Incisor Width Ratio

An Aid in Evaluation of Interarch Tooth Width Harmony In the Mixed Dentition

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Analysis of interarch tooth width harmony in the mixed dentition using an incisor ratio. The mean ratio of lower to upper incisor tooth width in excellent occlusions was found to be 0.73:1 (73%).

LITERATURE REVIEW

A primary goal of diagnosis and treatment of the mixed dentition is its culmination in an excellent occlusion in the permanent dentition. An important prerequisite for excellent occlusion is interarch tooth width harmony, which can be measured in the permanent dentition with Bolton's tooth width ratios.[1,2]

In Bolton's ratios,[2,3,4] the anterior ratio is the sum of the mandibular incisor and cuspid widths, divided by the sum of the maxillary incisor and cuspid widths, expressed in percent. The overall ratio is the sum of mandibular tooth widths mesial to the second molars, divided by the sum of all maxillary tooth widths mesial to the second molars, expressed in percent.

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Bolton measured the mesiodistal widths of teeth on 55 casts of patients with excellent occlusion. The mean, standard deviation and coefficient of variation for the anterior ratio were 77.2%, 1.7%, and 2.1% respectively. For the overall ratio the values were 91.3%, 1.9% and 2.1% (Table 1).

These values are comparable to those found in other odontometric studies.[6,7,8,9,10] The low values for the standard deviation and coefficient of variation indicate the potential usefulness of these ratios for meaningful assessment of interarch tooth width harmony.[2,3,4,5]

There is a significant positive correlation between the sum of maxillary tooth widths and the sum of mandibular tooth widths, with r ranging from 0.63 to 0.85 ($p < .001$). Mesiodistal widths of contralateral teeth also have high correlation coefficients ($r = 0.85$ to 0.97, $p < .001$).[6,7,11,12] No significant differences have been found between the mean widths of contralateral teeth.[5,11]

Those correlations suggest that we can expect most patients to have teeth with a potential for excellent occlusion following dental and skeletal alignment. However, a significant number will not, so the possibility of interarch tooth width disharmony should be considered.[7]

Bolton, reporting on a random sample of 100 patients from his private practice, found 29% with an anterior ratio discrepancy deviating more than one standard deviation above the mean. He further reported that Richardson, in an unpublished study at the University of Washington, found 33.7% of 205 randomly selected patients with ratios more than one standard deviation above the mean.[2]

TABLE 1
Comparison of Interarch Tooth Width Ratios

*Ratio**	*Author*	*N*	*Occlusion*	*Mean*	*Range*	*S.D.*	*S.E.M.*	*C.V.%*
Incisor	Present Study	26	Excellent	72.6	67.8-78.3	2.35	0.46	3.23
Incisor	Tonn	50	Normal	74.0	67.0-81.0	2.4	0.34	3.24
Incisor	Seipel	365	Random	74.1				
Anterior	Present Study	26	Excellent	77.8	74.4-81.5	1.92	0.38	2.47
Anterior	Bolton	55	Excellent	77.2	74.5-80.4	1.65	0.22	2.14
Anterior	Stifter	24	Excellent	77.6				
Anterior	Neff	200	Random		70.9-85.5			
Anterior	Neff	300	Random	79.0	73.5-84.7			
Anterior	Lundström	264	Random	78.5	73.0-84.5	2.07	0.13	2.64
Anterior	Ballard		Artificial	75.0				
Overall	Present Study	26	Excellent	92.3	87.9-95.2	1.50	0.29	1.62
Overall	Bolton	55	Excellent	91.3	87.5-94.8	1.91	0.26	2.09
Overall	Stifter	65	Random	91.1				
Overall	Tonn	50	Random	92.5		1.8	0.25	1.95
Overall	Lundström	63	Random	92.3	88.0-97.5	2.07	0.26	2.24

* All ratios have been converted to sums of mandibular tooth widths divided by sums of maxillary tooth widths and the result multiplied by 100.

S.D. = Standard Deviation

S.E.M. = Standard Error of the Mean ($S.D./\sqrt{N}$)

C.V. % = Coefficient of Variation (S.D./mean)

High tooth width ratios suggest that the occlusion may have mandibular crowding, maxillary spacing, small overbite and overjet, or some combination of those features. Low tooth width ratios suggest some combination of the opposite features, such as mandibular spacing, maxillary crowding, or large overbite and overjet. The overall ratio is correlated with crowding or spacing with an $r = 0.41$ ($p < .001$).[6]

Several authors have examined interarch tooth width ratios as predictors of anterior occlusion, particularly overbite and overjet.[5,6,13,14,15,16] No correlation has been found between overbite or overjet and any tooth width ratio.[2,3,4,6,14,15]

An incisor ratio has been derived in the same way as the anterior and overall ratios.[10,16] The purpose of this study was to determine whether the incisor ratio could be used to assess interarch tooth width harmony for patients in the mixed dentition, by

TABLE 2
Mean Overbite, Overjet, and Mesiodistal Tooth Widths

	N	*Sex*	*Mean*	*Range*	*S.D.*	*S.E.M.*	*C.V.%*
Overjet	26	MF	2.60	1.7 - 3.8	0.63	0.12	24.23
Overbite	26	MF	2.29	0.3 - 3.5	0.98	0.19	42.80
U M1	14**	M	10.09	9.50-10.65	0.32	0.10	3.15
	12**	F	9.85	9.30-10.5	0.42	0.12	4.23
L M1	14	M	11.03	9.75-11.75	0.58	0.16	5.30
	12	F	10.75	10.00-11.45	0.43	0.12	3.97
U PM2	14	M	6.64	5.90- 7.15	0.36	0.10	5.45
	12	F	6.49	5.90- 7.05	0.32	0.09	4.97
L PM2	14	M	7.28	6.70- 8:00	0.44	0.12	6.06
	12	F	6.98	6.30- 7.65	0.46	0.13	6.66
U PM1	14	M	6.98	6.15- 7.85	0.55	0.15	7.82
	12	F	6.87	6.10- 7.40	0.39	0.11	5.74
L PM1	14	M	7.05	6.45- 8.00	0.45	0.12	6.42
	12	F	6.88	5.90- 7.30	0.40	0.12	5.85
UC	14	M	7.65	6.95- 8.40	0.42	0.11	5.45
	12	F	7.35	7.00- 8.25	0.36	0.10	4.89
LC*	14	M	5.86	6.05- 7.45	0.44	0.12	6.49
	12	F	6.40	6.15- 6.65	0.17	0.03	2.65
U 12	14	M	6.78	5.40- 7.65	0.60	0.16	8.81
	12	F	6.62	6.05- 7.25	0.38	0.14	5.74
L I2*	14	M	5.97	5.45- 6.50	0.34	0.09	5.63
	12	F	5.64	5.35- 6.15	0.26	0.08	4.63
U I1*	14	M	8.84	8.05- 9.95	0.51	0.14	5.80
	12	F	8.34	7.75- 8.90	0.34	0.10	4.13
L I1	14	M	5.34	4.80- 5.75	0.27	0.07	5.02
	12	F	5.25	4.85- 5.85	0.30	0.09	5.63

* Male/female differences statistically different from zero, $P < 0.05$.

** Right and left pairs were combined, so there are 14 pairs of male teeth and 12 pairs of female teeth.

evaluating its correlation with Bolton's anterior ratio.

Methods and Materials

Twenty-six sets of casts were selected from 450 orthodontically treated adolescents. The selection criteria were: Angle Class I molar and cuspid relationships, all teeth present mesial to the second molars, no interproximal restorations that might affect tooth width, no significantly anomalous teeth, less than 2 mm total spacing in either arch, and no crowding. All 26 subjects were Caucasian, 14 males and 12 females.

Measurements were made with a Boley gauge with vernier calibrations of 0.1 mm. Mesiodistal widths of all teeth mesial to the second molars were measured. Overjet was measured from the labial surface of the most prominent mandibular central incisor to the labial surface of the opposing central incisor. Overbite was measured perpendicular to the occlusal plane from the incisal edge of the same mandibular incisor to the level of the incisal edge of the opposing maxillary central incisor.

The mean, standard deviation, range, standard error of the mean and coefficient of variation were calculated for all measurements and for the tooth width ratios. Correlations were calculated between overbite, overjet, and tooth width ratios.

Results

Measurement reliability was found to be satisfactory.

The mean mesiodistal widths (Table 2) were consistent with previous studies.[7,8,10,17] Comparing contralateral teeth, the maximum mean difference in mesiodistal width was 0.18 mm, so widths for contralateral teeth were combined. Student's t-test showed no statistically significant sex differences in tooth width.

The mean overjet was 2.6 mm, with a standard deviation of 0.6 mm. Mean overbite was 2.3 mm with a standard deviation of 1.0 mm.

The statistical results of the analysis of tooth width ratios are shown together with those of previous studies in Table 1. Of special interest among the significant correlations among the tooth width ratios is the high correlation of the incisor ratio with the anterior ratio $r = 0.80$ ($p < .001$).

Correlations among the tooth width ratios, overbite and overjet are shown in Table 3. Overjet and overbite were found to be significantly correlated with each other ($r = 0.56$ $p < .001$), but no significant correlation was found with any of the tooth width ratios.

TABLE 3

Correlation Coefficients (r) and Significance Levels (P) Among Tooth Width Ratios, Overbite and Overjet

	Anterior Ratio	*Overall Ratio*	*Overbite*	*Overjet*
Incisor Ratio	0.80 <0.001	0.52 0.006	0.18 0.331	0.11 0.548
Anterior Ratio		0.54 0.005	—0.07 0.679	—0.01 0.971
Overall Ratio			—0.24 0.202	—0.11 0.568
Overbite				0.56 0.001

Upper number = r = correlation coefficient.
Lower number = P = probability of correlation coefficient that high by chance if the true correlation is zero.

Discussion

Tooth widths and width ratios are remarkably stable statistically. The ratios from this study have low coefficients of variation, as did those

reported by Bolton.[2,3,4] The ranges and standard deviations are also similar to those from Bolton's study, which was based on a similar sample of excellent occlusions.

Tooth width ratios derived from randomly selected subjects tend to cover a broader range and are somewhat higher, though the mean is within one standard deviation of ratios derived from patients selected for excellent occlusion (Table 1).

The low coefficient of variation of the incisor ratio, together with the high correlation with the anterior ratio ($r = 0.80$, $p < .001$), indicates that it can be used to identify and quantify interarch tooth width disharmony for patients in the mixed dentition.

The absence of correlation between overjet or overbite and tooth width ratios emphasizes the need to consider other factors such as incisor crown inclination and functional environment.

TABLE 4
Interarch Tooth Width Analysis for the Incisor Segments

$$\text{Incisor Ratio} = \frac{(\text{Sum Mand Incisor Widths})}{(\text{Sum Max Incisor Widths})} \times 100$$

Mean —1 S.D. = 70.2%
Mean = 72.6%
Mean +1 S.D. = 75.0%

Table for Mandibular Excess or Deficiency			Table for Maxillary Excess or Deficiency		
Actual Sum Max	*Sum Mand +1 S.D.*	*Sum Mand −1 S.D.*	*Actual Sum Mand*	*Sum Max +1 S.D.*	*Sum Max −1 S.D.*
25.0	18.8	17.6	19.0	27.1	25.3
25.5	19.1	17.9	19.5	27.8	26.0
26.0	19.5	18.3	20.0	28.5	26.7
26.5	19.9	18.6	20.5	29.2	27.3
27.0	20.3	19.0	21.0	29.9	28.0
27.5	20.6	19.3	21.5	30.6	28.7
28.0	21.0	19.7	22.0	31.3	29.3
28.5	21.4	20.0	22.5	32.1	30.0
29.0	21.8	20.4	23.0	32.9	30.7
29.5	22.1	20.7	23.5	33.5	31.3
30.0	22.5	21.1	24.0	34.2	32.0
30.5	22.9	21.4	24.5	34.9	32.7
31.0	23.3	21.8	25.0	35.6	33.3
31.5	23.6	22.1	25.5	36.3	34.0
32.0	24.0	22.5	26.0	37.0	34.7
32.5	24.4	22.8	26.5	37.7	35.3
33.0	24.8	23.2	27.0	38.5	36.0
33.5	25.1	23.5	27.5	39.2	36.7
34.0	25.5	23.9	28.0	39.9	37.3
34.5	25.9	24.2	28.5	40.6	38.0
35.0	26.3	24.6	29.0	41.3	38.7

Interarch tooth width values for the incisor segments are shown in Table 4. These provide a means for determining tooth width excess or deficiency greater than one standard deviation in either arch. The method requires calculation based on mesiodistal measurements of the incisors. The quantified tooth disharmony can then be considered along with other factors in assessing the treatment needs of the patient.

Conclusions

1. The incisor width ratio can be useful in the assessment of tooth width disharmony.
2. A satisfactory incisor ratio in the mixed dentition suggests a similarly satisfactory anterior ratio in the permanent dentition.

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