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LINGUAL ORTHODONTICS- AN OVERVIEW

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ABSTRACT

Esthetics is one of the major goals in orthodontic treatment Lingual orthodontics is the only orthodontic technique which is really invisible and permits the patient to have a beautiful smile not only after, but also during treatment and allowing a realistic control of the results.This article reviews the development, advantages and disadvantages, bonding techniques, biomechanics, and treatment procedures of the lingual appliance The aim of this article is to give a broad view of Lingual Orthodontics concepts and treatment in a simplified way, to encourage the orthodontist to use this important treatment modality regularly in their practice.

KEY WORDS: Deepbite, Indirect bonding, Light wire Technique, Lingual Bracket

INTRODUCTION

Every individual nestles a desire to have a perfect and a beautiful smile without putting their looks at jeopardy, hence lingual orthodontia has come of age as an aesthetically pleasing option. As the name suggests, the brackets are placed on the lingual/ palatal surface of teeth **(Fig. 1** and **Fig. 2)**, rendering them practically invisible. The increased affordability and even more a never ending aesthetic demand by adult patients sets the dawn for developing this recent breakthrough further.

Esthetics being the major goal in orthodontic treatment **(Table 1)**, lingual Orthodontics is the only treatment modality that does not deteriorate the physical appearance of the patient during the treatment. For the patient, Lingual Orthodontics has several obvious advantages over labial appliances. Many adults would prefer to have invisible brackets, when recommended by their clinician, as an appliance that will give them comparable results to the labial appliance treatment.

The technique has evolved since 1970 when Dr.Calvin Kurz[1] started placing brackets on lingual surfaces of patient's teeth. Initially the lingual brackets used were the same as those for the labial appliances with their bases recontoured. Kinya Fujita[2] developed the lingual light wire technique. In 1979 Ormco- Kurz[3] appliance was engineered which over the years got more and more refined thereby resuting in various generations of lingual brackets. Ormco -7th generation lingual bracket have been very popular for long but recent advances in the technique has led to the evolution of various designs of lingual brackets.

Apart from esthetics, there are also some mechanical advantages of the lingual appliance in cases of deep bite (**Fig.3** and **Fig.4**). The problem of bracket interferences due to deep bite, were addressed when an anterior bite-plane was added to the maxillary anterior brackets **(Fig 3)**. This caused an instant bite opening in deep bite cases **(Fig 5)**.

The upper anterior bite plane determines the big difference between the lingual technique and the labial one, specially when using the Kurz-Ormco 7Th generation lingual brackets.[3] These bite plane will allow the intrusion of the incisors and a limited extrusion of the molars. The bite plane can help the Orthodontist solve serious cases of deep bite with very little effort. It is important to anticipate some problems that may occur due to bite plane effect. In cases of excessive deep bite or very big overjet the positioning of the brackets on the lingual surface of the upper incisors may hinder the anterior-posterior correction of the malocclusion. The upper incisors cannot be retraced, or the lower ones advanced, as a negative anterior anchorage effect would result with the risk of closing the extraction space for mesialization of the posteriors.

The anterior bite plane effect, generally creates a posterior openbite, leading to difficulty in

mastication during the first phase (two months maximum – the duration depends on the amount of anterior deep bite). To avoid this inconvenience, occlusal built up (made of composite material) on the labial cusps of lower molars **(Fig. 6)** may be given which would be reduced in stages during treatment.[4]

Alexander et al[5] hypothesized that the vertical opening caused by the bite plane of the maxillary lingual brackets and the immediate rotation of the mandible (down and back) aggravates the class II tendency and increases the anchorage requirements. The posterior disocclusion that follows excludes the interdigitation that is a natural anchorage component. In contrast, Kurz and Bennett[6], suggested that the lingual archwire is more rigid because of their smaller arch perimeter. This configuration implies a more rigid buccal segment and anchorage enhancement during retraction of anterior teeth.

The span between two brackets placed on lingual tooth surfaces is very short because of the lingual tooth surfaces is very short because of the lingual anatomies of the teeth. In addition, because brackets are placed on the lingual side, expansion by labial tipping is difficult, which in turn makes rotation correction difficult with a flat wire alone.

Diagnosis

Diagnosis, treatment planning and case selection for lingual appliance is very important because of the different mechanics involved with the lingual appliance. There is a larger amount of anchorage available in lingual orthodontics, especially with the mandibular arch. If a lingual orthodontic case involving four first premolar extractions is diagnosed and treated in the same way as a similar labial case, less anchorage loss would occur with greater retraction of anterior teeth in the lower arch, thereby leaving the patient in a class II relationship with an excessive overjet.[7]

Diagnosis of an adult patient is different from that of an adolescent. The need for the esthetic benefits of the lingual appliance is found mostly in the adult patient. Histological changes of the bones depend on age, adult bones, being less trabeculated, have a reduced blood supply, so tooth movement is slower than in an adolescent and during orthodontic treatment, pressure applied to an adult's teeth in the dental arches will take approximately three months of tissue conditioning to produce the necessary changes in circulation to result in orthodontic movement.[4]

Class II non-extraction cases also need to be evaluated carefully before being treated, as in some of these cases, due to the presence of the anterior bite in the lingual appliance, may increase the Class II with mandibular clockwise rotation.

All these points need to be taken into consideration during the diagnostic phase of a correct treatment plan.

Extractions

Vectors of orthodontic forces applied to lingual brackets pass lingually to the center of rotation of the teeth, which increases lingual crown torque on the anterior teeth and forces the posterior teeth into an upright position. A case requiring extraction in labial orthodontics may be treated by non-extraction in lingual orthodontics. A case indicated for surgery in the labial approach may be treated non-surgically in the lingual approach[4].

In lingual orthodontics, the decision to extract first or second premolar is based on the severity of anterior crowding or midline deviation and not on the amount of anterior molar movement that can be afforded. When possible, the second premolar is preferable for extraction in lingual cases for two reasons[8]:

1. It maximizes esthetics during treatment (that is, the extraction site of the first premolar is much more visible in lingual treatment when no brackets are seen on teeth).

2. The inset bend that is present between the canine and the posterior dentition, to compensate for the buccolingual width differences of these teeth, can interfere with space closure.

However it has been claimed that second premolar extraction reduces the size of the posterior anchorage unit and increases the size of the anterior retracted unit.[9] Additionally, anchorage loss is only 0.5 mm greater with second premolar extractions when assessed from cephalometric radiographs or dental casts.[9] This difference is not significant, suggesting that the location of the premolar extraction site cannot be considered a major anchorage loss factor[10].

Fig .1 - Lingual Appliance- Anterior teeth

Fig. 2 - Lingual Appliance-Posterior teeth

Fig 3 - Bite plane effect in lingual appliance-Buccal view

Fig 4 - Bite plane in lingual appliance- Frontal view

Fig. 5. Posterior openbite due to anterior bite plane effect

Fig.6 .Composite built up

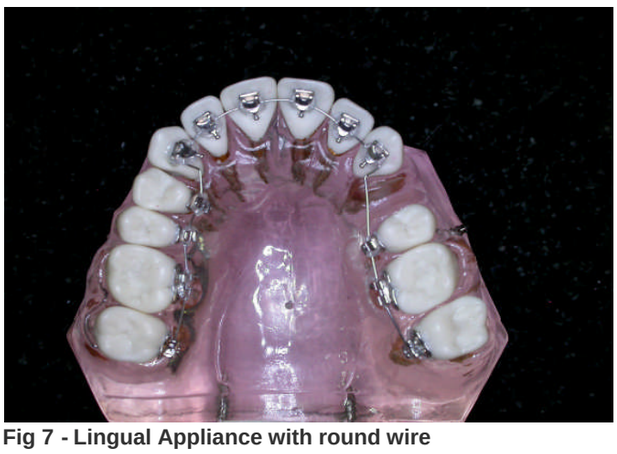

Fig 7 - Lingual Appliance with round wire

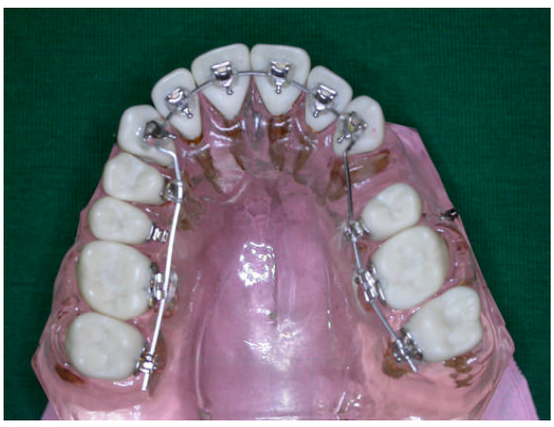

Fig 8-Lingual Appliance with rectangular wire

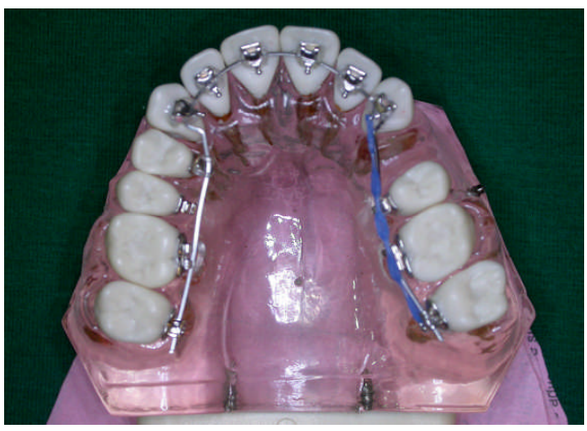

Fig 9 – En masse retraction - sliding mechanics

10 - En masse retraction- loop mechanics

Bio-mechanics

The lingual appliance just like the labial preadjusted appliance, has the tendency to incline anterior teeth forward during the leveling phase[11] due to built in tip of the anterior brackets. Bennett and Mclaughlin[12] suggest the use of "lacebacks" to avoid this proclination. The laceback is a 0.010 inch figure-8 ligature wire that extends from the most distal banded molars to the canines in all four quadrants. This technique is also effective in minimizing the forward tipping of the incisors during alignment in lingual orthodontics.[8] The mechanics of tooth movement from the lingual side has different characteristics from labial mechanics. The most significant mechanical difference between the labial and the lingual techniques is the point of force application. As the appliance is located on the lingual side, vectors of forces to the teeth are directed lingually to the center of rotation of each tooth, which puts labial root torque on anterior teeth. Consequently, anterior teeth tip lingually[13,14] in reaction to which posterior teeth become upright distally. In the horizontal plane, forces are applied that rotate posterior teeth distally. During anterior retraction and space closure, the phenomena called "vertical bowing effect" and "transverse bowing effect" occurs, causing archwires to deform three-dimensionally, which in turn causes anterior teeth to tip lingually, posterior teeth to tip mesially and the posterior bite to open. In the horizontal plane, the

inter-premolar width is expanded (flared out). The lower arch is less susceptible because of strong anchorage, but adequate care should be taken to prevent these bowing effects in the upper arch.

These adverse effects can be minimized by –

1. Adequate torque control - using 0.0175 x 0.0175 or 0.017 x 0.025 TMA wire.[4]

2. Over-torqued brackets- Kurz and Bennett[6] suggested using anterior brackets at 10 degrees over-torque, can incorporate additional torque in the maxillary anterior brackets during bracket positioning.

During space closure, the anterior teeth have a tendency to retrocline. Anderws[15] and Roth[16] suggested building extra torque into the labial preadjusted incisor brackets, and an anti-tip and anti-rotation in the canine, premolar and molar brackets. This idea was accepted by Kurz and Bennett[6] for the lingual appliance. However, the increase in tip and torque may extend the load on the posterior anchorage and reduce anchorage control.

Table 1: Advantages of Lingual Appliances

- Most aesthetic appliance system available.
- Greater acceptance of treatment by adults.
- Bite opening is faster and easier.
- True intrusion of incisors is possible.
- Risk of enamel decalcification being visible after de-bonding is avoided.
- Lesser forces are used during treatment.
- Precise visualization of profile and lip posture, without the interference of labially placed brackets.
- Acts as a reminder appliance in cases with tongue thrust habit.

Based on these principals, the lingual appliance can remain with a standard prescription, without changing the torque and tip individually from case to case. The lingual-bracket-jig (LBJ)[17], which is a precision device for direct and indirect lingual bracket positioning, concurs with this notion, ie, the same prescription is applied for all types of treatment and malocclusion, extraction and non-extraction. The LBJ prescription follows the rationale of Hilgers.[18] Bios labial bracket prescription, which presents a slight overtorque and normal tip for the anterior brackets. When extra torque is needed, it is built into the system. At treatment stages, when the torque is surplus, the wire size is reduced below the bracket tolerance. The force level should be reduced during space closure by using “lacebacks” or light elastic chains.

Retraction with a round wire **(Fig.7)** causes only the crown of anterior teeth to tip lingually producing the vertical bowing effect. To counteract this effect, anterior teeth should be retracted with a rectangular wire of sufficient rigidity, 0.017 x 0.025 TMA wire[19] **(Fig 8)**.

When considering the esthetic demands, soft tissue sensitivity, and patient compliance, the most desirable space closure mechanics in the adult patient treated with lingual appliance is sliding mechanics**(Fig.9),** with standard appliance prescription, extraction of the second premolars, and en-masse retraction of the anterior teeth[8]. Sliding mechanics is generally preferred over loop mechanics**(Fig.10)**. Adjunctive appliances, such as headgear, palatal bar, Nance’s appliance, or lip bumper, usually added to improve anchorage control, may increase soft tissue irritation and compliance demands.

The six anterior teeth are retracted as a unit in lingual orthodontic treatment, which is called En masse retraction. This method of retraction is preferred with this technique as it is more esthetically more acceptable since a space does not open between the lateral and canine. In addition, when space is available distal to the canine, the insets placed into the archwire between the canine and premolar **(Fig 8)**, which are required in lingual orthodontics, do not get in the way during retraction[20].

Light wires are preferred for detailing and finishing[4] as rigid rectangular wire with precise bends to correct individual tooth positions is difficult to engage into bracket slots and ligate securely due to short inter-bracket spans. Such wires also apply excessive forces and incorrect torque to teeth. Light wires should therefore be used to allow physiological tooth movement during detailing.

Anchorage

Cortical bone anchorage is established when roots approach the cortical bone. Cortical anchorage is increased in lingual orthodontics, compared to labial mechanics[13] particularly in the lower arch, which has thicker cortical bone than the upper arch. This finding refers to the cortical bone anchorage produced during space closure and the application of a mesial force on the molar. This force system produces mesiobuccal rotation of the crown, adjunct with labial root torque. This response is accentuated when using loop mechanics compared to sliding mechanics[14]. However loop mechanics in lingual technique are more difficult because of the bending complexity of the 3-dimentional wires and possible tongue irritation. Since adult patients have greater sensitivity, it is not surprising that most clinicians favor sliding mechanics over loop mechanics in lingual orthodontics[8].

Anchorage control in the vertical plane- The lingual appliance has the tendency to extrude the incisors at the initial leveling stage[21,22], due to built in torque and the use of rectangular wires for alignment and leveling. In cases of deep bite, anterior vertical control is provided by mandibular incisor contact on the built-in bite plane of the anterior brackets. For open bite, in which there is no contact, incisor extrusion is a favorable effect, contributing to the correction of open bite[22]. When molar and premolar vertical control is needed in skeletal high-angle cases, to prevent molar extrusion and further opening of the mandibular plane angle, posterior occlusal stop or bite plate can be used.

Anchorage control in lateral plane- The lingual appliance has a tendency for mesio-buccal rotation of the molars. The molar bracket should not be positioned at the center of the palatal surface, but off center, more mesially. The mesial location, with mesial inclination position of the molar bracket, accomplishes sagittal and lateral anchorage control during initial treatment stages. The buccal groove is the reference for correct maxillary molar bracket inclination, which shows a 5-degree angulation to the occlusal plane[21].

There are some inherent shortcomings of the lingual appliance **(Table 2)** over the labial appliance. Treatment is done under indirect vision and so more chair side time is required.

Speech and hygiene considerations

There may be associated initial speech problems after the bonding of the lingual appliance. Pronunciation problems, caused by an obstruction to the tongue because of the appliance, are more emphasized in patients with narrow arches. In some cases there may be some soreness and swelling of the tongue. During the initial phase of therapy, it may be useful to cover the appliance with orthodontic wax or silicone in order to make the patient feel more comfortable [23].

The lingual orthodontic patients have a significant increase in salivary flow rate, decreasing the risk of caries during treatment. Problems of hygiene are rather subjective and depend especially on the care taken by the patient. The clinical length of the crown is a very important factor when considering the hygiene. The brackets must be positioned at least 1 mm away from the gingiva, to allow the removal of excess composite and maintenance of oral hygiene. An extremely short clinical crown, frequent in the lower arch, may be an absolute contraindication for lingual technique.

Table 2: Disadvantages of Lingual Appliances

- Treatment needs to be done under indirect vision.
- Speech might be distorted initially.
- Treatment not possible if lingual crown height is less.
- Chair side time is greatly increased.
- Lab backup is essential
- Expensive technique
- Expertise skills required.

Lab Procedures

The wide variation in lingual contour of the teeth does not allow the accurate formation of bracket prescription, hence “one fits all” does not hold true with the lingual technique. With this technique the precise location of bracket is very important as a slight change in the occluso-gingival placement can produce a large change in the root torque values. If lingual brackets are directly bonded, it would be difficult to visualize and accurately position the brackets. Therefore indirect bonding technique along with a lab backup is a must to achieve

precision required in this technique. Having recognized the need for greater accuracy in indirect bonding techniques, many lingual practitioners have sought to incorporate laboratory procedures, which play a vital role in the success of this technique[23]. Conventional indirect bonding systems using silicone trays are associated with the following problems:

- Laboratory procedures are so complicated that accurate bracket positioning is difficult.
- Bonding trays are flexible and easily distorted when transferred to the mouth.

If a neighboring teeth drift after tooth extraction, trays will no longer fit and must be remade. The Hiro system (Using individual tooth trays made of a hard material) is the optimal indirect bonding system that allows accurate bracket positioning. With this system, trays are fabricated for individual teeth so that a bracket can be bonded to each tooth without being affected by neighboring teeth. In this way the accuracy of bracket positioning is increased several folds. Adjustments to bracket positions such as to torque and bracket height can be made only for those teeth that need correction. Brackets can be rebonded easily and quickly to ideal positions using cores, which can be prepared easily.

Retention

Special consideration should be given to retention since most lingual orthodontic patients are adults. Retention in adult patients has the following characteristics-

- Adult patients are esthetically more demanding and would not prefer visible retainers.
- Many adult patients have dental problems such as gingival recession, occlusal wear, poor restorations and missing teeth, requiring dental procedures during retention.
- Adult patients have limited time to wear retainers owing to social restrictions

Ideally, the use of retainers should be started on the day braces are removed. Clear retainers can be placed on the same day, following debonding. It is very important to fully explain the importance of retainers, proper handling and regular check-ups to patient.

Bonded lingual retainers are also used in cases where permanent retention is required or in a patient with reduced periodontal support.

Self Ligating Lingual Brackets

The lingual technique is more difficult than the labial technique because of several reasons, the difficulties in accurate bracket positioning, the discomfort to the patients and the mechanical difficulties. The small arch and small inter-bracket distance in the lingual technique reduce the appliance efficiency. Torque and the rotations are more difficult to control. Wire bending in a short interbracket distance is more difficult.

A common problem with horizontal slot lingual brackets is the difficulty in obtaining complete archwire engagement and the tendency for the archwire to be pulled out of the bracket slot. A ligation method termed the double-over tie is used with both metal and elastic ligatures to improve the ability to eliminate rotations and maintain archwire engagement throughout treatment[5]. This type of ligation increases frictional resistance; and is time consuming. Changing the elastic ligature is required frequently throughout treatment for oral hygiene purpose and because of force decay of the elastics. If a steel overtie ligation is used instead of elastic modulus, friction is reduced and wire engagement is improved, but it significantly increases chair side time, and it may occasionally be displaced between appointments and cause discomfort to the patient and soft tissue trauma, leading to more emergency appointments

.

The self ligating brackets have some important benefits that can contribute to the efficiency of Lingual Orthodontic treatment. Very low friction with self-ligating brackets has been clearly demonstrated and quantified in works by various authors[24]. With low friction the net tooth-moving forces are more predictably low and the reciprocal forces correspondingly smaller, leading to better anchorage control. Secure, full archwire engagement maximizes the potential long range of

action of low elasticity modulus wires and enables precise control on rotation, tip and torque. Activation range is increased and fewer appointments are needed for activation.[25,26]

The main benefits of the self ligating brackets is improved clinical efficiency and time saving. Arch wire replacement is quicker and easier. Several works demonstrated a significant reduction in ligation time with labial self ligating brackets compared to wire ligation of conventional brackets[24,26,27]. Clinical time is reduced also because there is no need to change the ligatures every appointment for hygienic purpose.

Lingual Straight- Wire Technique

Most clinical cases treated with conventional lingual brackets require so called mushroom arches[28] with insets between the canine and premolar and between premolar and molar. Many of them also need vertical steps between the canine and premolar. These have to be placed because of lingual crown anatomy, but result in cumbersome wire-bending making consistent arch forming in lingual orthodontics problematic.

Variations in the wire-bending skills of the operators can be reduced with the use of straight archwires and there is no variation in the amount of insets associated with archwire changes. Preformed archwires can be used to minimize or eliminate the need for wire-bending and thus save time on wire bending. Sliding mechanics can be simplified, with no inset bend between the canine and premolar.

Lingual Light wire Technique

This involves the use of Begg brackets on the lingual side of the teeth. As with any technique there are advantages as well as disadvantages. The main advantages are, the small bracket size which maximizes the inter-bracket distance and the minimal friction between archwire and bracket which allows tooth movement under the influence of very light forces. The main disadvantage is lack of torque control, which plays a very important role in this technique, as the incisors have a tendency to retrocline during retraction with the lingual appliance. Therefore it is necessary to incorporate auxiliary springs to carry out the necessary root movements.

STb (SCUZZO-TAKEMOTO bracket) AND LIGHT LINGUAL PHILOSOPHY

The Light Lingual philosophy with the STb (Scuzzo Takemoto bracket) came to life[29] with the spirit to improve the quality and comfort of orthodontic treatment for the lingual patients, with maximum occlusal aims, functional and aesthetic, without interfering with the private life of the patient.

The STb is a lingual bracket **(Fig 11 and Fig.12)** is so comfortable that it lets the patient forget about wearing the appliance, not only while looking in the mirror but also during speaking or brushing. The Light Lingual philosophy is based on 3 fundamental points [29]:

1. *Less Lab Procedures* - Apart from improving the orthodontic life of the patient, these brackets also improve the orthodontist's life, simplifying as much as possible the sophisticated and expensive laboratory procedures. STb does not need a lab set-up in non-extraction cases which
2. can be managed by the Orthodontist thereby, reducing time, work and costs.
3. *Low Friction* - The STb lingual bracket is an exclusive bracket design characterized by a friction free system and a low friction system which increases with arch-wire size.
4. *Low Forces*- The use of very light arch-wires (.010/.012 NiTi), which express biological forces bring about physiological orthodontic movements and minimizes patient discomfort. The low force mechanics makes this appliance reliable not only from a biomechanical but also from a biological point of view.

The appliance is completely aesthetic and invisible, does not require any patient compliance. Its reduced dimension together with its special rounded design, makes it unique from all other lingual brackets for its comfort and easy hygiene maintenance. Clinical studies have evidenced very low and irrelevant speech problems just after the

bracket has been mounted, which disappear completely after a few days[29]. The new STb bracket used with the " Light Lingual system " (gentle forces), finally unite in lingual orthodontic treatment the maximum aesthetics and maximum comfort and reduces treatment duration significantly.

CONCLUSION

Today we are at the crossroad where in a lot of confusion prevails, both in the minds of the patient and the doctor, regarding the lingual technique and its execution.

During the last few years the lingual technique has evolved, simplified and got decoded allowing an easier approach for the Orthodontists to adopt it in their practice. It not only caters to achieve facial balance, but also a balance between esthetical treatment, functionality and patients aspiration.

With lingual technique there are no limits to the solution of any kind of malocclusion whether dental or skeletal with a high percentage of success[6]. It needs wider diffusion and should become part of every orthodontist's cultural baggage.

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