Eur. J. Prosthodont. Rest. Dent., Vol.17, No. 4, pp 177-181
Printed in Great Britain

doi:10.1922/EJPRD_837Pretty05

Patients' Ranking of Interdental "Black Triangles" Against Other Common Aesthetic Problems

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Abstract - *The purpose of this study is to assess patients' aesthetic perceptions of interdental "black triangles", both in terms of the number of triangles visible and their severity; and to ascertain how patients rank the presence of "black triangles" against other aesthetic problems. It is based on a questionnaire of 80 randomly selected individuals who were asked to rate the aesthetics of digitally-manipulated images. Patients' perceptions of interdental "black triangles" were compared with their perceptions of other 'non-aesthetic' features. Interdental "black triangles" were rated as the third most disliked aesthetic problem below caries and crown margins. This study demonstrates the importance of interdental "black triangles" to patients, and therefore, as they can occur during prosthetic treatment, must be discussed with patients prior to commencing therapy.*

KEY WORDS: Dental aesthetics, Papilla, Loss, Self assessment, Implants, Prosthodontics

INTRODUCTION

The absence of the interdental papilla can cause patients problems with appearance, phonetics and with the impaction of food. Any changes to the shape and/or symmetry of the gingivae through developmental, pathologic or iatrogenic factors, can cause significant and detrimental changes in the appearance and balance of the natural dentition and any prosthetic tooth replacement. Dentists may see this as an aesthetic challenge but do patients? It has been shown that there are differences between what patients and dentists deem aesthetic[1].

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Dental and facial attractiveness

It has been shown that from an early age, people who are considered unattractive are less liked and not as likely to be chosen as friends[2]. When eye movements were monitored in a face-to-face situation, it was found that most of the focus was on the other person's eyes and mouth[3]. The predictor of overall attractiveness has been found to be more likely the face than the body[4].

What are dental aesthetics?

There are many variables that contribute to dental aesthetics, including:

- Shape and size of teeth
- Colour of teeth/restorations
- Position of teeth
- Shape of the arch
- Dental health, both tooth and gingival
- Gingival level and contour
- Lip position, both static and during smiling
- Gingival embrasures and contact points
- Tooth inclination
- Dental occlusal classification

While beauty may be 'in the eye of the beholder,' research has shown that there is usually agreement on who is and what features are attractive[5].

Patients' perception of dental-facial appearance

People with more attractive features were judged to be more popular, interesting, intelligent, extroverted and of a higher social class[6] and women especially are more likely than men to be critically judged on the basis of their perceived attractiveness[7]. In one study, patients were asked to assess papillary height and contact point length. They did not classify the papillary height as unattractive if there was a uniform reduction from canine to canine of 1.5mm. If the reduction was unilateral, then they found it unacceptable when it was reduced by 2mm[8].

Loss of teeth

There has been shown to be a discrepancy in the need for treatment between dentists and patients[9]. There are several reasons for this discrepancy including financial considerations, cultural differences and availability of dental services[10]. When anterior teeth are missing, patients tend to be less satisfied with their oral condition and there is a higher perceived need to replace them[11]. A clinical indicator for satisfaction was found to be an inverse relationship between decayed teeth and satisfaction with the mouth[12].

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Studies have shown that it is aesthetics, rather than function, which motivate patients to pursue tooth replacement[13, 14].

Patients' perception related to own appearance

In the UK's 1998 Adult Dental Health Survey[15] the general level of dissatisfaction with dental appearance was similar to that of the previous decade. The level of dissatisfaction with tooth colour, however, had increased by 10% to 48%.

There is little research on the subjective perception of dental appearance and attractiveness. Orthodontic studies that have looked at malocclusions and facial attractiveness have found that malocclusions could adversely affect body image from adolescence through to adulthood[16]. Studies that have looked at the role of dental appearance and how people are perceived show that individuals with impaired dental conditions will be perceived differently from those with healthy dentitions[17, 18].

When looking at a predictive aspect of aesthetic satisfaction, although general dental variables were stronger than orthodontic variables, there was also some mismatching between the clinical findings and the patterns of self perception[19]. This suggests that when treatment planning, it is important to discuss aesthetic considerations in order to reduce the risk of not meeting patients' expectations. It was also found that patient satisfaction in denture aesthetics improved when patients were consulted about their feelings on appearance[20].

In general it has been found that most people believe that their smile could be improved [19, 21]. When seeking restorative dental treatment, poor dental appearance seems to be a compelling reason[22]. When choosing a dental procedure, patients rank their appearance and self image as the most important factors[21].

In terms of patients' own perception of dental attractiveness, tooth shade, followed by natural unrestored teeth and the number of teeth displayed, appeared to be the most important variables in predicting dental attractiveness[23]. When perceived by other people, however, the whiteness did not contribute to an increase in the overall facial attractiveness[24].

MATERIALS AND METHODS

Subjects

Ethical approval was granted for the use of a questionnaire to be used with patients who were attending The University of Manchester's Dental School and Hospital radiography department. The study involved 80 patients who attended as part of their routine care. Inclusion criteria included the presence of a minimum of three adjacent teeth and edentulous individuals with no current prosthesis were excluded.

Photographs

An aesthetic wax up of an upper arch was constructed, processed and then photographed with a digital camera. This image was then manipulated to produce nine other images with different aesthetic problems. The questionnaire was based around ten laminated photographs which are shown in Figure 1. These images represented:

1. The original image
2. Lightened teeth
3. Darkened teeth
4. "Black triangles" involving a third of the distance from the contact to the gingival margin
5. "Black triangles" involving half the distance from the contact to the gingival margin
6. "Black triangles" involving greater than half the distance from the contact to the gingival margin
7. Exposed crown margin on the upper left central incisor
8. Missing tooth upper right lateral incisor
9. Fractured upper left lateral incisor
10. Carious upper left lateral incisor

Recording of demographics

The questionnaire was filled in by the operator and patient were asked their age, gender and ethnicity. Ethnicity categories were adapted from the UK census. They were also asked about how frequently they visited the dentist and were given a choice of four possible answers: 'once a year'; 'twice a year;' 'when I have problems,' and 'never'.

Grading of images

Subjects were asked to rank ten laminated images of anterior teeth in order of increasing, and then decreasing aesthetic preference. The photographs were shown to the subjects in a random order. They were then asked to express their opinion on their own teeth and to indicate their satisfaction using a four point scale of 'very satisfied', 'satisfied', 'dissatisfied' or 'very dissatisfied'.

Finally the subjects were asked to select an image from the ten available to fit into one of the following four categories: 'very satisfied', 'satisfied', 'dissatisfied' or 'very dissatisfied' if their own teeth permanently looked like the ones in the photograph.

Photograph of subjects

Lip retractors were used and a single digital photograph was taken of the anterior teeth so that the appearance of the subjects' teeth was recorded and could be used to compare to their questionnaire responses.

Statistical analysis

The photographs were placed in mean ranking of order of preference. Independent sample t-tests for each photograph comparing: male vs. female, age, "black triangles", carious anterior teeth, missing teeth, crown margin and fractured anterior teeth were undertaken using a Bonferroni correction for multiple comparisons. Patient satisfaction with their own teeth was dichotomised into satisfied and dissatisfied before it was analysed with an independent t-test. Ages were analysed with the Pearson correlation, after they were dichotomised into less than 40 and greater than 40 years old.

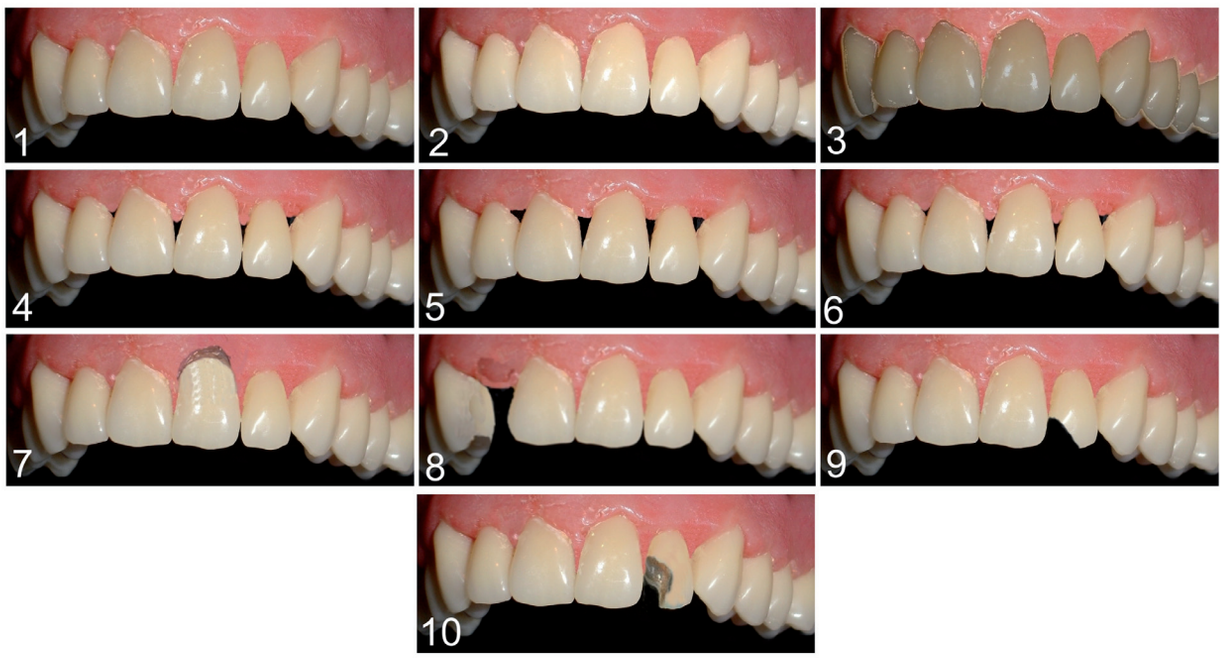

Figure 1. *The images shown to each of the participants in the study.*

Table 1. *Ethnic mix within the study population*

Ethnicity	*N*
White	63
Irish	1
Black Caribbean	4
Black African	2
Asian Indian	1
Asian Pakistani	3
Asian Chinese	3
Asian other	1
Other	2

Table 2. *Mean ranking of photographs by subjects.*

Photograph	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
1 (OI)	1.00	8.00	1.8250	1.13377
2 (LT)	1.00	6.00	1.9000	1.15397
3 (DT)	1.00	10.00	4.6625	2.21012
4 (BTS)	1.00	10.00	4.8375	1.84490
5 (FT)	1.00	9.00	5.5875	2.25968
6 (BTM)	2.00	10.00	6.0625	2.03354
7 (BTL)	1.00	10.00	6.3875	2.00312
8 (ECM)	3.00	10.00	6.6125	1.87248
9 (MT)	2.00	10.00	8.3500	1.76535
10 (CT)	3.00	10.00	8.7750	1.76445

OI-original image, LT-Lightened teeth, DT-Darkened, BTS-"Black triangles" involving a third of the distance from the contact to the gingival margin, BTM-"Black triangles" involving half the distance from the contact to the gingival margin, BTL-"Black triangles" involving greater than half the distance from the contact to the gingival margin, ECM-Exposed crown margin on the upper left one, MT-Missing tooth upper right two, FT-Fractured upper left two, CT-Carious upper left two.

RESULTS

A total of 80 subjects completed the study. The male to female ratio was 2:3, with 40% male and 60% female. The ages ranged from 18-67 (mean 40 ±13.7). The ethnic demographics are demonstrated in Table 1. Table 2 shows the mean ranking of the pictures along with their minimum and maximum position. As can be seen, the photograph that the patients preferred the most was number 1 (Figure 1.1) and the least preferred was number 10 (Figure 1.10).

When the variables were compared to the mean rankings, it was found that there were no statistical significant differences in the mean ranking of subjects with and without crown margins visible, fractured teeth, caries in their anterior teeth or their gender. In terms of ethnicity, sample numbers were too low in some of the categories to analyse. When the rankings were compared to the subjects' attitude to their own teeth, the significance was so weak that it was thought to be related to the large number of tests performed and this naturally brought out a very weak significance. Table 3 demonstrates the percentage of the patients with "black triangles", crown margins, missing teeth, caries in the anterior teeth and fractured teeth, while Table 4 shows the age distribution of subjects with "black triangles" and missing teeth.

There were statistically significant differences in some of the photographic assessments of subjects with "black triangles" and missing teeth. Age also showed significant differences for some of the photographs. These differences are summarised in Table 5.

Table 3. *Percentage of subjects with "black triangles", crown margins, missing teeth, caries in the anterior teeth and fractured teeth.*

Variable present	*% WITH*
"Black triangle"	31.3
Crown margin	31.3
Missing teeth	13.8
Carious teeth	12.5
Fractured teeth	11.3

Table 4. *Age distribution of patients with "black triangles" and missing teeth.*

Variable	*Age (min)*	*Age (max)*	*Mean*	*SD*
"Black triangle"				
Yes 25	30	67	46.68	10.51
No 55	18	62	36.98	13.99
Missing teeth				
Yes 11	25	67	45.45	11.8
No 69	18	67	39.14	13.86

Table 5. *Summary of statistical differences detected between subjects presenting with a variable and their assessment of aesthetic problems.*

Variable (feature)	Photograph	Mean ranking	Std. Deviation	SIG (2 TAILED)
Missing teeth	"Black triangle"			
Yes	(large)	5.09	2.17	.02
No		6.59	1.91	
Missing teeth	Fractured teeth			
Yes		7.09	1.58	.005
No		5.35	2.27	
"Black triangles"	Missing tooth			
Yes		8.84	1.18	.047
No		8.13	1.94	
"Black triangles"	Fractured teeth			
Yes		6.48	2.20	.016
No		5.18	2.19	
"Black triangles"	Darker teeth			
Yes		3.96	1.59	.027
No		4.98	2.38	
Age	Fractured teeth			
<40		4.70	2.09	.00
>40		6.47	2.08	
Age	Darker teeth			
<40		5.20	2.40	.029
>40		4.13	1.88	
Age	"Black triangle"			
<40	small	5.32	1.83	.017
>40		4.35	1.75	

Subjects with missing teeth were more likely to rank a large "black triangle" higher than those without a missing tooth. Also the patients with missing teeth ranked a fractured tooth lower. Both these findings were statistically significant. Subjects with "black triangles" tended to rank lower the photograph of the missing tooth and the fractured tooth, but they ranked the photograph of the darker teeth higher. When the subject's age was taken into account, the older patients (>40 years) were more likely to rank the darker teeth and small "black triangles" higher, whereas the younger patients (<40 years) were more likely to rank the fractured tooth higher.

DISCUSSION

The method of an artificial tooth set up and a single image taken of it that was manipulated digitally was chosen to reduce other variables such as tooth colour, position and shape. It also eliminated other factors that may have influenced the subjects' assessment of the images such as ethnicity and possibly gender.

If we look at the ranking of the photographs, the first three photographs are the aesthetic set ups but with different shades. What is evident is that the shade A3.5 was preferred

to the lighter B1 shade. This group of subjects seemed to prefer the more natural shade. As patients' age increased, they were more likely to rank darker teeth higher. These older patients may be more willing to accept darker teeth as they see this as a consequence of getting older. This finding may have an affect on level of the demand for whitening in the older population as well as the degree to which the whitening is required, depending on age.

The smaller the "black triangle", the higher it ranked. This is probably because as the triangle increased, then the more the subjects perceived deterioration of the dentition. After the smallest "black triangle", the next to rank was the fractured tooth then the bigger and biggest "black triangles". Why does the fractured tooth rank higher than the other aesthetic problems? It may be that the subjects perceived that this was treatable. In addition, as the fractured tooth is not due to age or disease, it may feel more desirable.

The lowest rankings were the exposed crown margin, missing tooth and finally the caries. These are all due to disease processes and this may make them more unattractive to the subjects. Caries was the least desirable and this may reflect that it not only looks unattractive but it may be viewed that it is also a sign of neglect.

Two factors of the patients' own oral health were statistically significant on the ranking of the photographs. These were missing teeth and "black triangles". Patients with missing teeth ranked the largest "black triangle" higher. Whereas patients with missing teeth ranked fractured teeth lower, this may be a predictor of tooth loss to the patients with fractured teeth. If we look at the age distribution of the patients with missing teeth the mean age was 45.45 compared to subjects without missing teeth of 39.17.

Patients with "black triangles" ranked missing teeth and fractured teeth lower. The patients with "black triangles" had a higher mean age than those without and therefore as the patient ages, this may become more of a concern.

CONCLUSION

The advent of implant-supported fixed prostheses has enabled the replacement of missing teeth with natural-looking aesthetic restorations. Ensuring that the gingival profile is optimal is crucial to maintaining, or creating, an aesthetic appearance when employing extra-coronal restorations.

The dislike of "black triangles" could have a major influence on the satisfaction of restorative treatment both of teeth and implants. As patients become more aware and demanding of good aesthetics, there needs to be reliable ways to predict and therefore warn a patient that after restoration there may be a "black triangle". There are methods that have been studied[25] to predict the presence of a "black triangle", but this method is invasive. Therefore further work needs to be undertaken to find a simple and consistent way to predict the absence of a papilla after restoration of an implant or tooth. This study will further inform a series of planned in vitro and in vivo experiments looking at means of predicting the likely gingival contour and to the development of clinical care pathways for the treatment of anterior teeth by extra-coronal restoration.

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