Lingual Orthodontics: A Status Report, Part 1

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In the past few months, many of you have undoubtedly been questioned about "invisible braces". News articles and television reports have appeared, discussing orthodontic treatment with fixed appliances bonded on the lingual. In some instances, these reports may have been misleading.

As we all know, there's an increased interest in adult orthodontics, and everybody is striving for the utmost in esthetics as well as functional excellence. But, who wants to go to all the trouble to put appliances on the inside? Look at all the problems! The lingual surfaces vary so much more than the labial; when the patient closes might one expect that the brackets would shear off from the lingual surfaces of the upper anterior teeth? What about irritation to the tongue? What about speech? What's more, would we be able to achieve the quality results that we have worked for so many years to attain with our labial appliances? These were just some of the questions that went through our minds when we were asked to participate in this Lingual Task Force to study "invisible braces". That's the bad news. Is there any good news? What about people who have a definite need for orthodontics to correct a deep bite that has resulted in a TMJ problem, but the thought of wearing conventional braces has kept them from seeking orthodontic treatment? Maybe invisible braces could help those who would not have sought orthodontic treatment otherwise.

In the following report, it is the intent of the authors to help clarify the current status of lingual orthodontics, and relate some of-our experiences with the appliance to answer some of the questions posed above.

History

Many of us have bonded lingual attachments, buttons, cleats, and retainers. Since plastic and other labially bonded brackets have not provided the esthetics we strive for, many orthodontists at least considered bonding brackets on the lingual, and a few were bold enough (or foolish enough, depending upon your point of view) to attempt lingual orthodontics.

Thomas Edison and many others must have had the concept of a light source without a flame, but it took several advances in electromagnetic technology and the development of tungsten filaments before the electric light bulb became a reality. Likewise, refinements in bonding technology and the development of more resilient orthodontic alloys and wires were necessary before lingual orthodontics became practical.

In 1975, Dr. Craven Kurz of Beverly Hills, California, became convinced that a lingual bonded edgewise appliance was feasible and would make a significant contribution to adult orthodontics.

He created his own lingual appliances by modifying labial appliances, and utilized them on a limited basis in his practice. His initial results encouraged him to continue his work in lingual orthodontics. In 1976, research and development on a nonedgewise lingual appliance was initiated by Ormco in close cooperation with Dr. Alexander (Jim) Wildman in Eugene, Oregon. This program pointed out many of the difficulties involved with a totally lingual fixed appliance. Later in 1976, Dr. Kurz submitted specific designs and concepts to the U.S. Patent Office for the patent rights to his unique edgewise lingual appliance. Shortly thereafter, Dr. Kurz and Ormco began an intensive program to develop the appliance and bring it from a dream to reality.

In 1978 detailed studies were conducted, measuring the morphology of the lingual surfaces of the teeth in order to reduce the size of the bracket bases and facilitate lingual bonding. The lingual arch form was studied topographically, to establish lingual torque and tip angulations in reference to accepted labial measurements. From this accumulated data and using a design concept to assure proper function and patient comfort, the initial lingual edgewise prototype was manufactured in 1979.

Interestingly enough, in December 1979, Dr. Kinya Fujita, of Kanagawa Dental University, Japan, published an article describing appliances with a lingual bracket design and mushroom shaped archwires.[1] His work confirmed the experiences of Dr. Kurz and Ormco that, certainly with refinements, lingual appliances were a viable adjunct to the orthodontist's armamentarium. In 1979,

Dr. Kurz selected twenty patients for detailed clinical study, and with the help of Ormco's research and development staff, design changes and improvements came rapidly.

Initial difficulties with patient comfort and archwire ligation were soon overcome. The indirect bonding procedures, an absolute necessity, were refined and, after gaining experience with an additional forty patients over a two-and-one-half year period, the following conclusions were reached by mid-1980:

1. bracket retention rates were as reliable as with properly bonded labial brackets.

2. patient comfort and acceptance after the initial adaptation period were, in most cases, as good or better than with traditional appliances, and

3. patients' speech patterns returned to near normal within a short period after bonding the appliance.

Although encouraged, Dr. Kurz and the engineers and management of Ormco realized that there were still many questions to be answered. In order to gain input from additional specialists, the Lingual Task Force was formed in December 1980. The Task Force consists of the authors of this article: Dr. C. Moody Alexander, Dr. Richard (Wick) Alexander, Dr. John Gorman, Dr. James Hilgers, Dr. Craven Kurz, Dr. Robert Scholz and Dr. John (Bob) Smith. Technical and logistical support to the Task Force is provided by Dr. Michael Schwartz and Mr. Ernie Strauch from Ormco.

The Task Force was initially charged with the responsibilities of evaluating the revised appliance design over a two-year period. Our specific objectives were:

1. to help refine bracket design (dimensions, torques, angulations, thickness, etc.),

2. to develop mechanotherapy techniques,

3. to create archwire designs,

4. to discuss treatment sequences, and

5. to determine case selection criteria.

Ormco and all of the Task Force felt strongly that the appliance should not be marketed until a workable system had been developed and tested. It was intended that, at the end of the two-year evaluation period (January 1983), the then-modified appliance and techniques would be provided to an expanded group of orthodontists for an additional two-year development and evaluation program.

Events were soon to change the plan, however. After just nine months into our Task Force evaluation program, we decided to expand the number of evaluators, because of the rapidly growing interest among orthodontists, the enthusiasm of all the Task Force members, and the significance of the advances being made. Thus, in September 1981, Ormco held the first lingual appliance educational seminar. The Task Force members and Ormco engineers shared their ideas and clinical experiences with a group of thirty-eight orthodontists, who were to help in the development of lingual orthodontics by treating cases, documenting results, and providing periodic progress reports and photographic records. This brought the total number of evaluators up to forty-five.

The circle of knowledge continued to grow, and, with increased confidence in the revised appliance design and a better understanding of treatment potential and limitations, further seminars were scheduled. The seminar program was expanded to include an additional eighty orthodontists in December 1981, and seminars in January, February, and March of 1982 brought to five hundred and fifty the total number of lingual evaluators who were involved in the development program . We found it remarkable and very stimulating that, even with prior warning of increased treatment difficulties and limitations, and foreknowledge that we had no finished cases to present, over five hundred of our peers attended these seminars in order to participate in the development program.

The purpose of the lingual seminars was to:

1. instruct the practitioners in the laboratory and clinical procedures of lingual indirect bonding;

2. explain how each bracket has to be adapted to the model and is, in essence, custom made by the manufacturer;

3. permit the Task Force to express both our enthusiasm and reservations; and

4. inform the new evaluators of the progress made and remaining work to be accomplished.

The overriding theme stressed was the developmental nature of lingual orthodontics. We don't have all the answers. Patient selection is very critical, and other limitations will be discussed later on in this article.

In discussing the history of lingual orthodontics, we should mention the contributions made by Dr. Vince Kelly, Tulsa, Oklahoma, and of his support from Unitek. Dr. Kelly has been actively working on a lingual appliance design for approximately two years. The experience gained by Dr. Kelly has made significant contributions to the profession's understanding and rapid progress in lingual orthodontics.

As of February 1982, we have over five hundred and twenty cases undergoing lingual orthodontic treatment. Of these, 60% are less than six months into treatment, 16% six months to one year, and 24% over 12 months. Very few cases have completed their entire treatment with the lingual appliance. Obviously, no one is yet in a position to give an objective, complete report. It appears, however, that many of the major obstacles have been overcome, and the remaining task of defining treatment modalities will be complete in the near future. At that time an in-depth discussion by each of the Task Force clinicians will be presented in a series of articles to be published in this journal. Therefore, only a brief overview will be discussed at this time.

The Lingual Appliance

Brackets

The brackets, in their present configuration, are composed of a hardened stainless steel with a single design, varying in width with each tooth in the arch. The brackets are brazed to a diffusion bonded foil/mesh base. The bonding base is contoured to approximate the lingual morphology of each individual tooth. Since there is such a wide variety of lingual anatomy, additional adaptation is achieved in the laboratory on a custom tooth-by-tooth basis at the time of the indirect bonding setup. Brackets have an .018" archwire slot which parallels the occlusal plane. Although wire ligatures are indicated in specific instances, elastomeric ligatures are more commonly used, due to their ease of application.

Brackets are provided with various degrees of torque, angulation, and bracket thickness (Fig. 1). These characteristics were determined after extensive study of lingual morphology, and by comparing this anatomy and tooth position to accepted standards for labial appliances.

Maxillary anterior brackets incorporate a bite plane designed into the incisal edge of the bracket (Fig. 2). The bite plane is parallel to the archwire and the occlusal plane.

All brackets have a gingival ball hook which greatly facilitates elastic ligature placement, rotation control, and placement of intra- and intermaxillary elastics (Fig. 3).

Patient selection is of the utmost importance, and patients with short clinical crowns on the maxillary anteriors present definite limitations. Maxillary incisor lingual crown heights of less than 6mm will not permit sufficient space for bonding the brackets to avoid gingival impingement and still finish with 1 to 2mm of overbite.

Mandibular bicuspids also present a limitation to lingual bonding. Frequently, the lingual cusps, even on fully erupted teeth, have less than the 4mm of crown length necessary to place the bracket. Since these lower bicuspids are not visible on most patients, they can usually be banded without losing the "invisible" aspect of the appliance. Banding of the mandibular posterior teeth, with the use of buccal segmental wires and lingual attachments, has become a common and preferred option.

The preferred mechanotherapy approach has evolved into a combination using both buccal and lingual posterior segments, with the lingual brackets alone being confined to the incisors, canines, and maxillary bicuspids. This approach will be described and illustrated in greater detail in future articles. As the mechanotherapy has improved, this arrangement--termed the "crossover technique" or "buccolingual segmental technique"--appears to offer the best features for both esthetics and anchorage control. Presently, first and second molars are banded with a terminal lingual tube welded to the first molar band. Buccal tubes are also placed on the molar bands. Some of our practitioners prefer to bond second molars on the buccal. Bonded or banded buccal brackets are occasionally placed on maxillary second bicuspids, if the patient's smile permits. In the mandible, buccal attachments on the bicuspids add considerably to the options of the buccal segmental approach and do not usually compromise esthetics. Thus, the mandibular buccal segment consists of bonded buccal brackets on the bicuspids and a banded first molar with both buccal and lingual attachments, thus providing the option of bypassing the bicuspids on the lingual, with the lingual archwire terminating in the first molar lingual tube. It has been suggested that, since many patients don't show their lower teeth in normal speech and smiling, often the entire lower arch can be treated with the clinician's choice of labial appliances.

All the members of the Task Force would like to emphasize that, at the present stage of development, there is limited experience with final detailing of the dentition. It has, therefore, been a common practice among the Task Force clinicians to advise the patients that a positioner may be required in finishing the case. Another option is to place "visible braces" during the last few months of treatment, if necessary. Patient acceptance of these concepts has been excellent.

Archwires

As mentioned previously, lingual orthodontics could not have progressed to its present state without the development of the

more resilient alloys and wires. Because of the greatly restricted lingual arch radius, interbracket distance is significantly reduced, especially in the lower anterior area. This reduction must be offset by utilizing more resilient archwires to accomplish rotational and torque control. Placement of loops becomes more difficult, but can be utilized if carefully contoured for patient comfort. The requirement for precise bracket placement becomes far more critical and, therefore, makes an indirect bonding procedure a necessity.

There is a dramatic difference in arch form with lingual treatment, and the ideal archwire takes on a mushroom shape. This is due to the large constriction in arch width that occurs as one proceeds distally from the lingual surface of the canine to the bicuspid. Since the brackets are designed to minimize bracket profiles, it is necessary to place compensating first order bends interproximally at the cuspid-bicuspid and bicuspid-molar locations (Fig. 4).

In cases with short clinical crowns, or if there is a problem with incisal clearance, a second order bend, or step-down, may also be needed between cuspids and bicuspids. To facilitate arch formation, acetate overlays providing lingual archform guides have been adapted from labial arch forms by mathematically subtracting the facial-lingual tooth dimensions and bracket base dimensions from a selected existing arch form.

Retraction in extraction cases utilizing properly contoured closing loop wires has been successful in numerous cases.

Treatment Results

While a great deal of development remains to be done, the treatment results achieved have been more than satisfactory and are most encouraging. Initial concerns about shearing brackets off the upper anterior teeth have proven to be the least of the problems encountered. Bond failures have been no greater than with labial bonding, and most difficulties are attributable to bonding technique errors rather than the forces of occlusion or orthodontic manipulation.

Patient hygiene is better than expected as the tongue seems to provide a self-cleansing effect. Invariably, the lingual brackets will collect significantly less plaque than the labial attachments on the same patient. Periodic scaling of calculus on the lower incisors is required.

Although there is an adaptation period, the patients' enthusiasm and positive attitude about the braces being invisible seem to help them overcome the problems with speech and tongue irritation. A majority of patients remark that the buccal attachments are more irritating than the lingual appliances. After a few months of treatment, the following comment was heard: "Doctor, I am sorry I missed my appointment, but I forgot that I had braces on".

On the first few patients, chairtime is frequently double that of a labial appliance, but the learning curve is indeed steep, and the office can steadily reduce appointment time. The reader must recognize, however, that lingual orthodontics is considerably more demanding of the orthodontist's time and talents and that, although improvements are sure to follow, lingual treatment is not for every patient. It has been found to be advisable to inform the patient at the consultation that this technique is still in a developmental stage, and that he should expect longer appointment times and the possibility that the entire treatment may take longer than with "outside" braces. While the first has proven true, the latter has often not. Orthopedic and dental alterations appear to be as effective as with any conventional edgewise appliance, and most cases are progressing at a similar rate.

There seem to be some tendencies inherent in this appliance which still need greater study, so that appropriate counteractive mechanics can be utilized where necessary. As an example, there is a tendency to expand arch width, if transverse dimension is not careefully controlled. Also, there is a degree of bite opening that occurs rapidly, but without observable root resorption or significant changes in the mandibular plane. Williamson has reported some interesting electromyographic studies of reduced biting force when the anterior teeth occlude on metal.[2,3] Vertical considerations must be incorporated into the treatment plan in order not to produce bite opening when it is not desirable.

The Value of Lingual Orthodontics and the Future

Thus far, this introductory status report has been directed toward the appliance. Certainly we don't need to further complicate our lives and practices with just another edgewise appliance, as challenging as this may be.

The value of "invisible braces" is not in the hardware, but perhaps best expressed by the word "invisible" There are many patients who would strongly benefit from better function, healthier periodontal tissues, and improved self-image if they had orthodontic correction. Many of these patients never consider orthodontics because of their preconceived ideas of "tinsel teeth" and "metal mouth"

The lingual appliance is no panacea; but, if patients are carefully selected, lingual braces can be a valuable addition to the contemporary orthodontist's armamentarium and provide much-needed care for that segment of the population who need our services but, up to now, would not consider any type of orthodontic correction due to esthetic concerns.

There is extreme public interest in "invisible braces", and Ormco, the Lingual Task Force, and the additional lingual evaluators

have attempted to contain the news media, because we did not feel that we should release the information until sufficient progress had been made. Our plan was to have presented finished cases with final records. However, in view of the great interest both from the public and within the profession, and to clarify rumors, we decided to present this status report and to conduct a news conference in order to present an accurate picture.

It is the intent of the authors, with the cooperation of the American Association of Orthodontists and the orthodontic industry, to keep the profession fully informed of the appliance's progress by way of articles in this journal and with seminar programs to be conducted regionally throughout the U.S.

The enthusiasm among the Task Force and the evaluators grows each day. The opportunity to assist in this development in orthodontics presents an exciting challenge. We realize, however, that the desire to share our limited experiences with you must be tempered with patience and cautious optimism. It was never our intent to come up with a lingual technique per se, but to find out whether this appliance would work with various techniques. The appliance should not dictate technique. This opportunity brings new responsibilities and liabilities. It is incumbent upon each of us to insure an ethical and professional utilization of this new resource to provide the highest quality care for our patients.

Figures

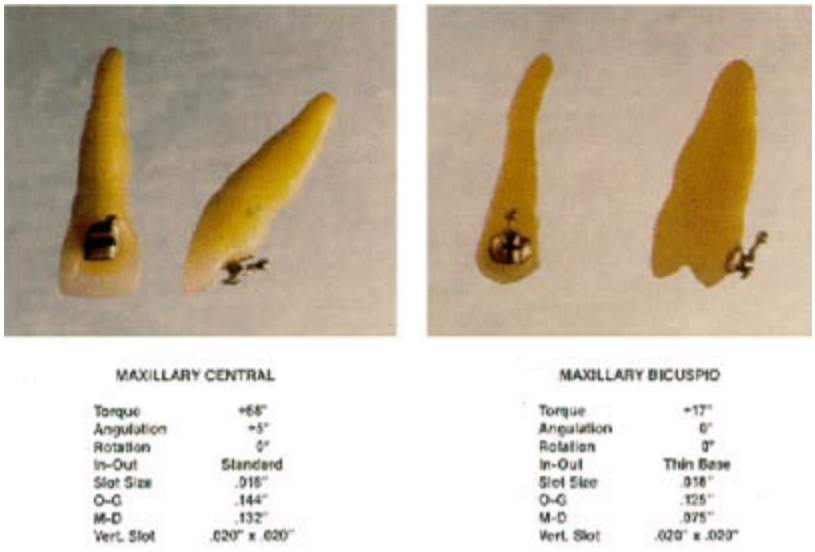

Fig. 1 Examples of bracket characteristics.

Fig. 2 Bite plane incorporated in maxillary anterior brackets.

Fig. 3 Ball hooks on all brackets facilitate elastic and elastic ligature placement.

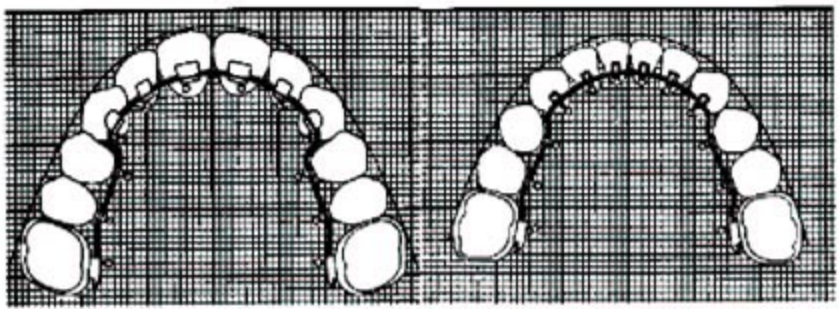

Fig. 4 Lingual arch form templates.

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2. Williamson, E.: Occlusion and T.M.J. dysfunction, Part I, J. Clin. Orthod. 15: 333-350, 1981.

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Footnotes

1. Ormco, Division of American Hospital Supply Corp., 1332 South Lone Hill Avenue, Glendora, California.