Assessment of dental and facial aesthetics in adolescents

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SUMMARY The Index of Orthodontic Treatment Need (IOTN) is currently widely used for clinical, as well as epidemiological purposes. The Aesthetic Component (AC) of this index focuses on dental aesthetics and does not include facial aesthetics. The aim of the present study was to evaluate whether dental aesthetics as measured by the AC of the IOTN correlates with facial aesthetics.

Facial attractiveness of 69 males and 75 females was scored on facial photographs at two different ages (11–13 years and 14–16 years). Scoring of the AC of the IOTN was undertaken on the dental casts. Increments between the observations at the two ages were calculated. To assess the association between scores of dental and facial aesthetics, correlation coefficients were calculated.

There was a highly significant influence of orthodontic treatment on facial and dental aesthetic scores in the group which was not treated orthodontically at the first observation, but was treated orthodontically at the second observation. No correlation, however, was found between the increments in the facial aesthetic score and those in the dental aesthetic score. The results indicate that facial and dental aesthetics are influenced by different factors, and both should be evaluated when judging dentofacial aesthetics.

Introduction

Many procedures performed by orthodontists or prescribed for their orthodontic patients such as functional appliance therapy, extractions, and orthognathic surgery, can alter facial appearance (Crawford, 1991; Lew, 1992; Bravo, 1994; Levin, 1994; Pancherz and Anehus-Pancherz, 1994). Current orthodontic treatment philosophies strive for occlusal goals that match with facial aesthetics (Mackley, 1993; Sarver, 1993). The measurement of facial aesthetics, however, seems to be a subjective measurement that depends on many variables. Within each race and sex there appears to be a balance of facial features that are viewed by the majority as being 'pleasing to the eye' (Bravo, 1994). Psychologists state that our perception of form depends on the development of 'form concepts'. The more frequently we observe a particular facial pattern, the more likely we perceive it as 'correct'. People seem to share a common basis for aesthetic judgement regardless of nationality, age, sex, or occupation (De Smit and Dermaut, 1984; Cons and Jenny, 1994). Television, films, newspapers and magazines all provide daily reinforcement for facial stereotypes (Ford *et al.*, 1966; Child and Iwao, 1968).

Most investigations with respect to orthodontics and dentofacial aesthetics have been limited mainly to the establishment of a hierarchy of treatment need or to the preference of dentofacial appearance (Peerlings *et al.*, 1995). Nowadays, the IOTN introduced by Brook and Shaw (1989), later modified by Richmond *et al.* (1992), is widely used to establish treatment need. The index has two components: a Dental Health Component (DHC) and an Aesthetic Component (AC). The index attempts to rank malocclusion in terms of the significance of various occlusal traits for an individual's dental health and perceived aesthetic impairment. The AC of the IOTN consists of 10 intra-oral pictures on a photographic scale for recording the aesthetic impairment related to the malocclusion (Evans and Shaw, 1987). With this scale it is possible to score the AC from photographs, from dental casts or

clinically. One of the shortcomings of this index, however, is that it measures only dental aesthetics. Katz (1978) and Tedesco *et al.* (1983a) have stated that more attention should be given to methods that provide a natural reproduction of the face and anterior teeth alignment when determining dentofacial aesthetics.

The facial aesthetic scale of Peerlings *et al.* (1995) appears to meet these criteria. This scale was developed to measure facial aesthetics on facial photographs showing a three-quarter view of a smiling face and the anterior teeth. The facial aesthetic scale consists of four components, each having been developed for specific age and sex groups (male and female 11–13 years; male and female 14–16 years). The categorization of the facial aesthetics according to age and sex was supported by knowledge gained from growth studies which have clearly shown that dynamic, sex-dependent changes in dental, skeletal, and facial integument occur over the entire period of active growth and, therefore, aesthetic standards must be different for various age groups (Nanda and Ghosh, 1995).

From the above-mentioned studies it can be concluded that dental aesthetics is not the only parameter that should be measured when assessing treatment need or treatment outcome. However, if measurements of dental and facial aesthetics show a high correlation, then only one scale could be used to assess treatment need or treatment outcome. The aim of the present study was to evaluate whether dental aesthetics as measured by the AC of the IOTN, correlates with facial aesthetics.

Subjects and methods

From the files of the Department of Orthodontics and Oral Biology, University of Nijmegen (The Netherlands), children of two different age groups were chosen. Only Caucasian children without facial or dental trauma or congenital defects were included. Angle Class III malocclusions were excluded because of the small number. Two groups of children were used in this study, prior to and on completion of orthodontic treatment. Children in group A1 (male, *n* = 35; female *n* = 37) were 11–13 years of age and were

in the pre-treatment phase. Children in group B1 (male, *n* = 34; female *n* = 38) were also 11–13 years old, but were in the post-treatment phase. These children were followed until the age of 14–16 years. At that age, A1 was in the post-treatment phase (A2) and group B1 was several years in the post-retention phase (B2). As there were some missing dental casts, the number of valid observations at the post-treatment phase (A2) was smaller (male = 33; female = 36).

At both ages, the following records were used for evaluation: facial photographs with a standard three-quarter view of the smiling face and dental casts. The photographs were taken with a macro lens Olympus OM-4 Ti. camera system and Olympus Zuiko Auto-Macro lens 135 mm (Olympus Optical Co. Ltd, Tokyo, Japan). An Ekta-chrome professional daylight (EPD) colour film (Kodak BV, Odijk, The Netherlands) was used. The size of the facial photographs was 10×15 cm. The dental casts were standard orthodontic study models, taken at both ages.

Facial aesthetics (FA) were determined at two different ages (11–13 years and 14–16 years) on the facial photographs, using the facial aesthetic scale developed by Peerlings *et al.* (1995). The FA is scored by comparing the picture with a standardized scale resulting in a score from 25 to 175 (25 = worst; 175 = best). For this study the data from one of Peerlings' (1992) samples was used. Scoring of dental aesthetics (range 1–10) was carried out using the AC of the IOTN. The AC is scored by comparing the dental cast with a standardized series of 10 photographs resulting in a score from 1 to 10 (1 = best; 10 = worst). As recommended (Woolass and Shaw, 1987; Buchanan *et al.*, 1994), the black and white photographic scale was used to assess the AC on the dental casts to exclude variables such as cleanliness, tooth colour, and gingival health.

Three examiners were incorporated into this study. To determine the measurement error in the recording of the AC and to assess the intra- and inter-observer agreement, a random sample of dental casts of 18 patients was evaluated by the three observers. For each patient two different dental casts (pre- and post-treatment) were measured twice. The time interval between the two measurements was at least 3 months.

Table 1 Mean, standard deviations and number of valid observations of facial aesthetics (FA) and dental aesthetics (DA) for each gender and group.

Groups		Facial aesthetics		Dental aesthetics	
		Male	Female	Male	Female
Pre-treatment	*n*	35	37	35	37
(A1)	Mean	84.5	87.9	7.8	7.5
(11 to 13 years)	SD	18.8	17.3	1.9	1.8
Post-treatment	*n*	35	37	33	36
(A2)	Mean	102.1	93.1	2.4	2.3
(14–16 years)	SD	14.5	23.7	0.9	0.7
Post-treatment	N	34	38	34	38
(B1)	Mean	93.0	103.8	3.2	2.8
(11–13 years)	SD	18.2	18.4	1.7	1.4
Post-retention	N	34	38	34	38
(B2)	Mean	104.5	97.2	3.5	2.4
(14–16 years)	SD	15.9	28.4	1.9	1.0

Statistical analysis

The magnitude of the duplicate error was calculated for the AC score of the pre- and post-treatment dental casts separately. Systematic differences between observers were tested by the paired *t*-test. The inter- and intra-observer reliability was estimated by means of Pearson's correlation coefficients between duplicate measurements.

Pearson's correlation coefficients were calculated to assess the correlation between the scores for dental and facial aesthetics. Increments were calculated between the first and the second observations of group A and group B, respectively. The significance of change over time was tested with the paired *t*-test. Finally, the correlation of the increments between facial aesthetics (FA) and dental aesthetics (DA) was determined with Pearson's correlation coefficient.

Results

Reproducibility of measurements

No significant systematic differences were found between examiners (paired *t*-test). The measurement errors were 0.34 and 0.55 scale point (scale from 1 to 10) for the intra- and the inter-observer measurement, respectively, indicating a high level of reproducibility. The intra-observer correlation ranged from 0.96 to 0.97 and the inter-observer correlation from 0.89 to 0.96. This also showed a high level of reliability.

Variables

Mean and standard deviations for facial and dental aesthetics are given in Table 1. A higher facial aesthetic score means a more attractive facial appearance, while a higher dental aesthetic score means a lower dental attractiveness. After grouping the sample according to gender and treatment phase, i.e. pre-treatment (A1), post-treatment (A2 and B1), and post-retention (B2), it was found (Table 2) that in the pre-treatment phase the FA for males showed a highly significant correlation with DA ($r = -0.48$; $P < 0.01$). However, in the post-treatment group of the same age (B1) such a correlation was found only among the females. For the 14–16-year-old children of both sexes in the post-retention phase (B2), significant correlations were found between FA and DA. To test the influence of treatment on dental and facial aesthetics, the increments were tested between A1 and A2 and between B1 and B2 (Table 3). Group A, which was treated between A1 and A2, showed a significant increase in FA, meaning a positive effect on

Table 2 Correlation coefficients between facial aesthetics (FA) and dental aesthetics (DA) according to gender and group.

	FA							
	Pre-treatment (A1) (11–13 years)		Post-treatment (A2) (14–16 years)		Post-treatment (B1) (11–13 years)		Post-retention (B2) (14–16 years)	
	Male	Female	Male	Female	Male	Female	Male	Female
DA	–0.48**	–0.18	–0.16	–0.14	–0.20	–0.32*	–0.47**	–0.32*

*$P < 0.05$; **$P < 0.01$.

Table 3 Increments (mean and SD) for FA and DA. Significance was tested by the paired t-test.

	Pre-treatment/post-treatment (A1/A2)				Post-treatment/post-retention (B1/B2)			
	n	Mean	SD	Significance	n	Mean	SD	Significance
FA	72	11.2	18.9	0.001	72	1.9	21.1	0.4
DA	69	–5.2	2.0	0.001	72	–0.04	1.5	0.8

facial aesthetics. The DA decreased significantly, meaning a positive effect on dental aesthetics. In group B, which was an observation between B1 (post-treatment) and B2 (several years after retention), no significant changes were found for FA and DA. No significant correlations existed between the increments of FA and the increments of DA.

Discussion

In this study, two groups of patients were evaluated. The children of group A were 11–13 years of age at the start of the study and had not yet been treated. The children in group B were also 11–13 years of age at the start of the study, but their treatment had already finished. Dental and facial aesthetics of both groups were assessed with two different scales.

The AC, as part of the IOTN, is generally used to measure treatment need from the aesthetic point of view (Richmond *et al.*, 1992). It is known, however, from other studies that dental aesthetics is a different entity from facial aesthetics and that background facial attractiveness

appears to dominate (Shaw *et al.*, 1991). Therefore, a comparison was made with a facial attractiveness scale, which was developed by Peerlings *et al.* (1995). In using this scale the judges are instructed to rate the aesthetics of the face in total, and not only the aesthetics of the eyes, mouth, or nose, for example. Of course, such a photograph is only a random indication picture of the test person's facial attractiveness at that particular point in time. However, it has been shown in earlier studies that photographic records provide valid, reproducible, and representative ratings of facial aesthetics (Melamed and Moss, 1975; Tedesco *et al.*, 1983b; Howells and Shaw, 1985; Cohn *et al.*, 1986).

In our sample, dental and facial aesthetics were significantly correlated only in male patients at the pre-treatment phase. From other studies, it is known that male patients seeking orthodontic treatment have more severe malocclusions than females (Espeland and Stenvik, 1991; Holmes, 1992). Generally speaking in this sample, it was true that male patients had a more severe arch length discrepancy, a larger overjet and overbite, and a larger median diastema. It is possible
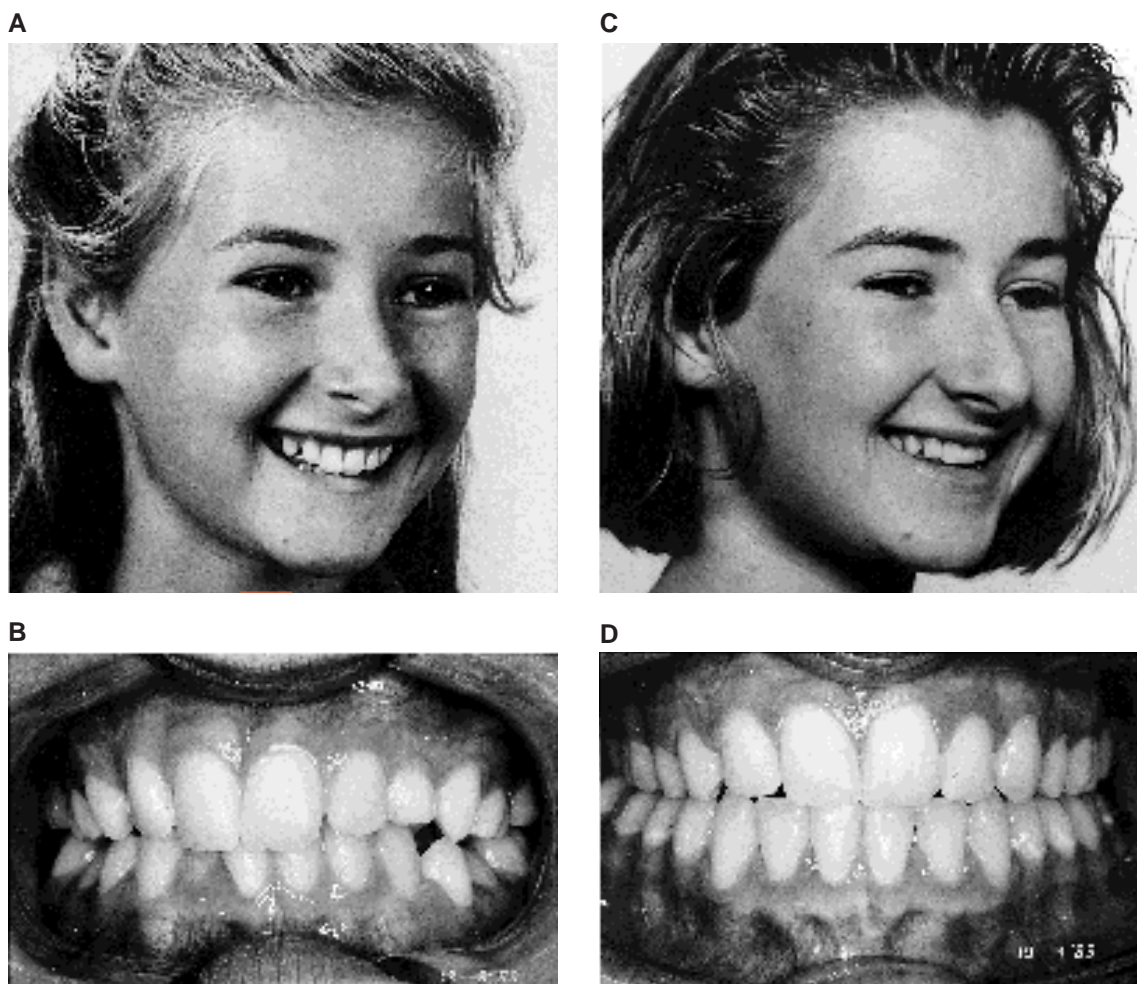
A

C

B

D

Figure 1 (A and B) Three-quarter facial and intra-oral photographs prior to treatment. The facial aesthetic score was 170 and the dental aesthetic score was 6. (C and D) Post-treatment 3/4 facial and intra-oral photographs for the same patient. The facial aesthetic score decreased to 110 and the dental aesthetic score improved to 2.

that the relationship between dental and facial aesthetics is only clear when a more severe malocclusion is present. Several other significant correlations were found between facial and dental aesthetics, but they showed no consistent pattern.

Our study shows that facial aesthetics improved in the group treated orthodontically during the observation period. Facial aesthetics did not change significantly in the group that was already in the post-treatment phase and who therefore did not undergo active orthodontic

treatment during the observation period. The same holds true for dental aesthetics. This means that the changes after treatment were minor.

No significant correlations were found between the changes in facial and dental aesthetics in both groups. The findings are illustrated in Figure 1. This patient shows an improvement in the dental aesthetics in the post-treatment compared with the pre-treatment stage. The scores according to the AC of the IOTN were 2 and 6 respectively. For the same patient the score according to the FA scale was 170 at the pre-treatment and

110 at the post-treatment stage. This means that dental aesthetics improved, while at the same time the effect on facial aesthetics was negative. This suggests that facial and dental aesthetics as measured in this study are influenced by different factors. For example, several studies have shown that a convex profile and a vertical facial pattern result in less positive ratings for facial aesthetics (Cox and Van der Linden, 1971; Prahl-Andersen *et al.,* 1979; Lundström *et al.,* 1989; Peerlings, 1992). However, those features will probably not affect the dental aesthetic score, because they are not visible on dental casts. Therefore, in an index that determines orthodontic treatment need, a dental as well as a facial aesthetic scale should be incorporated, in order to obtain an adequate judgement of the aesthetic impairment associated with a certain malocclusion.

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