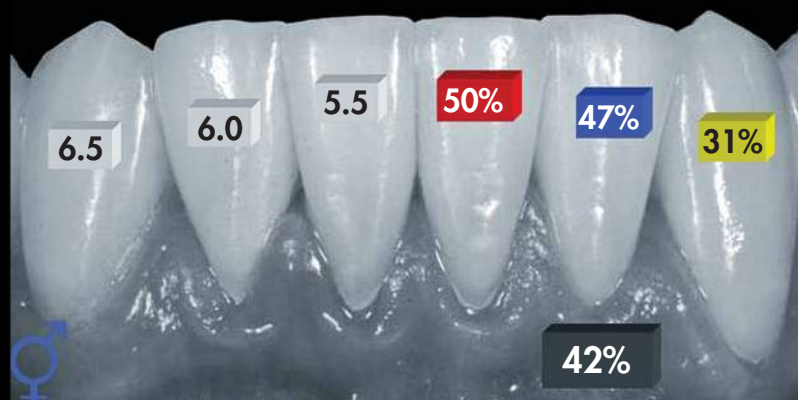


RANGE AND MEAN DISCORDANCE OF INDIVIDUAL TOOTH WIDTH OF THE MANDIBULAR ANTERIOR DENTITION

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Average Discordance %



Proper diagnosis of tooth size for each patient is critical in treatment planning for restorative dentistry. The purpose of this study was to find a clinically relevant and applicable range and mean discordance of individual tooth width of the mandibular anterior dentition. The central incisor (CI), lateral incisor (LI), and canine (CA) teeth varied in range from 4.5 mm to 6 mm, 4.5 mm to 7 mm, and 5.5 mm to 8 mm, respectively (N = 417). Nearly 90% of the patients fell within ± 0.5 mm of the combined gender normative values. The results suggest that there exists an average discordance between normative values and actual tooth width of the mandibular anterior dentition in a population of male and female patients.

Learning Objectives:

This article will discuss the clinical relevance, range, and mean of individual tooth width of the mandibular anterior dentition, as well as the average discordance between normative values and actual tooth width. Upon reading this article the reader should:

- Become more familiar with individual tooth size as it pertains to the mandibular anterior dentition.
- Appreciate the factors that may affect tooth size between individuals.

Key Words: Biometry, individual tooth width, mean discordance, mandibular, anterior, proportion

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Individual tooth size, composed of width and length dimensions, is the primary building block within the clinician's creation of an aesthetic smile. A variation in maxillary anterior tooth-width dimensions and average discordance from the normative values and the actual tooth width exists between genders.^{1,3} Although less attention has been given to the mandibular anterior teeth, correct tooth size will allow the proper tooth arrangement and proper occlusion to be developed.^{4,6} Aesthetic restorative dentistry frequently entails correction of tooth-size discrepancies associated with length and/or width, secondary to the aging process.⁷ Mandibular tooth biometry may be an important aspect of aesthetic reconstruction, wherein identification of tooth size variations (ie, discordance) within individual patients and tooth groups is critical to smile analysis, correction of tooth size discrepancies, and occlusion.^{1,3}

Much attention has been paid to the maxillary anterior teeth.^{8,9} Mandibular aesthetics are equally important, however, as anterior tooth display increases with age (Figures 1 through 3).¹⁰ In addition, they play a role in occlusion—specifically, anterior guidance and posterior disclusion. During the aging process, incisal attrition with compensatory eruption can lead to excessively short teeth, whereas gingival recession can result in excessively long teeth (Figure 4). Malocclusion may cause selective accelerated localized attrition (Figures 4 and 5). Parafunctional habits (eg, bruxism) can also cause excessive and accelerated loss of coronal tooth insufficient structure in the mandibular anterior aesthetic zone, and insufficient tooth length must be addressed as a result (Figure 6). In order to replace lost



Figure 1. Mandibular anterior tooth display increases with age. A patient in the fifth decade of life exhibits equal maxillary and mandibular tooth exposure during smiling.



Figure 2. A patient in the sixth decade of life exhibits a greater amount of mandibular tooth exposure than maxillary (ie, 40% maxillary/60% mandibular) at rest and during smiling.



Figure 3. A patient in the seventh decade of life exhibits a greater amount of mandibular tooth exposure than maxillary (ie, 20% maxillary/80% mandibular) during smiling.



Figure 4. Mandibular central incisors show more accelerated wear than the lateral incisors due to their greater labial version within the dental arch.

coronal tooth structure and create a stable occlusion, the restoration of proper tooth dimensions is required, since they are paramount to a successful aesthetic and functional outcome (Figure 7).

Tooth proportion of the mandibular anterior dentition, defined by the width and length as a percentage ratio, falls within a range of 60% to 70%.¹¹⁻¹³ The maxillary



Figure 5. The mandibular central incisors occlude in centric occlusion and protrusive movements and, as a result, they exhibit wear first.



Figure 6. Parafunctional habits can cause excessive and accelerated loss of coronal tooth structure, leading to excessively short teeth and a potential decrease in anterior guidance.



Figure 7. Correction of the proper tooth size, dimensions, and form become critical aspects in aesthetic restorative care. Patient restored to aesthetic and functional health.

anterior teeth, on the other hand, have a ratio of 72% to 86%,^{2,9} indicative of a wider tooth, while the mandibular anterior teeth are narrower in size and form.

In an effort to restore proper tooth size, tooth proportion, individual tooth aesthetics, and occlusion within the arch and smile framework, clinicians often reference published dimensions.¹¹⁻¹³ The questions are:

- What percentage of the time are these anatomic dimensions valid within a given population?
- Is there a clinically relevant and applicable average discordance of mandibular tooth-width sizes between normative values and the actual widths that is representative of patient width variations?

From the tooth width, clinicians can derive the desired tooth length by using the anatomic width/length percentage ratio (eg, 60% to 65% CI and II; 65% to 70% CA).

The clinical significance of mandibular tooth biometrics and mean discordance is that size for tooth restoration may vary among patients of different age, race, or gender. Therefore, it is imperative that the proper tooth size for each patient be identified before any irreversible restorative procedures are performed.

A biometric analysis of tooth-width dimensions of the mandibular anterior dentition was thus performed in order to find:

- The average discordance between the normative values and the actual tooth width within a given sample of male and female patients;
- The distribution of discordance of different groups (ie, CI, II, and CA) within this same patient sample; and
- Whether the discordances differ between men and women.

Materials and Methods

Seventy gypsum model stone diagnostic casts were obtained from 36 female and 34 male patients in a private practice population for evaluation. The mandibular

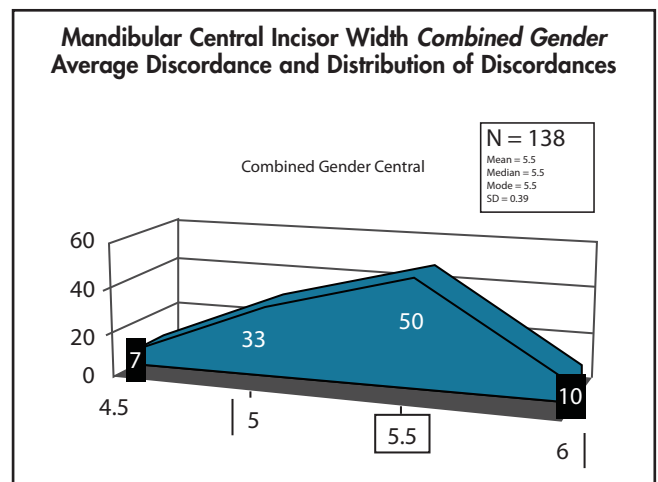


Figure 8. Combined gender mean and distribution discordance for the mandibular central incisors (ie, N=138). A 50% width distribution discordance is noted for the mean value of 5.5 mm.

Table 1

<i>Descriptive Statistics for Mandibular Width: Combined-Gender Data</i>							
Tooth Number	N Statistic	Range Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Mean Standard Error	Standard Deviation Statistic
22	70	2.00	5.00	8.00	6.59	.067	.495
23	69	2.32	4.49	6.81	5.85	.063	.459
24	69	1.34	4.57	5.91	5.29	.048	.348
25	69	1.67	4.32	5.99	5.26	.053	.383
26	69	1.55	5.06	6.61	5.84	.056	.413
27	70	2.10	5.66	7.76	6.61	.067	.495

anterior dentition encompassing the CIs, IIs, and CAs was measured. Fabricated from irreversible hydrocolloid impression material (ie, Jeltrate, Dentsply Caulk, Milford, DE), the casts were immediately fabricated in gypsum stone material mixed under vacuum pressure. Six-inch digital calipers (ie, Avenger Measuring Tools, Boulder City, NV) with LED display SAE/Metric (graduations: 0.01 mm, accuracy: ±0.02 mm, repeatability: 0.01 mm) were employed in order to measure individual tooth width at the widest mesial-distal aspect on obtaining each cast. The digital calipers were calibrated and set to zero prior to each measurement. A single operator performed all cast measurements under 2.5x magnification via surgical loupes (ie, SurgiTel, General Scientific Corp, Ann Arbor, MI).

The criteria of the sample population consisted of nonrestored mandibular anterior teeth and non-orthodontic patients without excessive incisal attrition and/or gingival recession. Anterior tooth crowding was not an obstacle in measurement.^{14,15} Cases exhibiting diastemata due to tooth malformation were excluded from the sample population. Mandibular tooth width was the only parameter measured in this study.⁷ The patients ranged in age from 16 to 72 years, and 55 of 70 patients (ie, 79%) were Caucasian with a mean of 42 years old.

Range, mean, median, and mode values were calculated (Table 1). Combined gender distribution discordance of tooth width for the mandibular CI, II, and CA teeth was calculated (Table 2), as was comparative gender discordance (Tables 3 and 4). Numeric data in Table 1 were rounded to the nearest 0.5 mm, ensuring to make the information would remain clinically applicable, since size differences are not visually perceptible below this value.

Results

Among the 70 patients studied, the width of the individual teeth ranged from 1.5 mm to 2 mm of the mean. Specifically, the CIs, IIs, and CAs varied in range from 4.5 mm to 6 mm, 4.5 mm to 7 mm, and 5.5 mm to 8 mm, respectively. Mode data—the value with the highest frequency within a statistical range—did not show an asymmetry in the left and right dentition.

Respectively, 50%, 47%, and 31% of the total population exhibited the mean tooth width of 5.5 mm for CI,

Table 2

<i>Total Mandible Distribution Percentages: Combined-Gender Data</i>		
3.0% [5.5]	1.0% [4.5]	7.0% [4.5]
16.0% [6.5]	8.0% [5.0]	33.0% [5.0]
31.0% [6.5]	26.0% [5.5]	50.0% [5.5]
36.0% [7.0]	47.0% [6.0]	10.0% [6.0]
13.0% [7.5]	17.0% [6.5]	0
1.0% [8.0]	1.0% [7.0]	0
Mean = 6.50 [N = 140]	Mean = 6.00 [N = 139]	Mean = 5.50 [N = 138]
Median = 6.50	Median = 6.00	Median = 5.50
Mode = 7.00	Mode = 6.00	Mode = 5.50
StDev = 0.52	StDev = 0.44	StDev = 0.38
Range = 5.50 - 8.00	Range = 4.50 - 7.00	Range = 4.50 - 6.00

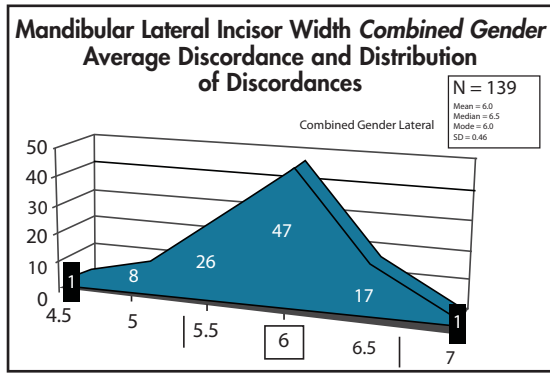


Figure 9. Combined gender mean and distribution discordance for the mandibular lateral incisors (ie, N=139). A 47% width distribution discordance is noted for the mean value of 6 mm.

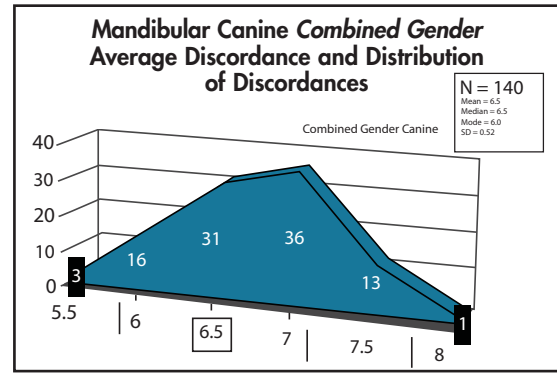


Figure 10. Combined gender mean and distribution discordance for the mandibular canines (ie, N=140). A 31% width distribution discordance is noted for the mean value of 6.5 mm. Note that 36% of the teeth were 7 mm wide.

6 mm for LI, and 6.5 mm for CA (Figures 8 through 10). As a group, a CI with a width of 5.5 mm, LI with a width of 6 mm, and a CA with a width of 6.5 mm occurred in 42% of the population (Figure 11); 89% of the patients fell within ± 0.5 mm of the mean values (Figure 12).

Male patients ranged from 0.5 mm to 1 mm greater in tooth width than female patients for the mandibular CAs only. The majority of males were +0.5 mm and females were -0.5 mm of the combined gender mean for the CA tooth group. There were no gender differences for the mandibular CI and LI tooth groups (Figures 13 and 14). The average discordance and distribution of discordance for CIs revealed 57% for males and 39%

for females, indicating slightly greater variation of tooth width for females (Figure 13). The mean LI values were the same for both at 6 mm, with different distribution frequencies at 54% and 40% for males and females, respectively (Figure 14). While the CA mean distribution frequencies were 50% and 43% for males and females, respectively (Figure 15), the mean values differed by +0.5 mm for male patients. Results of nonparametric Wilcoxon 2-sample test and parametric t test revealed evidence for significant gender effects for the mandibular CA only; no differences were found for the CI and LI tooth groups (Figure 16). The findings of the two tests were consistent.

Table 3

Male Mandibular Distribution Percentages			
Tooth Number	#22/#27	#23/#26	#24/#25
	5.0% [6.0]	4.0% [5.0]	3.0% [4.5]
	21.0% [6.5]	19.0% [5.5]	30.0% [5.0]
	50.0% [7.0]	54.0% [6.0]	57.0% [5.5]
	22.0% [7.5]	21.0% [6.5]	10.0% [6.0]
	2.0% [8.0]	2.0% [7.0]	
Mean	7.00 [N = 68]	6.00 [N = 68]	6.00 [N = 68]
Median	7.00	6.00	5.50
Mode	7.00	6.00	5.50
StDev	0.43	0.40	0.35
Range	6.00 - 8.00	5.00 - 7.00	4.50 - 6.00

Table 4

Female Mandibular Distribution Percentages			
Tooth Number	#22/#27	#23/#26	#24/#25
	7.0% [5.5]	1.0% [4.5]	10.0% [4.5]
	24.0% [6.0]	10.0% [5.0]	41.0% [5.0]
	43.0% [6.5]	35.0% [5.5]	39.0% [5.5]
	22.0% [7.0]	40.0% [6.0]	10.0% [6.0]
	4.0% [7.5]	14.0% [6.5]	
Mean	6.00 [N = 72]	6.00 [N = 71]	5.50 [N = 71]
Median	6.50	6.00	5.00
Mode	6.50	6.00	5.00
StDev	0.49	0.46	0.40
Range	5.50 - 7.50	4.50 - 6.50	4.50 - 6.50

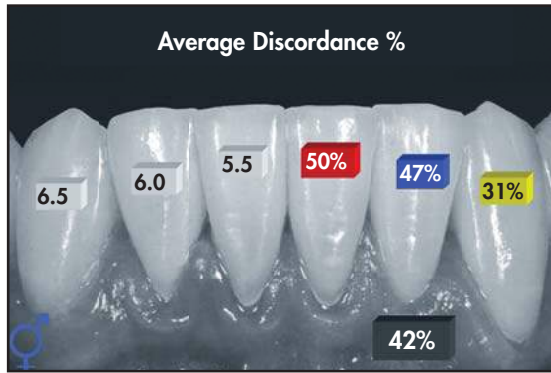


Figure 11. Total mean discordance percentages are given for each individual tooth group, in addition to the aggregate total percentage, which is only at a 42% confidence level.

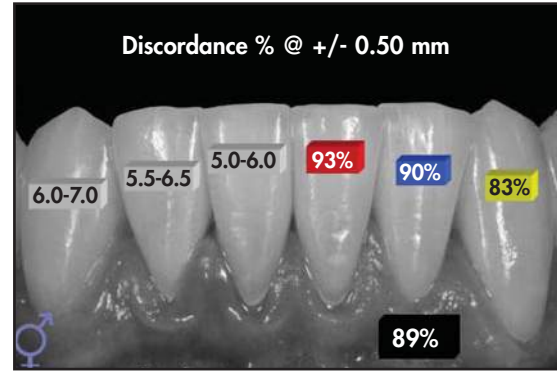


Figure 12. Combined gender mean width discordance percentages for the mandibular anterior teeth (ie, N=417). An 89% width distribution is noted for the mandibular anterior teeth as an aggregate.

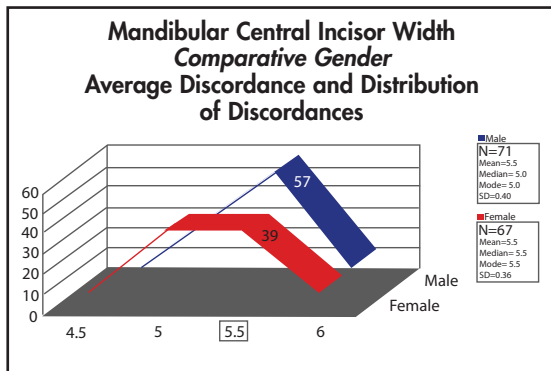


Figure 13. Comparative-gender mean width discordance percentage for the mandibular CIs. Mean values are identical for CIs in both gender groups at 39% for females and 57% for males width discordance, respectively.

Discussion

Anatomic values for tooth size are well established in the dental literature. The misconception is that these numbers are applicable to the majority of patients. These data have demonstrated that a relatively low percentage (ie, an average of 40%) of the sample population exhibited the combined-gender mean tooth width of 50% CI, 47% LI, and 31% CA. Therefore, restoring anterior teeth to the average dimensions would be correct in only about 40% of patients in a combined gender population (Figure 11).

If the range was expanded within each tooth group to ± 0.5 mm of the combined-gender mean value, however, then the percent of the population increased to 89% for all mandibular anterior teeth (Table 4, Figure 12). Thus, expanding the tooth width by ± 0.5 mm of the mean increased the population percentage from about 40% to 90%. This can also be thought of as a "confidence level." The clinical

significance of these data is that there exists a range of patient tooth sizes with different confidence levels; therefore, proper diagnosis of patient tooth size is critical before any treatment is rendered. In addition, the absolute mean values for the different size groups of patients are not interchangeable.

The mandibular central incisors exhibited the least variability, with 83% (ie, 5 mm to 5.5 mm) being -0.5 mm of the mean width (ie, 5.5 mm); 7% at 4.5 mm and 10% at 6 mm, respectively. The mandibular LI and CA teeth showed a greater variability (Table 4, Figure 12).

Gender differentiation of tooth size was a major consideration in this study, even though gender differences in tooth shape have not been supported in the dental literature.¹⁶ Comparative-gender, tooth-width range for males was consistently 0.5 mm larger, and for females invariably 0.5 mm smaller than the mean for the mandibular canines only. Expanding the mean range by $+0.5$ mm for males (eg, 6.5 mm to 7 mm) increased the population from 36% to 72% for CA (Figure 17). Decreasing the mean range by 0.5 mm for females (eg, 6.5 mm to 6.5 mm) increased the population from 36% to 67% for CA (Figure 18). Male and female comparative mean values were the same for LI and CI, though distribution frequencies differed. Expanding the range by -0.5 mm, the mean averages increase from 42% to 69% for male LI, 42% to 75% for female LI, 44% to 85% for male CI, and 44% to 80% for female CI—with an increase of 35% from 40% to 75% for both gender groups (Figures 11, 17, 18).

With the aging process, changes in tooth length can occur. The restoration of proper tooth length is, therefore, important in aesthetics and function. Proper tooth length can be derived with the tooth proportion

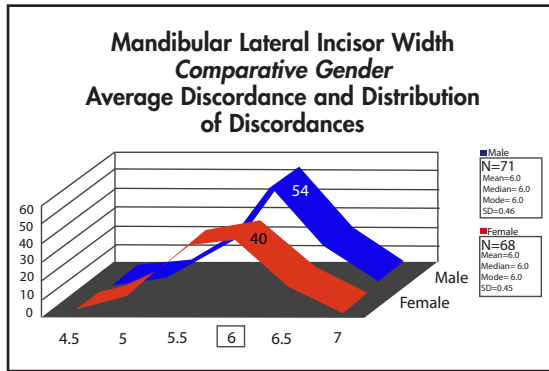


Figure 14. Comparative-gender mean width discordance percentages for the mandibular IIs. Mean values are identical for IIs in both gender groups at 40% width discordance for females and 54% width discordance for males.

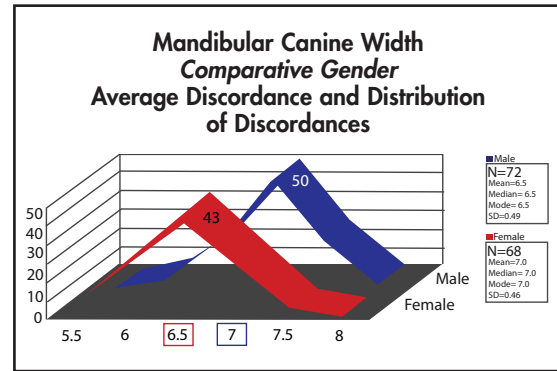


Figure 15. Comparative-gender mean width discordance percentages for the mandibular CAs. Mean values differ between gender groups, with males appearing +0.5 mm wider than females.

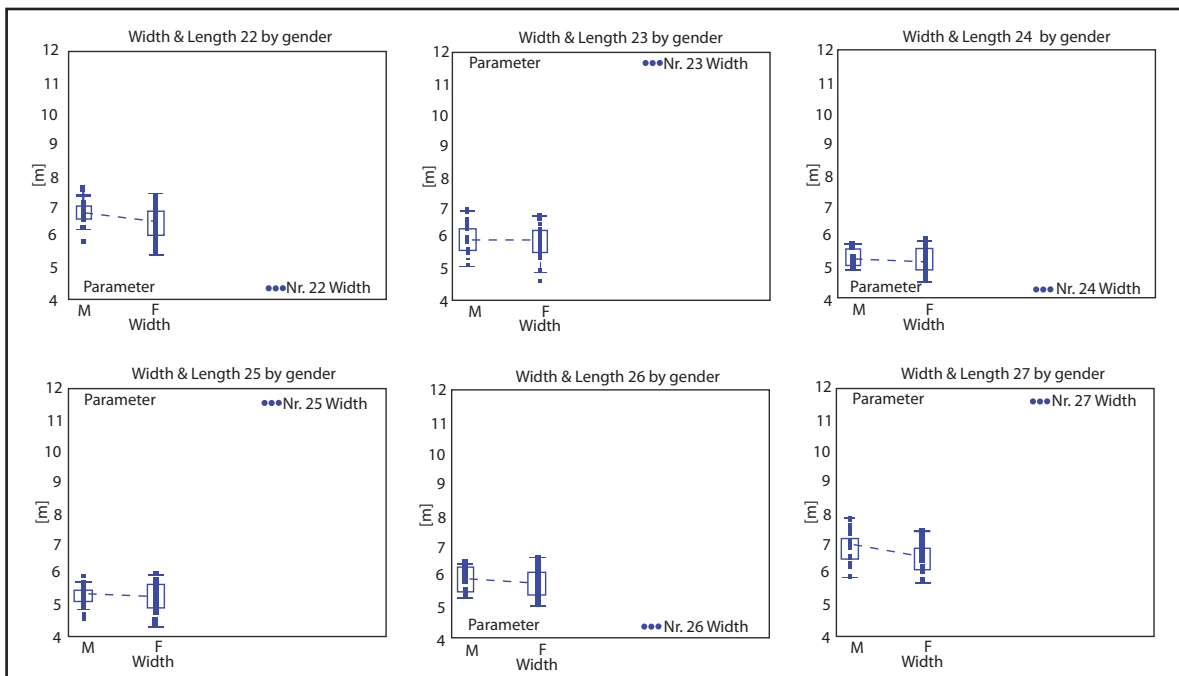


Figure 16. Results of nonparametric Wilcoxon 2-sample test and parametric *t* test revealed evidence for significant gender effects for the mandibular canines. The findings of the two tests were consistent.

equation $L = W / \text{tooth proportion } \%$ (ie, approximately 60% to 70% for the mandibular anterior teeth), once tooth width is established. During aesthetic reconstruction, these values are very useful because they can be applied to their respective gender group with a reasonable level of confidence; 75% for both males (Figure 17) and females (Figure 18).

Conclusion

There is a broad range (ie, 5.5 mm to 8 mm) of individual tooth width for the mandibular anterior teeth within a combined-gender population of Caucasian patients.

Despite this, the groups of individual teeth fell within a narrower range, with CIs ranging from 4.5 mm to 6 mm, IIs of 4.5 mm to 7 mm, and CAs measuring 5.5 mm to 8 mm. Approximately 40% of the 70 patients in the study were at the mean value of 5.5-mm width for CI, 6.0 mm for II, and 6.5 mm for CA. The patient majority, at about 90%, fell within ± 0.5 mm of the combined-gender mean value for individual tooth width within each tooth group. The data exhibited a traditional bell-curve distribution frequency. Ten percent of the patients in the study exhibited tooth sizes indicative of small and large tooth width for all tooth groups.

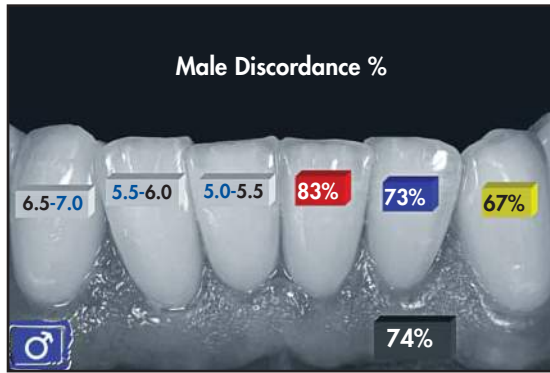


Figure 17. Male mean discordance percentage values are presented for each tooth group. Male patients were consistently +0.5 mm of the mean, with a total aggregate of approximately 75% confidence level.

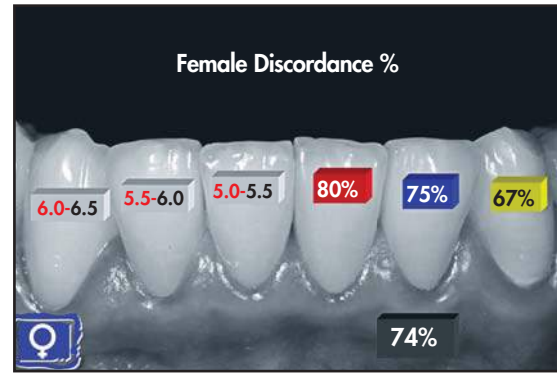


Figure 18. Female mean discordance percentage values are presented for each tooth group. Female patients were consistently -0.5 mm of the mean, with an aggregate of approximately 75% confidence level.

Statistically significant gender differences existed for the mandibular CA teeth; no gender differences existed for the CI and LI teeth. Nearly 75% of male patients fell within -0.5 mm of the mean value for CI and LI and +0.5 mm for CA. Approximately 75% of female patients fell within -0.5 mm of the mean value for CI, LI, and CA. Comparative-gender male CA mean values were consistently 0.5 mm greater than the combined-gender CA mean value (ie, 6.5 mm to 7 mm) about 70% of the time. Comparative-gender female mean values were consistently 0.5 mm less than the combined-gender CA mean (ie, 6 mm to 6.5 mm) approximately 70% of the time.

In summary, a mean discordance of tooth-width size exists for a given population of male and female patients. Only 42% of the population is clustered around their respective mean tooth width. Expanding the range around the mean by ± 0.5 mm, however, increases the discordance from the mean from 42% to almost 90%. Mean values and distribution frequency differed significantly between genders for only the mandibular CA tooth group, finding that females are consistently smaller by 0.5 mm to 1.0 mm than males. There were, however, no gender differences found for the mandibular CI and LI tooth groups.

Mandibular anterior teeth are more consistent in size and variability than maxillary anterior teeth, in which mean discordance values are 50% and 36%, respectively, and 90% (ie, at ± 0.5 mm) and 80%, respectively (fn 3).

Unlike the maxillary anterior teeth, in which gender differences exist for all tooth groups,³ only the mandibular CA tooth group showed a gender difference, which is a critical factor in restoration. These findings have clinical relevance in that proper tooth biometry for each individual patient must be diagnosed and identified before any tooth restoration is attempted, in order to create an aesthetically pleasing smile and functional occlusion.

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