



REVIEW ARTICLE

SHOW YOUR SMILE ...NOT BRACES - LINGUAL ORTHODONTICS

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ABSTRACT

Esthetics is prime consideration of adult patients. An adult patient has a negative reaction toward the conventional fixed orthodontic appliances mainly due to esthetic reasons. Lingual Orthodontics has become an alternative treatment technique for those patients who would like to have beautiful smiles but are more concerned about unsightly labial brackets. Lingual Orthodontics as a multibracket appliance began in the 1970s. It was started in Japan by Fujita K. This article reviews the historical perspective, development of lingual brackets and recent advances of lingual brackets.

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INTRODUCTION

Eliakim Mizrahi (2006) once rightly said that nothing stays the same in life. In this age of self improvement with its emphasis on health, there has been an explosion of interest in exercise regime, diet and nutrition, as well as realization that personal appearance has much to do with professional success. Everything changes with time, and so it is with Orthodontics. As far as mechanical techniques are concerned, over the last decade, orthodontists have been in a comfort zone. We have had at our disposal the most remarkable sophisticated wires, high quality brackets and clinically proven reliable bonding materials.¹ As the number of adults seeking orthodontic treatment has increased, the demand for esthetic brackets is also on the rise. Many individuals would like to have the benefits offered by esthetic orthodontic treatment because they do not want an appliance that is visible to their friends and colleagues. Lingual Orthodontics has become an alternative treatment technique for those patients who would like to have beautiful smiles but are more concerned about unsightly labial brackets. Some adult patients display a negative reaction toward the esthetics of conventional fixed orthodontic appliances. Such patients become uncooperative towards

treatment and there is a breakdown in communication between patient and the treating doctor. For the benefit of the patient, lingual appliances have several clear-cut advantages over labial appliances; the foremost being esthetics.

Historical perspective

In 1726, Pierre Fauchard suggested the possibility of using appliances on the lingual surfaces of teeth. (Walter, 1981) In 1841, Pierre Joachim Lefoulon designed the first lingual arch for expansion and alignment of the teeth. (Siciliani and Terranova, 2001) Since the era of Sir Edward Hartley Angle, numerous orthodontists such as the Mershon (lingual arch), Goshgarian (transpalatal bar), Ricketts (Quad-Helix) and Wilson (3D Modular Enhanced Orthodontics) have combined active labial appliances with lingual appliances. (Fujita, 1978; Fujita, 1979) Lingual Orthodontics, as we understand it today; as a full, multibracket appliance; began in the 1970s. Curiously, the lingual appliance was not the consequence of an esthetic demand. It was started in Japan by Fujita (1982, 1994) Who would have thought when Fujita K placed orthodontic brackets on the lingual surfaces of his patient's teeth; not for esthetic reasons but to avoid trauma to the lips and cheeks from the physical contact encountered during martial arts activities; that this would spawn the discipline of lingual orthodontics. (Echarri, 2006; Huang and Lin Li, 2013) The Fujita bracket had three slots occlusal, horizontal, and vertical. (Buckley, 2012)

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Craven Kurz started his investigations with Jim Mulick in 1975(UCLA School of Dentistry), using plastic brackets bonded to the lingual tooth surfaces. (Buckley, 2012) In 1976, research and development on a non edgewise 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. (Echarri, 2006; Huang Yu and Lin Li, 2013)

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. Ormco founded a "Lingual Task Force" comprising Craven Kurz (Beverly Hills, CA), Jack Gorman (Marion, IN), Bob Smith (Stanford, FL), "Wick" Alexander and "Moody" Alexander (Dallas, TX), James Hilgers (Mission Viejo, CA) and Bob Scholz (Alameda, CA), and administrators Floyd Pickrel, Ernie Strauch, and Michael Swartz. (Echarri, 2006) This group held teaching seminars from 1981 to 1983. The Task Force was initially charged with the responsibilities of evaluating the revised appliance design over a two-year period. 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.

Major Milestones in History of Lingual Orthodontics

1889	Lingual removable arch by John Farrar
1918	Removable Lingual arch by John Mershon
1922	Merchon's presentation on labial and lingual arches with F-spring
1942	Labio lingual appliance by Dr. Oren Olives
Mid 50's	Dr. William Wilson demonstrates labio - loop lingual appliance
1975	Dr. Kurz - lingual bonded edge wise appliance
1976	Jim Wildman - Non edge wise lingual appliance
1979	Dr. Fujita K - Lingual edge wise prototype
1979	Dr. Fujita K - Lingual bracket design and Mushroom shaped arch wires
1980	Lingual Task force
1981	Ormco held first seminar
1982	Dr. Stephen Paige - Lingual Begg appliance

Development of lingual bracket

The initial lingual appliance used a custom modified labial appliance bonded to the lingual surface. Tip and torque angulations were not ideal in this appliance. A similar philosophy was used to design the Kurz Lingual Appliance. A site was selected on the lingual surface of each tooth. It was consecutively transferred from the lingual first molar, as high as it could go, without missing the rounded lingual anatomy. Reciprocal tip and torque values to Andrew's published values were used to establish the prescription. There was no grand procedure used in obtaining the reciprocal lingual reference of angles with regard to Andrew's published values. It was a

simple matter of mathematically milling a hundred molds to a constant labial vertical. As with all appliances, accurate contour of base pads improves not only retentive capabilities but also the accuracy of bracket placement and, therefore, the quality of treatment. Topographic maps were constructed for each tooth and individual bracket base curvatures were calculated (Figure 1).

Bracket design

Early developments of lingual appliances were largely modifications of existing labial appliances. However, the lingual topography and arch form is significantly different from the labial. The straight wire concept that works well on the labial aspect does not necessarily hold well in the lingual environment. Lingual bracket and lingual arch wire designs have been continually modified to develop a solution for the special demands of lingual orthodontics; a system that would make treatment from the lingual aspect as simple, efficient and precise as treatment from the labial aspect.

Bracket Design Criteria

The initial criteria:

1. To ultimately offer the same degree of control as is obtainable with conventional fixed appliances.
2. To develop a smooth low profile appliance with minimal interference with soft tissue for patient comfort.
3. To develop a lingual appliance with the least deviation from familiar well established labial edgewise appliances, if possible, with a straight wire approach. (Walter, 1981)

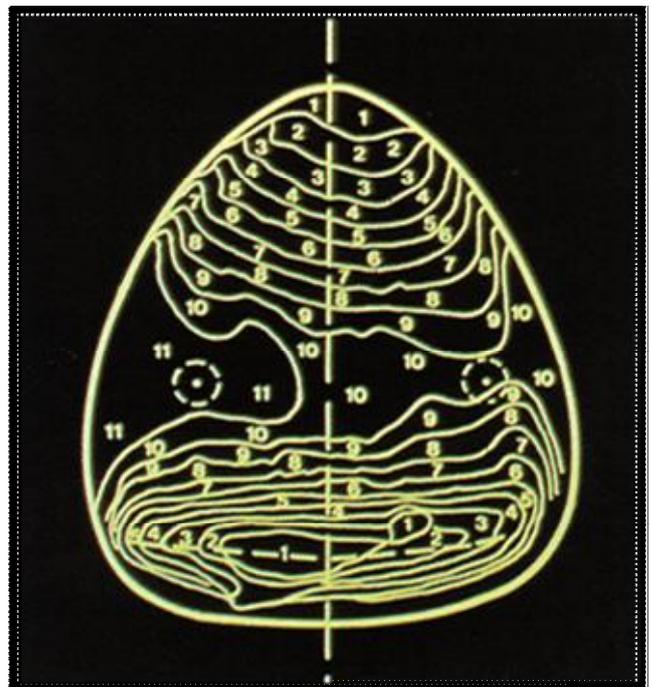


Figure 1. Topographical illustration used to study the lingual dental anatomy for the purpose of construction of lingual appliances bases



Figure 2. First Generation Lingual Brackets

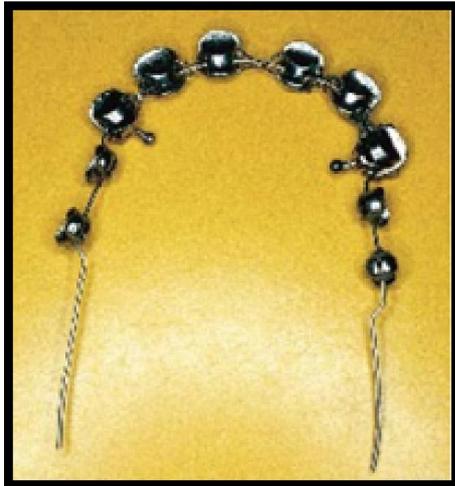


Figure 3. Second Generation Lingual Brackets



Figure 4. Third Generation Lingual Brackets

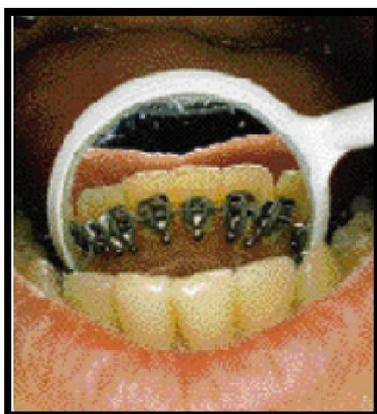


Figure 5. Fourth Generation Lingual Brackets

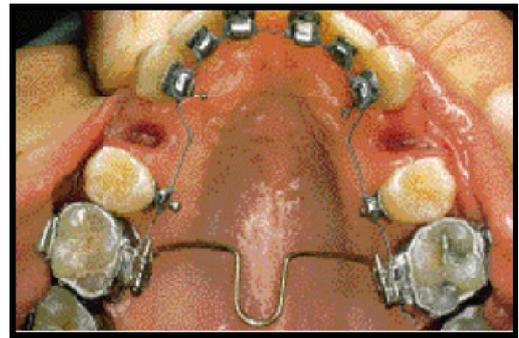
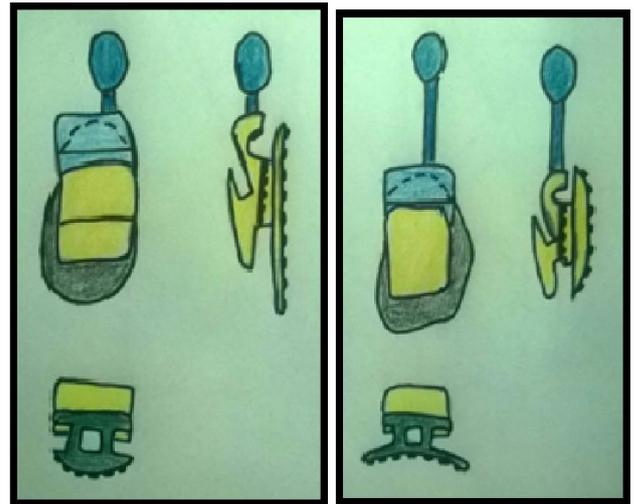


Figure 6. Fifth Generation Lingual Brackets



Upper Central

Upper Central

Figure 6. Fifth Generation Lingual Brackets

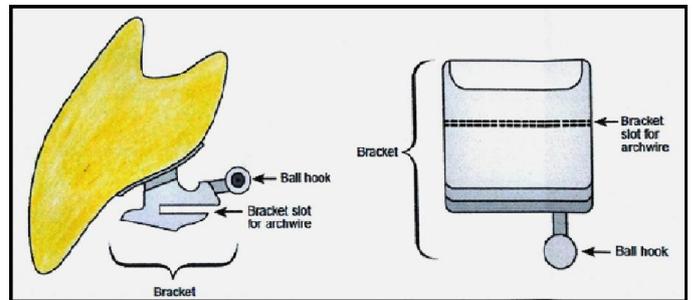


Figure 8. Sixth Generation Lingual Brackets. Anterior Inclined plane became flat

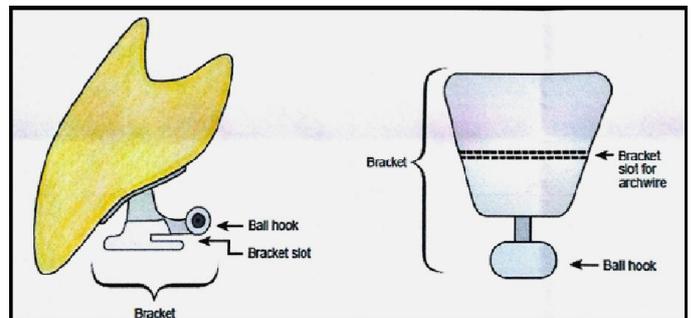


Figure 9. Seventh Generation Lingual Brackets. Inclined plane became heart shaped

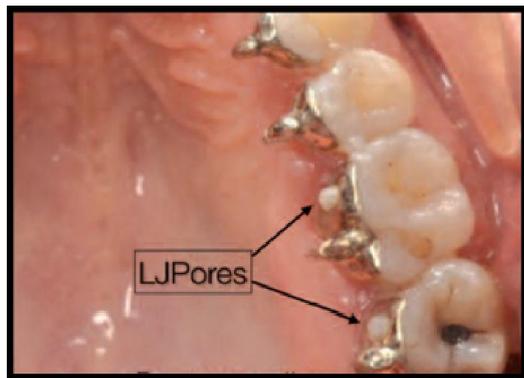


Figure 10. Lingual-Jet (LJ) Brackets

History of lingual brackets

1. First generation lingual brackets (1976) - The first generation brackets included a bite plane and rounded margins, hooks were absent and the brackets were large. The advantages of the bite plane included opening the bite anteriorly with possible repositioning of the mandible, extrusion of the molars, intrusion of incisors and facilitating any expansion and mesiodistal movement of molars uninhibited by occlusal forces (Figure 2).

2. Second generation lingual brackets (1980) - In the second generation brackets, hooks were added to the canine brackets (Figure 3).

3. Third generation lingual brackets (1981) - In the third generation brackets, hooks were added to all brackets and to the molar tubes as well (Figure 4).

4. Fourth generation lingual brackets (1982-1984) - The fourth generation brackets included a lower profile facilitating insertion of the archwire. A low profile anterior inclined plane on the central and lateral incisor brackets was present as the hooks were optional (Figure 5).

5. Fifth generation lingual brackets (1985-1986) - The fifth generation brackets had more pronounced bite plane, the torque was increased and the molar brackets included an accessory tube for transpalatal bar (Figure 6, 7).

6. Sixth Generation Lingual Bracket (1987-1990) - For the sixth generation brackets, the hooks were elongated, the transpalatal bar attachment was optional and the hinge cap tube for the second molar was developed (Figure 8).

7. Seventh Generation Lingual Bracket (1990 - present) - For the seventh generation brackets, the square bite plane became rhomboid shaped, increasing the interbracket distance and the premolar brackets were widened mesiodistally for better rotational control (Figure 9).

Recent advances

The biggest changes in technical aspects of lingual orthodontics include development of patient and orthodontist

friendly lingual treatment system with new appliances and digital technology for computerized treatment plan modeling and wire bending. Lingual orthodontics is no longer difficult nor a complicated technique. (Magali *et al.*, 2005)

1. I brace (Incognito)

Lingual orthodontics has advanced to a highly sophisticated level where CAD/CAM (computer-aided design/computer-aided manufacture) technology is employed to manufacture both the brackets and arch wires for each patient individually in the Incognito appliance system. (Stuart, 2006) State-of-the-art Rapid Prototyping technology is used for the actual manufacturing of the lingual brackets.

1. Each bracket body is designed independent of the bracket base, on which it is optimally positioned. Filler spaces such as those occurring in the individualized positioning of prefabricated brackets can, thus, be avoided. This also makes the lingual appliance decidedly more favorable for good oral hygiene.
2. The fact that the archwire runs parallel to the tooth surface gives it its characteristic platform shape in the anterior segment. The actual bracket body can consequently be much more delicately shaped. The resulting archwire morphology differs substantially from the previous customary design. Such archwires can be precision manufactured using the bending robot.
3. Maxillary bite plateaus are used selectively, only in cases of deep bite and even then, only in the canine region. (Beyling *et al.*, 2013)

Other Advantages (Scuzzo and Takemoto, 2004)

1. Another advantage of the new INCOGNITO Bracket System is the vertical slot. By making use of it, corrective derotation of teeth can be performed along the archwire even without the additional application of lasso elastics. The ligation itself is performed with so-called German Overties (GOT). In the ligation process, the archwire is clearly deflected, thus, contributing in addition to enlargement of the dental arch. This procedure is increasingly superseding more complex mechanics such as the frequently used advancement stops.
2. Furthermore, the modular bracket structure of the new system allows the single components (base, bracket body, hook) to be positioned independent of one another, thus, differing markedly from previous systems. Even in cases of rotated teeth and short clinical crowns, the available enamel area of the tooth can be optimally utilized.
3. Manufacturing the new bracket system by a Rapid Prototyping technique gives it great flexibility. Each individual bracket series can be adapted not only to the patient but also to the orthodontist. In addition, clinically promising modifications and further developments can be implemented immediately with minimum resource input and without involving any changes in the production process.

4. As the brackets are made of an alloy with a high gold content, they offer an alternative especially for patients who are allergic to nickel.
5. The production costs are comparable with those involved in the manufacture and laboratory positioning of existing systems.
6. They have also been shown to reduce the enamel decalcification risk during comprehensive orthodontic treatment. (Massimo Ronchin, 1998)

2. The 2D and 3D lingual-brackets

Frostadent lingual brackets (1998) are available as 2D-brackets for treating less complex and 3D-brackets for complex cases. They have an extremely low profile and are barely noticeable for the patient. The 2D and 3D lingual-brackets are easy to use self ligating brackets with a vertical slot for fast and easy archwire insertion.

2D-Lingual brackets:

The 2D – lingual brackets are ideally suited for clinicians who would like to gain experience in lingual orthodontics treating less complex cases. Because of the unique bracket design, no large inventory is required, therefore, helping to control the cost. The 2D Philippe lingual bracket system is a cost effective way to introduce lingual orthodontics in any practice. (Georg, 1998)

3. Straight Wire Lingual Bracket

Takemoto and Scuzzo in 2001 found that the bucco-lingual distances at the gingival margins do not vary substantially. This led them to conclude that straight archwires could be used in lingual orthodontics if they were placed as close to the gingival margin as possible (Georg, 1998). Compared to other lingual brackets, archwire insertion in this design is from the top instead of the bottom.

4. The Evolution of SLT bracket

Dr. Hatto Loidl, an Orthodontist from Berlin, Germany and Mr. Claus Schendell, owner and engineer of Adenta GmbH, together designed a *new self-ligating lingual bracket* and modified HIRO system to form the Evolution SLT bracket system. Thus, eliminating the old lingual system's disadvantages and producing a lingual technique with individual transfer caps that can be fabricated easily without the use of costly equipment using Smart Jig technology. The Smart Jig eliminates the need for indirect bonding trays and simplifies the lingual technique system.

5. STb Social 6 Bracket

STb Social 6 delivers consistent high-quality results for routine anterior crowding or spacing in as little as 6 weeks. Any orthodontist can quickly master STb Social 6 treatment with or without prior lingual experience. For patients motivated to correct minor to moderate crowding or spacing issues affecting the social six, STb Social 6 represents an excellent alternative. This method delivers outstanding results, with treatment time

typically ranging from 6 to 16 weeks. (Macchi *et al.*, 2002) Brackets feature a 1.5 mm profile and rounded contours that are clinically proven to reduce lingual interference and minimize speech issues. (Macchi *et al.*, 2002) STb Social 6 is easy to learn and use even for practitioners without lingual experience. A simple two wire sequence quickly unravels and aligns teeth.

6. In-ovation- I bracket

The small dimension of these brackets provides better patient comfort and provides greater interbracket distance. It can be placed in the deepest portion of the lingual fossa for better adapting to the anatomical contours. In particular, the forked design built in to the base allows the base pad to be easily bent to fit the complicated lingual shape of the cuspid securely. It had a self ligating clip that remains interactive and in stage of constant activation, this eliminates the need to change ligature ties during office visits. (Navarro *et al.*, 2006)

7. Kelly bracket (unitek): horizontal insertion bracket

This bracket is best in controlling rotations since it is twin with two actual contact points between the bracket and wire. It is a labial Unitek bracket adapted as a lingual one and not related to any special technique. (Vasumurthy and Saritha, 2009)

8. Philippe self ligating lingual brackets

It can be directly bonded to the lingual tooth surface because they do not have slots, only 1st and 2nd order movements are possible. Four types are available as a standard medium twin (regular use), a narrow single wing bracket for lower incisors, a large twin and a three wing bracket for attachment of intermaxillary elastics and application of 3rd order movements. (Vasumurthy and Saritha, 2009)

9. Lingualjet bracket (Ij bracket)

In 2009, Lingualjet introduced an appliance that is created in every step of its construction and application, by computer programs (Figure 10).

Following are the special features of lingualjet technique:

i. A numerical set-up

A set-up of the final positioning of the teeth is generated after obtaining 3D information of the dental arches.

ii. A custom made bracket

The brackets are manufactured utilizing CAD/CAM (computer-aided design/ computer-aided manufacture) technology. 3D software is used to design each individual bracket. Features include low profiles, smooth contours and special pad surface design.

iii. A flat archwire

The archwire has a standard shape and is adjusted to fit exactly in the center of the arch slots. The archwire is fixed to one

plane and results in a very precise and accurate straight wire system.

iv. 3D Imaging

The patient's facial details can be captured via CT Scan or Cone Beam technology. A 3D image report utilizing individualized parameters can then be generated. Lingualjet bracket base increase the efficacy of their bonding due to presence of LJ pores that improve retention by leaving extruded composite buttons and facilitate better polymerization of the bonding agent by letting light penetrate to the bracket base. (Baron and Gualano, 2012)

Conclusion

Aesthetic concerns were initially responsible for the development of this appliance system and they continue to remain at the forefront for adult patients seeking orthodontic treatment. Appearance is undoubtedly the most important motivating factor for adults whether it is termed "facial appearance", "dental appearance", or "straight teeth". With the advent of lingual orthodontic treatment, an alternative is available to the adult patient who preferred to avoid the unaesthetic appearances of conventional orthodontic appliances.

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