An Anterior Tooth Size Comparison in Unilateral and Bilateral Congenitally Absent Maxillary Lateral Incisors

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Abstract

The purpose of this study is to compare the anterior tooth size width in patients with congenitally missing maxillary lateral incisors using the Bolton Index and divine proportion. The study sample consisted of thirty pairs of orthodontic models with unilateral (twelve patients; 7 females, 5 males) and bilateral (eighteen patients; 13 females, 5 males) absence of maxillary lateral incisors. The mean ages of the selected cases were 17.7 and 17.5 years, respectively. Descriptive statistics were used for the data analysis. The result showed the mean of the Bolton Index in cases with bilateral absence was closer to the Bolton mean than in cases with unilateral absence. In the unilateral absence cases the width of the existing lateral incisor (5.5 mm) was an average of 1.00 mm less compared to the standard mean (6.5 mm). The divine proportion showed the maxillary central incisors were small in width as indicated by the adjusted value or they were slightly larger in width than the mandibular central incisors. In cases with unilateral and bilateral absence the Bolton Index exhibited maxillary insufficiency, which was confirmed by evaluating the divine proportion of the maxillary and mandibular incisors. The result of the present study will be of great help to both the orthodontist, whether to open or close the space, and to the prosthodontist to restore the missing teeth of patients having missing maxillary lateral incisors.

Keywords: Tooth size, Bolton Index, divine proportion, congenitally missing teeth

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Introduction

The unilateral or bilateral absence of maxillary lateral incisors present challenging problems with respect to treatment planning and mechanical therapy. A comprehensive treatment plan must take into consideration the potential effects of treatment upon the patient's profile as well as the need to estimate the amount and direction of any future growth. Superimposed on these issues are such factors as the position of the maxillary canines, their inclination, size, shape, color, as well as the need for extractions in the mandibular arch to provide optimum occlusion and tooth size relationships.[1] However, there are treatment options, i.e., maintaining the spaces left by missing incisors open for future bridge placement of implants or to orthodontically close the space.

The incidence of missing maxillary lateral incisors has been found to be 5%.[2] Presently there are two theories on the etiology of congenitally missing maxillary lateral incisors that lack sufficient supportive documentation. The first theory is due to an expression of an evolutionary trend to relaxed selection leading to the simplification of man's dentition through reduction in the number of teeth[2], whereas the second is due to a disturbance in the fusion of the embryonic facial development, which may result in the incomplete expression of a primary cleft that is manifested as the absence of the maxillary lateral incisor(s).[3] Moreover, these studies have proposed the absence of maxillary lateral incisors may only be one representation of a complex, multifactorial craniofacial anomaly.[4] A higher incidence of the absence of other teeth, more frequent impaction, and tooth size discrepancies in both arches were found to be in association with the absence of lateral incisors.[5] Reduced tooth size and delayed tooth development were also observed in children with hypodontia of the permanent dentition.[6]

To achieve a harmonious relationship between the maxillary and mandibular arches, it is important to examine the mesiodistal width of the teeth. Bolton[7] developed a method of tooth size comparison, which serves as an aid in the diagnosis and treatment planning of orthodontic cases and in determining the functional and esthetic outcome. In developing the index Bolton compared his figures for tooth size with Wheeler's text book of tooth size dimensions.[8] If there are no discrepancies in tooth size and an ideal overjet and overbite can be established, then by definition in Bolton's Index, the orthodontist should be able to establish an ideal class I, canine protected occlusion.

Ricketts[9] also conducted a study comparing tooth sizes in the mesiodistal dimension. His study researched the biological significance of the divine proportion and the Fibonacci series in the craniofacial complex. This is a geometric proportion of 1.618 and its reciprocal of 0.628. Fibonacci's numbers express precisely the same ratio and are mathematically unique.

Measurements of arch length and tooth size were taken on 104 stable, long-term treated patients. The lower incisor became the basic unit. The upper incisor was divine to the lower incisor. Taking both the upper and the lower central incisor as a ratio, the 1.618 relationship is a mark of dynamic symmetry.

The purpose of this study is to compare the anterior tooth size width in patients with congenitally missing maxillary lateral incisors using the Bolton Index and divine proportion. This will assist orthodontists in establishing the correct diagnosis and treatment of patients with congenitally missing maxillary lateral incisors.

Material and Methods

The Sample

The sample comprised of thirty pairs of orthodontic models with unilateral (twelve patients; 7 females, 5 males) and bilateral (eighteen patients; 13 females, 5 males) absence of maxillary lateral incisors. The mean ages of the selected cases were 17.7 and 17.5 years, respectively. The cases were selected from the dental college at King Saud University and a private practice clinic. The sample selection was based primarily on the availability of good quality dental models.

Measurements

An electronic digital caliper (Digimatic caliper, Mitutoyo, U.K.) was used for measuring the greatest mesiodistal width of each anterior tooth. The procedure for measuring the mesiodistal tooth width was performed as described by Hunter and
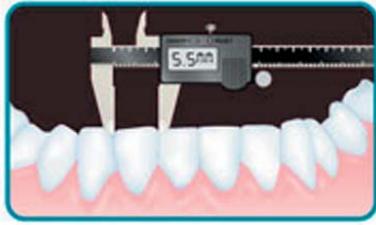
Priest.[10] The caliper beaks were inserted from the buccal (labial) and held occlusal and parallel to the long axis of the tooth. The beaks were then closed until gentle contact was made with the contact points of the tooth. The measurements included the mesiodistal width of all the six maxillary and mandibular teeth from the right permanent canine to the left permanent canine. The measurements were made as carefully as possible to avoid any damage to the casts.

Prediction Equation

From the recorded mesiodistal width measurements of the six maxillary and mandibular front teeth, the Bolton Index was determined for each model. The following formula was used:

Sum mandibular six front teeth (mm) x 100 = 77.2%
Sum maxillary six front teeth (mm)

In cases with an absence of maxillary lateral incisors the maxillary central incisors were used as a reference to determine the ideal mesiodistal width. This was a ratio based upon Wheeler's Index. According to the Wheeler Index, the average size of a maxillary lateral incisor is 8.5 mm and a mandibular lateral incisor is 6.5 mm. This ratio was determined to be 1.31.[8]

When all anterior teeth were measured, the anterior Bolton Index was then calculated using a mean value of 77.2 with a standard deviation of 1.65.

To determine the divine proportion, the mesiodistal widths of the central incisors were measured and calculated. The sum of the mesiodistal widths of the maxillary central incisors was divided by the sum of the mesiodistal widths of the two mandibular central incisors. Based upon this ratio, the mandibular central incisors

were then multiplied by 1.618 to determine the ideal size of the maxillary central incisors based upon the size of the mandibular central incisors.

Statistical Analysis
Descriptive statistics was used for the data analysis.

Results

Measurement Error
In order to determine measurement error seven sets of the dental models were randomly selected from the whole sample. They were measured and then measured again one week later by the same operator. Dahlberg's formula was used for testing the error of the method (EM).
$$EM = \sqrt{s\,(d)^2\,/2n}$$

The result exhibited the highest error was observed in the measurement of the upper left central incisor (0.126), whereas the lowest in the upper right lateral incisor (0.022).

Bilateral Missing Lateral Incisors
Table 1 shows the mean of the maxillary central incisor width was 8.6 mm with standard deviation of 0.62. The minimal and maximal widths were 7.4 and 9.3, respectively. This was also observed when the Bolton Index was calculated. The mean Bolton Index was 79.1 with standard deviation of 3.5 and a range of 74.5 to 84.4.

When the widths of the maxillary central incisors were compared to the widths of the mandibular central incisors, the results exhibited a mean divine proportion of 1.59 with standard deviation of 0.10 with a range of 1.43 to 1.76.

Unilateral Missing Lateral Incisors
Table 2 shows the mean width of the maxillary central incisors was 8.6 mm with standard deviation of 1.1 and a range of 7.6 mm to 9.6 mm. The Bolton Index calculated for the unilateral absence was 81.7 with a standard deviation of 3.2 and a range of 75.7 to 86.7.

The divine proportion between the maxillary and mandibular central incisors calculated showed slight variance from the standard of 1.618. The mean was 1.58 with a standard deviation of 0.10 with a range of 1.47 to 1.83.

#	Age	Rt Max CI	Lt Max CI	Rt + Lt	Rt Mand CI	Lt Mand CI	Rt + Lt	Divine pro	Adjust CI	Bolt index
Mean	17.92	8.57	8.51	17.08	5.38	5.39	10.76	1.59	17.48	79.08
Std. Dev.	4.46	0.62	0.54	1.14	0.33	0.34	0.66	0.10	1.07	3.47
Min	14	7.43	7.77	15.27	4.85	4.8	9.65	1.43	15.6	74.5
Max	31	9.26	9.11	18.3	5.91	5.9	11.81	1.76	19.1	84.4

#	Age	Rt Max CI	Lt Max CI	Rt + Lt	Rt Mand CI	Lt Mand CI	Rt + Lt	Divine pro	Adjust CI	Bolt index	Max LI
Mean	17.4	8.58	8.57	17.15	5.46	5.45	10.91	1.58	17.65	81.68	5.54
Std. Dev.	6.16	0.56	0.55	1.10	0.46	0.46	0.92	0.10	1.49	3.24	0.88
Min	13	7.61	7.61	15.22	4.77	4.69	9.46	1.47	15.3	75.7	4.35
Max	34	9.65	9.76	19.41	6.1	6.11	12.21	1.83	19.76	86.7	6.7

Discussion

Harmony in the mesiodistal widths of the maxillary and mandibular teeth is a major factor in coordinating posterior interdigitation, overbite, and overjet in centric occlusion.[11]

Although the natural teeth match well in most individuals, approximately 5% of the population have some degree of discrepancy among the sizes of individual teeth.[12] A significant variation in this harmony will lead to malocclusion and difficulties in obtaining an occlusion with optimal overjet, overbite, and class I canine and molar relationship.[12]

An anomaly in the size of the upper lateral incisors is the most common cause of tooth size discrepancy. Unless the upper lateral incisor is 12-14% wider than the lower lateral incisor, a discrepancy usually exists.[13]

All calculations are, therefore, based on the theory teeth that are either too wide or too small create the deviation. Thus, if the value of the six mandibular anterior teeth is greater than 77.2, this indicates the lower teeth are either too wide or the upper teeth are too small. Conversely, if the value is less than 77.2, it is the upper teeth that are too wide or the lower are too small. The same evaluation can be applicable for the 12 anterior teeth. When calculating both indices, it is possible to locate the area of the discrepancy whether it is in the front or in the lateral segments. To determine the magnitude of excessive width of the upper or lower teeth, the Bolton analysis can be used. On the other hand, divine proportion will also help in determining if there is maxillary excess or insuffiency of space.

The Bolton mean value (79.1 SD 3.5) in the present study in cases with bilateral absence of maxillary lateral incisors indicate the sum of the upper incisors were small as indicated by the adjusted value (Tables 1 and 2). This was confirmed when the divine proportion was calculated giving a less mean value (1.59 SD 0.10) compared to the divine proportion of 1.618. The calculation of the divine proportion verified the accuracy of the Bolton Index. However, in cases with bilateral absence of maxillary lateral incisors there is insufficiency in the amount of the maxillary anterior

tooth substance. This discrepancy was determined to be in the width differences of the maxillary to mandibular central incisors.

The result of the cases with unilateral absence of the maxillary lateral incisors demonstrated the calculated Bolton Index mean was 81.7 with a standard deviation of 3.2. This value was out of the range of normal (75.6 – 78.9) indicating a maxillary insufficiency. This maxillary insufficiency and the large standard deviation may be related to the unilateral maxillary lateral incisor. On the other hand, the divine proportion obtained in the cases of unilateral absence of the maxillary lateral incisor (1.58 SD 1.10) was less than the standard of 1.618. The divine proportion of the unilateral cases confirms the maxillary insufficiency.

The mean value of the maxillary lateral incisor reported in Wheeler's[8] study and a study carried out in a Saudi population with normal occlusion[13] was 6.5 mm. In the present study the mean mesiodistal width of the maxillary lateral incisor was 5.5 mm with standard deviation of 0.8 and a range of 4.5 to 6.7 mm. Thus, a patient with a unilateral absence of maxillary lateral incisor will have an undersized lateral incisor which may be malformed or discolored.[7] In the present study it was noticed in some cases the existing lateral incisor was peg shaped.

When comparing the results of the present study with the result obtained by Bird[15], it was noticed the mean Bolton Index (74.3 sd 3.3, 78.2 sd 1.3) as well as the divine proportion values (1.69 sd 0.1, 1.64 sd 1.4) in bilateral and unilateral cases were less. This finding is not in line with the result of the present study. This could be attributed to the size of tooth width between the different races[16], criteria of sample selection, and measurement methodology.[10]

However, the result of the present study provides encouragement for a further investigation in this area using a larger sample size. This will be of great help to both the orthodontist and the prosthodontist in making treatment planning decisions regarding the management of space created as the result of congenitally missing maxillary lateral incisors.

Conclusion

1. The mean of the Bolton Index in cases with bilateral absence was closer to the Bolton mean than with unilateral absence.
2. In the unilateral absence cases the existing lateral incisor (5.5 mm) averaged 1.00 mm less than the reported standard mean (6.5 mm).
3. The divine proportion showed the maxillary central incisors were small in width as indicated by the adjusted value (Tables 1 and 2) or they were slightly larger in width than the mandibular central incisors.
4. In cases with unilateral and bilateral absence the Bolton Index exhibited maxillary insufficiency, which was confirmed by calculating the divine proportion of the maxillary and mandibular incisors.

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