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The Effect of Forced Oral Lavage on the Oral Hygiene of Orthodontic Patients

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THE EFFECT OF FORCED ORAL LAVAGE ON THE ORAL HYGIENE OF ORTHODONTIC PATIENTS

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BY

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AUTOBIOGRAPHY

Dr. J. Earl Hurst was born October 15, 1937. He studied at the University of Utah from 1956 - 1958 and 1960 - 1962. Upon completion of his predental education in 1962, he entered Loyola University School of Dentistry. He received the degree of Doctor of Dental Surgery in June, 1966. In June, 1966, he was accepted into the graduate program of Oral Biology, Loyola University.

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INTRODUCTION

Oral hygiene is an important problem to the patient who is undergoing orthodontic treatment. Research has shown a dramatic increase in the *Lactobacillus* and total aerobic count in patients fitted with orthodontic appliances, Bloom and Brown (1964). The Orthodontist is concerned with the problem of good oral hygiene of his patients. How can he control or reduce this undesirable environmental change? Recent exposure to the profession and the public to the use of forced oral lavage, has possibly opened a new aid to provide the orthodontic patient with more complete and better oral care.

STATEMENT OF THE PROBLEM

It is the *first* specific aim of this research to determine the ability of forced oral lavage to reduce the *Lactobacillus* and total aerobic counts in the mouths of orthodontic patients; *secondly*, to determine the length of time that any oral flora reduction can be maintained between uses; and *thirdly*, to determine how long any bacterial reduction can be maintained over an extended period of time with regular use of forced oral lavage. A study of the bacterial reduction will suggest the level of oral environment.

REVIEW OF THE LITERATURE

Prevention of oral disease has always been the concern of mankind. Ancient people evolved customs for the cleansing of the teeth that contributed to the prevention of caries. The priests of the Brahma of Hindustan cleansed their teeth very carefully with the twig of the fig tree. They must have realized some of the importance of oral hygiene for the prevention of caries and periodontal diseases, since their intent seems to have been to preserve the beauty of the face and to prevent pain. Much has been written concerning the dental caries that affected our ancestors, both in ancient and modern times. Scientific studies and writings of merit concerning the dental carious process, however, have been restricted to relatively modern times. Most of the literature before 1840 was based on speculation, deduction and limited observations and is chiefly of historical interest.

Pierce (1876) morphologically identified rods, vibrios, and bacteria taken from carious dentin, therby adding impetus to the theory that oral microorganisms are a possible etiological factor in dental caries.

One of the first books concerned with the etiology of dental caries on a scientific basis was a text by Miller (1890). He described dental decay as a chemico-parasitic process consisting of two stages: Stage I, consisted of the decalcification of the tooth structure, and Stage II, followed with the dissolution of the softened, decalcified residue. He felt that decalcification of tooth structure was primarily caused by organic acids that were produced by the bacteria found in the oral cavity and that dissolution was caused by the bacteria themselves. Miller was a strong advocate of the multiple microbial etiology of dental caries.

Goadby (1903) compiled a comprehensive, systematic study of the bacteria of healthy and diseased teeth in which he isolated microorganisms from carious lesions. These organisms were basically acid producing and proteolytic in nature. He found aerobic proteolytic organisms which produced no acid in the periphery of the carious lesions.

McIntosh, James, Lazarus-Barlow, (1922) found from their research that there was a consistant presence of the Lactobacillus organism in active lesions.

Bunting and Parmeley (1925) found that when material from tooth scrapings was examined for microorganisms, Lactobacillus acidophilus was observed in every early lesion of dental caries and was usually in high concentration. They found the organism to be highly pleomorphic thereby explaining the many forms described by others.

Continued efforts were made by Jay and Voorhees (1927) to confirm these earlier reports. They reported on a study of twenty-two children, whose salivas were cultured at various times during a six month period, to determine the possible relation between Bacillus acidophilus and dental caries. From their research studies, they felt there was a definite and positive relationship between dental caries and the presence of Lactobacillus acidophilus.

Enright, Friesell and Trescher (1933) determined that the active agents of a carious lesion must be able to withstand a hydrogen ion concentration of at least a pH of 5.0. They showed that Lactobacillus acidophilus was the only organism that was found in the carious lesion which was able to exhibit both aciduric and acidogenic capabilities below the pH of 5.0.

Jay, Crowley, Hadley and Bunting (1933) claimed that if Lactobacillus acidophilus remained at a sufficient level for a sufficient length of time, dental caries would invariably follow. To support this research theory, a study conducted by Blayney, Bradel and Hartley (1939) found there was a high degree of correlation between dental caries, the continuous presence of Lactobacillus acidophilus and the absence of caries with the absence or sporadic presence of Lactobacillus acidophilus.

Snyder (1939) felt that he could predict the future carious rates for groups of individuals by correlating the presence of Lactobacillus acidophilus with patient susceptibility to dental caries. It is assumed that this correlation was of statistical significance. However, it would be possible to predict the future carious rates for groups only and not for the individual.

Krasse (1954) determined from his studies that the correlation of carbohydrate consumption by patients and caries activity was of considerable significance. But he felt that the correlation must be associated with both carbohydrate consumption and caries activity at the same time. He felt that Lactobacillus as a measure of caries activity in a given case is of limited value. In (1962) Krasse felt Lactobacillus was only partly responsible for the cause of dental caries. He suggested that it was only a "link" in a chain of processes leading to the development of caries. Fitzgerald and Keyes (1960) induced in experimental hamsters by the inoculation of pure cultures of Streptococcus. It was emphasized again by Keyes and Jordan (1963) that "rampant coronal caries followed the inoculation of pure strains of hamster streptococci in association with the proper diet." Later, in (1966) Krasse proposed that streptococci caused smooth surface caries while pit and fissure caries may be caused by other organisms. However, he suggested that the presence of Lactobacillus may indicate the presence of conditions favoring caries.

THE MEASUREMENT OF ORAL HYGIENE AND CARIES ACTIVITY BY BACTERIOLOGICAL METHODS.

An accurate laboratory test for oral hygiene and caries activity has long been sought. The first and most widely used bacteriological method for measuring caries activity was the determination of the amount of lactobacilli in stimulated saliva, that is, saliva secreted while the subjects chew paraffin. The earliest method for counting oral lactobacilli, devised by Rodriquez in (1930), consisted of culturing anerobically, a suitable amount of saliva on a horse-serum agar at pH 7.2 to 7.4. The lactobacilli that grew on this medium could be differentiated from other organisms by colony type and by the development of opacity about the colony as the serum protein was precipitated by the acid produced by the lactobacilli. Using this method, the numbers of salivary lactobacilli were correlated with age, caries incidence, the number of open carious lesions, oral hygiene, and intake of carbohydrates.

Within a few years, a selective medium was developed by Hadley (1933) for the growth of oral lactobacilli. It consisted essentially of a nutrient agar base to which tomato juice was added to a concentration of 40 per cent and whose pH was adjusted to 5.0 after sterilization, by the addition of lactic acid. Oral lactobacilli grow well on this medium, whereas most other oral microorganisms are suppressed, except for a few streptococci, some yeasts, micrococci, and staphylococci. The colonial morphology of these microorganisms can be differentiated from that of the lactobacilli.

In (1951) Rogosa et.al. described an improved medium for Lactobacillus counts (Selective Lactobacillus or SL medium) that appeared to supersede the others. Owing to the action of a wetting agent (tween 80), an acid pH of (5.4) and a special salt mixture, very few, if any oral microorganisms can grow on this medium except lactobacilli, which are quite unaffected. The pour plate technique is commonly used with 1.0 ml. and 0.1 ml. samples of a 1:100 dilution of saliva in physiological saline solution. The deep colonies of lactobacilli can be easily counted in the almost transparent medium.

The interpretation of the Lactobacillus count has been the subject of a continuing debate. It is necessary to assume that saliva is a reliable indicator of events at the critical sites on tooth surfaces and that a particular sample of saliva is representative of conditions in the mouth from which it came. Despite these limitations, the Lactobacillus count has been a useful indicator of events in large groups.

In the epidemiological sense, there is about 80 per cent correlation between the numbers of salivary lactobacilli and the presence of one or more carious lesions, Burnett and Scherp (1962). Additional studies have been made in an effort to specifically localize the areas of bacterial growth.

A study conducted by Steinle, Madonia and Bahn (1967) using the "Agar Replica" method determined an 82 per cent correlation between areas of bacterial localization and caries lesions. They found also that through proper restorative measures, 92 per cent of the Lactobacillus growth sites could be eliminated.

ORTHODONTICS AND ITS INFLUENCE ON THE CHANGES IN BACTERIAL DEVELOPMENT.

The orthodontist's responsibility extends beyond the mere diagnosis and treatment of malocclusions. It is of the upmost importance that the highest level of oral care be practiced by the orthodontic patient during the period of treatment. The orthodontist is aware of the additional increases of bacterial and oral debris created by placement of orthodontic appliances.

Dolce, (1950) concluded that the banding itself did not create the caries but added adversely to the overall oral condition. He found that most sites of caries were in areas not covered by band material and that most of the caries were found on the occlusal surfaces or areas above or below band material.

Bach (1954) found a 1.5 per cent increase in dental defects or .75 per cent of a defect per tooth. He classified the defects as follows: (1) caries (2) white line (3) decalcification (4) white spot decalcification (5) restorations (6) beginning caries (7) white surface decalcification. He found there was a slight increase in the incidence of dental caries in orthodontic patients, however, this increase was of no statistical significance.

Quinn (1956) conducted a study to determine the rate of caries activity in banded teeth. He concluded that caries under bands progressed at a slower rate than caries exposed to the total oral environment.

A study conducted by Owen (1949) concluded the following: (1) there was a significant increase of Lactobacillus with the placement of bands and and archwires. (2) There was a direct correlation between the number of bands present and the number of lactobacilli found in the patient's mouth. (3) The longer the treatment time, the greater the increase of lactobacilli.

Dikeman (1962) studied orthodontic and non-orthodontic patients. He found a direct correlation between the decayed, missing and filled teeth, and the Lactobacillus counts of the patients tested. He found in his survey of orthodontic subjects, an increase in Staphylococcus and Lactobacillus counts. He also stated there was little relationship between Lactobacillus counts, carbohydrate consumption, tooth brushing frequency, and flouride in the water.

Bloom and Brown (1964) conducted a study of patients prior to orthodontic treatment and during active treatment. They measured seven different organisms. They found upon banding of the patient, an increase was found in all microorganisms measured. Lactobacillus increased 3,500 per cent or expressed in terms of organisms, an average of over 90,000 lactobacilli per ml. of saliva. Streptococcus increased 52 per cent after banding procedure. Both Streptococcus and Lactobacillus counts were considerably higher than the staphyloccal or yeast counts. Bloom and Brown also pointed out that the greater the number of bands placed on the teeth, the greater the increase in bacterial and yeast counts after the orthodontic bands were in place for 6 months. The multiband technique so popular in orthodontics today favors retention of food and debris and protection of the microbial mass, which may result in new caries and in gingivitis. This combination of debris and lack of oral care may be responsible for the pronounced inflammatory gingival enlargement seen frequently in orthodontic patients.

Sakamaki (1967) conducted a study of the localization of oral lactobacilli in orthodontic patients with the agar replica technic. He found there was a considerable rise in _Lactobacillus_ after orthodontic banding. Once the bands had been removed, the _Lactobacillus_ count was reduced to pretreatment level.

FORCED ORAL LAVAGE AND ITS RELATION TO ORAL HYGIENE

Recent exposure of the profession and the public to the use of forced oral lavage has possibly opened new aids to provide the patient with more complete and better oral care.

G. V. Black (1915) was one of the early advocates of the use of a water syringe to irrigate the oral cavity. He felt the water pressure device would aid in the removal of oral debris.

Sanjana (1962) experimented with various subgingival irrigating solutions for three office visits, 3 or 4 days apart. He found with the use of these various antiseptic solutions, a decrease in the total oral flora could be obtained.

Emslie (1964) utilized hydrotherapy as the main method of treatment in aiding periodontal disease. He felt that hydrotherapy stimulated the tissue as well as removed debris and microorganisms that may cause irritation.

Sumner (1965) concluded from a study conducted on dogs that the use of hydrotherapy in periodontal disease caused a de-epithelization of the gingival crevice. He noted clinically that lateral abcesses resulted from forced water pressure.

Krajewski, Rubach and Higgenbotham (1966) concluded that hydrotherapy can be beneficial when used on normal healthy tissue. They also concluded that if severe periodontal pathology exists, a water pressure device should not be the only form of therapy, it may do more harm than good.

Crumley and Sumner (1965) used subjects which had periodontal pockets ranging in depth from 6 to 12 mm. with comparable involvement on both sides of the mouth. Without any periodontal treatment or toothbrush instruction, the subjects were instructed to use the Water Pik for a period of 2 to 6 weeks on only one side of their mouth, the other side serving as the control.

In a clinical and histological comparison of the tissues, the authors reported finding no differences in the deep or apical portions of the pockets when comparing the experimental side of the mouth with the control side. However, the crestal or marginal portion of the pockets showed an entirely different picture. "In the marginal portion of the pocket, a definite improvement in health and lessening of inflammation was a consistent finding in the experimental specimens."

Dunkin (1965) experimented with a water-irrigating device which the patient could use regularly at home and found that the irrigating spray offered an excellent method of removing the microbial mass or its byproducts; this resulted in the reduction of periodontal pocket depth, and incidentally, prevented formation of new calculus. He noted a reduction in the general microbial flora and a decrease in the formation of dental plaque. Also, the water pressure device provided the necessary stimulus to firm the gingival tissue, therefore reducing the severity of the periodontal involvement.

Krajewski, Giblin and Gargiulo (1964) conducted a two-part study in which they determined the effect of forced oral lavage as an adjunct to surgical and nonsurgical periodontal treatment. Non-surgical cases showed a significant decrease in the presence of plaque and materia alba. Clinically they also noted a general improvement of the gingival condition. In cases treated surgically, histological studies confirmed a decrease in tissue inflammation and an increase in keratinization.

Berman (1966) conducted a study to evaluate the use of two types of home oral irrigators as a supplement to the "classical" treatment of necrotizing ulcerative gingivitis (NUG) or Vincent's infection. The two irrigating devices used in this study were the Water Pik and a faucet-attached device (Dento-Spray).

In a single blind design involving 31 cases of NUG, the investigators found that only 45% of the patients used their faucet devices during the treatment, wheras over 90% used the Water Pik.

In those cases where hydrotherapy was used in the treatment of NUG, the investigators found that improvement was more rapid and the recurrence rate of the disease was reduced. "50% of the control group had a recurrence of NUG after one month, whereas only 10% of the Water Pik users had a recurrence after a similar period of time."

Phillips (1967) conducted a study of the effects of forced oral lavage on oral bacteria. He found that forced oral lavage in conjunction with conscientious toothbrushing and rinsing, showed an average of 42 per cent additional oral microorganisms removed from the mouth as compared to the number removed by brushing and rinsing procedure alone. He found over a 60 day period, with the aid of forced oral lavage, the total oral flora was reduced by an average of 72 per cent.

York (1967) conducted a study on the control of periodontal problems in orthodontic patients by the use of forced oral lavage. He measured the changes that occured by determining the changes of the Microbial mass index, and clinical plaque appraisal. Color photographs were made on each patient. He found a reduction of bacteria, dental plaque and an improvement of the general condition of the gingival tissue.

Hoover and Robinson (1967) conducted a study on the effectiveness of forced oral lavage in a non-instructed population. Fifty-eight subjects who had periodontally diseased tissues with deep pocket formation were used. Thirty-two subjects were randomly assigned to the test group, the rest serving as controls. Before and during the test period, the oral tissues were periodically photographed and clinically examined by a periodontist and by an oral pathologist.

The investigators reported finding no evidence of periodontal abscess formation or other tissue damage in the test group.

Aside from finding no evidence of tissue damage in the test group, the investigators found that this group as compared to the control group had experienced a highly significant reduction in their gingival inflammation index and in their plaque index. Other studies by the same investigators have shown that the benefits of the forced oral lavage to the periodontal patient is greatly enhanced when combined with professional care.

Beget and Bram (1967) used Beagle hounds in their study of periodontal disease because of their rapid rate of forming dental calculus and the coincident highly inflammed gingiva. Four experimental groups of dogs were used to study the effect of irrigation. Once a day, irrigation lasting 20 seconds, was confined to the right maxillary arch, the left maxillary arch serving as a control. The investigators found an improvement in cleanliness and a retardation of calculus formation on the irrigated side of the dog's mouths. They concluded that irrigation alone is twice as effective as scaling alone in reducing gingival inflammation but the greatest effect occured when scaling was combined with irrigation.

Krajewski, Rubach and Pope (1967) studied the effect of directing the water stream from a forced oral lavage unit with its pressure control at its highest setting into the "normal" gingival crevice. In this microscopic study, 30 biopsy specimens from 14 patients were studied. They reported finding the experimental and control specimens as morphologically similar in the buccal and crevicular aspects of both the epithelium and connective tissues. They concluded that forced oral lavage has no apparent adverse effect on non-pathologic gingiva, even when directing the water stream into the gingival crevice at highest pressure.

METHODS AND MATERIALS

I. SELECTION OF THE SUBJECTS

To determine the effect of forced oral lavage as compared to conventional methods of oral hygiene among orthodontic patients, two groups of fully banded orthodontic patients were selected. These patients were chosen from the Dental Clinic of the Department of Orthodontics, Loyola University. Each group contained thirty patients ranging in age from 10 to 17 years. Each of the patients had been under orthodontic treatment from 8 to 10 months.

II. OUTLINE OF TESTS

The specific microbial populations assayed in this study were *Lactobacillus* and total aerobic flora. These organisms are a reliable means of measuring the changes in oral microbial flora, Burnett and Scherp (1962).

Each patient was required to provide a saliva sample 1 hour after brushing. This sample was taken to provide a base line to establish a "before instruction" control. Any significant change in the number of organisms after the "before instruction" base line, was considered to be a reflection of the instructed use of forced oral lavage, rinsing and proper brushing methods. The samples covered a sixty day period.

III. PATIENT INSTRUCTION

Group I contained thirty patients. Each individual received a forced oral lavage unit,[1] toothbrush, toothpaste and specific instructions on the proper use of each item. Each patient was given a record sheet to record daily each oral cleansing.

The patients were instructed to use four measured cups of water in the forced oral lavage unit. (Time to run through four cups of water required approximately 1½ min.) To eliminate variation in brushing methods, the patients were given specific instructions. Upon completion of the brushing procedure, the patient was instructed to rinse the mouth with 1 cup of water. These patients were examined and required to provide saliva samples at three week intervals for a 63 day period.

In order to standardize the procedure, each patient was instructed to perform the above procedure 1 hour prior to their three week examination and not to eat or drink anything that would alter the saliva sample after brushing.

Group II contained thirty patients. These patients were given the same equipment and instructions with the exception of the forced oral lavage unit. These patients substituted for the use of forced oral lavage, rinsing

[1]Aqua Tec Cor.

(swishing) with four measured cups of water for a 1½ min. period, prior to brushing. These patients were examined under the same test conditions as Group I.

In order to determine the immediate effect of forced oral lavage, the patients in Group I, after approximately forty days of routine instruction in the test period, provided a series of saliva samples. The patients were instructed to perform the instructed cleansing procedures 1 hour before their clinic appointment. A saliva sample was provided by each patient at the end of this 1 hour period. Then the patients were instructed to once again perform the instructed cleansing procedure with the forced oral lavage and brushing. Immediately saliva samples were collected, again at 10 minutes, at 30, 60, and 90 minutes. Each of these samples were analysed for their bacterial content and graphically illustrated to show the short term effect of forced oral lavage.

A long term study was conducted to determine changes in bacterial levels of patients in both Group I and Group II. Readings were taken at 21, 42, and 63 days after instructed use. These samples were evaluated for their bacterial contents.

IV. SALIVA COLLECTION

Salivary samples were evaluated on the following basis: Paraffin stimulated saliva was used in all cases to provide a means to dislodge the various organisms from the orthodontic appliances. The samples were collected in sterile specimen jars. The individual samples were each throughly mixed by mechanical means for a one minute period. Then serial ten fold dilutions of the saliva samples were made by transferring 1 ml. aliquots of the saliva to sterile 9 ml. water blanks. The dilutions ranged from 1×10^{1} to 10^{12}.

The plating of the bacteria was carried out by transferring 1 ml. of the dilution to a sterile petri dish. Preheated media was then distributed using the pour plate method. The specific groups of organisms were isolated by using the following specified media: Lactobacillus Selective Media,[2] to isolate the <u>Lactobacillus</u> organism, and Trypticase, Soy Agar,[3] to determine the total aerobic population. All of the prepared plates were incubated for a 72 hour period at 37 degrees C.

V. COUNTING TECHNIQUE AND STATISTICAL EVALUATION

Following incubation, the colonies on each plate were counted with the aid of an illuminated background. Plates containing 30 to 300 colonies were selected for enumeration.

[2,3] Baltimore Biological Laboratories, Baltimore, Md.

The final counts were averaged, and the differences in Group I, between the before instruction mean counts and the first 3 week interval mean counts were recorded as a change in the oral flora population; consequent to the instruction of the patients in the use of the forced oral lavage and proper brushing procedures. The same evaluation was made with Group II. In order to gain a comparison between the group using forced oral lavage and brushing and the group using the instructed brushing and rinsing procedure, a comparison was made between the two group microbial levels at the before instruction reading and each succeding examination. The difference between the two test groups were compared and evaluated by using the t test.

RESULTS

The results of this study are illustrsted numerically in tables I, II, III and IV. The mean values, per cent reduction and the level of significance are presented within these tables. The basic data from which these results were tabulated are found in Tables V, VI and VII in the appendix.

I. LONG TERM EFFECT OF BRUSHING AND FORCED ORAL LAVAGE ON LACTOBACILLUS AND TOTAL AEROBIC COUNTS

The *Lactobacillus* count, before instruction gave a mean value of 4.63×10^5 per ml. of saliva. After 21 days of instructed use, the *Lactobacillus* count was reduced to a mean value of 1.60×10^5 per ml. of saliva. The 42 day reading showed a continued reduction. The count was a mean value of 1.59×10^5 per ml. of saliva. After 63 days the mean value was 1.57×10^5 per ml. of saliva. The per cent after 21 days of use of the forced oral lavage system and instructed brushing was 65 per cent. The 42 day reading showed a 66 per cent reduction. After 63 days the difference between the before instruction reading and the 63 day reading was 66 per cent. The t value after 21 days was 2.34 giving a p value of $p > 0.01$ The reduction of lactobacilli after 42 days gave a t value of 2.35 and a p value of $p > 0.01$. After a 63 day period the t value was 2.35 and the p value was $p > 0.01$.

Prior to instruction the patients in Group I gave a mean value of 4.69×10^{11} per ml. of saliva for the total aerobic count. After a 21 day period the saliva sample gave a mean value of 6.78×10^{10} per ml. of saliva. After 42 days of continued use of the forced oral lavage system and instructed brushing the mean value for the total aerobic count was 6.31×10^{10}. After 63 days the mean value was 5.91×10^{10}. The per cent reduction from the original reading was 85 per cent after 21 days. After 42 days the per cent reduction was 86 per cent. After 63 days the difference was still 86 per cent below the original reading. The t value reading after 21 days was 3.23 giving a p value of $p > 0.01$. The 42 day reading gave a t value of 3.24 and a p value of $p > 0.01$. After 63 days the t value was 3.25 and the p value was $p > 0.01$.

It is apparent from the above data that the greatest change in microbial reduction occured in the first 21 day period. Changes after the 21 day period were of insignificant value.

II. LONG TERM EFFECT OF BRUSHING AND ORAL RINSING ON LACTOBACILLUS AND TOTAL AEROBIC COUNTS

Table II shows a mean value of 4.36×10^{5} per ml. of saliva for the Lactobacillus count before the patients recieved instruction. After 21 days the mean value was 3.92×10^5 giving a 10 per cent reduction with a t value of .038 and a p value of $p > 0.30$. After 42 days the reading was 3.51×10^5 giving a 11 per cent reduction with a t value of .39 and a p value of $p > 0.30$. After 63 days the reading was 3.11×10^5 with the rest of the values unchanged.

The total aerobic count was 7.26×10^{11} before instruction. After 21 days 5.45×10^{11} with a 25 per cent reduction and a t value of 1.08 and a p value of $p > 0.10$. After 42 days the reading was 5.05×10^{11} showing a 26 per cent reduction with a t value of 1.09 and a p value of $p > 0.10$. The 63 day reading was 4.89 $\times 10^{11}$ and the remaining values were unchanged.

III. COMPARISON OF GROUP I TO GROUP II

Table III, Figure I and Figure II numerically and graphically illustrate the comparisons of Group I to Group II. Before instruction the Lactobacillus count for group I was 4.63×10^5 per ml. of saliva. The per cent difference between group I and group II was 0.06 per cent. The t value was .255, giving a p value of $p > 0.4$.

After a 21 day period, group I gave a Lactobacillus count of 1.60×10^5 per ml. of saliva. The Lactobacillus count for group II was 3.92×10^5 per ml. of saliva. The per cent difference was 61 per cent. The t value was 2.11, giving a p value of $p > 0.02$ which indicated the difference was of significant value.

The 42 day reading for the Lactobacillus count was 1.59×10^5 per ml. of saliva for group I. Group II gave a Lactobacillus count of 3.11×10^5 per ml. of saliva. The per cent difference was 60 per cent. The level of significance remained unchanged.

The 63 day reading showed the Lactobacillus count to be 1.57×10^5 per ml. of saliva, for group I. Group II gave a Lactobacillus count of 3.11×10^5 per ml. of saliva. The per cent difference and the level of significance remained essentially unchanged.

Before instruction, group I gave a total aerobic count of 4.69×10^{11} per ml. of saliva. Group II showed a total aerobic count of 7.26×10^{11} per ml. of saliva. The per cent difference was 35 per cent. The t value was .845 and the p value was $p > 0.20$. The difference was not statistically significant.

After a 21 day period, the total aerobic count for group I dropped to 6.78×10^{10} per ml. of saliva. Group II showed a reduction of 5.45×10^{11} per ml. of saliva. The per cent difference between group I and group II was 80 per cent. The t value was 3.15 and the p value was $p > 0.01$.

The difference was of statistical significance.

The 42 day reading gave a total aerobic count of 6.31 x 10^{10} per ml. of saliva, for group I. The reading for group II was 5.05 x 10^{11} per ml. of saliva. The per cent difference was 80 per cent and the t value was 3.11 and the p value was $p > 0.01$.

The 63 day reading for group I was 5.91 x 10^{10} per ml. of saliva. The reading for group II was 4.89 x 10^{11} per ml. of saliva. The per cent difference was 79 per cent. The t value was 3.09 and the p value remained unchanged.

Graphic illustration comparing group I with group II is illustrated in figures I and II. Figure I illustrates the value of forced oral lavage and proper brushing as opposed to instructed brushing and oral rinsing. These effects are graphically illustrated showing the before instruction readings, 21 day, 42 and the 63 day readings. The greatest effect of both methods on the Lactobacillus count occured within the first 21 days. Figure II illustrates the effect of forced oral lavage and proper brushing as opposed to instructed brushing and oral rinsing on the total aerobic count. These effects are graphically illustrated showing the before instruction readings, 21 day, 42 and the 63rd day. Once again the major change occured within the first 21 day period.

IV. SHORT TERM OR IMMEDIATE EFFECT OF FORCED ORAL LAVAGE ON LACTOBACILLUS AND TOTAL AEROBIC COUNTS.

The next area of consideration was the short term effectiveness of forced oral lavage. Table IV and Figure III illustrate the effects obtained in this phase of the study. Before use of the forced oral lavage and brushing, the *Lactobacillus* count was 1.56×10^5 per ml. of saliva. Immediately after the oral cleansing procedure, the *Lactobacillus* count was measured at 4.3×10^4 per ml. of saliva. The ten minute reading gave a mean value of 4.9×10^4 per ml. of saliva. The thirty minute reading gave a mean value of 5.8×10^4 per ml. of saliva. A continued rise in the *Lactobacillus* count was indicated by the 60 minute reading. The mean value for this reading was 7.2×10^4 per ml. of saliva. The final 90 minute reading gave a mean value of 1.57×10^5 per ml. of saliva. This reading was near the before cleansing reading. Table III and Figure IV illustrate the effect of forced oral lavage and brushing on the total aerobic count. The initial reading before use, gave a mean value of 6.31×10^{10} per ml. of saliva. Immediately after use of the cleansing procedure, the reading was reduced to 2.15×10^{10}. The ten minute reading was 2.46×10^{10} per ml. of saliva. At 30 minutes the mean value was 2.52×10^{10} per ml. of saliva. At 60 minutes the mean value was 3.43×10^{10} and the 90 minute reading was a mean value of 3.91×10^{10} per ml. of saliva. The total aerobic flora was temporarily reduced, but returned to the established before reading similar to the Lactobacillus counts.

TABLE I

LONG TERM EFFECT OF BRUSHING AND FORCED ORAL LAVAGE ON LACTOBACILLI AND TOTAL AEROBIC COUNT

LACTOBACILLUS COUNT X 10^5

	Before Instruction	21 Days	42 Days	63 Days
MEAN	4.63	1.60	1.59	1.57
% RED.		65%	66%	66%
t VALUE		2.34	2.35	2.35
p VALUE		$p > 0.01$	$p > 0.01$	p 0.01

TOTAL AEROBIC COUNT X 10^{10}

	Before Instruction	21 Days	42 Days	63 Days
MEAN	46.94	6.78	6.31	5.91
% RED.		86%	86%	86%
t VALUE		3.23	3.24	3.25
p VALUE		$p > 0.01$	$p > 0.01$	$p > 0.01$

TABLE II

LONG TERM EFFECT OF BRUSHING AND ORAL RINSING ON LACTOBACILLI AND TOTAL AEROBIC COUNT

LACTOBACILLUS COUNT X 10^5

	Before Instruction	21 Days	42 Days	63 Days
MEAN	4.36	3.92	3.51	3.11
% RED.		10%	11%	11%
t VALUE		.38	.39	.39
P VALUE		$p > 0.30$	$p > 0.30$	$p > 0.30$

TOTAL AEROBIC COUNT X10^{10}

	Before Instruction	21 Days	42 Days	63 Days
MEAN	72.62	54.58	50.54	48.90
%RED.		25%	26%	26%
t VALUE		1.08	1.09	1.09
P VALUE		$p > 0.10$	$p > 0.10$	$p > 0.10$

TABLE III

COMPARISON OF GROUP I TO GROUP II

LACTOBACILLUS COUNT X 10^5

	Before Instruction	21 Days	42 Days	63 Days
GROUP I MEAN	4.63	1.60	1.59	1.57
GROUP II MEAN	4.36	3.92	3.51	3.11
% Diff.	0.06%	61%	60%	60%
t VALUE	.255	2.11	2.09	2.08
P VALUE	$p > 0.4$	$p > 0.02$	$p > 0.02$	$p > 0.02$

TOTAL AEROBIC COUNT X 10^{10}

	Before Instruction	21 Days	42 Days	63 Days
GROUP I MEAN	46.94	6.78	6.31	5.91
GROUP II MEAN	72.62	54.58	50.54	48.90
% Diff.	35%	80%	80%	79%
t VALUE	.845	3.15	3.11	3.09
P VALUE	$p > 0.20$	$p > 0.01$	$p > 0.01$	$p > 0.01$

TABLE IV

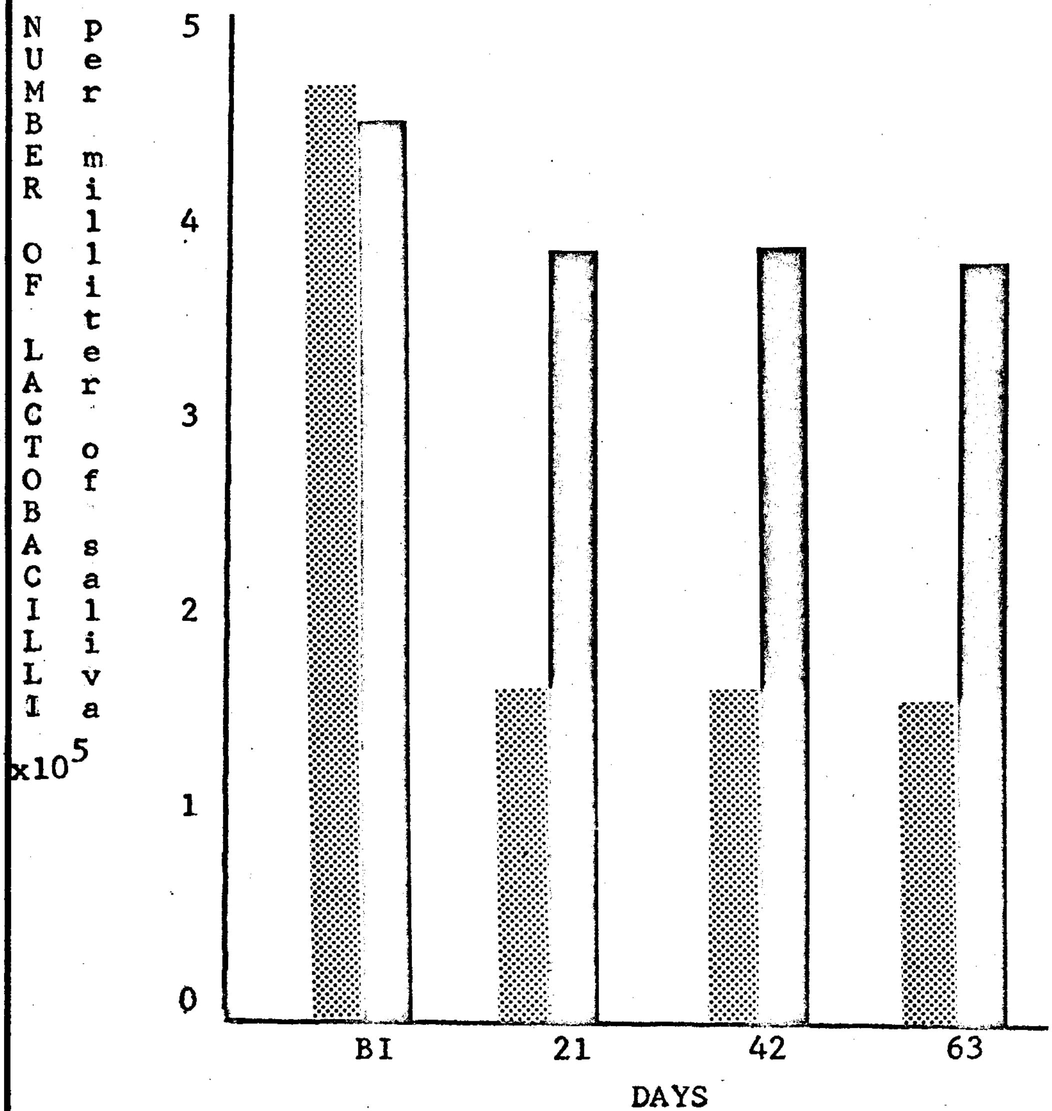
SHORT TERM OR IMMEDIATE EFFECT OF FORCED ORAL LAVAGE ON LACTOBACILLI AND TOTAL AEROBIC COUNT

LACTOBACILLI COUNT X 10^5

	Initial Reading	0	10	30	60	90
MEAN	1.56	.43	.49	.58	.72	1.57

TOTAL AEROBIC COUNT X 10^{10}

	Initial Reading	0	10	30	60	90
MEAN	6.31	2.15	2.46	2.52	3.43	3.91

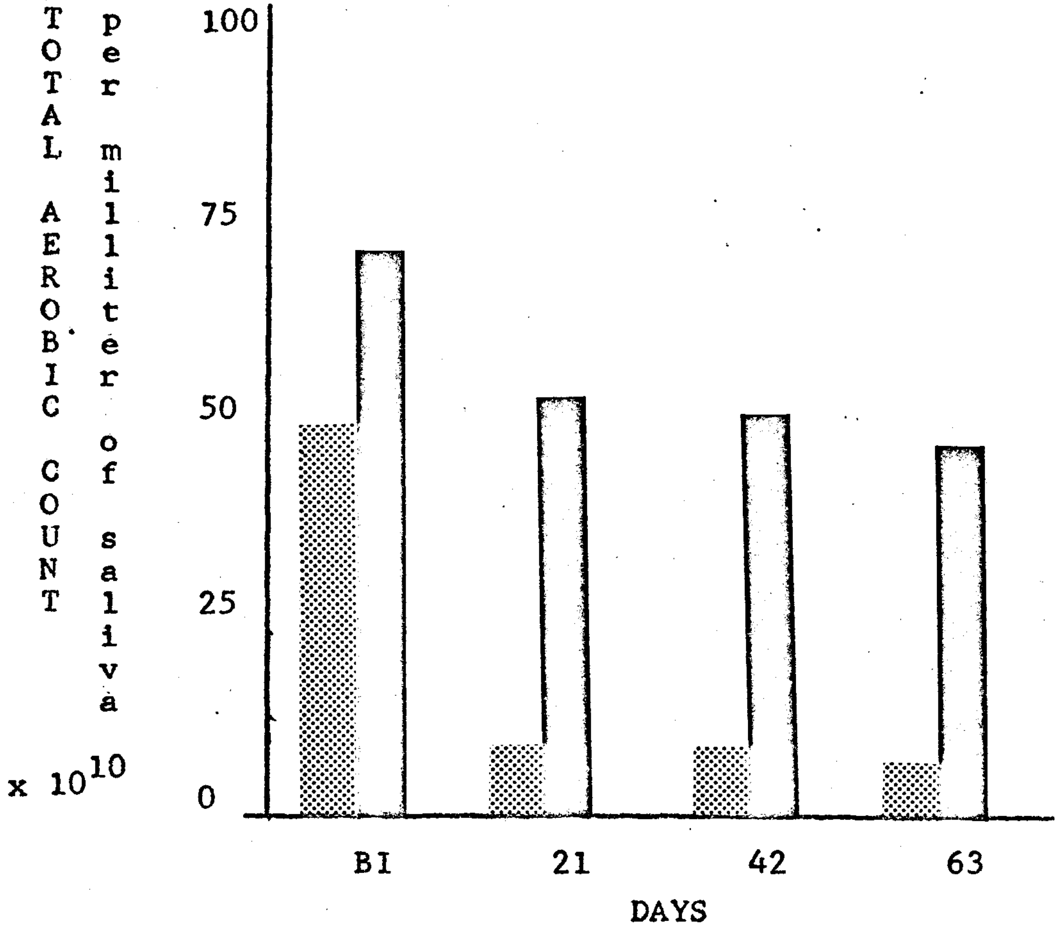


BI = BEFORE INSTRUCTION

GROUP I (BRUSHING AND FORCED ORAL LAVAGE) = [stippled]

GROUP II (BRUSHING AND ORAL RINSE) = [white]

FIG. I: LONG TERM EFFECT COMPARING GROUP I WITH GROUP II.



BI = BEFORE INSTRUCTION

GROUP I (BRUSHING AND FORCED ORAL LAVAGE) = [shaded]

GROUP II (BRUSHING AND ORAL RINSE) = [open]

FIG. II: LONG TERM EFFECT COMPARING GROUP I WITH GROUP II

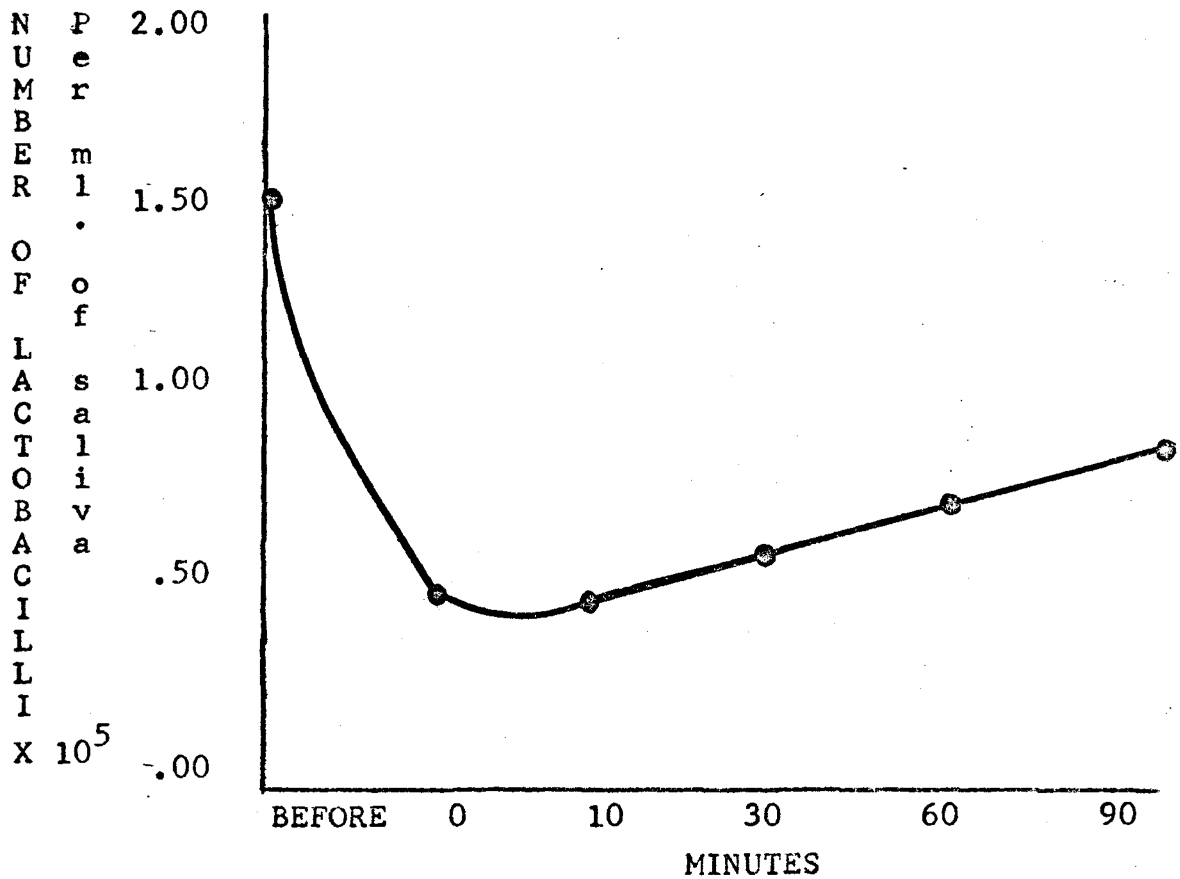


FIG. 111
SHORT TERM EFFECT OF BRUSHING AND FORCED ORAL LAVAGE ON THE NUMBER OF LACTOBACILLI

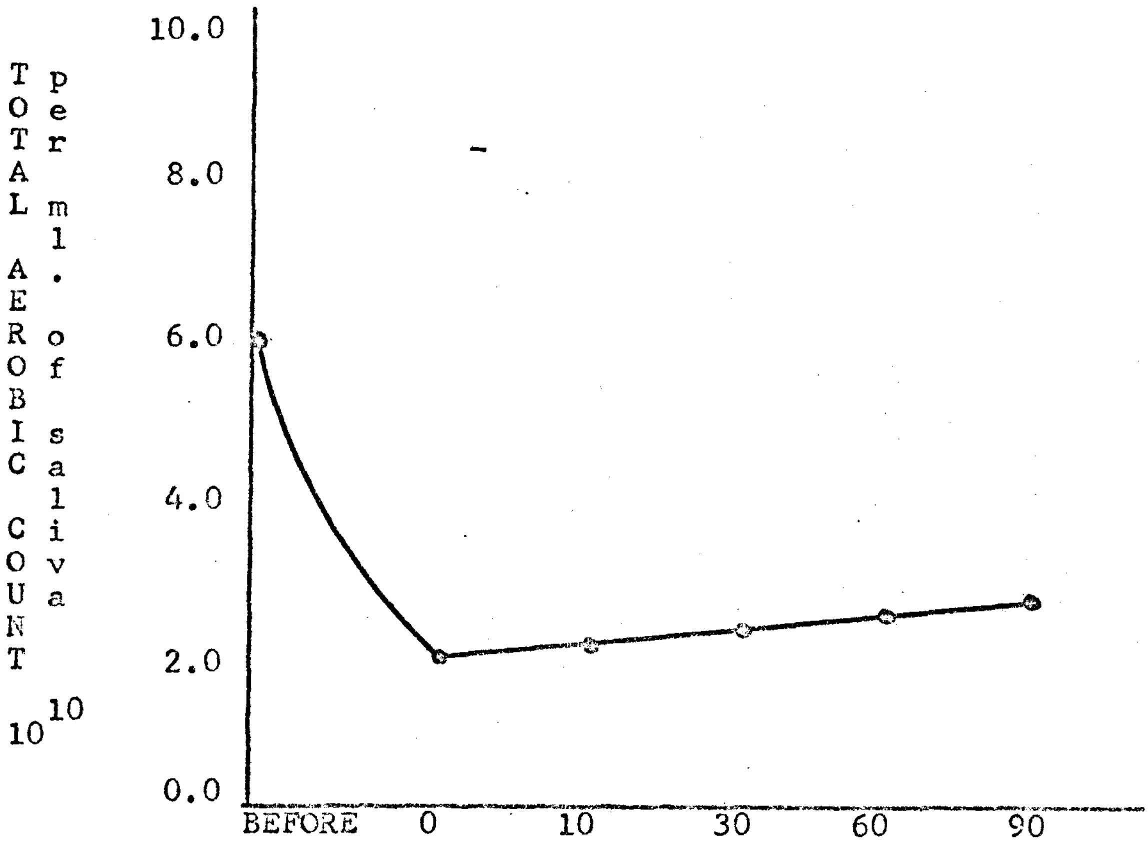


FIG. IV

SHORT TERM EFFECT OF BRUSHING AND FORCED ORAL LAVAGE ON THE TOTAL AEROBIC COUNT

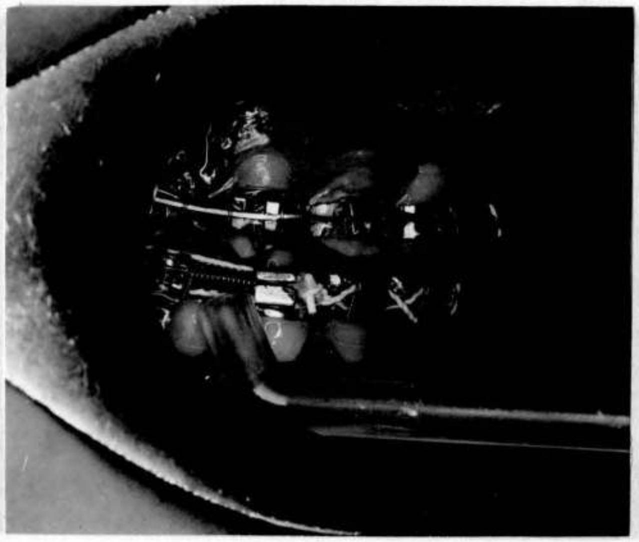


FIG. V. ILLUSTRATION OF THE PLACEMENT OF WATER JET TIP IN THE MOUTH.

FIG. VI FORCED ORAL LAVAGE UNIT USED IN EXPERIMENT

DISCUSSION

The patients used in this study exhibited much enthusiasm about taking part in a dental research project. The patients were generally conscientious in the care of their oral needs. The awareness that orthodontic appliances created oral hygiene problems increased their desire to perform adequate oral cleansing. A study conducted by Bloom and Brown (1946) indicated the placement of orthodontic appliances increased the Lactobacillus count by a significant amount. In his study, Owen (1949) found there was a rise in the number of lactobacilli as the length of the treatment time progressed. As an observation, the patients used in this study who had been under treatment for longer periods of time, generally showed a higher Lactobacillus count, however, the reliability of this measurement fluctuated. It is suggested that the variation of oral care and intervention of auxiliary appliances could have influenced the changes in the counts.

The observation of microorganisms in this study provided an index by which we could measure the variations in the oral cavity. Lactobacillus organisms have been relied upon as a measure of changes in the oral environment for many years, Blayney, Bradel, and Hartley (1939), James and Parfitt (1954). The bacterial level in the individual fluctuates with a range of variability, however, when used in a group comparison, it provides a meaningful measure of comparison.

The selection of a large sample of patients provided an adequate range of comparison and enabled an investigation, with a degree of accuracy, of the changes in the level of oral environment.

By using improved culturing media such as Selective *Lactobacillus* agar for isolation of the *Lactobacillus* organism and the Trypticase Soy agar for the isolation of the aerobic bacteria, it was possible to reproduce a countable bacterial growth from the saliva samples. This growth represented the changes in the oral flora of the mouth.

Because of the very design and placement of orthodontic appliances, it becomes very difficult for the patient to perform adequate oral cleansing. The placement of arch wires, ligature wires, individual design of the bracket attachment, band adaptation, and the use of various auxiliary aids, greatly increases the bacterial growth and development. The self cleansing action of the masticatory system is inhibited because of the inability of the lips and cheeks to perform their normal cleansing action.

The build up of dental plaque in patients who are undergoing orthodontic treatment is greatly increased. Dental plaque is composed of about 20 per cent precipitated salivary mucoid or mucin and about 80 per cent microorganisms. This build up of dental plaque acts as a confining organ and "dialyzing membrane" for confining the acids required for dissolving enamel, Burnett and Scherp (1962). As a result, the chances may be increased for the development of dental caries. Sampling the patient's saliva provides an indication of the amount of microorganisms in the mouth that may be dislodged by paraffin chewings. From these samples, we are able to estimate the changes that occured in the bacterial levels.

Random selection of the subjects for this study provided a base line of control and comparison. Prior to instruction, Group I as compared to Group II indicated no statistically significant differences in their *Lactobacillus* and total aerobic counts.

The long term effect of forced oral lavage provided a means by which we could evaluate the effect of forced water pressure on the *Lactobacillus* count and the total aerobic count over an extended period of time. From this study it was determined what happened to the *Lactobacillus* count and total aerobic count. The results indicated that after a 21 day period after instruction, the *Lactobacillus* count

SUMMARY AND CONCLUSIONS

To determine the effects of forced oral lavage as compared to conventional methods of oral hygiene among orthodontic patients, two groups of fully banded orthodontic patients were selected for this study. These patients were chosen from Loyola University, Department of Orthodontics Dental Clinic. Each group contained thirty patients ranging in age from 10 to 17 years. Each of the patients had been under orthodontic treatment from 8 to 10 months.

Stimulated saliva samples were taken from each patient prior to instruction, to establish a base line of control. Group I was instructed in the use of forced oral lavage and instructed brushing methods. Group II was instructed in proper brushing methods and oral rinsing (swishing). Saliva samples were taken at three week intervals and evaluated for the *Lactobacillus* and total aerobic content. Changes in the number of organisms would suggest the change in the level of *Lactobacillus* and total aerobic content. The specific groups of bacteria were isolated by using the following media: *Lactobacillus* Selective Media and Trypticase, Soy Agar for growth of aerobic bacteria. After a 72 hour incubation period at 37 degrees centigrade, the samples were evaluated.

Comparison between Group I and Group II indicated after 21 days the difference was statistically significant. This study has shown the effectiveness of forced oral lavage procedures. The action of the forced oral lavage system reduced the *Lactobacillus* count 61 per cent as compared to the group using the oral rinsing procedure. The total aerobic count difference between Group I and Group II was 80 per cent. The difference was statistically significant. The greatest amount of reduction occured within the first 21 day period and maintained that level without further significant reduction. This reduced flora was stable as long as the daily regime was continued.

The results of the short term study gave insight into the immediate effect of forced oral lavage. The ability of the pulsating water stream and brushing to dislodge microbial masses initially resulted in a temporary reduction of the bacterial count. The oral microorganisms were still in large numbers and rapidly re-established their previous level. This is similar to reductions seen with the use of some mouthwashes and dentrifices. Immediately after the use of the forced oral lavage system the difference between the before and after effect was a reduction of one logarithmic interval. The reading dropped from 1.56×10^5 to 4.30×10^4 on the

Lactobacillus count. The total aerobic count showed a similar reduction. One advantage of the forced oral lavage system is its ability to maintain a lowered microbial level under continued use. This reduction probably maintained a lower flora by a continuing dilution of the bacterial population by eliminating food and oral debris. The food and oral debris probably acted as a substrate for bacterial growth. However ,the indirect influence of diet on the composition of saliva in relation to dental caries, has not been extensively investigated.

Jay and Arnold (1946) noted lower Lactobacillus counts evidenced in areas where water was flouridated. Apparently, the amount of flouride in the diet, determined the amount secreted in the saliva. This, in turn, affected the oral flora and the patients susceptibility to dental caries. Increased salivary fluoride was associated with reduced prevalence of oral lactobacilli and susceptibility to dental caries. Whether or not this relationship was direct, was not certain. Since Chicago area water was and is fluoridated, the possibility that the bacterial counts were affected by the extensive oral rinsing carried out by the patients was not confirmed. Speculation and further investigation in this area may be of interest to the research worker.

Since the lactobacilli utilize refined carbohydrates, mainly sucrose and glucose, it is suggested that dietary factors could easily influence variation in the <u>Lactobacillus</u> count. Patients with high carbohydrate diets should favor the predominance of acidogenic microorganisms in the mouth. With the advent of forced oral lavage, a great portion of the carbohydrates present in the mouth should and could be rinsed away during the oral cleansing.

The orthodontic patient is plagued by the entrapment of food and oral debris. The caries potential of various foods has been investigated almost from the time Miller first postulated that the microbial conversion of carbohydrates to acids was a factor in dental decay. Since orthodontic patients are at the age where carbohydrate intake is high, oral lavage can greatly benefit them. It has been found that the exclusion of sugar from the diet reduces the incidence of both lactobacilli and caries, Burnett and Scherp (1962). The oral retention of some foodstuffs can be of great harm to the patient. The use of oral rinsing dilutes sugars and other retained food particles and may remove much of their harmful effect.

The patients in Group I benefited from the use of forced oral lavage and toothbrushing in the reduction of the Lactobacillus counts and the total aerobic counts. It must also be noted that the patients in Group II showed some reduction in Lactobacillus and total aerobic counts also. It is suggested that the effect of swishing removed and diluted the microbial masses to some degree and also improved oral habits. Forced washing and the ability to direct the flow of water enabled the patient to more carefully and completely cleanse the oral cavity than with normal brushing and rinsing.

It was noted, just as a observation, that patients in Group I showed some improvement in the tone of the periodontium.

A study conducted by Phillips (1967) on non-orthodontic patients was concerned with bacterial clearances under the effect of forced oral lavage. He found a 42 per cent greater reduction of microorganisms with the patients using forced oral lavage and toothbrushing, as compared to patients using brushing and rinsing alone. He found over a 60 day period that a continued reduction occured. After the 60 day period, the bacterial count had been reduced 72 per cent.

In contrast, this study after the 21 day period found little additional reduction had occured. It might be suggested that orthodontic appliances could be cleansed only to a certain level. When this level was obtained, continued bacterial reduction was of insignificant value.

With the aid of forced oral lavage, in conjunction with proper toothbrushing procedures, more complete and adequate oral cleansing may be obtained in orthodontic patients. Proper toothbrushing is an important factor since the forced oral lavage system only partially removes oral debris. The toothbrushing procedure should involve the back and forth movement to follow the lines of the band edges and to better reach the gingival margin area. It is suggested that the use of forced oral lavage, in conjunction with toothbrushing, can more completely cleanse areas in and around the orthodontic appliances. These areas are not normally reached by toothbrushing alone.

Some of the problems encountered during this study might give suggestion to further investigation. Specific and more rigid diet control and determination of the individual dietary intake should be taken into consideration. In this study, the patients were instructed to perform the oral cleansing procedure 1 hour prior to each appointment and not to eat or drink anything that would alter the saliva sample. By this effort, we eliminated a portion of the dietary factor and were able to standardize in the sampling procedure. Removal and addition of auxiliary appliances during the phase of this study, caused some variation of the bacterial counts. Since a large sample was used, the variation was compensated for to some degree.

Forced oral lavage needs continued investigation as to its beneficial and harmful effects. Use of an antiseptic mouthwash in the device may possibly increase the range of its effectiveness in reducing bacterial activity. A final suggestion is to derive and utilize an agent to reduce the carbohydrate content of dental plaque in combination with development of a mild protelytic agent to break down the protein content of the mucoid base in dental plaque. This would enable the bacterial contents to be loosened and rinsed from the oral cavity.

SUMMARY AND CONCLUSIONS

To determine the effects of forced oral lavage as compared to conventional methods of oral hygiene among orthodontic patients, two groups of fully banded orthodontic patients were selected for this study. These patients were chosen from Loyola University, Department of Orthodontics Dental Clinic. Each group contained thirty patients ranging in age from 10 to 17 years. Each of the patients had been under orthodontic treatment from 8 to 10 months.

Stimulated saliva samples were taken from each patient prior to instruction, to establish a base line of control. Group I was instructed in the use of forced oral lavage and instructed brushing methods. Group II was instructed in proper brushing methods and oral rinsing (swishing). Saliva samples were taken at three week intervals and evaluated for the Lactobacillus and total aerobic content. Changes in the number of organisms would suggest the change in the level of Lactobacillus and total aerobic content. The specific groups of bacteria were isolated by using the following media: Lactobacillus Selective Media and Trypticase, Soy Agar for growth of aerobic bacteria. After a 72 hour incubation period at 37 degrees centigrade, the samples were evaluated.

1. Group I, the patients using forced oral lavage and instructed brushing showed a 65% reduction in the *Lactobacillus* count after 21 days of instructed use. The total aerobic count was reduced 86% in the same period. The 42 and 63 day readings showed little additional change. The level of reduction was of significant value.

2. The patients instructed in proper brushing and rinsing showed a 10% reduction in the *Lactobacillus* count and a 25% reduction in the total aerobic count after a 21 day period. Little additional reduction occured at the 42 and 63 day readings. Addition of oral rinsing to the oral hygiene procedure was of benefit but not statistically significant.

3. Comparing Group I to Group II indicated a significant difference between the group instructed in the use of forced oral lavage and the group using instructed brushing and oral rinsing methods. The *Lactobacillus* count indicated a 61% difference between Group I and Group II at the 21 day reading. The total aerobic count difference at the same period indicated an 80% difference. The 42 and 63 day readings once again indicated minor variance. The difference between Group I and Group II was statistically significant.

4. Determination of the short term effect of forced

oral lavage indicated that over a 90 minute period, the temporarily reduced bacterial level returned to the pre-oral cleansing level. This phase of the study determined that the bacterial level could be temporarily reduced.

The use of forced oral lavage used in conjunction with proper toothbrushing methods is of significant value to the orthodontic patient in reducing the oral *Lactobacillus* and aerobic microbial flora counts. Areas in the mouth generally non-accessible to normal toothbrushing may be more completely cleansed by use of the forced oral lavage system. This improvement in oral hygiene should help the patient to resist carious breakdown of his teeth.

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APPENDIX

TABLE V

LONG TERM EFFECT OF BRUSHING AND FORCED ORAL LAVAGE

	Before Instruction		21 Days		42 Days		63 Days	
	L	TA	L	TA	L	TA	L	TA
J.B.	1.90	1.80	1.85	1.12	1.20	1.65	1.20	1.55
J.G.	7.50	42.00	1.05	3.50	1.09	3.50	1.10	3.00
C.C.	16.00	14.00	1.40	11.00	1.40	11.20	1.40	10.50
M.S.	1.70	195.00	1.60	17.00	1.70	17.00	1.60	16.50
D.D.	2.10	5.70	.075	.80	.085	.80	.08	.75
R.C.	1.30	17.00	1.40	16.00	1.20	14.00	1.35	14.50
F.K.	1.40	16.50	.090	1.30	.10	1.40	.10	1.50
J.L.	22.00	200.00	21.00	21.50	18.50	20.50	29.00	24.00
S.W.	1.60	19.00	1.40	17.00	1.30	16.00	1.20	2.00
D.R.	1.90	1.75	1.40	.016	1.45	.017	1.45	.01
M.C.	.75	.48	.12	.50	.12	.55	.11	.60
K.M.	2.50	248.00	.40	6.00	.40	7.00	.40	7.00
K.K.	12.50	110.00	1.65	11.50	1.45	5.40	3.00	2.10
J.M.	1.05	.90	.42	[illegible]	.50	.98	.52	.90
K.B.	12.70	6.00	4.00	7.00	4.00	7.50	4.00	7.50
C.M.	.45	.75	.262	.30	.016	.14	.015	.11
J.P.	1.60	17.30	1.50	16.00	1.60	15.00	1.50	16.50
M.D.	1.74	1.08	.06	1.80	1.60	1.10	1.60	1.10
C.P.	4.70	8.60	.165	1.10	.170	1.15	.14	1.18
D.S.	2.20	19.00	1.65	14.90	2.30	14.00	2.00	15.00
M.S.	1.27	49.00	.145	7.30	.150	7.50	.16	9.00
J.J.	.60	7.50	.39	.17	.10	.12	.10	.16
L.T.	6.50	140.00	1.60	.15	1.65	.15	1.60	.15

L = Lactobacilli count x 10^5

TA = Total aerobic count x 10^{10}

	Before Instruction		21 Days		42 Days		63 Days	
	L	TA	L	TA	L	TA	L	TA
R.T.	.085	1.20	.080	.97	.09	1.05	.10	1.00
M.K.	1.20	14.90	1.10	10.50	1.00	10.00	1.20	11.00
H.L.	.75	4.00	.160	1.40	.160	1.45	.150	1.50
D.K.	1.90	16.00	1.65	14.00	1.60	14.00	1.60	14.00
P.Z.	.154	84.00	.150	17.00	.14	16.00	.16	16.00
G.K.	16.00	42.00	1.20	.190	1.09	.190	1.10	.16
A.S.	13.00	125.00	.160	.110	.70	.112	.160	.10
Total	139.054	1408.40	48.127	201.26	47.02	189.54	47.22	177.37
Average	4.63	46.94	1.60	6.78	1.59	6.31	1.57	5.91

TABLE VI

SHORT TERM EFFECT OF BRUSHING AND FORCED ORAL LAVAGE ON THE LACTOBACILLI AND TOTAL AEROBIC COUNTS

	Before Instruction		0		10		30		60		90	
	L	TA	L	TA	L	TA	L	TA	L	TA	L	TA
J.B.	1.20	1.65	.10	1.05	.12	1.10	.15	1.20	.17	1.40	.20	2.10
J.G.	1.09	3.50	.15	1.20	.17	1.30	.29	1.90	.35	2.40	1.01	3.20
C.C	1.40	11.20	.40	1.45	.45	1.50	.55	1.70	.90	8.90	1.50	12.00
M.S.	1.70	17.00	1.10	9.00	1.20	9.50	1.30	11.50	1.50	12.50	1.60	15.00
D.D	.085	.80	.025	.40	.027	.45	.04	.58	.075	.60	.08	.80
R.C.	1.20	14.00	.105	1.60	.115	1.70	.13	1.90	.210	2.30	.25	2.10
F.K.	.10	1.40	.02	.90	.03	1.00	.05	1.20	.07	1.30	.09	1.40
J.L.	18.50	20.50	2.00	.20	2.15	.23	2.19	.245	2.30	2.80		
S.W.	1.30	16.00	.19	.17	.195	.19	.21	.200	1.10	2.10	1.45	2.20
D.R.	1.45	.017	.06	.012	.65	.014	.80	.016	1.20	.017	1.40	.01
M.C.	.12	.55	.06	.091	.09	.098	.11	.12	.12	.47	.135	.52
K.M.	.40	7.00	.125	.110	.135	.12	.15	.135	.19	.19	.60	1.05
K.K.	1.45	5.40	1.75	1.23	1.95	1.40	2.05	1.60	2.10	1.85		
J.M.	.50	.98	.120	.105	.13	.11	.15	.125	.195	.18	.60	.40
K.B.	4.00	7.50	1.50	.70	1.60	7.50	1.75	1.30	2.20	2.90	3.90	6.00
C.M.	.016	.140	.019	.13	.0205	.145	.025	.195	.60	1.05	.28	1.20
J.P.	1.60	15.00	1.20	11.00	1.25	11.50	1.30	12.00	1.45	13.00	1.52	14.00
M.D.	1.60	1.10	.18	.039	.21	.04	.22	.065	.26	.19	1.40	1.20
C.P.	.170	1.15	.11	.95	.13	.98	.15	1.11	.16	1.14	.18	1.15
D.S.	2.30	14.00	.245	7.10	.254	7.50	.27	8.40	1.05	9.30	1.90	10.00
M.S.	.150	7.50	.12	4.10	.125	4.80	.135	5.00	.145	5.90	.15	7.00
J.J.	.10	.12	.12	.13	.15	.15	.19	.16	.25	.17	.30	.18
L.T.	1.65	.15	.12	.121	125	.128	1.36	.135	1.45	.145	1.50	.15

L = Lactobacilli count x 10^5
TA = Total aerobic count x 10^{10}

	Before Instruction		0		10		30		60		90	
	L	TA	L	TA	L	TA	L	TA	L	TA	L	TA
R.T.	.09	1.05	.055	.160	.060	.17	.030	.195	.085	.28	.099	.39
M.K.	1.00	10.00	.65	6.50	.70	5.00	.80	5.90	.89	8.00	1.00	10.00
H.L.	.16	1.05	.10	.98	.11	1.00	.12	1.15	.15	1.30	.17	1.50
D.K.	1.60	14.00	1.00	1.90	1.20	2.50	1.40	2.90	1.50	6.50	1.60	7.50
P.Z.	.14	16.00	.09	13.00	.09	13.50	.120	14.50	.145	16.00	.16	16.00
G.K.	1.09	.19	1.10	.09	1.12	.12	1.19	.15	1.20	.17	1.25	.20
A.S.	.70	.112	.12	.09	.140	.095	.155	.110	.165	.111	.17	.113
Total	47.02	189.54	12.93	64.52	14.70	73.82	17.42	75.67	21.82	103.17	24.49	117.37
Average	1.56	6.31	.43	2.15	.49	2.46	.58	2.52	.72	3.43	.81	3.91

L = Lactobacilli count x 10^5

TA = Total aerobic count x 10^{10}

TABLE VII

LONG TERM EFFECT OF BRUSHING AND ORAL RINSING

	Before Instruction		21 Days		42 Days		63 Days	
	L	TA	L	TA	L	TA	L	TA
W.N.	1.25	13.50	1.60	16.00	1.20	14.00	1.20	14.50
S.L.	2.12	127.00	1.95	116.00	1.60	115.00	1.70	116.90
M.H.	2.10	128.00	.80	75.00	1.60	12.00	1.10	12.00
H.R.	2.96	240.00	.75	124.60	.80	125.00	.75	124.00
J.Z.	1.35	11.00	1.20	14.50	1.20	14.00	1.20	13.50
J.L.	1.70	145.00	1.75	116.00	1.60	110.50	1.60	112.50
K.A.	21.20	.39	16.50	.26	17.00	.30	15.00	.90
J.G.	1.50	.85	1.45	.90	1.50	.90	1.50	.85
K.R.	.93	125.00	1.60	114.30	1.50	115.50	1.60	115.00
G.H.	.89	157.00	.12	150.00	.40	140.00	.72	140.00
R.D.	4.90	170.00	4.50	140.00	.40	130.00	.62	140.50
G.A.	1.85	1.40	1.60	1.30	1.53	1.30	1.50	1.25
P.A.	1.60	145.00	1.50	135.00	1.50	135.00	1.75	140.00
P.M.	1.60	145.00	1.50	130.60	1.50	130.00	1.35	130.00
M.M.	1.40	11.00	1.40	10.50	1.30	10.00	1.50	11.40
B.T.	3.70	40.00	6.80	15.90	3.50	15.00	3.80	5.00
R.C.	1.90	169.00	1.70	170.00	1.45	160.00	1.39	130.00
R.B.	1.63	1.69	1.60	1.70	1.60	1.70	1.50	1.60
B.W.	4.50	70.00	4.60	62.00	4.20	40.00	5.00	21.40
H.W.	4.50	70.00	1.70	66.00	1.00	60.00	1.80	55.00
P.H.	4.30	12.00	4.00	11.00	3.00	10.50	3.00	11.00
D.S.	12.00	1.15	12.50	1.08	12.30	1.05	12.00	1.05
G.O.	4.90	9.80	5.00	8.00	5.00	8.10	5.00	9.00

L = Lactobacilli count x 10^5
TA = Total aerobic count x 10^{10}

	Before Instruction		21 Days		42 Days		63 Days	
	L	TA	L	TA	L	TA	L	TA
K.N.	1.40	105.00	1.02	10.00	1.25	1.10	2.00	4.20
B.W.	1.05	11.00	1.00	10.50	6.50	19.50	2.00	10.40
S.P.	1.45	105.00	1.40	95.00	1.20	100.00	1.20	100.00
K.P.	9.00	140.00	9.00	18.60	.73	14.50	.70	14.00
S.M.	1.40	11.00	1.06	12.00	1.30	10.50	1.05	11.20
C.C.	16.00	11.50	14.00	10.80	14.00	10.50	1.05	11.20
L.J.	16.00	11.50	14.00	10.00	14.00	10.50	13.00	10.00
Total	131.08	2188.78	115.335	1637.54	105.56	1516.45	87.58	1468.35
Average	4.36	72.62	3.92	54.58	3.51	50.54	2.91	48.90

APPROVAL SHEET

The thesis submitted by Dr. J. Earl Hurst has been read and approved by members of the Department of Oral Biology.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Science.

May 10, 1968
Date

John V. Madonia D.D.S. Ph.D.
Signature of Advisor