Correlation Between Degree of Mandibular Incisors Crowding, Lower Incisor Position and Vertical Craniofacial Configuration in Different Malocclusions

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ABSTRACT

Objective: To evaluate the correlation between the degree of mandibular incisor crowding, lower incisor position and vertical craniofacial configuration in different malocclusions.

Study Design: Cross-sectional analytical study.

Place and Duration of Study: Orthodontics department, Armed Forces Institute of Dentistry, Rawalpindi Pakistan, from Jan to Dec 2018.

Methodology: This study was conducted on 100 pre-treatment study casts and lateral cephalographs of orthodontic, aged 10 to 26 years. Patients who presented with complaints of lower incisors crowding were included in the study. The cephalogram tracings, calculations and lower incisor crowding measurements were taken. All the fifteen parameters of vertical craniofacial configuration, lower incisors position and sagittal skeletal base relationship were measured.

Result: Out of 100 patients, 45 were males and 55 were females with a mean age of 16.11 ± 3.53 years. According to this study, there was no statistically significant correlation between the degree of lower incisor crowding and vertical facial proportions and incisor position in studied malocclusions.

Conclusion: The lower incisor crowding was a local and independent discrepancy. It was a frequently encountered problem, successful therapy depends upon several contributing factors that must be identified for successful management.

Keywords: Crowding, Incisors, Incisors protrusion, Malocclusion.

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INTRODUCTION

The mandibular incisor position is important in orthodontic treatment planning and is considered one of the keys in orthodontic diagnosis.[1] The position of lower incisors has a significant contribution to functional occlusion and harmony of the temporo-mandibular joint.[2] Dental crowding is one of the most common malocclusions faced by orthodontists. Common factors that affect the severity of mandibular incisors crowding are the direction of mandibular growth, premature loss of primary molars, mesiodistal tooth width and arch length disproportions,[3,4] the surrounding oral musculature and incisor angular and linear position. Three-dimensional positions of mandibular incisors dictate sagittal and vertical occlusion and intra-arch space conditions. Various angular and linear measurements by different researchers have been derived regarding vertical, sagittal and transverse planes to differentiate the patients with vertical skeletal discrepancies mostly exist with shortcomings.[5] The position of the lower permanent incisor should be assessed in all the three planes of space and relation to the mandibular alveolar processes, bony chin,[6] antero-posterior and vertical composition of the facial complex. The ideal position of lower incisors should be upright over basal bone, commonly known as a neutral zone between tongue and pressure of lower lip,[7] as this space in antero-posterior plane, considered the very restricted field, so it is important to assess lower incisors angulation. Increased proclination of lower permanent incisors may lead to gingival recession and bone dehiscence. Excessive ratiocination can also be deleterious and leads to fenestration.[8] Changes in the inclination of the lower incisors to compensate for the skeletal discrepancy might cause surface remodeling of the mandibular symphysis, affecting its morphology, and was found to be significantly affected by the vertical facial pattern.[9] Implementation of cephalometric radiography in orthodontics has revolutionized the diagnosis, have been extraordinarily useful to in treatment planning procedures by allowing accurate valuations of skeletal and dental mal-relationships.[10] Several cephalometric analyses,[6,8] have been used to facilitate diagnosis by enabling accurate assessment of skeletal and dental relationships occurring in a different type of malocclusions.

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The objective of this study was to evaluate the correlation between the degree of mandibular incisors crowding and lower incisor position and vertical craniofacial configuration in different malocclusions.

METHODOLOGY

This cross-sectional analytical study was conducted at the Department of Orthodontics, Armed Forces Institute of Dentistry (AFID), Rawalpindi Pakistan, from January to December 2018, after approval from the Ethical Committee (ltr no: 905/Trg-ABP 1K2).

Inclusion Criteria: Patients with a full complement of healthy dentition up to the first molar were included in the study.

Exclusion Criteria: All the patients who had a history of trauma and subsequent lower incisors loss, syndromes, supernumerary teeth, missing teeth, prosthetic dentures at the lower anterior segment, previous orthodontic treatment, advanced periodontal diseases and those with congenital anomalies were excluded from the study.

All the patients who reported to orthodontic OPD for treatment of lower incisors crowding were clinically examined.

Pre-treatment lateral cephalo-graph was taken in centric occlusion, and the impression was recorded with Alginate impression material (Cavex CA 37).

Impressions were then poured in hard dental plaster and cast were labelled with name and age of a patient. Calliper and millimetre-scale were used for measurement.

Our investigations were made on 100 study cast and lateral cephalometric radiographs of orthodontic patients aged 10-26 years divided into three groups, group-1, 10-15 years, group-2, 16-20 years and group-3, 21-26 years.

Pertinent information was collected on the proforma.

The sample size was calculated using the WHO calculator, keeping the confidence interval (1-α) at 95%, absolute precision (d) at 0.067, anticipated population proportion (*p*) at 0.864,[11] a total sample size of 99 was calculated, which was rounded off to 100.

The cephalographs tracings, calculations (vertical parameters, sagittal relationships and incisors position) and lower incisor crowding measurements were taken by the same operator; a total of 15 parameters were traced (Table-I).

Table-I: Cephalometric readings.

Cephalometric Analysis		
Measurements	**Norms**	**± SD**
Sagittal Skeletal Relationships		
Sella-Nasion-Point A angle SNA	80˚	± 2˚
Sella-Nasion-Point B angle SNB	78˚	± 2˚
Maxillomandibular differential ANB	0-4˚	± 3˚
WITTS (AO-BO)	F=0 mm, M=-1 mm	-
Facial angle (FA)	87˚	3.6˚
Vertical Relationships		
Sella-Nasion-Mandibular plane angle SN-MP	32˚	±4˚
Frankfort-Mandibualr plane angle FH-MP	25˚	± 4˚
Maxillary-Mandibualr angle MMA	24˚	± 4˚
Posterior face height to anterior face height ratio PFH-TAFH	65%	± 4%
Lower face height to anterior face height ratio LFH-TAFH	55%	± 2%
Incisors Position		
Incisor-Mandibular plane angle IMPA	90	± 5˚
Frankfort-Mandibular-Incisor angle FMIA	54˚	6.8˚
Lower incisor-Point A-Pognion LI-A-Pog	22˚	± 4˚
Lower incisor-Nasion point B line LI-NB	4mm	-
Lower incisor-Nasion point B line: Lower incisor-A Pognion line LI-NB:LI-Pog (Holdaway Ratio)	1:1	-

The degree of mandibular crowding was recorded with callipers by subtracting mesio-distal tooth width of permanent mandibular incisors from the arch circumference of the anterior segment. To measure the degree of mandibular incisor crowding, the sample was divided into three groups, mild (1-2vmm), moderate (2.1-4 mm) and severe (>4 mm) according to severity.

Statitiscal Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. Quantitative variables were summarized as mean ± SD and qualitative variables were summarized as frequency and percentages To evaluate the correlation between mandibular incisors crowding and obtained cephalometric findings, Pearson's correlation analysis was performed. Chi-square test was applied to find out the association.

RESULTS

The measurements based on 100 study casts showed the degree of crowding (Figure) was -4.1 mm (range-1 mm to -13 mm).

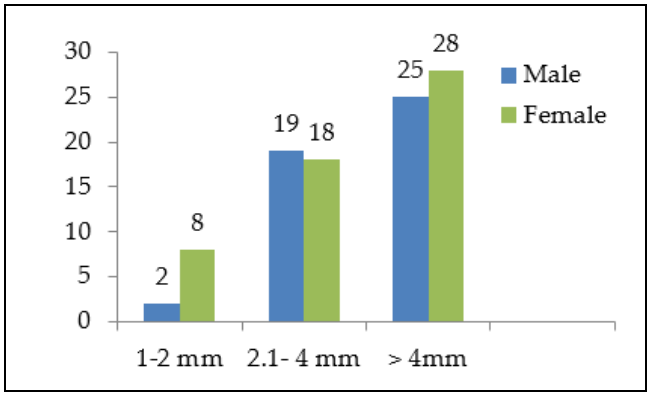

Figure: Degree of lower incisors crowding in study sample.

The results of this study revealed no correlation between mandibular anterior crowding and vertical craniofacial configuration, lower incisors inclination and sagittal incisors positions in different malocclusions (Table-II).

The mean FA was 77˚ (range 66-91˚), LI-A-Pog 25˚ (range 8-44˚), FMIA 61˚ (range 28-108˚), LI-NB 1mm (range 1-9 mm) and Holdaway ratio of 2:1 revealed significant relationship (*p*-value 0.005) between lower incisors crowding and lower incisors relation to the bony chin.

DISCUSSION

The tooth and jaw size discrepancy is often expressed as crowding and spacing. Dentition should be analyzed as an equilibrium between dento-alveolar process and surrounding musculature because the natural oral function relates to the proper position of the inferior incisors within the facial harmony.[12,13]

In this study, the mean degree of crowding was -4.1 mm, these results were similar to a previous study, [11] which showed that patients with tooth size jaw size discrepancy have severe crowding of > 4.0 mm. In this study, lower incisor crowding was primarily dental and unrelated to malocclusions and atypical skeletal patterns.

Tabel-II: Correlation coefficient (r) between lower incisors crowding and vertical configuration, lower incisor position and malocclusion.

Dependent variable(s)		Parameters		Pearson's correlation	
Vertical Parameters	**Mean ± SD**		**Mean ± SD**	**r (correlation coefficient)**	***p*-value**
SN-MP	30.78 ± 6.76	Degree of crowding	-4.9 ± 2.4	-0.066	0.516
MMA	23.11± 6.64	Degree of crowding	-4.9 ± 2.4	0.104	0.303
PFH/TAFH	64.87 ± 7.24	Degree of crowding	-4.9 ± 2.4	-0.017	0.865
LAFH/TAFH	56.31 ± 2.95	Degree of crowding	-4.9 ± 2.4	0.082	0.419
FHMP	25.71 ± 7.69	Degree of crowding	-4.9 ± 2.4	-0.113	0.263
Sagittal Relationship					
SNA	80.25 ± 4.47	Degree of crowding	-4.9 ± 2.4	-0.064	0.528
SNB	77.13 ± 4.47	Degree of crowding	-4.9 ± 2.4	0.035	0.730
ANB	3.20 ± 3.43	Degree of crowding	-4.9 ± 2.4	-0.129	0.200
Witts	1.21 ± 3.93	Degree of crowding	-4.9 ± 2.4	-0.068	0.499
Facial Angle	78.32 ± 4.66	Degree of crowding	-4.9 ± 2.4	0.042	0.681
Incisors Position					
IMPA	99.11 ± 7.97	Degree of crowding	-4.9 ± 2.4	-0.016	0.871
FMIA	58.45 ± 14.71	Degree of crowding	-4.9 ± 2.4	0.140	0.166
LI-A-Pog	23.14 ± 10.54	Degree of crowding	-4.9 ± 2.4	0.018	0.855
LI-NB	4 ± 2.35	Degree of crowding	-4.9 ± 2.4	-0.140	0.166
Holdaway Ratio	259.68 ± 242.63	Degree of crowding	-4.9 ± 2.4	-0.278	0.005

Vertical parameters were within norms such as MMA 20˚ (range 16-40˚), SN-MP 30˚ (range 11-50˚) and FH-MP 30˚ (range 17-47˚). The ratio between lower face height and total anterior face height (LFH/TAFH) was 55% (range 48-65%).

Parameters used to locate lower incisors inclination were IMPA 103˚ (range 80-114˚) showing proclination of mandibular incisors in the studied population. A total of 53% patients fell within skeletal class I malocclusion as revealed by ANB 4˚, class II (36%) and 11% were in class III relationship.

There was no statistically significant difference between vertical skeletal morphology and lower incisor position between the three crowding groups. Thus, the difference in the severity of lower incisor crowding this study and previously cited literature,[14,15] were not contradictory.

In our study, no statistically significant correlation was found between crowding lower incisor and either skeletal facial proportions and lower incisor

position, results were similar with those of Miethke *et al,*[12] and Spasova *et al,*[8] they did not find any significant correlations between severity of mandibular incisor crowding with either skeletal proportions or lower incisor angular and linear position. Berg,[14] studied the crowding of dental arches and reported a significant inverse correlation between anterior cranial base length (S-N), crowding and lower facial height. He also observed children with crowding had significantly decreased mean values for mandibular corpus length.

Goldberg *et al,*[15] observed patients between 9 and 14 years of age with severe crowding and found a steeper mandibular plane, shorter mandibular body len-gth with no increase with age, decreased posterior facial height, and a more downward and backward rotation of the mandible. In this study, vertical parameters were within norms showing no correlation between crowding and vertical craniofacial morphology; these results were not similar to the study done by Rasul *et al,*[16] based on the Pakistani population; their results showed a significant correlation between vertical parameters and lower incisors crowding. The long-term effects of mandibular rotation may affect the position of lower incisors, as stated in the above study that can be evaluated in detail in future research.

The results of another study,[17] revealed that there was a significant correlation between the inclination of lower incisors and the ANB angle. A statistically significant relationship was observed between the mandibular plane in the different malocclusions; lower incisor inclination was higher in dolicofacial patterns. No such relationships were seen in our study; the factors associated with the aetiology of mandibular incisor crowding were not examined in this study. The statistically significant results of relation between the inclination of the lower incisors and the mandibular plane (IMPA) were found in this study similar to previous studies,[18,19] especially in skeletal Class-II malocclusions.

The A-Pog line was used to evaluate the modification that has been done during the orthodontic treatment; in our study, no correlation was found between the A-Pog line and incisors inclination.[20]

In Class-III malocclusion,[21] pronounced divergences of the maxillo-mandibular complex and an obtuse gonial angle were related to retroclinedlower incisors. The observed correlation was stronger in males as compared to females and was incontestably more prominent in preadolescents. The natural lower incisor inclination was dependent on the skeletal pattern, the link between lower incisor inclination and skeletal background was more intensified in late adolescence might be why this association was not fostered in many,[13,17,20] studies. This study found no significant correlations between the degree of mandibular incisors crowding and SNB, LI-NB angle, and FMIA.

A correlation between lower anterior crowding and growth vector of the mandible as a prediction of arch form, final tooth position, and the available space was possible only if the relationship between the skeletal growth pattern and development of the dentition was known.[21] However, Lundstrom,[22] found no correlation among dimensional changes of the arch and developmental stage, changes in the incisor position within the mandible, and direction of mandibular growth. The results of this study were contrary to Bell *et al,*[23] who observed that between the ages of 8 and 14 years, in cases with lower incisor crowding, an increase in lingual crown tipping occurred.

The degree of crowding of lower incisors is considered a mechanism that allows their accommodation in different skeletal relationships. The results of this study could be helpful as lower incisors angulations, proclination and tooth size discrepancies can compromise anterior occlusal and buccal segment relationships during the finishing stages of orthodontic treatment.

CONCLUSION

The lower incisor crowding was a local and independent discrepancy. It was a frequently encountered problem successful therapy depends upon several contributing factors that must be identified for successful management.

Conflict of Interest: None.

Author Contribution

EA: Direct, intellectual (conception, design, analysis), RZ Direct (design analysis), TW: Direct (design analysis data, interpretation), AF:, MK:, FN: Intellectual (data analysis and interpretation).

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