

A Survey of Dentulous and Edentulous Patient Preference among Different Denture Esthetic Concepts

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ABSTRACT

Statement of Problem: Most esthetic preference research and anatomical average analysis come from dentulous populations. If edentulous patients have a different preference, application of this data during denture construction is problematic.

Purpose: The aim of this survey was to compare dentulous and edentulous respondent preference among three different denture esthetic concepts.

Material and Methods: A questionnaire and test booklet of standardized full-face digital photographs were used. It included three arrangements during maximum smile for six subjects. Dentulous and edentulous respondents were asked questions about their preference among the three randomly ordered concept photographs for each of the six subjects. A total of 167 dentulous and 269 edentulous questionnaires were analyzed descriptively and with Chi-squared tests to compare the esthetic preference of the respondents.

Results: There was no statistically significant difference overall between dentulous and edentulous preference. Respondent preference varied significantly depending upon subject set and gender. Preference data compared closely to previous research.

Conclusion: Within the limitations of this survey, dentulous and edentulous respondent preference among the three esthetic concepts was not significantly different. Questionnaire respondents continued to frequently prefer appearances that are far from the anatomical average.

CLINICAL SIGNIFICANCE

Dentulous and edentulous patients show a similar esthetic preference. Application of dentulous patient preferences and anatomical averages during edentulous patient treatment is appropriate.

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INTRODUCTION

Complete denture construction techniques have resulted in a high degree of patient satisfaction.^{1,2} Traditionally discussed predictors of success include functional and comfort-related concerns.^{3–8} Where conventional improvements fail, the long-term success of dental implants has allowed dentistry to address

many of the functional and comfort-related problems that previously resulted in complete denture failures.^{9–14} The esthetic placement of prosthetic teeth may therefore no longer be limited by arrangement techniques that stress functional concerns. In contrast to comfort and function, restoring the appearance of an edentulous patient has received little attention in the modern prosthodontic literature. Several authors have

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found evidence that esthetics is the predominant factor in complete denture success.^{15–18} The psychological importance of a pleasing dental appearance is clear¹⁹ and is often discussed with regards to denture success.^{20–26} A common conclusion made by these authors was that clinicians often fail to appreciate the significant positive influence that denture esthetics can have on the overall success of the treatment.

Traditional denture esthetic concepts have included the temperamental theory,^{27,28} the typical form theory,²⁹ and the dentogenic theory.^{30,31} More recently, an increased reliance on the patient's own body image has resulted in a more patient-centered approach.^{32–34} This approach may contradict principles of the dentist-directed philosophies previously mentioned. This contradiction is highlighted in research comparing differing esthetic preferences between laypeople and dental professionals.^{35–38} Information regarding this potential treatment quandary has been previously reviewed.³⁹ In summary, three basic esthetic concepts exist for complete denture fabrication. The primary question that remained was whether edentulous patients seek a different oral appearance than dentulous patients. As most of the patient preference research and data on anatomical averages are gathered from dentulous subjects, there is a possibility that this information is not entirely applicable to edentulous subjects.

Edentulous patient perception of how teeth should look may be different from that of dentulous patients.^{15,40} The edentulous patient population tends to be of older age. It is known that the appearance of natural teeth changes with age.^{41–43} In addition, the already difficult to quantify patient self-image may be distinct for older generations. One study analyzed whether personality determinants existed for denture preference.⁴⁴ Denture patients were asked whether they preferred beautiful or natural-looking teeth. High patient self-esteem was correlated to the choice of natural looking. Unfortunately, the study provided no visual guidance to respondents. In general, older populations tend to rate their dental appearance higher than younger or more completely dentate populations.^{37,43,45,46} This is not entirely surprising considering layperson ratings of dental appearance continue to be shown as favorable

and more forgiving of faults when compared with dentist ratings.^{38,47} Interestingly, a German population aged 73 to 75 years of age was more critical of their own natural teeth than prosthetic denture teeth.⁴⁶ However, a survey of elderly respondents with an average age of 74 years was done in the Los Angeles, California region. It showed that 60% of patients who rated their dental appearance as less attractive than others wore full or partial dentures.³⁷ This is disappointing considering that removable prostheses in general, and complete dentures in particular, have the ability to greatly improve dental appearance for patients with debilitated dentitions. Unfortunately, the previously discussed analyses fail to give specific guidelines for clinicians, and studies analyzing esthetic preferences with this specific patient population have been few.

In 2006, Waliszewski and colleagues performed an investigation of edentulous esthetic preferences.⁴⁸ Three denture trial arrangements, each representing one of the esthetic concepts, were made for each of six patients of varying age and gender demographics. Frontal smile photographs of the test subjects were combined into a booklet for evaluation by respondents. Edentulous respondents then answered questions regarding their preference among the three appearances. Of 147 respondents, the *natural* arrangement was preferred by 55%, *supernormal* by 19%, and *denture look* by 26%. The primary conclusion was that appearances far from what was considered average or normal were selected nearly half the time.

As this study was the first looking exclusively at the esthetic preferences of edentulous patients, it remains to be determined whether this preference is in fact different than the preference of dentulous patients. If it can be conclusively determined that edentulous patients view esthetics differently, research can further specify what these differences are.

A search of the English language peer-reviewed literature back to 1880 failed to find a comparison between dentulous and edentulous patient esthetic preference. The purpose of the present study was to determine if dentulous respondent preference was

significantly different from that of edentulous respondents. The primary null hypothesis was that edentulous and dentulous respondent preference among the three esthetic concepts would not be significantly different.

MATERIALS AND METHODS

In order to allow direct comparison between projects, the previously created photographic test booklets were used for this project. The process of their creation has been described previously.⁴⁸ In summary, six edentulous test subjects underwent conventional complete denture therapy. One male and one female of three differing age categories were selected. Each test subject had three trial dentures fabricated, one of each of the three denture esthetic concepts. Criteria for these trial arrangements are summarized in Tables 1–3. In general, the *denture-look* arrangements followed the appearance described by Vig,⁷⁰ the *natural* arrangements followed that described by Frush and Fisher,^{30,31} and the *supernormal* appearance exaggerated the tendencies described by Shor and colleagues from whom the term originated.³⁴ Digital photographs of the subject's full face during smiling were printed in color in 8 × 10-inch size.

These photographs were then arranged in booklet format as previously described. This resulted in a booklet of 18 photographs (six subjects × three arrangements). The final images are shown together in Figures 1 through 18. A large-font typed questionnaire was then created to accompany the photo booklet. Figure 19 is the primary question page used for each of the six subject sets. Respondent demographic information was also collected. Data collection was conducted by two investigators at Marquette University School of Dentistry. The questionnaires were administered in quiet, undisturbed locations free from input by other respondents.

Inclusion criteria for dentate survey respondents included the following: literate English speakers, willing and able to complete the survey in a single sitting.

TABLE 1. Guidelines for *natural* arrangement

Guidelines used for <i>natural</i> arrangement	
Extra-oral	Nasolabial angle = 100 degrees ^{49,50}
	Mentolabial angle = 140 degrees ^{49,50}
	OVD preventing over-closed appearance ^{51,52}
	OVD allowing competent lips
	OVD allowing relaxed extra-oral musculature
Occlusal plane	Placed slightly below the commissure of the lips in mandibular premolar area ⁵³
	Maxillary incisal plane following lower lip line ^{38,54–56}
Tooth selection	Size/proportion matching averages for gender, age, and size ^{57–59}
	Selected teeth altered to appear age appropriate ^{41,60,61}
Tooth arrangement	Teeth positioned visually according to above parameters
	Tooth display determined by age and soft tissue anatomy/mobility ^{62–65}
	Midline coincident and perpendicular ^{38,66}
Characterization	Subtle dental restorations when age appropriate
	Diastemas, rotations, and angulations to avoid ideal symmetry
	Skeletal jaw relationship dictated dental classification
	Anatomically correct color and contour waxing
OVD = Occlusal Vertical Dimension.	

Respondents were considered dentate if they demonstrated a complete or unbroken dentition from left first molar to right first molar on both the maxillary and mandibular arches. Fixed tooth replacements, whether tooth or implant-supported were therefore included. Likewise, respondents with spaces closed via orthodontics were also eligible. Exclusion criteria for dentate survey respondents included the following: use of any removable prosthesis, a nonrestored anterior edentulous space, and any formal education in dental esthetic concepts.

TABLE 2. Guidelines for *supernormal* arrangement

Guidelines used for <i>supernormal</i> arrangement	
Extra-oral	OVD = same as <i>natural</i> arrangement ^{51,52}
Occlusal plane	Maxillary incisal plane following lower lip line ^{38,54–56}
Tooth selection	Size/proportion above averages for gender, age, and size ^{36,54}
	Teeth unaltered to appear ideal
	Square teeth for men; ovoid or square for women ^{54,67}
Tooth arrangement	Teeth positioned according to <i>natural</i> arrangement
	2 mm facially and 2 mm incisally
	Tooth display maximized by above changes
	Teeth arranged symmetrically ^{32,36,68}
	Midline coincident and perpendicular ^{38,66}
Characterization	Anatomically correct color and contour waxing
OVD = Occlusal Vertical Dimension.	

Inclusion criteria for the edentulous respondents included the following: currently edentulous in both arches, literate English speakers, and willing and able to complete the survey in a single sitting. Edentulous patients treated with dental implants were included as long as the implant positions did not affect tooth arrangement. The kappa statistic was determined previously. Statistical analysis using a Chi-squared test at a 0.05 level of significance was conducted for those associations the descriptive statistics deemed important or possibly significant.

RESULTS

Results for the edentulous respondents are summarized in Table 4. Of those additional edentulous patients eligible to complete the survey, six declined and twelve were excluded because of mental status (nine) or vision problems (three). Four surveys were excluded because of improper completion. An additional 122 edentulous

TABLE 3. Guidelines for *denture-look* arrangement

Guidelines used for <i>denture-look</i> arrangement	
Extra-oral	OVD = same as <i>natural</i> arrangement ^{51,52}
Occlusal plane	Maxillary incisal plane arranged flat disregarding lip line ⁶⁹
Tooth selection	Size/proportion below averages for gender, age, and size ⁷⁰
	Texture and anatomy of teeth removed with heavy pumice ⁷⁰
Tooth arrangement	Teeth positioned according to <i>natural</i> arrangement
	Moved 2 mm lingually and 2 mm apically
	Tooth display minimized by above changes ⁷⁰
	Teeth arranged in occlusal oriented arrangement ^{71,72}
	Symmetrical circular curve of arch arrangement ⁷³
	Midline coincident and perpendicular ^{38,66}
Characterization	Flat waxing filling embrasures ^{69,70}
	Single color pink wax with fibers ⁷⁰
OVD = Occlusal Vertical Dimension.	

surveys were collected for a total edentulous sample of 269 surveys. One hundred and nineteen respondents were male and 150 were female. The respondents included 209 Caucasians, 47 African Americans, and 13 other ethnicities. The mean age was 62.6 years, with a maximum age of 92 and minimum of 20. One hundred and seventy-three of the respondents had been edentulous for over 1 year, and 113 had been edentulous for at least 9 years. The average duration was 13 years.

Results for the dentate respondents are summarized in Table 5. A total of 167 dentate surveys were collected; none had to be excluded. Ninety respondents were male and 77 were female. These respondents included 132 Caucasians, 8 African Americans, 15 Hispanics, and 12 other ethnicities. The average age of this population was 24, with a maximum age of 53. Forty-three (26%) of the dentate respondents were missing a tooth, whereas



FIGURE 1. Thirty-year-old female subject—natural.



FIGURE 2. Thirty-year-old female subject—supernormal.



FIGURE 3. Thirty-year-old female subject—denture look.



FIGURE 4. Thirty-year-old male subject—natural.



FIGURE 5. Thirty-year-old male subject—supernormal.



FIGURE 6. Thirty-year-old male subject—denture look.



FIGURE 7. Fifty-year-old female subject—natural.



FIGURE 8. Fifty-year-old female subject—supernormal.



FIGURE 9. Fifty-year-old female subject—denture look.



FIGURE 10. Fifty-year-old male subject—natural.



FIGURE 11. Fifty-year-old male subject—supernatural.



FIGURE 12. Fifty-year-old male subject—denture look.



FIGURE 13. Seventy-year-old female subject—natural.



FIGURE 14. Seventy-year-old female subject—supernatural.



FIGURE 15. Seventy-year-old female subject—denture look.



FIGURE 16. Seventy-year-old male subject—natural.



FIGURE 17. Seventy-year-old male subject—supernatural.



FIGURE 18. Seventy-year-old male subject—denture look.

Answer these questions for Patient 2 only.

1. Do you see a noticeable difference between any of the three photographs of this patient?

☐ YES
☐ NO

*If NO please proceed to question 1 for patient 3.

2. Which do you consider most attractive?

☐ Appearance **R**
☐ Appearance **Q**
☐ Appearance **P**

3. Which do you consider most natural?

☐ Appearance **R**
☐ Appearance **Q**
☐ Appearance **P**

4. Which would you choose if this patient was you?

☐ Appearance **R**
☐ Appearance **Q**
☐ Appearance **P**

5. Use the letters to rank the three smiles from least artificial to most artificial.

Least artificial More artificial Most artificial

FIGURE 19. Survey question page for patient 2.

15 (9%) had an anterior restoration at least as large as a veneer. A large majority (62%) had whitened their teeth at one time or another.

Both dentulous and edentulous respondents noted a difference among the three appearances 96% of the time. Questions 2, 3, and 4 were found to agree in most instances. For question 3, dentate respondents selected the denture look as the most natural (32%) more frequently than edentulous respondents (27%). This was at the cost of selecting the supernormal arrangement less frequently (13%) than in the edentulous group (18%). A greater difference between the dentulous respondents' selection of supernormal as most attractive (23%) or most natural (13%) thereby developed. For questions 2, 3, and 4, the natural arrangement was always selected between 53 to 55% of the time. Unless otherwise specified, question 4 was therefore used for analysis.

There was no statistically significant difference overall between dentulous and edentulous respondents. Therefore, when respondents noted a difference, the

ratio between natural, supernormal, and denture look remained consistent. Demographic, denture history, and esthetic focus modifiers were also tested for statistical significance. Males were found to select either the supernormal or denture-look appearances statistically significantly more often than females. However, the gender differences were not seen when edentulous males or females were compared with their dentulous counterparts.

Table 6 shows the subject set responses separated according to the entire sample, the edentulous sample, and the dentulous sample. As in the previous analysis, the individual subject sets showed considerable variation. In general, the denture-look appearance was preferred with increased frequency for the female subjects, and the supernormal appearance was preferred with increased frequency for the male subjects. Moreover, dentulous and edentulous respondent preference was statistically significantly different for the middle- and upper-aged male subjects. Dentulous respondents chose both denture look and supernormal with somewhat increased frequency for the middle-aged male subject. Likewise, dentulous respondents preferred the supernormal appearance for the upper-aged male with increased frequency. The preference was not statistically different for any of the female subject sets.

The only education modifier found was when late first year dental student preference was compared with the rest of the dentate respondents. These dentulous respondents selected the natural look more frequently at the expense of selecting the supernormal appearance. However, when this same group was compared with experienced denture wearers, no statistically significant difference was seen. Table 7 shows Chi-squared tests of interest.

When edentulous respondents answered the ranking question 5.3, natural was rarely selected (11%) as the most artificial arrangement. Dentulous respondents were even less likely to select the natural arrangement (6%) as the most artificial. A larger percentage of dentulous respondents selected supernormal as the most artificial (71%) than in the edentulous sample

TABLE 4. Edentulous response totals for 269 surveys

Question	Yes	No	Natural	Supernormal	Denture look	Blank
1	1,552 (96%)	62 (4%)				
2			823 (53%)	342 (22%)	375 (25%)	74
3			852 (55%)	270 (18%)	419 (27%)	73
4			850 (55%)	302 (20%)	398 (25%)	64
5.1			766 (53%)	258 (18%)	423 (29%)	167
5.2			497 (35%)	360 (26%)	547 (39%)	210
5.3			155 (11%)	804 (57%)	444 (32%)	211

TABLE 5. Dentate response totals for 167 surveys

Question	Yes	No	Natural	Supernormal	Denture look	Blank
1	962 (96%)	40 (4%)				
2			506 (53%)	217 (23%)	235 (24%)	44
3			531 (55%)	121 (13%)	309 (32%)	41
4			512 (53%)	204 (21%)	246 (26%)	40
5.1			499 (52%)	114 (12%)	346 (36%)	43
5.2			399 (42%)	169 (18%)	390 (40%)	44
5.3			60 (6%)	676 (71%)	223 (23%)	43

(57%). This ranking question saw a high number of blank responses in the edentulous population, even when a difference was seen between the images. This was not the case for the dentate respondents. The overall kappa value was 0.625.

DISCUSSION

This study was undertaken to answer one of the remaining questions following completion of the previously published survey of edentulous patient preference. Overall, no statistically significant difference was found between edentulous and dentulous respondent preference among the three esthetic concepts. The primary null hypothesis was therefore accepted. Remarkable consistency between the responses for the previously published survey and this

additional patient population was found. The overall preference ratio of 2:1:1 was again demonstrated with only minor variations in percentage.

Somewhat surprisingly, demographic factors such as age, duration of edentulism, and income of the respondents did not significantly change the preference. Likewise, the esthetic focus of respondents did not significantly affect the preference. It seems that within the respondent population tested, a fairly consistent preference exists. This preference appears to remain consistent despite the loss of teeth or increased age. The only gender interaction that was found to be statistically significant was that males tended to select supernormal and denture-look arrangements more often than females. Perhaps males were not as critical in their selections, or perhaps they have a wider preference range than females.

TABLE 6. Response totals for question 4 only

Respondent group	Test subject	Natural	Supernormal	Denture look	No difference
All respondents		1,362 (54%)	506 (20%)	644 (26%)	104
Edentulous respondents	Lower-aged female	113 (43%)	43 (16%)	107 (41%)	6
	Lower-aged male	182 (69%)	29 (11%)	52 (20%)	6
	Middle-aged female	163 (63%)	28 (11%)	68 (26%)	10
	Middle-aged male	169 (64%)	32 (12%)	65 (24%)	3
	Upper-aged female	124 (51%)	47 (19%)	72 (30%)	26
	Upper-aged male	99 (39%)	123 (48%)	34 (13%)	13
Dentate respondents	Lower-aged female	70 (43%)	34 (21%)	59 (36%)	4
	Lower-aged male	126 (77%)	11 (7%)	26 (16%)	4
	Middle-aged female	120 (73%)	14 (8%)	31 (19%)	2
	Middle-aged male	82 (49%)	27 (16%)	58 (35%)	0
	Upper-aged female	65 (46%)	19 (13%)	59 (41%)	24
	Upper-aged male	49 (30%)	99 (62%)	13 (8%)	6
Total number of responses per choice is listed with percentage of responses who noticed a difference in parentheses.					

TABLE 7. Chi-squared tests comparing dentulous versus edentulous respondents

Comparison	Probability	Degrees of freedom	χ^2 statistic	Significance level
Overall	0.562	2	1.15	NS
Lower-aged female subject	0.364	2	2.02	NS
Lower-aged male subject	0.178	2	3.45	NS
Middle-aged female subject	0.100	2	4.60	NS
Middle-aged male subject	0.011	2	9.09	0.025
Upper-aged female subject	0.065	2	5.46	NS
Upper-aged male subject	0.026	2	7.28	0.05
Gender of respondent	0.037	2	6.60	0.05
>9 years edent. versus dentate	0.682	2	0.76	NS
Dentate bleached versus nonbleached	0.318	2	2.29	NS
>9 years edent. versus dentate bleached	0.845	2	0.34	NS
Second year dental versus other dentate	0.002	2	12.13	0.005
NS = not statistically significant.				

As discussed in the original study, the supernormal and denture-look concepts resulted in what the authors felt were several unattractive appearances. It again was very interesting that despite the fact that the natural concept was created to be attractive and the others created to represent opposite extremes, respondents selected the extremes with regularity. Any esthetic bias or assumption by the restorative dentist may therefore become evident while recreating a patient's appearance.

The most distinct differences in preference were again found when the individual subject sets were considered. The previous discussion regarding body image of the patient holds true and will not be repeated here. When the preference between the edentulous and dentulous respondents was analyzed for each subject set, there was a significant difference for the middle-aged and upper-aged male subjects. In the case of the middle-aged male, dentate respondents selected the two extremes with a much greater frequency. For the upper-aged male, dentate respondents selected the supernormal look with greater frequency. The authors feel this was the result of several factors. First, in accordance with the criteria for the natural arrangement, a diastema was placed between the maxillary right lateral and central incisors for the middle-aged male and a full-cast crown can be seen on the maxillary right first molar for the upper-aged male. Perhaps these factors were less preferred than the dramatic difference in incisal edge position and tooth size. Although a diastema was also placed for the lower-aged male this did not significantly change respondent preference. It is also possible that dentate respondents simply preferred greater tooth display for the upper-aged male than was present in the natural arrangement.

Another possible factor for this and other findings is the soft tissue dynamics of the subjects themselves. In the case of the upper-aged male, his supernormal arrangement does not appear as dramatic as that of the other male subjects. This is likely because of reduced mobility and length of the upper lip. Similar critique can be leveled upon other subject sets, but did not appear to alter respondent preference. It was felt that because the principles of each arrangement depend upon a starting point that is standardized for that

individual subject, the conceptual differences among appearances would not necessarily be influenced by standardization of lip dynamics.

Several other limitations exist for this study. The questionnaire format only allows a two-dimensional analysis of the arrangements by the respondents. This is significant because the intentionally exaggerated arrangements visibly distorted the soft tissues and interfered with speech. When viewed in profile, this was obvious to the clinician (present author Waliszewski) and certainly was to the subjects themselves. Five of the six subjects selected the natural arrangements with the upper-aged female selecting a compromise between the denture-look and natural arrangement. The edentulous respondents tended to be elderly patients, and although much attention was given to excluding those with vision problems or cognitive deficiencies, concern regarding repeatability is warranted. This is demonstrated by the frequently blank or incorrectly marked ranking question 5. Fortunately, repeatability tests proved acceptable for all other questions. The fact that the younger dentate responses were similar gives further evidence. A final limitation is the fact that the majority of dentulous respondents were dental students. This was done for two reasons; first for ease of data collection and second to assure a younger-aged sample. The primary concern is that dental education will bias the student preference. It has been clearly shown that the dentist's perception is often quite different from that of patients.³⁵⁻³⁸ None of the student respondents had yet received any formal lectures or courses in dental esthetics, as all took the survey prior to beginning their second year of training. Over half of student respondents took the survey within their first two months in dental school. One would think that formal dental education would alter the preference of the student respondents to overwhelmingly select the natural arrangements. This was not entirely the case. It was found that late first-year students selected the natural appearance more frequently than the rest of the dentate respondents. However, there was no significant difference in preference between more experienced students and edentulous respondents. There was no significant difference in preference

between any other combinations of duration of edentulism or dental education. So although dental education did appear to alter the dentulous respondent preference, it did not have a significant influence when these groups were compared with edentulous respondent preference. It would seem that a more random dentate sample would also be expected to not show a difference.

A logical follow-up study would be to compare a natural appearance with a supernormal appearance created more true to that described by Shor and colleagues. This may include less dramatic alterations in tooth repositioning and length/width proportion changes. Another possibility would be a study designed to more directly evaluate patient body image in relationship to dental esthetic preference. However, the challenge of yielding clinically useful results with reasonable effort levels is great.

Considering all these factors, it appears that clinicians can reliably use dentulous preference findings in their treatment of edentulous patients. This supports the idea that patients maintain their preference with regards to dental esthetics despite the loss of their teeth. It therefore appears that the denture-look concept was indeed more a result of dentist-directed esthetics and focus on functional goals rather than denture patient preference. The supernormal appearance, on the other hand, is likely a result of the increased attention to patient-assisted esthetics. For the average restorative dentist who treats edentulous patients, utilization of dentate preference data is helpful in more efficiently arriving at an appearance the patient will prefer. Unfortunately, these findings also mean that all of the respondent populations tested have a wide and varied preference, which the clinician must determine.

CONCLUSIONS

Within the limitations of this study, the following conclusions were made:

- 1 Dentulous and edentulous respondent preference among the three esthetic concepts was not significantly different.

- 2 Dentulous and edentulous respondent preference was significantly different when asked about the middle- and upper-aged subjects.
- 3 For all respondents, males selected the supernormal and denture-look appearances significantly more often than females.
- 4 Respondents continued to prefer supernormal or denture-look arrangements with regularity.

CLINICAL IMPLICATIONS

When using standardized representations of three different esthetic appearances, dentulous and edentulous survey respondent preference was similar. Because of the continued variability of preference demonstrated by this research, it remains necessary to determine esthetic goals individually. Fortunately, with the consistency in preference shown here, the time-saving application of dentulous patient preference research appears valid for an edentulous patient.

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