



## Quality of Life and Orthodontic Treatment Need Related to Occlusal Indices

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### Introduction

Malocclusion is a common oral disorder which manifests itself during childhood and the correction of malocclusion (orthodontic treatment) is frequently carried out during childhood<sup>1</sup>. With the growing demand for orthodontic treatment a variety of clinician-based indices have been developed to classify various types of malocclusion and determine their orthodontic treatment need<sup>2-4</sup>. These indices can be used in estimating orthodontic treatment need, prioritising of treatment need in patients referred for orthodontics particularly where there are limited resources for orthodontics among public health care services, and safeguarding for the patients<sup>5,6</sup>. It is reported that patients' occlusion might become worse if patients with minor malocclusion receive orthodontic treatment<sup>4</sup>. The most commonly employed malocclusion indices are the Dental Aesthetic Index (DAI), Index of Orthodontic Treatment Need (IOTN), Peer Assessment Rating<sup>7,8</sup> and Index of Complexity, Outcome and Need (ICON)<sup>9-11</sup>.

Significant advances have been made in the assessment of oral health related quality of life (OHQoL) in a comprehensive manner in recent decades. A plethora of valid and reliable measures already exists for use among adults and promising research is emerging on the use of such a measure among children<sup>12</sup>. Some studies have been attempts to determine the association between individual occlusal indices and oral health related quality of life. Understanding the relationship between the child's subjective perception and occlusal indices can help orthodontist to comprehensively evaluate the treatment need since a person's subjective perceptions of their oral health are central to the assessment of their oral health needs.

The purpose of this review is to briefly describe the commonly used occlusal indices and evaluate the relationship among them and in addition, to assess the association between the occlusal indices and patients' perceptive oral health related quality of life (OHQoL).

### Occlusal indices

Generally, among the commonly used indices, IOTN (AC, DHC), DAI and ICON are used to assess the

orthodontic treatment needs while ICON and PAR are used to assess the treatment outcome. In some ways, the indices of IOTN, DAI and ICON are similar. All include two components-morphological and esthetic. The difference is that for the IOTN, the esthetic component is separated from the dental health component. All the three indices measure similar traits such as overjet, reverse overjet, open bite, overbite, antero-posterior molar relationship, and displacement. However, the weight of these traits are rated differently by each index<sup>9-11</sup>. The four indices are described below.

### Index of Orthodontic Treatment Needs

Brook and Shaw<sup>10</sup> developed a valid and reproducible index (Index of orthodontic treatment need - IOTN) to determine orthodontic treatment need. This index attempts to rank malocclusion in terms of the significance of various occlusal traits for an individual's dental health and perceived aesthetic impairment. It intends to identify those individuals who would most likely benefit from orthodontic treatment. The index has two components, the aesthetic and dental health components, which rank malocclusion in increasing priority according to aesthetic considerations and dental health implication.

#### (1) Aesthetic Component (AC)

AC consists of a scale of ten colour photographs showing different levels of dental attractiveness<sup>13</sup>. The dental attractiveness of prospective patients can be rated with reference to this scale. Grade 1 represents the most and grade 10 the least attractive arrangement of teeth. The score reflects the aesthetic impairment. Monochrome photographs are used for dental cast assessment. These have an advantage in that raters are not influenced by oral hygiene, gingival conditions or poor colour matches in restorations affecting anterior teeth. Grade 1, 2, 3 and 4 represents no or slight need for treatment, grade 5, 6 and 7 represents moderate or borderline need for treatment, grade 8, 9 and 10 represents need for orthodontic treatment.

#### (2) Dental Health Component (DHC)

DHC involves features that might impair the health and function of the dentition. It is based on the index of the Swedish Medical Health Board<sup>14</sup>. The DHC records the



various occlusal traits of a malocclusion that would increase the morbidity of the dentition and surrounding structures. The traits of malocclusion are: overjet, reverse overjet, overbite, open bite, crossbite, displacement of teeth, impeded eruption of teeth, buccal occlusion, hypodontia and defects of cleft lip and palate. Functional disturbances are also recorded which included lip competency, mandibular displacement, traumatic occlusion and masticatory or speech difficulties. Only the worst occlusal feature is recorded. There are five grades, Grade 1 and 2 represent no need or slight need for treatment, grade 3 represents moderate or borderline need for treatment, grade 4 and 5 represents need for orthodontic treatment. The components of DHC are shown in *Table 1*.

**Table 1. The Dental Health Components of the index of index of orthodontic treatment need (IOTN) (Shaw et al, 1989)**

Grade 5 (Need treatment)	
5.i	Impeded eruption of teeth (except for third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause.
5.h	Extensive hypodontia with restorative implications (more than 1 tooth missing in any quadrant) requiring pre-restorative orthodontics.
5.a	Increased overjet greater than 9mm
5.m	Reverse overjet greater than 3.5mm with reported masticatory or speech difficulties.
5.p	Defects of cleft lip and palate and other craniofacial anomalies.
5.s	Submerged deciduous teeth.
Grade 4 (Need treatment)	
4.h	Less extensive hypodontia requiring pre-restorative orthodontic or orthodontic space closure to obviate the need for prosthesis.
4.a	Increased overjet greater than 6mm but less than or equal to 9mm.
4.b	Reverse overjet greater than 3.5mm with no masticatory or speech difficulties.
4.m	Reverse overjet greater than 1mm but less than 3.5mm with reported masticatory or speech difficulties.
4.c	Anterior or posterior crossbites with greater than 2mm discrepancy between retruded contact position and intercuspal position.
4.l	Posterior lingual crossbite with no functional occlusal contact in one or both buccal segments.
4.d	Severe contact point displacements greater than 4mm.
4.e	Extreme lateral or anterior open bite greater than 4mm.
4.f	Increased and completed overbite with gingival or palatal trauma.
4.t	Partially erupted teeth, tipped and impacted against adjacent teeth.
4.x	Presence of supernumerary teeth.
Grade 3 (Borderline need)	
3.a	Increased overjet greater than 3.5mm but less than or equal to 6mm with incompetent lips.
3.b	Reverse overjet greater than 1mm but less than or equal to 3.5mm.
3.c	Anterior or posterior crossbites with greater than 1mm but less than or equal to 2mm discrepancy between retruded contact position and intercuspal position.
3.d	Contact point displacements greater than 2mm but less than or equal to 4mm.
3.e	Lateral or anterior open bite greater than 2mm but less than or equal to 4mm.
3.f	Deep overbite complete on gingival or palatal tissues but no trauma.
Grade 2 (Little need)	
2.a	Increased overjet greater than 3.5mm but less than or equal to 6mm with competent lips.
2.b	Reverse overjet greater than 0mm but less than or equal to 1mm.
2.c	Anterior or posterior crossbites with less than or equal to 1mm discrepancy between retruded contact position and intercuspal position.
2.d	Contact point displacements greater than 1mm but less than or equal to 2mm.
2.e	Anterior or posterior open bite greater than 1mm but less than or equal to 2mm.
2.f	Increased overbite greater than or equal to 3.5mm without gingival contact.
2.g	Pre-normal or post-normal occlusions with no other anomalies (includes up to half a unit discrepancy).
Grade 1 (None)	
1.	Extremely minor malocclusions including contact point displacements less than 1mm.

The Dental Health Component is usually recorded at the chair side by direct examination of the subject but can also be recorded from dental casts. When using dental casts alone it is unlikely that clinical information will be readily available to the examiner. For this reason a protocol has been developed which should be employed when using dental casts. The protocol always assumes the worst scenario.

(1) If the overjet is 3.5mm - 6mm on the dental casts, it is assumed the lips are incompetent and will be awarded grade 3a.

(2) If there are crossbites on dental casts, it is assumed a discrepancy between retruded contact position and intercuspal position of greater than 2mm is present and will be awarded grade 4c.

(3) If there are reverse overjets on dental casts, it is assumed that masticatory or speech problems are present and will be awarded at least 4m.

## Peer Assessment Rating

The PAR index is a quantitative occlusal index measuring how much a patient deviates from normal alignment and occlusion. This index is designed to measure the efficacy or the outcome of orthodontic treatment by comparing the severity of occlusion on pretreatment and post-treatment casts. The PAR index has five components<sup>7,8</sup>:

(1) Upper and lower anterior segments. Scores are recorded for both upper and lower anterior segment alignment. The features recorded are crowding, spacing and impacted teeth.

(2) Buccal occlusion. The buccal occlusion is recorded for both left and right sides. The recording zone is from the canine to the last molar. All discrepancies are recorded when teeth are in occlusion.

(3) Overjet. Positive overjet as well as teeth in crossbite is recorded. The most prominent aspect of any one incisor is recorded. If the two lateral incisors are in crossbite while the centred incisors are with increased overjet of 4mm, the score will be 3 for crossbite and 1 for the positive overjet, 4 in total.

(4) Overbite. The vertical overlap or open bite of the anterior teeth is recorded.

(5) Centreline assessment. The centreline discrepancy between the upper and lower dental midline is recorded in relation to lower central incisors.

The PAR index is applied to an individual's pre- and post-treatment study casts. Scores are assigned to each component. The individual scores are calculated in each component and multiplied by a weight of each component. Scores are summed to obtain a total score that represents the degree a case deviates from normal alignment and occlusion. The degree of improvement as a result of orthodontic intervention is obtained by calculating the difference between the pre- and post-treatment PAR scores. The degree of improvement can be assessed using two different methods:

(1) Nomogram: The degree of change is separated into 3 sections: (a) worse or no difference, (b) improved and (c) greatly improved.

(2) Percentage improvement: This method gives a more sensitive assessment than the nomogram which only provides three broad bands of treatment change. A change of score from 40 to 10 would represent an 80% improvement as would a change from 15 to 3. However, the actual reduction in PAR scores is also relevant as in the first case where there has been a much greater change with a 30 point reduction as opposed to the second case in which the degree of change is less with only a 12 point reduction.



### Index of Complexity, Outcome and Need

The Index of Complexity, Outcome and Need (ICON) has been developed recently and claims among other things, to evaluate orthodontic treatment complexity. ICON is based on the subjective judgements of 97 orthodontists from nine countries<sup>11</sup>. It is a single assessment method to quantify orthodontic treatment complexity, outcome and need. The ICON consists of following five weighted components, Table 2:

- (1) The Aesthetic Component (AC): The dental aesthetic component of the IOTN is used. Once this score is obtained it is multiplied by the weighting of 7.
- (2) Crossbite: Crossbite is deemed to be present if a transverse reaction of cusp to cusp or worse exists in the buccal segment. This includes buccal and lingual crossbites consisting of one or more teeth with or without mandibular displacement.
- (3) Anterior vertical relationship: This trait includes both open bite (excluding development conditions) and deep bite. If both traits are present only the highest scoring raw score is counted. Scoring protocol is given in Table 2.
- (4) Upper arch crowding/spacing: The sum of the mesio-distal crown diameters is compared to the available arch circumference, mesial to the last standing tooth on either side.
- (5) Buccal segment antero-posterior relationship: The antero-posterior cuspal relationship is scored according to the protocol given in table 2 for each side in turn. The raw scores for both sides are added together.

#### (6) Calculation of the final scores

Once all of the raw scores have been obtained and multiplied by their respective weights, they are added together to yield a weighted summary score for a particular cast. The summed score is interpreted as following: pre-treatment scores give the treatment needs and complexity grades; end of treatment scores gives the acceptability; while pre-treatment scores - 4 x post-treatment scores gives the degree of improvement, Table 3.

### Dental Aesthetic Index

The Dental Aesthetic Index (DAI) has been adopted by the World Health Organization as a cross-cultural

index<sup>15</sup>. It identifies deviant occlusal traits and mathematically derives a single score<sup>9</sup>. Its structure consists of 10 occlusal features of malocclusion; overjet, underjet, missing teeth, diastema, anterior openbite, anterior crowding, anterior spacing, largest anterior irregularity (mandible and maxilla), and anteroposterior molar relationship. The ten occlusal features are weighted on the basis of their relative importance according to a panel of lay judges. The codes and criteria are as follows:

- (1) Missing incisor, canine and premolar teeth: The number of missing permanent incisor, canine and premolar teeth in the upper and lower arches should be counted and recorded.
- (2) Crowding in the incisal segments: Both the upper and lower incisal segments should be examined for crowding. Crowding in the incisal segments is recorded as following: 0 - no crowding; 1 - one segment crowded; 2 - two segments crowded.
- (3) Spacing in the incisal segments: Both the upper and lower incisal segments should be examined for spacing. Spacing in the incisal segments is recorded as following: 0 - no spacing, 1 - one segment spaced, 2 - two segments spaced.
- (4) Diastema: A midline diastema is defined as the space, in millimetres between the two permanent maxillary incisors at the normal position of the contact points.
- (5) Largest anterior maxillary irregularity: Irregularities may be either rotation out of, or displacements from, normal alignment. The four incisors in the maxillary arch should be examined to locate the greatest irregularity.
- (6) Largest anterior mandibular irregularity: The measurement is the same as on the upper arch except that it is made on the mandibular arch.
- (7) Anterior maxillary overjet: The largest maxillary overjet is recorded to the nearest whole millimetre.
- (8) Anterior mandibular overjet: Mandibular overjet is recorded when any lower incisor is in crossbite.
- (9) Vertical anterior openbite
- (10) Antero-posterior molar relation: The right and left sides are assessed with the teeth in occlusion and only

**Table 2 Protocol for occlusal trait scoring (Daniels and Richmond, 2000)**

	Score	0	1	2	3	4	5
Aesthetic	1-10 as judged using IOTN AC						
Upper arch crowding	Score only the highest trait either spacing or crowding	Less than 2.0 mm	2.1-5.0 mm	5.1 to 9.0 mm	9.1-13.0 mm	13.1-17.0 mm	> 17.0 mm or impacted teeth
Upper spacing	Transverse relationship of cusp to cusp or worse	Up to 2.0 mm	2.1-5.0 mm	5.1-9.0 mm	>9.0 mm		
Crossbite	Transverse relationship of cusp to cusp or worse	No crossbite	Crossbite present				
Incisor open bite	Score only the highest trait either open bite or overbite	Complete bite	Less than 1 mm	1.1-2.0 mm	2.1-4.0 mm	>4.0mm	
Incisor overbite	Lower incisor coverage	Up to 1/3 tooth	1/3-2/3 coverage	1/3 up to full covered	Fully covered		
Buccal segment anteroposterior	Left and right added together	Cusp to embrasure relationship only, Class I, II, or III	Any cusp relation up to but not including cusp to cusp	Cusp to cusp relationship			





the largest deviation from the normal molar relation is recorded. The following codes are used: 0 - normal, 1 - half cusp, 2 - full cusp.

### (11) Calculation of DAI scores

The regression equation used for calculating standard DAI scores is as follows: (missing visible teeth x 6) + (crowding) + (spacing) + (diastema x 3) + (largest anterior maxillary irregularity) + (largest anterior mandibular irregularity) + (anterior maxillary overjet x 2) + (anterior mandibular overjet x 4) + (vertical anterior openbite x 4) + (antero-posterior molar relation x 3) + 13. The severity of malocclusion is classified on the basis of the DAI scores as shown in the *table 4*.

Severity of malocclusion	Treatment indication	DAI score
No abnormality or minor malocclusion	No or slight need	< 25
Definite malocclusion	Elective	26-30
Severe malocclusion	Highly desirable	31-35
Very severe or handicapping malocclusion	Mandatory	≥ 36

## Correlation among the indices

It is reported that there was a significant correlation between the various occlusal indices (AC, DHC, DAI and ICON). However, the correlation between the occlusal indices for the most part could best be described as weak-moderate except the correlation between AC and ICON<sup>3,16,17</sup>. The proportion of orthodontic treatment needs varied somewhat depending on the occlusal indices used to determine orthodontic treatment needs. Lowest estimates of orthodontic treatment were observed when AC was used to assess orthodontic treatment need<sup>17,18</sup>. This suggested that different proportion of orthodontic treatment need can be obtained depending on the occlusal indices employed. The agreement between the four indices could be described as poor to fair by calculating the Kappa value which indicated that different results can be obtained by using different indices in deciding whether a subject has an orthodontic treatment need or not<sup>19</sup>.

## Correlation between occlusal indices and OHQoL

It is reported that there was a significant but weak correlation between OHQoL and the occlusal indices<sup>17,20</sup>. Patients ascribed as having an orthodontic treatment need by occlusal indices had poorer OHQoL than those ascribed as not having an orthodontic treatment need<sup>17</sup>. Thus poor oral health related quality of life and orthodontic treatment need appear to coexist in the same population.

## Summary

This study introduced 4 occlusal indices which were commonly used to assess the malocclusion. Among them, IOTN, DAI and ICON can be used to evaluate to assess the prevalence of malocclusion and determine orthodontic treatment need while ICON and PAR can

be used to assess treatment outcome. Moreover, ICON can also be used to assess the treatment difficulty. Although the occlusal indices assess the similar traits, the correlation can be best categorised as moderate. The agreement of determining the prevalence of malocclusion needs to be further investigated. The correlation between the occlusal indices and oral health related quality of life was also weak.

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MCHK CME Programme Self-assessment Questions

Please read the article entitled "Quality of Life and Orthodontic Treatment Need Related to Occlusal Indices" by Prof. Urban Hagg, and complete the following self-assessment questions. Participants in the MCHK CME Programme will be awarded 1 CME credit under the Programme for returning completed answer sheets via fax (2865 0345) or by mail to the Federation Secretariat on or before 31 October 2007. One credit will be awarded for the Dental Council's CPD Program for Practising Dentists. Answers to questions will be provided in the next issue of The Hong Kong Medical Diary.

Questions 1-10: Please answer T (true) or F (false)

- 1. Patients' occlusion might become worsen if patients with minor malocclusion receive orthodontic treatment.
2. Index of Orthodontic Treatment Need (IOTN) can used to assess orthodontic treatment outcome.
3. Dental Health Component (DHC) have five grades, grade 1 and 2 represent need for orthodontic treatment.
4. Index of Complexity, Outcome and Need (ICON) is used to assess orthodontic treatment Outcome.
5. The method of assessing molar relationship in both DAI and ICON is same.
6. If crossbite is presented in a patient's model, this patient will be recorded at least grade 4 from dental model by assessing with DHC.
7. The PAR index is used to assess orthodontic treatment need.
8. For PAR index, a patient has a change of PAR score from 40 to 10 would have higher improvement than a patient who has a change of PAR score from 15 to 3 when percent improvement is used to assess the degree of improvement.
9. Index of ICON can be used to assess orthodontic treatment complexity.
10. If a patient has crowding of 2mm in maxillary incisal segment while lower incisal has no crowding, the crowding will be scored as 2 when assessing by PAR index.

ANSWER SHEET FOR OCTOBER 2007

Please return the completed answer sheet to the Federation Secretariat on or before 31 October 2007 for documentation. 1 CME point will be awarded for answering the MCHK CME programme (for non-specialists) self-assessment questions. One credit will be awarded for the Dental Council's CPD Program for Practising Dentists.

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Answers to September 2007 issue

Neuro-ophthalmology for General Practitioners: A Revision

- 1. C 2. D 3. A 4. E 5. C 6. B 7. A 8. D 9. E 10. E