ISSN: 1812–1217

Effectiveness of educational program on fixed orthodontic appliance treatment on patient's oral hygiene

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ABSTRACT

The aim of the present study was to investigate whether educated dental patients undergoing fixed orthodontic treatment showing better oral hygiene than dental patients who are not educated.

The sample is comprised of 16 orthodontic patients (3 males and 13 females), 11–22 years old chosen randomly among patients at Department of Pedodontics, Orthodontics and Preventive Dentistry of College of Dentistry at Mosul University. The sample is divided equally into 2 groups; the first group was educated concerning fixed orthodontic treatment in relation to oral hygiene and given education and instruction to keep good oral hygiene during orthodontic treatment. The second group is not educated. Swabs were taken from supra–gingival plaque of facial surface of upper right and lower left central incisors, and upper left and lower right first molar teeth; one before orthodontic treatment and another (4–6 weeks) later and subjected to bacteriological investigation. Qualitative data about oral microorganisms were collected and subjected to statistical analysis.

The results indicated that during treatment records for both educated and non–educated groups show significant difference for certain types of microorganisms and at different locations with the educated group scores the least in comparison with non–educated group.

Key Words: Oral hygiene, microorganisms, education, bacteria, plaque.

Al–Hamdany AKh, Al–Sayagh NM, Al–Khatib AR. Effectiveness of educational program on fixed orthodontic appliance treatment on patient's oral hygiene. *Al–Rafidain Dent J*. 2005; 5(1): 37-45.

Received:
5/5/2004
Sent to Referees:
11/5/2004
Accepted for Publication:
11/12/2004

INTRODUCTION

Oral hygiene is one of the most important issues in patients undergoing orthodontic treatment,[1] but personal oral hygiene is difficult to perform when fixed orthodontic appliances are in place.[2] Therefore, optimum oral hygiene management is essential during orthodontic treatment.[3–6]

Optimal oral hygiene can be achieved when oral hygiene programs are implanted in fixed orthodontic treatment.[7] Otherwise, decalcification, caries and injury of the soft tissues may occur.[4, 8, 9]

The long term reports concerning the oral hygiene of orthodontic patients are controversial. Some investigators[4, 10, 11] found that fixed appliance treatment, by preventing adequate oral hygiene, favours local plaque accumulation and, as a consequence, gingival inflammation, while Fe-

liu[12] found that orthodontic treatment improves the oral hygiene of the patients and this improvement can be expected to last beyond the period of orthodontic treatment.

However, oral hygiene measures are always instituted because bands, brackets, ligature wires and elastics encourage accumulation of microflora and food residues, which in time cause periodontal disease and caries.[12, 13]

Many investigators had implanted dif-ferent oral hygiene measures, other had compared the effectiveness of different types of tooth brushes and / or tooth brushing technique on plaque control and gingival health for patients undergoing orthodontic treatment with fixed appliances.[1,2,13–19]

The aim of the present study was to investigate whether educated dental patients toward fixed orthodontic treatment who are undergoing fixed orthodontic trea-tment display better oral hygiene than den-tal patients who are not educated.

MATERIALS AND METHODS

The study sample is comprised of 16 orthodontic patients (3 males and 13 females); all Iraqis, ranging in age from 11–22 years. the subjects were randomly selected without regard for the type of malocclusion. All were screened to ensure that there was no history of recent orthodontic treatment, systemic disease or a course of antibiotic therapy within the preceding one month. No medications were used from the first to the second sample collection. No extraction or missing of upper right and lower left central incisors, and upper left and lower right first molar teeth.

The subjects were chosen among patients at Department of Pedodontics, Orthodontics and Preventive Dentistry, College of Dentistry, Mosul University. Sex discrimination was not included in this study.

Edgewise orthodontic brackets (Dentaurum, 891,220, Germany) bonded with composite resin (alpha–dent chemical cure composite resin, ADA) with standard arch wire sequence were used. The four first molars were banded using orthophosphate cement.

The two types of broths were used:

1) Nutrient broth for isolating aerobic bacteria.
2) Thioglycollate broth (reducing agent + 0.2 agar) for isolating anaerobic bacteria.

The culture media used for aerobic and anaerobic incubation including:

1. For aerobic incubation: Blood agar, chocolate agar, MacConkey's agar and Sabouraud's dextrose agar for Candida.
2. For anaerobic incubation: Blood agar, Mitis Salivarious agar for Streptococcus type, Schaedler agar for Bacteroids and Ragosa SL media for Lactobacilli.

The sample was divided equally into two groups (8 subjects in each). First group was educated by giving them an oral hygiene program consisting of instructional lectures concerning fixed appliance treatment and its effect on oral hygiene, tooth brushing technique and the use of dental floss and other dental plaque removing aids. The importance of oral hygiene was stressed and evaluated throughout the study. No fluoride rinses or gels were used either before or during the study, to exclude their influence on microbial flora. The performance was evaluated during tre-atment visits by the investigators. The sec-ond group was not educated.

All patients were informed not to brush their teeth on the day of swab taking, only rinsing with tap water. The criteria that considered in the examined teeth including lack of gingivitis and periodontal pockets, and no calculus present on tooth surface. Also, no carious lesion or restoration present on the examined tooth surface. Swabs were taken from supragingival plaque of facial surface of upper right and lower left central incisors, and upper left and lower right first molars teeth twice, one before orthodontic treatment and the other 4–6 weeks later.

From each tooth surface two swabs were taken: One for aerobic and the other for anaerobic bacteriological study. All these swabs were cultured aerobically and anaerobically. After the time of culturing, the aerobic and anaerobic culture plates were examined and checked under light microscope. The morphology of different types of colonies were smeared to study

the isolated type and then sub–cultured to get isolated colonies and made biochemical test on each microorganism.

Statistical analysis (descriptive statistics) included frequency tables and percentage for all types of microorganisms. Z–test was employed to show any statistically significant association between the tested variables for each microorganism. The value of tabulated Z = 1.96.

RESULTS

Sixteen patients were included in this study and divided into 2 groups (8 patients for each): Educated and non–educated groups towards fixed orthodontic treatment.

The total number of plaque samples (swabs) was 256, meaning 16 for each patient (8 before treatment and 8 during treatment); four from molars and four from incisors. For each tooth, one swab for aerobic and other swab for anaerobic plaque sample.

Table (1) shows the distribution of occurrence of microorganisms according to the time of sampling. For educated gro-up, it shows the reduction in occurrence of microorganisms during treatment; while the non–educated group shows positive occurrence than the educated group.

Table (1): Occurrence of microorganisms in the swabs according to the time of sampling

Occurrence		Pre–treatment n = 128	During–treatment n = 128	Total n = 256
Educated	**Positive**	55 (85.94%)	18 (28.12%)	73 (57.03%)
	Negative	9 (14.06%)	46 (71.88%)	55 (42.97%)
Non–educated	**Positive**	61 (95.31%)	43 (67.19%)	104 (81.25%)
	Negative	3 (4.69%)	21 (32.81%)	24 (18.75%)

n = Number of swabs.

Concerning the occurrence of microorganisms according to location, Table (2) illustrates that positive occurrence was more in molars than in incisors for both educated and non–educated groups, and that the non–educated group shows more positive occurrence than the educated group.

Table (2): Occurrence of microorganisms in the swabs according to location of sampling

Occurrence		Molar n = 128			Incisor n = 128			Total n = 256
Educated	**Positive**	47(73.43%)	UL 21(65.63%) LR 26(81.25%)	28(43.75%)	UR 13(40.63%) LL 15(46.87%)			75(58.58%)
	Negative	17(26.57%)	UL 11(34.37%) LR 6(18.75%)	36(56.24%)	UR 19(59.38%) LL 17(53.12%)			53(41.42%)
Non–educated	**Positive**	53(82.81%)	UL 27(84.38%) LR 26(81.25%)	48(75%)	UR 25(78.13%) LL 23(71.88%)			101(78.91%)
	Negative	11(17.19%)	UL 5(15.62%) LR 6(18.75%)	16(25%)	UR 7(21.88%) L L 9(28.13%)			27(21.09%)

UL = Upper left; LR = Lower right; UR = Upper right; LL = Lower left; n = Number of swabs

Table (3) shows the prevalence of different types of microorganisms before and during treatment for both educated and non–educated groups.

For educated group, the facultative anaerobes were isolated from 35 swabs (27.34%), 27 (42.19%) pre–treatment and 8 (12.5%) during treatment.

The most commonly isolated type of bacteria was Gram positive cocci group followed by Gram negative bacilli then Gram positive bacilli group.

Of the Gram positive cocci group, *Streptococcus mutans* was found to be the most predominant type, while the most common Gram negative bacilli was *Escherichia coli*.

For non–educated group, the facultative anaerobes were isolated from 56 swabs (43.75%), 25 (39.06%) pre–treatment and 31 (48.44%) during treatment.

The most commonly isolated type of bacteria was Gram positive cocci group followed by Gram negative bacilli, Gram negative cocci group then Gram positive bacilli.

Of Gram positive cocci group, Staphylococcus was found to be the most predominant type, while the most common Gram negative bacilli was Pseudomonas.

The anaerobic bacteria were isolated from 37 swabs (28.9%), 27 (42.19%) pre–treatment and 10 (15.06%) during treatment for educated group.

The most commonly isolated anaerobe was the Gram positive cocci group, followed by Gram negative cocci group, Gram negative bacilli then Gram positive bacilli. Of Gram positive cocci group, Peptostreptococcus is most predominant type.

For the non–educated group, the anaerobic bacteria were isolated from 52 swabs (40.63%), 30 (46.88%) pre–treatment and 22 (34.38%) during treatment.

The most commonly isolated anaerobe was the Gram positive cocci followed by Gram negative bacilli, Gram negative cocci then Gram positive bacilli. Of Gram positive cocci type, Peptostreptococcus is found to be the most predominant type.

Candida was isolated from 2 swabs (1.56%), 2 (3.12%) pre–treatment and zero (0%) during treatment for educated group.

For non–educated group, Candida was isolated from 3 swabs (2.34%), 1 (1.56%) pre–treatment and 2 (3.13%) during treatment.

Table (4) illustrates the significance of different types of microorganisms for educated and non–educated groups whether the swabs were taken from the incisor or molar regions when comparing the (pre–treatment) with (during treatment) records.

For educated group, there are some locations where the differences are statistically significant when comparing the pre–treatment with during treatment records as: *Streptococcus mutans*, Staphylococcus, Peptostreptococcus, Gram negative cocci (Veillonella), and Gram negative bacilli (Bacteroid) taken from incisor and molar regions, α–Streptococcus, β–Streptococcus, *Escherichia coli* and Gram positive coli taken either from molar or incisor region, and Candida taken molar region as found in Table (4). All these differences are statistically significant when $Z \geq 1.96$.

On the other hand, in the non–educated group, the microorganisms are more prevalent than the educated group, and these microorganisms are more prevalent during treatment than pre–treatment with some exceptions. However, not all these observations were found to be statistically significant.

Facultative anaerobes significantly increased in prevalence with treatment especially α–Streptococcus (in molar and incisor regions), *Streptococcus mutans* in molar region and Gram negative cocci (in inci-sor and molar regions). Of Gram negative bacilli, Pseudomonas (in incisor region) and *Escherichia coli* in molar region.

Anaerobes were significantly more prevalent than facultative anaerobes in non–educated group. Some types of micrroorganisms are more prevalent during treatment than before treatment; but not all these observations were found to be statistically significant. Of Gram positive cocci, Peptostreptococcus and Peptococci (in molar and incisor regions) are significantly prevalent during treatment. Gram negative cocci (Veilonella), in molar and incisor regions, are also significantly prevalent during treatment. Candida taken from mo-lar region is also significantly prevalent during treatment.

Table (3): Prevalence of different types of microorganisms before and during orthodontic treatment for educated and non–educated groups

Microorganisms	Educated			Non–Educated		
	Pre–Treatment n = 64 (%)	During Treatment n = 64 (%)	Total n = 128 (%)	Pre–Treatment n = 64 (%)	During Treatment n = 64 (%)	Total n = 128 (%)
Facultative Anaerobes	27 (42.19)	8 (12.5)	35 (27.34)	25 (39.06)	31 (48.44)	56 (43.75)
G+ve Cocci	23 (35.94)	8 (12.5)	31 (24.21)	14 (21.88)	21 (32.81)	35 (27.34)
Streptococcus	10 (15.63)	4 (3.13)	14 (10.94)	0 (0)	1 (1.56)	1 (0.78)
α–Streptococcus	2 (3.12)	1 (1.56)	3 (2.34)	2 (3.13)	8 (12.5)	10 (7.81)
β–Streptococcus	2 (3.12)	1 (1.56)	3 (2.34)	0 (0)	0 (0)	0 (0)
Staphylococcus	9 (14.06)	2 (3.12)	11 (8.59)	12 (18.75)	12 (18.75)	24 (18.75)
G+ve Bacillus (Lactobacilli)	1 (1.56)	0 (0)	1 (0.78)	3 (4.69)	0 (0)	3 (2.34)
G–ve Cocci (Neisseria)	0 (0)	0 (0)	0 (0)	4 (6.25)	0 (0)	4 (3.13)
G–ve Bacilli	3 (4.69)	0 (0)	3 (2.34)	4 (6.25)	10 (15.65)	14 (10.93)
Escherichia coli	2 (3.12)	0 (0)	2 (1.56)	0 (0)	1 (1.56)	1 (0.78)
Pseudomonas	1 (1.56)	0 (0)	1 (0.78)	3 (4.64)	7 (10.94)	10 (7.81)
Klebsiella	0 (0)	0 (0)	0 (0)	1 (1.56)	2 (3.13)	3 (4.69)
Anaerobes	27 (42.19)	10 (15.06)	37 (28.9)	30 (46.88)	22 (34.38)	52 (40.63)
G+ve Cocci	13 (20.31)	5 (7.81)	18 (14.06)	13 (20.3)	12 (18.75)	25 (19.53)
Peptostreptococci	13 (20.31)	5 (7.81)	18 (14.06)	6 (9.38)	8 (12.5)	14 (10.94)
Peptococci	0 (0)	0 (0)	0 (0)	7 (10.94)	4 (6.25)	11 (8.59)
G+ve Bacilli	2 (3.12)	0 (0)	2 (1.56)	1 (1.56)	0 (0)	1 (0.78)
G–ve Cocci (Veillonilla)	9 (14.06)	4 (3.13)	9 (7.03)	5 (7.81)	6 (9.38)	11 (8.59)
G–ve Bacilli (Bacteroid)	3 (4.69)	1 (1.56)	3 (2.34)	11 (17.19)	4 (6.25)	15 (11.72)
Candida	2 (3.12)	0 (0)	2 (1.56)	1 (1.56)	2 (3.13)	3 (2.34)

n = Number of swabs.

Table (4): Significance of different types of microorganisms before and during orthodontic treatment according to location of sampling with comparison between educated and non–educated groups

Microorganisms	Educated				Non–Educated				Educated				Non–Educated			
	Pre–Pre				During–During				Pre–During				Pre–During			
	UR1	UL6	LL1	LR6	UR1	UL6	LL1	LR6	UR1	UL6	LL1	LR6	UR1	UL6	LL1	LR6
Facultative Anaerobes	NS	NS	NS	NS	S	S	S	S	S	S	S	S	S	S	NS	NS
G+ve Cocci	NS	NS	S	S	S	S	S	S	S	S	S	S	S	NS	NS	S
Streptococcus mutans	S	S	S	S	NS	NS	S	S	S	S	S	S	NS	S	NS	NS
α–Streptococcus	NS	S	S	NS	S	NS	S	S	S	NS	NS	NS	S	S	NS	S
β–Streptococcus	NS	S	S	NS	NS	NS	S	NS	NS	NS	S	NS	NS	NS	NS	NS
Staphylococcus	NS	S	NS	NS	S	S	S	NS	S	S	S	S	NS	S	NS	NS
G+ve Bacillus *(Lactobacilli)*	S	NS	S	S	NS	NS	NS	NS	S	NS	NS	NS	NS	NS	S	S
G–ve Cocci *(Neisseria)*	S	S	S	S	NS	NS	NS	NS	NS	NS	NS	NS	S	S	S	S
G–ve Bacilli	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Escherichia coli	NS	S	S	NS	NS	NS	NS	S	NS	S	S	NS	NS	NS	NS	S
Pseudomonas	S	NS	NS	NS	S	NS	S	S	NS	NS	NS	S	NS	NS	S	NS
Klebsiella	NS	NS	NS	NS	S	NS	S	S	S	NS	NS	NS	S	NS	S	NS
Anaerobes	NS	NS	NS	NS	S	S	NS	NS	S	S	S	S	S	NS	S	S
G+ve Cocci	S	NS	NS	S	NS	S	NS	NS	S	S	S	S	S	NS	S	NS
Peptostreptococci	S	NS	NS	S	S	S	NS	NS	S	S	S	NS	NS	NS	S	S
Peptococci	S	S	S	S	S	S	S	S	NS	NS	NS	NS	NS	S	S	S
G+ve Bacilli	S	NS	NS	S	NS	NS	NS	NS	S	NS	NS	S	S	NS	NS	NS
G–ve Cocci *(Veillonilla)*	S	NS	S	S	S	NS	NS	NS	S	S	S	S	S	S	NS	NS
G–ve Bacilli	S	NS	S	S	S	S	NS	NS	NS	S	S	NS	S	NS	S	S
Candida	NS	S	NS	NS	NS	S	NS	NS	NS	S	NS	S	NS	S	NS	S

n = 16 for each group; S = Significant if the value of Z is greater than 1.96; NS = Not significant if Z is less than 1.96

UL6 = Upper left first molar; LR6 = Lower right first molar; UR1 = Upper right central incisor; LL1 = lower left central incisor.

DISCUSSION

The amount and type of microorganisms isolated in this study varied and this variation may be related to oral cavity which varies greatly among persons, time of day, food intake, oral hygiene, salivary flow, pH of saliva[20, 21] and placement of appliances during treatment.[22]

The negative occurrence of microorganisms from plaque samples could be due to the absence of these types of bacteria in the sample area or due to technical errors. These errors include: Manner of plaque collection, homogenicity of plaque,[21] variation in the composition of the plaque flora[23] and culturing procedure and technique.[24]

In this study, a comparison in the type of microflora associated with orthodontic patients treated with fixed appliance in pre and during orthodontic treatment for educated and non–educated subjects is carried out (i.e., the study is related to quality of microorganisms not the quantity). The results indicated that orthodontic patients harbour different types of microflora: facultative anaerobes, anaerobes and Candida (Table 3); and the manner in their distribution vary greatly between the educated and non–educated groups when comparing the pre– with during treatment data.

For educated group, from 128 swabs (100%), the total isolation was 35 (27.34%) as shown in Table (3) for facul-tative anaerobic bacteria, while for anaero-bic the isolation was 37 (28.9%) and for Candida was 2 (1.56%).

Any appliance inserted in the oral cavity cause break of the balance of microorganisms and needs a period of time to re–establish this balance.[21, 23] The period from pre–insertion to after placement and treatment become inactive period in this study is 4–6 weeks. Some investigators found it enough to re–establish the microorganisms with appliance;[22, 25, 26] while other studies stressed on a longer period of time to allow for plaque maturation, more microorganisms growth and get more significant difference.[27, 28]

The total cultivable flora affected by treatment, the facultative anaerobes, anaerobes and Candida show significant reduction in different locations. This is in agreement with Feliu[12] who found that orthodontic treatment improves the oral hygiene of patients and that oral hygiene habits of the subjects may have been influenced by the fact that they knew they were participating in a research study.[2]

For non–educated group, from 128 plaque sample (100%), the total isolation was 56 (43.75%) as shown in Table (3) for facultative anaerobic bacteria, for anaerobic was 52 (40.63%) and for Candida was 3 (2.34%).

The cultivable flora affected by treatment including the facultative anaerobes, especially Gram positive cocci, of which α–Streptococcus type show highly signifi-cant increase in molar and incisor regions and this may be due to the presence of the brackets, band and bonding material that cause increase in this type of bacteria.[26, 29]

Other Gram positive an–aerobic cocci show significant increase is *Streptococcus mutans*; while β–*Streptococcus mutans* show negative occurrence. This may be due to either the need for more time to propagate in plaque or the plaque not mature enough to get more significant difference.[23] Anaerobic Gram negative bacilli also show significant increase in growth of microorganisms.

The anaerobic microorganisms also affected by the time of treatment, so during treatment the plaque greatly increase and microorganisms also show increase in the anaerobic types.

The anaerobic microorganisms were affected by thickness of plaque and duration of appliance, so in this study there was an increase of anaerobic microorgani-sms significantly. This is in agreement with Al–Sheakli.[26] Anaerobic Gram nega-tive cocci (Veillonella) was most type aff-ected and show significant increase during treatment. This finding is in agreement with most of previous studies.[26, 29, 30]

Gram positive anaerobic cocci also show significant increase especially Peptostreptococci. This agrees with other studies.[26, 29, 31–33]

The last type of microorganisms was Candida. Also it was affected by time and quality of bacteria. When bacteria increase with long period Candida propagate in area especially when any hard surface pre-sent in oral cavity, and also found when there was rough surface present. This type

increase significantly during treatment. This is in agreement with other studies.[26,32,33]

When comparing the pre–treatment records for both educated and non–educated groups, it was found that little differences were found in different types of microorganisms; but when comparing during treatment records for both groups, significant difference for different types of micrroorganisms was found with the educated group scores the least. This may be due to the fact that the patient instruction in home care in regard to oral hygiene and good patient cooperation and motivation achi-eve the optimum levels of dental health.

According to location of swabbing, supra–gingival plaque swabs were taken from facial surface of upper right and lower left central incisors, and upper left and lower right first molar teeth. This is so because in fixed appliance the incisors are bonded by a bracket and the molar teeth receive bands which is another type of attachment and which affect the type and amount of microorganisms isolated.

Also, the location of the molar is in the posterior region while the incisor is in the anterior region of the oral cavity so different types of microorganisms from place to another.[23, 34]

For educated group, as shown in Table (4), generally it was found more significant growth in molars than incisors especially for anaerobic types where incisor tee-th show more growth of anaerobic types. This is true because the position of molars in posterior region makes a good environment for especially the anaerobic type and the opposite is true for incisor teeth.

For non–educated group, also it was found that significant growth of anaerobic type in molars and anaerobic types in incisor region.

When comparing the pre–treatment records for both educated and non–educated groups, it was found that significant differences were found in some regions and no significant difference in others according to different types of microorganisms as shown in Table (4). The same thing is said for post–treatment records for educated and non–educated groups.

Generally speaking, the non–educated group shows significant growth for certain types of microorganisms in comparing with educated group during fixed orthod-ontic treatment and that we can not ignore the fact that oral hygiene measures and instructions improve the patient attitude toward good oral hygiene which could be expected to last for long period during the treatment.

CONCLUSIONS

Supra–gingival plaque samples from pre– and during treatment orthodontic patients showed a variety of microorganisms for both educated and non–educated groups toward fixed orthodontic treatment.

The educated group shows significant reduction in growth for most types of microorganisms in comparing with non–educated group during fixed orthodontic treatment.

Patient instruction and education during orthodontic treatment is essential to keep good oral hygiene throughout the period of fixed orthodontic treatment.

REFERENCES

1. Kilicoglu H, Yildirim M, Polater H. Comparison of effectiveness of two types of tooth brushes on the oral hygiene of patients undergoing orthodontic treatment with fixed appliances. *Am J Orthod*. 1997; 111: 591-594.
2. Wilcoxon DB, Ackerman RJ, Killoy WJ, Love JW, Sakumura JS, Tira DE. The effectiveness of a counter–rotational action power tooth brush on plaque control in orthodontic patients. *Am J Orthod*. 1991; 99: 7-14.
3. Brkley RF. Disease control programs in orthodontics. *J Clin Orthod*. 1972; 6: 709-711.
4. Zarichsson BU. Oral hygiene for orthodontic patients: Current concepts and practical advice. *Am J Orthod*. 1974; 66: 487-497.
5. Gold SL. Plaque–control motivation in orthodontic practice. *Am J Orthod*. 1975; 68: 8-14.
6. Clark JR. Oral hygiene in orthodontic practice: Motivation, responsibilities and concepts. *Am J Orthod*. 1976; 69: 72-82.
7. Lundstrom F, Hamp SE, Nyman S. Systematic plaque control in children under-

going long–term orthodontic treatment. *Eur J Orthod*. 1980; 2: 27-39.
8. Albino JE. Effects of an instructioned–motivational program on plaque and gingivitis in adolescents. *J Public Health Dent*. 1977; 37: 281-289.
9. Teni FV. Orthodontics and prevention. *Rev Stomatol*. 1977; 3: 41-44.
10. Gusberti FA. Klinische und mikrobiologische parodontalaspekte bei kieferorthopädischen behandlugen. *Schweiz Monatsschr Zahnmed*. 1984; 94: 462-468. (English Abstr)
11. Hartmann F, Jeromin R, Flores de Jacoby L. Untersuchung uber den parodontalen zustand jugendlicher trager festsitzender kieferorthopadischer gerate (Klinische Studie). *Dtsch Zahnarztl Z*. 1982; 37: 585-589. (English Abstr)
12. Feliu JL. Long–term benefits of orthodontic treatment on oral hygiene. *Am J Orthod*. 1982; 82(6): 473-477.
13. Polson AM, Subtelny JD, Meitner SW, Sommers FW, Iker HP, Reed BE. Long–term periodontal status after orthodontic treatment. *Am J Orthod*. 1988; 93: 51-58.
14. Kobayashi LY, Ash MMJr. A clinical evaluation of an electric tooth brush used by orthodontic patients. *Angle Orthod*. 1964; 34: 256-267.
15. McKendrick AJW, Barbenel LMH, McHugh WD. A two–year comparison of hand and electric tooth brushes. *J Periodont Res*. 1968; 3: 224-231.
16. Womack RW, Guay AH. Comparative cleansing efficiency of an electric and a manual tooth brush in orthodontic patients. *Angle Orthod*. 1968; 38: 256-267.
17. Coontz EJ. The effectiveness of a new oral hygiene device on plaque removal. *Quintessence Int*. 1983; 7: 739-742.
18. Williams P, Fenwick A, Schou I, Adams W. A clinical trial of an orthodontic tooth brush. *Eur J Orthod*. 1987; 9: 295-304.
19. Yeung SCM, Howell S, Fahey P. Oral hygiene program for orthodontic patients. *Am J Orthod*. 1989; 96: 208-213.
20. Schuster GS. Oral Microbiology and Infectious Disease. 2nd Student ed. Baltimore, London. 1983; p: 35.
21. Jawetz E, Milnick JL. Review of Medical Microbiology. 17th ed. Blackwell Scientific Pub. 1991; Pp: 26-61.
22. Paalantonion N, Pedrazzoli V, Piaccolmini R. Clinical significance of *Actinobacillus actinomycetemcomitans* in young individuals during orthodontic treatment. A 3–year longitudinal study. *J Clin Periodontol*. 1997; 24(9 pt 1): 610-617.
23. Nolte WA. Oral Microbiology with Basic Microbiology and Immunology. 4th ed. CV Mosby Co, St Louis. 1982; Pp: 31-65.
24. McNamara TF, Alexander JF. The role of the oral microorganisms. *Oral Surg*. 1979: 34-41.
25. Corbett JA, Brown LR, Keenee HJ. Comparisonal *Streptococcus mutans* concentration in non–banded and banded orthodontic patients. *J Dent Res*. 1981; 60: 1936-1942.
26. Al–Sheakli E. The effect of removable and fixed orthodontic appliances on the microflora of dental plaque among two age groups (A cross–sectional study). MSc thesis. College of Dentistry. University of Baghdad. 1999.
27. Owen OW. Study of bacterial count in saliva related to orthodontic appliances. *Am J Orthod*. 1949; 35: 672-678.
28. Klenberg I, Cross GH, Goldenberg DJ. Plaque formation and effect of age. *J Periodont Res*. 1979; 14: 407-417.
29. Chung S, Reindorf M, Kudlick T, Gregory S. Tooth brushing and transient bacteremia in orthodontic patient. *Am J Orthod Dentofac Orthop*. 1986; 90: 181-186.
30. Balaklicks N, Balaklicks T. Specific microorganisms isolated from oral cavity of orthodontic patients. *Am J Orthod Dentofac Orthop*. 1991; 99(7): 85-98.
31. Huser MC, Long R, Bachni PC. The effect of orthodontic bands on microbiologic and clinical parameters. *Am J Orthod Dentofac Orthop*. 1990; 97(3): 213-218.
32. Helfgen EH, Wiedeman B, Koeck B. The intra–oral bacterial colonization of temporary denture plastic. *J Am Dent Assoc*. 1995; 105(5): 629-632.
33. Radrigrez T, Archilla S. Isolation of *Candida albicans* in selected medium. *J Prosthet Dent*. 1996; 75(4): 426-431.
34. Mellville TH, Russel C. Microbiology for Dental Students. 3rd ed. Heinemann Medicals, London. 1981; Pp: 299-307.