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Original Research Article

Assessment of the Efficacy of Customized Lingual Orthodontic System (Lingual Matrix) in Initial Leveling and Aligning

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Abstract

Along with advantages in LO there existed many other disadvantages for LO. Variation in the morphology of the lingual surfaces especially on the maxillary anterior teeth is commonly seen. Wide range of labial-lingual thickness of the teeth and the smaller inter bracket distance in the anterior region requires numerous in-out bends which are difficult. Tissue irritation, speech difficulties, difficulty in oral hygiene has been also seen in many conditions. The problems traditionally associated with lingual orthodontics cannot be solved with conventional manufacturing processes; instead, complete individualization of all appliance components is needed. Lingual Matrix (LMX) is such a system that involves a fully digital process. As LMX is a new concept, this study was carried out to assess the efficacy of lingual matrix in initial leveling and aligning.

Keywords: Lingual Matrix, customized lingual brackets, Lingual orthodontics, Initial Levelling.

INTRODUCTION

The number of adult patients in orthodontic practise is increasing. Adult orthodontic treatment can be more demanding than that for a child or adolescent.

Adults are more esthetically concerned, more sensitive to appliance irritation, and much less cooperative with extraoral appliances. Growth has ceased, periodontal health may be compromised, and periodontal tissue is more vulnerable to deterioration during treatment.

The introduction of lingual orthodontics (LO) opened new horizons in adult orthodontic treatment [2]. Lingual orthodontics has been gaining space around the world due to its particularity to offer a discreet treatment option, "invisible", in "secret" for the correction of malocclusion, combining biomechanical efficiency and enhancement of the smile during treatment.

LO does offer the orthodontist a fixed three dimensional control over tooth movement, a concept with which we are familiar and for the most part are comfortable with. Over the last 60 odd years lingual orthodontics has been growing, developing and maturing and is now bursting into the clinical scene.

What was needed lingually was not simply an adaptation of existing labial technology, but a radical new design that started with state-of-the-art engineering techniques to develop a custom-made solution for the special demands of lingual orthodontics, a system that would make treatment from the lingual aspect as efficient and precise as treatment from the labial aspect. However, technological advancements in materials and processes are creating renewed interest in lingual protocol [4].

Even though there has been too many advantages for lingual orthodontics, there has been many disadvantages with the traditional lingual orthodontics [1, 4]. The main disadvantage of LO is the difficulty to bond on the lingual surfaces of the teeth. However, further developments at different levels, such as laboratory-based bracket positioning, archwire fabrication, and indirect bonding, have led to a rise in the number of lingually treated patients. Yet, when measured against its potential, the lingual technique is still clearly under-represented, compared with conventional appliances. The reasons given for the same by most of the orthodontists are: bracket loss rate is substantially higher than in labial cases, and the rebonding technique is complex and imprecise; the finishing process is time-consuming, and the average quality falls far short of that of labial cases [5, 6]; and patients often have difficulty adapting to the appliance, especially when undergoing lingual treatment in both arches [7, 8].

OBJECTIVES

1. To determine the efficacy of lingual matrix in subjects with mild to moderate crowding.
2. To determine the efficacy of the customized lingual brackets on both maxilla and mandible.

METHODOLOGY

Criteria for patient selection it is a multi-centre study. 9 subjects between the age group of 15-25 years, were selected from Yenepoya Dental College Mangalore (5 subjects), KVG Dental College Sullia (2 subjects) and a private practitioner (2 subjects) for the study.

Inclusion Criteria

- Subjects with mild to moderate crowding in the anterior region
- Subjects between age 15-25years.
- Subjects with good periodontal health. Exclusion criteria:
- Subjects with cleft lip, cleft palate or any congenital facial defects
- Subjects with compromised periodontal status.
- Uncooperative subjects.

Armamentarium

- Lingual Matrix brackets (CAD CAM customized brackets) with 0.022” slot (Figure 1).
- Bracket placement tray for indirect bonding (Figure 2).
- Nickel Titanium wires
- Etchant -3M ESPE Scotchbond
- Light cure Composite and bonding agent
- Digital vernier caliper

Figure 1: Lingual Matrix Brackets

Figure 2: Bracket placement trays

Patients with mild to moderate crowding in the maxillary and/or mandibular anterior region according to Little’s irregularity index26 were selected for this study. A quantitative method of assessing mandibular anterior irregularity is proposed. The technique involves measurement directly from the mandibular cast with a caliper (calibrated to at least tenths of a millimeter) held parallel to the occlusal plane. The linear displacement of the adjacent anatomic contact points of the mandibular incisors is determined, the sum of the five measurements representing the Irregularity Index value of the case. Though Little’s irregularity index is used to calculate crowding in mandible, we have used the same for maxilla.

METHOD

It is a multi-center study with a total of 9 subjects, meeting the selection criteria were selected. Routine records of all the patients such as case history, study models, extra oral and intra oral photographs, lateral cephalograms and orthopantomograms were made.

Lingual matrix bracket system with a 0.022" slot was used for all the subjects. Indirect bonding protocol was followed.

STEPS INVOLVED IN THE MAKING

Step I:

Maxillary and mandibular impressions of all the subjects are made using elastomeric impression material (Figure 3).

Figure 3: Maxillary and mandibular elastomeric impressions

Step II

The impressions made are packed well and send to the Lingual Matrix lab.

Step III

After a gap of 15 days, the Lingual Matrix bracket kit is send for bonding (Figure 4). It includes: Impressions we sent Kesling setup done for the particular case Subsequent arch wires for both upper and lower arch Brackets positioned on the tray for indirect bonding.

Figure 4: Lingual Matrix bracket kit

Step IV

The tooth surface for bonding is rinsed and air dried properly. Etchant is applied to the required location. After keeping for 15-20 sec, it is washed off and air dried. Then bonding agent is applied and light cured. Once the tooth surface is ready for bonding, procedures for indirect bonding are started. The kit comes with a set of three trays for each arch. One for the anterior region, two for posterior region (one on either side). Indirect bonding is then done. Any one of the tray is first taken. Composite is applied to brackets positioned on the tray. Seat the tray in the mouth and hold it in the mouth without applying much force. It is then light cured through the soft tray. Once it is light cured sufficiently, the tray is carefully removed. The same procedure is done for all other trays. Indirect bonding is thus done for both the arches (Figure-5).

Figure 5: Indirect bonding done on both the arches

After bonding, 0.014 NiTi archwires are placed. The subjects were reviewed approximately every 4 weeks, and sequence of arch wire was changed as per the kit instructions (differs in each patient according to the amount of crowding). The date of bonding was recorded for each patient and was recalled on a regular basis. Once initial alignment was obtained, records were made to calculate the rate of decrowding (Figure-6).

Figure 6: Upper and lower arches after initial alignment

Measurement of Decrowding

Measurements were made on the initial pre-treatment cast (T1) and on the cast obtained after aligning (T2) by using a fine-tip digital calliper.

The rate of alignment of the anterior region were measured from the difference in the irregularity index of serial casts taken at T1 and T2 using digital vernier caliper, divided by the number of days between the 2 measurements.

RESULTS

Irregularity index of maxilla was 3.56 (SD=0.943) mm. Irregularity index of mandible was 3.62 (SD=1.397) mm.

Irregularity (mean crowding) before treatment was more in mandible compared to maxilla (Figure 7). But the difference is not significant with p value of 0.916.

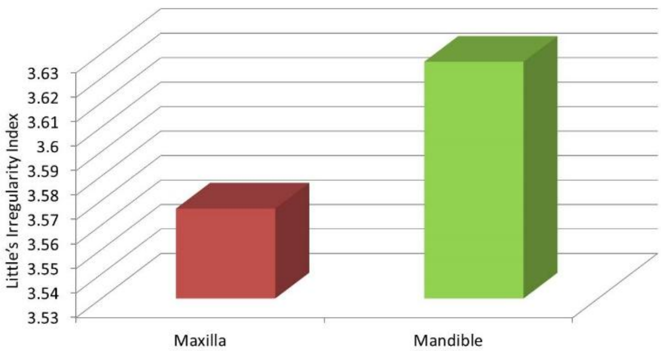

Figure 7: Irregularity (mean crowding) before treatment

It took 50.33 (SD=15.8) days for initial leveling and alignment in maxilla with the reduction of irregularity index by 3.56 mm.

It took 65.33 (SD=26.04) days for initial leveling and alignment in mandible with the reduction of irregularity index by 3.62mm.

Time taken for initial levelling and alignment was more in mandible compared to maxilla, with greater reduction of irregularity index in mandible (Figure 8). But the difference was insignificant with p value of 0.159.

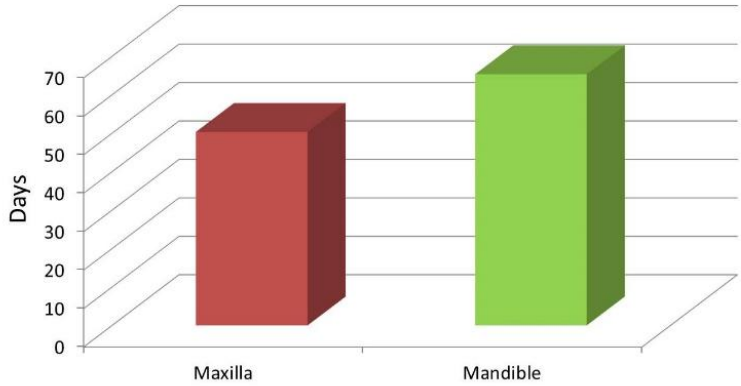

Figure 8: Time taken for initial levelling and alignment

The initial rate of alignment was more for maxilla 0.071(SD=0.004) mm/day compared to mandible 0.055 (SD=0.004) mm/day. There was a statistical difference with p value of 0.00 (Figure 9).

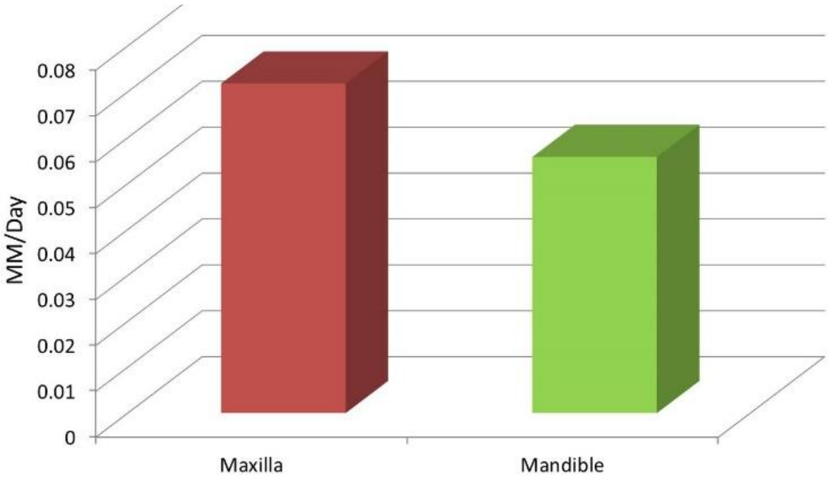

Figure 9: Difference in rate of alignment

The initial rate of alignment was 0.07 mm/day for maxilla and 0.051 mm/day for mandible, from which it can be concluded that the time taken for initial alignment in case of LMX is less when compared to the traditional lingual brackets.

When time taken taken for initial leveling and alignment in both the arches was compared, it was seen that time was more for mandible than maxilla but it was statistically insignificant.

DISCUSSION

Variation in the morphology of the lingual surfaces especially on the maxillary anterior teeth is commonly seen. Wide range of labial-lingual thickness of the teeth and the smaller inter bracket distance in the anterior region requires numerous in-out bends which are difficult. Tissue irritation, speech difficulties, difficulty in oral hygiene has been also seen in many conditions.

The problems traditionally associated with lingual orthodontics cannot be solved with conventional manufacturing processes; instead, complete individualization of all appliance components are needed. As the technology advanced, the processes of bracket fabrication and optimized positioning of the fabricated brackets on the tooth, which are normally quite separate, are fused into one unit. Individualization of the bracket base, a process used in various laboratory processes and always essential in the lingual technique, takes place during fabrication of the single brackets4,9;

in other words, each tooth has its own customized bracket, made with state-of-the-art computer-aided design computer-aided manufacturing (CAD/CAM) software coupled with high-end, rapid prototyping techniques.

The first step in the manufacturing process is to take a standard 2-phase silicone impression. The casts produced from this impression are used to prepare a customized target setup. Noncontact scanning of the therapeutic setup is performed with a highresolution optical 3D scanner.

As with human perception, the 3-dimensional (3D) scanner examines the model from various perspectives to create a complete 3D representation. The outcome is a compound surface consisting of many thousands of minute triangles that can be turned, observed, and processed on a computer with appropriate design software.

Before further processing, the arch to be bonded is aligned optimally to the later slot plane. In contrast to conventional lingual brackets, which have standardized mesh bases, a customized “virtual” base is generated on the lingual surfaces of each tooth. The bases are later positively locked with the teeth [10]. The pad surfaces generated are large enough to provide greater bond strength and exact form-fit properties. The bracket base is 0.4 mm thick.

The bracket bodies are freely designed with appropriate design software. The bracket body we use is extremely low profile compared to others, guaranteeing absolute control over the tooth and making for a simplified ligation procedure. The testing of various slot types has shown a horizontal slot with a horizontal insertion direction to be ideal.

The archwire thus runs like a ribbon. By using custom software, the bracket bodies are added to the setup and the pad surfaces, and are arranged so that the slots are aligned in the virtual archwire plane. The vertical height, angulation, and torque are thus present.

High-end rapid prototyping machines are used to convert the virtual bracket series into a wax analogue and then into a final product made of a hard alloy. Because of the extended customized base, which permits clear-cut positioning on the tooth, the brackets can be directly bonded by the orthodontist. As with straight-wire concepts, the archwire geometry is yielded by the 3D location of the bracket slots. Their exact position is known through the bracket manufacture described above in 3D design software and is transmitted to a bending robot through the export of slot coordinate systems [11].

Lingual Matrix is such a system that involves a fully digital process. The treatment starts with 3D scanning of upper and lower models. Lingual Matrix software produces a CAD model of lingual bracket with a customized base which undergoes a very precise manufacturing process using laser sintering machine to manufacture a customized single piece 3D lingual bracket that adapts seamlessly to the shape and contour of the teeth.

Salient Features of LMX can be summed up as: It is a single piece 3D lingual bracket system with customized base and offers one of the most economical CAD/CAM based customized bracket in the world. Versatility of using different forms, features and sizes of brackets as per the occlusion and requirement of each case can be done. Choice of using straight arch to mushroom shaped archwire as per the demand from orthodontists.

Horizontal slot opening for better bio-mechanical control with add or delete hooks on brackets as per your requirement. Ease of re-bonding due to single piece metal bracket and laser etched marketing system for easy identification has been considered as a major advantage.

CONCLUSION

From the present study, it was concluded that, the advantage of such custom made bracket is not only the individuality of the appliance making it comfortable for both the patient and the orthodontist, but also the increased rate of decrowding than the traditional lingual brackets.

The purpose of this study was to determine the efficacy of lingual matrix in subjects with mild to moderate crowding in both maxilla and mandible. The results of this study led to the following conclusions:

1. The initial rate of alignment was 0.07 mm/day for maxilla and 0.051 mm/day for mandible, from which it can be concluded that the time taken for initial alignment in case of LMX is less when compared to the traditional lingual brackets.
2. When time taken taken for initial leveling and alignment in both the arches was compared, it was seen that time was more for mandible than maxilla but it was statistically insignificant.

The custom bracket manufacturing like LMX, provides new opportunities by solving the most frequently cited drawbacks of lingual appliances:

Thus it can be concluded that, the advantage of such customized brackets is not only the individuality of the appliance making it comfortable for both the patient and the orthodontist, but also the increased rate of decrowding than the traditional lingual brackets.

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Conflict of interest: NIL

Permissions: NIL

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