

ORAL HYGIENE EFFECTIVENESS OF SELECTED  
ORTHODONTIC PATIENTS

---

A THESIS  
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF MASTER OF SCIENCE  
IN THE GRADUATE SCHOOL OF THE  
TEXAS WOMAN'S UNIVERSITY

INSTITUTE OF HEALTH SCIENCES  
SCHOOL OF HEALTH CARE SERVICES  
HEALTH SCIENCES INSTRUCTION PROGRAM

BY  
DEBORAH ANN STUTTS COOPER, B.S., R.D.H.

---

DENTON, TEXAS

MAY 1980

## ACKNOWLEDGMENTS

This author wishes to express her appreciation to the members of her graduate committee, Dr. Barbara J. Cramer, Dr. Mildred Pittman, and Dr. Dorothy Smith, for their assistance and counsel throughout the study. A special gratitude is expressed to Dr. David Marshall and Mrs. Deborah Odam for their cooperation concerning the statistics of this study. Finally, an appreciation is expressed to her parents, Dr. and Mrs. William Floyd Stutts, for their unceasing support and understanding, and especially to her husband, John Cooper, for his continual encouragement, patience and prayers during the completion of this study.

"I press toward the mark for the prize of the high calling of God in Christ Jesus."

Phillippians 3:14

## TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS . . . . .	iii
LIST OF ILLUSTRATIONS . . . . .	vi
LIST OF TABLES . . . . .	vii
 Chapter	
I. INTRODUCTION . . . . .	1
Statement of Problem . . . . .	1
Purpose of the Study . . . . .	2
Research Hypotheses . . . . .	3
Operational Definitions . . . . .	6
Limitations . . . . .	8
Assumptions . . . . .	9
II. SELECTED REVIEW OF LITERATURE . . . . .	10
Plaque . . . . .	10
Plaque Formation . . . . .	12
Plaque Composition . . . . .	13
Plaque Related to Caries . . . . .	14
Plaque Removal . . . . .	15
Oral Irrigation . . . . .	17
Behavioral Concepts and Management . . . . .	20
Conclusions . . . . .	23
III. METHODOLOGY . . . . .	25
Population and Selection Criteria . . . . .	25
Standard Procedures in Oral Hygiene . . . . .	28
Selection of Toothbrushes . . . . .	28
Bass Toothbrush Technique . . . . .	29
Oral Irrigation Technique . . . . .	30
Use of Disclosing Solution . . . . .	31
Oral Hygiene Index . . . . .	31
Patient Education Oral Hygiene Regimen . . . . .	33
Control Group . . . . .	33
Experimental Group . . . . .	37
Collection and Analysis of Data . . . . .	38
Analysis of Variance . . . . .	38
Mean . . . . .	39
Correlation Coefficients . . . . .	39
Newman-Keuls Multiple Coefficient . . . . .	40

IV. FINDINGS . . . . .	Page 41
Hypotheses Tested . . . . .	41
Hypothesis One . . . . .	41
Hypothesis Two . . . . .	45
Hypothesis Three . . . . .	47
Hypothesis Four . . . . .	49
Hypothesis Five . . . . .	52
Hypothesis Six . . . . .	55
Hypothesis Seven . . . . .	58
Hypotheses Eight, Nine, Twelve and Thirteen . . . . .	60
Hypothesis Eight . . . . .	60
Hypothesis Nine . . . . .	63
Hypothesis Twelve . . . . .	63
Hypothesis Thirteen . . . . .	64
Hypothesis Ten . . . . .	64
Hypothesis Eleven . . . . .	67
Hypothesis Fourteen . . . . .	69
Conclusions . . . . .	69
V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS .	71
Summary . . . . .	71
Conclusions . . . . .	76
Recommendations . . . . .	78
APPENDICES . . . . .	79
1. Toothbrush Positions . . . . .	80
2. Oral Irrigation . . . . .	81
3. Oral Hygiene Index . . . . .	82
4. Sample Oral Hygiene Index . . . . .	83
SELECTED BIBLIOGRAPHY . . . . .	84

## LIST OF ILLUSTRATIONS

Figure	Page
1. Dental Caries Initiation . . . . .	15
2. Oral Hygiene Index Mean for All Patients . .	44

# LIST OF TABLES

Table		Page
1.	Division of the Population . . . . .	27
2.	Oral Hygiene Index Mean Scores by Visit and Treatment . . . . .	42
3.	F Statistic and Level of Significance for Treatment, Appliances, Time, and Interactions . . . . .	43
4.	Oral Hygiene Index Mean Score by Visit and Appliance for All Patients Using Oral Irrigation . . . . .	45
5.	F Statistic and Level of Significance for Appliance, Time, and Time/ Appliance Interaction for All Patients Using Oral Irrigation . . . . .	46
6.	Oral Hygiene Index Mean Scores by Visit and Appliance for All Patients Not Using Oral Irrigation . . . . .	48
7.	F Statistics and Level of Significance for Appliance, Time, and Time/ Appliance for All Patients Not Using Oral Irrigation . . . . .	49
8.	Oral Hygiene Index Mean Scores by Visit and Treatment for All Patients With Only Bands . . . . .	50
9.	F Statistic and Level of Significance for Treatment, Time, and Time/ Treatment Interaction for All Patients With Only Bands . . . . .	52
10.	Oral Hygiene Index Mean Scores by Visit and Treatment for All Patients With a Combination of Bond/Bands . . . . .	53

Table	Page
11. F Statistic and Level of Significance for Treatment, Time, and Time/Treatment Interaction for All Patients With a Combination of Bond/Bands . . . . .	55
12. Oral Hygiene Index Mean Scores of Anterior Tooth Surfaces by Visit and Appliance for All Patients Using Oral Irrigation . . . . .	56
13. F Statistic and Level of Significance for Appliance, Time, and Time/Appliance Interaction of Anterior Surfaces of All Patients Using Oral Irrigation . . . . .	57
14. Oral Hygiene Index Mean Scores of Posterior Tooth Surfaces by Visit and Appliance for All Patients Using Oral Irrigation . . . . .	58
15. F Statistic and Level of Significance for Appliance, Time, and Time/Appliance Interaction of Posterior Tooth Surfaces for All Patients Using Oral Irrigation . . . . .	59
16. Distribution of Means for Hypotheses Eight, Nine, Twelve and Thirteen by Visit, Treatment, and Appliance . . . . .	61
17. Correlation Coefficient Between Anterior and Posterior Tooth Surfaces of All Patients by Visit and Treatment . . . . .	62
18. Oral Hygiene Index Mean Scores of Anterior Tooth Surfaces of All Patients Not Using Oral Irrigation by Visit and Appliances . . . . .	65
19. F Statistic and Level of Significance for Anterior Tooth Surfaces of All Patients Not Using Oral Irrigation by Time and Time/Appliance Interaction . . . . .	66

Table		Page
20.	Oral Hygiene Index Mean Score of Posterior Tooth Surfaces of All Patients Not Using Oral Irrigation by Visit and Appliance . . . . .	67
21.	F Statistic and Level of Significance for Appliance, Time, and Time/ Appliance Interaction for Posterior Tooth Surfaces of All Patients Not Using Oral Irrigation . . . . .	68
22.	Q Statistics for All Patients by Time . . .	69

## CHAPTER I

### INTRODUCTION

The dental profession is presented with an opportunity to provide leadership, guidance and participation in the implementation of education programs for achieving total oral health in patients. Orthodontists, in particular, experience a concern for optimal oral hygiene because fixed oral appliances encourage plaque accumulation. Oral appliances act as food traps for plaque formation, even when fabricated correctly.<sup>1</sup> The risk of initiating periodontal disease during orthodontic therapy is also present. Gingivitis may occur due to plaque retention on appliances, thereby encouraging further development of periodontal disease.

#### Statement of the Problem

As orthodontic appliances encourage an increased amount of plaque accumulation, it is important to determine effective methods in motivating and educating patients toward using optimal oral hygiene procedures.

---

<sup>1</sup>Allan Schlossberg, The Dental Clinics of North America, Vol. 16, (Philadelphia: W. B. Saunders Co., 1972), p. 574.

It is also relevant to upgrade current oral hygiene programs utilized in selected orthodontic offices.

The use of small resin-bonded brackets has offered a more physiologic approach to orthodontic therapy than the conventional circumferential bands. While gingival irritation and enamel decalcification are associated with banding, similar findings are also being observed with direct/indirect bonded brackets.<sup>2</sup> Since one etiologic factor in enamel demineralization, caries, and periodontal disease is plaque, it is essential that oral hygiene steps be taken to prevent its accumulation at vulnerable tooth sites.<sup>3</sup>

#### Purpose of the Study

It was the primary purpose of this study to determine the effectiveness of an oral hygiene regimen incorporating the use of oral irrigation and compare it to an oral hygiene regimen not using oral irrigation. Secondly, a comparison was made between orthodontic patients with only bands and patients with a combination

---

<sup>2</sup>A. John Gwinnett and R. F. Ceen, "Plaque Distribution on Bonded Brackets: A Scanning Microscope Study," American Journal of Orthodontics 75 (June 1979):667.

<sup>3</sup>Ibid.

of bond/bands in relation to plaque accumulation. Thirdly, recordings of differences in plaque accumulation were made between the patient's anterior and posterior teeth. Lastly, Oral Hygiene Index scores were measured over time.

### Research Hypotheses

For the purpose of this study the following hypotheses were stated:

1. There will be no significant difference in plaque accumulation between orthodontic patients using oral irrigation and patients not using oral irrigation as determined by the Oral Hygiene Index.

2. There will be no significant difference in plaque accumulation between patients with only bands and patients with a combination of bond/bands using oral irrigation as measured by the Oral Hygiene Index.

3. There will be no significant difference in plaque accumulation between patients with only bands and patients with a combination of bond/bands not using oral irrigation as measured by the Oral Hygiene Index.

4. There will be no significant difference in plaque accumulation between patients with only bands using oral irrigation and patients with only bands not

using oral irrigation as determined by the Oral Hygiene Index.

5. There will be no significant difference in plaque accumulation between patients with a combination of bond/bands using oral irrigation and patients not using oral irrigation as determined by the Oral Hygiene Index.

6. There will be no significant difference in plaque accumulation between the anterior teeth of patients with only bands and patients with a combination of bond/bands using oral irrigation as determined by the Oral Hygiene Index.

7. There will be no significant difference in plaque accumulation between the posterior teeth of patients with only bands and patients with a combination of bond/bands using oral irrigation as determined by the Oral Hygiene Index.

8. There will be no significant difference in plaque accumulation between anterior and posterior teeth of patients with only bands using oral irrigation as determined by the Oral Hygiene Index.

9. There will be no significant difference in plaque accumulation between anterior and posterior teeth of patients with a combination of bond/bands

using oral irrigation as determined by the Oral Hygiene Index.

10. There will be no significant difference in plaque accumulation between anterior teeth of patients with only bands and patients with a combination of bond/bands not using oral irrigation as determined by the Oral Hygiene Index.

11. There will be no significant difference in plaque accumulation between posterior teeth of patients with only bands and patients with a combination of bond/bands not using oral irrigation as determined by the Oral Hygiene Index.

12. There will be no significant difference in plaque accumulation between anterior and posterior teeth of patients with only bands not using oral irrigation as determined by the Oral Hygiene Index.

13. There will be no significant difference in plaque accumulation between anterior and posterior teeth of patients with a combination of bond/bands not using oral irrigation as determined by the Oral Hygiene Index.

14. There will be no significant difference in plaque accumulation of orthodontic patients between each of the four oral hygiene sessions as determined by the Oral Hygiene Index.

The above hypotheses included the following components:

1. Hypotheses 1, 2, 3, 4, 5, 6, 7, 10 and 11 will have the oral hygiene visits (1, 2, 3 and 4) analyzed over time.

2. The significant level for interaction of treatment over time of Hypotheses 1, 4 and 5 will be analyzed.

3. The significant level for the interaction of appliance over time of Hypotheses 2, 3, 6, 7 and 10 will be analyzed.

4. The significant level for the interaction of appliance and treatment over time of Hypothesis 1 will be analyzed.

#### Operational Definitions

For the purpose of this study the following terms were defined:

1. Orthodontics--"The branch of dentistry which deals with correction and prevention of irregularities of the teeth and poor occlusion."<sup>4</sup>

---

<sup>4</sup>Webster's New World Dictionary, rev. ed. (1972), s.v. "Orthodontics."

2. Plaque--A dense, noncalcified mass of bacterial colonies in a gel-like intermicrobial matrix which adheres to the tooth.<sup>5</sup>

3. Periodontal Disease--A disease including all parts of the periodontium, namely, the gingiva, periodontal ligament, bone, and cementum.<sup>6</sup>

4. Caries--A disease of the calcified structures of the teeth, characterized by decalcification of the mineral components and dissolution of the organic matrix.<sup>7</sup>

5. Posterior Teeth--The group of teeth including bicuspid and molars of both dental arches.

6. Anterior Teeth--The group of teeth including incisors and cuspids of both dental arches.

7. Oral Hygiene Index (OHI)--A standardized method of determining the effectiveness of present oral hygiene which is used in the dental profession.<sup>8</sup>

8. Disclosing Solution--A preparation in liquid form which contains a coloring agent of dye. In

---

<sup>5</sup>Ester M. Wilkins, Clinical Practice of the Dental Hygienist (Philadelphia: Led and Febiger, 1976, p. 237.

<sup>6</sup>Ibid., p. 169.

<sup>7</sup>Ibid., p. 745.

<sup>8</sup>Ibid., p. 280, 287.

dentistry it is used for the identification of plaque for instruction, evaluation and research.<sup>9</sup>

9. Direct/Indirect Bonding--A procedure used in orthodontic treatment of teeth whereby a bracket is cemented into the enamel surface. The bracket covers only a portion of tooth surfaces touching the cheek.

10. Circumferential Banding--A procedure used in orthodontic treatment of teeth whereby a circumferential band is cemented around each tooth. All surfaces except the biting or chewing surfaces are partially covered by the band (Synonym: band).

11. Combination bond/bands orthodontic appliance--A treatment involving the placement of both bands and bonds in the oral cavity (Synonym: bond/bands).

#### Limitations

The limitations of this study were:

1. The sample consisted of patients' records from one orthodontic office.
2. The initial selection of patients was not randomized.

---

<sup>9</sup>Ibid., p. 381.

### Assumptions

The assumptions for this study were:

1. Each orthodontic patient voluntarily chose the selected orthodontist to carry out the prescribed treatment.
2. The orthodontist analyzed and prescribed the treatment plan for each participating patient.
3. Each patient carried out the oral hygiene regimen as instructed.
4. The dental hygienist carried out oral hygiene sessions consistently with each patient.
5. Differences in sex did not influence oral hygiene effectiveness.

## CHAPTER II

### SELECTED REVIEW OF LITERATURE

Selected literature was reviewed to justify the need of plaque control programs for orthodontic patients. Included in the review was information related to plaque, toothbrushing, oral irrigation and patient behavior.

#### Plaque

Dental plaque is a dense, noncalcified mass of bacterial colonies in a gel-like intermicrobial matrix.<sup>1</sup> It adheres to an unstructured film covering the surfaces of the tooth termed the acquired pellicle.<sup>2</sup> Microorganisms which compose plaque are a vital factor in the development of dental caries. For this reason, the prevention and removal of plaque is pertinent. All dental plaque varies in content and effect. The main differences between plaques are due to chemical and microbial components. Wilkins states that the three main categories of plaque are based on their pathogenic effects. They include:

---

<sup>1</sup>Ester M. Wilkins, Clinical Practice of the Dental Hygienist (Philadelphia: Led and Febiger, 1976), p. 237.

<sup>2</sup>Ibid., p. 236.

1. Cariogenic plaque--associated with the initiation of dental caries
2. Periodontal-disease-producing plaque--directly involved in promoting the inflammatory responses demonstrated by the gingival and periodontal tissues
3. Calculus plaque or calculogenic plaque--invites the mineralization of the plaque, leading to calculus formation.<sup>3</sup>

The distribution of plaque begins at the gingival margin and increases rapidly when left undisturbed. It progresses toward the middle third of the tooth. The least amount of plaque occurs on the palatal surfaces of the maxillary teeth because of tongue activity.<sup>4</sup>

Gwinnett and Ceen stated that plaque accumulates on orthodontic bonds and bands, even in subjects with good oral hygiene.<sup>5</sup> They have also shown that plastic and metal brackets, recovered after two years of treatment, exhibit significant amounts of plaque.<sup>6</sup> It is evident that bracket configuration, and the presence of wires, elastics, springs and other attachments interfere

---

<sup>3</sup>Ibid., p. 237.

<sup>4</sup>Ibid., p. 239.

<sup>5</sup>A. John Gwinnett and R. F. Ceen, "Plaque Distribution on Bonded Brackets: A Scanning Microscope Study," American Journal of Orthodontics 75(June 1979):668.

<sup>6</sup>A. John Gwinnett and R. F. Ceen, "An Ultraviolet Photographic Technique For Monitoring Plaque During Direct Bonding Procedures," American Journal of Orthodontics 73 (1978):178.

with the patients' ability to keep portions of their mouth clean. One of the most common sites for demineralization lies at the junction between the bonding resin and the enamel. Another common site for breakdown is coronal to enamel-band junctions.

### Plaque Formation

Plaque is formed in five steps according to Wilkins.<sup>7</sup> These steps include:

1. Pellicle formation: an amorphous organic membrane which forms over exposed tooth surfaces. It is free from bacteria or other cell forms. Within minutes after all external material is removed, the pellicle begins to form. It is composed mainly of glycoproteins which are selectively absorbed into the tooth surfaces.

2. Bacteria attach to the pellicle: Selective absorption of bacteria from the environment in the oral cavity prompt attachment of this bacteria to the pellicle.

3. Bacterial multiplication: Bacteria grows and produces microcolonies in layers on the tooth surface. An increased size in growth provides the colonies to meet and form a continuous bacterial mass.

---

<sup>7</sup>Wilkins, p. 240.

4. Plaque growth and maturation: The increase in mass and thickness of plaque is due to multiplication or bacterial growth and absorption of bacteria to the plaque surface.

5. Matrix formation: A carbohydrate-protein-lipid matrix is derived from saliva and gingival sulcus fluid.

#### Plaque Composition

Plaque is composed of 20 percent organic and inorganic solids and 80 percent water. Microorganisms constitute at least 70 percent of the solid matter.<sup>8</sup> The probability of caries development increases as the number of microorganisms increase. Organism types change as the plaque matures. The changes in oral flora follow a pattern such as:

1. Day 1-2: Plaque consists mainly of bacterial cocci. (Streptococci mutans and Streptococci sanguis)

2. Day 2-4: Filamentous cocci layers replace initial cocci. (Slow plaque formers continue to produce plaque consisting of cocci for a longer period of time than fast plaque producers.)

---

<sup>8</sup> Ibid.

3. Day 6-10: Rods, spirilla and fusobacteria appear in the oral flora. As plaque matures, more gram-negative and anaerobic organisms appear. Signs of inflammation are observable at this stage.

4. Mature plaque: Vibrios and spirochetes are prevalent in addition to cocci and filamentous forms.<sup>9</sup>

#### Plaque Related to Caries

Decalcification of mineral components and dissolution of the organic matrix of the tooth surface results in dental caries.<sup>10</sup> Plaque becomes more acidogenic as sucrose is introduced into the diet.<sup>11</sup> The acid acts to dissolve tooth surfaces. When there is little sucrose in the diet, stored intracellular polysaccharides may be converted into acids. Critical acid levels for the decalcification of enamel occurs below 5.0.<sup>12</sup> The following diagram by Wilkins<sup>13</sup> illustrates the caries process:

---

<sup>9</sup>Ibid., p. 241.

<sup>10</sup>Ibid., p. 243.

<sup>11</sup>Ibid.

<sup>12</sup>Ibid., p. 244.

<sup>13</sup>Ibid., p. 303.

Carbohydrate + Oral Microbial Enzymes = Acid Formation

Foodstuff (Dextran-Forming  
(Sucrose) Streptococci)

Acid + Tooth Surface = Decalcification  
(Initial Dental Caries)

Fig. 1. Dental caries initiation.

### Plaque Removal

#### Toothbrushes and Toothbrush Methods

History records various methods used on oral hygiene. Excavations in Mesopotamia uncovered gold toothpicks used by the Sumerians about 3000 B.C.<sup>14</sup> Chinese literature records the "chewstick" which is considered the primitive toothbrush in 1600 B.C.<sup>15</sup> The care of the oral cavity was also associated with religious training as the Mohammedans used a "miswak" and the Buddhists used a "toothstick."<sup>16</sup> Fauchard, in

---

<sup>14</sup>Ibid., p. 307.

<sup>15</sup>Ibid.

<sup>16</sup>Ibid.

1728, condemned the toothbrush made of horse's hair in Le Chirurgien Dentiste because it was destructive to the teeth. He advised the use of herb roots or sponges.<sup>17</sup> In 1938, World War II events prevented the Chinese export of wild boar bristles and synthetic materials in toothbrushes were substituted in the United States.<sup>18</sup> Since a major instrument in plaque removal is the toothbrush, many techniques have been developed to increase its effectiveness in oral hygiene. Specific toothbrushing methods serve different functions in plaque removal. For example:

1. Modified Stillman Method--designed for massage, stimulation and cleansing of cervical areas.

2. Bass Method--designed for plaque removal adjacent to and directly beneath the gingival margin.

3. Charters' Method--intended to stimulate the gingival margin, especially interdentally. This method is not normally used when interdental papillae are present.<sup>19</sup>

---

<sup>17</sup>Ibid., p. 308.

<sup>18</sup>Ibid.

<sup>19</sup>Ibid., p. 315.

## Oral Irrigation

As researchers have recently considered plaque control as a method of controlling dental disease, the oral irrigating devices have received greater attention.<sup>20</sup> During the past 20 years oral irrigation has become more popular in the United States.<sup>21</sup> As early as 1911, Black stressed the importance of oral irrigation and recommended the use of "dental rubber bulbs" or "water syringes."<sup>22</sup> In 1912, Kells developed self-contained pump units and water faucet attachment devices. Arnim has experimented with oral irrigation and concludes that the faucet-type is the most practical.<sup>23</sup>

Many researchers included Arnim (1967), Goldman and Cohen (1968), Bohannon (1965), Wilderman (1966), and Grant, Stern and Everett (1968) agree that irrigation devices remove food debris when used properly. This particular effect is beneficial for orthodontic patients, in cases with fixed appliances or during the maintenance phase following periodontal therapy.<sup>24</sup>

---

<sup>20</sup>R. T. Dunkin, "Oral Irrigation in Your Patient's Home Care Control Program," The American Society for Preventive Dentistry 2 (March-April 1972):48.

<sup>21</sup>Robert Jann, "Water Irrigating Devices," The Journal of the Western Society of Periodontology 18 (March 1970):6.

<sup>22</sup>Sumter, Arnim, "Dental Irrigation-Its Place in the Total Concept of Oral Hygiene," Dental Practice 3(1965):9.

<sup>23</sup>Jann., p. 7.

<sup>24</sup>Ibid.

Water irrigation also appears to stimulate gingival circulation which may greatly aid orthodontic patients experiencing inflammation of the gingiva during treatment.<sup>25</sup>

The utilization of the water spray in an oral preventive program presents several advantages. When interproximal contact relationships of teeth produce a depression between the facial and lingual gingiva, a difficult cleansing area is established. Neither brush nor floss can reach these depressions consistently. A jet of water forced into these areas has been shown to be effective in removing debris.<sup>26</sup> Along with the normal depression, an orthodontic patient experiences a more difficult environment for cleaning. Since research shows that plaque accumulation and retained food debris are increased during treatment the water spray provides an excellent adjunct in home care procedures.

Investigators have shown that oral irrigation is "effective" even in the elimination of some anaerobic microorganisms which have a direct effect on dental

---

<sup>25</sup>Ibid., p. 10.

<sup>26</sup>Harry Bohannon, C. Ochsenbein, and S. R. Saxe, "Preventive Periodontics," Dental Clinics of America (July 1965):442.

disease.<sup>27</sup> Hurst, using orthodontic patients, showed a 66 percent reduction in lactobacilli and an 86 percent anaerobic reduction with the same irrigation device after two months.<sup>28</sup> Hoover and Robinson demonstrated that the plaque index of a population using oral irrigation was significantly reduced over a three-month period as compared to a population using the toothbrush and interdental stimulator without oral irrigation.<sup>29</sup>

Studies on oral irrigator design have been essential to the success in patient use. According to Black's principles of instrumentation, oral irrigator nozzles should be contra-angled for effective patient use. Also, a thumb guide which informs the patient of the direction of water spray is beneficial. These considerations produce the most effective oral irrigators which will clean most thoroughly, leaving the least residue on tooth surfaces.<sup>30</sup>

---

<sup>27</sup>Dunkin, p. 50.

<sup>28</sup>Ibid.

<sup>29</sup>Ibid.

<sup>30</sup>Arnim, p. 9.

Behavioral Concepts and Management

As the need for optimal oral hygiene procedures is recognized by the dental profession, the development of successful preventive programs rises. Orthodontists who begin plaque control programs learn that patients often do not follow professional recommendations. They are not the only profession which encounters this problem. The study of how and why behavior occurs becomes of primary interest to those establishing motivational programs. It has been noted that behavior occurs in a sequence of events which include:

1. Events preceding the behavior
2. The behavior itself
3. The consequence of the behavior.<sup>31</sup>

The essence of the behaviorists' concept in a single phrase may be that "behavior is controlled to a large extent by its consequences."<sup>32</sup>

Researchers have recognized that patient behavior changes immediately following instruction are not always maintained over time.<sup>33</sup> While many orthodontists

---

<sup>31</sup>Dunkin, p. 48.

<sup>32</sup>Jann, p. 6.

<sup>33</sup>A. Aderud, "The Short and Long Term Effects of A-V Motivation, Motivation by Dentists and Motivation by Hygienists," Journal of Periodontics 4 (1969):171.

recognize a need for motivating the patient, the means for carrying out these procedures are often vague and without clear specifications of the activity involved.

Specific suggestions for successful dental behavioral management in oral hygiene include:

1. Problem assessment
2. Communication of the problem to the patient
3. Correction of skill deficit
4. Determine initial rate of baseline behavior
5. Specify terminal objectives to patient
6. Formulate modification plan
7. Review program with patient
8. Follow-up.<sup>34</sup>

An important key to a successful program is individual patient management. Other factors such as evaluating each patient according to his motivational incentives, using empirical assessment of the patient needs, repeating instruction and reinforcing desired behaviors are essential in establishing a successful preventive program in orthodontics.<sup>35</sup> However, procedures involving

---

<sup>34</sup>Rona Levy, P. Milgrom, and P. Weinstein, "Behavioral Guidelines for Plaque Control Programs," Journal of the American Dental Hygienists' Association 51 (January 1977):14.

<sup>35</sup>Janet Seiwert, "A Review of the Preventive Dentistry Counseling Approach," Journal of the American Dental Hygienists' Association 53 (June 1979):262.

change may not be effective with every patient because motivation will differ in each individual.<sup>36</sup>

Behavior objectives are needed to define the direction of desired action. To minimize vagueness of plaque control programs, an attempt to establish specific objectives should be made. Behavioral changes will most likely occur when the patient commits himself to self-established goals. This method is likely to produce a higher-quality and longer-lasting behavioral change than simply teaching mechanical skills because it involves the patient's personal and intellectual needs to elicit the commitment.<sup>37</sup>

Although there are several approaches to changing behavior, an emphasis has been made on the behavioral change theory as it applies to the dental setting.<sup>38</sup> Basically, modification utilizes several learning principles to achieve desired changes in behavior. Although procedures in behavior modification vary according to

---

<sup>36</sup>Hersel Thornburg, T. Kratochwill, and E. Thornburg, "Changing Patient Behavior in the Dental Environment," Journal of the American Dental Hygienists Association 52 (September 1978):429.

<sup>37</sup>Seiwert, p. 264.

<sup>38</sup>Hersel Thornburg, et al., p. 429.

the type of behavior problem, all change strategies share the following characteristics in the dental setting. They:

1. Are designed to change only those responses which are observable or measurable by dental personnel
2. Require identification of specific goals for the patient by dental personnel
3. Require personnel to assess existing behavior related to desired goals
4. Determine the strength of undesired behavior
5. Determine the cause of the undesired behavior
6. Instruct the patient in a better alternate behavior
7. Require observation to determine effectiveness of behavioral change<sup>39</sup>

### Conclusions

The need for effective oral hygiene procedures to be used by orthodontic patients is evident. The success of preventive programs in oral hygiene depends on multiple factors. Some of the factors include an understanding of the effects of plaque, the proper

---

<sup>39</sup>Ibid., p. 432.

instruments for plaque removal such as toothbrushes, toothbrushing methods, oral irrigating devices, and a knowledge of the changing behavior theory when constructing an oral hygiene program. If an understanding of these factors is achieved, the patient may benefit.

## CHAPTER III

### METHODOLOGY

This project was an experimental study in oral hygiene effectiveness of orthodontic patients with two different types of appliances. Topics which pertained to this study were: (1) the population; (2) standard procedures in oral hygiene effectiveness (including the selection of toothbrushes, toothbrushing technique, oral irrigation and the use of disclosing solution); (3) Oral Hygiene Index; (4) patient education oral hygiene program (including the control group regimen and the experimental group regimen); and (5) collection and analysis of data.

#### Population and Selection Criteria

The population consisted of forty qualifying patients from one selected orthodontic practice in Dallas, Texas. To qualify the patient had to meet the following criteria:

1. Have a chronological age between 11 and 19 years.
2. Have a minimum of 20 teeth.

3. Have at least 12 bands or bond/bands.
4. Have an Oral Hygiene Index score equal to or greater than 10 percent.

A total of 66 orthodontic patients were screened before a population of 40 patients was obtained. Selection of patients was made commencing with the most recent qualifying orthodontic patients in treatment. Each previous patient by date was considered until the total population was selected. The patients which participated in this study began their treatment between the dates of June, 1978 and August, 1979. The oral hygiene patient education sessions were completed by the dental hygienist by December, 1979.

This population (40) contained 20 patients with only bands and 20 patients with a combination of bond/bands. The names of all patients with only bands were placed on paper.

Every other name chosen was placed into the control or experimental group. For example, the first patient with only bands was randomly selected and placed into the control group, the second patient with only bands was placed in the experimental group. This process of placement continued until both the control and the experimental groups for patients with only

bands consisted of 10. The same process of group assignment was used for patients with a combination of bond/bands. The final breakdown of groups included 10 patients with only bands and 10 patients with a combination of bond/bands in the control group. The experimental group (20) also contained 10 patients with only bands and 10 patients with a combination of bond/bands. The following table illustrates the population.

TABLE 1

## DIVISION OF THE POPULATION

Control Group (20)	Patients with only Bands (10)
Without Oral Irrigation	Patients with a combination of Bond/Bands (10)
Experimental Group (20)	Patients with only Bands (10)
With Oral Irrigation	Patients with a combination of Bond/Bands (10)

N=40

### Standard Procedures in Oral Hygiene

It is necessary to establish certain standard procedures for the purpose of producing scientific data. The standard procedures utilized in this study included the following: selection of toothbrushes, toothbrushing technique, oral irrigation and the use of disclosing solution.

#### Selection of Toothbrushes

Two Oral B-30 or Oral B-40 toothbrushes were given to each patient. One toothbrush was given to the patient for home use and one toothbrush was kept at the dental office and used prior to each oral hygiene session. The specific toothbrush given to the patient depended on the size of their oral cavity. Usually, those patients under fourteen years of age were given Oral B-30 toothbrushes, which had three rows of soft bristles with rounded tips. The Oral B-40 toothbrushes had four rows of soft bristles with rounded tips and were given to most patients over fourteen years of age.

## Bass Toothbrush Technique

The Bass toothbrush technique was utilized in this study. It is an effective method for plaque removal near the gumline.<sup>1</sup> The technique is as follows:

1. Grasp brush with the bristles pointed toward the gum
2. Place brush with bristles directed into the gums
3. Place bristles lightly to reach under gumline
4. Vibrate brush back and forth without disengaging the bristles from underneath the gums. Count ten strokes
5. Apply brush to the next group of two or three teeth making certain to overlap teeth already brushed
6. Follow each arch until every tooth has been brushed
7. Hold brush the long narrow way to brush inside teeth
8. Place bristles under the archwire directing them toward the gums
9. Follow the entire archwire in this manner

---

<sup>1</sup>Ester Wilkins, Clinical Practice of the Dental Hygienist (Philadelphia: Led and Febiger, 1976), p. 237.

Each patient was given written instructions similar to these (see appendix 1) and was cautioned not to convert short strokes into a hard scrubbing motion. This would prevent any undue trauma to the gums.

### Oral Irrigation Technique

Each patient with only bands or a combination of bond/bands in the experimental group was given a Dento-Spray oral irrigator for home use. This kit provided a portable water faucet adaptor with one oral irrigation tip. Thumb contours on the oral irrigator tip enabled the patient to determine the direction of water spray. At each office visit patients performed the oral hygiene procedures with the same type of irrigator provided in the office. Dento-Spray instructions for the use of the oral irrigation device included the following:

1. After aerator is on faucet, turn on hot water until it starts to get warm.
2. Bend low over basin, place tip in mouth. Grasp tip and keep mouth partly open so water runs into basin. Turn off water before removing tip from mouth.
3. Pressure should be high enough to dislodge material but not high enough to cause pain. Use plenty of warm water.

4. Clean around upper, then lower teeth. Move spray slowly from one side to the other. Concentrate on spaces between teeth.
5. Continue irrigation until all areas are cleansed thoroughly until your mouth feels refreshed.
6. After using, turn off water, then take tip from mouth. Disconnect spray unit from faucet and store in its box.

Patients were given additional instructions at the first oral hygiene session (see appendix 2). Dento-Spray instructions provided an adjunct to the recommended procedures used in the dental office.

#### Use of Disclosing Solution

DisPlaque disclosing solution, a product of the Pacemaker Corporation, was used to stain plaque. The directions were as follows:

Apply at full strength with cotton swab; gently rinse mouth with water. Plaque is immediately disclosed. After disclosing, examine all tooth surfaces with a mouth mirror and record Oral Hygiene Index scores. Stains may be brushed off after recording is completed.

#### Oral Hygiene Index

An Oral Hygiene Index recording consisted of the following procedures:

1. The dental hygienist charted the mouth placing a "B" beside each tooth which was bonded and a "BA"

beside each tooth which was banded. Missing teeth or unerupted teeth were recorded by a straight line through the specific tooth (see appendix 3).

2. The total number of teeth were counted and then multiplied by five to calculate the total possible (tooth) surfaces in the oral cavity. (Each tooth has five surfaces including: Buccal, Lingual, Mesial, Distal and Occlusal or Incisal). For example, the total possible tooth surfaces of a patient containing 27 teeth equals 135 ( $27 \times 5 = 135$ ).

3. DisPlaque solution was applied after the patient performed the specified oral hygiene regimen in the dental office.

4. Plaque-containing surfaces appeared a blue color after DisPlaque was applied. The blue-colored surfaces were charted. After charting was complete the number of plaque-containing surfaces was counted (see appendix 4).

5. An Oral Hygiene Index percentage was obtained by dividing the total plaque-containing surfaces by the total possible tooth surfaces. For example, 14 plaque surfaces divided by 135 possible surfaces equals .1037. This figure is converted to a percentage by multiplying it by 100 ( $.1037 \times 100 = 10.37\%$ ).

6. This Oral Hygiene Index percentage was recorded in the chart blank specified for each visit. A typical Oral Hygiene Index chart appears in Appendix 4.

Following each patients' oral hygiene visit the Oral Hygiene score was divided into anterior and posterior surfaces. The total OHI score of posterior surfaces was subtracted from the total OHI score of anterior surfaces to obtain a "difference" score.

Each orthodontic participant received an Oral Hygiene Index score of 10 percent or more on the first oral hygiene session. At this time, the orthodontist recommended that the patient attend further oral hygiene sessions to improve his or her oral hygiene procedures. In this way, the oral hygiene instruction authority was transferred from the orthodontist to the dental hygienist.

#### Patient Education Oral Hygiene Regimen

##### Control Group

The control group received an oral hygiene regimen presented and evaluated by the dental hygienist. This method included the following procedures for each patient:

1. Instructions, both written and oral, were given of the Bass toothbrushing technique (see appendix 1)
2. The Bass toothbrushing technique was demonstrated on a selected model of the teeth
3. Two Oral B-30 or Oral B-40 toothbrushes were provided
4. Crest toothpaste, regular or mint flavored, was recommended to the patient for home use and provided for patient use prior to each oral hygiene session
5. The recording and computation of the standardized Oral Hygiene Index score followed an application of the disclosing solution

Each oral hygiene session was outlined. The events during each session were as follows:

1. First Session: (First week)
  - A. The dental hygienist presented a verbal introduction to the preventive oral hygiene program
  - B. Written instructions of the Bass toothbrushing technique were read aloud and given to the patient
  - C. The dental hygienist demonstrated the Bass toothbrushing technique on a model of the teeth
  - D. The patient practiced the Bass technique in his or her mouth as the dental hygienist observed
  - E. The patient was disclosed with DisPlaque

F. Information for determining the Oral Hygiene Index was recorded

G. Corrections and suggestions were made by the dental hygienist for problem toothbrushing areas

H. The Oral Hygiene Index percentage was computed (OHI #1)

I. The terminal goal set by the patient and the dental hygienist was the achievement of an Oral Hygiene Index score of less than 10 percent

## 2. Second Session: (Second week)

A. The patient demonstrated the Bass toothbrushing technique

B. The patient was disclosed with DisPlaque

C. Information for determining the Oral Hygiene Index was recorded

D. Corrections and suggestions were made by the dental hygienist for problem toothbrushing areas

E. The Oral Hygiene Index percentage was computed (OHI #2)

F. The goal established on the first session was reviewed

## 3. Third Session: (Third week)

A. The patient demonstrated the Bass toothbrushing technique

B. The patient was disclosed with DisPlaque

C. Information for determining the Oral Hygiene Index was recorded

D. Corrections and suggestions were made by the dental hygienist for problem toothbrushing areas

E. The Oral Hygiene Index percentage was computed (OHI #3)

F. The goal established on the first session was reviewed

4. Fourth Session: (Seventh week)

A. The patient demonstrated the Bass toothbrushing technique

B. The patient was disclosed with DisPlaque

C. Information for determining the Oral Hygiene Index was recorded

D. Corrections and suggestions were made by the dental hygienist for problem toothbrushing areas

E. The Oral Hygiene Index percentage was computed (OHI #4)

F. The goal established on the first session was reviewed

Experimental Group

The experimental group received an oral hygiene regimen also presented and evaluated by the dental hygienist. Each patient attended four oral hygiene sessions of approximately fifteen minutes in length. The first session was conducted during week one, the second session took place during week two, the third session was conducted during week three and the fourth session was conducted during week seven. This method included all procedures used by the control group with the addition of the following:

1. First Session: (First week)

A. Written instructions of a selected oral irrigation technique were read aloud by the dental hygienist and given to the patient

B. The patient practiced using the oral irrigation technique

2. Second Session: (Second week)

A. The patient demonstrated the use of oral irrigation

B. Corrections and suggestions were made by the dental hygienist for problem areas concerning oral irrigation use

3. Third Session: (Third week)

A. The patient demonstrated the use of oral irrigation

B. Corrections and suggestions were made by the dental hygienist for problem areas concerning oral irrigation use

4. Fourth Session: (Seventh week)

A. The patient demonstrated the use of oral irrigation

B. Corrections and suggestions were made by the dental hygienist for problem areas concerning oral irrigation use

Collection and Analysis of Data

Data was collected from confidential patient records in the dental office during the month of January, 1980. An analysis of data included statistical measures such as the: repeated measures analysis of variance, mean, correlation coefficient and Newman-Keuls multiple comparisons.

Analysis of Variance

The analysis of variance was chosen to determine whether the difference between two or more means was

greater than would be expected by chance alone. Data were analyzed by the analysis of variance to determine if Hypotheses 1, 2, 3, 4, 5, 6, 7, 10 and 11 could be accepted or rejected. The .05 level of significance was adopted for all analyses. Factorial arrangement of the analysis of variance included one-way, two-way, three-way, and six-way treatments. Repeated measures were used to incorporate the seven-week duration of this study into statistical measures.

#### Mean

The mean was computed for all hypotheses. Patterns which existed within or between variables such as treatment (oral or non-oral irrigation), appliances (bond/band or bands) were listed. A grand mean was computed for all hypotheses.

#### Correlation Coefficients

The correlation coefficient was chosen to statistically qualify the degree of relationship between variables. It was selected to test Hypotheses 8, 9, 12 and 13. The coefficient must have been at least .632 to be considered significant at the .05 level. Acceptance

or rejection of these null hypotheses was based on the correlation coefficient.

#### Newman-Keuls Multiple Comparisons

The Newman-Keuls multiple comparison method was chosen to compare subsets of means from a larger set of means. Hypothesis 14 was tested by this comparison. The Q statistic must have been at least 2.77 for the two-interval, at least 3.31 for the three-way interval, and at least 3.36 for the four-interval to be considered significant at the .05 level. Rejection or acceptance of this null hypothesis was stated based on the critical value for the Q statistic.

## CHAPTER IV

### FINDINGS

Multiple means of statistics were utilized to describe the results of this study. Statistics computed included the analysis of variance, mean, correlation coefficient, and Newman-Keuls multiple comparisons.

#### Hypotheses Tested

##### Hypothesis One

The Oral Hygiene Index mean scores of patients using oral irrigation were consistently lower on all four visits than Oral Hygiene Index mean scores of patients not using oral irrigation. See table 2.

TABLE 2  
ORAL HYGIENE INDEX MEAN SCORES BY VISIT AND TREATMENT

Visit Number	Mean Score of Patients	
	Not Using Oral Irrigation (N=20)	Using Oral Irrigation (N=20)
1	16.72	14.95
2	9.31	7.83
3	8.74	6.13
4	6.07	3.37
Grand Mean	10.21	8.07

N = 40

A six-way repeated measures analysis of variance was calculated with factors including treatment (oral and non-oral irrigation), appliances [bond/band (BA) or bands (B)], time, the interaction of treatment over time, the interaction of appliances over time, and the interaction of appliances and treatment over time. The

F statistics revealed a significant level for treatment, appliance and treatment over time ( $p < .05$ ) and time ( $p < .001$ ) as illustrated in table 3.

TABLE 3

F STATISTIC AND LEVEL OF SIGNIFICANCE FOR  
TREATMENT, APPLIANCES, TIME  
AND INTERACTIONS

Variable	F Statistic	Level of Significance
Appliance	1.38	0.247
Treatment	6.19	0.018*
Time	61.04	0.001*
Time/Appliance Interaction	0.54	0.653
Time/Treatment Interaction	0.25	0.861
Time/Appliance/ Treatment Interaction	2.85	0.041*

\* $p = < .05$

The analysis of variance revealed that there was a significant difference in plaque accumulation

between patients using oral irrigation and patients not using oral irrigation. The null hypothesis stated was rejected by statistical evaluation and interpretation. The time variable which was significant, revealed that the Oral Hygiene Index mean decreased during the seven-week period (see figure 2).

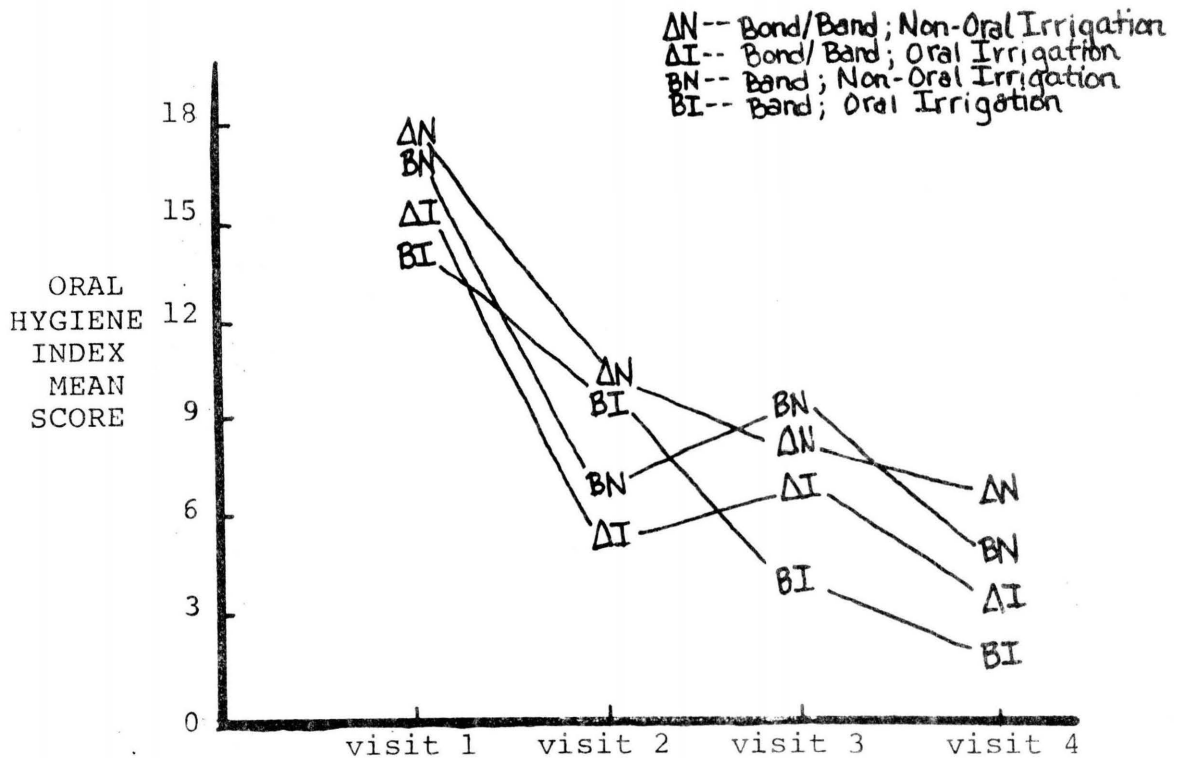


Fig. 2. Oral hygiene index mean scores for all patients.

## Hypothesis Two

The Oral Hygiene Index mean score of patients with only bands decreased on each of the four visits. Table 4 illustrates that the Oral Hygiene Index mean score of patients with a combination of bond/bands increases on the third visit.

TABLE 4

ORAL HYGIENE INDEX MEAN SCORE BY VISIT AND APPLIANCE  
FOR ALL PATIENTS USING ORAL IRRIGATION

Visit Number	Mean Score of Patients With		Grand Mean
	Combination Bond/Bands (N=20)	Only Bands (N=20)	
1	15.61	14.28	14.95
2	5.96	9.68	7.82
3	7.65	4.59	6.12
4	3.92	2.89	3.37
Grand Mean	8.29	7.84	8.06

A three-way repeated measures analysis of variance was calculated with factors including appliances (bond/band or bands), time, and the interaction of appliances over time. Although there was no significant difference between the Oral Hygiene Index mean scores of patients with only bands and patients with a combination of bond/bands using oral irrigation, it was illustrated in table 5 that overall plaque mean scores pertaining to this hypothesis decreased significantly ( $p < .001$ ) as well as the interaction of appliances over time ( $p < .05$ ).

TABLE 5

F STATISTICS AND LEVEL OF SIGNIFICANCE FOR  
APPLIANCES, TIME, AND TIME/APPLIANCE  
INTERACTION FOR ALL PATIENTS USING  
ORAL IRRIGATION

Variable	F Statistics	Level of Significance
Appliance	0.18	0.673
Time	33.84	0.001*
Time/Appliance Interaction	2.93	0.042*

\* $p = < .05$

The interaction of means was plotted and revealed that during the second visit there was an increase of Oral Hygiene Index mean scores of patients with only bands over patients with a combination of bond/bands. This accounted for the significant level in the interaction of appliances over time. Mean scores of patients with only bands decreased consistently whereas patients with a combination of bond/bands reduced rapidly on visit 2 but increased on visit 3. The null hypothesis stated was accepted by statistical evaluation and interpretation as revealed in the level of significance ( $p > .05$ ).

### Hypothesis Three

The Oral Hygiene Index mean scores of patients with only bands not using oral irrigation increased on the third visit whereas the Oral Hygiene Index mean scores of patients with a combination of bond/bands decreased on each consecutive visit. See table 6.

TABLE 6

ORAL HYGIENE INDEX MEAN SCORES BY VISIT AND APPLIANCE  
FOR ALL PATIENTS NOT USING ORAL IRRIGATION

Mean Scores of Patients Not Using Oral Irrigation With			
Visit Number	Bond/Band Combination (N=20)	Only Bands (N=20)	Grand Mean
1	17.17	16.26	16.72
2	10.88	7.73	9.30
3	8.89	8.59	8.74
4	7.05	5.08	6.06
Grand Mean	11.00	9.42	10.21

A three-way measure analysis of variance was calculated with factors including appliances (bond/band or band), time, and the interaction of appliances over time. Although there was no significant difference between the Oral Hygiene Index mean scores of patients with only bands and patients with a combination of bond/bands not using oral irrigation ( $p > .05$ ), it was

shown that overall Oral Hygiene Index mean scores pertaining to this hypothesis decreased significantly ( $p < .001$ ) over the seven-week period (see table 7). The null hypothesis was accepted.

TABLE 7

F STATISTICS AND LEVEL OF SIGNIFICANCE FOR  
APPLIANCE, TIME, AND TIME/APPLIANCE  
INTERACTION FOR ALL PATIENTS NOT  
USING ORAL IRRIGATION

Variable	F Statistic	Level of Significance
Appliance	1.32	0.266
Time	27.59	0.001*
Time/Appliance Interaction	0.52	0.672

\* $p = < .05$

#### Hypothesis Four

The Oral Hygiene Index grand mean score of patients with only bands using oral irrigation was

greater than the Oral Hygiene Index grand mean score of patients with only bands not using oral irrigation.

Table 8 illustrates that the mean score of patients with only bands using oral irrigation increased on the third visit.

TABLE 8

ORAL HYGIENE INDEX MEAN SCORES BY VISIT AND  
TREATMENT FOR ALL PATIENTS WITH ONLY BANDS

---

---

Mean Score of Patients With Only Bands			
Visit Number	Not Using Oral Irrigation (N=10)	Using Irrigation (N=10)	Grand Mean
1	14.28	16.26	15.27
2	9.68	7.73	8.71
3	4.59	8.59	6.59
4	2.82	5.08	3.95
Grand Mean	7.84	9.42	8.63

---

The three-way measures analysis of variance was calculated with factors including treatment (oral and non-oral irrigation), time, and the interaction of treatment over time. There was no significant difference in Oral Hygiene Index mean scores between patients with only bands using oral irrigation and patients with only bands not using oral irrigation ( $p > .05$ ). Table 9 reveals the level of significance for both time ( $p < .001$ ), and the interaction of treatment over time ( $p < .05$ ). Oral Hygiene Index mean scores pertaining to this hypothesis decreased over the seven-week period. The null hypothesis was accepted.

TABLE 9

F STATISTICS AND LEVEL OF SIGNIFICANCE FOR  
TREATMENT, TIME, AND TIME/TREATMENT  
INTERACTION FOR ALL PATIENTS  
WITH ONLY BANDS

Variable	F Statistic	Level of Significance
Treatment	1.69	0.211
Time	40.75	0.001*
Time/Treatment Interaction	2.75	0.052*

\*p =  $< .05$

#### Hypothesis Five

The Oral Hygiene mean scores of patients with a combination of bond/bands using oral irrigation was lower for all visits than the Oral Hygiene Index mean score of patients with a combination of bond/bands not using oral irrigation (see table 10). The difference between the grand means of the fourth and first visit was 10.91.

TABLE 10  
 ORAL HYGIENE INDEX MEAN SCORES BY VISIT AND  
 TREATMENT FOR ALL PATIENTS WITH A  
 COMBINATION OF BOND/BANDS

Mean Score of Patients With A Combination of Bond/Bands			
Visit Number	Not Using Oral Irrigation (N=10)	Using Oral Irrigation (N=10)	Grand Mean
1	17.17	15.61	16.39
2	10.88	5.96	8.42
3	8.89	7.65	8.27
4	7.05	3.92	5.48
Grand Mean	11.00	8.29	9.64

A three-way repeated measures analysis of variance was calculated with factors including treatment (oral and non-oral irrigation), time, and the interaction of treatment over time. There was a significant difference in the Oral Hygiene Index mean scores between

patients with a combination of bond/bands using oral irrigation and patients with a combination of bond/bands not using oral irrigation ( $p < .05$ ). Mean values showed that at each visit patients not using oral irrigation received a higher Oral Hygiene Index score than patients using oral irrigation. There was a significant effect for time ( $p < .001$ ) as illustrated in table 11. Oral Hygiene Index mean scores pertaining to this hypothesis decreased over the seven-week period. The null hypothesis was rejected.

TABLE 11

F STATISTICS AND LEVEL OF SIGNIFICANCE FOR  
TREATMENT, TIME, AND TIME/TREATMENT  
INTERACTION FOR ALL PATIENTS WITH  
A COMBINATION OF BOND/BANDS

Variable	F Statistic	Level of Significance
Treatment	4.91	0.040*
Time	24.46	0.001*
Time/Treatment Interaction	0.79	0.507

\*p =  $< .05$

#### Hypothesis Six

The Oral Hygiene Index mean scores for anterior surfaces of patients with only bands using oral irrigation were lower on all except the second visit than the Oral Hygiene Index mean scores for anterior surfaces of patients with a combination of bond/bands using oral irrigation. See table 12.

TABLE 12

ORAL HYGIENE INDEX MEAN SCORES OF ANTERIOR TOOTH  
SURFACES BY VISIT AND APPLIANCE FOR ALL  
PATIENTS USING ORAL IRRIGATION

Mean Score of Patients Using Oral Irrigation With			
Visit Number	Combination Bond/Bands (N=20)	Only Bands (N=20)	Grand Mean
1	13.23	11.84	12.54
2	4.98	9.47	7.23
3	7.13	4.29	5.71
4	3.92	2.75	3.33
Grand Mean	7.32	7.09	7.20

A three-way repeated measure analysis of variance was calculated with factors including appliances (bond/band or bands), time, and the interaction of appliances over time. There was no significant difference in Oral Hygiene Index mean scores between the anterior teeth of patients with only bands and patients

with a combination of bond/bands using oral irrigation ( $p > .05$ ) as illustrated in table 13.

TABLE 13

F STATISTICS AND LEVEL OF SIGNIFICANCE FOR  
APPLIANCE, TIME, AND TIME/APPLIANCE  
INTERACTION OF ANTERIOR SURFACES  
OF ALL PATIENTS USING  
ORAL IRRIGATION

Variable	F Statistics	Level of Significance
Appliance	0.05	0.822
Time	21.07	0.001*
Time/Appliance Interaction	3.61	0.019*

\* $p < .05$

A significant effect was revealed for time ( $p < .001$ ) and the interaction of appliances over time ( $p < .05$ ). Oral Hygiene Index mean scores pertaining to this hypothesis decreased over the seven-week period. The null hypothesis was accepted.

## Hypothesis Seven

The Oral Hygiene Index mean score of all patients using oral irrigation decreased consistently on each of the four visits. The difference between the Oral Hygiene Index mean score is greatest during the first visit (see table 14).

TABLE 14

ORAL HYGIENE INDEX MEAN SCORES OF POSTERIOR  
TOOTH SURFACES BY VISIT AND APPLIANCE FOR  
ALL PATIENTS USING ORAL IRRIGATION

Mean Scores of Patients Using Oral Irrigation With			
Visit Number	Combination Bond/Bands (N=20)	Only Bands (N=20)	Grand Mean
1	2.38	3.18	2.78
2	0.98	0.21	0.59
3	0.16	0.01	0.08
4	0.01	0.01	0.01
Grand Mean	0.88	0.84	0.86

A three-way measures analysis of variance was calculated with factors including appliances (bond/bands or bands), time, and the interaction of appliances over time. Although there was no significant difference in Oral Hygiene Index mean scores between posterior tooth surfaces of patients with only bands using oral irrigation ( $p > .05$ ) as shown in table 15, it was illustrated that overall Oral Hygiene Index mean scores pertaining to this hypothesis decreased significantly over the seven-week period ( $p < .001$ ). The null hypothesis was accepted.

TABLE 15

F STATISTICS AND LEVEL OF SIGNIFICANCE FOR  
APPLIANCE, TIME AND TIME/APPLIANCE  
INTERACTION OF POSTERIOR  
TOOTH SURFACES FOR  
ALL PATIENTS  
USING ORAL  
IRRIGATION

Variable	F Statistic	Level of Significance
Appliance	0.01	0.934
Time	10.34	0.001*
Time/Appliance Interaction	0.63	0.599

### Hypotheses Eight, Nine, Twelve and Thirteen

For readability purposes, hypotheses 8, 9, 12 and 13 which were measured by the correlation coefficient will be discussed together.

#### Hypothesis Eight

The mean scores revealed an increase in the Oral Hygiene Index on the second visit but a decrease on the third and fourth visits. See table 16. The null hypothesis was accepted.

TABLE 16

DISTRIBUTION OF MEANS FOR HYPOTHESES EIGHT, NINE,  
TWELVE AND THIRTEEN BY VISIT, TREATMENT,  
AND APPLIANCE

Visit Number	Patients With Only Bands		Patients With A Combination Of Bond/Bands	
	Using Oral Irrigation (N=10) (Hypothesis Eight)	Not Using Oral Irrigation (N=10) (Hypothesis Twelve)	Using Oral Irrigation (N=10) (Hypothesis Nine)	Not Using Oral Irrigation (N=10) (Hypothesis Thirteen)
1	8.66	12.03	10.85	10.69
2	9.26	7.21	4.00	8.57
3	4.29	7.93	6.97	6.37
4	2.75	4.96	3.92	6.04
Grand Mean	6.24	6.43	8.03	7.92

The mean values and correlation coefficients were computed between anterior and posterior teeth surfaces for each Oral Hygiene Index score.

Correlation coefficients revealed that there was no significant difference in Oral Hygiene Index scores between anterior and posterior tooth surfaces of patients with only bands using oral irrigation as indicated in table 17.

TABLE 17

CORRELATION COEFFICIENTS BETWEEN ANTERIOR AND POSTERIOR TOOTH SURFACES OF ALL PATIENTS BY VISIT AND TREATMENT

Visit Number	Patients With Only Bands		Patients With A Combination Of Bond/Bands	
	Using Oral Irrigation (N=10) (Hypothesis Eight)	Not Using Oral Irrigation (N=10) (Hypothesis Twelve)	Using Oral Irrigation (N=10) (Hypothesis Nine)	Not Using Oral Irrigation (N=10) (Hypothesis Thirteen)
1	-.037	.09	.358	.343
2	0.000	-.371	.588	-.167
3	.173	-.263	.043	.416
4	0.000	0.000	-.193	.586

Level of significance--coefficient .632

### Hypothesis Nine

The greatest difference in Oral Hygiene Index scores occurred between the first and second visits. Mean scores also revealed an increase in the Oral Hygiene Index score on the third visit (see table 16).

The mean values and correlation coefficients were computed between anterior and posterior tooth surfaces for each Oral Hygiene Index score. Correlation coefficients showed that there was no significant difference in Oral Hygiene Index scores between anterior and posterior tooth surfaces of patients with a combination of bond/bands using oral irrigation as indicated in table 17. The null hypothesis was accepted.

### Hypothesis Twelve

The Oral Hygiene Index mean score of the difference between anterior and posterior tooth surfaces of patients with only bands not using oral irrigation increased in the third visit (see table 16). Correlation coefficients revealed that there was no significant difference in plaque accumulation between anterior and posterior tooth surfaces of patients with only

bands not using oral irrigation (see table 17). The null hypothesis was accepted.

### Hypothesis Thirteen

The mean scores revealed a decrease in plaque accumulation as measured by the Oral Hygiene Index on each of the consecutive visits. See table 16. The correlation coefficients showed that there was no significant difference in plaque accumulation between anterior and posterior tooth surfaces of patients with a combination of bond/bands not using oral irrigation as shown in table 17. The null hypothesis was accepted.

### Hypothesis Ten

The Oral Hygiene Index mean scores of anterior tooth surfaces for all patients not using oral irrigation decrease on each of the consecutive visits. The greatest difference between Oral Hygiene Index score means of the fourth visit and the first visit occurs in patients with only bands (see table 18).

TABLE 18

ORAL HYGIENE INDEX MEAN SCORES OF ANTERIOR TOOTH  
SURFACES OF ALL PATIENTS NOT USING ORAL  
IRRIGATION BY VISIT AND APPLIANCES

Mean of Patients Not Using Oral Irrigation With			
Visit Number	Combination Bond/Bands (N=10)	Only Bands (N=10)	Grand Mean
1	13.72	14.15	13.93
2	9.79	8.28	9.04
3	6.67	8.26	7.46
4	6.55	5.52	6.03
Grand Mean	9.18	9.05	9.12

A three-way repeated measures analysis of variance was calculated with factors including appliances (bond/band or bands), time, and the interaction of appliances over time. Although there was no significant difference in plaque accumulation between anterior tooth surfaces of patients with only bands and patients

with a combination of bond/bands not using oral irrigation, it was shown that overall Oral Hygiene Index scores of this hypothesis decreased significantly ( $p < .001$ ). See table 19. The null hypothesis was rejected.

TABLE 19

F STATISTICS AND LEVEL OF SIGNIFICANCE FOR  
ANTERIOR TOOTH SURFACES OF ALL PATIENTS  
NOT USING ORAL IRRIGATION BY TIME  
AND TIME/APPLIANCE INTERACTION

Variable	F Statistic	Level of Significance
Appliance	0.01	0.921
Time	23.04	0.001*
Time/Appliance Interaction	0.97	0.412

\* $p = < .05$

## Hypothesis Eleven

The Oral Hygiene Index mean score of posterior tooth surfaces in patients with a combination of bond/bands is larger on the first and second visits, whereas the Oral Hygiene Index mean score of posterior tooth surfaces in patients with only bands is larger on the third and fourth visits. See table 20.

TABLE 20

ORAL HYGIENE INDEX MEAN SCORE OF POSTERIOR  
TOOTH SURFACES OF ALL PATIENTS NOT USING  
ORAL IRRIGATION BY VISIT AND APPLIANCE

Visit Number	Mean of Patients Not Using Oral Irrigation With		Grand Mean
	Combination Bond/Bands (N=10)	Only Bands (N=10)	
1	3.02	2.11	2.57
2	1.22	1.07	1.14
3	0.29	0.33	0.31
4	0.50	0.55	0.53
Grand Mean	1.26	1.02	1.14

A three-way repeated measures analysis of variance was calculated with factors including appliance (bond/band or bands), time, and the interaction of appliance over time. The difference in plaque accumulation between posterior tooth surfaces of patients with only bands not using oral irrigation and patients with a combination of bond/bands was not significant ( $p > .05$ ). There was a significant effect for time ( $p < .001$ ). See table 21. There was an overall decrease in Oral Hygiene Index scores pertaining to this hypothesis. The null hypothesis was accepted.

TABLE 21

F STATISTICS AND LEVEL OF SIGNIFICANCE FOR  
APPLIANCE, TIME AND TIME/APPLIANCE  
INTERACTION FOR POSTERIOR TOOTH  
SURFACES OF ALL PATIENTS NOT  
USING ORAL IRRIGATION

Variable	F Statistic	Level of Significance
Appliance	0.21	0.655
Time	9.26	0.001*
Time/Appliance Interaction	0.46	0.711

\* $p = < .05$

## Hypothesis Fourteen

A Newman-Keuls multiple comparison was calculated between each Oral Hygiene Index mean score. To be considered significant, a Q statistic of 2.77 was required for two-intervals, 3.31 for three-intervals, and 3.63 for four-intervals. Table 22 reveals that there were significant differences in plaque accumulation between the first and second oral hygiene visits and between the third and fourth oral hygiene visits. The null hypothesis was rejected.

---

TABLE 22  
Q STATISTICS FOR ALL PATIENTS BY TIME

---



---

Visit Intervals	Q Statistic
1-2	8.46*
1-3	9.78*
1-4	12.95*
2-3	1.32
2-4	4.48*
3-4	3.17*

---

\* = Q statistically significant at the 0.05 level

## Conclusions

Several statistical procedures were used to test the hypotheses. Included in the statistical evaluations were the following: the repeated measures analysis of variance, the mean, the correlation coefficient, and the Newman-Keuls multiple comparison. Each hypothesis was tested for significance at the 0.05 level. Rejection or acceptance of the null hypothesis was stated according to the evaluation of the appropriate statistic.

The appropriate statistical analysis was applied to each hypothesis. Based on these findings Hypotheses 1, 5 and 14 were rejected.

## CHAPTER V

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

#### Summary

It was the primary purpose of this study to determine the effectiveness of an oral hygiene regimen incorporating the use of oral irrigation and compare it to an oral hygiene regimen not using oral irrigation. Second, a comparison was made between orthodontic patients with only bands and patients with a combination of bond/bands in relation to plaque accumulation. Thirdly, recordings of differences in plaque accumulation were made between the patient's anterior and posterior teeth. Lastly, the Oral Hygiene Index scores were analyzed over time.

For the purpose of this study the following hypotheses were stated:

1. There will be no significant difference in plaque accumulation between orthodontic patients using oral irrigation and patients not using oral irrigation as determined by the Oral Hygiene Index.
2. There will be no significant difference in plaque accumulation between patients with only bands

and patients with a combination of bond/bands using oral irrigation as measured by the Oral Hygiene Index.

3. There will be no significant difference in plaque accumulation between patients with only bands and patients with a combination of bond/bands not using oral irrigation as measured by the Oral Hygiene Index.

4. There will be no significant difference in plaque accumulation between patients with only bands using oral irrigation and patients with only bands not using oral irrigation as determined by the Oral Hygiene Index.

5. There will be no significant difference in plaque accumulation between patients with a combination of bond/bands using oral irrigation and patients with a combination of bond/bands not using oral irrigation as determined by the Oral Hygiene Index.

6. There will be no significant difference in plaque accumulation between the anterior teeth of patients with only bands and patients with a combination of bond/bands using oral irrigation as determined by the Oral Hygiene Index.

7. There will be no significant difference in plaque accumulation between the posterior teeth of patients with only bands and patients with a

combination of bond/bands using oral irrigation as determined by the Oral Hygiene Index.

8. There will be no significant difference in plaque accumulation between anterior and posterior teeth of patients with only bands using oral irrigation as determined by the Oral Hygiene Index.

9. There will be no significant difference in plaque accumulation between anterior and posterior teeth of patients with a combination of bond/bands using oral irrigation as determined by the Oral Hygiene Index.

10. There will be no significant difference in plaque accumulation between anterior teeth of patients with only bands and patients with a combination of bond/bands not using oral irrigation as determined by the Oral Hygiene Index.

11. There will be no significant difference in plaque accumulation between posterior teeth of patients with only bands and patients with a combination of bond/bands not using oral irrigation as determined by the Oral Hygiene Index.

12. There will be no significant difference in plaque accumulation between anterior and posterior

teeth of patients with only bands not using oral irrigation as determined by the Oral Hygiene Index.

13. There will be no significant difference in plaque accumulation between anterior and posterior teeth of patients with a combination of bond/bands not using oral irrigation as determined by the Oral Hygiene Index.

14. There will be no significant difference in plaque accumulation of orthodontic patients between each of the four oral hygiene sessions as determined by the Oral Hygiene Index.

The above hypotheses included the following components:

1. Hypotheses 1, 2, 3, 4, 5, 6, 7, 10 and 11 will have the oral hygiene visits (1, 2, 3 and 4) analyzed over time.

2. The significant level for the interaction of treatment over time of Hypotheses 1, 4 and 5 will be analyzed.

3. The significant level for the interaction of appliance over time of Hypotheses 2, 3, 6, 7 and 10 will be analyzed.

4. The significant level for the interaction of appliances and treatment over time of Hypothesis 1 will be analyzed.

A sample of 40 patients was obtained from one orthodontic office in Dallas, Texas. Patient criteria for qualification included the following: The patient must (1) have a chronological age between 11 and 19 years; (2) have a minimum of 20 teeth; (3) have at least 12 bands or bond/bands; and (4) have an Oral Hygiene Index score equal to or greater than 10%. The population of 40 patients was obtained after screening 66 patients. The total population contained 20 patients with only bands and 20 patients with a combination of bond/bands. A division of the population was made by placing every patient's name, with only bands, on a piece of paper. Every other name chosen was placed into the control or experimental group. This process continued until both the control and experimental groups consisted of 10 patients. The same process of group assignment was used for patients with a combination of bond/bands. The final breakdown of the population consisted of 10 patients with only bands and 10 patients with a combination of bond/bands in the control group. The experimental group also consisted of 10 patients

with only bands and 10 patients with a combination of bond/bands.

The experimental group received the same oral hygiene regimen including oral irrigation. The control group received the same oral hygiene regimen excluding oral irrigation. Oral Hygiene Index scores were computed on each of the four oral hygiene sessions. This data was recorded by the dental hygienist on confidential patient records.

Collection of data was made after the oral hygiene sessions were complete. Statistics were then computed and analyzed to determine acceptance or rejection of each null hypothesis. Statistics used in this study included the repeated measures analysis of variance, the mean, the correlation coefficient, and the Newman-Keuls multiple comparison. Each hypothesis was accepted or rejected at the .05 level of significance.

### Conclusions

The conclusions of this study were based on three primary findings. These are:

1. Hypothesis Number One was rejected because there was a significant difference in plaque

accumulation between patients using oral irrigation and patients not using oral irrigation. Although the hypothesis was rejected, it was shown that overall Oral Hygiene Index scores decreased significantly over the seven-week duration.

2. Hypothesis Number Five was rejected because there was a significant difference in plaque accumulation between patients with a combination of bond/bands using oral irrigation and patients with a combination of bond/bands not using oral irrigation.

3. Hypothesis Number 14 was rejected. The Newman-Keuls multiple comparison revealed that there was a significant difference in plaque accumulation between the first and second oral hygiene session and between the third and fourth oral hygiene session. All other hypotheses were accepted.

As a result of the significant findings, it appears worthy to advise the orthodontist to prescribe the regular use of oral irrigation to patients with only bands and patients with a combination of bond/bands. It is also advisable to have the patient use the oral irrigation procedures as part of their daily oral hygiene regimen with the oral hygiene sessions for at least seven weeks.

### Recommendations

Factors present in this study reveal areas in which suggestions may be addressed. The recommendations include:

1. A follow-up of oral hygiene effectiveness of the orthodontic patients after different time intervals than used in this study
2. The continuance of oral hygiene sessions for at least seven weeks is emphasized as a result of the significant decrease in Oral Hygiene Index scores between the third and seventh weeks
3. A replication of the study utilizing orthodontic patients from different offices, settings and environments
4. A study involving the effectiveness of different oral hygiene instruments pertaining to orthodontic patients such as the periodontal aide, orthodontic toothbrushes or topical flouride
5. A study involving the effectiveness of a different approach to patient education

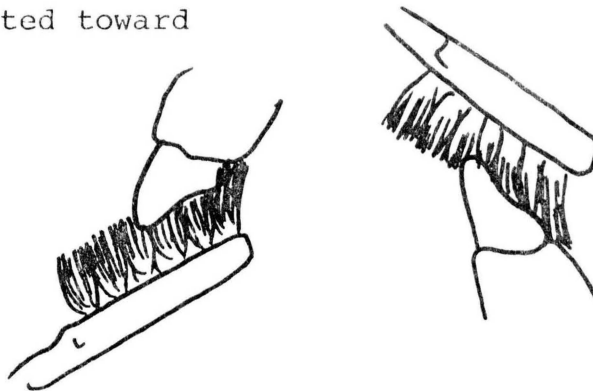
## APPENDICES

APPENDIX 1

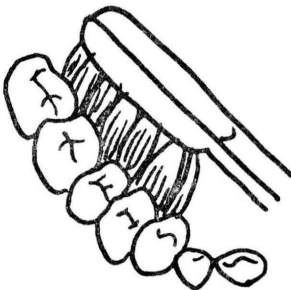
TOOTHBRUSH POSITIONS



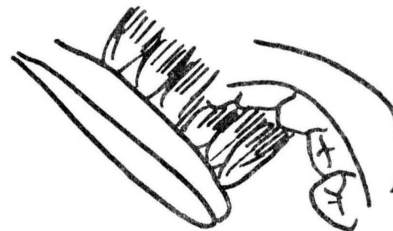
Bristles are directed toward the gum.



To brush inside teeth, hold brush the long, narrow way.



Position of brush for posterior teeth.



Position of brush for upper anterior teeth.

---

Ester M. Wilkins, Clinical Practice of the Dental Hygienist (Philadelphia: Lea and Febiger, 1976), p. 315.

## APPENDIX 2

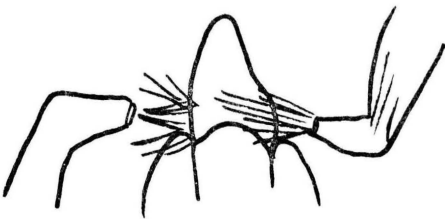
### ORAL IRRIGATION

Oral irrigation has proven to be a useful adjunct to toothbrushing but must not be considered a substitute for brushing. It is effective in the removal of loose debris around bands and bonds if used correctly.

#### Technique:

##### Procedure:

1. Turn irrigator on and adjust the water stream, lean over the washbowl and direct the tip in a horizontal direction along the margins of the gums and oral appliances. The stream of water should not be directed into the gum. This might cause damage to the soft tissue.
2. Pressure should only be great enough to flush out loose debris.
3. Avoid high pressure or prolonged application to a single area of the mouth.
4. Carry out procedure one time per day.
5. Refer to illustrations for irrigation positioning.



Correct position



Incorrect position

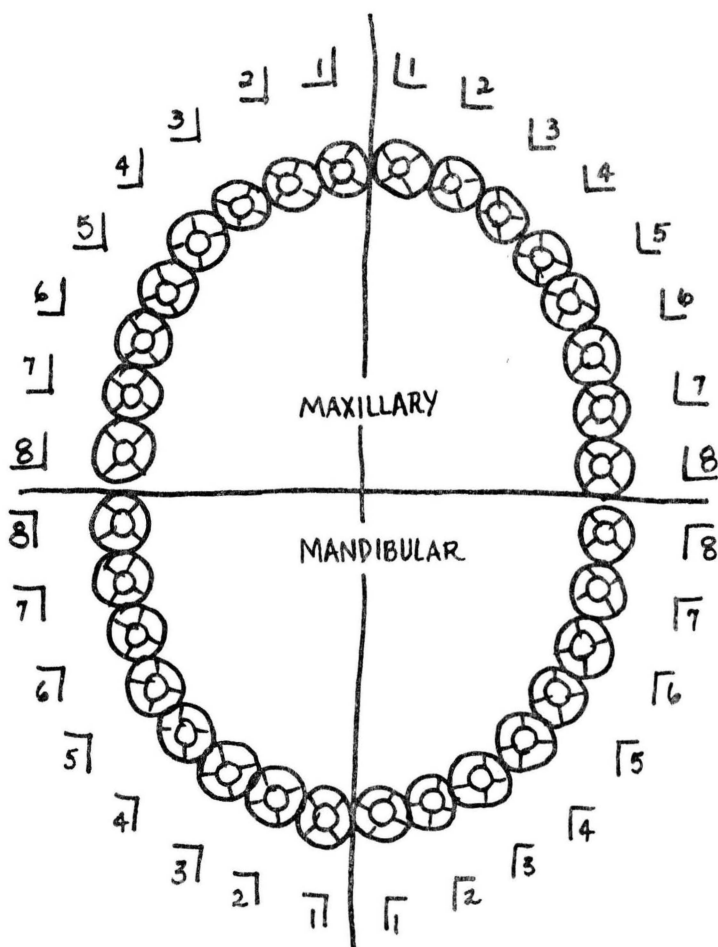
---

Ester M. Wilkins, Clinical Practice of the Dental Hygienist (Philadelphia: Lea and Febiger, 1976), p. 342-344.

APPENDIX 3  
ORAL HYGIENE INDEX

RIGHT

LEFT



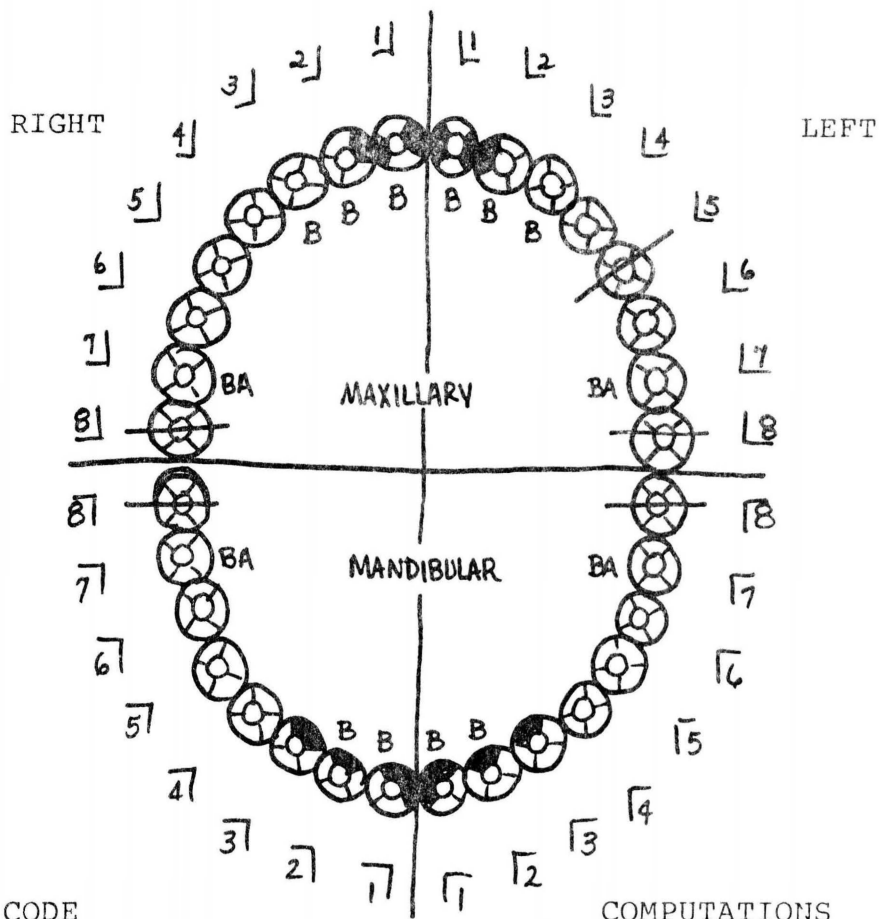
Key:

Inner circle-occlusal surfaces.

Outer circle-mesial, distal, facial, and lingual surfaces.

# APPENDIX 4

## SAMPLE ORAL HYGIENE INDEX



### CODE

BA--Banded tooth  
B--Bonded tooth



--one plaque surface



--Missing, extracted  
or unerupted tooth

### COMPUTATIONS

Total Number of Teeth=27  
 $27 \times 5$  surfaces =  
 135 possible surfaces  
 Total plaque surfaces=14  
 $14 / 135 = 1037$   
 $1037 \times 100 = 10.37\%$   
 Oral Hygiene Index  
 score = 10.37%  
 score = 10.37%

## SELECTED BIBLIOGRAPHY

## SELECTED BIBLIOGRAPHY

- Aderud, A. "The Short and Long Term Effects of A-V Motivation, Motivation by Dentists and Motivation By Hygienists." Journal of Periodontics 4 (1969):171.
- Albino, Judith. "Evaluation of Three Approaches to Changing Dental Hygiene Behaviors." Journal of Preventive Dentistry 5 (November-December 1978):4-10.
- Arnim, Sumter. "Dental Irrigation--Its Place in the Total Concept of Oral Hygiene." Dental Practice 3 (1965):9-12.
- Bohannon, Harry; Ochsenbein, C.; and Saxe, S. R. "Preventive Periodontics." The Dental Clinics of North America. Philadelphia: W. B. Saunders Co., 1965.
- Dunkin, R. T. "Oral Irrigation in Your Patient's Home Care Control Program." The American Society for Preventive Dentistry 2 (March-April 1972):48-50.
- Gwinnett, John. "Plaque Distribution on Bonded Brackets: A Scanning Microscope Study." American Journal of Orthodontics 75 (June 1979):667-677.
- Gwinnett, John; and Ceen, R. "An Ultraviolet Photographic Technique for Monitoring Plaque During Direct Bonding Procedures." American Journal of Orthodontics 73 (1978):178-186.
- Hopkins, Kenneth; and Glass, G. V. Basic Statistics for the Behavioral Sciences. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1978.
- Jann, Robert. "Water Irrigating Devices." The Journal of the Western Society of Periodontology 18 (March 1970):6-11.

- Levy, Rona; Milgrom, P.; and Weinstein, P. "Behavioral Guidelines for Plaque Control Programs." Journal of the American Dental Hygienists' Association 51 (June 1977):13-18.
- Rogalin, Joyce. "Designing a Plaque Program for General Dentistry Practices." Journal of the American Dental Hygienists' Association 53 (June 1979): 262-264.
- Schlossberg, Allan. The Dental Clinics of North America 16. Philadelphia: W. B. Saunders Co., 1972.
- Seiwert, Janet. "A Review of the Preventive Dentistry Counseling Approach." Journal of the American Dental Hygienists' Association 53 (June 1979): 262-264.
- Thornburg, Hersel; Kratochwill, T.R.; and Thornburg, E. "Changing Patient Behavior in the Dental Environment." Journal of the American Dental Hygienists' Association 52 (September 1978): 429-432.
- Webster's New World Dictionary. rev. ed. (1972) s.v. "Orthodontics."
- Wilkins, Ester. Clinical Practice of the Dental Hygienist. Philadelphia: Lea and Febiger, 1976.
- Zachrisson, Bjorn; Heimfard, E; Ruyter, I.E.; and Mjor, I. A. "Problems with Sealants for Bracket Bonding." American Journal of Orthodontics 75 (June 1979):641-649.