

Assessment of orthodontic treatment need: a comparison of study models and facial photographs

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Abstract – *Objectives:* The current study aims to examine how orthodontic treatment need is prioritized depending upon whether dental study models or facial photographs are used as the means of assessment. Methods: A group of three orthodontists and three postgraduate orthodontic students assessed: (i) dental attractiveness; and (ii) need for orthodontic treatment in 40 subjects (19 males, 21 females). The 40 subjects displayed a range of malocclusions. Separate assessments were made from study models and facial photographs. Results: There was a bias towards higher scores for dental attractiveness from facial photographs compared with assessment of study casts, for all examiners. This was statistically significant for five of the six examiners (P = 0.001-0.101). The need for orthodontic treatment was rated as 20% higher from study models compared with facial photographs (P < 0.001); overall the level of need for orthodontic treatment was rated as 18.9% higher from study models compared with facial photographs (P < 0.001). Reproducibility analyses showed that there was a considerable variation in the intra- and inter-examiner agreement. Conclusions: This study shows that a group of three orthodontists and three postgraduate students in orthodontics: (i) rated orthodontic treatment need higher from study models compared with facial photographs and; (ii) rated dental attractiveness higher from facial photographs compared with study models. It is suggested that the variable intra-examiner agreement may result from the assessment of orthodontic treatment need and dental attractiveness in the absence of any specific assessment criteria. The poor reproducibility of assessment of orthodontic treatment need and dental attractiveness in the absence of strict criteria may suggest the need to use an appropriate index.

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There is considerable diversity in the way that orthodontic treatment need is assessed. Several indices have been developed that attempt to categorize malocclusion into groups according to level of treatment need. Occlusal indices such as the Occlusal Index of Summers (1) and the Handicapping Malocclusion Assessment Record of Salzmann (2) apply a score to each occlusal trait, which is then weighted to give an overall score. The Index of Orthodontic Treatment Need (IOTN) (3, 4) is an index that combines both an aesthetic component and a dental health component. A dental–facial attractiveness scale has also been proposed to provide an objective assessment of relative dental–facial attractiveness independent of functional impairment (5), with some correlation between dental and facial aesthetics (6, 7).

A tendency to underscore exists on the Aesthetic Component of the IOTN when photographs of the anterior occlusion are used compared with study

Sherlock et al.

casts (8). One of the potential limitations of the Aesthetic Component of the IOTN may be that orthodontic treatment need is rated from assessment of dental appearance in isolation, and it does not consider the impact of the malocclusion in the context of the overall facial appearance. It has been shown that a principal concern of orthodontic patients is for improved facial appearance (9–11); therefore, this would seem to be a major disadvantage of the index. Certainly, dentofacial and overall facial appearance would seem to be more influential in the social attractiveness of children than dental appearance (12). Not all malocclusions are considered to be unattractive in the context of overall facial appearance; for example, protruded maxillary incisors can reinforce positive images of social skills, especially in the attractive face (13).

The aims of this study were to investigate how orthodontic treatment need is prioritized when malocclusion is assessed in the context of overall facial appearance from facial photographs, and to compare this with the assessment of orthodontic treatment need from study models that assess the malocclusion in isolation. The null hypothesis was therefore, that no difference exists whether orthodontic treatment need and dental attractiveness are assessed from study models or from facial photographs.

Materials and methods

This study investigated whether a group of orthodontists and postgraduate orthodontic students made different assessments of dental attractiveness and need for orthodontic treatment according to whether they use study models or full facial photographs as the means of assessment.

Sample

A sample of 40 orthodontic patients (19 males; 21 females) with a range of malocclusions (IOTN categories 2–5) was collected. Whilst all these patients had previously been selected for orthodontic treatment, it was felt that the range of malocclusion severity justified the use of this group for the study. The sample size was pre-determined using a power calculation. To have a 90% power of detecting a mean difference of one between study models and facial photographs (at the 5% significance level), 31 cases would be needed. Forty cases were used to account for the fact that the standard

22

deviation used in the power calculation came from only 15 cases in the pilot study.

Sample analysis

The materials examined for each subject in the study included pre-treatment study models showing the occlusion and colour facial photographs (four views for each patient: profile; full-frontal, full-frontal smiling; three-quarters). The photographs were uncropped and features, such as hair, eye colour and skin texture, were evident. The examiners comprised three qualified orthodontists (one consultant orthodontist; one associate specialist in orthodontics, one FTTA in orthodontics) and three postgraduate students in orthodontics (one first-year student, one second-year student and one third-year student). The study models and facial photographs were randomly arranged so that the number of the study models did not correspond to the number of the facial photographs. Each examiner was asked to observe the 40 sets of facial photographs and to:

- score on a visual analogue scale (VAS) the attractiveness of each patient's dentition;
- indicate whether or not orthodontic treatment was required;
- indicate, if orthodontic treatment was needed, whether the need for orthodontic treatment was mild, moderate or severe.

The same group of examiners were then required to observe the 40 sets of study models from the sample and to answer the same three questions.

Reproducibility study

A reproducibility study was carried out 2 weeks after the main study. The same group of six examiners were required to repeat the procedure on the first 20 sets of study models and facial photographs.

Results

Analysis of ratings of examiners

Dental attractiveness

Scatter plots showed that there was a poor relationship between the VAS scores from facial photographs and study models for the majority of the examiners (Fig. 1a–f). A Pearson correlation coefficient showed that only examiner 3 had a reasonable correlation between the VAS ratings from study models and facial photographs (correlation coefficient of 0.58). A paired *t*-test indicated that



Fig. 1. Scatter plots showing individual examiners' visual analogue scale ratings for dental attractiveness from assessment of study models and facial photographs (a–f: examiners 1–6 respectively; *x*-axis = SM (study models), *y*-axis = photos).

there was a bias towards higher scores for dental attractiveness from facial photographs compared with study models for all the examiners. This was statistically significant for five of the six examiners (P = 0.001-0.101). The mean average of the combined scores of the six examiners for dental attractiveness was rated as 23.8% higher from facial photographs compared with study models (P < 0.001, paired *t*-test).

Orthodontic treatment need

A Wilcoxon signed ranks test showed that the median values of the combined scores of the six examiners for need for orthodontic treatment were rated 20% higher from study models than from facial photographs (P < 0.001).

Level of orthodontic treatment need

The level of need for orthodontic treatment was analysed by means of:

 the percentage of cases where there was agreement between study models and facial photographs for assessment of level of treatment need;

- the percentage of the cases where level of treatment need was rated higher from facial photographs compared with study models;
- the percentage of cases where the level of treatment need was rated higher from study models compared with facial photographs;
- a weighted kappa value.

The analyses showed that the rating of level of orthodontic treatment need was more frequently higher from study models compared with facial photographs for all the examiners. A Wilcoxon signed ranks test showed that the median of the combined scores of the six examiners for rating level of orthodontic treatment need was 18.9% higher from study models compared with facial photographs (P < 0.001).

Comparison of assessments made by the two groups of examiners: qualified orthodontists and postgraduate orthodontic students

The mean VAS scores for attractiveness of the dentition from study models were slightly higher for the qualified orthodontists' group

(4.54) compared with the postgraduate orthodontic students (4.2) (P = 0.76). For facial photographs, the mean VAS scores were slightly higher for the qualified orthodontists' group (5.52) compared with the postgraduate orthodontic students (5.17) (P = 0.162).

For the assessment of need for orthodontic treatment from facial photographs, more qualified orthodontists thought that treatment was needed than postgraduate orthodontic students (P = 0.025).

For the assessment of level of need for orthodontic treatment from facial photographs, the group of qualified orthodontists expressed a higher level of need in more cases than postgraduate students (P = 0.067). For the assessment from study models postgraduates assessed a higher level of need for treatment in more cases than qualified orthodontists (P = 0.145).

Reproducibility study

Scatter plots showed that there was considerable intra-examiner variation in the assessment of dental attractiveness. Examiners 3 and 5 showed fairly good consistency in their ratings, the remaining examiners showed poor consistency between their first and second assessments of dental attractiveness from facial photographs and study models. A Pearson correlation coefficient showed that there was a good correlation for assessment from both study models and facial photographs for examiners 3 and 5, but not for the other four examiners. A paired t-test showed that for five of the six examiners there was no significant difference between the main and reproducibility studies for VAS assessment for dental attractiveness. For assessment from study models there was no significant difference for five of the six examiners.

Reproducibility of assessment of need for orthodontic treatment was assessed by means of percentage level of agreement between main study ratings and reproducibility study ratings, and kappa statistic. There was a high level of intraexaminer agreement for assessment of need for orthodontic treatment from study models. The level of intra-examiner agreement showed considerable variation between the examiners, ranging from 50% to 100% for facial photographs and 80% to 100% for the study models.

Reproducibility of assessment of level of need for orthodontic treatment was assessed by means of percentage agreement and weighted kappa. The agreement ranged from 20% to 75% for photographs and 45% to 90% for study models.

Discussion

Overall, the VAS scores for dental attractiveness were higher when facial photographs were used for assessment compared with study casts. The scores for the assessment of the need and the level of need for orthodontic treatment were higher for study models than for facial photographs. A tendency to underscore photographs of the dentition when compared with the clinical and study cast ratings for the Aesthetic Component of the IOTN has previously been described (8). This was attributed to the fact that a photograph is a twodimensional representation of a three-dimensional subject. The photograph might be expected to reduce conspicuousness of anterior irregularities and the prominence of overjet problems and this may account for the principal findings of this current study; higher ratings of dental attractiveness and lower ratings for orthodontic treatment need when assessed from facial photographs when compared with study models. It would be interesting to see how the results would have been affected if digital study models were used instead of plaster study models, to remove influence of the third dimension.

Another potential source of differences in assessment between study models and facial photographs could be a masking effect of the soft tissues on the full aesthetic or dental health impact of the malocclusion. In assessing dental appearance from study casts, there is no potential masking factor of the soft tissues and all the traits of a malocclusion can be identified. With facial photographs because of the masking effect of the soft tissues only the anterior dentition, or a part of it, can be assessed. This may contribute to a higher score for dental attractiveness and a lower score for need for orthodontic treatment when assessing facial photographs compared with study models.

The overall facial appearance may have an influence on the assessment of attractiveness of the dentition itself when facial photographs are used as the means of assessment. Some features in the photographs, such as hair and eye colour, skin texture or even adolescent acne, may have introduced bias into the ratings of scores of dental attractiveness as this was not an isolated feature. The aesthetic component of the IOTN assesses the impact of a malocclusion by rating an individual's dental appearance in isolation, without taking into account the overall facial appearance. This is a limitation, as the important influence of background facial attractiveness is clear (12).

A previous study obtained lower ratings of attractiveness from study models than from previously obtained photographic dental views of the same subjects (14, 15). It was suggested that the lack of comparability was due to a combination of examiner variability, the unfamiliar and unappealing nature of study casts and the differences in detail seen in photographs and study casts (15).

During preliminary evaluation of the Standardised Continuum of Aesthetic Need (SCAN), slides of the subjects' dentitions were used showing frontal views (3). One of the shortcomings is that such views poorly represent dentofacial imbalance in the anteroposterior plane, which is often associated with malocclusion. It is possible that this limitation also applies to the facial photographs used in the current study.

The intra-rater reliability showed considerable variability. The two examiners demonstrating good intra-examiner agreement in their ratings within this study included one from the group of qualified orthodontists and one first year postgraduate student in orthodontics. As there were effectively six examiners with varying levels of experience, no firm conclusions could be drawn regarding the relationship of examiner experience to reproducibility. This may suggest that, when assessing dental attractiveness and need for orthodontic treatment in the absence of any specific criteria, experience may not be a determining factor in examiner agreement. If clinical experience is considered important in the consistency of decision making, a subsequent study could test this assumption with an increased and calculated sample size of raters, with novices (postgraduate students) and experts as orthodontists with more than 5 years of experience.

There was considerable intra- and inter-examiner variability when assessing dental attractiveness, need for orthodontic treatment and the level of need for orthodontic treatment. No specific index criteria were given to examiners for assessing orthodontic treatment need and dental attractiveness in this investigation. However, the IOTN index has been shown to have good reliability (4), suggesting that, in the absence of an index or scale it may be difficult to assess the need for orthodontic treatment in a reproducible manner. Identifying the factors which constitute need for orthodontic treatment is a multidimensional construct. The providers' measures of their of dental attractiveness and severity of malocclusion differ from the consumers or patient's perception of the need/demand which may relate more to quality of life factors than to morphological criteria. This lack of concordance between providers and consumers poses a complex set of issues in developing an ideal index for comprehensively evaluating the need for orthodontic treatment.

Conclusions

This study examined how three orthodontists and three postgraduate orthodontic students assessed dental attractiveness and orthodontic treatment need using study models and facial photographs. Overall, dental attractiveness was scored higher and orthodontic treatment need scored lower when assessing facial photographs. The level of need for orthodontic treatment was scored higher from study casts. Therefore, further work is required to construct an ideal index for comprehensively evaluating the need for orthodontic treatment.

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Sherlock et al.

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