

SHORT-TERM PERIODONTAL AND GINGIVAL CHANGES OF TWO DIFFERENT ORTHODONTIC BRACKET DESIGNS: A CLINICAL PROSPECTIVE COHORT STUDY

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ABSTRACT

Orthodontic appliances usually impede proper oral hygiene; allow plaque accumulation and food stagnation around orthodontic brackets which will cause gingival inflammation and orthodontic treatment complications as short-term effects. If this remains the periodontal status may be also compromised. Metal brackets shape and design will affect cleansing and staining control throughout the duration of orthodontic treatment. In this study a comparison between synergy and conventional brackets will be carried out for both short and later the long term effects on periodontal status. Clinical prospective. At least one year. The objective of this prospective non-randomized controlled trial is to determine the short-term clinical effects of different bracket designs on periodontal and gingival health during fixed orthodontic treatment.

Sixty-eight consecutive healthy orthodontic patients aged between 14-18 years with Class I malocclusion, minimal crowding with no periodontal compromised dentition were recruited. All participants had their Plaque (PI) and gingival (GI) indices measured before commencing orthodontic brackets bond-up visit (T1). Participants were non-randomly divided into groups, group 1 (G1) treated using conventional pre-adjusted edgewise twin brackets (CB: Natural® Orthodontic products) while group 2 (G2) received straight wire low friction brackets (SB: Synergy®, Rocky Mountain Ortho. RMO). PI and GI were re-measured at 6 months during treatment (T2), the difference in PI and GI indices were compared using independent t-test.

There was a statistically significant increase in PI and GI during orthodontic treatment at T2; G2 had a higher PI and GI indices readings, the means difference (MD) for PI was -0.06966 while the MD for the GI was -0.12603, P:0.05). No adverse effects were reported during the trial.

Orthodontic brackets should be considered for width, height, tie wings and hooks configurations, as these features may affect plaque accumulation and gingival inflammation.

Key words: conventional orthodontic brackets, synergy brackets, plaque index, gingival index.

This article may be cited as: Alzoubi ZR, El Momani BR, Al-Majali N, Qatarneh F, Al Halholi AT. Short-Term Periodontal and Gingival Changes of Two Different Orthodontic Bracket Designs: A Clinical Prospective Cohort Study. Pak Oral Dent J 2021; 41(4):195-199.

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Received for Publication: Jul 22, 2021

Revised: Oct 11, 2021

Approved: Oct 12, 2021

INTRODUCTION

Conventional fixed orthodontic appliances that bonded to teeth represent the engine of orthodontic therapy.¹ They are commonly made from metals such as stainless steel alloys, titanium alloys or ceramics.² Bonded orthodontic fixed attachments clearly hinder the natural cleansing and the tooth brushing mechanisms, causing areas of food impaction and stagnation, and, subsequently, floral overgrowth which increases in microbial virulence.³ Surface and manufacture characteristics of brackets specifically at the bracket adhesive-enamel junction influences significantly the bacterial biofilm formation and plaque retention.⁴ Moreover, the form/ design of the bracket, its method

of ligation also influences the quantity and quality of the retained plaque significantly.^{5,6} The conventional Siamese twin bracket represents the most commonly used bracket design worldwide.⁷ Recently, a few manufactures introduced more versatile versions of bracket designs such as the narrow passive and active self-ligation orthodontic brackets and a low-friction wider Synergy® brackets (Figure1).

Usually orthodontic treatment may last between 18 to 24 months⁸, patients often develop some degree of transient gingivitis that might progress into more advanced periodontitis, if left untreated⁹, this often occurs with cervical enamel decalcification.¹⁰ Various tools and indices are available and have been developed to measure and assess patient's plaque control and periodontal status before and during fixed orthodontic therapy.¹¹ Few reports have examined prospectively periodontal and gingival parameters while comparing two types of brackets designs. The aim of this this prospective non-randomized controlled trial was compare the short-term periodontal status secondary to the use of two orthodontic bracket designs; the conventional Siamese twin brackets (Conventional Bracket: CB) and the recent synergy® brackets (Rocky Mountain Orthodontics:650 West Colfax Avenue/Denver, CO 80204 USA) (Synergy Brackets: SB).

MATERIALS AND METHODS

Participants

This clinical trial was approved by the ----- Ethical committee (Ethical approval No. 23-1-18). Sixty-eight (35 females, 33 males) consecutive healthy orthodontic patients (14 to 18 years range) were recruited. No sample size calculation was undertaken. Table 1 and 2 shows the distribution of study participants and the inclusion criteria, respectively.

Informed written consent from all parents/guardian were obtained. All participants had their periodontal indices (Plaque (PI) and gingival (GI)) assessed before commencing orthodontic brackets bond-up visit (T1). Periodontal records by means of Williams probe.¹² Nine teeth from each participant were selected for periodontal examination (teeth 15, 13, 11, 23, 25, 34, 31, 43, 45) at three sites (labial/buccal -mesial, labial/buccal- middle, labial/buccal-distal sites), molar teeth were excluded as they were banded. Periodontal indices were calculated for each patient as a sum of mean scores of each examined tooth divided by the number of teeth. PI and GI were re-measured at 6 months during treatment (T2). All participants had oral and written oral hygiene instructions, prior to commencing orthodontic treatment followed by live demonstration from a calibrated professional dental hygienist using a Typodont and a tooth brush.

Patients were non-randomly allocated to group 1 (CB) who received conventional brackets (CB: natural® Deerfield Beach – 33441 Florida 0.022-inch pre-adjusted edgewise slot) or group 2 (SB) who received Synergy® brackets (SB: RMO 0.022-inch pre-adjusted edgewise slot). Prime-dent® (One Step Orthodontic Adhesive Bonding System Dental Self Cure PRIME DENT USA) adhesive self-cure bonding was used for direct labial bracket bonding. First molars were banded using SIA Ortho® bands (Rocca D'Evandro, 81050 CASERTA, Italy) and they were cemented using glass-ionomer cement (Voco® Aqua Meron luting cement). All participants were treated at the same clinical settings under the care of one specialist orthodontist (B.M). Orthodontic follow-up visits were at six weeks' intervals.

Statistical analysis

SPSS software version 25 (SPSS Inc. Chicago, USA) was used for statistical analysis. We tested the data for normal distribution using Shapiro-Wilk test. Our analysis showed that they were not normally distributed ($p < 0.05$) see table 3. The pretreatment and post treatment records obtained from CB and SB at T1 and T2 were later analyzed using independent t-test.

RESULTS

Though, gender's distribution was uneven [55% females (number 31) and 45% males (number 27)], both group age's means were almost similar, 15.7 years \pm 0.98 for CB group and 15.4 years \pm 1.02 for SB group. Ten subjects dropped-out from the trial (4 females and 6 males), attrition bias was treated as per-treated protocol.

PI and GI score are shown in table 3. Results of this study indicated that PI scores increased for both the conventional twin brackets and synergy brackets, CB and SB respectively, though SB group had significantly higher in PI scores [MD (-0.06966), 95% confidence interval CI (-0.11538) – (0.02393), P value 0.003] and GI score [MD (-0.12603), 95% confidence interval CI (-0.19596) – (0.05611), P value 0.001].

DISCUSSION

This prospective analysis was accomplished to observe the effect of fixed orthodontic therapy with two different brackets designs (CB and SB), both brackets ligated with elastomeric ligatures, periodontal and gingival changes in the short term were attained via comparing plaque and gingival indices scores, these readings obviously would reflect on the status of periodontal health. The null hypothesis supposed that bracket type has no effect on gingival and plaque parameters. With new versatile brackets introduced into practice, the properties of the different bracket materials, designs and ligation techniques on the periodontal health have

TABLE 1: SUBJECTS' DISTRIBUTION

	CB Group(n=29)	SB Group(n=29)	Discontinue/ unfollowed/ debond(n=10)	Total
Female	15 (52%)	16 (55 %)	4	35
Male	14 (48 %)	13 (45 %)	6	33
Age (mean±SD)	15.7 ± 0.98	15.4 ± 1.02		68

TABLE 2: INCLUSION CRITERIA FOR THE STUDY

Inclusion criteria	
General criteria	<ul style="list-style-type: none"> • Healthy patients (non-smokers) with no relevant medical / dental history, and • No systemic or local medications.
Dental criteria	<ul style="list-style-type: none"> • Patients with regular follow up visits, • Full permanent dentition, • Acceptable measures of oral hygiene, • Absence of heavily restored teeth, • Right handed brushing patients only, with no use of accessory oral hygiene aids as water jets, and • Absence of local habits such as bruxism or thumb sucking or mouth breathing.
Orthodontic criteria	<ul style="list-style-type: none"> • No previous history of fixed orthodontic therapy or a relapse treatment, • Minimal crowding that require a non-extraction therapy plan, and • Mild degree of teeth rotations.

TABLE 3: MEDIAN AND RANGE FOR ALL DATA AND INTERGROUP COMPARISONS TEST

Group	Parameter	Median	Range	P value when normal distribution was assessed using Shapiro-Wilk test
CN	PIT1	0.20	0.67	0.00 (Not normally distributed)
	PIT2	0.20	0.70	0.00 (Not normally distributed)
	GIT1	0.33	0.89	0.00 (Not normally distributed)
	GIT2	0.33	0.89	0.00 (Not normally distributed)

-INTERGROUP COMPARISON (CN/SB) USING MANN-WHITNEY U TEST:

Parameter	Time period	Time period	Significant difference
PI	T1	T1	Absent
PI	T2	T2	Present
GI	T1	T1	Absent
GI	T2	T2	Present

-INTRAGROUP COMPARISON USING WILCOXON TEST:

Group	Parameter	Time period	P value	Significant difference
CN	PI	T1/T2	0.28	Absent
	GI	T1/ T2	0.090	Absent
SB	PI	T1/T2	0.00	Present
	GI	T1/ T2	0.00	Present

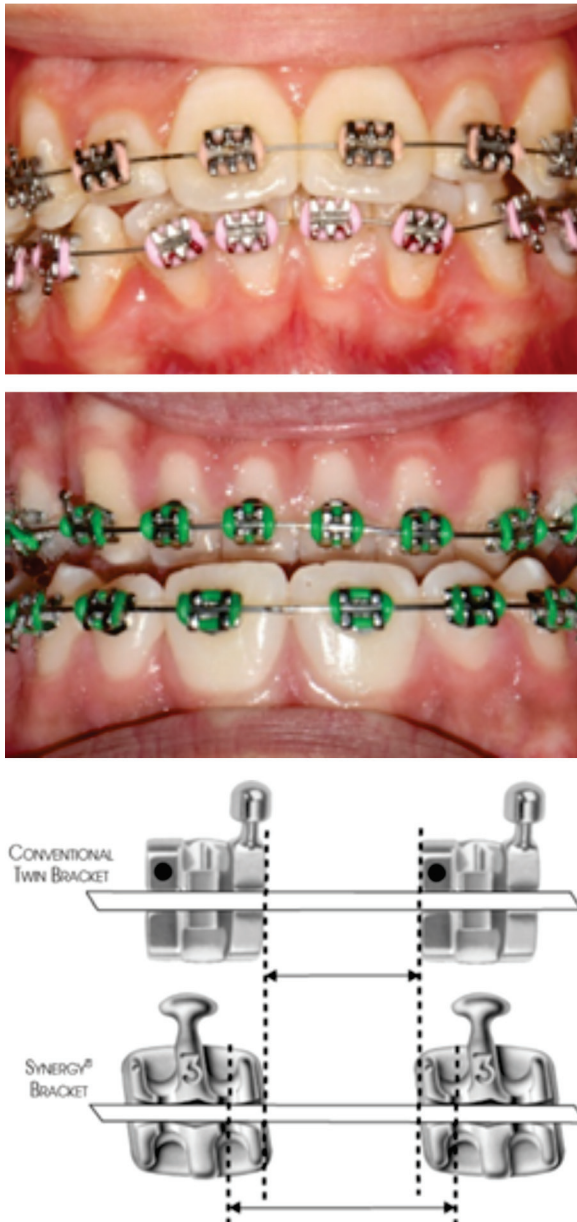


Fig 1: Basic differences for conventional twin brackets versus Synergy® brackets for two patients enrolled in the study, along with sketch demonstration (courtesy of RMO)

been under focus by several studies.^{13,14} Classically, fixed orthodontic therapy comprising from brackets bonded to teeth enamel undoubtedly create retention sites for plaque accumulation and stagnation, and this exacerbates the gingival draining, as gingivae become irritated with the higher adhesion potential for brackets and bonded attachments, eventually, this proves to be a significant etiologic factor in periodontal inflammation and demineralization of enamel.

Orthodontic practitioners pick out different bracket designs to exploit their advantages and minimize the drawbacks, synergy® brackets introduced relatively

recently claiming to have a lower friction properties compared with other brackets¹⁵, this property would absolutely shorten treatment and would accordingly avoid the common side effects associated with orthodontic care. Nevertheless, synergy brackets have a relatively larger space area occupying teeth enamel, along with wider and more retentive tie wings, this also place brackets in a more proximity to the gingival margins especially at the premolar teeth, leading to easier plaque accumulation as cleanability is harder to attain.

Our results found a significant increase in gingival and plaque indices for all subjects at their fourth orthodontic follow-up visit compared to the base line records. This actually in accordance with multiple reports concluding a steady increase in PI and GI for all subject undertaking fixed orthodontic therapy.¹⁶⁻¹⁹ As far as ligation method is considered Pellegrini et al²⁰ and Van Gastel et al²¹ also reported substantial shifts in periodontal and microbiological parameters while comparing different types of ligation protocols, specifically comparing conventional versus self-ligation brackets (SLB). While others as Pejda et al²² and Pandis et al²³ have reported that there is no difference in plaque aggregation between SLBs and CBs. Meanwhile, our study has similar elastomeric ligation, as both groups had the routine protocol of elastomeric ligation practiced in our clinical setting.

Unbiased short term associations were sought via:

1. A standard oral and written patient's instructions.
2. bond-up technique and materials.
3. Operator.
4. ligation protocol.
5. Age and gender.

Nevertheless, SB group showed a significant increase in plaque aggregation and gingival bleeding in comparison to the CB group, the increase in the values of the periodontal parameters during the treatment is probably advocated as a consequence of the bracket design itself. We believe the plaque-retentive effect of SBs hindered good oral hygiene in those patients, and this was translated in higher GI and PI scores. Authors also believe that molar bands worsen the periodontal status in general, but our clinical settings impose the use of bands for all subject in this study.

Clinically, in practice there are individual variations in cooperation, motivation for oral health, eating habits swings with time, age and other environmental factors still might affect the periodontal and gingival readings before, during and after an orthodontic course of therapy, Mombelli and colleagues²⁴ have shown in their 4 years longitudinal study that children during their puberty years have more tendency for gingival inflammation and bleeding due to hormonal changes around this age. Furthermore, our findings could have been exaggerated by the study design itself, such as the

type of brackets used (CB, SB), subject's puberty age, study population and consistency, and the different statistical analyses employed.

Still in a systemic review²⁵ assessing the effect of fixed orthodontic therapy on periodontal health; there was an absence of reliable evidence to describe an affirmative deleterious effects of orthodontic treatment and periodontal health, it concludes that the existing data suggests that orthodontic therapy results in minor detrimental effects to the periodontium post treatment.

CONCLUSION

In the short time period of 6 months, placement of fixed appliances caused increased plaque accumulation, and gingival inflammation for all subjects, so every attempt should be sought to select the best bracket design features and weigh its impact clinically and on the oral health.

REFERENCES

- Boyd RL, Baumrind S. Periodontal considerations in the use of bonds or bands on molars in adolescents and adults. *Angle Orthod* 1992;62:117-26.
- Anhoury P, Nathanson D, Hughes CV, Socransky S, Feres M, Chou LL. Microbial profile on metallic and ceramic bracket materials. *Angle Orthod* 2002;72:338-43.
- Magno AF, Enoki C, Ito IY, Matsumoto MA, Faria G, Nelson-Filho P. In-vivo evaluation of the contamination of super slick elastomeric rings by *Streptococcus mutans* in orthodontic patients. *Am J Orthod Dentofacial Orthop* 2008;133:104-9.
- Pandurangan H, Thillai SS, Varadhran K, Gnanamani A. Microbial adhesion on orthodontic ligating materials: An in vitro assessment. *Adv Microbiol* 2013;3:108-14.
- Naranjo AA, Triviño ML, Jaramillo A, Betancourth M, Botero JE. Changes in the subgingival microbiota and periodontal parameters before and 3 months after bracket placement. *Am J Orthod Dentofacial Orthop* 2006;130:275-17-22.
- Türk kahraman H, Sayin MO, Bozkurt FY, Yetkin Z, Kaya S, Onal S. Archwire ligation techniques, microbial colonization, and periodontal status in orthodontically treated patients. *Angle Orthod* 2005;75:231-36.
- Roth RH. The straight-wire appliance 17 years later. *J Clin Orthod*. 1987 Sep;21(9):632-42.
- Tsichlakia A, Chinb S, Pandis N, Fleming P. How long does treatment with fixed orthodontic appliances last? A systematic review. *Am J Orthod Dentofacial Orthop* 2016;149:3:308-18.
- Attack NE, Sandy JR, Addy M. Periodontal and microbiological changes associated with the placement of orthodontic appliances: a review. *J Periodontol*. 1996;57:78-85.
- Guzmán-Armstrong S, Chalmers J, Warren JJ. Ask us. White spot lesions: Prevention and treatment. *Am J Orthod Dentofacial Orthop* 2010;138:690-96.
- Ahn HB, Ahn SJ, Lee SJ, Kim TW, Nahm DS. Analysis of surface roughness and surface free energy characteristics of various orthodontic materials. *Am J Orthod Dentofacial Orthop* 2009;136:668-74.
- Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontol Scand* 1963;21:533-51.
- Papaioannou W, Gizani S, Nassika M, Kontou E, Nakou M. Adhesion of *Streptococcus mutans* to different types of brackets. *Angle Orthod*. 2007;77:1090-95.
- Ristic M, Vlahovic Svabic M, Sasic M, Zelic O. Clinical and microbiological effects of fixed orthodontic appliances on periodontal tissues in adolescents. *Orthod Craniofacial Res*. 2007;10:187-95.
- Patil B, Patil NS, Kerudi VV, et al. Friction between Archwire of Different Sizes, Cross Section, Alloy and Brackets Ligated with Different Brands of Low Friction Elastic Ligatures- An In vitro Study. *J Clin Diagn Res*. 2016;10(4):18-ZC22.
- Balenscifen JW, Madonia JV. Study of dental plaque in orthodontic patients. *J Dent Res*. 1970;49:320-24.
- Scheie AA, Arneberg P, Krogstad O. Effect of orthodontic treatment on prevalence of *Streptococcus mutans* in plaque and saliva. *Scand J Dent Res*. 1984; 92:211-17.
- Sinclair PM, Berry CW, Bennett CL, Israelson H. Changes in gingiva and gingival flora with bonding and banding. *Angle Orthod*. 1987;57:271-78.
- de Souza RA, de Araujo Magnani MBB, Nouer DF, da Silva CO, Klein MI, Sallum EA, Goncalves RB. Periodontal and microbiological evaluation of 2 methods of archwire ligation: ligature wires and elastomeric rings. *Am J Orthod Dentofacial Orthop*. 2008;134:506-12.
- Pellegrini P, Sauerwein R, Finlayson T, et al. Plaque retention by self-ligating vs. elastomeric orthodontic brackets: quantitative comparison of oral bacteria and detection with adenosine triphosphate-driven bioluminescence. *Am J Orthod Dentofacial Orthop*. 2009;135:426.e1-e9.
- van Gastel J, Quirynen M, Teugheles W, Coucke W, Carels C. Influence of bracket design on microbial and periodontal parameters in vivo. *J Clin Periodontol*. 2007;34:423-31.
- Pejda S, Varga ML, Milosevic SA, et al. Clinical and microbiological parameters in patients with self-ligating and conventional brackets during early phase of orthodontic treatment. *Angle Orthod*. 2013;83:133-39.
- Pandis N, Vlachopoulos K, Polychronopoulou A, Madianos P, Eliades T. Periodontal condition of the mandibular anterior dentition in patients with conventional and self-ligating brackets. *Orthod Craniofac Res*. 2008;11:211-15.
- Mombelli A, Gusberti FA, van Oosten MA, Lang NP. Gingival health and gingivitis development during puberty. A 4-year longitudinal study. *J Clin Periodontol*. 1989 ;16 :451-46.
- Bollen AM, Cunha-Cruz J, Bakko DW, Huang GJ, Hujoel PP. The effects of orthodontic therapy on periodontal health : a systemic review of controlled evidence. *J Am Dent Assoc*. 2008;139:413-22.

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