### EFFECTIVENESS OF AN ORAL HYGIENE PROGRAM FOR PATIENTS UNDERGOING FIXED ORTHODONTIC TREATMENT

### \*SAQIB NAEEM, FCPS (Orthodontics) \*SAAD ASAD, FCPS (Orthodontics) \*\*IRFAN-UL-HAQ \*\*\*M WAHEED-UL-HAMID, MS (Orthodontics), MOrtho Edinburgh

### ABSTRACT

The aim of the present study was to assess the effectiveness of an oral hygiene program for patients undergoing fixed orthodontic treatment. Main sample consisted of one hundred patients with an age range of 12-25 years, having a full complement of permanent dentition, reporting to the orthodontic department of the de,Montmorency College of Dentistry, Lahore. Community Periodontal Index was used to assess the periodontal status of these patients. From these 100 patients, 20 patients having good oral hygiene and in need of fixed orthodontic treatment were divided into experimental and control groups, and their periodontal status was assessed before and during fixed orthodontic treatment. Modified Bass toothbrushing technique and the relation between the fixed orthodontic appliances, plaque accumulation and gingival inflammation were explained to the experimental group. Data was analyzed by using SPSS (Version 8.0) in personal computer.

Results showed although no significant differences were noted in the periodontal status of experimental and control groups, but as a group, control group patients showed more statistically significant deterioration of periodontal health as compared to the experimental group.

**Key words:** Periodontal status, community periodontal index, patients undergoing fixed orthodontic treatment, oral hygiene instructions, experimental and control groups.

### INTRODUCTION

Maintaining good oral hygiene is a challenge for anyone but particularly for orthodontic patients, whose appliances make adequate plaque removal difficult, due to the increase in the surfaces and the inaccessibility of some areas<sup>1</sup>, resulting in poor oral hygiene, and accumulated food debris along the gingival margin leads to gingival and periodontal diseases<sup>2,3,4,5,6,7</sup>. Active cooperation of orthodontic patients is essential over a prolonged treatment and involves keeping appointments and maintenance of an adequate level of oral hygiene and refrain from hard and sticky foods<sup>8</sup>.

Orthodontists must emphasize patient education, motivation and regular monitoring of oral hygiene<sup>1</sup>. Infact ongoing monitoring of gingival and periodontal health by orthodontists throughout treatment period

- \* Assistant Professor/Head, Orthodontics Department, University College of Dentistry, The University of Lahore, 1-Km Raiwand Road, Lahore
- \*\* Senior Registrar, Orthodontics Department, de, Montmorency College of Dentistry, Lahore
- \*\*\* Professor/Head, Orthodontics Department, de,Montmorency College of Dentistry, Lahore

**Correspondence:** 138-B, B.O.R. Housing Society, Near Jinnah Hospital, Johar Town, Lahore, Pakistan. Ph: 03334359031, E-mail: saqibnaeem@hotmail.com

and repeated reinforcements of acceptable oral hygiene measures has become an integral part of modern orthodontic practice<sup>2</sup>.

A number of studies have been done in different parts of the world to evaluate the effectiveness of different oral hygiene programs for patients undergoing fixed orthodontic treatment  $^{9,4,10,11,12,13,14,15}$ .

This study was aimed to get such a data at the Orthodontic department, de,Montmorency College of Dentistry, Punjab Dental Hospital Lahore, by scoring with Community Periodontal Index (CPI) on 20 patients selected from the main sample by dividing them into an experimental and a control group.

### MATERIALS AND METHODS

One hundred patients reporting to the orthodontic department, de,Montmorency College of Dentistry, Punjab Dental Hospital, Lahore were selected randomly, irrespective of sex. The age range of the patients was 12 to 25 years chronologically. All patients had a full complement of permanent dentition through first/second molars<sup>16</sup>. Care was taken to exclude patients who were having major medical problems like diabetes mellitus<sup>9,4,5,6,10,17</sup>, antibiotic therapy during the past two months<sup>6</sup>, abnormal parafunctional habits<sup>4</sup>, abnormal hard and soft tissue morphology like cleft lip and cleft palate patients history of any active orthodontic treatment and smokers<sup>18</sup>.

After obtaining consent of the patients, periodontal examination was done by the authors using CPI index<sup>19</sup> (Community Periodontal Index) formerly known as CPITN index (Community Periodontal Index of Treatment Need), with the help of WHO CPI periodontal probe. Individual patient's CPI scores were recorded and assessed according to Annexure 1.

From the main sample of 100 patients, twenty patients having CPI scores of 0, 1 or 2 in each sextant, irrespective of sex and age were selected from the main sample.

For comparison of periodontal status, further two groups (experimental and control) often each were formed.

The experimental group received oral hygiene instructions<sup>2</sup>, while the control group did not receive these instructions.

- Accumulation of plaque and gingival inflammation related to the fixed orthodontic appliances was emphasized to the patients.<sup>2,4</sup>
- Modified Bass tooth brushing technique was demonstrated to the patients.<sup>4,21,22</sup>

No instructions were given to each group regarding the type of toothbrush, toothpaste, use of mouthwashes or any other special oral hygiene aids.

The patients received fixed orthodontic appliances and the level of their oral hygiene was scored with CPI Index, immediately prior to start of orthodontic treatment (pretreatment) and at 1, 3 and 6 months after the orthodontic appliance placement.

The mean, standard deviation and range for quantitative variables were calculated by using SPSS version 8.0 for Windows.

For inter-group and intra-group comparison of CPI scores of experimental and control groups, independent and paired t-tests were used.

For intra-examiner reliability, 20 cases were randomly selected from the main sample of 100 patients and their CPI scores were reevaluated two weeks after the first examination. For inter-examiner reliability, another colleague of the orthodontic department was asked to evaluate the CPI status of the selected patients. Data for the examiner reliability was analyzed by kappa statistics using SPSS 8.0 software for the Windows.

### COMMUNITY PERIODONTAL INDEX (CPI)<sup>23</sup>

(Formerly called Community Periodontal Index of Treatment Needs or CPITN)

### Indicators

Three indicators of periodontal status are used for this assessment: Gingival bleeding, calculus, periodontal pockets.

A specially designed lightweight CPI probe with a 0.5 mm ball tip is used, with a black band between 3.5 and 5.5 mm and rings at 8.5 and 11.5 mm from the ball tip.

### Sextants

The mouth is divided into sextants defined by tooth numbers: 18-14, 13-23, 24-28, 38-34, 33-43, and 44-48\*.

### Distribution of the mouth into six sextants

$**\mathbf{S}^1$	$\mathbf{S}^2$	$\mathbf{S}^{3}$
18-14	13-23	24-28
48-44	33-43	34-38
$\mathbf{S}^{6}$	$\mathbf{S}^{5}$	$\mathbf{S}^4$

\* Tooth numbering is according to the FDI system.

\*\* S represents the six sextants and the numbers from 1 -6 denotes the number of sextant.

### Index teeth

For adults aged 20 years and over, the teeth to be examined are:

17/16	11	26/27
47/46	31	36/37

The two molars in each posterior sextant are paired for recording.

For subjects under the age of 20 years, only six teeth; 16, 11, 26, 36, 31, and 46 are examined. This modification is made to avoid, scoring the deepened sulci associated with eruption as periodontal pockets. For the same reason, when examining children under the age of 15 years, pockets should not be recorded, i.e. only bleeding and calculus should be recorded.

### RESULTS

The mean age of the experimental group was 18.00  $\pm$  2.98 years with a range of 13 to 22 years. The male: female ratio was 3:7 making it 30%: 70%. Mean age of the male patients was 17.66  $\pm$  3.51 years with a range of 14-21 years, and that of the females was 18.14  $\pm$  3.02 years with a range of 13-22 years.

The mean age of the control group was  $17.30 \pm 4.29$ years with a range of 13-25 years. Male to female ratio was 6: 4 making it 60 % males and 40 % females. The mean age of the male patients was  $18.66 \pm 4.63$  years with a range of 13-25 years. The mean age of female patients was  $15.25 \pm 3.20$  years with a range of 13-20 years.

Tables 1 and 2 shows the mean CPI score of the experimental and control groups at baseline, first, third and sixth month during orthodontic treatment.

### COMPARISON BETWEEN EXPERIMENTAL AND CONTROL GROUPS

No statistically significant differences (p>0.05) were found between experimental and control groups at baseline, first, third and sixth month during orthodontic treatment, for the six sextants and their cumulative CPI score (Table 3).

# CHANGES WITHIN THE EXPERIMENTAL GROUP

Table 4 shows the month wise comparison groups of the experimental group for six sextants and their cumulative CPI score. First, third, fourth and sixth sextants showed no statistically significant (p>0.05) changes in the periodontal status, when compared from baseline to first, third and sixth month during orthodontic treatment.

Second sextant showed significant changes in the mean CPI score at first and third month after the start of orthodontic treatment at p<0.01. However changes at sixth month were less marked with p<0.05. This shows a slight improvement in the periodontal status statistically.

No significant changes (p>0.05) were noticed for the fifth sextant at first, third and sixth month when compared with the mean CPI score of the baseline. However, if the mean CPI score of the sixth month  $(1.80 \pm 0.42)$  is compared with the score of the first and third months  $(1.40 \pm 0.51$  and  $1.50 \pm 0.52$ , respectively), statistically significant changes were found.

As far as the cumulative CPI score of the experimental group is concerned, changes in the mean CPI score were statistically significant at first month (p<0.05), third month (p<0.01) and at sixth month (p<0.05), during orthodontic treatment.

### CHANGES WITHIN THE CONTROL GROUP

The mean CPI score of the control group at baseline, first, third and sixth month during fixed orthodontic

	MEAN CPI SCORE ± SD					
SEXTANTS	Baseline	First month	Third month	Sixth month		
First	$1.10 \pm 0.56$	$1.20 \pm 0.42$	$1.10 \pm 0.31$	$1.20 \pm 0.42$		
Second	$0.40 \pm 0.51$	$1.00 \pm 0.00$	$1.00 \pm 0.00$	$1.10 \pm 0.31$		
Third	$1.10 \pm 0.56$	$1.20 \pm 0.42$	$1.00 \pm 0.00$	$1.10 \pm 0.31$		
Fourth	$1.00 \pm 0.47$	$1.00 \pm 0.47$	$1.10 \pm 0.31$	$1.20 \pm 0.42$		
Fifth	$1.20 \pm 0.78$	$1.40 \pm 0.51$	$1.50 \pm 0.52$	$1.80 \pm 0.42$		
Sixth	$1.00 \pm 0.47$	$0.90 \pm 0.31$	$1.00 \pm 0.00$	$1.00 \pm 0.00$		
Cumulative CPI score	$5.80 \pm 1.81$	$6.70 \pm 1,25$	$6.70 \pm 0.94 1$	$7.40 \pm 1.26$		

TABLE 1: MEAN CPI SCORE OF EXPERIMENTAL GROUP AT BASELINE, FIRST MONTH, THIRD MONTH AND SIXTH MONTH

	MEAN CPI SCORE ± SD					
SEXTANTS	Baseline	First month	Third month	Sixth month		
First	$1.00 \pm 0.00$	$1.00 \pm 0.00$	$1.00 \pm 0.00$	$1.10 \pm 0.31$		
Second	$0.80 \pm 0.42$	$0.80 \pm 0.42$	$0.90 \pm 0.31$	$1.10 \pm 0.31$		
Third	$1.00 \pm 0.00$	$1.00 \pm 0.00$	$1.20 \pm 0.63$	$1.40 \pm 0.69$		
Fourth	$1.00 \pm 0.00$	$1.10 \pm 0.31$	$1.40 \pm 0.51$	$1.60 \pm 0.51$		
Fifth	$0.80 \pm 0.42$	$1.10 \pm 0.31$	$1.30 \pm 0.48$	$1.70 \pm 0.67$		
Sixth	$1.00 \pm 0.00$	$1.10 \pm 0.31$	$1.10 \pm 0.31$	$1.30 \pm 0.67$		
Cumulative CPI score	$5.60 \pm 0.69$	$6.10\pm0.56$	$6.90 \pm 0.99$	$8.20 \pm 1.75$		

## TABLE 2: MEAN CPI SCORE OF CONTROL GROUP AT BASELINE, FIRST MONTH, THIRD MONTH AND SIXTH MONTH

## TABLE 3: COMPARISON BETWEEN EXPERIMENTAL AND CONTROL GROUPS FOR STATISTICALLY SIGNIFICANT DIFFERENCES

P-VALUE	SEXTANTS						Cumulative
	First	Second	Third	Fourth	Fifth	Sixth	CPI Score
<b>Baseline</b> Experimental group Control group	NS	NS	NS	NS	NS	NS	NS
<b>First month</b> Experimental group Control group	NS	NS	NS	NS	NS	NS	NS
<b>Third month</b> Experimental group Control group	NS	NS	NS	NS	NS	NS	NS
<b>Sixth month</b> Experimental group Control group	NS	NS	NS	NS	NS	NS	NS
NS stands for "Not significant" p > 0.05							

### TABLE 4: WITHIN-GROUP COMPARISON FOR STATISTICALLY SIGNIFICANT DIFFERENCES (EXPERIMENTAL GROUP)

	COMPARISON GROUPS P-VALUE						
Sextants	Baseline ↓ First month	Baseline ↓ Third month	Baseline ↓ Sixth month	First month ↓ Third month	First month ↓ Sixth month	Third month ↓ Sixth month	
First	NS	NS	NS	NS	NS	NS	
Second	p<0.01	p<0.01	p < 0.05	NS	NS	NS	
Third	NS	NS	NS	NS	'NS	NS	
Fourth	NS	NS	NS	NS	NS	NS	
Fifth	NS	NS	NS	NS	p < 0.05	p < 0.01	
Sixth	NS	NS	NS	NS	NS	NS	
Cumulative CPI score	p < 0.05	p<0.01	p < 0.05	NS	NS	p < 0.05	

Note: NS stands for "Not significant" p > 0.05

### 

	COMPARISON GROUPS P-VALUE						
Sextants	Baseline ↓ First month	Baseline ↓ Third month	Baseline ↓ Sixth month	First month ↓ Third month	First month ↓ Sixth month	Third month ↓ Sixth month	
First	NS	NS	NSNS	NS	NS	NS	
Second	NS	NS		NS	NS	NS	
Third	NS	NS	NS	NS	NS	NS	
Fourth	NS	p < 0.05	p < 0.01	NS	p < 0.05	NS	
Fifth	NS	p < 0.05	p < 0.01	NS	p < 0.05	p < 0.05	
Sixth	NS	NS	NS	NS	NS	NS	
Cumulative CPI score	p < 0.05	p<0.01	p < 0.01	p < 0.05	p < 0.01	p<0.01	

Note: NS stands for "Not significant"

treatment is shown in Table 2. From Table 5, it is clear that First, second, third, and sixth sextants showed no statistically significant (p>0.05) changes in the periodontal status, when compared from baseline to first, third and sixth month during orthodontic treatment.

As far as the fourth and fifth sextants are concerned, they showed statistically significant changes in the mean CPI score at third month (p<0.05) and a little more significant changes (p<0.01) at sixth month during orthodontic treatment. Cumulative CPI score of the control group showed significant changes in periodontal status at first month (p<0.05) and significantly more worsening of the periodontal status at third and sixth month of treatment (p<0.01).

If we compare Tables 3, 4 and 5, it is clear that although no significant differences were found between experimental and control groups at different recordings (p>0.05), but as a group, control group showed more significant changes in CPI score at sixth month

(p<0.01) as compared to experimental group (p<0.05). Similarly the difference of the mean CPI score between baseline and sixth month for experimental group was 27 % and that for the control group was 46.4%.

### DISCUSSION

The periodontal status of patients receiving fixed orthodontic appliances has been the focus of attention, both by the orthodontists and periodontists<sup>2</sup>. It is believed that greater plaque retentive nature of orthodontic appliances aid in plaque accumulation at gingival margins, contributing to gingival inflammation<sup>2,3,4,5,6,7,24</sup>.

Monitoring of gingival and periodontal status by orthodontists throughout the treatment period and enforcement of an acceptable oral hygiene program has become an integral part of modem orthodontic treatment<sup>2,21,22,24,25,26,27,28</sup>.

The aims of the present study were to evaluate the effectiveness of an oral hygiene program demonstrated to patients undergoing fixed orthodontic treatment<sup>221</sup>.

Out of the main sample of 100 patients, 20 patients having good periodontal status, and in need of fixed orthodontic treatment were selected and divided into two groups (experimental and control) of 10 patients each, irrespective of sex. Relation between fixed orthodontic treatment, plaque accumulation and gingival inflammation was explained in detail to the experimental group. In addition they were asked to use modified Bass tooth brushing technique<sup>4\*21\*22</sup>. The periodontal status of these 20 patients (experimental and control groups) was evaluated before and during fixed orthodontic treatment.

# PERIODONTAL STATUS OF EXPERIMENTAL AND CONTROL GROUPS

Experimental and control groups consisted of ten patients each. The mean age of the experimental group was  $18.00 \pm 2.98$  years and that of the control group was  $17.30 \pm 4.29$  years. Both the groups received fixed orthodontic appliances, but the experimental group also received oral hygiene instructions, they were demonstrated and asked to use the modified Bass toothbrush technique. Comparing the experimental group with the control group; at first, third and sixth month during orthodontic treatment, no statistically significant differences (p>0.05) were found in the periodontal status between these two groups. However as a group, both experimental and control group patients showed deterioration of periodontal health. But statistically, this deterioration was more marked in the case of control group, not receiving oral hygiene instructions.

Study done by Fredrik Lundstrom, Sven-Erik Hamp and Sture Nvman 22 also supports the above findings. They studied periodontal health of 60 children undergoing orthodontic treatment, with a mean age of 13.5 years. Study sample was divided into four subgroups. Active orthodontic treatment was preceded by an introductory period of six weeks, consisting of oral hygiene instructions delivered to each patient on a fortnightly basis, regarding the use of Bass method of tooth brushing, along with tooth polishing using rubber cups and fluoride containing polishing paste.

At the start of active orthodontic treatment, different sets of hygiene instructions were given to the three test groups, while the control group patients did not receive any hygiene instructions. When the test group, which received instructions, regarding the use of Bass tooth brushing technique was compared with the control group patients, no significant differences in the periodontal status of the two groups were found, although as a group their periodontal health deteriorated. Similar findings were noticed for other two test groups, who received instructions regarding the use of chlorhexidine mouthwash and a combination of mouthwash use and tooth brushing technique.

Somewhat similar findings were noted by these authors in an another study<sup>29</sup>. Another finding in their studies<sup>22,27</sup> were mat after the removal of fixed orthodontic appliances, periodontal status improved significantly.

In an Australian study conducted at Westmead Hospital. University of Sydney, Yeung and associates claimed significant improvement of the oral hygiene of orthodontic patients receiving oral hygiene instructions, as compared to the control group, which although received fixed orthodontic treatment but did not receive any hygiene instructions. The results of this Australian study appear to be in contrast to the findings of the present study. However in the Yeung's study, no evaluation of the periodontal status was done during the period of active treatment, instead it was evaluated after the end of the orthodontic treatment. This is contrary to the procedures carried out in our study and in other studies mentioned earlier<sup>22'27</sup>. Another explanation for the better results could be that the oral hygiene program employed in this Australian study was more thorough and repetitive. This program consisted of four weekly sessions before the commencement of orthodontic treatment. Each session lasted 30 minutes and was administered by a dental hygienist. Session 1 consisted of provision of information on plaque formation and its relationship to gingival inflammation. Bass technique of tooth brushing was also demonstrated to the patients. Session 2 consisted of a brief lecture on nutrition and dietary habits. Session 3 consisted of plaque control evaluation using disclosing dyes. Session 4 provided an opportunity to review the dental health information received by the patient up to that time. As compared to this preventive program, oral hygiene instructions given to the orthodontic patients in our study were not so intense.

However, different studies done elsewhere<sup>21/22/24/25/27/28/29</sup> supports the findings of our study that as a group the oral hygiene of experimental and control groups deteriorated significantly during orthodontic treatment.

In the end it can be said that the effectiveness of a preventive program delivered to the orthodontic patients can be altered by factors such as: patient compliance, devotion and skillfulness of the people delivering the program, and contents of the preventive program.

### CONCLUSIONS

No statistically significant differences (p>0.05) were found on comparing the periodontal status of fixed orthodontic patients who received oral hygiene instructions with those who did not receive the instructions. However, it was found that as a group, periodontal status of patients who received oral hygiene instructions deteriorated less than those who were not instructed. There is a need to incorporate and evaluate more intense oral hygiene programs in future.

#### REFERENCES

- 1 Berglund LJ, Small CL. Effective oral hygiene for orthodontic patients. J din Orthod 1990; 24: 315-20.
- 2 Yeung SC, Howell S, Fahey P. Oral hygiene program for orthodontic patients. Am J Orthod Dentofacial Orthop 1989; 96: 208-13.
- 3 Lees A, Rock WP. A comparison between written, verbal and videotape oral hygiene instruction for patients with fixed appliances. J Orthod 2000; 27: 323-8.
- 4 Sinclair PM, Berry CW, Bennett CL, Israelson H. Changes in gingiva and gingival flora with bonding and banding. Angle Orthod 1987; 57: 271-8.
- 5 Anderson GB, Bowden J, Morrison EC, Caffesse RG. Clinical effects of chlorhexidine mouthwashes on patients undergoing orthodontic treatment. Am J Orthod Dentofacial Orthop 1997; 111: 606-12.
- 6 Kilicoglu H, Yildirim M, Polater H. Comparison of the effectiveness of the two types of toothbrushes on the oral hygiene of the patients undergoing orthodontic treatment with fixed appliances. Am J Orthod Dentofacial Orthop 1997; 111: 591-4.
- 7 McGlynn FD, LeCompte EJ, Thomas RG, Courts FJ, Melamed BG. Effects of behavioral self-management on oral hygiene adherence among orthodontic patients. Am J Orthod Dentofacial Orthop 1987; 91: 15-21.
- 8 Becker A, Shapira J, Chaushu S. Orthodontic treatment for disabled children - a survey of patient and appliance management. J Orthod 2001; 28: 39-44.
- 9 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.
- 10 Boyd RL, Leggott PJ, Quinn RS, Eakle WS, Chamber D. Periodontal implications of orthodontic treatment in adults with reduced or normal periodontal tissues versus those of adolescents. Am J Orthod Dentofacial Orthop 1989; 96: 191-8.
- 11 Gilbert AD, Nuttal NM. Self-reporting of periodontal health status. Br Dent J 1999; 186: 241-4.
- 12 Pereira AC, Castellanos RA, Silva SR, Watanabe MG, Queluz DP, Meneghim MC. Oral health and periodontal status in Brazilian elderly. Braz Dent J. 1996; 7: 97-102.
- 13 Grisi MF, Salvador SL, Martins Jr W, Castandi N, Silva-Neto CR. Correlation between CPITN score and anaerobic periodontal infections assessed by BANA assay. Braz Dent J 1999; 10: 93-7.
- 14 Dini EL. Changes in periodontal conditions of children and adolescents from Araraquara, Brazil: 1995-1998. Braz Dent J 2001;12:51-5.
- 15 Morris AJ, Steele J, White DA. The oral cleanliness and periodontal health of UK adults in 1998. Br Dent J 2001; 191: 186-92.
- 16 El-Mangoury NH, Gaafar SM, Mostafa YA. Mandibular anterior crowding and periodontal disease. Angle Orthod 1987; 57: 33-8.
- 17 Erverdi N, Acar A, Isguden B, Kadir T. Investigation of bacteremia after orthodontic banding and debanding follow-

ing chlorhexidine mouth wash application. Angle Orthod 2001; 71: 190-4.

- 18 American Academy of Periodontology. Epidemiology of periodontal diseases. J Periodontol 1996; 67: 935-45.
- 19 Naeem S, Mahmood A, Bokhari F. Oral Hygiene Status of Patients Seeking Orthodontic Treatment at the Orthodontics Department, de,Montmorency College Of Dentistry Lahore– Pakistan. Oral & Dent Jr 2004; 24: 197-203.
- 20 Ashraf M. The factors affecting tooth cleaning habits of secondary school children age 13-18 years. Pakistan Oral Dent J 1998; 18: 45-51.
- 21 Lundstrom F, Hamp SE. Effect of oral hygiene education on children with and without subsequent orthodontic treatment. Scand J Dent Res 1980; 88: 53-9.
- 22 Lundstrom F, Hamp SE, Nyman S. Systematic plaque control in children undergoing long term orthodontic treatment. Eur J Orthod 1980; 2: 27-39.
- 23 Malmo University. Community Periodontal index (CPI). In; Oral health surveys - basic methods, 4th ed. (online) 1997

(cited 2001 Oct 12), pages 36-38. Available from: URL: http://www.whocollab.od.mah. se/index.html.

- 24 Zachrisson S, Zachrisson BU. Gingival conditions associated with orthodontic treatment. Angle Orthod 1972; 42: 26-34.
- 25 Zachrisson BU, Zachrisson S. Gingival conditions associated with partial orthodontic treatment. Acta Odont Scand 1972; 30: 127-136.
- 26 Alstad S, Zachrisson BU. Longitudinal study of periodontal conditions associated with orthodontic treatment in adolescents. Am J Orthod 1979; 76; 277-86.
- 27 Hamp SE, Lundstrom F, Nyman S. Periodontal conditions in adolescents subjected to multiband orthodontic treatment with controlled oral hygiene. Eur J Orthod 1982; 4: 77-86.
- 28 Diamanti-Kipioti A, Gusberti FA, Lang NP. Clinical and microbiological effects of fixed orthodontic appliances. J Clin Periodontol 1987; 14: 326-33.
- 29 Zhao H, Xie Y, Meng H. Effect of fixed appliance on periodontal status of patients with malocclusion. Zhonghua Kou Qiang Yi Xue Za Zhi 2000;35:286-8.