Proportional Smile Design

Using the Recurring Esthetic Dental Proportion to Correlate the Widths and Lengths of the Maxillary Anterior Teeth with the Size of the Face

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KEYWORDS

• Proportional smile design • RED proportion • Central incisor width/length ratio
• Tooth/face proportion

KEY POINTS

- Proportional smile design can be used to design a smile in harmony with the face. A smile created with the 78% width/length ratio of the maxillary central incisor has been shown to be preferred by dentists surveyed.
- Keeping the relative lengths of the teeth consistent with the height of the patient is recommended.
- A method of determining the relative widths of the maxillary anterior teeth should be used.
- Producing an imaged view of the recommended smile before active treatment is important to allow discussion and input from the patient to achieve pleasing results.

INTRODUCTION

Dentists and laboratory technicians have an important role in creating pleasing smiles for their patients. Methods that can predictably satisfy the patient should be used. Studies have measured the sizes and key proportions of the natural teeth.[1,2] Most people have variations in their smile that deviate from the published standards for ideal smiles. Orthodontic treatment is performed on a significant population of patients who are not satisfied with what nature has given them in their smiles. People spend significant amounts of money with plastic surgeons and dermatologists to look different than what was their natural appearance. Do we as dentists always want to give patients a smile that mirrors what is often found in nature, such as crowded, overlapped, and twisted teeth, malocclusions or diastemas (**Figs. 1** and **2**)? Do we want to

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Fig. 1. Crowded teeth with malocclusion.

design smiles so they mimic the sizes and proportions found in nature? Should the use of proportions that are preferred by dentists be considered in addition to the proportions observed in nature?

THE GOLDEN PROPORTION

The golden proportion has been considered the standard by many for determining the ideal widths of the anterior teeth.[3,4] Based on formulas defined by ancient Greek mathematicians, the proportion has developed mythical connotations (**Fig. 3**).[5] Although often cited as the reference for designing smiles it has been this author's observance that smiles supposedly designed by this method were not conformant with this practice. When the proportions of natural anterior teeth were evaluated in numerous studies, the golden proportion was not found to be the predominant proportion observed.[6,7]

NATURAL PROPORTIONS

Studies have been conducted worldwide to determine the proportions of the teeth. Results vary according to location. Preston[8] observed that the average frontal tooth to tooth width proportion of North American dental students was 66% for the lateral incisor/central incisor and 84% for the canine/lateral incisor. Forster and colleagues[9] reported that the average tooth to tooth width proportion of patients evaluated at a

Fig. 2. Smile with diastema.

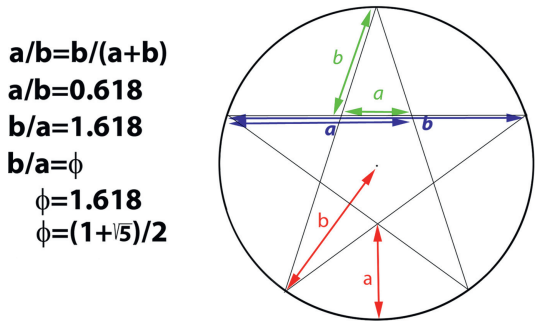


Fig. 3. The golden proportion.

faculty of dentistry in Hungary was 62% for the lateral incisor/central incisor and 85% for the canine/lateral incisor. Asians often report lateral incisors that are smaller than their North American and European counterparts. When reviewing articles to understand the natural proportions that exist, it is important to consider the ethnicity and region in which the study was performed to determine their applicability when designing smiles in other areas of the world.

The average width/length (w/l) ratio of the maxillary central incisor has been reported in one well-known study to be 85% to 86%.[10] Another study reports the mean w/l ratio of the central incisor to be 90%.[11] The w/l ratio can be influenced by several factors. Most studies evaluate the visible display of the length of the central incisor, not the distance from the incisal edge to the cementoenamel junction. Altered passive eruption in young patients who are often evaluated in studies would result in a higher reported observed w/l ratio than if the entire clinical crown were exposed.[12] As a patient ages, there can be incisal wear that also increases the w/l ratio.[13] Age variations can be a significant factor affecting the w/l ratio values reported. **Fig. 4** is an imaged photograph of a natural proportion smile with the Preston width proportion (66%, 84%) and the 86% w/l ratio of the central incisor.

Fig. 4. Natural height and width proportions.

RECURRING ESTHETIC DENTAL PROPORTION

The recurring esthetic dental (RED) proportion has been proposed as a model in designing smiles.[14] The RED proportion states that the proportion of the successive widths of the teeth as viewed from the front should remain constant as one moves distally (**Fig. 5**). The frontal view width of every maxillary tooth becomes smaller by a certain percentage as one moves posteriorly. This is a two-dimensional evaluation of a three-dimensional smile, so the buccal/palatal placement of the teeth affects their apparent widths. The range of suggested RED proportions is between 62% and 80%. The golden proportion (62% RED proportion) is applicable as one of many proportions that fit within the definition of the RED proportion. Different RED proportions can be proposed for use with the same individual according to the desired length of the teeth, the scope of treatment possible, and the desire to have the size of the teeth match the size of the face and body (**Fig. 6**). The expanded definition of the RED proportion includes using the relative tooth height and body height to determine the appropriate RED proportion.

PREFERRED PROPORTIONS VERSUS NATURAL PROPORTIONS

A study comparing different RED proportions with different heights of teeth found dentists surveyed preferred a resulting smile that kept the w/l ratio of the resulting central incisor in the 75% to 78% range.[15] Dentists surveyed preferred people with tall teeth to have a wider central incisor to maintain the preferred 75% to 78% w/l ratio. This is different than the 85% to 86% w/l ratio, which has been reported as what is observed in natural teeth (**Fig. 7**). Another study comparing different proposed and natural tooth to tooth width proportions found that a slight majority of dentists surveyed preferred the 70% RED proportion to the Preston proportion with normal-length teeth.[16] Most dentists surveyed preferred proportions that are not coincident with natural proportions. This asks the question whether naturally occurring proportions should always be used when patient elective treatment is sought. **Fig. 8** is an imaged photograph of a smile with the 70% RED proportion and the 78% w/l ratio of the central incisor.

AFFECT OF CENTRAL INCISOR HEIGHT ON CENTRAL INCISOR WIDTH AND APPROPRIATE RECURRING ESTHETIC DENTAL PROPORTION

Because the preferred maxillary central incisors of tall teeth are also wider they occupy a greater percentage of the smile leaving less space for the remaining anterior teeth (**Fig. 9**). The width of the lateral incisors and canines must be a smaller percentage of the central incisor resulting in a smaller RED proportion being preferred. The smaller the RED proportion, the more dominant is the central incisor. Smiles designed using

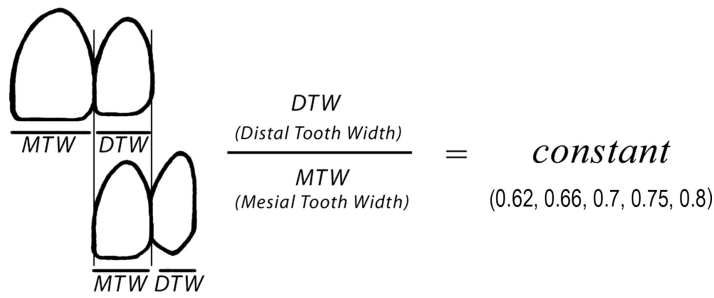
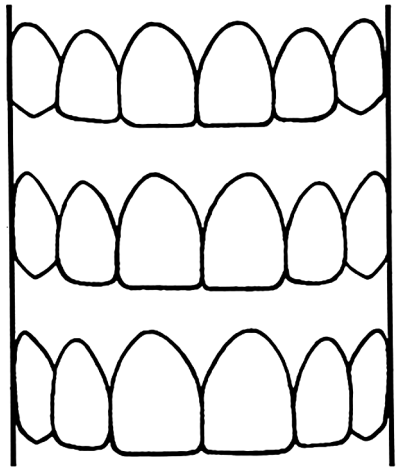


Fig. 5. RED proportion formula. (*Adapted from* Ward DH. Proportional smile design using the recurring esthetic dental proportion. Dent Clin North Am 2001;45:146; with permission.)



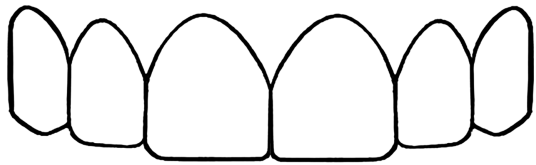
80% RED

70 % RED

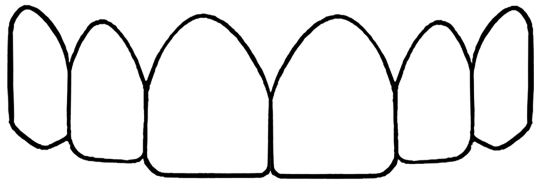
62% RED
(Golden
Proportion)

(78% Central Incisor w/l ratio)

Fig. 6. RED proportions.



NATURAL 86%
WIDTH/LENGTH RATIO



DENTIST PREFERRED 78%
WIDTH/LENGTH RATIO

Fig. 7. Natural versus preferred width/length ratio.

Fig. 8. 70% RED proportion, 78% width/length ratio.

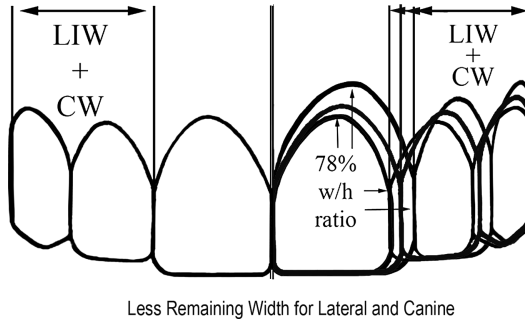


Fig. 9. Taller tooth yields more dominant central incisor. CW, canine width; LIW, lateral incisor width. (*Adapted from* Ward DH. Using the RED proportion to engineer the perfect smile. Dent Today 2008;27(5):112; with permission.)

the golden proportion (62% RED) exhibit prominent central incisors, which together occupy 50% of the intercanine width (ICW). This seems logical when one considers that tall models tend to look more attractive with smiles designed with the 62% RED (golden) proportion. Conversely, dentists preferred people with short teeth to have more narrow central incisors to maintain the preferred 75% to 78% w/l ratio. Because the central incisors do not occupy as much space there is more room for the remaining anterior teeth and the lateral incisors and canines are more similar in width resulting in a larger RED proportion (**Fig. 10**). The percentage difference is not as great as one moves distally, resulting in a RED proportion closer to 80%.

CORRELATING THE TOOTH AND BODY HEIGHT WITH THE RECURRING ESTHETIC DENTAL PROPORTION

It is recommended that the taller the individual and taller the teeth, the smaller the RED proportion. Extra tall individuals should have a 62% RED proportion, normal height persons a 70% RED proportion, and a very short person an 80% RED proportion. Interpolations should be used within these parameters for medium tall and medium short individuals (**Fig. 11**). These are guidelines that should take into account the preoperative conditions of the teeth.

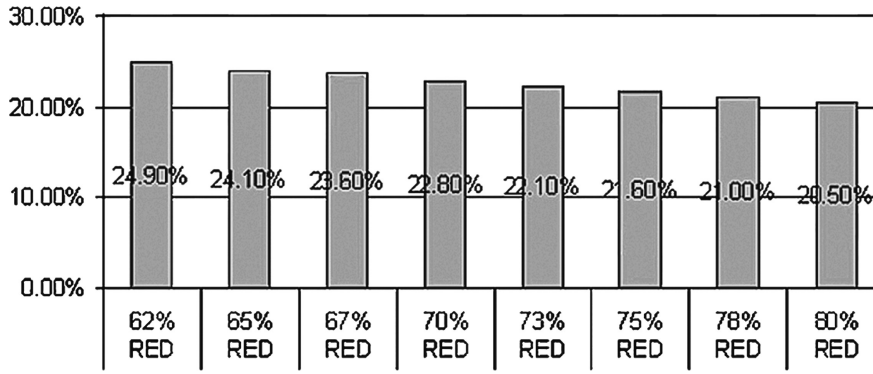


Fig. 10. Central incisor width percentage of intercanine width for different RED proportions.

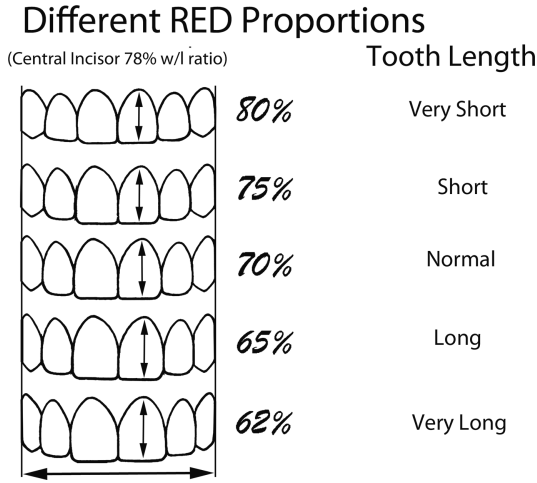


Fig. 11. RED proportions correlating to tooth length. (*Adapted from* Ward DH. Using the RED proportion template to create a beautiful smile. Oral Health 2014;104(4):103; with permission.)

COMPARING NORMAL HEIGHT 70% RECURRING ESTHETIC DENTAL PROPORTION SMILES WITH PRESTON NATURAL PROPORTIONS

When comparing norms as determined by Preston, the resulting width of the central incisor was nearly identical to the width as determined using the 70% RED proportion. The lateral incisor, however, was wider (70% the central incisor width [CIW]) when using the RED proportion compared with what was found in the population (66% the CIW). The canine was narrower (70% the lateral incisor width [LIW]) when using the RED proportion than when compared with the general population (84% the LIW) (**Fig. 12**).

USING THE RECURRING ESTHETIC DENTAL PROPORTION

When using the RED proportion, the ICW is used to determine the ideal width of the central incisor. The formula for determining the ideal width of the central incisor is CIW = ICW/2 ($1+RED+RED^2$). Substituting 0.7 for the RED value into the equation one finds that with normal-length teeth you divide the ICW by 4.38 to calculate the width of the central incisor (**Fig. 13**). The LIW is determined by multiplying the CIW times the RED proportion. The canine width is determined by multiplying the resulting

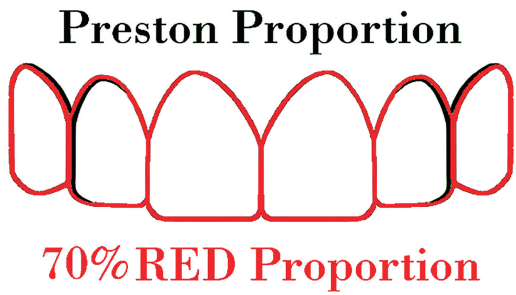


Fig. 12. Comparing Preston with RED proportion (normal length teeth). (*Adapted from* Ward DH. A study of dentists' preferred maxillary anterior tooth width proportions: comparing the recurring esthetic dental proportion to other mathematical and naturally occurring proportions. J Esthet Restor Dent 2007;19:330; with permission.)

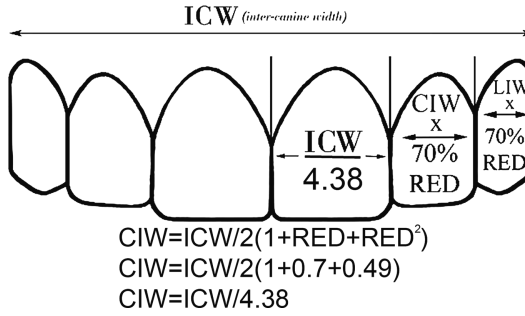


Fig. 13. Using RED proportion to determine tooth widths for normal length teeth CIW to ICW. (*Adapted from* Ward DH. Using the RED proportion to engineer the perfect smile. Dent Today 2008;27(5):114; with permission.)

LIW times the RED proportion. **Table 1** calculates tooth widths from relative tooth heights using the RED proportion and ICW.

For any given ICW there are several RED proportions that can be used. Body type, facial/skeletal form, lip form, gingival display, and tooth display should all be considered. Creating a smile that is coincident with the proportions of the body type dictates that a very tall person would have a smile with a 62% RED proportion, an average height person a 70% RED proportion, and a very short person an 80% RED proportion. The smile created using these proportions is quite different and yet all can be pleasing especially if they match the body type of the patient (**Fig. 14**).

SIMPLIFIED METHOD OF CALCULATING THE TOOTH DIMENSIONS USING THE RECURRING ESTHETIC DENTAL PROPORTION

A simplified method has been developed for determining the size of the maxillary anterior teeth using the RED proportion. If one substitutes the 78% w/l ratio into the formula and solves the equations for different height teeth one can use a chart to look up the appropriate widths of the anterior teeth. The first step is to measure the facial view intercommissural width of the anterior six teeth and divide it by the length of the central incisor. The resulting product is looked up in the chart and the intercommissural width is divided by the appropriate numbers in the chart to determine the widths of the central incisor, lateral incisor, and canine (**Table 2**).

Table 1
Calculating the RED proportion and anterior total widths from ICW with different tooth heights

Desired RED Proportion		Intercanine Divisors (Rounded): ICW/(N) = Tooth Width		
Tooth Height	**RED Proportion**	**Central Incisor Width**	**Lateral Incisor Width**	**Canine Width**
Very tall	62% RED	ICW/4.0	CIW *0.62	LIW ×0.62
Tall	66% RED	ICW/4.2	CIW *0.66	LIW ×0.66
Normal	70% RED	ICW/4.4	CIW *0.7	LIW ×0.7
Short	75% RED	ICW/4.6	CIW *0.75	LIW ×0.75
Very short	80% RED	ICW/4.8	CIW *0.8	LIW ×0.8

Adapted from Ward DH. Using the RED proportion to engineer the perfect smile. Dent Today 2008;27(5):116; with permission.

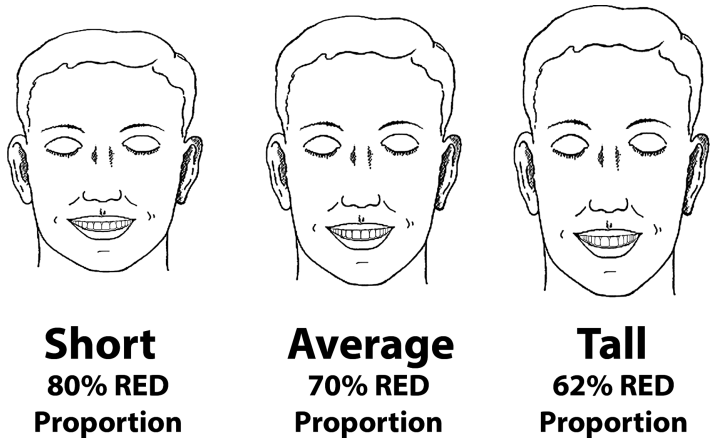


Fig. 14. Selecting appropriate RED proportion that coordinates with the body/tooth height.

The length of the central incisor is determined by dividing the width of the central incisor by 0.78. If a change in the length of the central incisor is desired, the Inter-canine Width (ICW) can be divided by the desired Central Incisor Length (CIL). This quotient should be between 3.1 and 3.8. and looked up in the left column of **Table 2** to determine the appropriate RED Proportion. The row with the RED Proportion is used to determine how to calculate the corresponding central incisor width, lateral incisor width and canine width.

USE OF DIGITAL IMAGING

Digital imaging is an invaluable tool in demonstrating to the patient the possible outcomes using different RED proportions and width/length ratios and can help them make informed decisions regarding additional procedures and the extensiveness of the prosthetic restoration. Patients are often reluctant to undergo additional surgical procedures but may be more willing to proceed if they can see the potential outcomes of their treatment decisions. A patient with short clinical crowns was interested in improving her smile. Photographs were taken (**Fig. 15**). A template with outlines of the anterior teeth with different RED proportions was moved over the smile

Table 2
Simplified method of determining anterior tooth widths from ICW and CIH

ICW/CIH	RED Proportion	Central Incisor Width (ICW/N)	Lateral Incisor Width (ICW/N)	Canine Width (ICW/N)
3.1	62% RED	4.00	6.47	10.43
3.2	65% RED	4.15	6.38	9.81
3.3	67% RED	4.24	6.33	9.44
3.4	70% RED	4.38	6.26	8.94
3.5	73% RED	4.53	6.20	8.49
3.6	75% RED	4.63	6.17	8.22
3.7	78% RED	4.78	6.12	7.85
3.8	80% RED	4.88	6.10	7.63

Abbreviation: CIH, central incisor height.

Adapted from Ward DH. Using the RED proportion to engineer the perfect smile. Dent Today 2008;27(5):116; with permission.

Fig. 15. Smile with short clinical crowns.

photograph to help evaluate the proportions and to select an appropriate RED proportion (**Fig. 16**). The 80% RED proportion was selected and the 80% template superimposed over the photograph (**Fig. 17**). An imaged photograph was produced to show the potential affect of crown lengthening and laminates (**Fig. 18**). Imaging is a powerful and effective way to communicate with patients, specialists, and the dental laboratory.

DETERMINING THE IDEAL WIDTH AND LENGTH OF THE CENTRAL INCISOR USING THE RECURRING ESTHETIC DENTAL PROPORTION

The RED proportion mathematical formulas can be useful to determine the width and length of the ideal central incisor. Using the 70% RED proportion calculations also results in a reliable way to determine the widths of the central incisors observed in nature as reported by Preston. Whether the RED proportion is used or not for the

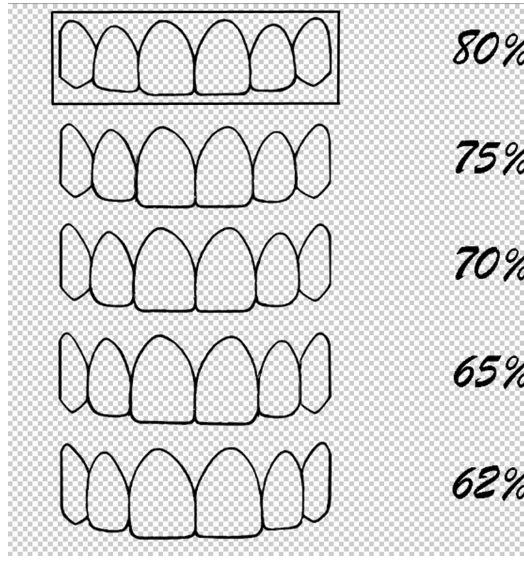


Fig. 16. Template chosen to superimpose over photograph. (*Adapted from* Ward DH. Using the RED proportion template to create a beautiful smile. Oral Health 2014;104(4):103; with permission.)

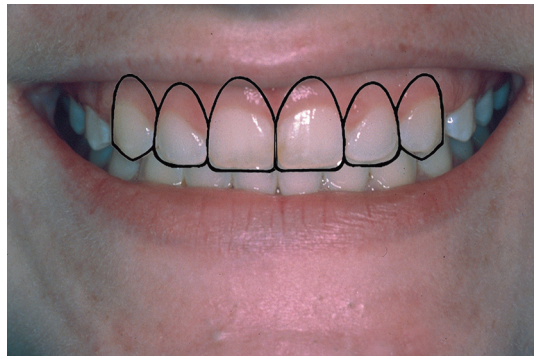


Fig. 17. Smile with 80% RED proportion template overlaid.

determination of the width of the lateral incisors is up to the dentist and the patient. It has been advocated with denture making, that variations of the lateral incisor in position and alignment help to give individuality to a smile. Some believe that a narrow lateral incisor is considered to be a more feminine trait, although this fact cannot be proved in studies of natural teeth.[17,18] If a narrower lateral incisor is used, then a wider canine is necessary. This seems to be the case in nature. **Table 3** is a simplified method to determine the ideal width and length of the central incisor using the principles of the RED proportion.

PREFERRED SMILE PROPORTIONS

Studies have been performed to determine the proportions most pleasing to dentists and patients. Generally patient preferences vary widely and are not as selective as those of dentists.[19,20] If dentists who are more particular about esthetic smiles are pleased, then it is hoped that in most instances the patient will also be satisfied. However, smile preferences can also be subjective. Patients should be shown the potential look of the smile before active treatment is commenced. Once approved this photograph should be conveyed to the specialists and the dental laboratory.

CASE STUDY

A 58-year-old man presented to the office unhappy with his smile. He had not been in a dental office for several years. A complete examination was performed, radiographs

Fig. 18. Imaged view of potential smile if crown lengthening and laminates are placed.

Table 3
Calculating CIL and CIW from ICW with different tooth heights

	Desired RED Proportion		
Tooth Height	**RED Proportion**	**CIW**	**CIL**
Very tall	62% RED	ICW/4	ICW/3.1
Tall	66% RED	ICW/4.2	ICW/3.25
Normal	70% RED	ICW/4.4	ICW/3.4
Short	75% RED	ICW/4.6	ICW/3.6
Very short	80% RED	ICW/4.8	ICW/3.8

Abbreviation: CIL, central incisor length.

exposed, and photographs taken (**Fig. 19**). There was a lack of posterior occlusion and the bite had collapsed. The patient was a musician who played a brass instrument. He wanted to keep his anterior teeth so his embouchure would remain intact.

The sizes of the teeth were evaluated. The intercommisural width measured 39.2 mm as viewed from the front (**Fig. 20**). It was determined that normal-length teeth were desired to match his dentition and his body type. Looking in **Table 3** for normal-length teeth the central incisor length is determined by dividing the ICW by 3.4, which was 11.5 mm (**Fig. 21**). The 70% RED proportion template was superimposed over the preoperative photograph to give an idea of the relative size of the desired anterior teeth (**Fig. 22**).

Unrestorable posterior teeth were extracted. The maxillary anterior teeth were restored with composite to give an idea of how the final restorations would look. This allowed us to see if the patient could accommodate the position of the incisal edges and if he could perform properly on his brass instrument (**Fig. 23**). Interim partial prostheses were fabricated to determine the proper vertical dimension of occlusion. The patient was allowed 6 months to adjust to the occlusion.

The maxillary anterior teeth were prepared for crowns and provisional restorations fabricated (**Fig. 24**). The laboratory was sent models and photographs of the provisional restorations. The crowns were fabricated by the laboratory, tried in, and seated (**Fig. 25**). The patient was thrilled with his new smile and his ability to play his instrument.

Treatment for this patient is not complete. He had three maxillary and three mandibular implants placed on his right side. Custom abutments were fabricated and crowns were seated (**Fig. 26**). Future plans include restoring his left side.

Fig. 19. Preoperative photograph.

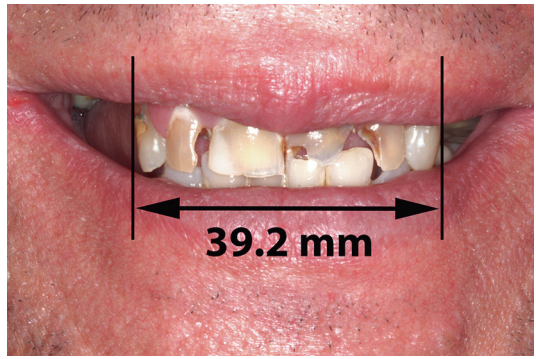


Fig. 20. Measuring ICW.

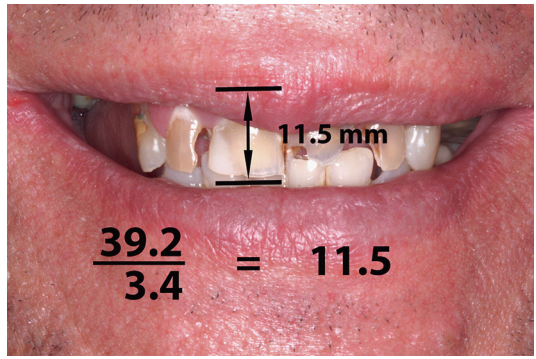


Fig. 21. Calculating central incisor length.

Fig. 22. Preoperative photograph with template.

Fig. 23. Anterior teeth built to desired size in composite.

Fig. 24. Anterior teeth prepared and provisionalized. Posterior teeth replaced with interim removable prostheses.

Fig. 25. Crowns seated.

Fig. 26. Anterior teeth and right side restored.

SUMMARY

Smile design should include evaluation of the body, face, and existing dentition of the patient. The RED proportion is a useful tool in designing a smile that is in sync with the size of the individual. Although not readily observed in nature, these methods can be useful when designing smiles.

REFERENCES

1. Chu SJ. Range and mean distribution frequency of individual tooth widths of the maxillary anterior dentition. Pract Proced Aesthet Dent 2007;19(4):209–15.
2. Fayyad MA, Jamani KD, Aqrabawi J. Geometric and mathematical proportions and their relations to maxillary anterior teeth. J Contemp Dent Pract 2006;7(5): 62–70.
3. Levin EI. Dental esthetics and the golden proportion. J Prosthet Dent 1978;40: 244–52.
4. Rufenacht CR. Fundamentals of esthetics. Chicago: Quintessence; 1990. p. 67–134.
5. Huntley HE. The divine proportion: a study in mathematical beauty. New York: Dover Publications Inc; 1970.
6. Hasanreisoglu U, Berksun S, Aras K, et al. An Analysis of maxillary anterior teeth: facial and dental proportions. J Prosthet Dent 2005;94:530–8.
7. Mahsid M, Khoshvaghti A, Varshosaz M, et al. Evaluation of "golden proportion" in individuals with an esthetic smile. J Esthet Restor Dent 2004;16:185–92.
8. Preston JD. The golden proportion revisited. J Esthet Dent 1993;5:247–51.
9. Forster A, Velez R, Antal M, et al. Width ratios in the anterior maxillary region in a Hungarian population: addition to the golden proportion debate. J Prosthet Dent 2013;110:211–5.
10. Sterrett JD, Oliver T, Robinson F, et al. Width/length ratios of normal clinical crowns of the maxillary anterior dentition in man. J Clin Periodontol 1999;26: 153–7.
11. Gillen RJ, Schwartz RS, Hilton TJ, et al. An analysis of selected normative tooth proportions. Int J Prosthodont 1994;7:410–7.
12. Rossi R, Benedetti R, Santos-Morales RI. Treatment of altered passive eruption: periodontal plastic surgery of the dentogingival junction. Eur J Esthet Dent 2008;3:212–23.

13. Magne P, Gallucci GO, Belser UC. Anatomical crown width/length ratios of unworn and worn maxillary teeth in white subjects. J Prosthet Dent 2003;89:453–61.
14. Ward DH. Proportional smile design using the RED proportion. Dent Clin North Am 2001;45:143–54.
15. Rosenstiel SF, Ward DH, Rashid RG. Dentists' preferences of anterior tooth proportion: a web-based study. J Prosthodont 2000;9:123–36.
16. Ward DH. A study of dentists' preferred maxillary anterior tooth width proportions: comparing the recurring esthetic dental proportion to other mathematical and naturally occurring proportions. J Esthet Restor Dent 2007;19:323–36.
17. Lombardi RE. A method for the classification of errors in dental esthetics. J Prosthet Dent 1974;32:501–13.
18. Basting RT, Trindale RS, Flório FM. Comparative study of smile analysis by subjective and computerized methods. Oper Dent 2006;31:652–9.
19. Ker AJ, Chan R, Fields HW, et al. Esthetics and smile characteristics from the layperson's perspective: a computer-based survey study. J Am Dent Assoc 2008; 139(10):1318–27.
20. Rosenstiel SF, Rashid RG. Public preferences for anterior tooth variations. J Esthet Restor Dent 2002;14:97–106.