Study on the angulation between the labial and lingual surfaces of anterior maxillary teeth for the creation of an innovative concept of an adjustable lingual brace

[1]Dr. Dhruv Yadav, [2]Dr. Rajiv Ahluwalia, [3]Dr Sanjay Labh, [1]Dr. Robin Malik, [1]Dr Mohit Chaturvedi,

[1]PhD scholar, Department of Orthodontics, Santosh Dental College, Santosh Deemed to be University, Ghaziabad

[2]Professor and Head, Department of Orthodontics, Santosh Dental College, Santosh Deemed to be University, Ghaziabad

[3]Professor and Head, Department of Orthodontics, Sarjug Dental College & Hospital, Darbhanga, Bihar

Corresponding Author: Dr. Dhruv Yadav

Abstract

Introduction: The lingual appliance is genuinely an aesthetic device since it is positioned on the lingual surface of the tooth. In comparison to labial appliances, lingual appliances have encountered challenges with sophisticated laboratory procedures, uneven lingual tooth morphology, high cost, and bonding trouble over time.

Objective: The aim of this study was to develop a preadjusted lingual bracket system that will be as efficient as labial orthodontics and can remove laboratory dependency. To accomplish it two parameters namely labiolingual angulation and labiolingual width were studied with the help of cast analysis.

Material & Methods: The sample consists of 100 Dental Casts (Maxillary & Mandible) of patients aged 16-20 years which were selected on the basis of Angle's Class I molar relationship without any crowding, rotation, attrition, abrasion, erosion, abfraction and anomaly on any tooth. Dental models / Impressions were made at Santosh Dental College, Ghaziabad, and were immediately poured by Orthokal at normal room temperature. Two important parameters were studied to develop the concept of the new Preadjusted Lingual Bracket. It includes measurement and comparison of two parameters i.e. (1) Average angulation between the Labial & Lingual surface of the crown of each anterior tooth and (2) Labio-Lingual width of each anterior tooth crown at different heights to compensate for in-out discrepancy of the anterior teeth. These measurements were done on the dental models and compared with the help of appropriate statistical analysis.

Results: In the study with cast conventional method, the maximum mean labio-lingual angulation for central incisor, lateral incisor, and canine was found to be 49.16 ± 5.18º, 49.84 ± 4.59º and 59.08 ± 4.87º respectively. The mean labio-lingual width for all three maxillary anterior teeth ranged from 2.2 ± 0.5mm at 2mm height and 6.64 ± 0.66 mm at 7 mm height, mesially, centrally, and distally in gradation with various dental heights.

Conclusion: Lingual orthodontics' future depends on technological advancements in appliance design, and laboratory operations. The preadjusted lingual system aims to provide a consistent, rapid, and economical way in the future, so many patients will choose Lingual orthodontics. especially adult patients who don't want to wear traditional visible appliances for social or professional reasons and want to maintain their appearance.

Keywords: Angulation, Labial surfaces, Lingual surfaces, Buccolingual width.

Introduction

Fixed lingual orthodontic appliances were first developed in the mid-1970s, owing to a surge in interest in adult orthodontics. These new "invisible braces" were created to provide a vital service to many patients who were hesitant to undergo labial appliance treatment due to aesthetic concerns. Various lingual bracket designs have been employed and often improved over the last ten years in an attempt to promote patient comfort, mechanical efficiency, and accurate tooth alignment.[1]

The lingual appliance is genuinely an aesthetic device since it is positioned on the lingual surface of the tooth and is completely invisible. Aesthetics is one of the key aim of orthodontic treatment and the invisible braces have widened the horizons of society, reaching out to more people, particularly those who are concerned about the appliance's sight.[2,3]

The most recent variants of fixed lingual orthodontic appliances were mostly developed as a result of recent breakthroughs in bonding technology. The wide innovation in the bonding materials, mechanisms enhancing bond strength, and use of orthodontic implants have made lingual orthodontics preferable in a large variety of cases.

In labial orthodontics, the Angle's edgewise appliance was 'non-programmed' and had shortcomings few of them being bracket base perpendicular to bracket stem, bracket bases not contoured occlusogingivally and bracket stems of equal faciolingual thickness. These shortcomings were corrected in the Preadjusted edgewise appliance by Lawrence F Andrews.[4,5] Andrew's straight wire technique is still the choice of most orthodontists due to more consistent results, ease in workability, reduced chair time, less patient discomfort, and less laboratory dependency. The facial axis of the clinical crown (FACC) and the facial axis point (FA point) formed the basis of the Andrews straight wire concept.[4,5]

In comparison to labial appliances, lingual appliances have encountered challenges with sophisticated laboratory procedures, uneven lingual tooth morphology, high cost, and bonding trouble over time. With the present improvement of processes, additional materials and methods have been introduced, making in-office bonding with lingual appliances a possibility.

Lingual orthodontics has been constantly growing, the customization method being the most recent one. However, this customization is limited to the bracket base and bonding material thickness. Very limited work has been done in the past that could develop a 'fully programmed' lingual bracket. A lingual system with the 'preadjusted' concept similar to the labial can be a great possibility if certain parameters favorable in lingual biomechanics are taken care of. These possibly include the FA point, FACC, labiolingual thickness, labiolingual angulation, labial, and lingual surface curvatures, and many more.

Recently, digital imaging is being used widely for pre-orthodontic treatment assessment. Unlike labial treatment which had the advantage of easy access and visibility, lingual treatment faced slower work to bypass this issue. With the advent of digital technology like rapid prototyping, stereolithography, and cone beam computed technology (CBCT), accuracy, lower laboratory dependency, and rapidity can be achieved easily. Latest digital software like Digital Imaging and Communication in Medicine (DICOM) is the latest standard for storing, handling, printing, and transferring information.[6] Use of such technologies permits us for developing a Preadjusted Lingual Bracket System that can remove laboratory dependency and make lingual orthodontics as easy, efficient, consistent, and economical as labial orthodontics.

By combining the conventional dental cast examination as well as CBCT scans, a holistic and accurate pathway can be formulated in the journey of developing the concept of a new preadjusted lingual brace. In this context, the current study looked at cast analysis of two important parameters to develop the concept of a new preadjusted lingual bracket. It includes measurement and comparison of (1) Average angulation between the Labial & Lingual surface of the crown of each maxillary anterior tooth and (2) the Labio-Lingual width of each maxillary anterior tooth crown at different heights to compensate for in-out discrepancy of the anterior teeth.

Material & Methods

The sample consists of 100 Dental Cast (Maxillary & Mandible) of patients in the age group between 16 - 20 years who were selected based on Angle's Class I molar relationship without any crowding, rotation, attrition, abrasion, erosion, abfraction, and anomaly on any tooth.

Dental Casts / Impressions were made at Santosh Dental College, Ghaziabad, and were immediately poured by Orthokal at normal room temperature with the help of a vibrator for 30-40 seconds until large bubbles largely stopped coming to the surface. Approximately 1 hour was given to achieve the maximum strength of the stone.

Two important parameters were studied to develop the concept of a new Preadjusted Lingual Bracket namely- (1) Average angulation between the Labial & Lingual surface of the crown of each maxillary anterior tooth and (2) Labio-Lingual width of each maxillary anterior tooth crown at different heights compensate in-out discrepancy of the anterior teeth. These measurements were done on the dental models and compared with the help of appropriate statistical analysis.

Labio – Lingual Angle – Measurement on the Cast was done by using 0.019 x 0.025 mm Stainless Steel Wire, Labial axis followed the facial axis of the clinical crown (FACC) touching the facial axis (FA) point contouring over the incisal edge to the most prominent part on the lingual surface. [Figure 1]

Labio–Lingual Width –The vertical crown height was measured 2mm from the incisal edge to varying heights of labial bracket placement progressing towards the Cemento Enamel Junction (CEJ) with the help of Boons Gauge. The labio-lingual width of each maxillary anterior tooth was measured with the help of Boley's gauge at every 2 mm along the long axis in the middle of the tooth from the coronal tip upto the CEJ. [Figure 2]

Inclusion criteria

Cast models from patients with full dentition except for third molars; and all permanent teeth in occlusion according to Andrews' keys of normal occlusion.

Exclusion criteria

Odontogenic anomalies, partial dental eruption, and the presence of erupted third molars were used as sample exclusion criteria.

Statistical analysis

The collected data was analyzed by using IBS-SPSS. The appropriate statistical method was used to make cross-tabulation, frequencies, ratios, histograms,and scatter plots. Different parametric and non-parametric measurements such as Pearson correlation test, independent-measures t-test, Anova tests, and the Spearman correlation test were used to analyze the data.

Results

In the study with the conventional method, the maximum mean labio-lingual angulation for central incisor, lateral incisor, and canine was found to be 49.16±5.18º, 49.84±4.59º and 59.08±4.87º respectively. [Table 1]

In our study, central incisor mean labiolingual width at 2mm height was 2.44±0.5mm and at 7 mm height was 6.64±0.66mm mesially, 2.24±0.62mm at 2mm and 6.50±0.64mm at 7 mm height centrally and 2.44±0.5mm at 2mm height and 6.53±0.66mm at 7mm height distally. [Table 2].

In our study, lateral incisor mean labiolingual width at 2mm height was 2.35±0.5mm and at 7 mm height was 6.51±0.66mm mesially, 2.33±0.62mm at 2mm and 6.52±0.64mm at 7 mm height centrally and 2.46±0.5mm at 2mm height and 6.55±0.66mm at 7mm height distally [Table 3].

In our study, canine mean labiolingual width at 2mm height was 2.38±0.5mm and at 7 mm height was 6.52±0.66mm mesially, 2.25±0.62mm at 2mm and 6.50±0.64mm at 7 mm height centrally and 2.39±0.5mm at 2mm height and 6.53±0.66mm at 7mm height distally [Table 4].

Discussion

Most orthodontic problems that can be addressed by standard labial methods, such as tooth malposition, anteroposterior discrepancies, and pre-prosthetic surgical situations, may be corrected using lingual orthodontics.[7] This technique contains of brackets that are specifically intended to be inserted on the lingual surface of the tooth.[8] In comparison to younger patients, adult patients are more hesitant to commit to orthodontic treatment .[9] Because of the growing number of adult patients in orthodontic offices[10], lingual orthodontic therapy has become a preferred treatment option for most people[11].

Kinja Fujita was the first to design lingual orthodontic brackets in 1967. Craven Kurz and Jim tried plastic brackets on the lingual surface of the tooth in the 1975s because they were easier to modify, but they ran into a lot of issues with patient comfort and bonding failures.[12] From the first to the seventh generation (1976-1996), the Kurz lingual bracket grew and evolved.[13] Lingual orthodontics was first popular in Japan in 1970 and as an aesthetic alternative in America.[14] In 1976, the first patient was treated with a lingual appliance in the United States.[15] The issue addressing related to lingual orthodontics has improved through time, and it has enhanced and extended all across the globe.

Lingual orthodontics is a good option for the comprehensive treatment of most malocclusions because the lingual surfaces of the teeth appear to be less prone to caries than the buccal surfaces due to differences in surface morphology, plaque retention, salivary flow, and mechanical cleaning of surfaces by the tongue, and it is the best option for adolescent and adult patients because aesthetic concerns are a big factor for these patients.[16-18] As there are drawbacks to traditional orthodontic treatment, such as a non-esthetic look, there are drawbacks to inserting brackets on the lingual surface, including patient pain, speech issues, and tongue irritation, which may lead to ulcers on the tongue's edge .[19]

On the other hand, owing to anatomical variances in the lingual surface and extensive chair time for patients and orthodontists[20], the practitioner has challenges in the insertion and management of these appliances[21] as well as the precision of bracket placement. Furthermore, brackets may induce changes in tooth shape over time.[22]

The reliability of a custom dental analysis conducted on virtual three-dimensional study models was presented and evaluated in this work. In addition to the conventional linear measurements, the transition from a normal "caliper and protractor" analysis to a virtual three-dimensional analysis permits the introduction of additional instruments and metrics (transverse dimensions, arch depth, and arch perimeter).

The labiolingual angulation and labiolingual width help in providing specific tip and torque values intended for the specific lingual tooth anatomy of specific teeth. The values change with changes in tooth angulation, height and thickness, and surface regularity [Figure 3]. Possible designs can be proposed based on the study as shown in Figure 4. The preadjusted lingual bracket will make lingual orthodontics as efficient as labial orthodontics. As there will be no dependency on the laboratory system, treatment can start faster. With this new bracket system, debonded or lost brackets will not be an issue, however, new randomised controlled trials need to be conducted to generate evidence in this regards.[22] With all this, the ease to work with the lingual appliance will increase, and costs will reduce which will be more economical for the patient.

Conclusion

The future of orthodontics is changing at a breakneck pace. The need for aesthetics is increasing, and lingual orthodontics is becoming well-known. Lingual orthodontics' future depends on technological advancements in appliance design and laboratory operations. The preadjusted lingual system aims to provide a consistent, rapid, and economical way, and so it's the greatest option for adult patients who don't want to wear traditional visible appliances for social or professional reasons and want to maintain their appearance. By combining cast as well as digital analysis, the holistic approach regarding this concept of a preadjusted lingual system can be developed in near future.

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Table 1: Mean and standard deviation of Labio-lingual angle of central Incisor, Lateral Incisor and Canine on conventional cast analysis

Labio-lingual Angle	Central Incisor	Lateral Incisor	Canine
Mean	**49.16 º**	**49.84 º**	**59.08 º**
SD	**5.18**	**4.59**	**4.87**

Table 2: Mean Labio-lingual Width for Central Incisor

Crown height	Labio-lingual Width for Central Incisor (mm)		
	Mesial	**Central**	**Distal**
2mm	**2.442**	**2.242**	**2.442**
3mm	**2.95**	**2.863**	**2.933**
4mm	**3.838**	**3.75**	**3.842**
5mm	**4.254**	**4.379**	**4.275**
6mm	**5.833**	**5.742**	**5.708**
7mm	**6.642**	**6.5**	**6.533**

Table 3: Mean Labio-lingual Width for Lateral Incisor

Crown height	Labio-lingual Width for Lateral Incisor (mm)		
	Mesial	**Central**	**Distal**
2mm	**2.345**	**2.333**	**2.358**
3mm	**2.913**	**2.908**	**2.954**
4mm	**3.749**	**3.825**	**3.742**
5mm	**4.3**	**4.308**	**4.304**
6mm	**5.792**	**5.746**	**5.746**
7mm	**6.513**	**6.525**	**6.546**

Table 4: Mean Labio-lingual Width for Canine

Crown height	Labio-lingual Width for Canine (mm)		
	Mesial	Central	Distal
2mm	2.379	2.246	2.288
3mm	2.946	2.854	2.858
4mm	3.792	3.792	3.738
5mm	4.333	4.258	4.329
6mm	5.671	5.746	5.929
7mm	6.521	6.504	6.529

Figure 1. Measurement of Labiolingual angle

Figure 2: Measurement of Labio–Lingual Width

Figure 3. Effect of variation in shape and height on torque

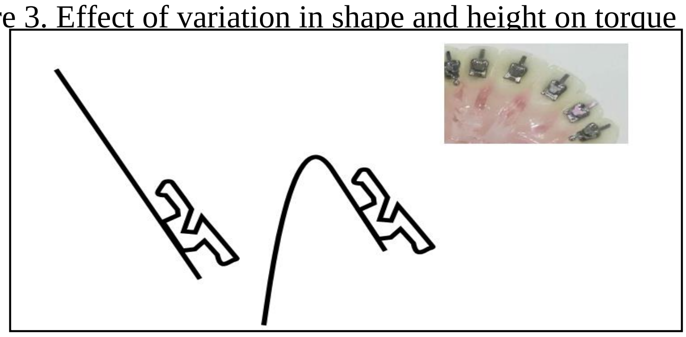

Figure 4. Design proposed based on the study