ORIGINAL RESEARCH

Sagittal Position of the Upper Incisor in Relation to the Forehead in Peruvian Individuals with Different Skeletal Relationships

José Renatto Bazán-Mendoza[1], Paula Betzabe Arias-Modesto[2], Gustavo Armando Ruíz-Mora[3], Yalil Augusto Rodríguez-Cárdenas[4], Aron Aliaga-Del Castillo[5], Vinicius Dutra[6], Luis Ernesto Arriola-Guillén[7]

Abstract

Aim: The aim of this study was to determine the sagittal position of the upper incisor considering Andrews' analysis based on the position of the forehead in Peruvian individuals with different skeletal relationships.

Materials and methods: This retrospective, cross-sectional study included 212 lateral head radiographs of Peruvian individuals (males: 85, mean age 21.38 ± 6.88, and females: 127, mean age 21.18 ± 6.95), with different skeletal relationships (Class I group = 96, Class II group = 57, Class III group = 59). The values of the ANB, SNA, SNB angles as well as the forehead anterior limit line (FALL) and goal anterior limit line (GALL) points were identified in the radiographs, and then a vertical line was drawn in each point to determine if the upper incisor was positioned forward (protruded), backward (retruded) or within (adequate) these lines. Two trained and calibrated investigators performed all the measurements. The Chi-square test was used to evaluate associations. A p-value < 0.05 was considered statistically significant.

Results: Overall, the sagittal position of the upper incisor showed a significant association with the sagittal skeletal relationship ($p = 0.001$). The upper incisors showed an adequate position (41.7%), protruded position (56.10%), and retruded position (42.40%), for Class I, II, and III skeletal relationships, respectively, as highest percentages in each Class. Statistical significance was found for females only ($p = 0.005$).

Conclusion: Skeletal Class I mainly showed an adequate position of the upper central incisor, whereas for Class II a protruded position was most frequently found, and Class III presented a retruded position.

Clinical significance: Andrews' analysis based on the position of the forehead in Peruvian individuals is a valuable tool for orthodontic diagnosis.

Keywords: Forehead, Skeletal relationship, Upper central incisor.

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Introduction

Cephalometric analysis is still a widely used option for the diagnosis of the soft tissue profile.[1–3] It is based on the determination of reference points, lines, and planes that allow orthodontists to accurately diagnose the sagittal position of the facial structures and, consequently, guide an efficient treatment plan.[4–7] In this regard, several quantitative methods have been implemented for facial analysis to diagnose the sagittal position of the maxillary and dental bases and be able to diagnose if there is lip protrusion or retrusion and plan its correction. However, these methods usually present some inaccuracies in the diagnosis since they are mainly derived from studies including small samples, of only a few racial groups and lack comparisons between clearly different groups in terms of skeletal relationships that provide knowledge of the sensitivity and specificity values.[8,9]

In order to define the ideal sagittal position of the upper central incisors, Andrews suggested the use of the position and angulation of the forehead called "element II" within "the six elements of orofacial harmony."[10] Analysis of element II proposes the evaluation of the optimal anteroposterior position of the upper incisor and uses the forehead as a reference point, since it is considered an anatomical landmark that does not vary over time and can, therefore, be used as a parameter for comparison.[11,12] The aim of the Andrews analysis is to find the ideal position of the upper incisors according to the face, specifically referring to the position of the "Fa" point of the upper incisor with respect to the forehead.[13,14] For this, he proposed to draw

[1,2]School of Dentistry, Universidad Científica del Sur, Lima, Perú

[3]Division of Orthodontics, Faculty of Dentistry, Universidad Nacional de Colombia, Bogotá, Distrito Capital, Colombia; Division of Oral and Maxillofacial Radiology, School of Dentistry, Universidad Científica del Sur, Lima, Perú

[4]Division of Oral and Maxillofacial Radiology, School of Dentistry, Universidad Científica del Sur, Lima, Perú; Universidad Nacional de Colombia, Bogotá, Distrito Capital, Colombia

[5]Department of Orthodontics and Pediatric Dentistry, School of Dentistry, University of Michigan, Ann Arbor, Michigan, United States of America

[6]Department of Oral Pathology, Medicine, and Radiology, School of Dentistry, Indiana University, Bloomington, Indiana, United States of America

[7]Division of Orthodontics and Division of Oral and Maxillofacial Radiology, School of Dentistry, Universidad Científica del Sur, Lima, Perú

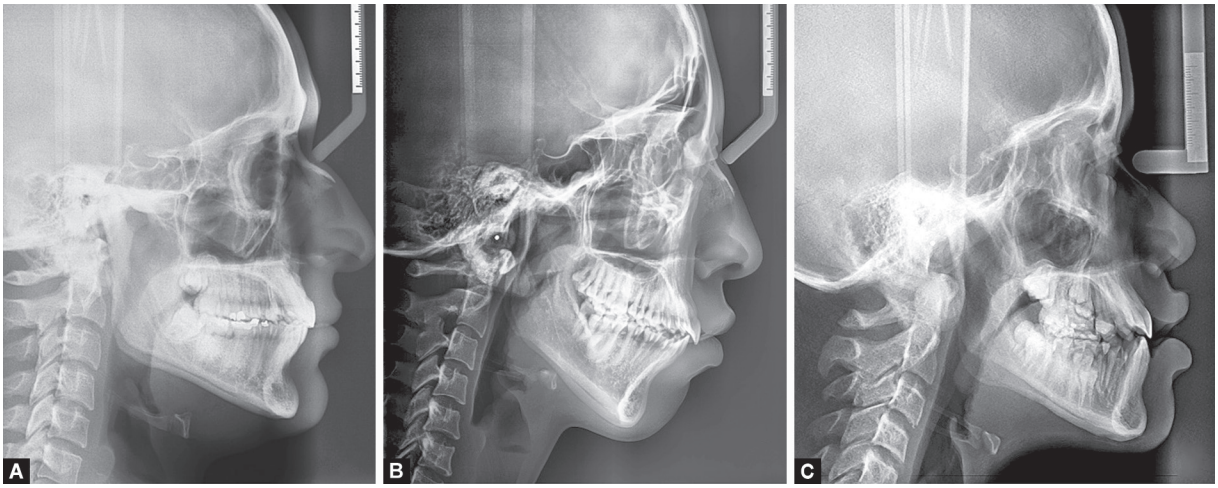
Corresponding Author: Luis Ernesto Arriola-Guillén, Division of Orthodontics, School of Dentistry, Universidad Científica del Sur, Lima, Perú, Phone: +51992124507, e-mail: luchoarriola@gmail.com

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Figs 1A to C: Determination of the FFA point in the upper incisor within of FALL and GALL lines

vertical lines passing through the center of the forehead [forehead anterior limit line (FALL)] and through glabella [goal anterior limit line (GALL)], placing the upper incisor preferably in contact with the FALL line, or between both lines according to each type of forehead, but no further forward than the GALL line.[15–19] However, a comparative study of the differential diagnosis between the different skeletal relationships has not been performed to date.

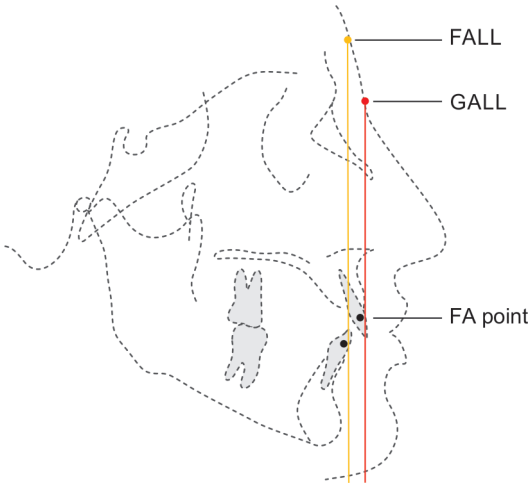
At present, orthodontists and maxillofacial surgeons continue to seek methods that allow determination of the ideal position of the upper incisors quickly in order to make a differential diagnosis.[20] In this sense, the method proposed by Andrews is a diagnostic alternative; however, it was performed in Caucasian and mainly harmonic samples, and the results cannot be generalized. In this way, it is important to carry out these studies in different populations like Peruvians so that the method can have greater external validity. Therefore, studies including Latin American samples and with different skeletal relationships are needed. Therefore, the purpose of this study was to determine the sagittal position of the upper incisor taking into account Andrews's analysis based on the position of the forehead in Peruvian individuals with different skeletal relationships.

Materials and Methods

This observational, cross-sectional, and retrospective study followed the guidelines of the STROBE checklist. Additionally, permissions for the execution were obtained following the guidelines of the Declaration of Helsinki and approval was obtained from the Ethics Committee of the Científica del Sur University, Lima, Peru with the protocol registration number PRE-8-2022-00118. Lateral headfilms of Peruvian individuals of different ages with different skeletal relationships, and of both gender, were measured between January and March 2023. Lateral radiographs of individuals presenting syndromic craniofacial deformities, individuals who had undergone previous orthodontic and orthopedic treatment or were under active treatment, and patients with a history of dentoalveolar trauma were excluded.

Sample Size

The sample size was determined using a sample size calculation formula to compare 2 proportions (the percentage of individuals with Class I skeletal relationship with the incisor in adequate position according to the Andrews analysis vs the percentage of individuals with Class II skeletal relationship) with the following data: confidence level 95%, power of the test 80%, expected proportion 1 = 80% vs expected proportion 2 = 45%. The minimum size required was 23 individuals per group for a total of 69 individuals for three groups. (https://www.fisterra.com/formacion/metodologia-investigacion/determinacion-tamano-muestral/). Finally, 212 lateral headfilms from Peruvian individuals (males = 85 and females = 127), with different skeletal relationships (ANB angle) (Class I group = 96, ANB = 2° ± 2°; Class II group = 57, ANB >4°; Class III group = 59, ANB <0°) were included (Fig. 1).



Figs 2A to C: Representative radiographic images of the sample. (A) Class I; (B) Class II; (C) Class III

Outcome Measurements

All headfilms were deidentified before analysis. The Microdicom software (information regarding the software, Version, Owner, State, Country) was used for the analysis. First, the forehead and glabella points were identified; then a vertical line was drawn on each to determine whether the FFA point in the middle of the buccal surface of upper incisor was positioned forward, backward of within these lines (FALL and GALL) (Fig. 2). Similarly, the Nasion, A and B points were identified to define the skeletal relationship of each patient according to the ANB angle.

Table 1: Initial characteristics of the sample evaluated

	Gender	*n*	*Mean*	*SD*
Age	Male	85	21.38	6.88
	Female	127	21.18	6.95

$p = 0.841$; SD, standard deviation; *t*-test

Table 2: Evaluation of the ANB, SNA, and SNB angles in the three groups evaluated

Variable	*Group*	*N*	*Mean*	*SD*	*Min*	*Max*
ANB	Class I	96	2.70[a]	1.04	0.19	3.95
	Class II	57	6.23[b]	1.48	4.17	9.96
	Class III	59	–2.61[c]	2.02	–9.51	–0.11
SNA	Class I	96	82.92[a]	3.99	72.65	92.64
	Class II	57	85.57[b]	3.80	78.28	95.62
	Class III	59	82.95[a]	3.48	76.66	91.24
SNB	Class I	96	80.67[a]	3.59	71.62	90.23
	Class II	57	81.18[b]	4.69	71.54	91.2
	Class III	59	83.91[c]	3.95	77.14	95.74

Different letters indicate significant difference ($p < 0.001$); One-way ANOVA, followed by *post hoc* Tukey tests; SD, standard deviation

Error Study

Two trained and calibrated investigators performed all the measurements. The training was performed with an expert orthodontist with more than 10 years of experience. For calibration, 30 headfilms were measured twice by the first examiner within a 2-week period. The second examiner measured the headfilms only once. The intraclass correlation coefficient (ICC) and kappa test were used to evaluate intra- and inter-observer reproducibility. Results showed ICC and Kappa values were greater than 0.9 ($p < 0.05$).

Statistical Analysis

Statistical analysis was performed with the statistical program SPSS 27.0 for Windows (IBM, Armonk, NY, USA). Age and gender distribution between groups was compared using *t*-test and Chi-square test. The ANB angle was compared with one-way ANOVA. Chi-square test was applied to evaluate the association between the variables. Subgroup analysis was performed considering gender. Significance level was set as $p < 0.05$.

Results

A total of 212 cephalometric radiographs were evaluated, of which 127 were female individuals with a mean age of 21.18 ± 6.95 and 85 were male with a mean age of 21.38 ± 6.88 $p = 0.841$ (Table 1). For the sagittal skeletal relationship evaluation, 96 patients presented Class I (2.70° ± 1.04°), 57 were Class II (6.23° ± 1.48°) and 59 were Class III (–2.61° ± 2.02°) ($p < 0.05$) (Table 2).

A higher percentage of individuals with adequate position of the upper central incisor (41.7%) was found in Class I group. In the Class II group, 56.10% of the individuals showed protruded upper central incisor position. In the Class III group, 42.40% had a retruded upper central incisor position, showing a significant association ($p = 0.001$) (Table 3).

Likewise, when evaluating this association between skeletal relationships and the position of the upper incisor according to gender, the tendency was the same, being mainly found in women ($p = 0.005$) (Table 4).

Table 3: Association between skeletal relationship and upper incisor position according to Andrews' analysis

Skeletal relationship		*Incisor position*			
		Adequate	*Retruded*	*Protruded*	*Total*
Class I		40	21	35	96
	%	41.70%	21.90%	36.50%	100%
Class II		10	15	32	57
	%	17.50%	26.30%	56.10%	100%
Class III		15	25	19	59
	%	25.40%	42.40%	32.20%	100%
Total		65	61	86	212
	%	30.70%	28.80%	40.60%	100%

Chi-square test; $p = 0.001$

Table 4: Association between the skeletal relationship and the position of the upper incisor according to Andrews' analysis, according to gender

Gender	*Skeletal relationship*		*Position*			
			Adequate	*Retruded*	*Protruded*	*Total*
Male	Class I	*n*	12	9	13	34
		%	35.30%	26.50%	38.20%	100%
	Class II	*n*	3	10	12	25
		%	12.00%	40.00%	48.00%	100%
	Class III	*n*	7	11	8	26
		%	26.90%	42.30%	30.80%	100%
	Total	*n*	22	30	33	85
		%	25.90%	35.30%	38.80%	100%
Female	Class I	*n*	28	12	22	62
		%	45.20%	19.40%	35.50%	100%
	Class II	*n*	7	5	20	32
		%	21.90%	15.60%	62.50%	100%
	Class III	*n*	8	14	11	33
		%	24.20%	42.40%	33.30%	100%
	Total	*n*	43	31	53	127
		%	33.90%	24.40%	41.70%	100%

Chi-square test; $p = 0.259$ (Male), $p = 0.005$ (Female)

Discussion

An alternative for sagittal diagnosis of the position of the upper incisor to obtain a harmonious smile is based on the use of element II of the "6 elements of orofacial harmony" described by Andrews.[3,8,9] This proposal is of interest since it incorporates the use of the forehead as an anatomical structure that presents few changes over time and uses the forehead as a reference for the anteroposterior location of the maxillary incisors. Moreover, several authors have reported a good correlation between the prominence of the forehead and the position of the incisors with the jaws.[8,9,21,22] However, few studies have replicated the evaluation of this method with even fewer studies having been carried out in Latin American groups, which would support the use of this method in individuals with different skeletal relationships. The present study determined the sagittal position of the upper incisor taking into account the Andrews' analysis based on the position of the forehead in Peruvian individuals with different skeletal relationship, since an efficient method would allow a good differential diagnosis.

The results of the present study showed that an adequate position of the incisor was most frequent in the Class I skeletal relationship (41.70%), although this value did not achieve higher values as in other studies.[8,17] In regard to the Class II skeletal relationship, a protruded position was the most frequent (56.10%) and finally, a retruded position of the incisor was the most frequent in the Class III skeletal relationship (42.40%). It is important to note that, although these values were the most frequent, they were not comparable with the values found in Caucasian groups. For example, the Andrews study,[8] compared 94 images of white women with good facial harmony (control) and 94 images of women who required orthodontic treatment (study sample), showing that 93% of the control group population presented an adequate position of the upper central incisor, while in 4% it was in a protruded position and, finally, in 3% it was in a retruded position. In contrast, in the study group, 21% presented upper central incisors located between the forehead facial approximation (FFA) point and the glabella, 64% posterior to the FFA point and 15% anterior to the glabella. However, it was not determined how many individuals with an altered position of the incisor were skeletal Class II or Class III to establish whether the diagnosis of a sagittal position of the incisor was to be expected, and thus, it remains unclear how many individuals with skeletal Class I had a good position of the central incisor. Likewise, another study also evaluated the anteroposterior relationship of the maxillary central incisors with the forehead, using images of 101 white adult males with good facial harmony and 97 white males seeking orthodontic treatment. It was observed that in the control group, the FA point (the center of the incisor crown) was located 3.22 mm anterior to the FFA point, while in the study group the FA point was located 0.31 mm posterior to the FFA point. However, the classification according to the skeletal relationship was not performed.[17]

It is expected that patients with Class I skeletal relationship and dental biprotrusion or biretrusion could present different sagittal position of the upper incisor in relation to the forehead. If skeletal and dental relationships including the anterior teeth are adequate, the central incisor is expected to be in good position. The incisor usually presents in a protruded position in Class II patients, although it may also be in the proper position. Very few Class II patients present the incisor in a retruded position since the skeletal relationship is influenced by the maxilla and mandible, and although Class II patients usually present mandibular retrusion, Class II-1 patients most frequently present dental proclination. In class III, individuals most frequently present maxillary deficiency, although the mandible may be advanced and, therefore, retrusion of the upper central incisor is generally present. Finally, all these tendencies were found in our study and although the values were not the highest percentage wise as in previous studies,[8,17] a logical trend was found, and orthodontists should consider these findings in their treatment plans. Considering gender, this relationship is more frequent in females, and although there was no statistical association in males, a numerical trend was observed. More research in Latin American samples should be performed to know the extrapolation potential of this method in order to ensure the most effective use in orthodontic practices.

Conclusion

According to Andrews analysis, there is an association between the skeletal relationship and the position of the upper central incisor. An adequate position of the upper central incisor was more frequently found in skeletal Class I, while Classes II and III present a protruded and a retruded position, respectively. These values should be considered for orthodontic diagnoses in clinical practice.

Orcid

José Renatto Bazán-Mendoza https://orcid.org/0000-0002-2727-0129
Paula Betzabe Arias-Modesto https://orcid.org/0000-0002-8875-5365
Gustavo Armando Ruíz-Mora https://orcid.org/0000-0002-9954-1047
Yalil Augusto Rodríguez-Cárdenas https://orcid.org/0000-0002-3107-3013
Aron Aliaga-Del Castillo https://orcid.org/0000-0003-3963-1742
Vinicius Dutra https://orcid.org/0000-0002-0534-3067
Luis Ernesto Arriola-Guillén https://orcid.org/0000-0003-0010-5948

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