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Lingual Orthodontic appliance

A project Submitted to

The Collage of Dentistry, University of Baghdad, Department of Orthodontics

in partial fulfillment for the Bachelor of Dental Surgery

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Certification of the Supervisor

I certify that this project entitled "Lingual orthodontic appliance" was prepared by Salma Mortadha Fakhre under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirement for the Bachelor Degree in Dentistry.

Supervisor's name: Assist. Prof. Noor Muhammed Hasan Garma

Date:

Dedication

I would to dedicate my humble effort to my father and mother. Their affection, love, encouragement and prays at day and night made me able to success with honor, without them, I wouldn't have reached what I am todays.

Acknowledgment

First of all, I thank "Allah" Almighty for granting me the will and strength to accomplish this project, and I pray that his blessings upon me may continue throughout my life.

I would like to express my deepest respect and gratitude to the Dean of College of Dentistry of Baghdad, Prof. Dr. Raghad Al-Hashimi.

My sincere thanks to Prof. Dr. Dheaa H. AL-Groosh, the Head of the Department of orthodontics for his pleasant cooperation.

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Introduction

Traditionally, orthodontic appliances have been fixed on the outer (labial) surface of the teeth. In recent years, the increased number of adult patients seeking orthodontic treatment and their higher esthetic demands have led to the development of various esthetic treatment approaches, including esthetic brackets, clear aligners, and appliances fixed on the inner (lingual or palatal) surface of the teeth (termed as lingual appliances). Since introduction of lingual appliances by FUJITA, progress has been seen in their design, manufacturing, and mechanotherapy **(Shetty et al., 2021)**.

The major advantage of lingual orthodontics is that the appliances are not visible. However, lingual orthodontics comprises a relatively new treatment option that has certain differences to the well established labial orthodontic treatment, mainly attributed to the position of the appliances, fixed appliance treatment has become an integral part of modern orthodontics and has been a major focus point of orthodontic research **(Shetty et al., 2021)**.

Lingual appliances, particularly customized appliances, are more expensive, and they are more technically difficult than labial appliances for the clinician, so it remains to be seen if further developments in this field will lead to more widespread use of lingual orthodontics **(Littlewood et al., 2019)**.

The basic aim of lingual orthodontics is to offer orthodontic treatments, primarily to adults, that are more esthetic than, but have the same level of quality as, labial orthodontics. Achieving satisfactory results in a reasonable time depends fundamentally on understanding the biomechanical and procedural differences between labial and lingual orthodontics **(Atwal et al., 2011)**.

Aim of study:

The aim of this study was to review lingual appliance regarding their uses, indications, malocclusion management and compare them with the conventional labial orthodontic appliance.

Chapter one: Review of Literature

1.1 Historical perspective

In 1975, Dr. Craven Kurz of Beverly Hills, California created his own lingual appliances by modifying labial edgewise appliances, and utilized them on a limited basis in his practice. He limited his treatment to the mandibular arch for fear that the forces of occlusion would dislodge brackets placed on the lingual surface of the maxillary anterior teeth. 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. He joined with Ormco Corporation to develop and produce a prototype of this appliance **(Shetty et al., 2021)**.

1.2 Lingual orthodontic appliance versus labial appliance

1.2.1 Lingual orthodontics offers a number of advantages:

1) More aesthetics than labial appliance **(Littlewood et al., 2019)**.

2) Facial gingival tissues are not adversely affected and facial surfaces of the teeth are not damaged from bonding, debonding, adhesive removal unlike labial appliances **(Antonio-Zancajo et al., 2020; Shetty et al., 2021)**.

3) Reduced incidence of white spot lesions as compared to labial fixed appliance as reported by various studies including randomized controlled clinical trial and systematic reviews and this is considered to be a major advantage to the lingual system **(Ata-Ali et al., 2017; Naveed et al., 2020**).

4) Facial contours are truly visualized since the contour and drape of the lips are not distorted by protruding labial appliances **(Antonio-Zancajo et al., 2020)**.

5) Position of the teeth can be seen more accurately as not obscured by the appliance **(Littlewood et al., 2019; Shetty et al., 2021)**.

6) Some lingual brackets create a bite-plane effect on the upper incisors and canines, making these types of brackets useful for treating deep overbites **(Littlewood et al., 2019)**.

1.2.2 Some potential disadvantages of lingual orthodontic:

1) One of most significant drawbacks is discomfort and pain to the tongue and difficulty in speech, both of which improve after 2 to 3 weeks of appliance placement. Whereas cheek and lip soreness were greater in the labial appliances. **(Littlewood et al., 2019; Naveed et al., 2020; Shetty et al., 2021)**.

2) Extended chair time and require specialized technical skills to operator for direct viewing and access, particularly of retroclined anterior teeth, and sensitivity laboratory technique **(Phulari et al., 2011; Littlewood et al., 2019)**.

3) No statistically significant differences in eating and oral care difficulties between the lingual and labial appliances but there was more adherence of food particles and more difficult to clean in the lingual appliance patients **(Ata Ali etal.,2017; Naveed et al., 2020**).

4) Increased cost **(Littlewood et al., 2019; Shetty et al., 2021)**.

5) Variations in morphology of the lingual surfaces, especially on the maxillary anterior teeth. Even a small height (vertical) deviation in the position of the brackets results in a marked effect on the third-order prescription **(Phulari et al., 2011; Roberts and Huja, 2016)**.

6) Wide range of labiolingual thickness of the teeth from 4.6 mm for lateral incisors to 9.2 mm for canines necessitating numerous in out bends **(Phulari et al., 2011)**.

7) Much smaller inter bracket distances in the anterior region, making compulsory bends difficult **(Phulari et al., 2011)**.

8) Evaluation of oral health related quality was better in the labial group compared to the lingual group during the first month of treatment and both of them gradually decreased over time (**Kara-Boulad et al., 2022)**.

1.2.3 Torque Control

One major difference between labial and lingual appliances with regard to treatment mechanics is the importance of accurate torque control and its consequences on vertical tooth position. Incorrect torque control results in a completely different effect in a labial bracket versus a lingual bracket as illustrated in (Fig.1). Two upper central incisors are depicted, one of which exhibits an ideal position the other one displays a torque problem of −10 degrees **(Roberts and Huja, 2016)**.

When a labial appliance is used, the effect of 10 degrees of torque discrepancy will be unnoticed by the patient, and only a very detail oriented orthodontist could recognize the problem (Fig. 1, A) **(Roberts and Huja, 2016)**.

When a lingual appliance is used, an incorrect torque of −10 degrees directly causes a visible malposition in the vertical plane, and the tooth appears extruded (see Fig.1, B). This is even more severe as the distance between the tooth surface and the archwire increases, which is the standard situation when using a lingual straight wire approach with thicker brackets; vertical discrepancies are easily detected by the patient (see Fig.1, C) **(Roberts and Huja, 2016)**.

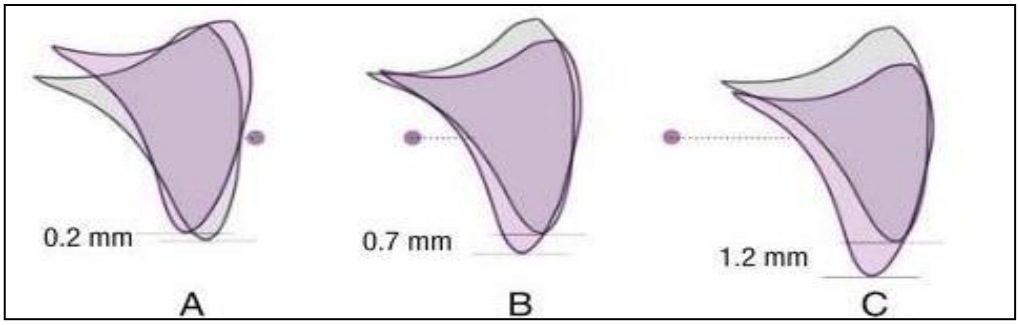

Figure 1 Effect of incorrect torque; (a) in labial appliance, (b) in lingual appliance, (c) in lingual appliance with straight wire and thick brackets **(Roberts and Huja, 2016)**

In state of the art lingual orthodontic appliance, torque control is achieved by the exact fit of a rectangular archwire into the bracket slot. Acceptable torque control in the course of the lingual treatment can be realized only if archwires and slots are precisely manufactured with only minimal tolerances **(Roberts and Huja, 2016)**.

To provide better torque control of the incisor during space closure and prevent a vertical bowing effect, the incorporation of extra torque into brackets of incisors was recommended, and the use of power arms for the lingual appliance. To prevent a transverse bowing effect, incorporation of the antibowing bend or application of retraction force from both buccal and lingual sides or temporary skeletal anchorage devices was recommended **(Komaki et al., 2022)**. In Lingual treatment it is crucial to increase the lingual root torque. The amount of retraction and arch widening were more in lingual appliance compared to labial technique **(Lekshmi et al., 2020)**.

1.2.4 Efficient Leveling and Aligning

It is an important difference between common labial and lingual approaches. Labial appliances allow bonding of all brackets from the start of treatment in most cases. This is not often the case for lingual systems, where in the mandibular arch braces have to be bonded in a multistage process depending on the inserted system **(Roberts and Huja, 2016)**.

1.3 Indications of Lingual Appliance

lingual appliance may be more effective than labial appliance because of their unique mechanical characteristics in the following conditions: **(Harsimrat Kaur et al., 2020; Shetty et al., 2021(**.

1. Intrusion of anterior teeth.
2. Distalization of maxillary molar.

3. Maxillary arch expansion. Lingual System were able to produce greater expansion in the posterior region when compared with labial system.

4. Combing mandibular repositioning therapy with orthodontic movement.

1.4 Indirect Bonding (Ureña and Harfin, 2015)

Indirect method is highly recommended due to the great difference in the palatal and lingual tooth anatomy. It must be easy to make, permit accurate bonding, have control of the possible failures, easy to rebond when it is necessary, and have high precision and reduced cost. **The first step** is to clean the enamel surface using pumice (Fig.2 a, b).

Figure 2 (a, b) A low-speed handpiece with a cleansing brush is recommended **(Ureña and Harfin, 2015)**

The second step is to rinse with water to remove any pumice paste and to dry thoroughly with oil free air. Cheek, lip, and tongue retractors are very helpful to maintain a completely dry field during all the bonding process. Thirty-seven percent phosphoric acid gel for about 30s is used for enamel conditioning (Fig.3 a, b). Then the enamel surface has to be dried very carefully until it acquires a frosty white appearance.

Third step a small amount of primer is applied to the tooth and to the bracket base at the same time. Light curing primer with filling microparticles is highly recommendable in order to diminish enamel decalcifications or carious lesions under the brackets (Fig.4 a, b).

Figure 3 (a , b) Before and after the plication of 37 % phosphoric acid gel **(Ureña and Harfin, 2015)**

It is important that all the excess adhesive is carefully removed to improve oral hygiene and less gingival inflammation or decalcification around the bracket.

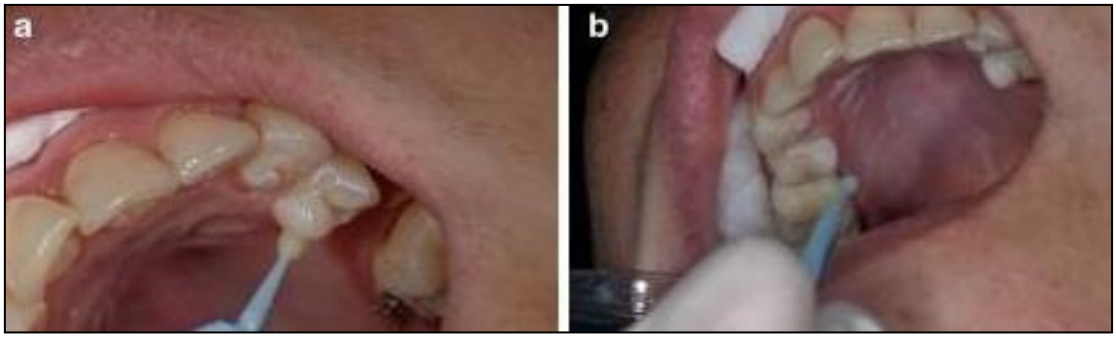

Figure 4 (a , b) Light-cure bonding agent adhesive in place **(Ureña and Harfin, 2015)**

Fourth step it is preferred to start transferring individual caps from the last molar to midline avoiding unnecessary contamination risks (Fig.5 a, b). The cap can be easily removed with a thin dental explorer instrument from occlusal to gingival **(Ureña and Haefin, 2015)**.

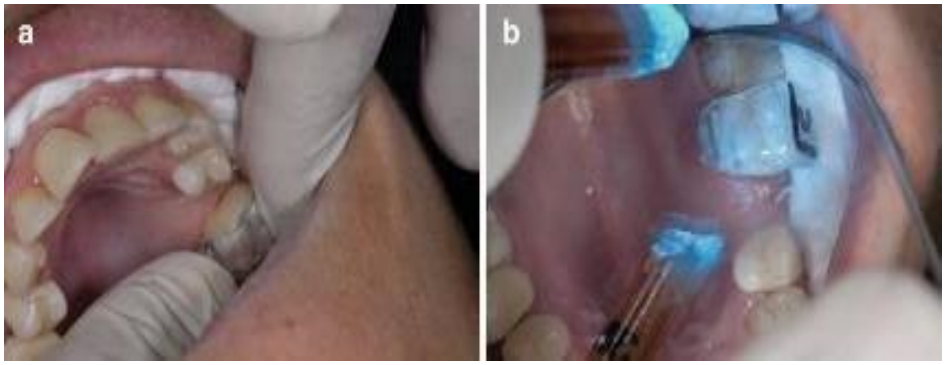

Figure 5 (a , b) Molar transferring cap in place **(Ureña and Hrfin, 2015)**

1.4 Methods of Ligation

There are different ligation approaches in lingual orthodontics that use stainless steel or elastomeric ligatures. The use of esthetic ligatures is highly recommendable since their visibility was improved in the upper and lower arches. The flexibility of the esthetic ligature allows better manipulation, twist, cut, and tuck under the archwire. The double tie ligature allows the full insertion of the archwire into the bracket slot avoiding the archwire to slip off the bracket **(Ureña and Harfin, 2015)**.

First, the ligature has to be placed behind the wire and the bracket in order to embrace and insert the wire at the end of the bracket slot (Fig.6 a, b). Then cross ligature around the bracket and pull up the ends in order to twist them on the side of the bracket (Fig.7 a, b).

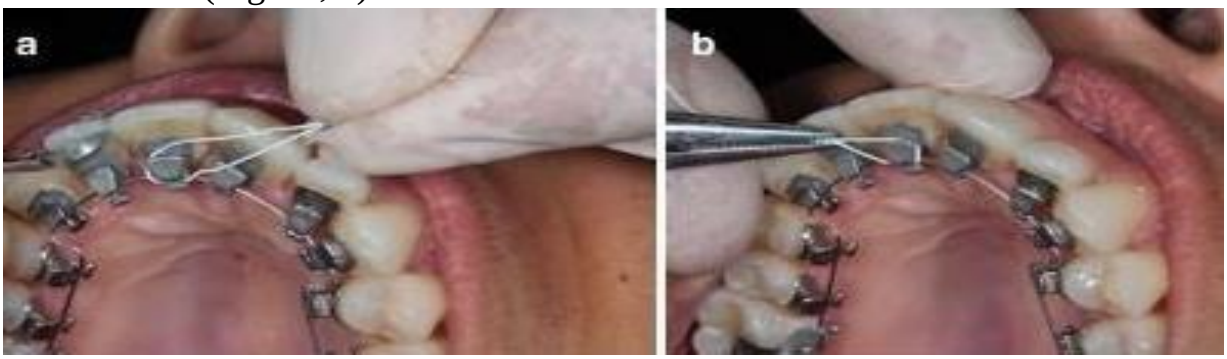

Figure 6 (a, b) How to place the ligature wire behind the archwire and the bracket **(Ureña and Harfin, 2015)**

After that with a cutting plier, loose ends should be cut and pressed behind the bracket, preventing any discomfort for patients. A ligature director or a Mathieu plier is helpful. Finally, the excess wire is cut after twisting the ligature under the bracket **(Ureña and Harfin, 2015)**.

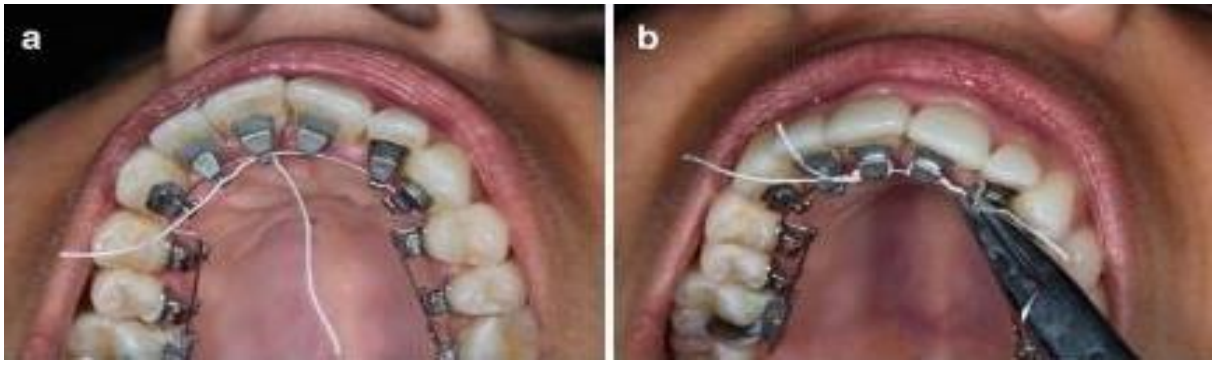

Figure 7 (a, b) After the ligature wire crosses the bracket, the ends have to be twisted around

them **(Ureña and Harfin, 2015)**

1.6 Various lingual appliances (Shetty et al., 2021)

1.6.1 Fujita lingual bracket (1979)

- The presently available Fujita system is still based on an occlusal slot opening, but has multiple slots (fig. 8).
- Anterior teeth and premolars have three slots: occlusal, lingual, and vertical.
- Molar brackets have five slots: one occlusal, two lingual, and two vertical.

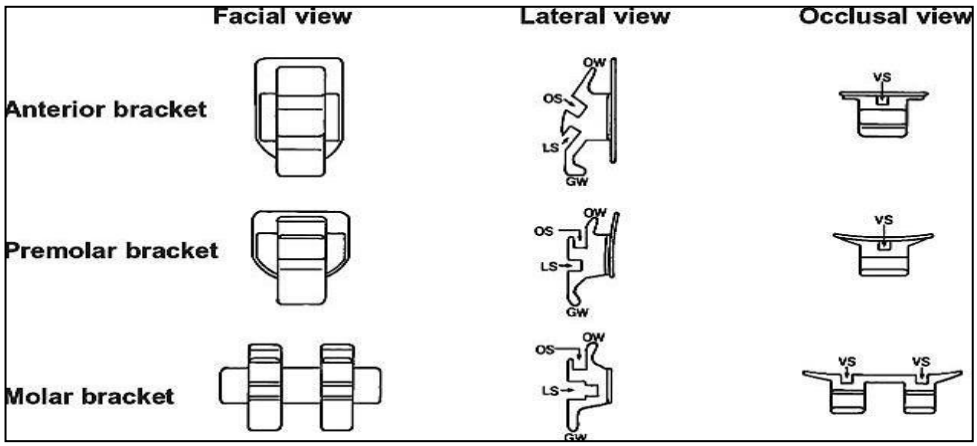

Figure 8 Fujita lingual bracket **(Hong et al., 1999)**

1.6.2 Begg's lingual brackets

- Dr. Stephen Paige introduced the lingual light wire technique in 1982. The bracket currently used in the Begg system is the unipoint combination bracket (Unite), with the slot oriented in the occlusal direction (fig. 9).

Figure 9 Begg's lingual brackets **(Yen et al., 1986).**

- Molar tube design: Oval tube with a mesiogingival hook.

The squashed oval tube has some advantages in that it allows molar control, and will accept a ribbon arch.

1.6.3 Conceal brackets (1989)

- Foundation of design is opening of archwire slots to the occlusal aspect rather lingual aspect 3 slot width for 3 different functions tip, torque, rotations.

1.6.4 Scuzzo-Takemoto brackt (STB)

- 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. Flossing is easier.

• Mesio-distal width of the bracket is smaller, allowing adequate inter-bracket distances (fig. 10). Rotations can be more easily accomplished as the archwire can be tied tightly to the bottom of bracket slots. Torque control is improved.

Figure 10 (STB) bracket **(Atwal et al., 2011).**

1.6.5 Self-ligating lingual brackets

Macchi in 2002 introduced standard medium twin bracket, narrow single, large twin bracket and three wing bracket (figure 11). Forestadent manufactures two different systems, the 2D and the 3D. The 2D system is specifically designed for those cases not requiring extractions, while the 3D system includes inclination in the slot to give sagittal angulation information to the archwire. Adenta manufactures active self-ligating lingual brackets, which are transferred to the patient using a modified version of the Hiro system **(Atwal et al., 2011)**.

Figure 11 Self-ligating lingual brackets **(Atwal et al., 2011)**

1.7 Wire Sequencing in Lingual Orthodontics

Successful lingual orthodontic treatment, more than any other orthodontic treatment modalities, requires the rigid adherence to a series of protocols of both intellectual and mechanical nature. The protocols maximize the potential of each wire and reduce archwire changes to a minimum, at the same time effecting high quality results (fig. 12). This sequence is followed for all cases: Class I, II, or III malocclusions, and extraction or nonextraction cases **(Romano, 1998)**.

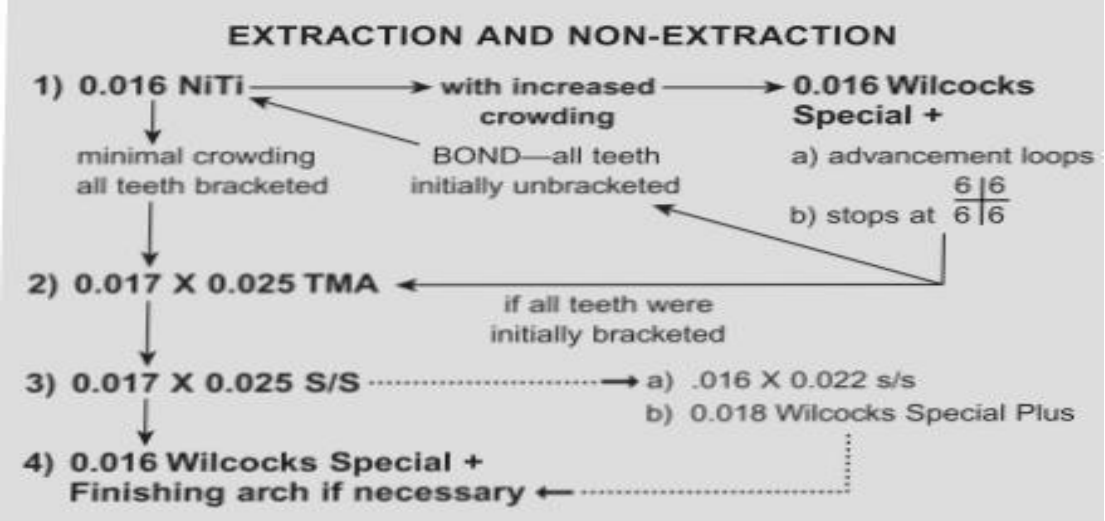

Figure 12 Wire sequence protocol **(Romano, 1998)**

1.8 Diagnostic consideration in lingual orthodontics

1.8.1 Periodontal considerations (Bajjad et al., 2020; Shetty et al., 2021)

- The status of the periodontium must be carefully evaluated.
- The lingual appliance can cause gingival hypertrophy, as the brackets are bonded close to the gingival crest. Brackets must be 1mm away from gingiva.
- Patients with history of periodontal problems or in whom oral hygiene motivation is questionable may not be the best candidates for lingual therapy.

1.8.2 Restorative considerations (Echarri et al., 2006; Shetty et al., 2021)

- In cases where there is a loss of several teeth, extreme tipping, and multiple or complex bridgework, the lingual appliance may be contraindicated.
- Porcelain-fused-to-metal crowns or other metallic restorations may need to be replaced with provisional plastic crowns to permit lingual bonding.
- Teeth with crowns and large restorations need to be treated with special bonding techniques.

1.8.3 Dental considerations (Echarri et al., 2006; Bajjad et al., 2020)

- The most suitable teeth are those with long smooth surfaces.
- Incisors with lingual surface shorter than 7mm should be reconstructed.
- The presence of prominent cingulae, marked marginal ridges, or prominent cusp of carabelli are unfavorable and if possible they should be reduced or reconstructed.
- Short lingual clinical crowns can present a contraindication to optimum lingual bracket positioning.

1.8.4 Extraction versus Non-extraction considerations (Bajjad et al., 2020)

In lingual orthodontics, strong molar anchorage, especially in the lower arch, makes mesial movement of molar difficult. Hence, in Class I cases, extraction of upper first and lower second premolars is preferred, in Class II cases, it is better to avoid lower arch extractions. While in open bite and Class III cases, four first premolar extractions are considered.

1.9 Biomechanics

1.9.1 Changes induced by the lingual appliance (Shetty et al., 2021)

1.9.1.1 Vertical changes

The most immediate and readily apparent appliance induced change is the bite opening resulting from the lower incisors occluding on the maxillary incisor bracket bite planes. This bite opening is beneficial in brachyfacial cases, temporomandibular disorder cases and rapid tooth movement due to posterior disocclusion.

1.9.1.2 Antero-posterior changes

Because of the vertical opening and the immediate rotation of the mandible (down and back), the lingual appliance also induces a Class II tendency. With bite opening, antero-posterior molar correction is easier.

1.9.1.3 Transverse changes

The lingual appliance has an expansive nature. This is coupled by posterior disoclusion. There is tendency to cause mesio-buccal molar rotation during space closure. Thus, placement of transpalatal arch is important.

1.9.1.4 Bowing Effect

Anterior teeth tip lingually, posterior teeth tip mesially and posterior bite open. Retraction is always done on stiffer wires to prevent bowing effect, both in the transverse and vertical planes.

1.9.2 Phase I

Phase I always includes the alignment and leveling of the maxillary and mandibular arches. In general, low load deflection arches are used as initial alignment wire depending on the amount of discrepancy, initial malocclusion, and treatment objectives. To initiate Phase I, it is important to bear in mind that since the interbracket distance is narrower than in labial orthodontics, the

suggested sequence is either coaxial archwire (0.0155″ or 0.0175″), Ni-Ti archwire (0.010″ or 0.013″), or Ni-Ti-Cu (0.016″) (Fig. 13 a, b) **(Ureña et and Harfin, 2015)**.

Figure 13 (a, b) Initial photograph and with a 0-013″ Ni-Ti archwire **(Ureña and Harfin, 2015)**

When all the slots are aligned, a 0.016″ titanium-molybdenum alloy (TMA) or 0.016″ stainless steel archwire is recommendable to finish Phase I. From the biological point of view, it is important to emphasize that the first archwire used must be very resilient to ensure very light forces at the beginning of the treatment. It is advisable that this archwire remains for a minimum period of 6–12 weeks **(Ureña and Harfin, 2015)**.

1.9.3 Phase II Anchorage Control

For lingual orthodontic treatment, an effective control is necessary with the help of some auxiliary appliances. The use of a Nance button with a transpalatal bar (TPA) is very useful in cases when maximum anchorage is required **(Ureña and Harfin, 2015)**.

1.9.3.1 Horizontal anchorage

There are several different methods by which the orthodontist may conserve to increase horizontal anchorage in lingual orthodontics. During retraction, the lower friction of self-ligating brackers facilitates anchorage conservation and microimplants may be used to reinforce anchorage (Fig. 14) **(Atwal et al., 2011)**.

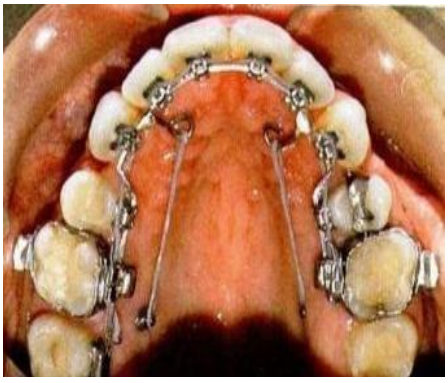

Figure 14 Microimplant can be used to reinforce anchorage **(Atwal et al., 2011)**

1.9.3.2 Sagittal anchorage

Given the difficulty involved with managing torque in lingual orthodontics, the main point here is that retractions should be carried out en masse that is with a closing arch from the canine especially in the upper arch and that sectional retraction should be avoided as much as possible. Conventionally ligated brackets are more appropriate in cases involving very large spaces because these brackets produce more friction and help to prevent loss of anchorage **(Atwal et al., 2011)**.

1.9.4 Phase III

Most orthodontic cases require some adjustment of individual tooth position to align and level marginal ridges, the gingival margin, or in-out position. When all the treatment objectives are achieved, it is recommendable that the finishing arch was maintained in place for 10–12 weeks to achieve optimal tooth position. A fixed retention wire is advisable in all types of malocclusions for a long period of time. It has to be placed the same day the brackets are removed **(Ureña and Harfin, 2015)**.

1.9.5 Vertical plane

Unlike labial brackets, the position of the lingual brackets on the maxillary incisors is closer to the long axis through the center of resistance, thus allowing easier movement whenever on occlusal force is applied. If the root tips are forward and the crowns lingually inclined (as in a Class II, division 2 malocclusion), the intrusive force should, however, be controlled because the point of application of the force is distal to the long axis passing through the center of resistance of the incisors and this increases the lingual inclination of the crowns. In these cases, it is better first to procline the crowns and then to perform the intrusion **(Siao et al., 2007)**.

1.9.6 Horizontal plane

The positioning of the lingual brackets on the maxillary incisors approximately of the long axis through the center of resistance results in a minor tendency to rotation whenever a force is applied from a mesiodistal direction, unlike in the labial technique **(Romano, 2006)**.

This implies that whenever on intrusive force is applied to the lingual brackets, the crowns of the teeth rotate in a lingual direction, and the opposite occurs whenever on intrusive force is applied to labial brackets crown rotation occurs in a labial direction. The mandibular molars are concerned there is no significant difference in the position of the brackets because the long axis passing through the center of resistance posses through the middle of the molars. The greater interproximal space and larger embrasure on the lingual side cause a lingual force to be applied along the horizontal plane, generating more crown rotation with the lingual technique than would be generated by a labial force **(Scuzzo et al., 2010)**.

1.9.7 Sagittal Plane

In the sagittal plane, when the same amount of force is applied in both systems (labial and lingual), so that the intrusion force (FI) equals the retraction farce (FR), the results obtained are different**.** In the labial system, the net force vector points directly towards the center of resistance (CR). However, the net force vector in lingual orthodontics produces a lingual tipping force and vertical bowing effect. Thus, the refractive force should be minimized during en masse retraction, and more intrusion and torque are needed to retract the anterior teeth (Fig. 15) **(Scuzzo et al., 2010)**.

In the mandibular arch, in the case of normally inclined mandibular incisors, the lingual bracket slot is closer to the long axis passing through the center of resistance, compared with slot of a bracket bonded on the labial side,

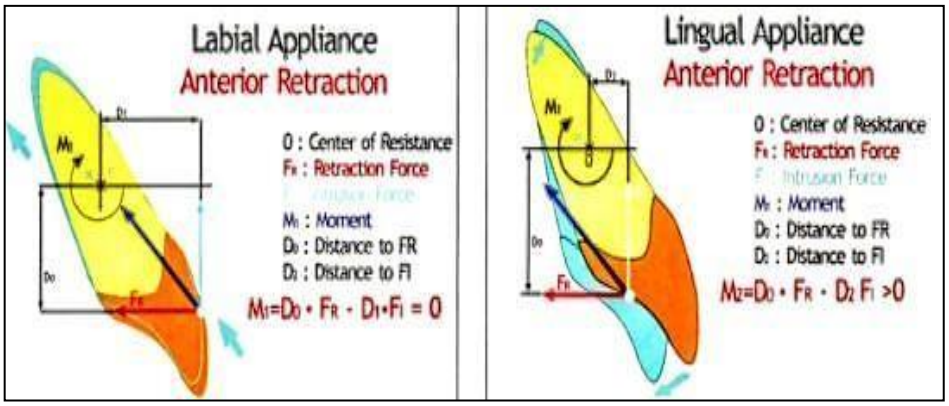

Figure 15 application of similar amount of intrusive and retractive forces may result in intrusion with labial appliance and tipping force with lingual appliance, owing in difference in force direction **(Gapta et al., 2005)**

for this reason, during the leveling phase of treatment, the lingual application of the force allows easier intrusion, that is less tendency for concomitant labial tipping of the crown compared with a labially applied force (Fig. 16). This movement also increases the effect of the force on the posterior segments, in the sagittal plane, compared with a labial force **(Bajjad et al., 2020)**.

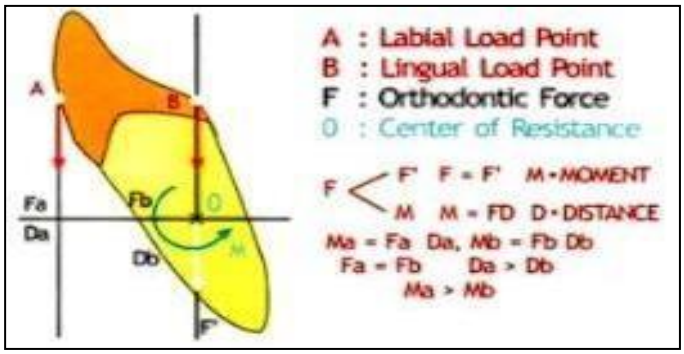

Figure 16 Lingual and labial points of application of orthodontics force on a mandibular incisor **(Scuzzo et al., 2010).**

In particular, this will generate more distal tipping of the mandibular molar crowns and more lingual tipping of the mandibular incisors (Fig. 17). In the occlusal plane, the inter-bracket distance in lingual orthodontics is shorter than in labial orthodontics. For this reason, the archwire stiffness increases with the lingual technique, in cases of crowding it is more difficult to engage the archwire in lingual brackets so more resilient archwire is required and there is less rotation moment than with the labial technique (Fig. 18) **(Bajjad et al., 2020)**.

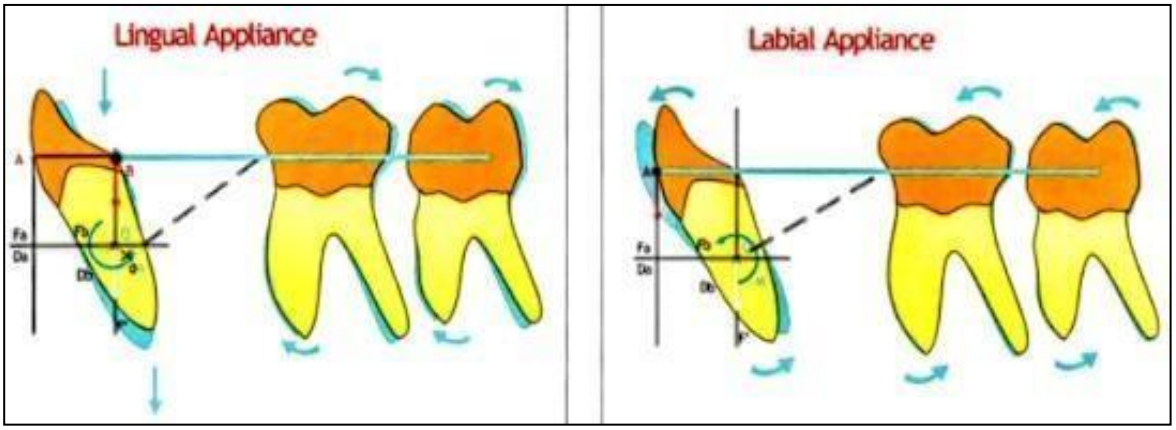

Figure 17 Different effects in the sagittal plane of a lingually and labial applied forces on the mandibular arch **(Scuzzo et al., 2010).**

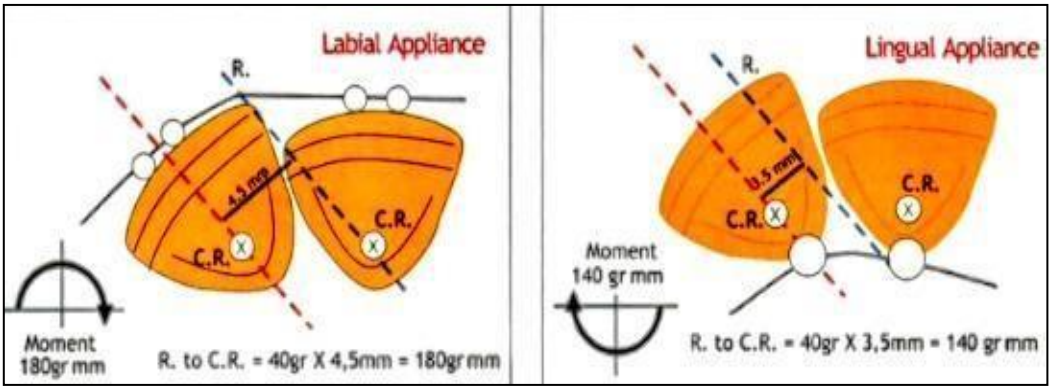

Figure 18 Inter-bracket distance and different effect of labial and lingual forces in horizontal plane **(Scuzzo et al., 2010).**

1.10 Examples

1.10.1 Case 1 (Ureña and Harfin, 2015)

22-year-old patient with anterior open bite, protrusion of the upper incisors with class I molar and almost class I canine (fig. 19).

Figure 19 (a, b) Lateral views at the beginning of the treatment **(Ureña and Harfin, 2015)**

Figure 20 (a, b) Initial panoramic and lateral radiograph **(Ureña and Harfin, 2015)**

In order to align and extrude the upper incisors in a secure way, a 0.016″ TMA wire has to be bent in the anterior part between the right and left canine insets (fig. 21). An activation every 6 weeks is advisable. Extra torque built into the anterior lingual bracket position can help to tip the incisors lingually and reinforce extrusion to correct the anterior open bite. When overjet and overbite are almost normal, clear buttons are bonded to the upper and lower canines and first bicuspids' labial surfaces for vertical rubber bands, used in order to improve canine guidance.

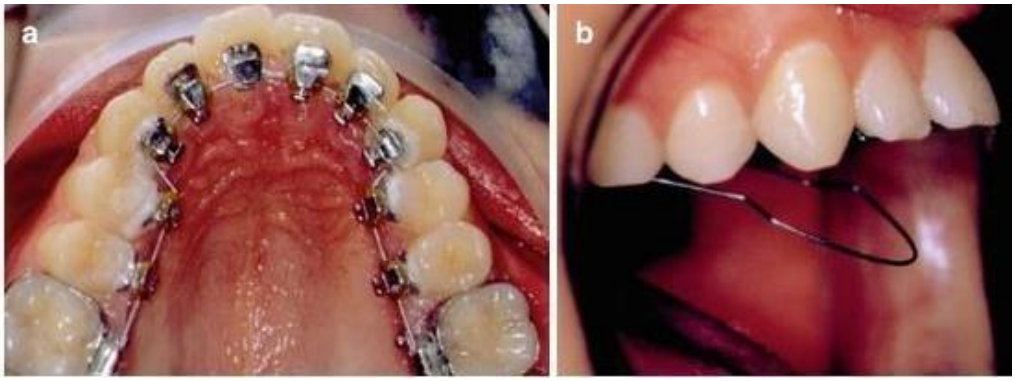

Figure 21 (a, b) 0.016″ TMA wire with an occlusal bend between the upper canines **(Ureña and Harfin, 2015)**

These are the results 20 months after treatment: midlines are centered and a flat occlusal plane is normalized (fig. 22.a). An upper fixed retainer is in place for a long period of time (fig. 22.b). Continuous control with the speech pathologist is advisable.

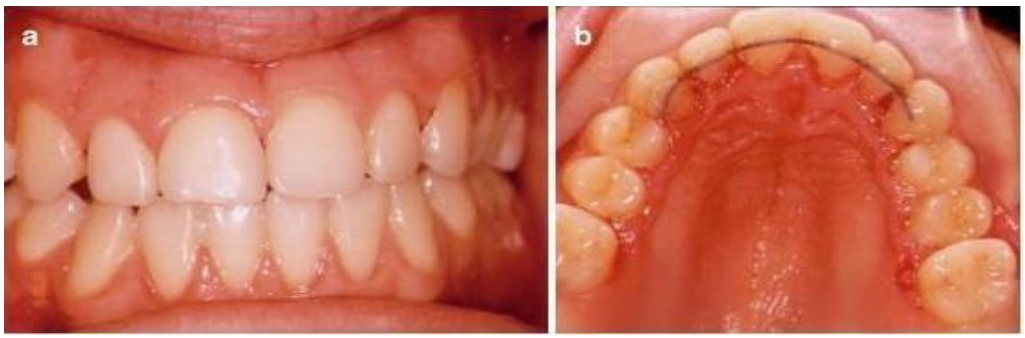

Figure 22 (a, b) At the end of the treatment, a fixed retention wire is advisable for a long time **(Ureña and Harfin, 2015)**

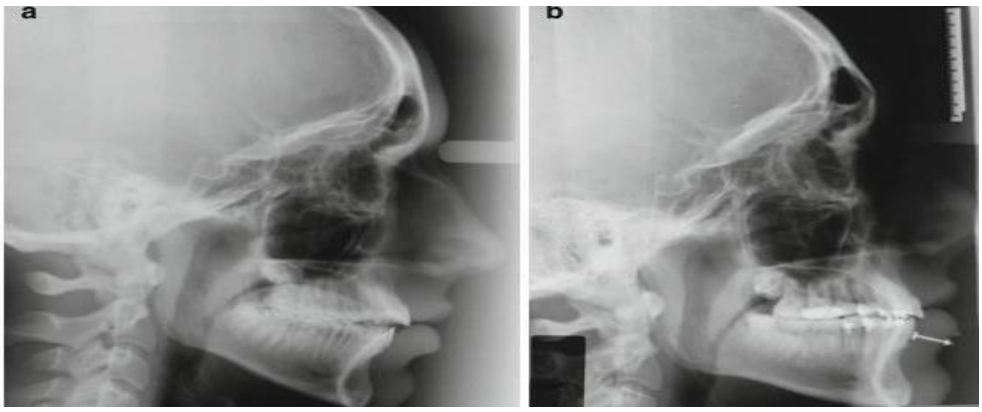

Figure 23 (a, b) comparison of pre and pos lateral radiographs **(Ureña and Harfin, 2015)**

The comparison of the pre- and postlateral radiographs clearly demonstrated the improvement of anterior occlusion, the leveling of the occlusal plane, and the normalization of the overjet and overbite (fig. 23 a, b).

1.10.2 Case 2 (Roberts and Huja, 2016)

14-year-old patient with a bilateral full class II division 2 malocclusion and retroclined upper incisors (fig. 24).

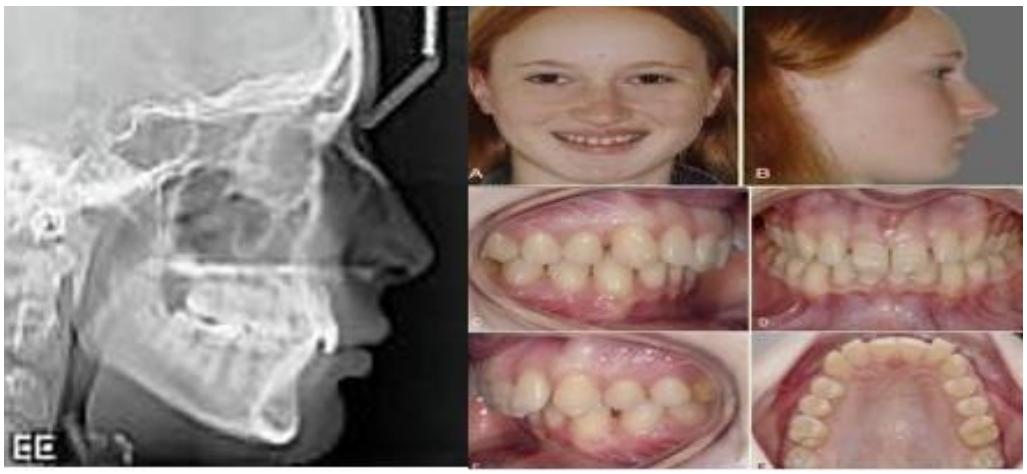

Figure 24 Pretreatment radiograph and photographs **(Roberts and Huja, 2016)**

All brackets were bonded in the first appointment, 0.012-inch round NiTi archwires were placed in both arches (fig.25). To prevent further space opening during leveling, a prestretched power chain was used in the lower arch. Partial extension of the bracket bases on the occlusal surfaces of all second molars helped to prevent bracket debonding and opened the bite.

Figure 25 All brackets were bonded in the first appointment **(Roberts and Huja, 2016)**

Then 0.016- × 0.022-inch NiTi archwires were placed in both arches for further leveling and aligning. After that 0.016- x 0.024-inch stainless steel archwires were placed in both arches (fig. 26).

Figure 26 0.016- x 0.024-inch stainless steel archwires were placed in both arches **(Roberts and Huja, 2016)**

The upper archwire had extra torque of 13 degrees in the anterior region from canine to canine. Buttons were bonded on the labial surface of the lower second molars for Class II elastic wear. After achievement of slight overcorrection of the Class II relationship, 0.018× 0.018-inch beta-titanium archwires were placed in both arches. To prevent space reopening, the wires were vertically bent back distal to the second molars in both arches. The final result and the treatment plan are compared by way of overlying the virtual wire on the treated model in the occlusal view. Upper and lower bonded retainers were placed for retention.

The patient was asked to wear a night activator to stabilize the anteroposterior correction. At the end of leveling and aligning, the torque in the upper front teeth was too negative and prevented achieving a Class I relationship. The torque of the upper canines was also a major obstacle for the lower canines to move forward. Torque was corrected with the upper 0.016 × 0.024-inch stainless steel archwire mainly because of the extra torque built into the anterior area of the wire (fig. 27).

Figure 27 Correction of torque **(Roberts and Huja, 2016)**

Continued attention to torque management is critical to anterior retraction in lingual appliances because of the lingual bracket placement relative to the center of tooth rotation. The patient had to wear Class II elastics full time. Total treatment time was 19 months (fig. 28).

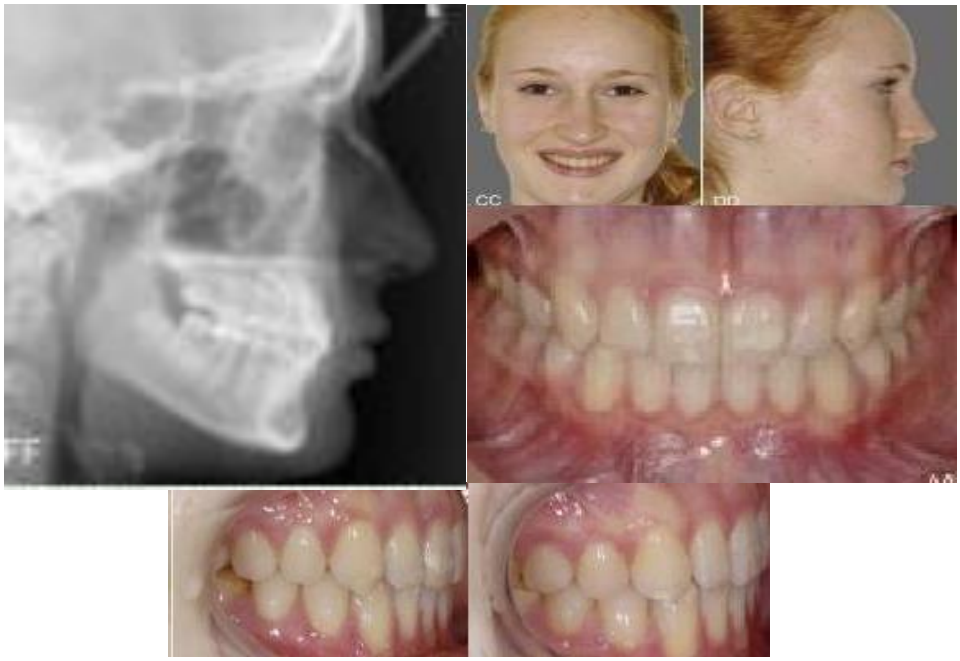

Figure 28 Post treatment radiograph, facial and intraoral photographs **(Roberts and Huja, 2016)**

1.10.3 Case 3 (Anh et al., 2023)

A 28-year-old female patient visited the clinic with the chief complaint of crowding and anterior crossbite. The patient had mild Class III canine and molar relationship on both sides, crossbite on lateral incisors, edge-to-edge bite on central incisors and there was lateral open bite in the canine region (fig. 29). The lateral cephalometric analysis showed a skeletal Class I jaw relationship (fig. 29). The treatment was initiated by bonding all teeth with 0.018×0.025-inch passive self-ligating lingual brackets except maxillary canines and mandibular central incisors due to lack of space. After gaining adequate space with open coil springs, these teeth would be bonded using the individual tooth indirect bonding tray.

Figure 29 Pretreatment radiograph, facial and intraoral photographs **(Anh et al., 2023)**

Archwire sequence wase 0.012, 0.014, 0.016 × 0.016 and 0.016 × 0.022 Nickel-titanium (NiTi) archwires during alignment and 0.016 × 0.022 stainless steel archwire during total arch distalization. After leveling and alignment stage, the incisors were proclined and anterior openbite developed (fig. 30 a). After 6 months of treatment, two miniscrews were inserted in the palatal alveolar bone between maxillary first and second molars and two miniscrews were inserted in the mandibular buccal shelf for total distalization of both arches to reduce incisor proclination and close anterior open bite (fig. 30 b, c).

Figure 30 (a) Anterior open bite after 4 months of treatment, (b) Improvement of anterior open bite after 2 months of two arch distalization, (c) Buccal button for vertical elastic application after 10 months of treatment **(Anh et al., 2023)**

The distalizing forces were applied by power chains from palatal miniscrews directly to lingual brackets of upper anterior teeth and from buccal shelf miniscrews to resin buttons bonded to labial surfaces of lower anterior teeth. After 5 months of distalization, Class I dental relationship was achieved with normal overbite and overjet (fig. 31). Buccal resin buttons were bonded on maxillary left canine, mandibular left lateral incisor, and canine for vertical elastic application. No interproximal striping was performed during the entire progress. All appliances were removed after 12 months of active treatment. Fixed retainers were placed in both arches in combination with nighttime wear of clear retainers to maintain long term stability.

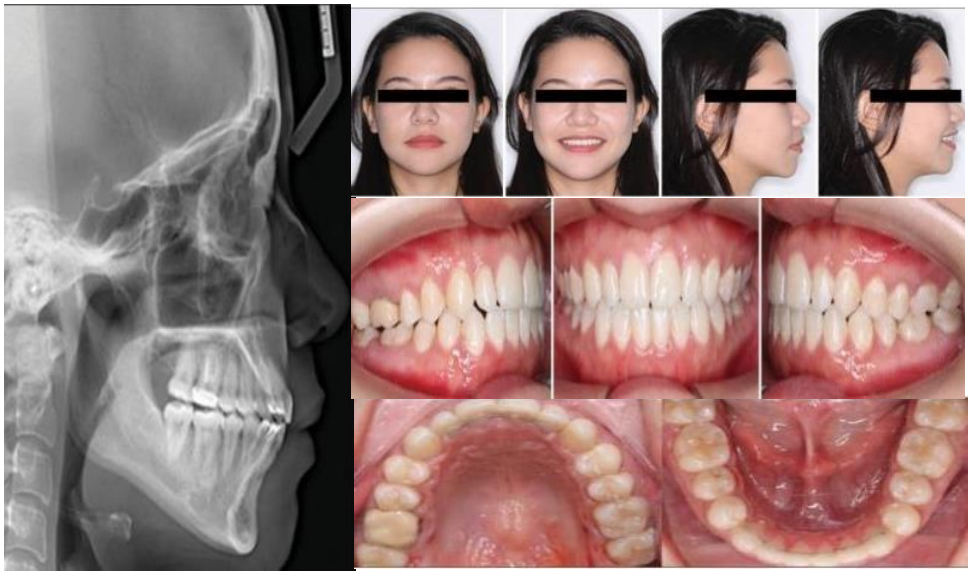

Figure 31 Post treatment radiograph, facial and intraoral photographs **(Anh et al., 2023)**

Chapter two: Discussion

The major advantages of lingual orthodontics are that the appliances are not visible, no damage to labial or buccal surfaces of the teeth. By the same token lingual treatment has inherent disadvantages over labial treatment, brackets are attached to very irregular and inconsistent lingual surfaces, and introduce pain that with customized lingual brackets may be associated with less pain than with the pre-fabricated ones, require specialized technical skills to operator for direct viewing and access, more accurate indirect bracket placement with predictable and accurate indirect bonding procedures is resolving these disadvantages **(Naveed et al., 2020; Shetty et al., 2021)**.

However, lingual orthodontics comprises a relatively new treatment option that has certain differences to the labial orthodontic treatment, mainly attributed to the position of the appliances, even a small height (vertical) deviation in the position of the brackets results in a marked effect on the third- order prescription and how to control the torque, it is crucial to increase lingual root torque **(Roberts and Huja, 2016; Phulari et al., 2011)**.

Lingual appliances may be more effective than labial appliances in achieving intrusion of anterior teeth, maxillary arch expansion and distalization of maxillary molars, but have to take first some consideration before start treatment like periodontal, dental, restorative, extraction and non-extraction consedration **(Bajjad et al., 2020; shetty et al., 2021)**.

The clinician has to know the changes that introduced by lingual appliance in vertical, antero-posterior and transverse planes like the bite opening resulting from the lower incisors occluding on the maxillary incisor bracket bite planes. This bite opening is beneficial in brachyfacial cases, antero-posterior molar correction is easier. In other side have to avoid bowing effect by make retraction with stiffer wire **(Shetty et al., 2021)**.

Chapter three:

Conclusions

- Lingual orthodontic appliances are effective in the treatment of malocclusion, and they represent a good choice for adults where esthetics is a major concern, especially when cost is not a matter.
- Correct diagnosis and treatment planning, patient selection and with the help of lingual orthodontic service laboratories the quality of result obtained with lingual appliance is comparable to ones achieved with labial orthodontic. With the development of customized lingual appliances much of the problems associated with the previous lingual appliances were overcome.

Suggestions

- Conduct a study to compare the efficiency of lingual appliance in treating different malocclusion using different types of brackets.

- Conduct a study to compare the time need to treat different types of malocclusions (classI, II and III) using lingual and labial appliance.

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