

# Plaque, caries level and oral hygiene habits in young patients receiving orthodontic treatment

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**Objective:** To assess plaque, caries, and oral hygiene habits amongst patients receiving fixed-orthodontic treatment at the Dental-Clinic, Universidad-El-Bosque, Bogotá, Colombia. **Basic research design:** Test-group: 74 12-29-year-olds receiving fixed-orthodontic treatment; reference-group: 63 12-29-year-olds before they started the orthodontic treatment. Visual examinations (one examiner) recorded the following: Ortho-plaque-Index (OPI) expressed per patient as good, fair and poor-oral-hygiene. Caries was scored with the modified-ICDAS-II criteria as: 0-sound; 1B/1W-brown/white-opacity-after-air-drying; 2B/2W-brown/white-opacity-without-air-drying; 3-microcavity; 4-underlying-shadow; 5/6-distinct/extensive-cavity. Filled/missing surfaces due-to-caries and caries-lesions on buccal surfaces at three sites around the brackets were recorded. A 7-item self-administered oral-hygiene habits' questionnaire was used. **Results:** Chi-square test revealed that the oral-hygiene level was significantly better in the reference group compared to the test group ( $p < 0.05$ ). The traditional mean DMF-S was  $6.7 \pm 6.3$  in the test- and  $6.2 \pm 5.9$  in the reference-group ( $p > 0.05$ ). When adding modified-ICDAS-II lesions scores 1-4, the figure increased to  $23.6 \pm 9.4$  in the test- and to  $13.6 \pm 10.3$  in the reference-group ( $p < 0.001$ ). A total of 96% had  $\geq 1$  white-opacity in the test group versus 56% in the reference group ( $P < 0.001$ ). In the test-group the buccal-surfaces accounted for most white-opacities and close to 1/3 of these lesions on the upper-anterior teeth were located around the brackets. The questionnaire disclosed that 58% in the test- vs. 44% in the reference-group did not accept having dental caries lesions during the orthodontic treatment. **Conclusions:** The results showed a high prevalence of white-opacities related to orthodontic appliances and indicate the need to implement preventive programmes at the dental clinic.

*Key words:* Buccal surfaces, dental caries, ICDAS-II criteria, oral hygiene, orthodontics.

## Introduction

It has been well documented that fixed orthodontic appliances increase the risk of caries lesions (Chang *et al.*, 1997; Gorelick *et al.*, 1982; Øgaard, 1989) by promoting bacterial plaque retention (Årtun and Thylstrup, 1986; Chang *et al.*, 1997; Øgaard *et al.*, 1988). Gorelick *et al.* (1982) showed among subjects less than 18-years old from their own private practice, a prevalence of white spot lesions (WSL) after orthodontic treatment of 50% in comparison to a prevalence of 24% in a control group of patients before their orthodontic treatment. Mizrahi (1982) found a prevalence of WSL among a 16-year-old sample after fixed orthodontic treatment of 84% versus a prevalence of WSL of 72% in a reference 12-year-old pre-orthodontic treatment group. Øgaard (1989) found five years after debonding in 19-year olds, a prevalence of WSL of 96% versus 85% among a same age control group. The latter author refers to the WSL after orthodontic treatment as an esthetic problem. Mitchel (1992) reports that amongst adolescents treated with fixed orthodontic appliances, the incidence of white spot lesions adjacent to the brackets has been estimated to be between 15 and 85%. Finally, Stecksén-Blicks *et al.* (2007) have shown that in Swedish children undergoing fixed orthodontic treatment the incidence of WSL was 25% in the placebo group versus 7% in a fluoride varnish group. All above mentioned figures should be seen in the light of the fact that there is a wide variation

in caries detection methods, time when patients were examined and variation in preventive methods used during treatment. An internationally accepted standardization of caries recording would be highly appreciated.

In Bogotá in 2000, there were around 456 orthodontists, members of the Colombian Orthodontic Society. On average, each professional had 100 regular patients per year (Isaza, 2000). Around 45,600 adolescents and young adults were thus under orthodontic treatment. In January 2004, the dental clinic at the Universidad El Bosque had 408 3-60-year-old patients undergoing orthodontic treatment, of which 8% were under fixed orthodontic treatment for periodontal or prosthetic reasons and 16% under early orthodontic treatment. The remaining 76% (310 patients) were under fixed orthodontic treatment for esthetic/functional reasons.

The aim of this study was to determine the plaque status, the caries status and oral hygiene habits of patients with fixed orthodontic appliances for more than one year at the dental clinics of Universidad El Bosque, Bogotá. The data were compared to similar data obtained on a reference group of patients who were enrolled for fixed orthodontic treatment but had not yet started the treatment. Internationally accepted scoring systems were used to standardize the plaque status (OPI Index) (Heintze *et al.*, 1999), and the caries status (ICDAS-II modified system) (Ismail *et al.*, 2007, Ekstrand *et al.*, 2007). Approval was obtained from the ethical board at Universidad El Bosque as required by the Colombian laws (Resolution 8430, 1993). Patients signed an informed consent form.

## Material and Method

### Sample

Inclusion criteria for the test group: 12-29 year olds without systemic conditions/diseases and who had the treatment done for at least one year in January 2004. A total of 94 persons fulfilled the inclusion criteria of which 74 (34 men and 40 women; mean age  $20\pm 6$ ) agreed to participate. Inclusion criteria for the reference group: 12-29 year olds without systemic conditions/diseases and who were due to start the fixed orthodontic treatment in January 2007. A total of 90 patients fulfilled these inclusion criteria of which 63 patients (33 men and 30 women; mean age 18 years  $\pm 5$ ) agreed to participate.

### Indexes

The oral health status was assessed in terms of: -bacterial plaque levels, evaluated with the Ortho-Plaque Index (OPI) (Heintze *et al.*, 1999). Dental caries was assessed with a slightly modified version of the International Caries Detection and Assessment System – II (ICDAS-II) (Ekstrand *et al.*, 2007; Ismail *et al.*, 2007). Finally, oral hygiene habits were assessed by means of a questionnaire (Martignon *et al.*, 2008).

One highly experienced clinician (SM) recorded the plaque and caries status of the participants in both groups.

### Bacterial plaque:

Presence of plaque was assessed using a disclosing agent (2% erythrosine) in three sites of the buccal surfaces of all teeth, excluding the second and third molars. According to the OPI-system (Heintze *et al.*, 1999) each tooth is assigned one score depending on the location of plaque: cases with plaque mesial or distal to the bracket= 3 points; cervical to the bracket= 2 points; and coronal to the bracket= 1 point. The total score is computed by the following formula (accumulated sum divided by the number of teeth present multiplied by 6 and multiplied by  $100^{-1}$ ). This yields a percentage that corresponds to the patient's OPI. Values 0-30% indicates good oral hygiene, 31-50% fair, and 51-100% poor.

During the last five years the examiner's intra-reproducibility has been tested in an in vitro as well as in an in vivo investigation and found excellent in both cases (Ekstrand *et al.*, 2007). For the purpose of this study, the ICDAS-II system was extended as score 1 and 2 were both divided into a W and B indicating white lesions (W) and brown lesions (B) as described by Ekstrand *et al.* (2007). After conducting professional prophylaxis and with the aid of the dental unit's light, triple syringe, oral mirror and a ball-ended probe, (CPI 11.5 -WHO) all surfaces were examined using the ICDAS-II scores: 0-sound; 1B/1W- brown/white opacity after air-drying; 2B/2W- brown/white opacity without air-drying; 3- microcavity; 4- underlying shadow; 5- distinct cavity; and 6-extensive cavity (Ekstrand *et al.*, 2007). Dental caries on buccal surfaces was further recorded at three sites (incisal, middle and cervical third). Filled or missing due-to-caries surfaces were also scored.

A 7-item self-administered questionnaire was used to assess subjects' knowledge (1), attitudes (4) and practices (2) in oral hygiene habits (Martignon *et al.*, 2008) (Table 1).

For the OPI Index, 13 of a set of 25 clinical pictures of orthodontically-treated dentitions with different grades of plaque were examined twice some weeks before the examination of both the test group and reference group. At least one week elapsed between the first and second assessments.

Regarding the ICDAS-II criteria, 5% of the patients with a total of 476 surfaces were examined twice in the test group. A similar number of patients in the reference group were assessed twice.

All data were entered into an Excel Spreadsheet®. Descriptive statistical analyses, both for the OPI, the caries status and oral hygiene habits, were conducted. Intra-examiner reliability (unweighted kappa values) was calculated for both the OPI on pictures (Kappa values: 0.80 before examining the test group; Kappa value 0.82 before examining the reference group) and for the ICDAS-II caries examination (Kappa values: 0.80, test group; 0.78, reference group). A Chi-square test was used to test for differences in oral hygiene levels between test and reference groups. Wilcoxon-Mann-Whitney tests were used to test for differences in caries scores between test and reference group. A Chi-square test was used to test differences in prevalence of white spot lesions in the two groups. p-values below 0.05 indicate significant differences.

## Results

Regarding oral hygiene status the OPI disclosed that in the test sample 20% and 65% of the patients showed a good- and a fair oral hygiene, and 15% a poor oral hygiene status. Corresponding figures in the reference group were 18%, 80% and 1%. Chi-square test revealed that the oral-hygiene level was significantly better in the reference group compared to the test group ( $P < 0.05$ ).

### Dental caries:

The mean DMF-S (ICDAS-II scores  $> 4$ ) in the test group was  $6.7\pm 6.3$ , of which  $0.6\pm 1.5$  was the D-component,  $1.1\pm 2.7$  the M component and  $5.0\pm 4.7$  the F component (Figure 1). When including ICDAS -scores 1-4, it increased to  $23.7\pm 9.4$ , of which  $11.3\pm 7.1$  mean surfaces corresponded to white opacities (scores 1W, 2W);  $3.1\pm 3.0$  to brown opacities (scores 1B, 2B);  $2.6\pm 2.2$  to loss of surface integrity/underlying shadow of dentine (scores 3, 4);  $0.6\pm 1.5$  to distinct/extended cavities;  $1.1\pm 2.7$  corresponded to missing surfaces; and  $5.0\pm 4.7$  to filled surfaces.

In the reference group, the mean DMF-S was  $6.2\pm 5.9$  (D:  $0.1\pm 0.3$ ; M:  $0.9\pm 2.8$ ; F:  $5.2\pm 3.9$ ). It increased to  $13.6\pm 10.3$  when including ICDAS-II scores 1-4 (scores 1W-2W:  $2.7\pm 4.8$ ; 1B-2B:  $3.8\pm 3.2$ ; score 3:  $0.6\pm 1.2$ ; score 4:  $0.2\pm 0.7$ ; score 5:  $0.1\pm 0.7$ ; and score 6:  $0.1\pm 0.8$ ). From figure 1 it can be seen that apart from the prevalence of white spot lesions and microcavities/shadows there were no significant difference in caries scores between test and reference group.

Figure 2 shows the percentage distribution of subjects in relation to the number of carious surfaces (scores 1W/B-6). In the test group all (100%) patients had at least one lesion, 96% had more than 4 lesions and 50% had 17 or more caries lesions. In the reference group 92% had one or more lesions, while 59 % had more than 4 lesions;

**Table 1.** Questionnaire on knowledge, attitudes and practices in oral hygiene habits.

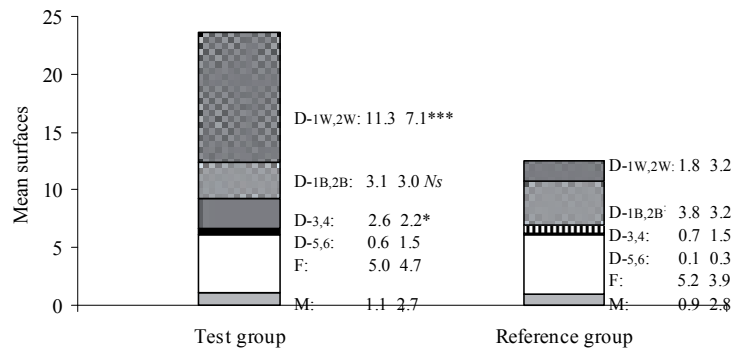
Nr.	Questions on knowledge	Items	Answer							
			Test group		Reference group					
			n	%	n	%				
1	In your opinion, which is the best manner to avoid dental caries?	a	By attending the dentist	19	25.9	17	27.4			
		b	By attending the orthodontist	4	5.6	3	5.2			
		c	With appropriate oral hygiene	34	45.5	31	49.5			
		d	With a good diet	7	9.1	4	6.3			
		e	By avoiding sweets	10	14.0	8	11.6			
Nr.	Questions on practices	Items	n	%	n	%				
			2	Do you brush your teeth at least twice a day?	a	Totally in agreement	54	73.0	46	73.0
					b	In agreement	16	21.6	16	25.4
c	Neutral	0			0.0	0	0			
d	In disagreement	4			5.4	1	1.6			
e	Totally in disagreement	0			0.0	0	0			
3	Do you use dental floss at least three times per week?	a	Totally in agreement	13	17.6	18	28.6			
		b	In agreement	22	29.7	18	28.6			
		c	Neutral	4	5.4	2	3.2			
		d	In disagreement	24	32.4	21	33.3			
		e	Totally in disagreement	11	14.9	4	6.3			
Nr.	Questions on attitudes	Items	n	%	n	%				
			4	Is the dentist/orthodontist responsible for your teeth not being clean?	a	Totally in agreement	4	5.4	1	1.6
					b	In agreement	9	12.2	2	3.2
c	Neutral	38			51.4	1	1.6			
d	In disagreement	13			17.6	19	30.1			
e	Totally in disagreement	10			13.5	40	63.5			
5	Are you responsible for your teeth showing signs of dental caries during the orthodontic treatment?	a	Totally in agreement	32	43.2	62	98.4			
		b	In agreement	28	37.8	0	0			
		c	Neutral	10	13.5	0	0			
		d	In disagreement	3	4.1	0	0			
		e	Totally in disagreement	1	1.4	1	1.6			
6	Do you believe it is normal to have new caries lesions during the orthodontic treatment?	a	Totally in agreement	2	2.7	16	25.4			
		b	In agreement	10	13.5	4	6.3			
		c	Neutral	19	25.7	15	23.8			
		d	In disagreement	28	37.8	10	15.9			
		e	Totally in disagreement	15	20.3	18	28.5			
7	Do you think besides the orthodontist you should attend another dentist to check if you have dental caries?	a	Totally in agreement	12	16.2	30	47.6			
		b	In agreement	26	35.1	24	38.1			
		c	Neutral	13	17.6	2	3.2			
		d	In disagreement	13	17.6	6	9.6			
		e	Totally in disagreement	10	13.5	1	1.6			

however, no one had 17 or more lesions.

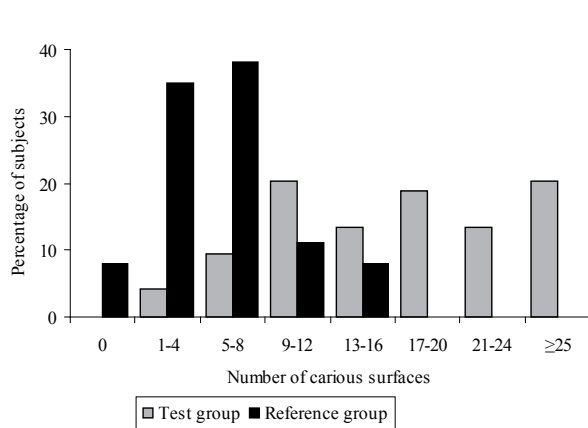
When considering white opacities only (1W, 2W), 96% of subjects in the test group had  $\geq 1$  lesion, around  $2/3 \geq 7$  lesions, 50%  $\geq 11$  lesions and 15%  $\geq 20$  lesions (Figure 3). In the reference group 56% of subjects had  $\geq 1$  lesion, 51% from 1-4 lesions; 3% from 5-8 lesions; and 2% from 9-12 lesions ( $p > 0.01$ ). Regarding the location of the white opacities about  $3/4$  (73.8%) in the test and  $1/3$  (32.2%) in the reference group were detected on buccal surfaces.

In the test group the most affected teeth with white opacities (mean 1W, 2W) in the buccal surface were the second lower premolars ( $0.8 \pm 0.5$ ); followed by the upper

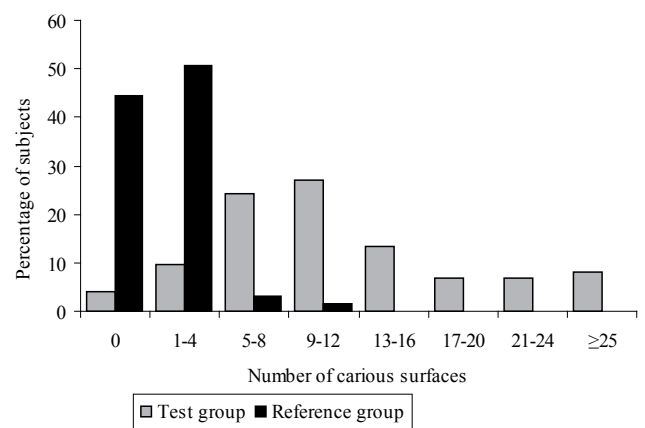
lateral incisors ( $0.7 \pm 0.4$ ), lower canines ( $0.7 \pm 0.5$ ), second lower molars ( $0.7 \pm 0.5$ ), and lower first premolars ( $0.6 \pm 0.5$ ) (Figure 4). In the reference group the most affected teeth with white opacities in the buccal surfaces (score 1W, 2W) were the second upper molar teeth ( $0.4 \pm 0.6$ ), followed by the first upper molar teeth ( $0.3 \pm 0.6$ ). Furthermore, while in the reference group all white opacities in the buccal surfaces were located in the cervical third, in the test group up to about  $1/3$  were located in the middle third of the surface: lateral-upper incisors - 34.5%; central-upper incisors - 28.8%; upper canines - 21.6%; second lower premolar - 16.7%; lower canine - 16.5%; first lower premolar - 12.1%; and second lower molar - 11.4%.



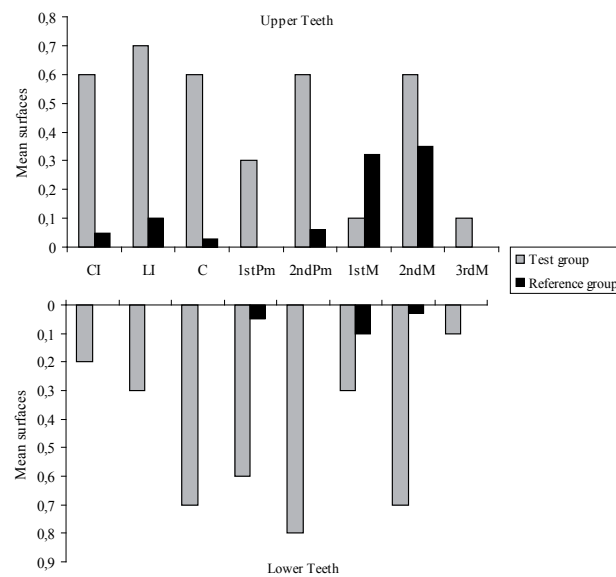
**Figure 1.** Caries experience / DMF-S (ICDAS D-scores: 1 – 6) in the test ( $23.7 \pm 9.4$ ) and in the reference group ( $11.8 \pm 5.3$ ).



**Figure 2.** Percentage distribution of subjects in relation to number of surfaces with caries lesions (ICDAS scores 1-6).



**Figure 3.** Percentage distribution of subjects in relation to number surfaces with white opacities (1W, 2W).



**Figure 4.** Mean of opacities (1W, 2W) in Buccal surfaces of upper and lower teeth (CI=central incisor; LI=lateral incisor; C=canine; Pm=premolar; M=molar).

The results of the questionnaire on oral hygiene habits (Table 1) show that almost half of the subjects (test group, 46%; reference group, 50%) consider that the best way to avoid dental caries is cleaning their teeth correctly. Nearly all (test group, 95%; reference group, 98%) brushed their teeth twice a-day. Regarding dental floss, 47% in the test and 57% in the reference group claimed to use it three times per week.

Almost two thirds of subjects in the test group (58%) versus less than half in the reference group (44%) did not consider it normal to have new caries lesions during the orthodontic treatment. While around one fifth of the test group (18%) agree or totally agree with the orthodontist being responsible for not having their teeth clean, only 5% in the reference group do. The opposite tendency was seen for the subjects in total agreement with feeling responsible for the development of new caries lesions during orthodontic treatment (test group, 43%; reference group, 98%). In addition, while most subjects in the reference group (86%) think that besides the orthodontist they should attend another dentist to check their dental caries status, only half of subjects approximately in the test group do (51%).

## Discussion

Due to variations in methods of recording caries (Ismail, 2004), it is difficult to compare results across different studies. The authors of the present study chose to use well-described recording systems, which eventually could make it possible to compare results across studies. Both scoring systems used in the present study were reliably interpreted in the hand of the examiner as the reproducibility in terms of Kappa-values exceeded 0.78.

Regarding plaque, there is a well-established relationship between dental caries and plaque (Thylstrup, 1994). The brackets and wires from the orthodontic fixed appliance are considered to favour plaque stagnation (Chang *et al.*, 1997; Øgaard *et al.*, 1988). To record the presence of plaque the OPI Index (Heintze *et al.*, 1999) has been used. This index was found to be easy to use and facilitated the interpretation of an individual's oral-hygiene status.

To record caries, it was decided to use the ICDAS-II scoring system, because it has both content and correlation validity with histological depth of carious lesions (International Caries Detection and Assessment System (ICDAS) Coordinating Committee, 2005) based on research conducted by Ekstrand *et al.* (1995, 1997). The ICDAS-II version used in the present study (Ekstrand *et al.*, 2007) was slightly different from the original one (Ismail *et al.*, 2007) because one of the purposes of this study was to differentiate white spot lesions from brown lesions.

Another reason for using the ICDAS-II system was to get experience as studies are in progress investigating the effect of different preventive methods on the prevention of dental caries in association with orthodontic treatment. Thus, the ICDAS score 1W/B or 2W/B can then be used as transition scores for progression/arrestment; for example if a baseline score 1W goes to score 2W after intervention it means progression and the opposite regression/arrestment.

There is little information reported on the literature regarding oral health habits among patients with orthodontic treatment (Klages *et al.*, 2005; Mandall *et al.*, 2006). Get-

ting information on a patient's oral hygiene knowledge, practices and attitudes may be useful for improving the success of orthodontic treatment (Klages *et al.*, 2005). The questionnaire used in this study was based on a previous questionnaire (Martignon *et al.*, 2008), which yielded results that were used for planning a preventive program on pre-school children.

The oral hygiene level expressed by the OPI-index was significantly better in the reference group compared to the test group. This indicates that orthodontic appliance make oral cleaning more difficult.

Comparing caries data from the two groups, the main differences were 1) a significant higher mean number of white spot lesions in the test group (Figure 1); 2) that while around 80% of subjects in the reference group had 0-8 ICDAS-II lesions scores 1-6, in the test group around same percentage had from 9 to more than 25 (Figure 2); 3) that in the reference group 40% of subjects had no- and around 50% 1-4 white opacities while in the test group over 85% had from 1 to more than 25 white opacities (Figure 3); 4) that the buccal white spot lesions in the reference group were primarily on molar teeth, whereas in the test group these showed a more even distribution along the arches (Figure 4), and finally 5) the buccal white spot lesions in the reference group were mainly located along the gingiva, while in the test group 1/3 of these lesions were located in the middle third of the surface (around the bracket). Thus, the data strongly suggest that on the test-group the orthodontic treatment promotes lesion development related to the fact that orthodontic bands etc. are to be considered as artificial plaque stagnation areas.

The incidence of white spot lesions reported in other similar studies was lower than that of the present study (Gorelick *et al.*, 1982; Mizrahi, 1982). This difference may be explained by the fact that the caries index used in this study is more sensitive and specific than the indices used in previous studies (Ismail *et al.*, 2007).

Regarding oral health care habits, there is a tendency to a shift in attitudes in the test versus the reference group in several aspects: significantly more patients in the test than in the reference group do not consider it normal to have new caries lesions during the orthodontic treatment. While half of patients in the test group think it is a shared responsibility between the orthodontist and themselves when caries signs appear, reference patients think it is their own responsibility. This observation highlights the ethical task of the orthodontist in preventing white spot lesions, because they are unhealthy, unaesthetic and potentially irreversible (Burkland, 1999).

The 12 year-old prevalence of caries experience in Colombia is 72% and the mean DMF-T is 2.3; corresponding figures for the 15-19 years old group are 90% and 5.2 respectively (Ministerio de Salud-Colombia, 1999), Class-II is the predominant malocclusion and straight arch the predominant treatment. The National Security System does not pay for the orthodontic treatment; hence patients have to pay for it themselves. More than 70% of young orthodontic patients in Bogotá are in middle to upper social economical groups.

The test subjects correspond to patients who attend the university's clinic and are being treated by orthodontic residents, who on average have 40 minutes for the monthly

orthodontic recall appointment. This time does not seem sufficient to do other procedures, such as plaque control, prophylaxis and oral health education or other preventive measures. This was confirmed by the high percentage of subjects showing a fair and a poor oral hygiene. However, a patient's monthly visit should be a good opportunity for assuring a good oral health status. This situation also highlights the importance of the legal aspects of the orthodontist in the supervision of the patient's oral care during the full orthodontic treatment programme (Machen, 1991).

The results indicate a need for implement preventive programmes. Preventive programmes based on different measures such as topical fluoride application (Stecksén-Blicks *et al.*, 2007) and education in oral hygiene (Nexo Public Dental Health Service, 2002) are therefore in progress to see if they can control the development of carious lesions during orthodontic treatment in the reference group.

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