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Orginal Article

RELATIONSHIP BETWEEN SAGITTAL POSITION OF LOWER INCISORS AND FACIAL PROFILE ESTHETICS WITH REFERENCE TO VERTICAL FACIAL DIVERGENCE

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ABSTRACT

Objectives: *To compare the sagittal position of the lower incisors and facial profile esthetics among sagittal and vertical pattern.*

Materials and Methods: *This comparative study on 229 participants at deparment of Orthodontics, Armed Forcers Institute of Dentistry, Combined Military Hospital, Rawalpind. Patients aged 20–30 years with no history of orthodontic treatment and a complete dentition up to the second permanent molars were included, while those with dental anomalies, craniofacial deformities, or a history of head and neck trauma or surgery were excluded. Pretreatment lateral cephalograms were obtained, and age and gender were recorded from patient files. Facial growth patterns were assessed using the SN-MP angle, facial profile convexity using Merrifield's Z-angle, and lower incisor inclination using the IMPA. Student t-test and ANOVA were used to compare lower incisor inclination and facial profile among vertical and sagittal patterns.*

Results: *Males were 95 (41.5%). IMPA was significantly higher in the high-angle (100± 9.9) than in the low-angle group (94.8±15.320) (p = 0.004), while the Z angle was significantly lower in the high-angle (66.02±7.880) than in the low-angle group (72.07 ± 11.35) (p < 0.001). Significant differences in IMPA and Z angle across skeletal classes (p < 0.001), with Class II showing the highest IMPA (108.68 ± 5.54) and lowest Z angle (64.59 ± 7.510), while Class III had the lowest IMPA (66.88 ± 6.630) and highest Z angle (90.12 ± 5.970).*

Conclusion: *High-angle participants had more proclined lower incisors and a retrusive profile, while Class II showed the most proclined incisors and flattest profile.*

Key words: *DCephalometry, Growth Patterns, Incisor Mandibular Plane Angle(IMPA), Malocclusion*

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INTRODUCTION

Facial profile convexity, an important aspect of craniofacial aesthetics, indicates the sagittal relation between jaws, commonly evaluated through the Z-angle; lower values signify a higher degree of convexity, characteristic of skeletal Class II malrelation[1]. Skeletal Class III malocclusions are linked to more pronounced Z-angles and a protruded mandible position[2]. Vertical growth patterns affect craniofacial structures, with hypo divergent growth leading to decreased mandibular plane angles, a lower facial height, and increased prominence of the mandible, frequently enhancing the profile's concavity in skeletal Class III malocclusions[3]. Growth patterns that are hyper divergent, noted for greater mandibular plane angles and extended lower facial heights, contribute to facial convexity and are frequently associated with

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skeletal Class II discrepancy[4].

The sagittal alignment of the lower incisors is crucial in developing orthodontic treatment plans[5]. The positioning of lower incisors in the sagittal plane influences facial aesthetics, with protruded incisors in hyperdivergent Class II cases serving as compensation for skeletal mismatches, while retroinclined incisors in hypo divergent Class III cases exacerbate concave facial profiles[6]. Cephalometric parameters such as FMIA, IMPA, and Z-angle evaluate the positioning of incisors, with optimal values of FMIA (65°) and Z-angle (80°) associated with aesthetically pleasing facial proportions in Class I or slight Class II malocclusions[7,8]. Tweed highlighted that for instances of class I, II malocclusion, and bimaxillary protrusion, a value of 90◦ ± 5◦ for the IMPA angle is suggested to attain harmonious facial aesthetics[9]. Margolis was the pioneer in examining the connection between the mandibular incisor's long axis and the mandible's base, a relationship referred to as incisor-mandibular plane angle[10].

Skeletal and dental characteristics exhibit significant variation across different ethnic groups, which can profoundly influence orthodontic diagnosis and treatment planning. Despite this, there is a lack of region-specific research examining the interplay between the inclination of lower incisors, facial profile esthetics, and underlying skeletal patterns in our local population. Understanding these relationships is crucial for developing accurate and individualized treatment strategies. This study aims to fill this gap by providing localized data on the sagittal position of the lower incisors and its correlation with facial profile esthetics across various sagittal and vertical skeletal patterns. The findings are expected to enhance evidence-based clinical decision-making tailored to the unique characteristics of our population.

The present study aimed to compare the sagittal position of the lower incisors and facial profile esthetics among sagittal and vertical pattern.

MATERIALS AND METHODS

This comparative cross-sectional investigation was conducted on 229 participants in the Orthodontics Department, Armed Forces Institute of Dentistry ,Combined Military Hospital Rawalpindi, from January to June 2023, following approval from the Institutional Ethical Review Board (918/Trg/23). Non-probability consecutive sampling was used. The sample size was determined using OpenEpi software, with 5% margin of erros, a design effect equal to 1, a population size of 1000, and an anticipated frequency of 75.6%.11

The inclusion criteria were patients having age from 20 to 30 years with no previous history of orthodontic care and a complete set of teeth up to the second permanent molars. The exclusion criteria included patients with a history of previous orthodontic treatment, dental anomalies related to form, structure, number, or development, craniofacial deformities, facial asymmetry exceeding 2 mm of Menton point deviation from the mid-sagittal plane, cleft lip and/or cleft palate, genetic syndromes, history of trauma, or surgical history in the orofacial region. These data were recorded from patient files.

The study procedure involved obtaining pretreatment lateral cephalograms of patients from the department. Age and gender were recorded from patient files. To ensure accuracy, two operators traced the cephalograms on paper mad up of acetate with a lead pencil. Facial growth patterns were assessed by measuring the sella-nasion to mandibular plane (SN-MP) angle, formed by the intersection of the sella-nasion line and the mandibular plane. Based on this measurement, participants were categorized into three groups: normal divergent (28° ± 5°), hypodivergent (<25°), and hyperdivergent (>33°).12 The facial profile convexity was assessed using Merrifield's Z-angle, which is formed by the intersection of the Frankfort horizontal (FH) plane and a line connecting the soft tissue pogonion to the most prominent point of the lips (Labrale Superior or Labrale Inferior). Its normal range is 70–80°.[12] The position of mandibular incisors was evaluated using the incisors-mandibular-plane angle (IMPA), defined as the angle between the long axis of the mandibular central incisor and the mandibular plane, with a normal range of 90° ± 5°.12 (Fig 1) Inter-observer reliability was assessed on 10 cases using a paired t-test, and results were reliable($p = 0.91$).

The data was analyzed using SPSS 26. Quantitative variables are presented as Mean ± SD, while qualitative variables are represented as frequencies and percentages. Independent samples t-tests and ANOVA were conducted to assess the relationship and compare lower incisor inclination and facial profile among vertical and sagittal patterns, respectively. A p-value of <0.05 was considered the significance threshold.

RESULT

Of total 229 participants, 95 (41.5%) were males and 134 (58.5%) were females. In the 20–25 age group, 122 (53.3%) participants were in the low-angle group, compared to 75 (32.8%) in the high-angle group (p = 0.201), while the 26–30 group had an equal distribution of 16 (7.0%) in both categories. Among males, 60 (26.2%) were low-angle and 35 (15.3%) were high-angle, while for females, 78 (34.1%) were low-angle and 56 (24.5%) were high-angle (p = 0.451). No significant differences were observed. Skeletal classification showed no significant association with gender (p = 0.46) or age (p = 0.30). Among males, 46 (20.1%) were Class I, 36 (15.7%) Class II, and 13 (5.7%) Class III. Among females, 64 (27.9%) were Class I, 58 (25.3%) Class II, and 12 (5.2%) Class III. In the 20–25 age group, 94 (41.0%) were Class I, 79 (34.5%) Class II, and 24 (10.5%) Class III, while the 26–30 group had 16 (7.0%) in Class I, 15 (6.6%) in Class II, and 1 (0.4%) in Class III. (Table I)

Independent samples t-test was used to compare lower incisor inclination and facial profile between high- and low-angle groups. The mean IMPA was significantly higher in the high-angle group (100.00 ± 9.91) than in the low-angle group (94.80 ± 15.32) (p = 0.004, 95% CI: -8.81 to -1.66). Similarly, the Z angle was significantly lower in the high-angle group (66.02 ± 7.88) compared to the low-angle group (72.07 ± 11.35) (p < 0.001, 95% CI: 3.35 to 8.74). (Table II)

ANOVA revealed significant differences in lower incisor inclination and facial profile across skeletal

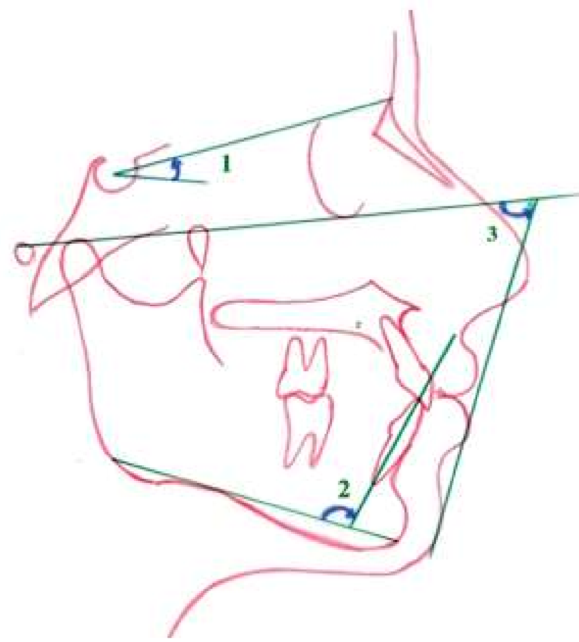

Fig 1: Diagram showing 1: SN-MP, 2: IMPA, and 3: Z angle

Table 1: Distribution of age and gender across both vertical patterns and skeletal classes

Parameter	Variable	Vertical Pattern		p-value	Skeletal Class			p-value
		Low (n, %)	High (n, %)		Class I (n, %)	Class II (n, %)	Class III (n, %)	
Gender	Male	60 (26.2%)	35(15.3%)	0.451	46 (20.1%)	36 (15.7%)	13 (5.7%)	0.460
	Female	78 (34.1%)	56(24.5%)		64(27.9%)	58 (25.3%)	12 (5.2%)	
Age Group	20–25 years	122 (53.3%)	75(32.8%)	0.201	94 (41.0%)	79(34.5%)	24(10.5%)	0.300
	26–30 years	16 (7.0%)	16 (7.0%)		16 (7.0%)	15 (6.6%)	1(0.4%)	

*Chi-square test

Table 2: Comparison of lower incisor position inclination and facial profile among high and low angle (N=227)

Variables	Low angle (N = 138) Mean (SD)	High (N = 91) Mean (SD)	p-value	95% CI for Mean Difference
IMPA	94.80 (15.32)	100.00 (9.91)	0.004	-8.81, -1.66
Z angle	72.07 (11.35)	66.02 (7.88)	<0.001	3.35, 8.74

*Independent samples t test

Table 3: Comparison of lower incisor position inclination and facial profile among skeletal class malocclusion (N=229)

Variables	Class I (N=110)	Class II(N=94)	Class III(N=25)	p
IMPA (degree)	93.62 (4.13)	108.68(5.54)	66.88(6.63)	<0.001
Facial profile - Z angle (degree)	69.35(7.62)	64.59(7.51)	90.12(5.97)	<0.001

*ANOVA test

classes ($p < 0.001$). The mean IMPA was highest in Class II (108.68° ± 5.54), followed by Class I (93.62° ± 4.13) and lowest in Class III (66.88° ± 6.63). Similarly, the Z angle was lowest in Class II (64.59° ± 7.51), followed by Class I (69.35° ± 7.62), and highest in Class III (90.12° ± 5.97), indicating a significant variation in facial profile across skeletal classifications. (Table III)

Tukey's HSD test showed significant differences in lower incisor inclination and facial profile among skeletal classes ($p < 0.001$). IMPA was significantly higher in Class II than in Class I and lowest in Class III. Similarly, the Z angle was lower in Class II than in Class I and highest in Class III. These findings highlight notable skeletal class variations in incisor inclination and facial profile. (Table IV)

In the adjusted analysis, skeletal malocclusion was significantly associated with both IMPA and Z angle. Compared to Class I, Class II malocclusion showed increased IMPA ($\beta = 15.06$, $p < 0.001$) and decreased Z angle ($\beta = -4.76$, $p = 0.006$), indicating more proclined incisors and a convex profile. Class III showed reduced IMPA ($\beta = -26.74$, $p < 0.001$) and increased Z angle ($\beta = 20.77$, $p < 0.001$), reflecting retroclined incisors and a concave profile. Gender and age group were not significantly associated with either outcome. (Table VI)

DISCUSSION

The growth patterns play a crucial role in determining the positioning of the lower incisors and the appearance of the facial profile, with hyperdivergent cases exhibiting proclined incisors and greater convexity. In contrast, hypo-divergent cases show reclined incisors and more linear profiles[1]. Zhang et al. (2022) showed that in hyperdivergent cases, the proclination of the lower incisors offsets skeletal discrepancies, aiding in developing a convex profile[13]. These results are consistent with those of Grippaudo et al. (2013), who demonstrated that vertical growth trends affect the placement of incisors and the skeletal framework, which directly affects facial aesthetics[14].

Skeletal classification has a notable impact on growth patterns and facial characteristics, with Class III being related to retroclination of the incisors and projection of the mandible. At the same time, Class II is connected to proclined incisors, retrusion of the mandible, and convex facial profiles[15,16]. Guo et al. highlighted the supportive function of the lower incisors in addressing skeletal discrepancies throughout different vertical growth patterns and skeletal classifications[17,18]. Rongo et al. emphasized the interactive relationship between skeletal classifications and dental compensations, stressing the necessity of assessing both elements to attain aesthetic balance[8]. Demographic variables like age and gender did not

Table 4: Multiple comparisons of lower incisor position inclination and facial profile among skeletal class malocclusion (N=227)

Variable	Groups		Mean differences	95% CI for Mean differences
IMPA (degree)	class I	class II	-15.05**	-16.72,-13.37
	class I	class III	26.74**	24.10, 29.39
	class II	class III	41.80**	39.11, 44.48
Z angle (degree)	class I	class II	4.75**	2.30, 7.21
	class I	class III	-20.76**	-24.63,-16.89
	class II	class III	-25.52**	-29.45,-21.59

* Tukey HSD;**, Significant p-value

Table 5: Multiple Linear Regression Analysis for IMPA and Z angle

Variable	IMPA			Z angle		
	coefficient (β)	SE	p-value	coefficient (β)	SE	p-value
Intercept	93.62	1.23	<0.001	69.35	1.12	<0.001
Gender (ref: Female)	2.10	1.75	0.230	1.85	1.42	0.195
Age group (ref: 26–30)	1.75	1.90	0.360	-0.92	1.55	0.560
Skeletal Class II (ref: class I)	15.06	1.85	<0.001	-4.76	.73	0.006
Skeletal Class III ref: class I)	-26.74	2.97	<0.001	20.77	2.60	<0.001

demonstrate a considerable effect on growth trends, emphasizing the importance of skeletal and dental indicators, such as Skeletal Class, IMPA, and Z-angle, in influencing craniofacial characteristics and informing orthodontic assessment and treatment strategies[19].

The positioning of lower incisors in the sagittal plane influences facial aesthetics, with protruded incisors in hyperdivergent Class II cases serving as compensation for skeletal mismatches, while retro-inclined incisors in hypo divergent Class III cases exacerbate concave facial profiles[9,10].

These findings emphasize the importance of considering both skeletal classification and growth patterns in orthodontic treatment planning. Understanding how lower incisor position, vertical growth, and facial profile interact can help orthodontists design more personalized treatments that improve both function and aesthetics.

LIMITATIONS

This study has two key limitations. First, its retrospective design limits the ability to establish a direct cause-and-effect relationship between lower incisor positioning and facial aesthetics—longitudinal studies are needed for deeper insights. Second, while 2D cephalometric analysis is reliable, it does not fully capture soft tissue dynamics. Future research using 3D imaging could provide a more comprehensive understanding of dental and facial aesthetics.

CONCLUSION

Our findings show that both vertical and skeletal classifications significantly affect lower incisor position and facial profile. Participants with a high-angle growth pattern had more forward-tilted lower incisors and a more retrusive facial profile than those with a low-angle pattern. Similarly, individuals with Class II skeletal patterns had the most proclined incisors and the flattest facial profile, while those with Class III had the opposite pattern. These differences highlight the importance of considering both vertical and skeletal relationships when planning orthodontic treatment.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	MH, US, JA, BA, FYA, EA
Acquisition, Analysis or Interpretation of Data:	MH, US, JA, BA, FYA, EA
Manuscript Writing & Approval:	MH, US, JA, BA, FYA, EA

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.