was included in the analysis.

All measurements were carried out by the same investigator at the following time intervals:

1. T0: before orthodontic elastomeric separator placement.
2. T1: immediately after orthodontic elastomeric separator placement.
3. T2: one week after placement of orthodontic appliances.
4. T3: two weeks after placement of orthodontic appliances.
5. T4: one month after placement of orthodontic appliances.
6. T5: three months after placement of orthodontic appliances.
7. T6: six months after placement of orthodontic appliances.
8. T7: nine months after placement of orthodontic appliances.

9. T8: twelve months after placement of orthodontic appliances.
10. T9: fifteen months after placement of orthodontic appliances.
11. T10: eighteen months after placement of orthodontic appliances.

Results

Data was analysed using Statistical Package for Social Sciences (SPSS) version 21.

The sample was divided into two groups i.e. Group 1 (extraction cases) and Group 2 (non-extraction cases). An intra group comparison was made within Group 1 and Group 2 which is shown in table 1.

In group 1 (table1) the maximum bite force was observed at T10 (302.11±38.68) and minimum was at T2 (154.88±33.21). Post hoc pairwise comparison by Boneferroni test showed that the bite force at T0, T1, T6, T7, T8, T9, T10 were found to be significantly more than that at T5 followed byT4, T3, and T2. A reduction of bite force was observed at T2 which kept on increasing for T3, T4, T5 and eventually get stabilized at T6.

In group 2 (table 1) the maximum bite force was observed at T9 (303.31±33.09) and minimum was at T2 (165.05±23.32). Post hoc pairwise comparison by Boneferroni test showed that the bite force at T8, T9, T10 were found to be significantly more than that at T6 & T7, followed by T0, T1, T5, T4, T3, and T2.

Intergroup comparison among Group 1 and 2 was done using Independent t test (table 2) and it was found that no statistically significant difference existed between the two.

As represented by table 3, there was a statistically significant difference in bite force from T2 to T3, from T8 to T9 & from T9 to T10 among Group 1 and 2. This difference was more among the values of Group 1 as compared to Group 2. This suggested that there was a significant increase in bite force from T2-T3 ($p=0.005$), T8-T9 ($p=0.008$) and T9-T10 ($p<0.0001$).

Another intergroup comparison was made by comparing the bite force value at each interval with the initial value recorded at T0 in table 4. It was found that the difference in Bite force from T0 to T6, from T0 to T7, from T0 to T8, from T0 to T9, & from T0 to T10, among Group 1 and 2 were found to be significantly different. In Group 1, the bite force decreased from T0 to T6, from T0 to T7, from T0 to T8, while in Group 2, it increased during above mentioned periods. From T0 to T9, & from T0 to T10, the bite force increased among both the groups, but this increase in magnitude was significantly more in Group 2 as compared to Group 1.

Discussion

Previous studies that have been performed so far have evaluated the bite force changes during fixed orthodontic treatment for up to six months after the placement of orthodontic appliance and mainly considered the stages of levelling and aligning[6]. A study done by Sonneson et al compared bite forces during orthodontic treatment in relation to pre and post unilateral crossbite correction[7]. Few studies have evaluated the bite force changes before and after orthodontic treatment[8]. But in the present study, evaluation of bite force has been done for eighteen months of fixed orthodontic treatment.

Sample size estimation was done by using GPower software (version 3.0). A minimum total sample size of 90 (45 for extraction group & 45 for the non-extraction group) was selected.

Subjects aged 15-25 years were recruited as OBF stabilises after the age of 14 years[9].

Mean pre-orthodontic bite force value recorded was in accordance with the mean unilateral molar bite force as reviewed by Merete Bakke (2006)[10].

In both extraction and non-extraction cases it was observed that the bite force decreased a little when recorded immediately after the placement of orthodontic separators. Placement of orthodontic separators decreased the chewing efficiency for most of the patients. Steen et al (2000) observed the timeline of post adjustment orthodontic pain, which suggests that the mechanism involves an inflammatory response as a result of tissue damage which would presumably result in greatest pain levels immediately after the separator placement appointment[11]. The decrease in OBF in the study may be because, of muscle fatigue as the T0 and T1 reading was taken on the same day. Also, there can be a psychological pain due to instrumentation while placing separators. The other reason could be occlusal disturbance felt by the patient between the upper and the lower jaw after the separator placement.

Almost 50% reduction in OBF was recorded at the end of first week, after the placement of fixed appliances. This reduction in bite force was continued to the second week and started to increase at the end of first month. When the incorporated tip and torque value in the bracket system expresses itself, the molars tip lingually and distally. This disturbs the occlusal relationship of maxillary and mandibular molars which leads to decrease in the bite force. With the treatment, the occlusion stabilizes, hence the bite force increases. The results of the present study confirmed those of Thomas et al. who observed reduction in occlusal bite force during treatment[12]. In addition, the present results were supported by Goldreich et al. who suggested that the orthodontic adjustments tended to reduce the functional muscle activity[13]. This was due to changes in occlusal support, periodontal mechanoreceptor effects and jaw elevator muscle reflexes. The reduction in OBF detected in the present study may be due to changes in occlusal relationship which occurred during the course of treatment, as it was previously stated that the occlusal contacts determine 10% to 20% of the variation of maximum bite force in adults[3].

Bite force remained significantly reduced during the first week and after first month it gradually increased which may be due to reduction in the occlusal disturbances, achievement of new stable occlusal relationship and increase in the pain threshold for the patients. OBF shows a tendency to return to pre-treatment level in both extraction and non-extraction group at the third month after fixed orthodontic appliance placement. This is due to the improvement in alignment of teeth and levelling of curve of spee which increases the occlusal contact area. This is in accordance to the study conducted by Sawson et al (2012) to determine the occlusal bite force changes during first six months of orthodontic treatment and its correlation with patient's subjective pain level using visual analogue scale[6]. They stated that levelling the curve of spee increases the occlusal contact area of the posterior teeth. Michelotti et al in his study to find the association of post orthodontic pain with the quality of life, observed that the short-term occurrence of orthodontic pain was associated with motor and sensory changes of the masticatory muscles and represented by a decrease of the motor output and pressure pain thresholds of the jaw closing muscles[14].

After six months, it was found that no statistically significant difference existed between bite force changes in extraction & non-extraction cases.

The difference in the consequent stages i.e. twelfth to fifteenth and fifteenth to eighteenth months were compared among extraction cases and non-extraction cases and were found to be significantly more among extraction cases as compared to non-extraction cases. The reason may be the completion of retraction, and closure of spaces, thus attainment of occlusal contacts and settling of

occlusion happened in these stages of extraction cases. Whereas in the non-extraction group correction of malocclusion and establishment of stable occlusion relationships occur much before these timings, thus the increase of bite force is less than that of extraction group.

Occlusal bite force measured at each stage was compared with the initial or pre-orthodontic bite force value and a comparison was made between the two groups. At sixth, ninth, and twelfth month, the value of bite force in extraction case was less than the initial value whereas in non-extraction group it was more than the pre-orthodontic value. An increase in bite force was observed in non-extraction group because of the correction of the occlusal discrepancies. But at the fifteenth and eighteenth month, both the groups showed increase in the value of bite force but this but this increase in magnitude was significantly more among non-extraction cases as compared to extraction cases which may be due to correction of maloclusion, improvement in occlusal contacts and improved ability to bite. Similar increase in extraction group was not observed because of lesser number of teeth, thus decreased contact points and hence decreased force values[3].

Further research needs to be carried with the use of latest bite force measuring devices that are more precise and sensitive. Also, in the present study the sample size was not divided by gender or growth pattern, both of them affects the bite force. Furthermore, as in the study of Bakke et al, bite force correlated with the number of occlusal contacts and that the peak force was reached three months after debonding[10]. Considering these views, it is recommended that the bite force value needs to be assessed in post orthodontic phase also.

Figures and Tables

Figure 1: Bite Force Measuring Gauge

Figure 2: Bite Force Measurement Taken Before Orthodontic Separator Placement

Group	Time Interval	N	Minimum	Maximum	Mean	Std. Deviation
Group 1	T0	45	242.77	367.51	301.3002	38.43254
Group 2			261.29	379.34	304.5776	38.02908
Group 1	T1	45	238.69	348.65	295.6958	35.75889
Group 2			246.14	371.52	301.1422	43.99728
Group 1	T2	45	115.13	204.72	154.8849	33.21341

Group 2			129.65	210.97	165.0496	23.32130
Group 1	T3	45	159.64	247.43	200.1793	29.19274
Group 2			161.68	242.10	204.2311	23.59210
Group 1	T4	45	197.42	291.13	247.0816	31.72228
Group 2			204.57	291.48	250.9867	25.07863
Group 1	T5	45	243.49	328.47	283.9396	30.83467
Group 2			221.19	364.52	289.0771	39.84760
Group 1	T6	45	245.82	340.27	298.1609	32.71054
Group 2			263.41	377.43	309.6102	35.08230
Group 1	T7	45	246.92	367.44	300.5556	38.90675
Group 2			267.16	380.25	310.8427	35.57917
Group 1	T8	45	243.87	366.51	300.6053	38.04065
Group 2			279.67	380.45	313.1673	32.98241
Group 1	T9	45	243.06	366.46	301.4087	38.28307
Group 2			279.46	380.74	313.3104	33.08674
Group 1	T10	45	243.68	367.82	302.1093	38.68587
Group 2			279.56	380.23	313.1813	33.10707
Group 1	P value			<0.0001, S		
Group 2				<0.0001, S		
Group 1	Post hoc pairwise comparison			T2<T3<T4<T5<T0, T1, T6 T7, T8, T9, T10		
Group 2				T2<T3<T4<T5<T1<T0<T6,T7<T8,T9,T10		

Table 1: Intragroup Comparison

	Group	N	Mean	Std. Deviation	P value	Mean difference
T0	1	45	301.3002	38.43254	0.685	-3.27733
	2	45	304.5776	38.02908		
T1	1	45	295.6958	35.75889	0.521	-5.44644
	2	45	301.1422	43.99728		
T2	1	45	154.8849	33.21341	0.096	-10.16467
	2	45	165.0496	23.32130		
T3	1	45	200.1793	29.19274	0.471	-4.05178
	2	45	204.2311	23.59210		
T4	1	45	247.0816	31.72228	0.519	-3.90511
	2	45	250.9867	25.07863		
T5	1	45	283.9396	30.83467	0.496	-5.13756
	2	45	289.0771	39.84760		

T6	1	45	298.1609	32.71054	0.113	-11.44933
	2	45	309.6102	35.08230		
T7	1	45	300.5556	38.90675	0.194	-10.28711
	2	45	310.8427	35.57917		
T8	1	45	300.6053	38.04065	0.098	-12.56200
	2	45	313.1673	32.98241		
T9	1	45	301.4087	38.28307	0.118	-11.90178
	2	45	313.3104	33.08674		
T10	1	45	302.1093	38.68587	0.148	-11.07200
	2	45	313.1813	33.10707		

Table 2: Intergroup comparison of Bite force among extraction cases and non-extraction cases.

Intergroup comparison of differences in Bite force						
	Group	N	Mean	Std. Deviation	Mean difference	P value
T0 to T1	1	45	5.6044	12.19230	2.16911	0.369
	2	45	3.4353	10.51803		
T1 to T2	1	45	140.8109	26.36885	4.71822	0.447
	2	45	136.0927	31.93849		
T2 to T3	1	45	-45.2944	6.99404	-6.11289	0.005, S
	2	45	-39.1816	12.55163		
T3 to T4	1	45	-46.9022	13.32318	-0.14667	0.971
	2	45	-46.7556	23.02771		
T4 to T5	1	45	-36.8580	9.48054	1.23244	0.715
	2	45	-38.0904	20.45204		
T5 to T6	1	45	-14.2213	19.67557	6.31178	0.099
	2	45	-20.5331	16.07156		
T6 to T7	1	45	-2.3947	13.32831	-1.16222	0.575
	2	45	-1.2324	3.79121		
T7 to T8	1	45	-.0498	5.82966	2.27489	0.056
	2	45	-2.3247	5.30673		
T8 to T9	1	45	-.8033	1.58758	-0.66022	0.008, S
	2	45	-.1431	.42633		
T9 to T10	1	45	-.7007	1.09640	-0.82978	<0.0001, S
	2	45	.1291	.36227		

Table 3: Intergroup comparison of difference in Bite force among extraction cases and non-extraction cases.

Difference in Bite force						
	Group	N	Mean	Std. Deviation	Mean difference	P value
T0 to t1	1	45	5.6044	12.19230	2.16911	0.369
	2	45	3.4353	10.51803		
T0 to T2	1	45	146.4153	27.08688	6.88733	0.229
	2	45	139.5280	26.80978		
T0 to T3	1	45	101.1209	24.24907	0.77444	0.877
	2	45	100.3464	23.19848		
T0 to T4	1	45	54.2187	28.84642	0.62778	0.91
	2	45	53.5909	23.51310		
T0 to T5	1	45	17.3607	31.39446	1.86022	0.718
	2	45	15.5004	14.18418		
T0 to T6	1	45	3.1393	11.96564	8.172	<0.0001
	2	45	-5.0327	7.01265		
T0 to T7	1	45	.7447	5.51940	7.00978	<0.0001
	2	45	-6.2651	7.71197		
T0 to T8	1	45	.6949	1.98391	9.28467	<0.0001
	2	45	-8.5898	9.16913		
T0 to T9	1	45	-.1084	.81965	8.62444	<0.0001
	2	45	-8.7329	9.31352		
T0 to T10	1	45	-.8091	.89150	7.79467	<0.0001
	2	45	-8.6038	9.09805		

Table 4: Intergroup comparison of differences in bite force as compared to initial value.

Conclusion

From the findings observed in the study, following conclusions were made:

- Occlusal bite force is altered with fixed orthodontic treatment.
- In both extraction and non-extraction cases:
  - ❖ Occlusal bite force reduces immediately after separator placement
  - ❖ It reduces to 50% after the end of first week
  - ❖ It gradually increases with time and reaches to almost pre-treatment levels within three months.
- In extraction cases, at the end of fifteenth and eighteenth month there was significant increase in occlusal bite force when compared with previous reading.
- In non-extraction cases, there was significant increase in bite force at the end because of comparatively a greater number of teeth present.

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