

An extensive comparative evaluation of the fit of mandibular lingual arch wire bracket to establish ideal lower anterior

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Abstract

Introduction: This study aimed to evaluate the lingual archwire-bracket fit to establish the ideal lower anterior archwire span required for an Indian population.

Materials and Methods: This study was carried out in 120 ideal mandibular casts using commercially available preformed lingual archwires from Rabbit Force (Libral Traders, New Delhi, India) (27mm, 30mm, 31mm), Ormco (Kleen Pak TM System, Glendora, California) (26mm, 29mm) and G&H (Franklin, U.S.A OrthoForce G 4) (27mm, 30mm, 31mm). The brackets from Ormco Generation 7 brackets (0.018 slot), American Orthodontics, Stealth Brackets (0.022 slot), Orthox Orthodontics (0.018 slot) and Panama Orthodontics (0.018 slot)

Results: The results show a difference existing in the commercially available preformed lingual archwire-bracket fit and lower anterior archwire span in Indian population.

Conclusion: This study sheds light on the requirement of more customisation of pre-formed lingual archwires based on the ethnicity prevails.

Keywords: Lingual orthodontics, Lingual archwire, Dental materials, Archwire span.

Introduction

The post orthodontic occlusal stability is enhanced through maintenance of the original inter-canine and inter-molar widths and preservation of the original arch form.¹⁻³ There exist a large variation in arch forms amongst individual members of an ethnic group which depends vastly on their genetic background and habits which in turn leads to a varied pattern of malocclusions.^{4,5} Thus a single ideal arch form to every member of an ethnic group, despite individual variations, may adversely affect post-treatment stability.

Many researchers have attempted to identify a lingual arch form unique to a specific ethnic group.^{6,7} Most of their studies compare standard clinical arch forms derived by measuring arch dimensions using the incisal edges and cusp tips as landmarks.⁸

In lingual orthodontics, there are many confounding factors to keep in mind for maintaining the original arch form and characteristic lingual anatomies of teeth, such as the offset (mushroom shaped arch form), the thickness of bracket base and composite for altering in-out and torque.^{9,10} In preformed archwires, the length of the anterior span gets reduced, leading to a change in the selection of wire idea to that particular arch.

Keeping in mind all the above factors the aim of this extensive study was to assess the following:

1. To compare the anterior demarcation and posterior demarcation reference points which were used to measure the anterior span length.
2. To compare the available pre-formed archwires with the mean anterior span ranges and to evaluate the accuracy of the match between the same.

3. To determine the most suitable and nearly ideal archwire for an Indian population to help the orthodontist on the inventory.

Material and Methods

This in-vitro study was carried out from ideal untreated 120 mandibular casts obtained from the department of orthodontics & dentofacial orthopaedics, Meenakshi Ammal Dental College, Chennai. As per the planned objectives, eight commercially available preformed lingual archwires from three companies along with lower anterior brackets from four different manufacturers were procured.

The Inclusion criteria for the ideal untreated mandibular casts were:

1. No history of orthodontic treatment;
2. Angle Class I molar relationship with arch form symmetry and minimal arch-length & tooth size discrepancy;
3. Complete dentition, excluding third molars;
4. Ideal overjet and overbite;
5. No prosthetic crowns;
6. Minimal restorations; minimal signs of attrition & fracture
7. No ectopic teeth or anomalies in tooth shape
8. No supernumerary or congenitally missing teeth
9. No anterior or posterior cross-bite

A total of 8 lingual mushroom shaped pre-formed NiTi archwires with size configurations of small, medium and large that were chosen for the study are listed below

Lingual Archwires from Rabbit Force (Libral Traders, New Delhi, India)

1. Lower 0.016 NiTi Lingual Mushroom Shaped size 1 Archwire (27mm)
2. Lower 0.016 NiTi Lingual Mushroom Shaped size 2 Archwire (30mm)
3. Lower 0.016 NiTi Lingual Mushroom Shaped size 3 Archwire (31mm)

Lingual Archwires from Ormco (Kleen Pak TM System, Glendora, California)

1. Lower 0.016 NiTi Lingual Mushroom Shaped size 2 Archwire (26mm)
2. Lower 0.016 NiTi Lingual Mushroom Shaped size 3 Archwire (29mm)

Lingual Archwires from G&H (Franklin, U.S.A Ortho Force G 4)

1. Lower 0.016 NiTi Lingual Mushroom Shaped size 1 Archwire (27mm)
2. Lower 0.016 NiTi Lingual Mushroom Shaped size 2 Archwire (30mm)
3. Lower 0.016 NiTi Lingual Mushroom Shaped size 3 Archwire (31mm)

Lower anterior Brackets were grouped as:

1. Group A- Ormco Generation 7 brackets (0.018 slot)
2. Group B- American Orthodontics, Stealth Brackets (0.022 slot)
3. Group C- Lingual Brackets from Orthox Orthodontics (0.018 slot)
4. Group D- Lingual Brackets from Panama Orthodontics (0.018 slot)

Scanning of casts

A total of 120 mandibular casts were scanned with the help of HP scanner F 2400 series in 1:1 ratio along with two rulers, one placed vertically and the other placed sagittally adjacent to the cast for verification. The scanned image was subjected to measurements, and the dimensions of the rulers in the image were compared to the dimensions of the measurement rulers which were placed over the image. This aided in ruling out any magnification errors produced by the image during the scanning process. preformed lower lingual mushroom shaped archwire

Measurements

For the measurements of the anterior span on the wire as well as the casts, the digimizer software (Version 4.2.1 ©MedCalc Software Broekstraat 52, 9030 Mariakerke, Belgium) (Fig.1) was used that allows precise manual measurements as well as automatic object detection with measurements of object characteristics.

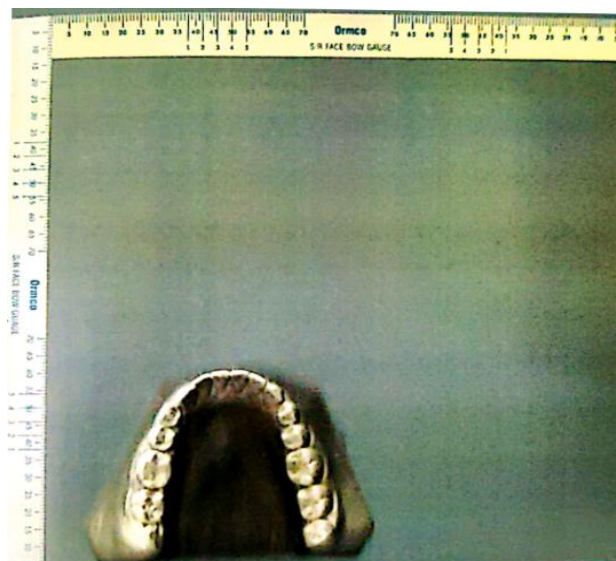


Fig. 1: Scanned image in 1:1 ratio with rulers placed sagittally and vertically.

To measure the possible fit of the lingual arch wire a fixed anterior and posterior demarcation point had to be designated. The midpoint between the long axis of the canine and the contact point between the canine and premolar served as the anterior limit. This point would be slightly posterior to the distal surface of the canine bracket. The canine and premolar contact point served as the posterior limit. The following two measurements were undertaken.

Anterior demarcation (AD)

The right extent of the anterior span was measured at a fixed point equidistant from the long axis of the canine to the contact point of the canine and premolar, this measurement technique was followed on the left extent of the anterior span and then finally the length of the anterior span was measured from right to left points along the middle one third of all the anterior teeth and the measured anterior span of all the 120 samples.

Posterior demarcation (PD)

The precise extent of the anterior span length from the contact point of the canine and premolar was measured along the middle one-third of all the anterior teeth to the contact point of the canine and premolar to the left extent of the anterior span [Posterior Demarcation (PD)]. This posterior span length of all the samples was recorded.

The lingual anatomy of the teeth precludes the use of preformed brackets as received by the manufacturer. The tip, torque and in-out are modified for each patient with the addition of composite at the base of the bracket. This leads to a considerable decrease in the arch perimeter and thereby a change in the length of the anterior span. Henceforth the measurements were successively made without the lingual brackets (Fig. 2) and with the lingual brackets on the scanned images of all 120 mandibular lower casts.

For direct bonding, the standard bracket positioning technique, i.e. HIRO system was adopted, and the procedure was carried out to evaluate the anterior span on the cast among the four groups. 0.017" x 0.025" SS wire was formed into a mushroom shape as per the ideal cast arch form. Brackets were tied to the wire and then bonded with the help of the composite to the lingual surface of the teeth on the cast. Following this, the archwires were removed, and the models were scanned (Fig.3). The same measurement technique has been done as mentioned for the Anterior Demarcation-AD and Posterior Demarcation-PD. This anterior span length of all the 120 casts was recorded.



Fig. 2: AD and PD in ideal casts without lingual brackets using digimizer software.



Fig. 3: AD and PD in ideal casts without lingual brackets using digimizer software.

Range Measurement

The Anterior Demarcation – AD and the Posterior Demarcation – PD point values of the cast which were bonded with brackets were subtracted from the respective values obtained from the cast without brackets. This difference in measurement constituted the difference that occurred because of the thickness of the bracket base and the composite.

The calculated difference for each group was noted and subtracted from the measurements of the one hundred and twenty almost ideal casts to obtain the corrected Anterior Demarcation and Posterior Demarcation limits for each group, respectively.

Statistical analysis was done to find out the mean range for the Anterior Demarcation, and Posterior Demarcation

points for each group, respectively. This mean range of Anterior Demarcation and Posterior Demarcation values were compared with the measured anterior span of the eight pre-formed lingual arch wires to obtain the fit.

Statistical Analysis

The results obtained after measurement of the anterior demarcation and posterior demarcation points were tabulated for all the four groups;

The following statistical formulae were used to calculate the mean and the mean range among the four groups

Arithmetic mean = sum of the measurements/2

To calculate the mean range of the following was used:

$$\text{Mean} \pm \frac{1.96 \times \text{standard deviation}}{\sqrt{\text{number of samples}}}$$

Results

The comparison of the mean range at the 95th percentile of the anterior demarcation and the posterior demarcation reference points and the wire fittings among the four samples groups of the 120 samples is listed in (Table 1). The results of the wires that fit these mean ranges are listed in (Table 2).

From the results the combination of wires in group A shows the mean range that was calculated by using the formula as mentioned above was found to be 28.81mm – 29.40mm and 31.70mm – 32.29mm for the anterior and posterior demarcation points respectively. To this mean range, the available preformed archwires were matched and analysed. It was inferred that the ORMCO Large, G&H Medium, G&H Large, Rabbit Force Medium and Rabbit Force Large were the wires that most accurately fit.

The results for group B shows the anterior and posterior demarcation points was found to be 26.94mm - 27.50mm and 29.70 mm- 30.29mm for respectively. To this mean range. The available preformed archwires were matched and analysed. It was inferred that the ORMCO Large, G&H Small, G&H Medium, Rabbit Force Small and Rabbit Force Medium were the wires that most accurately fit.

Based on the results the group C shows the anterior and posterior demarcation points was found to be 28.94mm - 29.51mm and 31.64mm - 32.23mm respectively. To this mean range, the available preformed archwires were matched and analysed. It was inferred that the ORMCO Large, G&H Medium, G&H Large, Rabbit Force Medium and Rabbit Force Large were the wires that most accurately fit.

Group D results shows the mean anterior and posterior demarcation points were found to be 28.78mm - 29.37mm and 31.60mm - 32.19mm for respectively. To this mean range, the available preformed archwires were matched and analysed. It was inferred that the ORMCO Large, G&H Medium, G&H Large, Rabbit Force Medium and Rabbit Force Large were the wires that most accurately fit.

Table 1: Mean anterior span range calculated in all the four groups

Reference points	Group A (ORMCO) in mm	Group B (AO) in Mm	Group C (ORTHOX) in mm	Group D (PANAMA) in mm
Anterior demarcation	28.81 - 29.40	26.94 - 27.50	28.94 - 29.51	28.78 - 29.37
Posterior demarcation	31.70 - 32.29	29.70 - 30.29	31.64 - 32.23	31.60 - 32.19

Table 2: Wires fitting 95% of the total samples analyzed (nf- not fit; f- fit)

	ORMCO Medium (OM)	ORMCO Large (OL)	G&H Small (GS)	G&H Medium (GM)	G&H Large (GL)	Rabbit Force Small (RFS)	Rabbit Force Medium (RFM)	Rabbit Force Large (RFL)
ORMCO (Group A)	NF	F	NF	F	F	NF	F	F
AO (Group B)	NF	F	F	F	NF	F	F	NF
ORTHOX (Group C)	NF	F	NF	F	F	NF	F	F
PANAMA (Group D)	NF	F	NF	F	F	NF	F	F

Discussion

The dental arch form is an essential element in orthodontics, and it forms the fundamental basis of orthodontic planning and therapy.¹¹ The arch forms, dimensions and variations obtained by orthodontic treatment have been a subject of importance and studies emphasising this is carried out time and again.¹²⁻¹⁴ The literature reveals many studies over the years emphasising the importance of arch form in labial orthodontics, a considerable need for studies assessing these arch forms in the lingual orthodontics exists. With an increasing demand for the patient requirement for nearly invisible orthodontic appliances, the lingual orthodontics is fast gaining popularity.

With the introduction of mushroom-shaped lingual archwires by Fujita, which became a custom template in lingual orthodontics,¹⁰ the need for customisation of archwires became an essential factor. However, this is a time consuming and technique sensitive. To resolve these the use of preformed archwires in lingual orthodontics came to existence. Even though reports were suggesting the various types and variations in the lingual arch forms, the implications of pre-formed archwires and comparison with patient lingual archform have not been subjected to study. Hence this study was designed to assess the lingual archwire-bracket fit in the lingual arch form of the Indian population.

This study analysed the mandibular arch-form as the specific study by Currier in 1969 establishes a strong correlation between the maxillary arch form with that of the mandibular inter-canine width for establishing and maintaining stable orthodontic results.¹⁵ The basic design of this study evaluates the lingual archwire-bracket fit, the most common factor the possible interferes with the tooth movement in lingual mechanics is the offset bends. With the evolution of the lingual straight wire system, there are specific alterations seen in the bracket base to accommodate the minimised offset bends but altering the composite thickness. Hence this offset bends in the lingual archwire

have to be considered while choosing the ideal arch form which can interfere in the tooth movement.

This study varies vastly from the previous studies in consideration of the Anterior and Posterior Demarcation points (AD & PD).^{16,17} The rationale upon consideration of the points is that this particular span of length between AD and PD offers the most comfortable position for the placement of offset bends where it has minimal influence on the tooth movements.

This current study is the first of its kind to assess the lingual archwire-bracket fit, have managed to perform a extensive research incorporating a lingual archwires from Rabbit Force (Libral Traders, New Delhi, India) (27mm, 30mm, 31mm), Ormco (Kleen Pak TM System, Glendora, California) (26mm, 29mm) and G&H (Franklin, U.S.A OrthoForce G 4) (27mm, 30mm, 31mm). The brackets from

Ormco Generation 7 brackets (0.018 slot), American Orthodontics, Stealth Brackets (0.022 slot), Orthox Orthodontics (0.018 slot) and Panama Orthodontics (0.018 slot). From the results of this study, the G&H 31mm and Rabbit force 31mm were the wires that matched the maximum percentage of samples followed by Ormco 29mm. Thus there is a requirement of extensive customisation of existing commercial pre-formed lingual archwires.

Conclusion

This current study assessing the lingual archwire-bracket fit using computerised models replicas has provided sufficient evidence indicating a need for customisation of the preformed lingual archwire in Indian population. However, there remains a vast lacuna in assessing the field of the lingual arch form and its stability post orthodontic treatment. Also, this study has focused only on the Indian population, with more studies assessing across various ethnic groups is more likely to present a bigger picture in the variation of lingual arch forms. Thus the need for more

customisation of pre-formed lingual archwires based on the ethnicity prevails.

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Conflict of Interest: None.

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