

# Dental plaque associated with self-ligating brackets during the initial phase of orthodontic treatment: A 3-month preliminary study

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## ABSTRACT

**Background:** To compare changes in the amount and distribution of dental plaque associated with placement of elastomeric modules over a self-ligating bracket during orthodontic treatment and to relate these changes to the periodontal inflammation.

**Materials and Methods:** A cross-arch randomization trial was carried out at Bristol Dental School, United Kingdom. Clinical measurements of periodontal inflammation and plaque accumulation and microbiological test were done on 24 patients aged 11-14 years [Mean (SD) age = 12.6 (1.01) years] wearing fixed appliances (Damon 2 brackets, Ormco, Orange, CA, USA) at the start and 3 months into fixed orthodontic treatment.

**Results:** In the first 3 months of treatment there was no statistically significant difference in bleeding on probing between incisors with and without elastomeric modules ( $P = 0.125$  and  $0.508$ , respectively). The difference in plaque accumulation was not statistically significant ( $P = 0.78$ ). The difference in probing depths between the incisors was not statistically significant ( $P = 0.84$ ). The microbiological analysis showed no difference.

**Conclusions:** Based on this preliminary 3 months study, elastomeric modules were not significantly associated with any increased risk during treatment when compared to self-ligating brackets. The longer term studies are needed to further confirm the findings of the present study.

**Key words:** Dental plaque, microbiological analysis, orthodontic treatment, periodontal inflammation, self-ligating brackets

## INTRODUCTION

Self-ligating brackets have an inbuilt metal labial face that can be opened and closed. Although early systems have been described since 1930s, they only made major impact last decade.<sup>[1]</sup> Periodontal disease is a known to be possible risk associated with fixed orthodontic appliances.<sup>[2,3]</sup> In a recent study,<sup>[4]</sup> the placement of orthodontic brackets influenced the accumulation and composition of the subgingival microflora, giving rise to inflammation.

Investigating changes in dental plaque during fixed appliance treatment could lead to improved means of preventing or at least reducing the risks associated with such treatment. Brackets ligated with elastomeric modules are thought to be at more risk of decalcification as reported previously

by Forsberg *et al.*<sup>[5]</sup> They showed that the incisor which was attached to the archwire with an elastomeric module exhibited a greater number of micro-organisms in the plaque than the incisor ligated with steel ligatures. In a more recent study<sup>[6]</sup> it was demonstrated that two archwire ligation methods, namely elastomeric modules and steel ligatures, showed no significant difference in plaque accumulation.

However, teeth ligated with elastomeric modules were more prone to bleeding and so it was suggested that elastomeric modules should perhaps not be used in patients with poor oral hygiene. Although it has been claimed that one of the advantages of the self-ligating brackets is that they collect less dental plaque,<sup>[7,8]</sup> there is no substantial evidence to support

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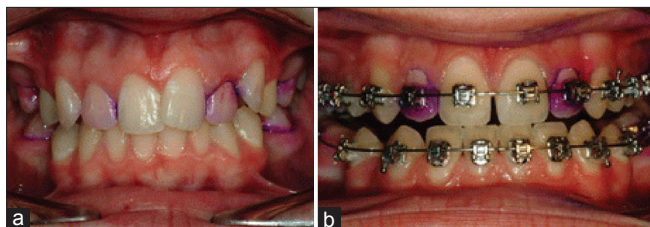
this. Therefore, the objectives of this study were to compare changes in the amount and distribution of dental plaque associated with elastomeric modules ligation during orthodontic treatment and to relate these changes to shift in subgingival microorganisms.

## MATERIALS AND METHODS

The North Somerset and South Bristol Research Ethics Committee in the United Kingdom granted ethics committee approval for the present study. Twenty-four consecutive patients, aged 11 to 14 years [Mean (SD) age = 12.6 (1.01) years], about to begin orthodontic treatment with fixed appliances were included in the study. The age group was chosen to obtain a homogenous sample of patients likely to have similar oral hygiene practice and no potential age-related differences in oral flora.

Exclusion criteria were patients requiring arch expansion, or distalization of molars, with auxiliary appliances because these additional appliances could interfere with oral hygiene practices. Patients with systemic diseases and patients on antibiotics for less than 3 months before the start of treatment were excluded to prevent disturbance of the oral flora that may influence the results.

The selected participants and their parents were given information about the study and informed consent was obtained. The patients then had a cross mouth randomization of self-ligating brackets with or without elastomeric ligatures in the upper arch. All patients had self-ligating Damon 2



**Figure 1:** Clinical photograph of one of the subjects at (a) T0 (prior to treatment) and (b) T3 (three months after treatment). The elastomeric module was randomized to the upper left lateral incisor for this patient

brackets (Ormco, Orange, CA, USA) placed and then randomly ascribed the upper lateral incisors to have an elastomeric module placed over the wings of one lateral incisor bracket. They all had the same oral hygiene instructions. The use of self-ligating brackets enables the only experimental variable on the lateral incisors to be the presence or absence of elastomeric ligatures.

### Assessment of Bleeding on Probing (BOB), Plaque Accumulation and Probing Depth

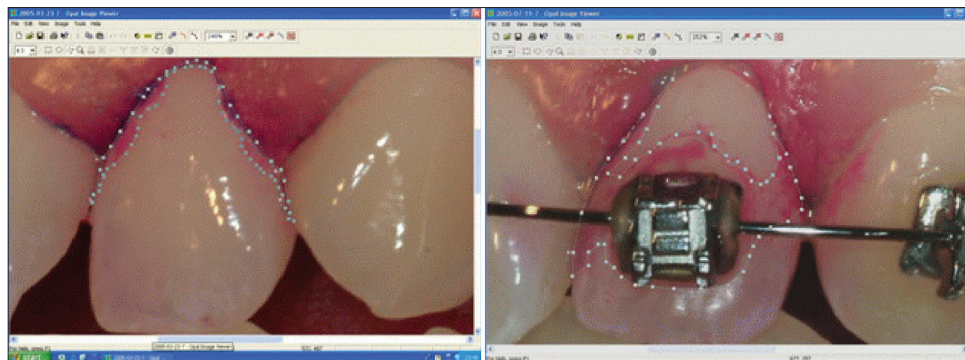
Clinical assessment of periodontal health including the presence of bleeding on probing and probing depths were taken of the upper lateral incisors at T0 [Figure 1a] and T3 [Figure 1b]. Probing depths were recorded at three points (mesial, mid-crown, and distal) on the buccal and palatal surfaces of the upper lateral incisors. In this report, the measures from the buccal surfaces are presented. The three buccal measurements from each tooth were added to give a total value.

In addition, plaque accumulation was scored on the upper lateral incisors using the area measurement method as described previously.<sup>[9]</sup> This method was advocated by the authors in the form of an abstract, the actual article was not found by either hand search or electronic search. Briefly, the incisors were disclosed with Butler Red-Cote® dental disclosing agent (Gum Butler, Chicago, USA) and photographed in a standard manner using Canon EOS 350 digital camera (Canon Inc., Tokyo, Japan).

The outline of the tooth was digitized and then the area of the plaque was measured using a computer with Orthognathic Planning and Analysis software (OPAL™, British Orthodontic Society, London, United Kingdom) [Figure 2]. The results were then expressed as a percentage rather than as an absolute area of plaque, to take account of different sizes of teeth and of the potential for different magnifications of the photographic images.

### Microbiological Profile

In addition, subgingival plaque samples were collected with sterile paper points from the lateral incisors ligated with



**Figure 2:** OPAL screen diagrams showing the marked plaque area for one of the patients at start (left) and 3 months in treatment with a bracket in place

and without elastomeric modules. These samples were subsequently transported to laboratory for Denaturing Gradient Gel Electrophoresis (DGGE) analysis.<sup>[10,11]</sup> Universal primers allow amplification of the gene from all bacteria. The mixed PCR (Polymerase Chain Reaction) product may be separated using DGGE, creating a “barcode” of DNA fragments derived from, and representing, different bacteria within the sample. This was done at T0 and T3.

### Statistical Analysis

Probing depths for incisors ligated with and without elastomeric modules were analyzed using standard parametric tests (ANOVA and *t*-test). Bleeding on probing results were assessed with non-parametric tests appropriate to the data distribution, i.e. non-normal. Furthermore, intraclass correlation was used to investigate the plaque scores in the area measurement method. The level of significance was set at 0.05.

## RESULTS

### Bleeding on Probing

The change in BOP for both incisors, with and without elastomeric modules, is given in Table 1. Out of all the participants in the study, it was found that in T0, only two lateral incisors ligated with elastomeric modules and six without expressed BOP. Three months into treatment, the number of incisors with elastomeric modules expressing BOP increased to 7, whereas incisors without modules decreased to 3. However, the difference for both incisors between T0 and T3 was not statistically significant ( $P = 0.125$  and  $0.508$ , respectively).

### Plaque Accumulation

Three months into treatment, incisors with and without elastomeric modules collected a statistically significant amount of plaque ( $P = 0.001$  and  $0.002$ , respectively). However, there was no statistically significant difference in the mean percentage increase in plaque coverage of upper lateral incisors with and without elastomeric modules.

### Probing Depth

The change in probing depth for upper lateral incisor teeth with and without elastomeric modules [Figure 3] was not statistically significant ( $P = 0.840$  and  $0.398$ , respectively).

The difference in changes in mean probing depth per patient between incisors ligated with elastomeric modules and without was tested and it was not statistically significant ( $P = 0.84$ ).

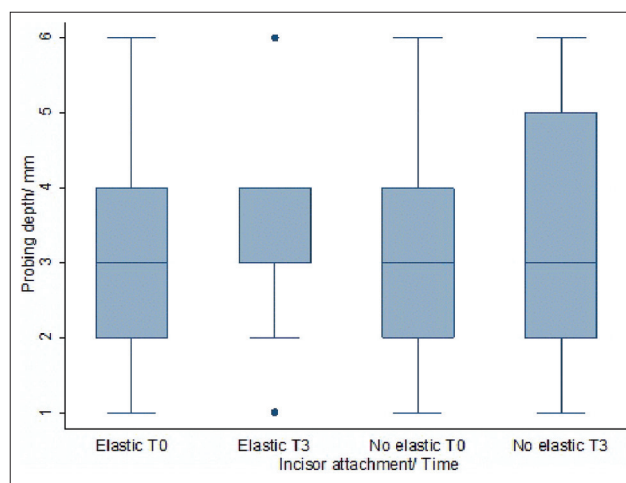
### Microbiological Results

“Barcode” changes were observed between the T0 and T3 samples for the lateral incisors with and without elastomeric module, but there were commonalities between these changes, suggesting a similar microflora at these sites [Figure 4].

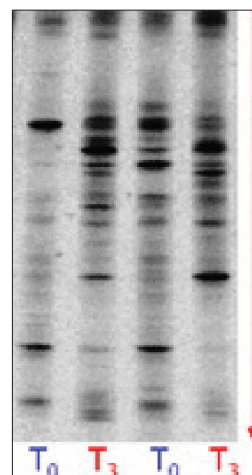
**Table 1: BOP of lateral incisors with and without an elastomeric module at start (T0) and at 3 months (T3) for 24 patients**

	Time	n (%)	McNemar P value
Elastics	T0	2 (8.3)	0.125
	T3	7 (29.2)	
No elastics	T0	6 (25)	0.508
	T3	3 (12.5)	

BOP – Bleeding on probing



**Figure 3:** Box and whisker plots of total buccal probing depth (mm) for incisor attachments with and without an elastomeric module at times T0 and T3



**Figure 4:** The DGGE profile for the lateral incisors with elastomeric modules at the start of treatment (T0) and 3 months into treatment (T3), is shown on the left hand side of the diagram. The result of the incisors without the elastomeric modules at T0 and T3 is illustrated on the right hand side of the diagram

## DISCUSSION

The link between the malocclusion and dental health has not been firmly established yet,<sup>[12,13]</sup> but deterioration in oral health during orthodontic treatment is a matter of interest. Clinicians should take any known steps toward preventing



the potential risks of decalcification and periodontal disease during orthodontic treatment. In the present study, the number of the lateral incisors that were ligated with elastomeric modules and expressed BOP has increased during treatment [Table 1]. It can be argued that the expression of BOP with initiation of fixed appliance treatment is expected, but surprisingly, there was a decrease in the number of incisors without elastomeric modules, which showed BOP [Table 1].

Although both changes, i.e. incisors with and without elastomeric modules, were not statistically significant, the decrease in BOP in incisors without elastomeric modules needs further investigation. Both methods of ligation also showed no statistically significant changes in probing depth over this period [Figure 3]. During fixed appliance treatment, the distribution of plaque can be altered hence the carious lesion development may be changed. In Zachrisson<sup>[14]</sup> longitudinal study, orthodontic treatment did not increase the prevalence of dental caries. However, the distribution of the carious lesions was significantly altered. In general, orthodontic treatment resulted in a shift in carious lesions from posterior to anterior teeth and from interproximal to facial and lingual aspects.

In this study, although there was a very significant increase in plaque score for upper lateral incisors in the first 3 months [Table 2], the difference in the mean changes of plaque area of incisors ligated with or without elastomeric modules was also not statistically significant. Therefore, this confirmed the previous finding that there is no difference in plaque accumulation associated with either self-ligating brackets or those with elastomeric modules.<sup>[6]</sup> However, Forsberg *et al.*<sup>[5]</sup> had shown that the incisors attached with elastomeric modules exhibited a greater number of microorganisms in the plaque after 3 months than incisors ligated with stainless steel ligatures.

This finding would appear to disagree with the current findings, but it raises the question as to whether more microorganisms on the ligatures equates to more plaque on the actual tooth surface or actual damage to that surface or to the adjacent periodontium. In Forsberg's study,<sup>[5]</sup> although the findings are relevant to this investigation, no clinical measurements were

**Table 2: Mean and 95% confidence interval for plaque accumulation of lateral incisors with an elastomeric module at T0 and T3**

	Mean (SD) change %	95% CI of the mean changes	P value
Plaque accumulation in the lateral incisor area with elastic T3 to T0	24.09 (3.70)	10.56-37.62	0.001
Plaque accumulation in the lateral incisor area without elastic T3 to T0	22.40 (3.49)	9.07-35.73	0.002
The difference in means	1.69 (0.27)	11.01-14.38	0.78

CI – Confidence interval; SD – Standard deviation

recorded; hence no direct clinical comparisons can be made with that particular study.

Turkkahraman *et al.*<sup>[6]</sup> found that elastomeric modules and steel ligatures showed no significant difference in terms of bonded bracket plaque index, gingival index, and pocket depths, but teeth ligated with elastomeric modules were indeed more prone to bleeding on probing. They hence suggested that elastomeric modules should probably be avoided in patients with poor oral hygiene. The Microbiological results in this study [Figure 4] indicated some changes in the microflora of the lateral incisors ligated with elastomeric modules and those without. The DGGE method considers the presence of unidentified and difficult to cultivate bacterial species present in subgingival plaque. Fujimoto *et al.*<sup>[15]</sup> showed that DGGE analysis has the potential to examine bacterial shift in periodontal disease. It therefore can be concluded that microbial shift has taken place 3 months into treatment; this shift is similar to both sites.

In support of this current study, an investigation<sup>[16]</sup> aimed to investigate the effect of bracket type (conventional and self-ligating) on the levels of *Streptococcus mutans* and total bacterial counts in whole saliva of orthodontic patients. It was found that the levels of *S. mutans* levels did not differ significantly between the conventional and self-ligating brackets 2-3 months into treatment.

Therefore, the plaque difference for incisors ligated with and without elastomeric modules was not significant. There are no directly comparable studies in the literature. With the increasing use of self-ligating brackets, comparisons between elastomeric ligation and self-ligation will become of correspondingly increased importance. Meanwhile, there is no evidence from this study that in a short term elastomerics cause more damage to periodontal health than self-ligation.

In a recent systematic review,<sup>[17]</sup> several aspects were tested between conventional and self-ligating brackets. In terms of plaque retention and periodontal health, it was concluded that only two trials were found. In these two studies, there is no evidence to support the use of self-ligating over conventional brackets or vice versa.

In support of the current study, an *in vivo* study<sup>[18]</sup> investigated the influence of the bracket design on microbial and periodontal parameters. It was found that there is no significant difference between self-ligating (Speed), conventional (GAC), and control teeth in terms of bleeding on probing. However, they demonstrated significant higher gingival crevicular flow in the bracket group than in the control group at day 7. Furthermore, interestingly they showed more gingival hypertrophy with the self-ligating than with the conventional brackets.

In theory, reducing dental plaque during treatment may be of particular benefit especially in some medical conditions where

maintaining a good standard of oral hygiene is considered to be essential during treatment.<sup>[9]</sup> However, interpreting the findings of the study must be done cautiously considering its preliminary and short observation period. Future studies can address these shortcomings.

## CONCLUSIONS

Elastomeric modules were not found to be associated with a greater risk of gingival inflammation when compared to self-ligating brackets 3 months into fixed orthodontic treatment. Further, the microbiological results showed a microbial shift 3 months into treatment, but with no difference in both sites. The longer term results will be of great interest.

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