

Morphological, functional and aesthetic criteria of acceptable mature occlusion

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SUMMARY At present, there are no generally accepted criteria that could easily be applied to the evaluation of occlusal acceptability in clinical examinations at population level. The present study analyses the opinions of Finnish orthodontists and general practitioners on the characteristics required for acceptable occlusion in the full permanent dentition.

A questionnaire was sent to all 37 health centres where at least one orthodontist was employed, 31 regionally comparable health centres without an orthodontist, 12 private orthodontists, and 13 orthodontists working at university dental clinics. Seventy-four orthodontists returned the questionnaire giving a response rate of 80 per cent. They were asked to give their views on the importance of morphology, function, long-term stability, and dental appearance as elements of acceptable occlusion. They were also encouraged to indicate other significant characteristics and requested to assess the relative significance of these features.

In general, the respondents expressed the need to assess morphological, functional and aesthetic aspects of occlusion as a whole. Good function, rather than morphology, was considered to be the most important feature of an acceptable occlusion, with a relative significance of 40 per cent (range 20–90 per cent). According to the respondents, the acceptability of occlusion is determined not only by morphological features, but also by the functional status and long-term stability, as well as by the patient's opinion of the dental appearance.

Introduction

Since Angle's 'Classification of malocclusion' in 1899, the concept of malocclusion has been expanded to cover the functional and aesthetic aspects of occlusion. Jenny (1975) and Prah Andersen (1978) further suggested that the occlusion should be studied in its social context. According to Prah Andersen (1978), an occlusion, either with or without functional disturbances, might become a handicap, if it failed to meet the society's standards. Similarly, McLain and Proffit (1985) emphasized that untreated malocclusions do not always have physical consequences, but may have a negative impact on the person's social well being. Many studies have been conducted to analyse the impact of facial attractiveness on social interactions and the features making a face

attractive (Mealey *et al.*, 1999; Langlois *et al.*, 2000). The importance of both the oral region and visible malocclusions has been emphasized and the lay-groups' negative response to dental deviations has been demonstrated in several studies (Terry and Davis, 1976; Terry, 1977; Shaw *et al.*, 1980, 1985; Lucker *et al.*, 1981; Shaw, 1981; Tulloch *et al.*, 1993; Phillips *et al.*, 1995).

The preference for attractive faces is already present in infancy (Langlois *et al.*, 2000). Moreover, studies have indicated that the perception of dental aesthetics is similar among different racial groups (Kiyak, 1981; Cons *et al.*, 1983; Tedesco *et al.*, 1983). Prah Andersen *et al.* (1997) found that dental aesthetics was the most important feature describing the acceptability of occlusion. However, if aesthetic aspects are added to the professional evaluation of occlusion,

the evaluators, as well as the target group, would presumably affect the range of acceptability (Shaw *et al.*, 1975; Prah-Andersen, 1978; Kiyak, 1981; Lucker *et al.*, 1981; Meerdink *et al.*, 1990; Peck and Peck, 1995; Prah-Andersen *et al.*, 1997).

Recently, Buttke and Proffit (1999) suggested that 'the achievement of the best balance between dental and facial aesthetics, ideal occlusal relationships and long-term dento-alveolar stability' is the goal of comprehensive orthodontic treatment. Accordingly, aesthetic and functional considerations have been included in the latest treatment need indices and gradings (Norges offentlige utredninger, 1986; Brook and Shaw, 1989; Solow, 1995). The Index of Orthodontic Treatment Need (IOTN) and the Need of Orthodontic Treatment Index (NOTI) have been applied in the evaluation of residual treatment need in treated and untreated adolescents, and in measuring the quality of treatment (Burden *et al.*, 1994; Richmond *et al.*, 1994a; Espeland and Stenvik, 1999). However, a study in which orthodontists in nine countries assessed treatment outcome, indicated that different criteria were used in the evaluation of treatment need and outcome (Prah-Andersen *et al.*, 1997).

In an earlier report, the opinions of Finnish professionals on the morphology of an acceptable occlusion in young adults were analysed (Svedström-Oristo *et al.*, 2000). The results indicated that consideration of functional factors was of importance. Small variations from the ideal, e.g. moderate space anomalies or an increased overbite without functional disturbances, were generally accepted, whereas anterior or posterior crossbite with a sign of dysfunction was not.

Aim

At present, there are no generally accepted criteria to assess the acceptability of occlusion. For the purpose of defining such criteria in the future, this study may serve as a tool in collecting pertinent background information. The aim of this investigation was, firstly, to analyse the opinions of Finnish orthodontic professionals on the main characteristics required for an acceptable occlusion

in young adults and, secondly, to compare the relative significance of these characteristics.

Subjects and methods

In 1995, there were approximately 230 health centres in Finland. A questionnaire was sent to all 37 municipal health centres employing at least one orthodontist, 31 regionally comparable health centres without an orthodontist, 12 private orthodontists, and 13 orthodontists working at university dental clinics. In the health centres, the specialist orthodontist or the dentist mainly responsible for orthodontics was requested to answer the questionnaire (Appendix I). The definitions of the NOTI group D and the IOTN grade 2 were used as a reference for what might comprise an acceptable occlusion (Appendix II). An analysis concerning Finnish professionals' opinions on the given morphological details has been reported previously (Svedström-Oristo *et al.*, 2000).

Of the 93 subjects, 74 returned the questionnaire, giving an 80 per cent response rate. Of the respondents, 62 per cent were specialists in orthodontics, 5 per cent other specialists, and 33 per cent general practitioners. Seventy-four per cent of the respondents worked at municipal health centres, 11 per cent at university dental clinics, and 15 per cent in private clinics. The working experience of the respondents varied from 8 to 38 years (mean 22 years) and their weekly time spent in orthodontics ranged from 1 to 45 hours per week (mean 25 hours per week). The mean age of the respondents ($n = 74$) was 47 years (range 34–64 years) and that of the non-respondents ($n = 19$) 51 years (range 42–63 years). Of the 19 non-respondents, 14 (74 per cent) were specialist orthodontists and five (26 per cent) general practitioners. All non-responding general practitioners and eight of the non-responding specialist orthodontists worked at municipal health centres (69 per cent), five of the non-responding specialist orthodontists worked at university clinics (26 per cent), and one in a private clinic (5 per cent).

The respondents were grouped according to their orthodontic training level (general practitioner/orthodontist), regional distribution

(south, central and north Finland), type of employment (health centre/university clinic/private), age, and working experience.

Statistical analysis

The chi-square test was used to analyse differences between the groups. In the case of low frequencies, exact *P*-values were calculated using Fisher's exact test (Cytel Software Corporation, 1991). *P*-values less than 0.05 were interpreted as statistically significant.

Results

In general, the respondents wanted to assess the given characteristics of occlusion together. Good function was considered to be the most significant individual feature of an acceptable occlusion, corresponding to approximately 40 per cent of relative significance (Table 1). The remaining 60 per cent were accounted for almost equally by long-term stability, morphology, and appearance as a whole.

Function

All the respondents, except one, regarded good function as important or very important. For assessment of the occlusion, 81 per cent of the respondents recommended a thorough functional examination including recording of discrepancies between retruded contact position (RCP) and intercusp contact position (ICP), registration of mandibular mobility (lateral excursions, protrusion, maximal opening with deviations),

and palpation of the joints and masticatory muscles. Orthodontists emphasized the importance of functional analysis more often than general practitioners (*P* = 0.015).

Long-term stability

Good long-term stability was considered important or very important by 93 per cent of the respondents. Three out of four respondents would include this characteristic in the assessment of occlusion. The inter-incisal angle, the facial growth pattern and history of temporomandibular joint (TMJ) problems, as well as occlusal, soft tissue, and muscle function were mentioned as the most significant predictors of good long-term stability.

Acceptable morphology

Acceptable morphology was regarded as important or very important by three out of four respondents. Thirty-three respondents (45 per cent) did not want to evaluate morphological features separately. Additional information was most often required in the form of functional and soft tissue analyses. The interincisal angle was mentioned as the most important morphological feature to be added to the assessment. The desire for further information was more often expressed by orthodontists than general practitioners (*P* = 0.014).

Dental appearance

Only one-fifth of the sample (23 per cent) considered professional assessment of the dental

Table 1 The respondents' views on the relative significance of the characteristics of an acceptable occlusion in the full permanent dentition. An acceptable occlusion is represented by 100 per cent (*n* = 74).

Characteristic of occlusion	Relative significance (%)			
	Mean	SD	Median	Range
Good function	38	15	32	20–90
Long-term stability	21	11	20	3–50
Acceptable morphology	19	11	20	3–50
Appearance, patient's view	14	9	10	2–50
Appearance, professional view	6	5	5	2–20

appearance as important or very important. Half of the sample were of the opinion that this aspect should be included in the evaluation, while the other half considered it unnecessary. According to the respondents, the visibility of malocclusion, the profile, soft tissues, and the smile line should be assessed. However, the patient's opinion on the dental appearance was fully respected. Three out of four respondents regarded it as important or very important. Fifty-eight respondents (78 per cent) were of the opinion that the patient's view should be included in the assessment. The detailed distribution of the respondents' views on the importance of the main characteristics is given in Table 2.

Other characteristics of acceptable occlusion

Nine per cent of the sample suggested some other characteristics to be considered. Those mentioned were tooth wear, harmony between skeletal and soft tissues, breathing pattern, and factors such as co-operation, oral hygiene, caries, and risk of trauma to the teeth.

Discussion

In several previous articles, occlusion has predominantly been considered either from a morphological or a functional point of view. More recently, the evaluation of aesthetic aspects has been added to these considerations. Rather than being purely the sum of the details,

the occlusion represents a harmony between morphological, functional, and aesthetic aspects as suggested by Buttke and Proffit (1999). However, while it is evident that the achievement of harmony between these different aspects requires compromises, there are no guidelines as to how far these compromises can be made without sacrificing the acceptability of occlusion.

Given that the main reason for seeking orthodontic treatment is aesthetic, and that satisfaction with the outcome depends on the patients' expectations, their point of view in the assessment of dental aesthetics is decisive (Shaw *et al.*, 1991; Pietilä and Pietilä, 1996; Buttke and Proffit, 1999; Vig *et al.*, 1999). In the present study, the patient's opinion on aesthetics was emphasized by the orthodontic professionals. However, the range of acceptability has been shown to be highly individual, and dependent, e.g. on gender (Grabner and Lucker, 1980; Lucker *et al.*, 1981; Meerdink *et al.*, 1990; Peck and Peck, 1995). Nevertheless, when rated by questionnaire, young adults have presented a high level of awareness of their dental appearance and a realistic view of their occlusion (Espeland and Stenvik, 1991; Pietilä and Pietilä, 1996).

The importance of good occlusal function was a prevailing concept among Finnish orthodontists and orthodontically active general practitioners. This preference may reflect the general opinion that subsidized orthodontics should be allocated to promote occlusal health, rather than cosmetics. In addition, the Finnish Medical Board has

Table 2 The distribution of the respondents' views on the importance of the characteristics of an acceptable occlusion in the full permanent dentition. (Expressed in percentages. $n = 74$, the most frequent choice in bold print.)

Characteristics of occlusion	Degree of importance			
	1 Less or not at all important	2 Rather important	3 Important	4 Very important
Good function	1	0	27	72
Long-term stability	0	6	45	49
Acceptable morphology	4	19	62	15
Appearance, patient's view	3	25	57	15
Appearance, professional view	32	45	19	4

recommended that priority should be given to the treatment of functionally handicapping malocclusions (Medical Board of Finland, 1988). On the other hand, a functionally optimal occlusion is frequently mentioned as one of the most important goals of orthodontic treatment, even if the role of function in the aetiology of TMJ disorders remains debatable (Ingervall, 1976; Roth, 1981; Sadowsky and Polson, 1984; McNamara, 1997; Luther, 1998).

Traditionally, evaluation of treatment outcome has focused on the morphological features of occlusion immediately or shortly after completion of treatment. However, it was recently suggested that good long-term stability should be taken as one of the primary objectives of orthodontic treatment (Buttke and Proffit, 1999). This suggestion was supported by the present findings: over 90 per cent of the respondents considered long-term stability important, and three out of four suggested that an assessment of stability should be incorporated into the evaluation of occlusion. In addition, the respondents frequently emphasized the inclusion of functional considerations, i.e. analysis of occlusal, soft tissue, and muscle function. Presumably because of the rather high prevalence of deep bites in Finland, the interincisal angle was considered a significant predictor of long-term stability (Myllärniemi, 1970; Hannuksela, 1977). This is in agreement with the results of Prah-Andersen *et al.* (1997), which ranked incisor inclination third among the determining factors in the evaluation of occlusal acceptability. Regarding long-term stability, the interest in previously experienced TMJ dysfunction seems to be based on the view that functional disturbances, if present, could jeopardize morphological stability (Pullinger and Seligman, 2000).

In 1995, the total number of actively working orthodontists in Finland was 124. The 46 orthodontists, who responded to the questionnaire, comprised approximately 37 per cent of this group. Free dental care including orthodontics is provided up to the age of 19 years at municipal health centres. Only a few health centres (usually the largest ones) employ a full-time specialist.

Orthodontics is therefore commonly carried out by general practitioners under the guidance of a consulting orthodontist (Pietilä *et al.*, 1997). As a result, many private orthodontists and those employed by universities work as part-time consultants and gain experience in the public health services. On the basis of the 80 per cent response rate and the 22 years' average working experience, the study group can be regarded as representative.

Because the concept of acceptable occlusion is vague, a semi-structured questionnaire was chosen to help respondents in considering the different aspects of acceptability. However, care was taken not to guide the answers too strictly. Significant differences in opinions were found with regard to the level of orthodontic education. Orthodontists more often than general practitioners emphasized the importance of functional analysis and background information in the evaluation of the occlusion. This is in line with other studies (Shaw *et al.*, 1991; Richmond *et al.*, 1994b), as well as earlier finding that orthodontists use a narrower range of acceptability in the assessment of morphological features (Svedström-Oristo *et al.*, 2000).

Conclusions

According to Finnish orthodontists and general practitioners, functional and aesthetic aspects of occlusion, in addition to morphological features, are important determinants of its acceptability. They suggested that a functional examination, together with an assessment of long-term stability, should be included in the evaluation of acceptability. In addition, the importance of the patient's perception of the dental appearance was emphasized.

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Appendix I: the questionnaire

The aim of this questionnaire is to analyse the opinions on the main characteristics describing an acceptable, mature occlusion in young adults. When answering these questions, please tick the appropriate box giving additional comments, when needed.

1. Do the definitions in DHC/IOTN grade 2 and NOTI group D describe the occlusal morphology clearly enough or would you like to add some detail?
 No need ☐
 Yes, I suggest ... ☐
2. These two indices take only little account of function. Do you feel there would be any need for a further functional evaluation?
 No need ☐
 Yes, I suggest ... ☐
3. The indices do not include any assessment of the long-term stability. Do you think this should be incorporated in the evaluation of occlusion?
 No need ☐
 Yes, I suggest ... ☐
4. Do you think that a professional assessment of the dental appearance should be added to the evaluation?
 No need ☐
 Yes, I suggest ... ☐
5. Do you think that the patient's view on the dental appearance and/or function should be included in the evaluation?
 No need ☐
 Yes, I suggest ... ☐
6. Which other significant characteristics defining an acceptable, mature occlusion should be included in the assessment?
 No need ☐
 Yes, I suggest ... ☐
7. Any further comments?
 No need ☐
 Yes, I suggest ... ☐

When assessing the acceptability of a mature occlusion in young adults, how important are the following characteristics in your opinion?

Please tick the appropriate box.

	Very important	Important	Rather important	Less or not important
Acceptable morphology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Good function	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Good long-term stability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Satisfactory dental appearance assessed by professional	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Satisfactory dental appearance assessed by patient	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other characteristic(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Could you please further assess the relative significance of all the different characteristics comprising an acceptable, mature occlusion. An acceptable occlusion as a whole is rated as 100 per cent.

- | | |
|---|---------|
| (a) Acceptable morphology | _____ % |
| (b) Good function | _____ % |
| (c) Good long-term stability | _____ % |
| (d) Satisfactory dental appearance, professional assessment | _____ % |
| (e) Satisfactory dental appearance, patient's view | _____ % |
| (f) Other characteristic(s) _____ | _____ % |
| An acceptable occlusion as a whole | 100 % |

Appendix II*NOTI: Group D: little/no treatment need*

1. Overjet less than 6 mm
2. Bilateral crossbite
3. Anterior and lateral open bite on fewer than three pairs of opposing teeth
4. Increased overbite (deep bite) with occlusal contact incisal to the gingival $\frac{1}{4}$ of the palatal surface of the maxillary anterior teeth
5. Local cross- and scissors bite without asymmetry or forced bite
6. Moderate crowding in anterior and lateral segments
7. Median diastema less than 3 mm
8. Moderate spacing in anterior and lateral segments

IOTN: Grade 2: little treatment need

- 2.a Increased overjet greater than 3.5 mm, but less than or equal to 6 mm with competent lips
- 2.b Reverse overjet greater than 0 mm, but less than or equal to 1 mm
- 2.c Anterior or posterior crossbite with less than or equal to 1 mm discrepancy between retruded contact position and intercuspal position
- 2.d Contact point displacements greater than 1 mm, but less than or equal to 2 mm
- 2.e Anterior or posterior open bite greater than 1 mm, but less than or equal to 2 mm
- 2.f Increased overbite greater than or equal to 3.5 mm without gingival contact
- 2.g Pre- or post-normal occlusions with no other anomalies

