A Study of Dentists' Preferred Maxillary Anterior Tooth Width Proportions: Comparing the Recurring Esthetic Dental Proportion to Other Mathematical and Naturally Occurring Proportions

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ABSTRACT

Statement of the Problem: Presently, there are no generally accepted standards for designing smiles using tooth proportion relationships.

Purpose: The purpose of this study was to determine whether North American dentists prefer smile designs created using the recurring esthetic dental (RED) proportion, other mathematically defined tooth proportion relationships, or naturally occurring tooth-to-tooth width proportions previously reported to occur in the North American population.

Materials and Methods: Three hundred and one North American dentists were surveyed to determine their preferences of imaged smiles exhibiting different anterior tooth width proportions and the primary proportion influencing their decision. One-sample *t*-tests were used to compare preferences of constructed smiles. Pearson's Chi-square test was used to assess the independence of the relationship between the subjects' demographic attributes and the factors reported as being instrumental in their decision processes.

Results: Fifty-seven percent of dentists surveyed preferred the smiles with the 70% RED proportion over the smiles with the naturally occurring maxillary anterior tooth width proportions in normal-length teeth. Dentists preferred the smiles of the naturally occurring maxillary tooth proportions (70%) and the 70% RED proportion (75%) over the golden proportion. In smiles with tall teeth, the golden proportion was preferred by 58% of the surveyed dentists over the naturally occurring tooth-to-tooth width proportions as previously defined by Preston. Sixty-two percent of dentists cited the overall balance as the primary factor affecting their selection. Twenty-three percent made their selection based on the size of the maxillary central incisors, whereas 15% used other teeth or factors.

Conclusion: Smiles created using the principles of the RED proportion were preferred by a majority of dentists surveyed. The majority of dentists reported that overall balance was the primary factor affecting their selection.

CLINICAL SIGNIFICANCE

The RED proportion may be useful in creating smiles preferred by North American dentists. Seventy-five percent of North American dentists preferred using the RED proportion when designing smiles with normal-length teeth over using the golden proportion, which has been a pseudostandard in esthetic dentistry. Applying the golden proportion universally in smile design should be reconsidered as it was found to be the least pleasing and accepted in this study for normal-length teeth.

(*J Esthet Restor Dent* 19:324–339, 2007)

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DOI 10.1111/j.1708-8240.2007.00114.x

INTRODUCTION

Smile design has long been considered a subjective art. Although most esthetic disciplines have prescribed proportions or ratios, objective standards defining what is considered to be an esthetic smile are not well established. Plastic surgeons measure angles and proportions when evaluating patients before planning potential surgeries. Orthodontists routinely measure cephalometric radiographs to determine critical hard-tissue angulations and compare them to accepted norms.[1] Cephalometric analysis is vital in orthodontic treatment planning, although it may not equate to dental, dentofacial, or facial esthetics. The need exists for an objective analytical method of smile design using accepted proportional smile design norms.

Tooth Proportion Theories

Several tooth proportion theories have been advocated that relate the relative widths of the maxillary anterior teeth. The golden proportion is based on the theory that a relationship exists between beauty in nature and mathematics.[2] Applied to smile design, it states that the width of the maxillary lateral incisor, as viewed from the front, should be in golden proportion to the width of the maxillary central incisor[3] (Figure 1). The maxillary lateral incisor should be 62% of the width of the maxillary central incisor, and the width of the maxillary canine should be 62% of the width of the resulting lateral incisor. Another proposed theory of smile design, as defined by Snow,[4] is the "golden mean," which states that the width of the maxillary central incisor should be 25% of the total frontal view width from the distal of the maxillary canine on one side to the distal of the canine on the contralateral side. Each maxillary lateral incisor should be 15% and each maxillary canine 10% of the intercanine distance as viewed from the front (Figure 2).

The repeated ratio, discussed by Lombardi,[5] states that the existing proportion between the width of the central incisor and lateral incisor should be consistent, progressing anteriorly to posteriorly in the mouth. Several repeated tooth width proportions have been presented, including the Plato beauty proportion (57%), the esthetic norm proportion (71%), the quarter 3:4 proportion (75%), and the human norm 5:6 proportion (80%).[6] The golden proportion, golden mean, and repeated ratio have been advocated without compensation for different body proportions, body types, or clinical crown tooth-length displays of the maxillary central incisors.

Recurring Esthetic Dental (RED) Proportion

A concept of proportional smile design has been proposed that

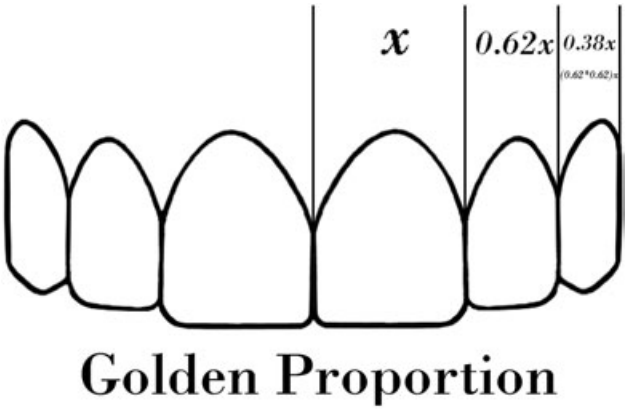

Figure 1. Graphic representation of the six maxillary anterior teeth in golden proportion.

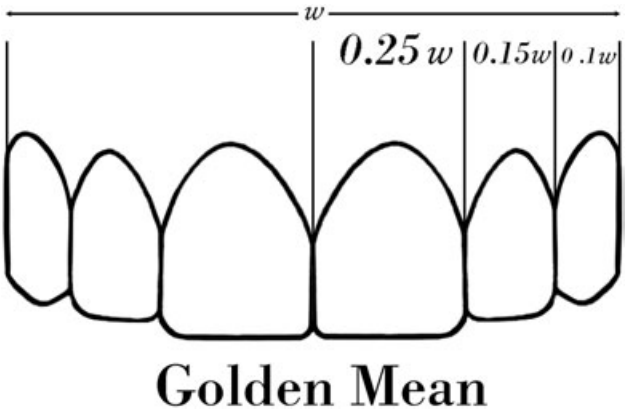

Figure 2. Graphic representation of the six maxillary anterior teeth in golden mean proportion.

factors variability among individuals and factors the proportions of the tooth, face, and body into the calculations. The RED proportion states that the proportion of the successive widths of the maxillary teeth as viewed from the front should remain constant, progressing distally.[7] Smiles designed using this principle are based on a linear coefficient progression in which the width of each successive tooth as viewed from the front diminishes by the same proportion. The width of the lateral incisor is reduced by a selected percentage from the width of the central incisor, and the width of each tooth distally is reduced by this same percentage from its mesial tooth. The 70% RED proportion has been recommended for normal-length teeth with a 78% width/height ratio of the maxillary central incisors (Figure 3). When using the 70% RED proportion, the width of the maxillary lateral incisor is 70% of the frontal view width of the maxillary central incisor, and the maxillary canine is 70% of the width of the resulting lateral incisor. Different RED proportions may be used on different people as long as the same RED proportion is used consistently with the same individual smile.

Studies by Rosenstiel and colleagues[8] examined the relationship between maxillary tooth height and the preferred RED proportion. Dentists surveyed favored the smile with an 80% RED proportion when viewing very short teeth, the smile with the central incisor corresponding to the 70% RED when viewing normal-length teeth, and the smile with the golden proportion (62% RED) when viewing very tall teeth. The golden proportion fits the definition of the 62% RED proportion because the proportion between the successive tooth widths decreases by a fixed proportion (62%) distally. The golden proportion (62%) is one of many RED proportions that may be used. The majority chose the smile proportions that resulted in central incisors that were closest to the 75 to 78% width/height ratio.

If the central incisors are longer, they must also be wider to maintain this preferred width/height ratio (Figure 4). The result is wider, more dominant central incisors with tall teeth and narrower, more similar-width central and lateral incisors with short teeth. When applying the principles of the RED proportion, the taller the teeth, the smaller the RED proportion used, and the

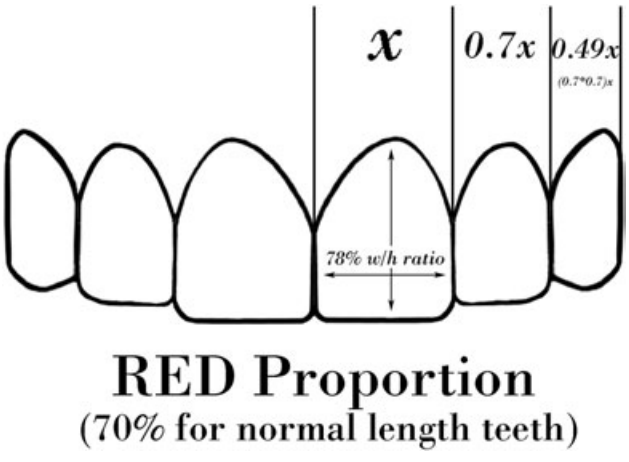

Figure 3. Graphic representation of six normal-length maxillary anterior teeth using the recommended 70% recurring esthetic dental (RED) proportion.

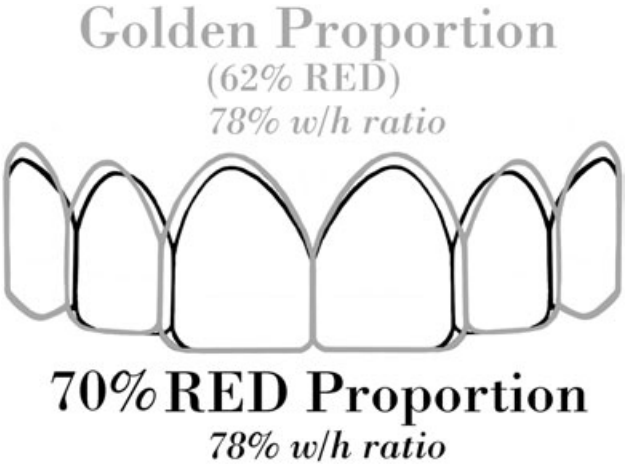

Figure 4. Graphic representation of different length maxillary anterior teeth maintaining a 78% width/height (w/h) ratio of the central incisors.

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shorter the teeth, the larger the RED proportion. The 62% RED proportion is recommended for use in smiles with very tall teeth. For very short teeth, a RED proportion approaching 80% is recommended. Gradations within the range of 62 to 80% RED proportions may be used based on the amount of deviation from normal lengths.

Successive Tooth Width Proportion Studies

The golden proportion, golden mean, and RED proportion have not been observed in a majority of casts of surveyed populations.[9,10] It was reported in one surveyed North American population by Preston[11] that the width of the average maxillary lateral incisor was approximately 66% of the width of the average maxillary central incisor, and that the average maxillary canine was approximately 84% of the width of the average maxillary lateral incisor. Other studies have reported similar width proportion percentages.[12] Mahshid and colleagues[13] reported that the golden proportion was not readily observed in smiles deemed to be esthetic. Basting and colleagues[14] found that the majority of dentists surveyed considered smiles with a width proportion greater than 69.9% between the maxillary central incisor and lateral incisor to be esthetically acceptable and suggested consideration for the use of the 70% RED proportion.

Purpose of the Study

The purpose of this study was to determine whether North American dentists surveyed prefer the RED proportion, the golden proportion, the golden mean, or the naturally occurring proportions (Preston proportion) reported to occur in the North American population. The Preston proportion was defined as the average maxillary anterior tooth width proportions reported to occur in North American patients in which the maxillary lateral incisor was 66% of the frontal view width of the maxillary central incisor, and the maxillary canine was 84% of the frontal view width of the resulting maxillary lateral incisor.[11] The working hypothesis of this study was that dentists prefer the smile constructed using the principles of the RED proportion to the smile constructed using the maxillary anterior tooth width proportions reported to occur naturally in the North American population (Preston proportion).

MATERIALS AND METHODS

Full-smile frontal images were made at a 1:2 magnification using a 100-mm focal length macro lens mounted on a 6-megapixel digital SLR (single lens reflex) camera with ring flash (Canon Rebel XT, Canon, Lake Success, NY, USA). A computer image manipulation program (Adobe Photoshop CS, Adobe Systems, San Jose, CA, USA) was used to produce a smile with a 70% RED proportion between the successive widths of the six maxillary anterior teeth as viewed from the front and a 78% width/height ratio of the maxillary central incisors. Changes were made to the teeth and the gingival contours to produce a smile that followed many of the principles of an ideal smile. From this reference image (Figure 5), manipulations were made to the six maxillary ante-

Figure 5. Master smile used to create all imaged proportion views.

rior teeth width proportions, keeping constant the facial-view width from the distal of the maxillary canine to the canine on the contralateral side. No manipulations were made to the widths of the posterior teeth or the mandibular teeth.

Five sets of two different smiles in each set were constructed, with proportions representing: (*survey set 1*) the golden proportion (Figure 6A) and the golden mean (Figure 6B); (*survey set 2*) the Preston (naturally occurring) proportion (Figure 7A) and the golden proportion (Figure 7B); (*survey set 3*) the golden proportion (Figure 8A) and the 70% RED proportion (Figure 8B); (*survey set 4*) the Preston (naturally occurring) proportion (Figure 9A) and the 70% RED proportion (Figure 9B); and (*survey set 5*) the tall Preston (naturally occurring) proportion (Figure 10A) and the tall golden (62% RED) proportion (Figure 10B). The displayed images on the screen were taller in survey set 5, although the widths of all the images displayed throughout the survey remained constant. The formulas used to determine the widths of the maxillary teeth in each proportion are displayed in Table 1. The survey sets of the width proportions created are listed in Table 2. A line drawing with the relative superimposed proportions between the two views in each set is represented in Figures 6C, 7C, 8C, 9C, and 10C.

The viewing order of the sets was predetermined, whereas the order of the two proportional images in each set was randomized. Once the order within each set was established, the images were displayed in

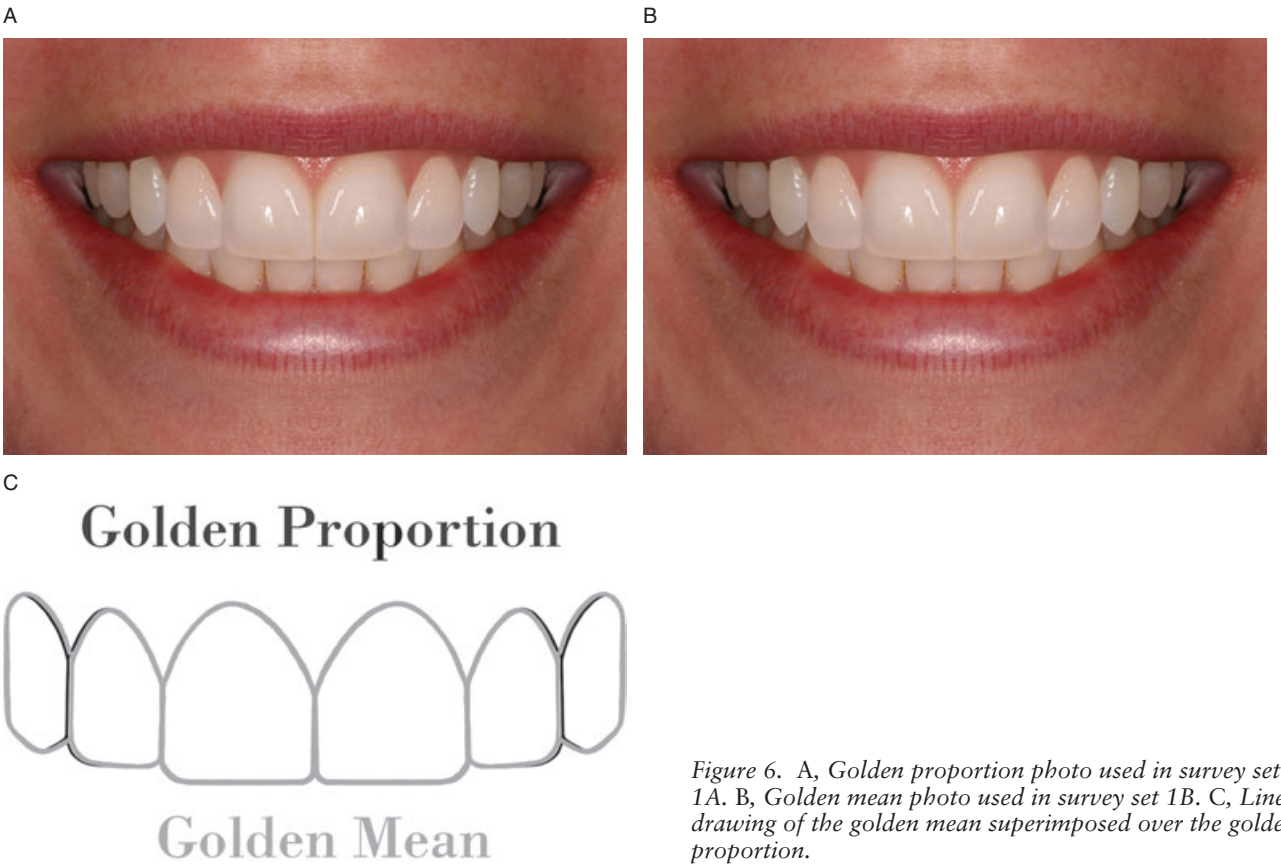

Figure 6. A, *Golden proportion photo used in survey set 1A.* B, *Golden mean photo used in survey set 1B.* C, *Line drawing of the golden mean superimposed over the golden proportion.*

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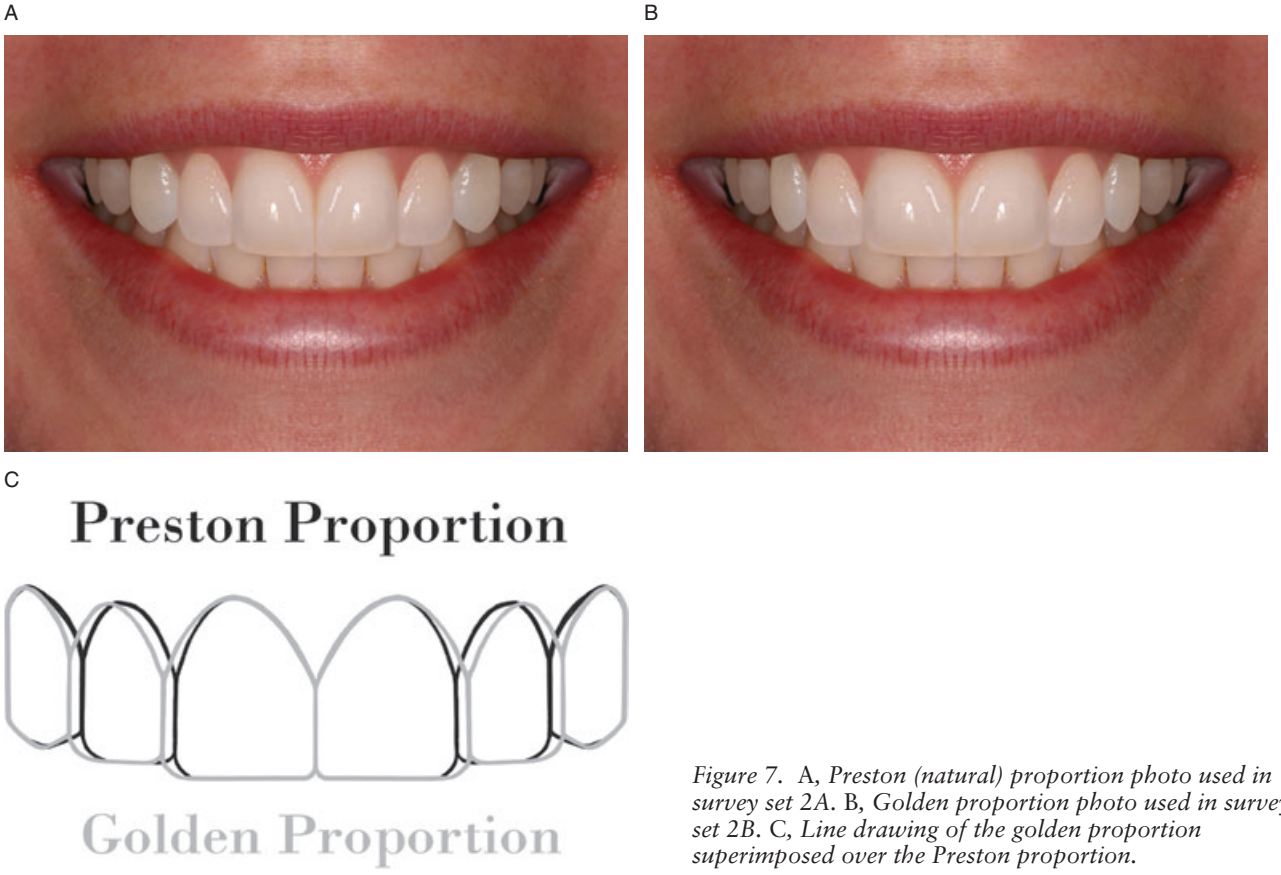

Figure 7. A, *Preston (natural) proportion photo used in survey set 2A.* B, *Golden proportion photo used in survey set 2B.* C, *Line drawing of the golden proportion superimposed over the Preston proportion.*

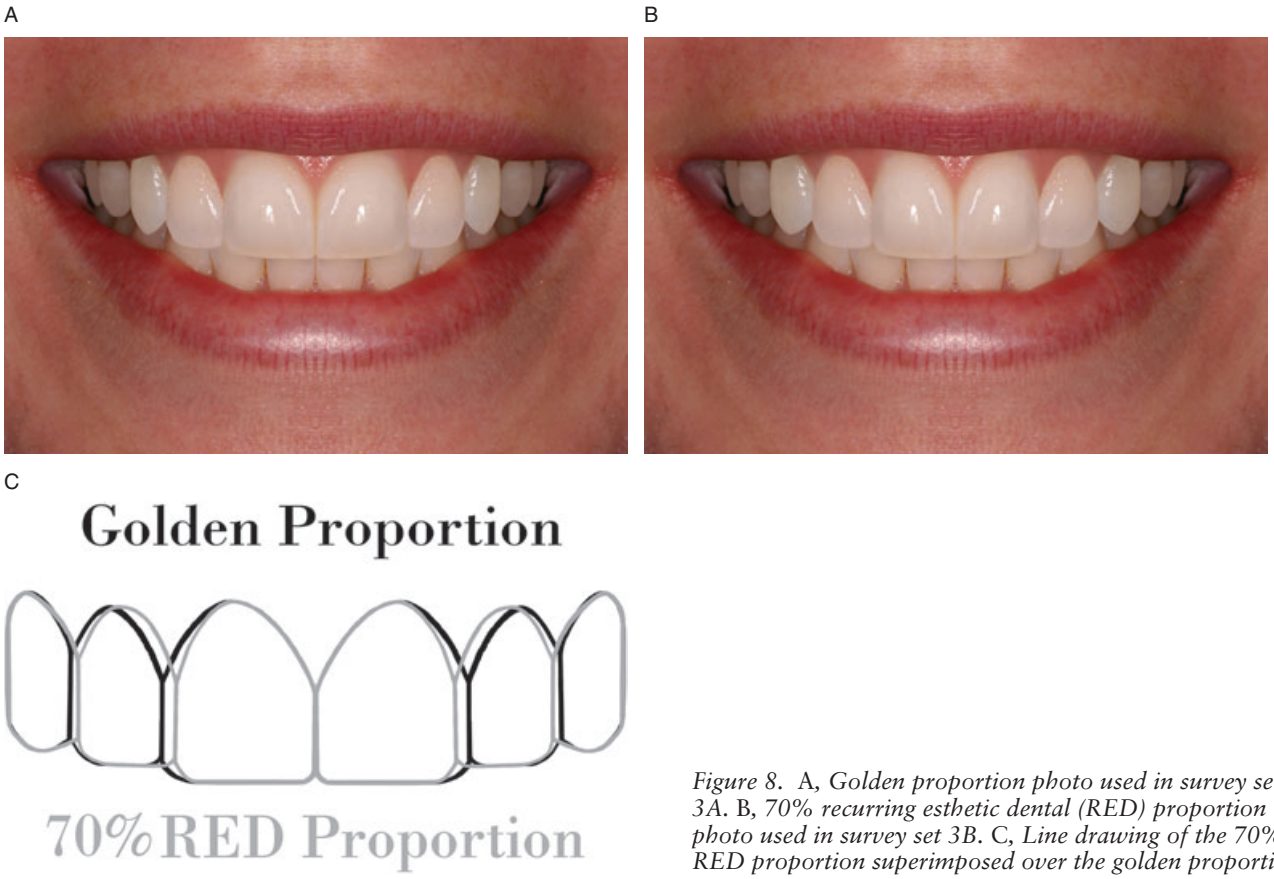

Figure 8. A, *Golden proportion photo used in survey set 3A.* B, *70% recurring esthetic dental (RED) proportion photo used in survey set 3B.* C, *Line drawing of the 70% RED proportion superimposed over the golden proportion.*

A

B

C

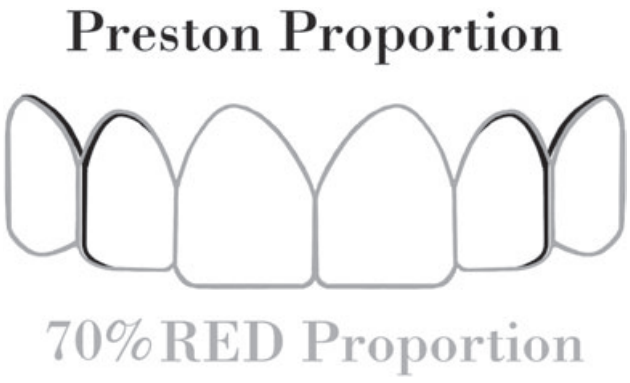

Figure 9. A, *Preston (natural) proportion photo used in survey set 4A*. B, *70% recurring esthetic dental (RED) proportion photo used in survey set 4B*. C, *Line drawing of the 70% RED proportion superimposed over the Preston proportion.*

A

B

C

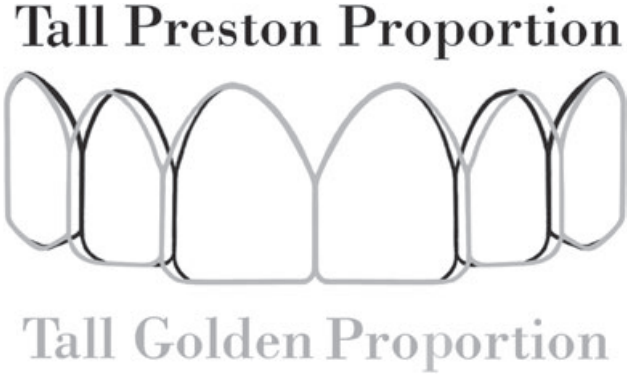

Figure 10. A, *Tall Preston (natural) proportion photo used in survey set 5A*. B, *Tall golden proportion photo used in survey set 5B*. C, *Line drawing of the tall golden proportion superimposed over the tall Preston proportion.*

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TABLE 1. FORMULAS USED FOR TOOTH WIDTH CALCULATIONS.

Tooth-to-Tooth Width Proportion	Central Incisor(CI) Width	Lateral Incisor (LI) Width	Canine Width
Golden proportion	IC width × 0.25	CI width × 0.62	LI width × 0.62
Golden mean	IC width × 0.25	IC width × 0.15	IC width × 0.10
Preston proportion	Preston CIW*	CI width × 0.66	LI width × 0.84
70% RED proportion	RED CIW†	CI width × 0.70	LI width × 0.70

RED = recurring esthetic dental; IC width = intercanine width of six maxillary teeth (as viewed from the front).
RED expressed as a decimal: a 70% RED is entered as 0.7.

$$*\text{Preston CIW} = \frac{\text{Total intercanine frontal view width}}{2(1+0.66+(0.66\times 0.84))}$$

$$\dagger\text{RED CIW} = \frac{\text{Total intercanine frontal view width}}{2\left(1+\text{RED}+\text{RED}^2\right)}$$

Note: Solving the two equations reveals that the maxillary central incisor width of the 70% RED proportion (1/4.38 rounded to 0.23) is similar to the width of the maxillary central incisor using the Preston proportion (1/4.42 rounded to 0.23).

TABLE 2. SURVEY SETS OF WIDTH PROPORTIONS.

Survey Set	View A	View B
1	Golden proportion (same length maxillary anterior teeth as Preston proportion)	Golden mean (same length maxillary anterior teeth as Preston proportion)
2	Preston proportion (78% w/h ratio central incisor)	Golden proportion (same length maxillary anterior teeth as Preston proportion)
3	Golden proportion (same length maxillary anterior teeth as Preston proportion)	70% RED proportion (78% w/h ratio central incisor)
4	Preston proportion (78% w/h ratio central incisor)	70% RED proportion (78% w/h ratio central incisor)
5	Tall Preston proportion (same length maxillary anterior teeth as tall golden proportion)	Tall golden proportion (78% w/h ratio central incisor)

RED = recurring esthetic dental; w/h = width/height.

the same order. The lengths of the teeth remained constant within each set of two views. It was felt that changing the height of the maxillary central incisor to keep the width/height ratio constant for each view would be distracting. The same length of the six maxillary anterior teeth was used for the first four survey comparison evaluations. In the final survey set, the entire images of both smiles were lengthened by the same percentage. The paired sets of smiles were inserted into a computer presentation program (Microsoft PowerPoint, Microsoft Corporation, Redmond, WA, USA). The images were carefully aligned so that there was no change in position of the lips and only the affected teeth would appear to move in order to make selection more definitive with the fewest distractions.

The same laptop computer (Dell Inspiron 1705, Dell, Inc., Round Rock, TX, USA) was used throughout the survey to assure identical viewing times. Because the same video projector could not be used at each location, the images on the screen were measured using a tape measure before conducting each survey to ensure proper proportions. The participants were placed in front of the screen within the confines of the width of the screen to reduce angular distortion. A beginning set of instructions was projected. A demonstration set of two different proportioned smiles, not subsequently displayed in the survey, was shown to acquaint the viewer with the protocol that would follow. Each view was displayed for 3 seconds and then faded to the other view for 3 seconds. This occurred four times. Then, for three more times, each view was shown for 1 second. This same sequence was used throughout the survey. The participants were asked

if there were any questions. Once the program began, nothing further was said and the participants were asked to remain silent. Each of the views in the set faded smoothly to the other view seven times. There was a 5-second interval between each set to allow time for recording their responses on the survey form. After the five sets of smiles had been shown, the participants were asked on the screen the primary proportion that influenced their decisions, the dental school in which they had graduated, and the state in which they practice. The questionnaires were collected and the participants were thanked.

The resulting smile preferences were analyzed with one-sample *t*-tests. The predetermined significance level was set at $p = 0.05$, in line with this being an exploratory study. The Pearson's Chi-square test, using the same level of significance, was conducted to assess the independence between the demographic attributes and the variation in the factors that influenced preference.

RESULTS

This survey was conducted on 12 different occasions throughout the United States, including the Northern, Midwestern, Southern, and Western regions. The dentists who responded were attending continuing dental education courses between April 2006 and December 2006, in which the topic for the presentation was related to esthetic dentistry. No discussion of smile principles occurred before the survey. The largest survey included 71 dentists, and the smallest involved four dentists. The average number of dentists in a survey was 26, and the median was 20 dentists.

A total of 318 responses were collected, but for the study only the responses of the 301 North American dentists were evaluated. The demographic data are shown in Table 3 and displayed in Figure 11. Dentists' practices were located in 36 different states and provinces.

TABLE 3. DEMOGRAPHIC DATA OF THE NORTH AMERICAN DENTIST RESPONDENTS.

Demographics	*N*	%
Gender		
Female	76	25
Male	220	73
Not reported	5	2
Total	301	100
Age (years)		
20–29	26	9
30–39	81	27
40–49	64	21
50–59	80	27
60+	40	13
Not reported	10	3
Total	301	100
Mean (SD)	45.8 (12.1)	
Years in practice		
00–09	93	31
10–19	47	16
20–29	82	27
30+	70	23
Not reported	9	3
Total	301	100
Mean (SD)	18.9 (12.4)	
Average units of fixed prosthetics per month		
00–09	33	11
10–19	59	20
20–29	69	23
30–39	38	13
40+	46	15
Not reported	56	18
Total	301	100
Mean (SD)	25.1 (21.6)	

Mean values based on reported observations; nonreporting observations omitted.

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Of the 301 respondents, 76 were female, 220 were male, and 5 did not identify their gender. Those subjects providing age information had a mean and median age of 46 years, ranging between 26 and 79 years. The mean tenure of practice was 19 years, with a median tenure of 20 years, ranging between 0.3 and 54 years. The average units of fixed prostheses placed per month by the participants was 25 units, with a median of 20 units, ranging between 0 and 180 units, with 18% (56) of the subjects not responding to this question.

The survey results are displayed in Tables 4 and 5. There was no significant difference in the levels of preference between the golden proportion (45%) and the golden mean (55%) (Figure 12). The percentage of dentists preferring the Preston proportion (naturally occurring) (70%) differed significantly ($p < 0.00001$) from the percentage of dentists preferring the golden proportion (30%) (Figure 13). Similarly, the difference in percentage of dentists preferring the 70% RED proportion (75%) to the golden proportion (25%) was also significant ($p < 0.00001$) (Figure 14). The level of preference (57%) for the 70% RED proportion was significantly different ($p = 0.0130$) from that found for the Preston proportion (naturally occurring) (43%) (Figure 15). Tall teeth in golden proportion were preferred by 58% of the dentists, whereas the tall Preston proportion teeth (naturally occurring) were selected by only 42% of dentists surveyed, with the difference in preference being significant ($p = 0.0046$) (Figure 16).

Although 62% of the dentists reported that the major factor that influenced their decision was the overall balance of the smile, significance ($p = 0.031$, Pearson Chi-square, df 4) was found only for the differences between male and

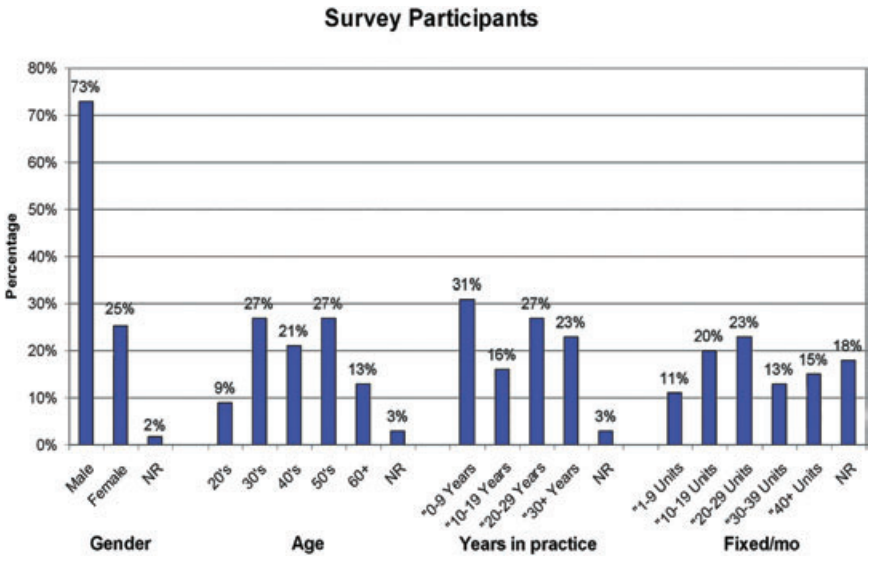


Figure 11. Graph of the demographic data of the survey participants.

TABLE 4. NORTH AMERICAN DENTISTS' PREFERENCES OF CONSTRUCTED SMILES.

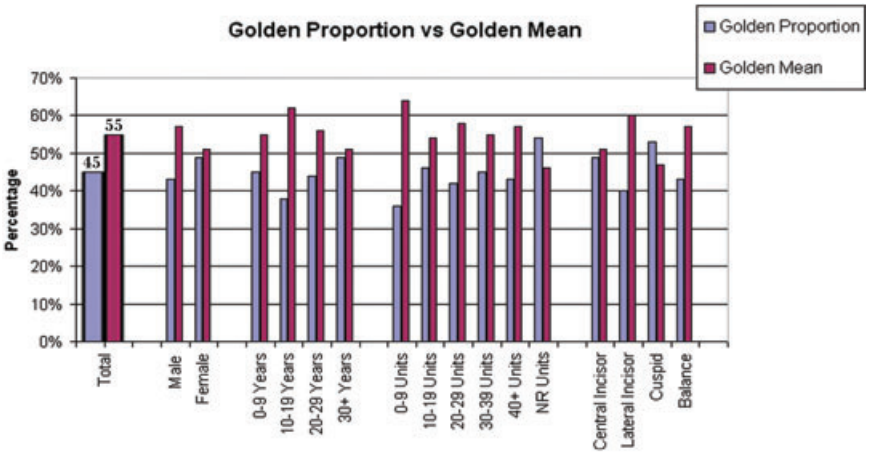
Survey Set	Smile A	*N*	%	*p*-Value	Smile B	*N*	%	*p*-Value
1	Golden proportion	135	45		Golden mean	165	55	
2	Preston proportion	211	70	<0.00001	Golden proportion	89	30	
3	Golden proportion	74	25		70% RED proportion	227	75	<0.00001
4	Preston proportion	129	43		70% RED proportion	172	57	0.01300
5	Tall Preston proportion	127	42		Tall Golden proportion	174	58	0.00460

RED = recurring esthetic dental.
Comparisons made via *t*-tests. *p*-Values reported only for comparisons yielding significant differences in preference between smile A and smile B.

TABLE 5. PRIMARY FACTOR AFFECTING DECISION RESULTS.

Sex	A Central Incisor Proportion	B Lateral Incisor Proportion	C Canine Proportion	D Overall Balance	E Other	Total
Male	41	10	15	143	6	215
Female	27	4	3	42	0	76
Total	68	14	18	185	6	291

Comparisons made via Pearson (4 df = 10.6229, $p = 0.031$).



Count	GP	GM	Years	GP	GM	Units	GP	GM	Influence	GP	GM
n=300						0-9	12	21			
Total	135	165	0-9	42	51	10-19	27	31	Central	34	35
Male	95	124	10-19	18	29	20-29	29	40	Lateral	6	9
Female	37	39	20-29	36	46	30-39	17	21	Cuspid	9	8
NR	3	2	30+	34	35	40+	20	26	Balance	80	108
			NR	5	4	NR	30	26	Other/NR	7	4

Figure 12. Graph of the survey set 1 responses (golden proportion versus golden mean).

female dentists (Table 5). Twenty-three percent said that the width of the central incisors most heavily influenced their decision. Five percent focused on the width of the lateral incisors, and 6% on the width of the canines. Two percent said that other factors influenced them, and 2% did not respond (Figure 17).

DISCUSSION

Support was found for the working hypothesis. Dentists preferred the smiles created according to the principles of the RED proportion to smiles created based on tooth-to-tooth width proportions found naturally in the population for normal and tall teeth. The maxillary central incisors in both the golden proportion and golden mean were identical. The widths of the maxillary lateral incisors in the golden mean were slightly smaller and the canines slightly larger than their corresponding teeth in the golden proportion. Dentists preferred the smiles with a less dominant maxillary central incisor than recommended by the golden proportion when viewing a normal-length smile. They preferred both the naturally occurring Preston proportion and the 70% RED proportion smiles over the golden proportion smiles with normal-length teeth. A majority of dentists preferred the 70% RED proportion smiles to the Preston proportion smiles reported to occur in nature. The difference between the proportions was that the lateral incisors were more prominent in the RED proportion, whereas the canines were wider in the Preston proportion. The golden proportion (62% RED proportion) smile with tall teeth was preferred by the surveyed dentists over the Preston proportion smile with tall teeth, confirming the published findings of Rosenstiel and colleagues.[8] The results support the recommendation that smiles with tall teeth should be created using a RED proportion that is smaller than the 70% recommended for normal-length teeth.

Balance was selected as the primary factor for deciding the preferred proportional view by a majority of dentists. The differences between

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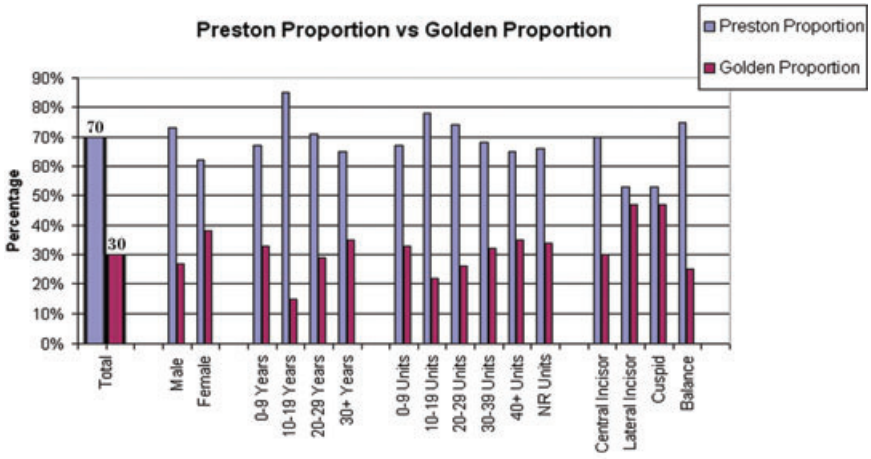
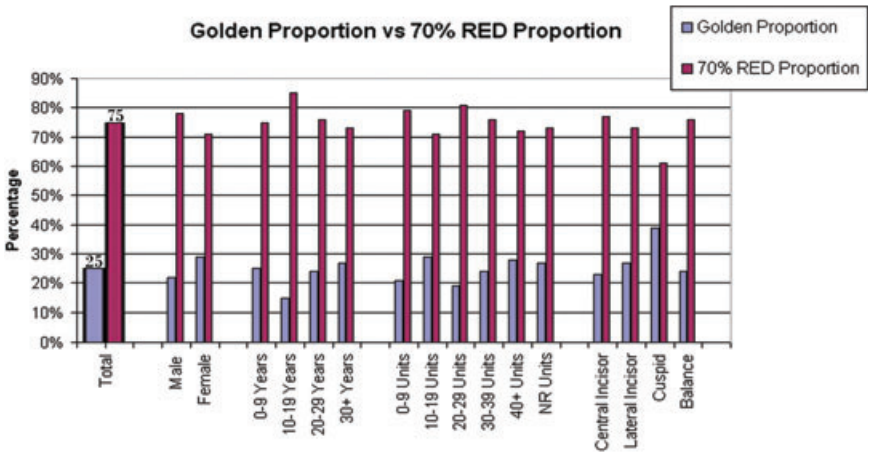


Count	PP	GP	Years	PP	GP	Units	PP	GP	Influence	PP	GP
n=300						0-9	22	11			
Total	211	89	0-9	62	31	10-19	45	13	Central	48	21
Male	161	58	10-19	40	7	20-29	51	18	Lateral	8	7
Female	47	29	20-29	58	24	30-39	26	12	Cuspid	9	8
NR	3	2	30+	45	24	40+	30	16	Balance	141	47
			NR	6	3	NR	37	19	Other/NR	5	6

Figure 13. Graph of the survey set 2 responses (Preston proportion versus golden proportion).

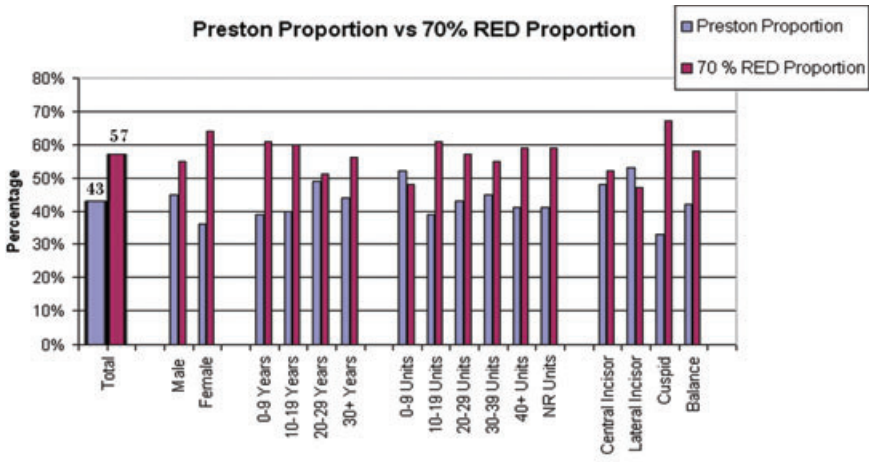


Count	GP	RED	Years	GP	RED	Units	GP	RED	Influence	GP	RED
n=301						0-9	7	26			
Total	74	227	0-9	23	70	10-19	17	42	Central	16	53
Male	49	171	10-19	7	40	20-29	13	56	Lateral	4	11
Female	22	54	20-29	20	62	30-39	9	29	Cuspid	7	11
NR	3	2	30+	19	51	40+	13	33	Balance	46	142
			NR	5	4	NR	15	41	Other/NR	3	8

Figure 14. Graph of the survey set 3 responses (golden proportion versus 70% recurring esthetic dental [RED] proportion).

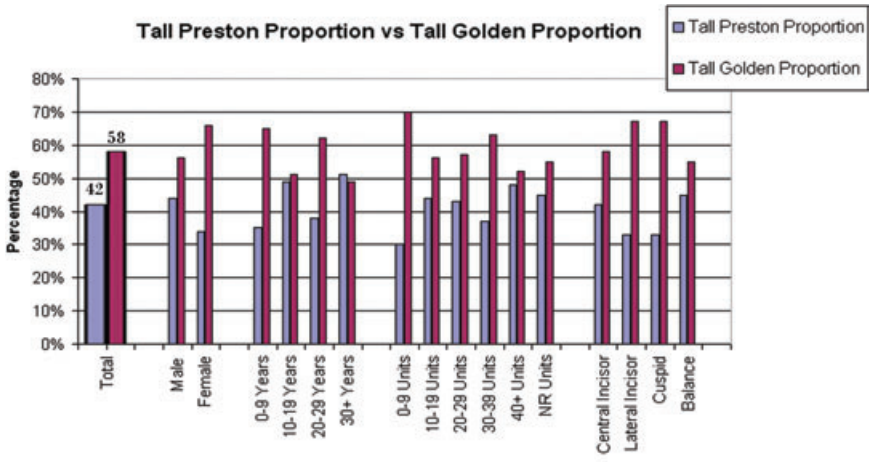
male and female responses to this question were statistically significant ($p = 0.031$). Females chose the proportion of the central incisor (36%) as the primary factor more frequently than males (19%). A higher percentage of females (38% survey set 2, 29% survey set 3) selected the smiles with wider central incisors than males (27% survey 2, 22% survey set 3) when comparing the golden proportion with the Preston or 70% RED proportion. A greater percentage of female dentists (64% versus 55% for males) preferred the smile with more dominant lateral incisors exhibited in the 70% RED proportion compared with the Preston proportion. In smiles with tall teeth comparing the Preston proportion with the golden proportion, the more dominant central incisor was chosen by 66% of females, yet by only 55% of males. Because of differences in gender-based decision factor preferences, future research may wish to examine whether the preferences found with female practitioners may also be correlated to those of the general population, for example, female patients.

This study was one of the first to use the capabilities of a computer to fade seamlessly between smiles, allowing more precise determinations to be made of the proportions preferred by dentists. Because of the diversity of locations, the participants were not able to be surveyed



Count	PP	RED	Years	PP	RED	Units	PP	RED	Influence	PP	RED
n=301						0-9	17	16			
Total	129	172	0-9	36	57	10-19	23	36	Central	33	36
Male	99	121	10-19	19	28	20-29	30	39	Lateral	8	7
Female	27	49	20-29	40	42	30-39	17	21	Cuspid	6	12
NR	3	2	30+	31	39	40+	19	27	Balance	79	109
			NR	3	6	NR	23	33	Other/NR	3	8

Figure 15. Graph of the survey set 4 responses (Preston proportion versus 70% recurring esthetic dental [RED] proportion).



Count	TP	TGP	Years	TP	TGP	Units	TP	TGP	Influence	TP	TGP
n=301						0-9	10	23			
Total	127	174	0-9	33	60	10-19	26	33	Central	29	40
Male	97	123	10-19	23	24	20-29	30	39	Lateral	5	10
Female	26	50	20-29	31	51	30-39	14	24	Cuspid	6	12
NR	4	1	30+	36	34	40+	22	24	Balance	85	103
			NR	4	5	NR	25	31	Other/NR	2	9

Figure 16. Graph of the survey set 5 responses (tall Preston proportion versus tall golden proportion).

again to determine the effects of different time intervals or sequences. Duplication of these surveys with patients would be useful to determine if their preferences are similar to dental practitioners. Future studies evaluating variables such as gender, ethnicity, tooth shapes, lip characteristics, gingival architecture, posterior teeth, and mandibular teeth may also be useful to better define an objective standard for smile design.

CONCLUSION

Within the limitations of this study, the following conclusions may be made:

1. The smile with normal-length teeth using the Preston naturally occurring maxillary anterior width proportions was significantly preferred (70%) over that constructed using the golden proportion.
2. The smile of the 70% RED proportion with *normal-length teeth* was significantly preferred over both the golden proportion and the Preston proportion (75 and 57%, respectively) smiles by the dentists surveyed.
3. The smile with *tall teeth* showing the golden proportion (62% RED proportion) was preferred (58%), to a significant degree, over the smile with *tall teeth* representing the Preston naturally occurring proportion by the surveyed dentists.

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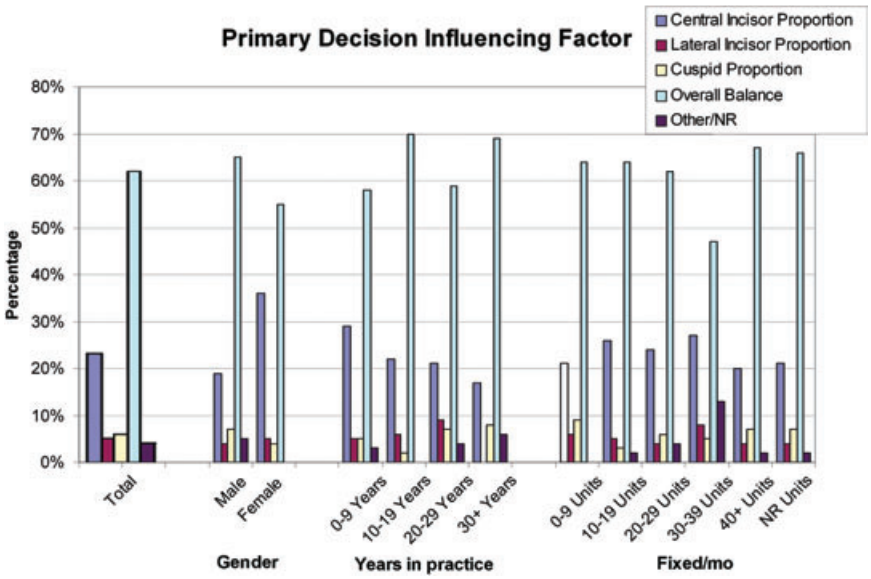

Figure 17. Graph of the primary decision-influencing factor demographic responses.

4. The majority of dentists (62%) made their selection primarily by the overall balance of the smile. Twenty-three percent made their selection based on the size of the maxillary central incisors, whereas 15% used other teeth or factors.

CLINICAL IMPLICATIONS

Smiles created using the principles of the RED proportion were preferred by a majority of North American dentists surveyed. The golden proportion (which also may be defined as a 62% RED proportion) should only be used when designing smiles for very tall teeth. The RED proportion results in balanced smiles that were preferred by a majority of surveyed dentists. Dentists may wish to use the concepts of the RED proportion as a guide when designing smiles for all lengths of teeth. Further studies should be performed to better define an accepted standard for proportional smile design.

DISCLOSURE AND ACKNOWLEDGMENTS

The author does not have any financial interest in the companies whose materials are included in this article.

The author would like to thank Nicholas S. Miceli, PhD, for performing the statistical analyses of the results. The author especially would like to thank Joyce Ward for inputting the data and assisting in the editing.

REFERENCES

1. Al-Balkhi KM. Orthodontic treatment planning: do orthodontists treat to cephalometric norms? J Contemp Dent Pract 2003;4(4):12–27.
2. Huntley HE. The divine proportion. New York: Dover Publications; 1970.
3. Levin EI. Dental esthetics and the golden proportion. J Prosthet Dent 1978;40:244–52.
4. Snow SR. Esthetic smile analysis of anterior tooth width: the golden percentage. J Esthet Dent 1999;11:177–84.
5. Lombardi RE. The principles of visual perception and their clinical application to denture esthetics. J Prosthet Dent 1973;29:358–82.
6. Albers HA. Esthetic treatment planning. Adept Report 1992;3:45–52.
7. Ward DH. Proportional smile design using the RED proportion. Dent Clin North Am 2001;45:143–54.
8. Rosenstiel SF, Ward DH, Rashid RG. Dentists' preferences of anterior tooth proportion—a web-based study. J Prosthodont 2000;9:123–36.
9. Hasanreisoglu U, Berksun S, Aras K, Arslan I. An analysis of maxillary anterior teeth: facial and dental proportions J Prosthet Dent 2005;94:530–8.
10. Ali Fayyad MA, Jamani KD, Agrabawi J. Geometric and mathematical proportions and their relations to maxillary anterior teeth. J Contemp Dent Pract 2006;5:62–70.
11. Preston JD. The golden proportion revisited. J Esthet Dent 1993;5:247–51.
12. Gillen RJ, Schwartz RS, Hilton TJ, Evans DB. An analysis of selected normative tooth proportions. Int J Prosthodont 1994;7:410–7.
13. Mahshid M, Khoshvaghti A, Varshosaz M, Vallaei N. Evaluation of "golden proportion" in individuals with esthetic smile. J Esthet Restor Dent 2004;16:185–92.
14. Basting RT, Trindade RS, Flório FM. Comparative study of smile analysis by subjective and computerized methods. Oper Dent 2006;31:652–9.

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