

**LINGUAL ORTHODONTICS – A REVIEW****Shreyadri Kashyap<sup>a</sup> , Sujit Panda<sup>b</sup> , Karuna Singh Sawhny<sup>c</sup> , Zeba Siddiqui<sup>d</sup>**

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**ABSTRACT-**

Today, achieving appropriate facial balance is the primary goal, and orthodontic treatment has developed to balance the patient's preferences with functional and structural balance (Jackson's Triad) and aesthetic therapy.

According to contemporary orthodontic theory, it is a mistake to adhere strictly to skeletal orthodontic treatment plans. As technology has advanced, the lingual technique has grown more sophisticated and pleasant, and it can produce outcomes that are comparable to the best of traditional labial treatments.

**Keywords**

Lingual orthodontic, Lingual bonding, Mechanotherapy.

**INTRODUCTION-**

Achieving treatment excellence with a comfortable and aesthetically pleasing appliance is one of orthodontics' greatest problems.<sup>1</sup> It also offers the best choice for comprehensive treatment of the majority of malocclusions from an aesthetic standpoint.

People are more confident and encouraged to establish personal connections when they have a pleasing appearance. Since first encounter is typically visual, it also facilitates interpersonal relationships. Being attractive is usually advantageous, especially in adult relationships. People are more likely to think well of someone who looks well.<sup>2</sup> These patients are unable to accept "visible braces" due to their social and professional liabilities.

Nowadays, achieving good facial equilibrium is the primary goal, and the evolution of orthodontic treatment strikes a balance between practicality and aesthetics.

Currently, lingual orthodontics is a comprehensive system that includes precise diagnosis, treatment plans, and lab and clinical operations. The history of lingual technique has not been an easy one.

When the lingual method made its clinical debut, there was initially a period of ecstasy, which was followed by a period of rejection and frustration.

The majority of the problems with refusal lingual application have been resolved because of the hard work of a few committed therapists. We are currently in a time of renewal, lingual method has gotten more complex and pleasant, and it can produce the same outcomes as the best traditional labial treatments.<sup>3</sup>

## Evolution of Lingual Brackets

Two distinct researchers presented two bracket designs in the early days of lingual mechanotherapy.

- **Dr. Craven Kurz's Contribution:** Working with engineers at Ormco, Dr. Kurz developed brackets with a horizontal slot. His goal was to replicate the control achieved with traditional fixed appliances, while creating a more comfortable, low-profile option for patients. The objective was to minimize soft tissue irritation and to align with the principles of labial edgewise and, ideally, the straight-wire technique.<sup>4</sup>
- **Dr. Fujita's Contribution:** Dr. Fujita introduced brackets with an occlusal slot, which likely offered a different approach in terms of appliance mechanics. This design choice was probably aimed at improving the fit or the functional mechanics of the brackets when placed on the lingual surfaces of the teeth

The designs of these early lingual brackets set the foundation for the development of more advanced and refined appliances in orthodontics. The focus was on achieving effective tooth control while ensuring patient comfort, a challenge in the early days of lingual orthodontic treatment.

Dr. C. Kurz and his team at Ormco Company have developed seven versions of lingual brackets.<sup>5</sup>

### First Generation (1976)<sup>20</sup>

- **Features:** Bite plane with rounded margins, large brackets.
- **Advantages:**
  - Aids in anterior bite opening, allowing mesiodistal movement or expansion.
  - Promotes molar extrusion and incisor intrusion.

### Second Generation (1980)<sup>20</sup>

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- **Feature:** Hooks added to canine brackets.

## Third Generation (1981)<sup>20</sup>

- **Features:**
  - Hooks added to all brackets.
  - An intraoral hook incorporated into the first molar tube.
  - The second molar featured a terminal sheath without a hook.

## Fourth Generation (1982-1984)<sup>20</sup>

- **Features:**
  - Low-profile brackets for improved comfort and aesthetics.
  - Optional hooks available for customization.

## Fifth Generation (1985-1986)<sup>20</sup>

- **Features:**
  - More pronounced bite plane.
  - Increased torque on maxillary anterior teeth.
  - Molar brackets equipped with accessory tubes for transpalatal arch integration.

## Sixth Generation (1987-1990)<sup>20</sup>

- **Features:**
  - Elongated hooks for improved functionality.
  - Option for transpalatal arch (TPA) attachment.
  - Hinge cap tube introduced for the second molar.

## Seventh Generation (1990–Present)<sup>20</sup>

- **Feature:** Rhomboid-shaped bite plane.

## Fujita's Lingual Bracket System

Dr. Kinya Fujita developed a bracket system in 1979 with two primary objectives<sup>21</sup>

1. **Enhancing aesthetics.**
2. **Minimizing trauma during physical activities.**

### Key Features:

- The bracket slot was positioned on the occlusal surface, facilitating easier wire placement.

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- This design also helped prevent wire deformation during insertion.
- Mesiodistal grooves (parallel to the wire) were incorporated for lock pin insertion.
- An auxiliary groove in the occlusogingival direction aided in correcting mesiodistal tipping.

## Current Fujita System:

- **Anterior and premolar brackets** feature **three slots**: occlusal, lingual, and vertical.
- **Molar brackets** include **five slots**: one occlusal, two lingual, and two vertical.<sup>2</sup>

## Bracket Systems

Over time, various lingual brackets have been designed and modified to enhance patient comfort, improve mechanical efficiency, and ensure precise tooth positioning .<sup>21</sup>

### Types of Lingual Brackets:

1. **Conceal (Thomas Creekmore)** – One of the early lingual bracket designs.<sup>6,7</sup>
2. **STb (Scuzzo-Takemoto Bracket)** – Developed by Dr. Scuzzo and Dr. Takemoto, marketed by ORMCO.<sup>6,8</sup>
3. **Forestadent** – Available in:
  - **2D brackets** for less complex treatments.
  - **3D brackets** for more complicated cases.<sup>9</sup>
4. **Stealth Brackets** – Feature small dimensions and increased inter-bracket distance for better patient comfort.<sup>9</sup>
5. **Philippe Lingual Brackets (Self-Ligating)** – Allow only first- and second-order movements; directly bonded to the lingual tooth surface without slots.<sup>10</sup>
6. **Kelly Bracket (UNITEK) – Horizontal Insertion Bracket** – Offers two points of contact between the bracket and wire for optimal rotational control.<sup>8</sup>
7. **Adenta Brackets (1999)** – Inspired by the self-ligating TIME Bracket, developed by Dr. Hatto Loidl in collaboration with Adenta GmbH.<sup>8</sup>
8. **In-Ovation L Bracket** – Small-sized with greater inter-bracket distance for improved patient compliance; designed to fit the deepest part of the lingual fossa.
9. **iBraces (Incognito)** – Low-profile, comfortable for patients, and ensures precise finishing.<sup>8</sup>

### Ideal Cases for Lingual Mechanotherapy

#### Non-Extraction Cases

1. **Deep bite, Class I** with mild crowding and a well-balanced facial pattern.
2. **Deep bite, Class I** with generalized spacing and a good facial profile.
3. **Deep bite, mild Class II** with a favorable facial pattern.
4. **Class II Division 2** with a retruded mandible.
5. Cases requiring **arch expansion**.

6. Cases involving a **midline diastema**.

## Extraction Cases

1. **Class II cases** requiring extraction of **upper first premolars** and **lower second premolars**.
2. Cases needing extraction of **upper first premolars only**.
3. **Mild maxillary and mandibular protrusion** treated with extraction of **all four first premolars**, where anchorage demand is minimal.

## Difficult Cases

1. **Surgical cases** requiring orthognathic intervention.
2. Cases with **Class III tendencies**.
3. **Class II cases** involving **extraction of all four first premolars**.
4. Patients with **mesiofacial patterns** and/or **average mandibular plane angles**.
5. Cases necessitating **multiple dental restorations**.

## Contraindicated Cases

1. Acute temporomandibular joint dysfunction (TMD).
2. Mutilated posterior occlusions.
3. High-angle (dolichofacial) growth patterns.
4. Extensive anterior prosthetic restorations.
5. Short clinical crowns.
6. Cases requiring critical anchorage.
7. Severe Class II discrepancies.
8. Patients with compromised oral hygiene or periodontal disease.
9. Highly apprehensive or anxious patients

## Time and Cost Factors

- **Extended Consultation & Planning:** Examination, diagnosis, and treatment planning require an additional **30 to 45 minutes**.
- **Higher Laboratory Costs:** The setup of an **indirect bonding appliance** significantly increases the overall cost of fixed appliances.
- **Increased Chairside Time:** Treatment procedures demand approximately **30-50% more chairside time**.
- **Additional Appliances for Detailing:** A **fully articulated positioner appliance** may be necessary for precise finishing in lingual cases.

## Bonding Technique

The two widely used methods for bonding in lingual orthodontics are –

- Direct Bonding Technique
- Indirect Bonding Technique

**Direct Bonding Technique<sup>21</sup>**

- **Introduced in 1984 by Dr. Michael Diamond.**
- Developed a device called the **Peri/Reflector** to simplify **direct bonding** in the **maxillary arch**.

The **Peri/Reflector** is a multifunctional device that combines a **mirror, tongue retractor, and saliva ejector**, making bonding procedures in the maxillary arch more efficient. It:

- **Isolates the working field** for better precision.
- **Enhances brightness** for improved visibility.
- **Allows a full view of the area** while keeping both hands free.<sup>11</sup>

**Indirect Bonding Technique<sup>21</sup>**

- Indirect bonding techniques utilize **two-component mix systems** such as **ENDUR** and **Concise**, as well as **no-mix systems** like **System 1** and **Instabond**.
- While these methods are **reliable and practical**, several **innovative modifications** have been introduced over time to enhance efficiency and accuracy.<sup>2</sup>

Several advancements have been introduced to enhance the precision and efficiency of indirect bonding:

- **Bonding in CLASS system<sup>2</sup>**
- **HIRO's method<sup>2</sup>**
- **Bonding with Equal Specific Thickness (BEST) system<sup>12</sup>**
- **Customized Indirect Bonding Method<sup>13</sup>**
- **New Customized Indirect Bonding Method<sup>14</sup>**
- **Lingual Bracket Jig<sup>15</sup>**
- **The Ray Set System<sup>2</sup>**
- **The Mushroom Bracket Positioner<sup>2,16</sup>**
- **Korean Indirect Bonding Set-Up (KIS) System<sup>12</sup>**
- **Convertible Resin Core System<sup>17</sup>**
- **Hybrid Core System<sup>12</sup>**
- **Orapix System<sup>9,12</sup>**
- **Incognito System**

These modifications improve accuracy, efficiency, and patient comfort in lingual orthodontic treatment.

**Incognito System**

This bracket system differs from traditional designs in both **manufacturing and positioning methods**, integrating **bracket production and placement into a single process** using **CAD/CAM technology**.<sup>21</sup>

### **Manufacturing Process:**

1. **Standard Silicone Impression:** A **two-phase** silicone impression is taken.
2. **Customized Setup Creation:** The resulting **casts** are used to design a personalized treatment setup.
3. **Non-Contact 3D Scanning:**
  - A **high-resolution optical 3D scanner** (GOM, Braunschweig, Germany) scans the therapeutic setup.
  - The scanner captures multiple angles to generate a **complete 3D model**.
4. **Digital Processing:**
  - The scan result forms a **compound surface** made up of thousands of tiny triangles, following the **Standard Triangulation Language (STL) format**.
  - The 3D model can be manipulated, observed, and modified using specialized **design software**.
5. **Alignment for Bonding:** Before further processing, the arch to be bonded is **aligned optimally to the later slot plane** to ensure **accurate bracket positioning**.

This advanced approach **enhances precision, efficiency, and customization** in orthodontic treatment.<sup>8</sup>

## **Lingual Technique in Orthognathic Surgeries**

Orthodontists can now utilize **lingual appliances** for patients undergoing **surgical treatment for dentofacial deformities**.<sup>21</sup>

### **Advancements with Rigid Internal Fixation (RIF):**

- **Rigid Internal Fixation (RIF)** is used to stabilize skeletal segments during surgery.
- Unlike traditional methods, **intermaxillary fixation** at the end of surgery is no longer required.
- This allows orthodontists to incorporate the **lingual technique** in both **pre- and post-surgical orthodontic treatment**.

### **Purpose of Pre-Surgical Orthodontics with Lingual Mechanotherapy:**

- The objective remains the same as in **labial orthodontics**:
  - **Prepare the dental arches** before skeletal repositioning.

- **Eliminate dentoalveolar compensations**, ensuring only skeletal discrepancies remain for **surgical correction**.

By integrating lingual appliances, orthodontic and surgical treatment can be efficiently combined, improving aesthetics and functionality in orthognathic cases.

## Advantages of Lingual Mechanotherapy

1. **Protects Facial Tooth Surfaces** – Prevents damage from **bonding, debonding, and adhesive removal**.
2. **Minimal Impact on Gingival Tissues** – Reduces irritation and maintains gum health.
3. **Preserves Natural Facial Contours** – The lips remain in their **natural position** without deformation from labial brackets.
4. **Optimized Inter-Bracket Width** – Though **reduced due to the smaller lingual arch radius**, this is compensated by the use of **more flexible archwires**.
5. **Aesthetic Preference** – Many **adults and young patients** prefer **invisible appliances**, provided the **cost, treatment time, and results** match those of labial appliances.
6. **Bite Plane Effect** – Allows **incisor intrusion** and **limited molar extrusion**, aiding in bite correction.<sup>8</sup>
7. **Enhanced Biomechanics** – The **lingual bracket position** aligns the **slot closer to the center of resistance** of incisors, leading to:
  - **Reduced unwanted tooth movements**.
  - **More predictable bodily tooth movement** during space closure and bite opening.<sup>18</sup>

Four different situations are seen where these appliances may become more effective as compared to labial appliances due to their distinctive mechanical characteristics, those are given as follows:

### Intrusion of Anterior Teeth in Lingual Therapy

- **Bracket Placement Advantage** – In **lingual orthodontics**, brackets are positioned **closer to the center of resistance** compared to labial brackets.
- **Intrusive Force Direction** – The **force vector** is aligned **through the center of resistance**, making the intrusion more effective and controlled.
- **Bite Plane Effect<sup>8</sup>** –
  - The **lower anterior teeth** make contact with the **horizontal plane** of the **upper anterior brackets**.
  - This interaction creates a **bite plane effect**, reducing deep bite.
- **Resulting Force Application** – Produces a **light, continuous, and effective intrusive force**, minimizing unwanted side effects and ensuring controlled tooth movement.

### **Maxillary Arch Expansion in Lingual Orthodontics**

Several factors contribute to **maxillary expansion** in lingual therapy:

1. **Centrifugal Force Effect** – Forces are directed **outward from the lingual side**, similar to the mechanics of **quad-helix and rapid palatal expanders**.
2. **Bracket Thickness Influence** – The **lingual brackets** create space between the **tongue and the lingual surface of the teeth**, which can naturally encourage expansion.
3. **Shorter Inter-Bracket Distance** – The **reduced arch radius** in lingual therapy may enhance the expansion effect due to biomechanical forces acting over a smaller span.

These factors collectively contribute to a **gradual and controlled widening** of the maxillary arch.

### **Mandibular Repositioning Therapy with Orthodontic Movements**

This approach integrates **temporomandibular disorder (TMD) management** with **orthodontic treatment** in two key phases:

1. **Phase 1: TMD Management & Pain Relief**
  - The **primary focus** is on treating **temporomandibular dysfunction (TMD)** and alleviating **associated pain symptoms**.
2. **Phase 2: Occlusal Adjustment & Orthodontic Correction**
  - As the **mandibular position** stabilizes, occlusal adjustments are made to accommodate the new jaw alignment.
  - **Labial appliances** are placed on **one arch**, while a **positioning splint** is used on the opposite arch to **maintain the corrected maxillomandibular relationship**.
  - The process is then **reversed**, ensuring **balanced occlusion** and proper jaw function.

This method allows **simultaneous mandibular repositioning and orthodontic treatment**, leading to stable, functional, and aesthetic outcomes.

### **The distalization of the upper teeth**

It's probable that lingual approaches for molar distalization result in less distal tilting and more tooth mobility. In a clinical setting, an open coil spring between the first and second teeth can do this. A vertical loop against the lingual twin bracket is included to counteract the mesial movement of first molars.

Both patients and the practitioner can benefit greatly from lingual appliances in today's clinical orthodontic treatment compared to labial appliances. Molar distalization seems to proceed more effectively, enamel surfaces are shielded, some treatments, such as deep

bite corrections, can happen more quickly, and TMD patients can start orthodontic therapy on time.<sup>19</sup>

## **Disadvantages of Lingual Mechanotherapy**

1. **Technique Sensitivity** – Lingual orthodontics is **more demanding and technique-sensitive**, requiring specialized training.
2. **Tissue Irritation** – Brackets may cause **discomfort** to the **tongue and soft tissues**.
3. **Speech Difficulties** – Some patients experience **temporary speech impairment** due to bracket placement.
4. **Challenges in Correcting Rotations** – **Rotational movements** can be more difficult to achieve.
5. **Compromised Oral Hygiene** – Brackets are harder to clean, increasing the **risk of plaque accumulation**.
6. **Higher Cost** – Lingual appliances are **more expensive** due to **customization and technique complexity**.<sup>2</sup>
7. **Increased Archwire Stiffness** – **Reduced inter-bracket distance** inadvertently makes archwires **stiffer**, affecting flexibility.
8. **Bonding Difficulties Due to Tooth Morphology** – Certain **tooth shapes** make bonding more complex, including:
  - **Peg-shaped laterals**
  - **Severely attrited teeth**
  - **Partially erupted or fractured teeth**

Patients with these conditions may **not be ideal candidates** for lingual appliances.<sup>19</sup>

## **Conclusion**

Lingual orthodontics has come a long way since its inception **over 36 years ago**. In the pursuit of a **patient-centric orthodontic approach**, researchers have overcome numerous challenges, including:

- **Technique refinement and material advancements.**
- **Criticism from the conventional orthodontic community.**

Despite these obstacles, dedicated clinicians remained steadfast in their efforts. From its early introduction to the present day, **continuous research and clinical trials** have led to the development of **highly precise, refined, and patient-friendly lingual bracket systems**.

This ongoing evolution ensures that **lingual orthodontics remains a viable and effective alternative** for patients seeking **aesthetic and efficient treatment options**.

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