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The correlation between lower incisor crowding and arch length discrepancy (ALD)

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Abstract

Introduction: The estimation of tooth size arch length (TSALD) is an important part of treatment planning in orthodontics. This procedure involves considerable time and efforts on the part of a busy clinician. The purpose of this study was to device a new method of predicting the tooth size arch length discrepancy of dental arches at chair without thorough and cumbersome procedure of measuring all teeth from mesial of the first molar to mesial of the contra lateral.

Material and Methods: Lower incisors were chosen as a standard to assess arch length discrepancy. The study was carried out on 100 patient's casts comprising of 43 males and 57 females. Mean age of patients was 21 years. All sample selected had a permanent set of dentition with a class one molar relation and incisor crowding. The correlation between lower incisor crowding and arch length discrepancy was calculated.

Results The results indicated that there was a moderate correlation between TSALD in lower arch. The correlation coefficient was calculated as 0.673. There was no correlation between lower incisor crowding and upper arch length discrepancy shown by a value of 0.264. Further, chi square test was applied to find an association between the two values (LIC and lower ALD) which showed a p value of 0.00, indicative of strong association.

Conclusion: The study suggests that there is a correlation LIC and ALD which further necessitates research in this area to quantify the correlation.

Keywords: Crowding; arch length; arch perimeter

Introduction

Arch length discrepancy (ALD) is the quantitative measure of space required or space excess in the arch causing a certain degree of malocclusion. ALD may manifest itself as crowding or spacing in dental arches. There is a greater correlation between dental arch size and crowding than between tooth size and crowding.[1] Crowding may occur due to different reasons, for example growth, decrease in dental arch length, maturation, aging of dentition, mesial drift, soft tissue pressures and tooth morphology.[2] As the permanent incisor buds lie lingual as well as apical to the primary incisors, the result is a tendency of mandibular permanent incisors to erupt lingually and slightly irregular. It is important to quantify the amount of crowding within the arches because treatment planning depends on the severity of crowding. For this purpose space analysis using dental casts is required. Space analysis may be done by two methods;

1. Measurement of the discrepancy between total tooth size (sum of mesio-distal widths of all teeth within the arch except molars) and space available (arch perimeter).[3]
2. Little's Irregularity index (degree of slip of any contact point).[4]

In assessment of a crowded dentition, the lower arch takes precedence over the upper arch and is the key to orthodontic diagnosis and treatment planning. Crowding in the mandibular arch most commonly affects the labial segment and it usually manifests itself in the teenage period.[2] A simplified method to determine ALD at chair side can be devised

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i.e. if we could establish a correlation between lower incisors crowding and lower ALD. Lower incisors are chosen to calculate the amount of crowding as they are the ones to erupt first in the oral cavity and can be measured accurately with relative ease. They show little variability in size and number, are directly in the midst of most space management problems and since treatment planning is mostly dependant on the lower arch hence it seems to be the most appropriate grounds for basing the said assessment around the lower arch.

Tooth eruption has a marked affect on the form of dental arches. If teeth fail to erupt properly into arch there may be crowding, rotations, tipping of teeth and resultant loss of arch perimeter. The size of arch is determined by size and alignment of teeth and shape is dependent on the direction of alveolar bone growth.[5,6]

It has been found that the palatal and mandibular lengths and mandibular posterior arch circumference decreases with age. The eruption sequence of teeth especially in the premolar region is an important factor in the decrease in the posterior arch parameters during growth of mandible[7]. The anterior and posterior arch circumferences are dependent on the growth of dentoalveolar complex, the degree of overbite and over jet.[8]

The size and shape of dental arches change form birth to twenty five years with major changes between ages 5 to 7 and than 11 to 13 years during the period of permanent tooth eruption.[5,9] Any disturbance during this period can cause loss of arch perimeter and cause crowding.

Transverse dental dimensions appear to reduce progressively. There has also been a secular trend towards the reduction of the anterior space with an incredible prevalence of crowding.[9]

Begg[10] in 1954 studied living and dead Australian aboriginals and found a very low prevalence of malocclusion. He concluded that loss of inter-proximal hard tissue because of attrition could be able to provide enough space for permanent teeth to achieve an adequate alignment. Corruccini and Whitley [11] supported the Price's hypothesis stating the "Disuse theory" contrary to Begg[10] who emphasized on the decreased function of the masticatory system leading to under development of the jaws. The cause of loss of proximal tooth material in the posterior teeth lacks in the in the modern populations because of refined diets. Conclusively, there is less tooth wear in the modern populations and hence more crowding.

It is paramount to find an easier and less time consuming method to assess TSALD in any busy practice and hence in this study, a correlation between lower incisors crowding and lower ALD was evaluated. This enabled us to assess the ALD by just measuring lower incisor crowding thus simplifying a time consuming procedure and eliminating the need of any radiograph or dental casts.

Material and Methods

The study was carried out at the dental OPD and department of orthodontics, KRL Hospital, Islamabad. The sample comprised of 50 patients. Initially a sample of 100 patients both males and females, age ranging between 15 to 40 years, having class 1 occlusion and lower incisor crowding were selected through non probability purposive technique. Out of these 100 patients, 50 were selected using probability sampling procedure. It took 18 months to complete the study, six months for data collection and 8 months for calculations and compilation of data. The inclusion criteria was; patients with crowded lower and upper arches, patients with full set of permanent dentition except third molars, age group 15-41 years, no history of premature loss of any deciduous teeth, class I crowding. Patients with microdontia, macrodontia, loss of tooth dimensions by caries and attrition, orthodontically treated cases, supernumeraries and cleft lip and palate were excluded.

Impression were taken in alginate (CA37, CAVEX Holland) and poured in orthodontic plaster (Elite, Zhermach Germany). Casts were made out of them. The arch length was measured, using a Boley gauge (Triangle, Pak). The arch was divided into segments from the midline to the mesial of canines, from mesial of canine to distal of canine, from distal of canine to mesial of first molar all around the arch. The measurement of these segments was recorded. The sum of measurements of these segments gave us the space available. The mesio-distal widths of incisor, canine and premolars were measured with the help of Boley gauge. The tooth mass present was calculated by adding the mesio-distal widths of these teeth, this being the space required.

Arch length discrepancy was calculated by the following formula: ALD = Space Available – Space Required

The crowding in the incisor segment was calculated by measuring space available between mesial of canine to mesial of canine on the other side. Space required was calculated by adding up the mesio-distal widths of lower four incisors. Data was recorded on the Proforma (annexure). The ALD of all the casts was re-evaluated by different orthodontists to rule out any inter observer bias. The data was analyzed on SPSS version 13. Descriptive studies like mean and standard deviation were calculated for numerical data e.g. age, arch perimeter. Frequency and percentages were calculated for categorical date and gender. The correlation test was applied to check the relationship between crowding and ALD. P value less than 0.05 was considered as significant.

Results

The overall number of patients selected as having lower crowding with class 1 molar relation and no missing teeth were n=50. Selection criteria were not dependent on number of females or males present in the sample. Figure 2 shows gender distribution. It was made sure that growth was over and there was full complement of teeth in the oral cavity. The mean age of patients selected was 21.2 years with a standard deviation of $\pm$5.22(Table I). Females constituted greater part of the sample (Table II). Cross tabulation of gender with different age categories is shown in Table III which shows significant difference p = 0.017 between gender and age groups. Cross tabulation of lower incisor crowding and lower ALD was also done. It was found that maximum number of patients (30 out of 50 patients) showed lower incisor crowding with a range between -6.5 to 3.6mm and lower ALD with a range -5 to -3mm. Table IV shows correlation between the lower incisor crowding and ALD. The results showed that there was moderate correlation between lower incisor crowding and lower arch length discrepancy. The value calculated was 0.673. There was no correlation between lower incisor crowding and upper arch length discrepancy. The value calculated was 0.264 (Table V). Chi square statistics was applied to show whether there was an association between lower incisor crowding and lower ALD. P value was found to be 0.000 and Pearson chi square value was 32.032 showing strong association between the two parameters. It was also shows that maximum number of patients (48 out of 50 pts) had lower incisor crowding ranging between -6.5 to -3.6mm. Maximum number of patients (25 out of 50 patients) showed ALD between -5 to -3mm.

Table I: Age statistics

Age in Years	
Number of Children	50
Mean Age	22.34
Std. Deviation	6.219
Minimum Age	15
Maximum Age	41

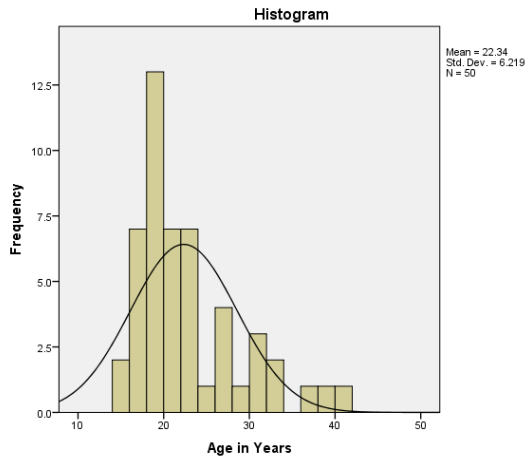

Figure 1

Table II: Frequencies and percentage distribution of gender

Gender	Frequency	Percent
Male	19	38
Female	31	62
Total	50	100

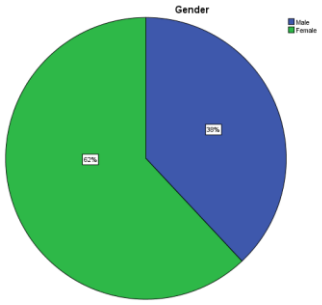

Figure 2:
Gender distribution

Table III: Cross-tabulation of age vs gender

Age Group	Gender		Total
	Male	Female	
Lowest to 20 Years	13	13	26
21-30 Years	4	15	19
31-40 Years	1	3	4
41+ Years	1	0	1
Total	19	31	50

Table IV

		Lower Incisor Crowding in mm	Lower ALD in mm
Lower Incisor Crowding in mm	Pearson Correlation	1	.673**
	P-value		.000
Lower ALD in mm	Pearson Correlation	.673**	1
	P-value	.000	
**. Correlation is significant at the 0.01 level (2-tailed).			

Discussion

Lower incisors play a pivotal role in the dentition. Many studies regarding their position, their mesiodistal width and their relationship to soft tissues have been carried out. Lower incisors show crowding even in the mixed dentition. It has been predicted that the resultant force of dentition is focused at the anterior portion of mandible, crowding occurs in the incisor region.[12] How much crowding occurs during life time is a question that has to be answered. Sayin defined the initial crowding as incisor liability which was quantified as approximately 1.6 mm in normal cases.[2] Age criteria in the present study was preferred to avoid any arch perimeter loss. This is a common incidence in older group of patients due to use, bruxisim or parafunctional habits which in turn may cause more masticatory force and thus proximal loss of tooth material. In all patients above 35 years it was made sure that there aren't any signs of proximal tooth loss. Patients younger than age 15 were avoided to ensure complete eruption of permanent teeth. In some cases maxillary arch ALD showed positive value indicative of extra space available, despite crowding in the lower arch. This kind of pattern was seen in cases having Bolton discrepancy between lower and upper arches. It is not necessary to have crowded upper arch in the presence of lower arch crowding.

When diagnosing patients the clinician needs to consider the impact of other associated

factors. These factors may not be quantified readily and therefore qualitative judgment of how a particular factor increase or decrease in the basic TSALD has to be done. The inclination and antero-posterior position of the incisor affect the arch length analysis. Orthodontic movement of lingually inclined incisors in a labial direction increase arch length and lingual movement of incisors decrease arch length. This can also be applied during the mixed dentition. Future space problems may also be predicted. The clinical implication is that clinicians, who will start treatment in the permanent dentition, can choose whether to pursue a non-extraction or an extraction approach in patients with crowding

Various studies have been carried to determine the correlation between crowding and different parameters of dental arch. These studies have been done on dental casts. Several studies have been done to improve the techniques of determining arch length discrepancy, but all these techniques are of dubious value as they involve a high degree of judgment and cannot display reproducibility.

In 1947 Nance translated Lundstrom's theory into clinical practice. He described the method to measure perimeter by means of 0.010 inch brass wire. The outside Perimeter described by Nance is no more popular although brass wire is still being used

Carey[13] used a 0.02 inch brass wire that bisects the lingual aspect of the inclined planes of buccal cusps of the deciduous molars or premolars and in the anterior region the wire should pass over the incisal edges, a point which the observer judges. Morees[14] presented a variation of brass wire method for measuring dental arch parameter. He used stainless steel tubes welded to a flange. William et al[15] compared the different methods to calculate arch length discrepancy. The purpose of his study was to evaluate the accuracy of two popular methods of estimating ALD (visual estimation method and the brass wire method) and to present a new method for assessing ALD (contact point method) and compared with the current method of evaluating ALD. He concluded that by visual estimation, the senior students had a range of 5.5mm for the cases with greatest disagreement. The case with closest agreement had a range of 2.5 mm.

By the brass wire method the results were less precise. A lack of agreement represented by range in estimation of 12.5 mm was presented in one case. The case with the smallest disagreement represented with a range of 5.5mm. A new method for constructing an individualized contact point arch chart was presented with most accurate and reliable results. Nordeval[16] studied mandibular crowding by comparing a group of adults having approximately ideal occlusion with a group with mild crowding in mandibular anterior segment. The statistical evaluation showed that in the latter group the mesiodistal diameter of the four mandibular incisor teeth was significantly greater where as intercanine width and frequency of presence of third molars were the same in both groups. No significant correlation was observed between the space condition and any of the variables that were studies.

Littles[17] concluded that sum of labio-lingual overlap of six anterior teeth does not give a valid estimate of space deficit. Another drawback is that it gives an estimate of anterior segment only. Mills[18] reported a significant correlation between crowding and arch width. Mckeown[19] evaluated 65 children and found greater correlation between dental arch size and crowding then between tooth sizes and crowding.

Randzic[20] in his study also found that a significant correlation was present between various arch dimensions and dento alveolar disproportions in both ethnic groups which he chose. Arch length and arch perimeter in particular showed significant correlation even at $p<0.001$. The partial regression coefficient for arch perimeter was highly significant

factor considered were mesiodistal width, arch perimeter and estimation of dento alveolar disproportions. Rhee and Nahm[21] carried out studies showing that there was a correlation between crown shapes of lower incisors and crowding. They calculated a correlation coefficient of 0.77 of mesiodistal width at the incisal and cervical areas of lower incisors and lower incisor crowding. Berger[22] concluded that the lower incisor crowding should be considered as result of its relation with antagonist teeth (the maxillary and their very base, the mandible and the chin). Moreover chin acts as a sort of buttress which converges here and which after the mandible has undergone phylogenetic changes makes the point partially vulnerable. Shah[2] in his study focused on the crowns shapes of lower incisors and their effect on crowding. He collected study models of fifty Pakistani untreated subjects (25 females and 25 males) and found that there was a correlation between incisor shape and TALD only in women.

In this study the correlation of lower incisor and ALD was calculated. A moderate correlation was calculated between lower incisor crowding and lower ALD (Pearson correlation of 0.673).This is indicative of the fact that if lower crowding is calculated in a larger sample and given a numerical value, it will be possible to predict the total arch length discrepancy without going through the cumbersome and regular procedure of measuring the space available, space required and then calculating TSALD. In this way norms for a larger population group can be ascertained which will make calculating ALD as a quicker chair side task.

Conclusions

From this study it was concluded that;

1. The lower incisor crowding is independent of gender distribution.
2. The arch length discrepancy of upper arch has no correlation with lower incisor crowding.
3. There is a moderate correlation of lower incisor crowding and lower arch length discrepancy. The correlation shows a p value of 0.001 and correlation value 0.067.
4. There is no correlation between upper and lower arch length discrepancy.
5. There is strong association between incisor crowding and lower arch length discrepancy.
6. There is no association between lower incisor crowding and upper arch length discrepancy
7. A method of prediction of arch length discrepancy at chair side would be possible by evaluating the lower incisor crowding in the oral cavity. If this is established it may be applied to the mixed dentition as well.

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