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Construction of Individualized Finishing Arch Wire Using the Occlusogram

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Summary

The purpose of this study was to test the premise that by tracing occlusograms at the pre-treatment stage, one can construct a precise finishing arch wire. The sample consisted of 22 male and 20 female dental students with skeletal Class I and near-normal occlusion. Occlusograms were taken for all plaster dental casts with 0.018 x 0.025 slot edgewise pre-angulated and pre-torqued brackets attached to all teeth. Futhermore, our method was applied clinically and an illustrative case is presented. Three different arches (A-arch ; a smooth line drawn through the contact points of anterior and posterior teeth, B-arch ; constructed by drawing a smooth curve through the cusp tips and incisive edges and C-arch ; represented the 0.016 nitinol arch wire) showed a close fit as determined by the fourth degree polynomial equation, with r^2 of 0.99.

Introduction

In clinical orthodontics, diagnosis and treatment planning rely on dental casts constructed for evaluating arch length discrepancy and determination of the finishing arch form. To accomplish treatment objectives, Burstone[1] developed a 1 : 1 photograph of dental cast and labeled it as "occlusogram". Marcotte[10], Deguchi and Teramachi[4] and Teramachi and Deguchi[14] described other methods and the usefulness of occlusograms in treatment planning. The use of occlusogram has also been reported in treatment planning of cleft palate cases[6] and ortho-surgical cases[15]. Furthermore, the occlusogram[1] could be used as a post-graduate educational material for understanding the relationship between growth prediction and arch length analysis. The main objective of occlusograms is to determine the individual ideal arch form, accurate total arch length discrepancy and the degree of anchorage preparation. In growing patients, the occlusograms are used with lateral head films to analyze the two-year growth prediction. In the finishing stage of active treatment, the ideal arch wire could be bent carefully in the mouth at the dental chair side.

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The purpose of the present study was to test the premise that by tracing occlusograms at the pre-treatment stage, one can construct a precise finishing arch wire.

Materials and Methods

The study population consisted of 22 males and 20 females with near–normal occlusion who were students at Matsumoto Dental University Clinic. After obtaining a signed consent form from each participant, upper and lower jaw study casts (Noritake Stone ; Noritake Co. Ltd., Aichi) were prepared for each student using alginate impression (Panacoll ; Nippon Shiken Dental Co. Ltd., Tokyo). Then, 0.018 x 0.25 slot preadjusted edgewise brackets were attached to all teeth using bonding material (Concise ; 3 M / Unitek, Tokyo). The height of brackets in the lower arch was 3.5 mm (incisors), 4.0 mm (cuspid), premolars (4.0 mm) and molars (3.5, 4.0 mm) and in the upper arch was 4.5 mm (central), 3.5 mm (lateral), 5.0 mm (cuspids), 4.0 mm (premolars) and molars (3.5, 4.0 mm). Brackets at rotating teeth were attached by holding the wire passively.

A 0.016 nitinol wire was adapted to each study cast and occlusograms were taken using a DS C–618–A PHOTOPET (Dainippon Screen MFG Co. Ltd., Kyoto), (Figure 1 A, 1 B and 2). The occlusal aspects of dental casts, in which are placed on center of lower table, have been photographed at the same length between the distances from film to lens and from lens to occlusal plane of the cast by this camera.

Arches were constructed on each of the upper and lower occlusograms by drawing three lines ; A–arch, B–arch and C–arch (Figure 3). A–arch represented a smooth line drawn through the contact points of anterior and posterior teeth. B–arch was constructed by drawing a smooth curve through the cusp tips and incisive edges. C–arch represented the 0.016 nitinol arch wire.

Following the construction of A, B and C–arch lines on the upper and lower occlusograms, the distances between two lines were measured separately. The mean and standard deviation of each of the distances were calculated for statistical analysis, and gender differences were examined using the Student's t–test. Coordination between upper and lower arches were statistically evaluated and

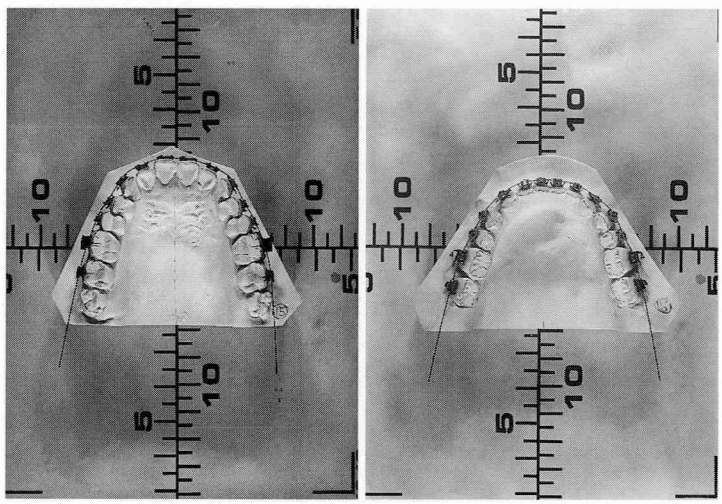

Fig. 1 A **Fig. 1 B**

Fig. 1 A : Occlusogram of the upper dental cast.
Fig. 1 B : Occlusogram of the lower dental cast.

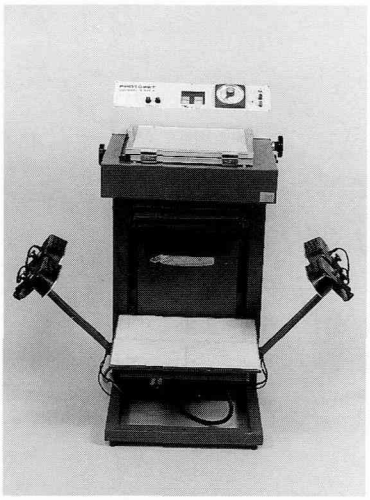

Fig 2 : DS C-618-A PHOTOPET.

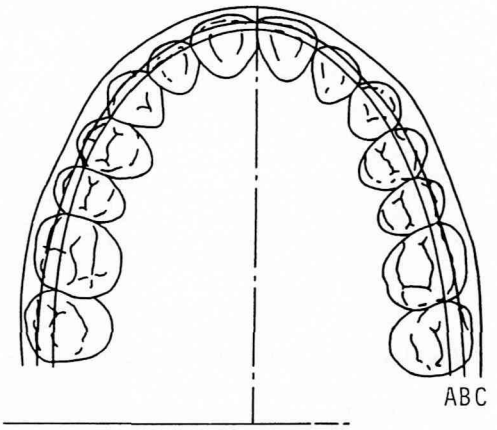

Fig. 3 : Construction of three ideal arches. A ; A-arch is constructed by drawing a smooth curve through the normal cusp tips and incisive edges. B ; B-arch is drawn by connecting all contact points of anterior and posterior teeth by a smooth curved line. C ; C-arch is 0.016 nitinol arch wire.

Table 1 : A fourth degree polynomial curve fits to A, B and C-arches. Numbers are the coefficients of determination (r).

		A-arch	B-arch	C-arch
Upper	Male	0.996	0.995	0.997
	Female	0.992	0.994	0.995
Lower	Male	0.998	0.997	0.998
	Female	0.996	0.9961	0.998

The number shows the coefficient of determination (r^2).

analyzed by applying a fourth degree polynomial equation according to the methods of Iwabayashi[7] and Lu[9] (Table 1).

Results

Curve fitting of three arch lines

To check the fit of these three curves, the coefficient of determination was calculated using multiple regression analysis based on X-Y coordinate. A, B and C-arches were a close fit as determined by direct observation and calculation of the coefficient of determination by the fourth degree polynomial equation ($r^2 = 0.99$, Table 1).

Distance between A-and B-arches

In both the upper and lower occlusograms, the distance between A and B arches was wider toward the posterior teeth. In the upper occlusogram, there was a significant gender difference ranging from 0.3 to 0.5 mm at the sites of second cuspid, first and second molars (Figure 4 A). On the other hand, gender differences were only noted at the site of second molar in the lower occlusogram (Figure 4 B).

Distance between B and C-arches

The largest distance between these two arches was at the site of first bicuspid in the upper arch (Figure 5 A), while the same distance showed a gradual and smooth increase toward the posterior teeth in the lower arch (Figure 5 B). Figure 6 shows the coordinated upper and lower C-arches. The distance in the coordinated upper and lower arches was about 1.3 mm at the sites of incisors, slightly but gradually increased through the cuspids to the first molars then decreased at the second

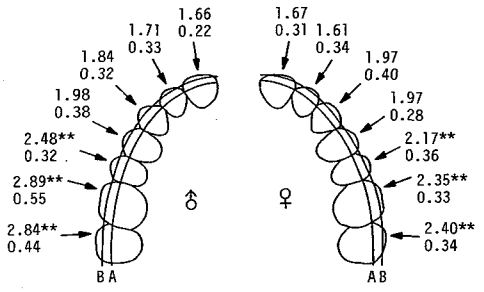

Fig. 4 A

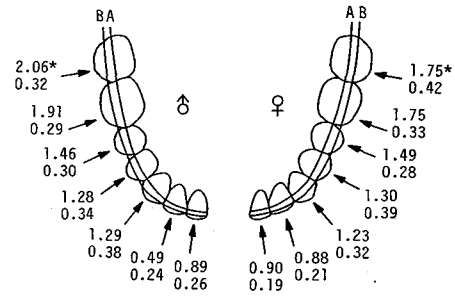

Fig. 4 B

Fig. 4 A : Mean ± SD of the distances between A and B–arches and gender difference in the upper arch. A ; A–arch. B ; B–arch. Significant gender difference : *p<0.05.

Fig. 4 B : Mean ± SD of the distance between A and B–arches in the lower arch. Significant gender difference : **p<0.01. Numbers represent distances in mm.

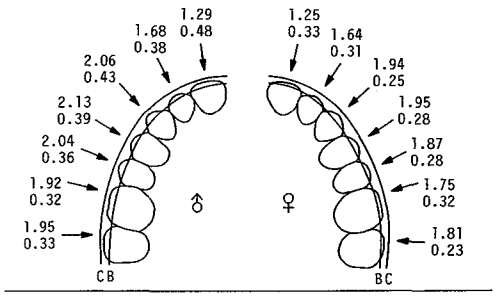

Fig. 5 A

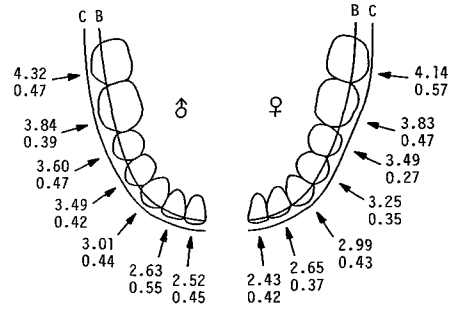

Fig. 5 B

Fig. 5 A : Mean ± SD of the distances between B and C–arches in upper arch.

Fig. 5 B : Mean ± SD of the distance between B and C–arches in the lower arch. Numbers represent distances in mm.

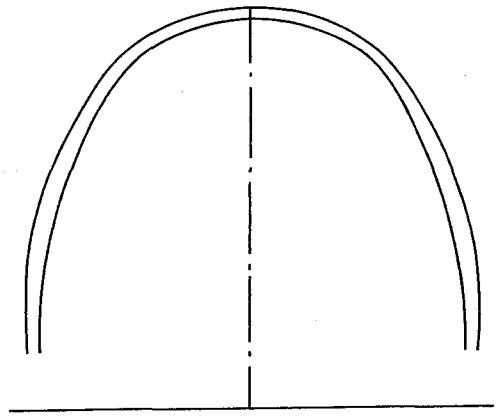

Fig. 6 : Coordinated upper and lower arch wires.

molars.

Case Report

The case was Angle Class I malocclusion with bimaxillary dento–alveolar protrusion (Figure 7). An occlusogram was obtained to analyze the discrepancy between active (total) arch length associated with 4 mm retraction of lower incisors. It showed a maximum anchorage in both upper and lower dentitions. The first four bicuspids were extracted. A, B and C–arches were drawn on tracing paper of the occlusograms (Figure 8). The finishing wire in upper C–arch and the lower C–arch were drawn to compose the coordinated upper and lower arch form (Figure 9). A dental cast at post–treatment is shown in Figure 10.

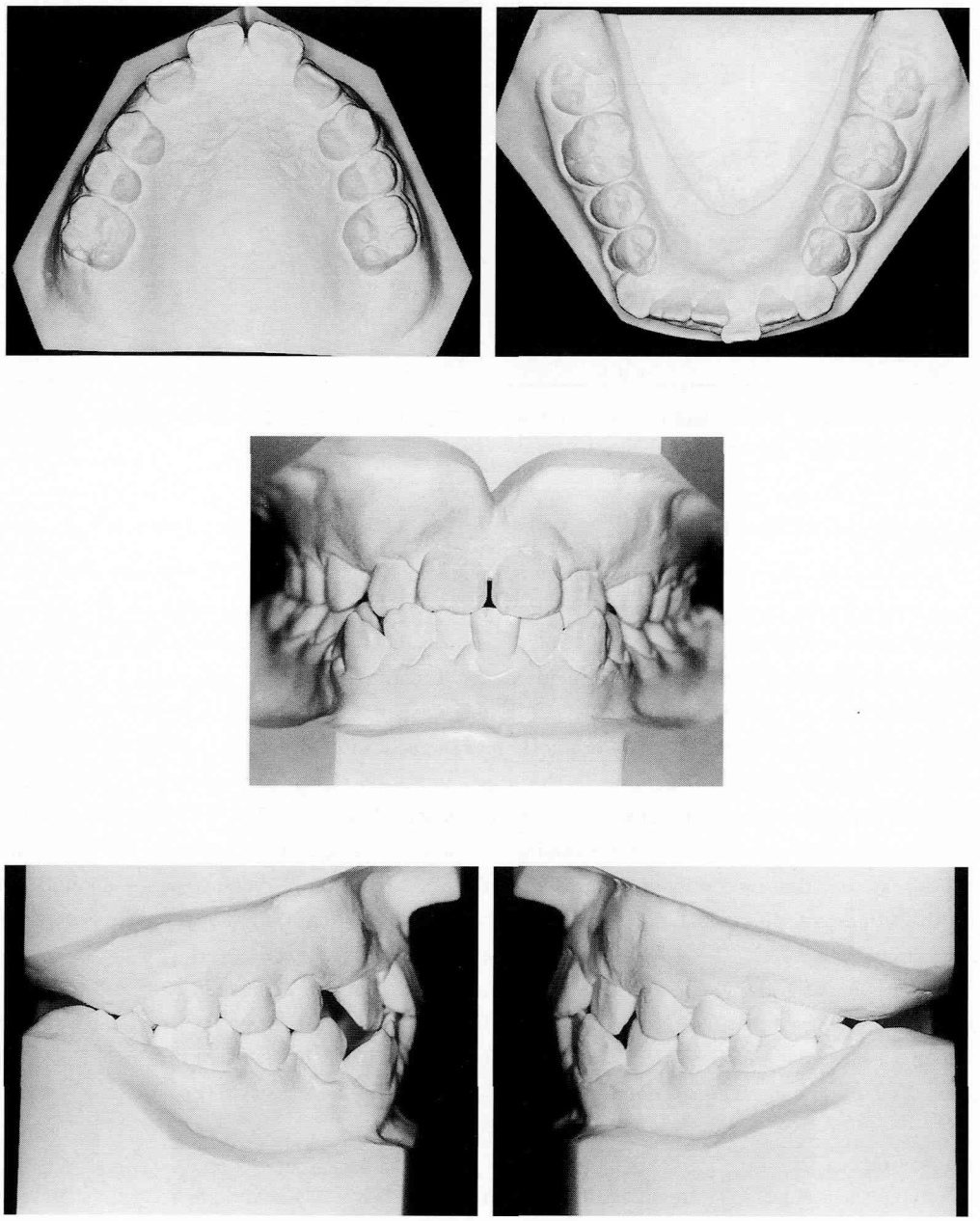

Fig. 7 : A pretreatment dental cast of a Class II patient.

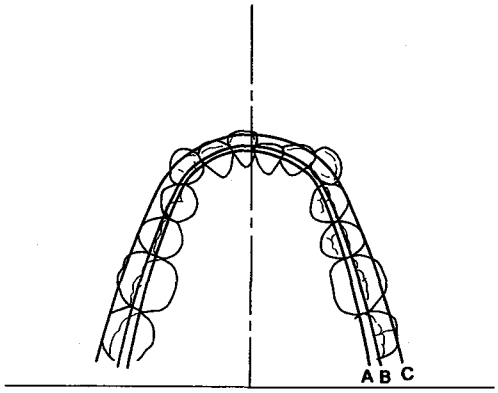

Fig. 8 : Construction of A, B and C arches on the tracing of occlusogram in the reported case.

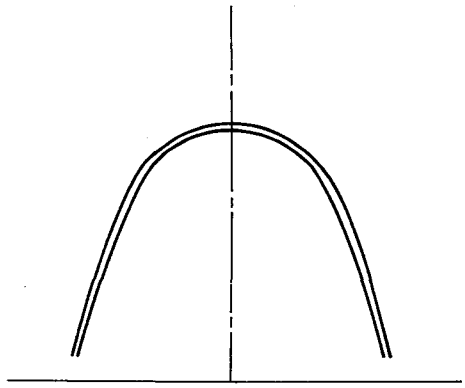

Fig. 9 : Coordinated C–arches of both upper and lower arches.

Discussion

It is known that the arch form is an individual phenomenon[16]. Felton et al[5] reported that 50% of all customized arch forms approximate the cases of three samples. The remaining 50% of the cases showed a wide variety of arch forms. Our study was carried out to determine the validity of using occlusograms to accurately construct an individual ideal finishing arch wire.

Occlusograms are used to draw the B–arch in lower dentition, which fits to A–arch in the upper dentition[1]. However, Marcotte[10], and Teramachi and Deguchi[14] found that the lower arch cusptips (A –arch) are slightly lingual to B–arch in the upper dentition. In the present study, the original method of Burstone[1] was applied due to its simplicity for clinical use. The 4 th degree polynomial equation was selected in this study to examine the curve fit of A, B and C–arches. Although there are other studies that have examined the shape of dental arches[2,3,8,11,13], the present study indicated that the 4 th degree polynomial equation fits quite nicely to the dental arch form, with a coefficient of determination of 0.99[12]. C–arch showed the closest fit to the equation.

We also calculated the mean and standard deviation of the distance between A, B and C–arches. These distances are essential in constructing the finishing arch wire, for both extraction or non–extraction cases. Once lower A–arch was constructed, upper and lower finishing arches are constructed systematically. Then, the individual ideal arch is obtained at each of the patients.

Conclusion

Applying the occlusogram, the individual ideal finishing arch is easily and precisely constructed at the time of pretreatment planning. This method could be useful to understand not only quality of treatment but also series of treatment planning at post–graduate programs in Orthodontics. This is similar to the idea of constructing the tooth positioner using a set–up model. A Japanese girl treated case with Angle Class I malocclusion was presented.

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Fig.10 : A dental cast constructed after treatment.

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抄録：Occlusogram を用いた Individualized finishing arch wire の作製

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本研究は，治療前にトレースしたOcclusogramによって正確な個々の患者のfinishing arch wireを作製することを目的とした．資料はskeletal Class Iで咬合状態もほぼ問題の無い歯学部学生男性22名と女性20名を用いた．Occlusogramは，石膏模型上の全ての歯に0.018 x 0.025 slotのアンギュレーションとトルクが組み込まれているedgewise bracketを装着したものから採得された．さらに本法を臨床応用し，その一例を提示した．トレースしたOcclusogramから得られた三つの異ったarch（A；前・臼歯の接触点を連ねた線，B；咬頭頂・切縁を連ねた線，C；bracket上の0.016インチのarch wireによる線）は，四次多項式で規定された際ほとんど一致した状態を示し，その決定係数；r^2は0.99であった．