ORTHODONTIC REHABILITATION OF LOWER INCISOR - LATERAL CEPHALOMETRIC EVALUATION

Alexandrina Muntean[1], Andreea Simona Pop[2*], Ada Gabriela Delean[3], Andrei Ilie Condurache[4], Patricia Soare[5], Viorica Țărmure[6]

[1] Iuliu Haţieganu‖ University of Medicine and Pharmacy Cluj-Napoca, Romania, Faculty of Dental Medicine, Department of Paediatric Dentistry;
[2*] Iuliu Haţieganu‖ University of Medicine and Pharmacy Cluj-Napoca, Romania, Faculty of Dental Medicine, Department of Oral Rehabilitation, Oral Health and Dental Office Management;
[3] Iuliu Haţieganu‖ University of Medicine and Pharmacy Cluj-Napoca, Romania, Faculty of Dental Medicine, Department of Conservative Dentistry;
[4] Cluj County Clinical Hospital, Romania, Resident physician - Laboratory Medicine;
[5] Dentist;
[6] Iuliu Haţieganu University of Medicine and Pharmacy Cluj-Napoca, Romania, Faculty of Dental Medicine, Department of Orthodontics.
* Corresponding author: spopandreea@yahoo.com

ABSTRACT

Lower incisor and its position in mandibular arch and in facial pattern are considered to be particularly important when we establish orthodontic diagnostic and treatment plan. In our study, we aim to determine which dental and skeletal pattern are recurrent in orthodontic patients from urban area (Cluj Napoca, Romania) and correlate the data with lower incisor position and standard cephalometric values. An observational analytic longitudinal prospective study was conducted, based on lateral cephalograms. Cephalometric parameters analysed were: Interincisive Angle, FMIA, IMPA, ANB. The analysis of IMPA, revealed values that are greater than those considered to be the normal. In our study group, FMIA value was significantly and highly correlated with the interincisal angle ($p<0.001$, $R=0.825$). Also, the ANB value was significantly and moderately correlated with the IMPA ($p=0.013$, $R=0.380$). In conclusion, for evaluated group, angular values indicated a more protruding position of the lower incisors.

Key words: lower incisor, angulation, skeletal pattern

INTRODUCTION

Lower incisor and its position in mandibular arch and in facial pattern are considered to be particularly important when we establish orthodontic diagnosis and treatment plan. Many authors agree on lower incisor status in orthodontics, based mainly on aesthetic and stability outcomes [1]. Relation between function and shape, as it is described in the evolutionist principles, can be applied to orthodontic patients in growing period through skeletal and dentoalveolar compensations, since nature need to have, in order to compensate, basic pathology present in the genetic code of the individual [2, 3]. In line with these principles, lower incisor position is associated with mandible appearance in facial complex, as a mechanism of dento-alveolar compensation [4, 5]. Many cephalometric parameters have been proposed to determine the most suitable and stable position of lower incisor, in order to achieve functional and aesthetics results [6].

Incisors are the most anterior teeth in the mouth and for this reason various extraoral and intraoral factors could impact their spatial parameters [7]. At the same time, incisors position and inclination influence on the upper and lower lip posture and static and dynamic smile aesthetics [7, 8, 9]. As facial

soft tissue appearance becoming extremely important in contemporary orthodontic, lower incisor is crucial in treatment evolution and stability [6, 7]. The lower incisors play an essential role because of their very restricted anatomical leeway; excessive tipping may result in significant recession of the gingival margin and in bony dehiscence [8, 10].

In our study, we intend to determine which dental and skeletal pattern are recurrent in orthodontic patients from urban area (Cluj Napoca, Romania) and correlate the data with standard cephalometric values regarding lower incisor. We hypothesized that the lower incisor natural position will be different with skeletal pattern of each person, elements that suggest the importance the cephalometric guidelines individualisation.

MATERIAL AND METHODS

The sample used in the study was obtained from the Paediatric Dentistry Department, University of Medicine and Pharmacy Cluj Napoca, Romania. This study was approved by the University Ethic Committee nr. 221/17.05.2017.

An observational, analytic, longitudinal, prospective study was conducted based on lateral cephalograms with sufficient sharpness to identify the lower incisors and other anatomical structures that are part of the reference planes, from patients aged between 6 to 14 years, that present themselves for clinical evaluation, in order to identify the need for orthodontic treatment.

Inclusion criteria: parental consent, patient age (between 6-14 years); lower incisor fully erupted, absence of general pathology and chronic medication.

Exclusion criteria: general pathology and medication, parental refusal.

After inclusion/ exclusion criteria were applied, 40 patients were selected for the study.

We used lateral cephalograms because it had been considered the best method for diagnosis the lower incisor position before the 3D-tomograph.

The lateral cephalograms were taken with the head stabilized in position by ear rods and nasal support. The Frankfort horizontal plane was set parallel to the floor, and teeth were in centric occlusion.

Lateral cephalograms were made using the same equipment Planmeca ProMax®**,** by the same technician, in order to reduce inter human variation. To obtain the cephalometric measures, cephalometric landmarks were defined by one single examiner, using Dolphin™ software (table I).

Table I. Cephalometric parameters analysed in our study.

Measure	Values	Definition
Inter-incisive Angle	125º± 4	Angle between upper incisor axial axis and lower incisor axial axis.
LI-A-Pg	22º± 4	Angulation of the incisor respect to the dentation plane.
FMIA	65º	Lower incisor inclination respect to Frankfurt plane (Po-Or).
IMPA	90º± 5	Angle between mandibular plane (Me-Go)- and lower incisor.
ANB	2º± 2	The angle formed between point A, nasion and point B

All data were analysed using IBM SPSS Statistics 25. Quantitative variables

were tested for normal distribution using the Shapiro-Wilk Test. Quantitative variables were tested between groups using: Mann-Whitney U/Kruskal-Wallis H tests, Spearman's rho correlations, One-Way ANOVA tests and Pearson correlations. Post-hoc tests were made to further analyse the results obtained in the quantitative variables testing. Significance was set at $p<0.05$.

RESULTS AND DISCUSSIONS

In our study group, the average patient age was 10.05 ± 2.508 years, with a median value of 10 years (table II).

Table II. Average value of patients' age

Aver. ± SD	Min. (years)	Max. (years)
10.05 ± 2.508	6	14

According to gender, male was prevalent compared to female (table III).

Table III. Patients distribution according to gender

Gender	Nr.	Percentage
Female	17	40.5%
Male	25	59.5%

Despite limitations of 2-D image, lateral cephalogram facilitates the evaluation of the spatial relationships of skeletal and dental structures, enhancing diagnosis and treatment plan [11, 12]. The bases of all cephalometric analysis were proposed years ago, and different studies establishes that a valid cephalometric reference should include: reliability, intraindividual reproducibility, low interindividual variability and orientation close to the vertical or horizontal true plane [13].

The analysis of IMPA and FMIA, universally adopted measures to characterize position of mandibular incisors, revealed in our sample values that are greater than those considered to be the normal. Similar evolution was notice for ANB angle, in line with other studies [14] (table IV).

Table IV. Angular values in selected group

Item	Average ± SD	Min.
ANB	3.933 ± 2.68	3.5 (2.375-5.775)
FMIA	62.51 ± 9	62.65 (56.6-68.05)
IMPA	93.92 ± 8.58	92.85 (88.25-98.025)

Patients with dental and skeletal class II were prevalent when compared with class I or III patients (table V).

Table V. Distribution of the patients according to dental and skeletal classes

Class (Nr. / Percentage)	Class I	Class II	Class III
Dental (Angle)	31.7%	65.9%	2.4%
Skeletal (A-Po)	22.5%	65%	12.5%
Skeletal (ANB)	53.8%	43.6%	2.6%

Skeletal class and interincisal angle distribution of the variable is normal, according to the Shapiro-Wilk test (table VI).

Table VI. Comparison of interincisal angle between skeletal classes (A-Po)

Skeletal class	Average ± SD	p* (p=0.852***)
Class I (p=0.455**)	140 ± 15.73	0.006
Class II (p=0.747**)	122.67 ± 13.89	
Class III (p=0.511**)	137.62 ± 16.2	

*One-Way ANOVA Test, **Shapiro-Wilk Test, ***Levene's Test of Homogeneity of Variances

Cephalometric values can be influenced by horizontal and vertical position of the jaw; APo line and IMPA angle, highlighting the need for appropriate tracing in order to eliminate the variability factors [10, 11, 13].

Differences between groups were detected to be significant using One-Way ANOVA test (p=0.006) and post-hoc analysis; patients with skeletal class I have significantly higher values of interincisal angle in comparison with skeletal class II patients (mean difference = 17.37) (p=0.011).

Tweed first highlighted the importance of the lower incisors, underlining the need to position them vertically on the medullary bone of the mandible body, in order to achieve balance and harmony in the inferior facial third [14].

In our study group, differences for FMIA angle were observed in relation with skeletal class (table VII).

Table VII. Comparison of FMIA between skeletal classes

Skeletal class	Average ± SD	Median (IQR)	p*
Class I (p=0.444**)	68.97 ± 7.918	69.5 (61.6-77.1)	<0.001
Class II (p=0.037**)	58.19 ± 7.067	59.5 (54.15-63)	
Class III (p=0.604**)	72.58 ± 6.911	70.4 (66.85-79.4)	

*Kruskal-Wallis H Test, **Shapiro-Wilk Test

Distribution of the variable in skeletal class II patients is non-parametrical (p=0.037). Differences between groups were significant (p<0.001), and post-hoc analysis shows that patients with skeletal class II have a significantly lower median of FMIA (59.5) in comparison to patients with skeletal class III (70.4) (p=0.003) or patients with skeletal class I (69.5) (p=0.005). Our results stress on the importance of accurate identification of lower incisor position, prior to orthodontic displacement, in order to prevent bone loss and radicular resorption.

Discerning the changes accomplished with respect to tooth position and their effects on facial aesthetics, Tweed introduced his concept of "diagnosis triangle" [14, 15]. Downs related incisor inclination to its upper antagonist, the mandibular plane and the occlusal plane. Ricketts integrate the lower incisor in accordance with upper arch development. In addition to the use of the Frankfort mandibular plane, he introduced the APo line as a reference. Both authors, unlike Tweed, draws attention to the importance of positioning the incisors in relation to the occlusal plane, and not fundamentally in relation to the mandibular plane [16].

Data from Figure 1 show the normal distribution of FMIA (L1-FH) and Interincisal Angle (U1-L1). According to the results, FMIA value is significantly and highly correlated with the interincisal angle (p<0.001, R=0.825); patients with a higher FMIA are more associated with higher values of the interincisal angle.

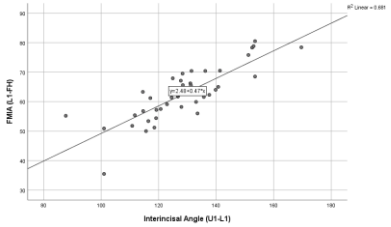

Figure 1. Correlation between FMIA (L1-FH) and Interincisal Angle (U1-L1)

Results in table VIII show the correlation between ANB and IMPA. It can be seen that the ANB distribution in the study is non-parametric (p=0.031); the ANB value is significantly and moderately correlated with the IMPA (p=0.013, R=0.380), patients with a higher ANB are more associated with higher values of IMPA.

Table VIII. Correlation between angles ANB and IMPA

Correlation	p*
ANB (p=0.031**) x IMPA (p=0.096**)	0.013, R=0.380

*Spearman's rho Correlation Coefficient, **Shapiro-Wilk Test

Malocclusion, incisors vertical position, as well as anteroposterior skeletal and vertical skeletal patterns are major factors in dental and facial balance. For better understanding, findings should be gender and ethnic related [16, 17]. Age-related changes might not represent the true growth and development as much as they represent an estimate of the actual biological nature of the subject at that period of time [13, 16].

Functional and stable occlusion and facial beauty represents the main goals of orthodontic treatment. Concepts changed with time and now, it is the soft tissue proportions that receive maximum attention, and not the skeletal proportions. Practitioners started placing importance on the clinical evaluation of the patients and assessment of the soft tissue changes that occurred with each dento-skeletal change, thus helping in better orthodontic treatment planning.

CONCLUSIONS

1. Lateral cephalograms are used to assess craniofacial growth and development.
2. The study group presented radiological features for lower incisor, similar to the standard values, when compared with ANB values.
3. IMPA angle values were higher, indicating a more protruding position of the lower incisors.
4. Class II dento-maxillary abnormalities (both skeletal and dental) had an increased incidence in the selected group of patients compared to class III abnormalities.

REFERENCES

1. 1.Harvold EP. The role of function in the etiology and treatment of malocclusion. Am J Orthod 1968; 54: 883-98.
2. 2.Corelius M, Linder-Aronson S. The relationship between incisor inclination and various reference lines. Angle Orthod 1976; 46:111-117.
3. 3.Romanec C., Dorobat V., Zegan G. Dental-alveolar Compensatory Phenomena of Malocclusion Class II Angle. Lateral Cephalometric Study. RJOR 2011; 3: 67-74.
4. 4.Kim JY, Lee SJ, Kim TW, Nahm DS, Chang YI. Classification of the skeletal variation in normal occlusion. Angle Orthod 2005; 75: 311-319.

5. 5.Ishikawa H, Nakamura S, Iwasaki H, Kitazawa S, Tsudaka H, Sato Y. Dentoalveolar compensation related to variations in sagittal jaw relationships. Angle Orthod 1999; 69: 534-538.
6. 6.Knosel M, Attin R, Kubein-Meesenburg D, Sadat-Khonsari R. Cephalometric assessment of the axial inclination of upper and lower incisors in relation to the third-order angle. J Orofac Orthop 2007; 68: 199-209.
7. 7.Knösel M, Engelke W, Attin R, KubeinMeesenburg D, SadatKhonsari R, GrippRudolph L. A method for defining targets in contemporary incisor inclination correction. Eur J Orthod 2008; 30: 374380.
8. 8.Gutermann C, Peltomaki T, Markic G, Hänggi M, Schatzle M, Signorelli L, et al. The inclination of mandibular incisors revisited. Angle Orthod 2014; 84:109-119.
9. 9.McNamara L, McNamara JA, Jr, Ackerman MB, Baccetti T. Hard- and soft-tissue contributions to the esthetics of the posed smile in growing patients seeking orthodontic treatment. Am J Orthod Dentofacial Orthop 2008; 133:491-4999.
10. 10.Hernandez-Sayago E, Espinar-Escalona E, Barrera-Mora JM, Ruiz-Navarro MB, Llamas-Carreras JM, Solano-Reina E. Lower incisor position in different malocclusions and facial patterns. Med Oral Patol Oral Cir Bucal 2013;18: 343-350.
11. Lamichane M., Anderson N.K., Rigali P.H., Seldin E.B., Will L.A. Accuracy of reconstructed images from cone-beam computed tomography scans. Am J Orthod Dentofacial Orthop 2009; 136:1-6.
12. 12.Mah J., Hatcher D. Three-dimensional craniofacial imaging. Am J Orthod Dentofacial Orthop 2004; 126: 308-309.
13. Madsen D, Sampson W, Townsend G. Craniofacial reference plane variation and natural head position. Eur J Orthod 2008; 30: 532540.
14. 14.Iacob M., Rosu S., Dorobat V., Zetu I. Computer Assisted Interpretation of the Profile Teleradiography – Steiner Analysis.RJOR 2012; 2: 55-59.
15. 15.Tweed CH. The Frankfort Mandibular Incisor Angle (FMIA) In Orthodontic Diagnosis, Treatment Planning and Prognosis. Angle Orthod 1954; 24: 121169.
16. 16.Tweed CH. Was the development of the diagnostic facial triangle as an accurate analysis based on fact or fancy? Am J Orthod 1962; 48: 823840.
17. McNamara JA, Ellis EE. Cephalometric evaluation of incisor position. Angle Orthod 1986; 56: 324344.