A comparative study using the Occlusal Index and the Index of Orthodontic Treatment Need

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The objective assessment of malocclusion is important when documenting the prevalence and severity of malocclusion in population groups. Such data are essential for epidemiologists, health administrators planning the provision of orthodontic treatment, and training programs for specialists. Such data are not available for the people of Hong Kong, where fewer than 25 qualified orthodontists serve about 6 million citizens. The need for such information is urgent.

Many methods[1-19] designed for assessing malocclusion have been developed (Table I). However, a universally accepted index does not yet exist. Among the various indices, the Occlusal Index[12] has been repeatedly shown to have the least amount of bias;[20] the best correlation with clinical standards;[21,22] and the greatest validity over time;[23] nonetheless, the OI has its shortcomings.[24,25]

Recently, the Index of Orthodontic Treatment Need[19] was also shown to be satisfactorily valid and reproducible.[26]

The aims of the present study were to: 1) investigate the reproducibility of these two indices; 2) study the association, if any, between the two indices; 3) suggest the preferred index, if possible, for use in assessing the malocclusion treatment need for the people of Hong Kong. Information regarding the prevalence of malocclusion problems and orthodontic treatment need in Hong Kong was not the goal of this study. Hopefully, a larger survey can be performed in the future.

Materials and methods

Dental casts of the permanent dentition of 50 male and 50 female first year dental students in the Faculty of Dentistry, University of Hong Kong, who had never received any orthodontic treatment, were randomly selected. The casts were studied

Abstract

Assessment of malocclusion is important for documentation of the prevalence and severity of malocclusion in population groups. Such information is needed in Hong Kong where less than 25 qualified orthodontists serve a population of about 6 million citizens.

The objective of the present study was to compare the Occlusal Index (OI) and the Index of Orthodontic Treatment Need (IOTN) when used to assess orthodontic treatment needs in a local population. Only a weak association (Spearman's correlation coefficient = 0.31) was found between the two indices. The shortcomings of both indices are discussed. Neither OI nor the IOTN is perfect, but using the IOTN is less time consuming, making the study of a large population group more practical.

Key words

Orthodontic treatment need • Occlusal Index • Index of Orthodontic Treatment Need

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Table I
Summary of Methods for Recording Malocclusion

Nature of Method	Author(s) and Year of Development
Qualitative	Angle (1899)[1]
Qualitative	Stallard (1932)[2]
Qualitative	McCall (1944)[3]
Qualitative	Sclare (1945)[4]
Quantitative	Massler & Frankel (1951)[5]
Quantitative	Vankirk & Pennell (1959)[6]
Quantitative	Draker (1960)[7]
Qualitative	Fisk (1960)[8]
Quantitative	Grainger (1960-61)[9]
Quantitative	Poulton & Aaronson (1961)[10]
Qualitative	Björk, Krebs & Solow (1964)[11]
Quantitative	Summers (1966)[12]
Quantitative	Grainger (1967)[13]
Quantitative	Salzmann (1968)[14]
Qualitative	Proffit & Ackerman (1973)[15]
Grade Index Scale	Linder-Aaronson (1974)[16]
Qualitative	Brzroukou, Freer, Helrn, Kalamkarov, Sardoinfirri& Solow (1979)[17]
Qualitative	Kinaan & Burke (1981)[18]
Grade Index Scale	Brook & Shaw (1989)[19]

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Figure 1
The Occlusal Index scoring form for permanent dentition stage developed by Summers[12].

separately by both authors to determine the Occlusal Index[12] (OI) and the Index of Orthodontic Treatment Need[19] (IOTN) of each set.

The Occlusal Index[12] (OI)

The Occlusal Index includes nine measurements: dental age, molar relationship, overbite, overjet, posterior crossbite, posterior openbite, tooth displacement or rotation, midline relations, and missing maxillary permanent incisors. The OI scoring form for the permanent dentition stage is shown in Figure 1. The five different classes of malocclusion severity which can be scored by the Occlusal Index and the treatment needs for each class are described in Table II and elsewhere in the literature.[12, 22]

The Index of Orthodontic Treatment Need[19] (IOTN)

The Index of Orthodontic Treatment Need[19] was developed to assess the need for orthodontic treatment. It has two components: the dental health component involves recognition of features that may impair the health and function of the dentition, the aesthetic component assesses the attractiveness of the dentition.

The dental health component[27] has five grades. Grade 1 represents a negligible need for treatment while Grade 5 indicates an urgent or high priority for treatment (Table III). In use, 10 features or traits of malocclusion are observed: overjet, reverse overjet, overbite, openbite, crossbite, displacement of teeth, impeded eruption of teeth, defects of cleft lip and palate, Class II and Class III buccal occlusions, and hypodontia. Grades are allocated to the severity of each trait. However, only the highest scoring trait is recorded. The grade of this trait describes the treatment priority.

The 100 sets of dental casts were reassessed one week after the initial assessment, and reproducibility for each index was tested. Association between the two indices was tested using the Spearman's Correlation Test.

Results

The mean age of the subjects was 19.83 years with a standard deviation of 0.98 year. Treatment needs as assessed with the Occlusal Index[12] and the Index of Orthodontic Treatment Need[27] are listed in Tables IV and V respectively. Both indices were highly reproducible. The correlation coefficient for the first and second OI scores is 0.98, and that for the IOTN is 0.97.

To more accurately assess the association between the two indices, ranges of OI scores and treatment need, grades of the IOTN were regrouped. OI scores falling into Grades I & II were defined as "good occlusions" and "no treatment" respectively, both indicating no treatment need. Therefore, these two ranges were combined to become Grade I - II. IOTN Grades 3 and 4 suggest the treatment needs are "moderate" to "great" respectively, again these two grades were combined to become Grade 3 - 4. A four by four table of the 100 cases, presented in Table VI, shows a weak association (r = 0.31) between the two indices.

Using the OI, one researcher can score one set of dental casts in about 2 to 3 minutes. A similar assessment using the IOTN can be completed in 30 seconds to 1 minute.

Discussion

Although both indices were shown to be highly reproducible, significant discrepancies in the treatment needs as assessed by these two indices did occur. For instance, the Occlusal Index method suggested 60% of the students had either "good occlusions" or "no treatment need" (Table IV). Only 2% of students were shown by the Index of Orthodontic Treatment Need[27] to have no need for treatment (Table V). This great discrepancy may

EXAMINATION: ITEM AND SCORE

OCCLUSAL SYNDROME — I & II: A B C D E; III: F G

1. Mixed Dentition Analysis: Not Scored

	MOLAR RELATION	Normal	1 side c to c	2 sides c to c or 1 side +	1 side c to c & 1 side +	2 sides +
2.	DISTAL	0	1.5	2.2	2.9	3.7
3.	MESIAL	0	2.0	2.6	2.9	3.7

4. If the molar relation is NORMAL or DISTAL, circle I & II; if the molar relation is MESIAL, circle III. If III is circled, all item codes must be entered under III.

	OVERJET (in mm.)	<-3	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11	>+11
5.	I & II	2.2	2.0	1.8	1.4	1.0	0.5	0	0	0.5	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3
	I & II	4.0	3.5	3.0	2.5	2.1	1.7	0	0	1.1	1.9	2.6	3.4	4.1	4.8	5.6	6.5	7.4
6.	III	6.7	6.1	5.9	5.6	3.4	2.2	0	0	0								

	OVERBITE (in mm.)	<-4	-4 to -2	-2 to 0	0 to 1/3	1/3 to 2/3	2/3 to 3/3	3/3	>3/3
7.	I & II	4.5	4.0	3.6					
8.	I & II				0	1.3	2.3	3.7	5.0
9.	III				0	0.8	1.8	2.7	3.9

	CONGENITALLY MISSING INCISORS	Number	0	1	2	3 or 4
10.	I&II	Code	0	5.4	6.5	8.0

POSTERIOR CROSSBITE

Count the number of upper posterior teeth which are BUCCAL to the lower teeth

		0	1	2	3	4	5	6	7	8
11.	I & II (c to c)	0	0.7	0.8	1.0	1.1	1.2	1.3	1.4	1.5
	I & II (>c to c)	0	1.5	2.0	2.5	3.5	4.0	5.0		

Count the number of upper posterior teeth which are LINGUAL to the lower teeth

		0	1	2	3	4	5	6
12.	I & II (c to c)	0	0.7	0.8	1.0	1.1	1.4	1.6
	I & II (>c to c)	0	1.5	1.8	2.0	2.5	2.8	3.0
13.	III (c to c)	0	1.2	1.4	1.7	2.0	2.5	3.0
	III (>c to c)	0	2.2	2.4	2.7	3.0	3.5	4.0

POSTERIOR OPENBITE

There must be at least two teeth in the same quadrant which are in openbite

		unilateral	bilateral
14.	I&II	3.0	4.2

TOOTH DISPLACEMENT (Remember the tooth displacement rules)

Count the number of teeth which are:

rotated 35-45° or displaced 1.5-2 mm. _____ + rotated > 45° or displaced > 2 mm. _____ x 2 = _____ Total

	(I&II and III have the same code)	0	1	2	3	4	5	6	7	8	9	10 or more
15.	Code the total	0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	8.6	9.3	10.0

	MIDLINE DIASTEMA (in mm.) (I&II and III have the same code)	0 to 1	2	3	4 or more
16.		0	0.5	1.0	1.5

	MIDLINE DEVIATION (in mm.) (I&II and III have the same code)	0 to 2	3 to 4	5 or more
17.		0	0.5	1.5

18. TOTAL SCORE FOR THE OCCLUSAL INDEX

19. If I&II were circled, ADD the HIGHEST score (A, B, C, D, E) plus ½ of the remaining scores

20. If III was circled, ADD the HIGHEST score (F or G) plus ½ of the remaining score

Table II
Relation of Subjective Classification of Occlusion to the Occlusal Index Scores[12, 22]

Suggested range of OI scores for class	Class	Description
I 0.0 - 2.5	Good occlusions	No evidence of an occlusal disorder.
II 2.6 - 4.5	No treatment	Slight deviations in the occlusion, but no treatment indicated at this time.
III 4.6 - 7.0	Minor treatment	Minor deviations in the occlusion which could be remedied by simple treatment (i.e. space regainers or removable appliances).
IV 7.1 - 11.0	Definite treatment	Major deviations in the occlusion which could be remedied by major treatment; (i.e. treatment which would include banding of many teeth).
V 11.1 - 16.0	Worst occlusions	Major deviations in the occlusion which could be remedied by major treatment; these occlusions were highly disfiguring to the patient and would probably rank first in treatment priority.

have resulted for three reasons:

Differences in weighting missing teeth

The IOTN puts a heavy weight on missing teeth in any quadrant. When more than one tooth is missing in any quadrant, the treatment need is "very great" according to the IOTN (refer to Table III, Grade 5, group 5.5). When the absence of one tooth in any quadrant results in tilting of adjacent teeth, the treatment need is also "great" (refer to Table III, Grade 4, group 4.7). The OI, on the other hand, does not take into account missing teeth except in cases of missing upper incisors where no prosthesis is present. Also, the OI does not score mesio-distal or bucco-lingual tipping of teeth that will occur subsequent to tooth loss. Therefore, discrepancy can be expected when comparing the results of OI scores and IOTN scores. Among the 100 students studied, 14 fell into the 4.7 or 5.5 groups of the IOTN scores, indicating they had one or more teeth missing in any one quadrant. Out of these 14 cases, 10 had OI scores less than or equal to 4.5, which implied either "good occlusion" or "no treatment need".

Differences in weighting crossbites

When using the IOTN on dental casts, posterior lingual crossbites, unilateral posterior buccal crossbites and anterior crossbites—even those involving only a single tooth—are assumed to be associated with mandibular displacement. Therefore, these features are weighted heavily and fall into Grade 4, group 4.4 (see Table III), which means "great treatment need". The OI does not make a similar assumption. In the sample studied, 13 students fell into group 4.4; of these, 8 had OI scores less than or equal to 4.5, which meant either "good occlusion" or "no treatment need".

Differences in weighting and measuring tooth displacement:

According to the IOTN, tooth displacement is measured from the contact points of the displaced tooth to the contact points of the adjacent teeth. Both mesial and distal contact point displacements are measured for all displaced teeth, and the largest displacement determines the grade. In Grade 4 (group 4.4) cases, the largest contact point displacement is greater than 4 mm. Displacements greater than 2 mm but less than or equal to 4 mm fall into grade 3 (group 3.4); while those greater than 1 mm but less than or equal to 2 mm are in grade 2 (group 2.3). Under this system, the presence of even a single contact point displacement greater than 1 mm means orthodontic treatment is needed, although the need is labeled "little" (see Table III). On the other hand, only whole tooth displacement of at least 1.5 mm from normal arch alignment is scored and weighed by the OI. If the tooth is rotated, the rotation has to be at least 35° before the OI will score and weight it. In the sample studied, 37 students were in groups 4.4, 3.4 or 2.3. Among these 37 cases, 22 had OI scores less than or equal to 4.5, representing either "good occlusion" or "no treatment need".

Having discussed these three major differences between the OI and IOTN in weighting occlusal features, it seems obvious that the IOTN puts much more weight on missing teeth, crossbites and tooth displacements than does the OI. Whether this is desirable or not when measuring or grading treat-

Table III
Orthodontic Index of Treatment Need (Dental Health Component) for Use on Study Models[27]

Treatment Grade (Need)		Description
5 (very great)	5.1	Defects of cleft lip and/or palate
	5.2	Increased overjet > 9 mm.
	5.3	Reverse overjet > 3.5 mm.
	5.4	Impeded tooth eruption (except third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any other pathological cause.
	5.5	Extensive hypodontia, with restorative implications (> 1 tooth missing in any quadrant) requiring pre-restorative orthodontics.
	4.1	Increased overjet > 6 mm but ≤ 9 mm.
	4.2	Reverse overjet > 1 mm but ≤ 3.5 mm.
4 (great)	4.3	Posterior lingual crossbites, unilateral posterior buccal crossbites, and anterior crossbites.
	4.4	Severe displacement of teeth > 4 mm.
	4.5	Extreme lateral or anterior open bites > 4 mm.
	4.6	Increased and complete overbite causing notable indentations of the palatal or labial gingivae.
	4.7	Less extensive hypodontia requiring pre-restorative orthodontics or orthodontic space closure to obviate the need for a prosthesis (Not > 1 tooth missing in any quadrant).
3 (moderate)	3.1	Increased overjet > 3.5 mm but ≤ 6 mm.
	3.2	Increased and complete overbite with gingival contact but without indentations or signs of trauma.
	3.3	Lateral or anterior open bite > 2 mm but ≤ 4 mm.
	3.4	Displacement of teeth > 2 mm but ≤ 4 mm.
	2.1	Increased overbite > 3.5 mm with no gingival contact.
2 (little)	2.2	Anterior or lateral open bite > 1 mm but ≤ 2 mm.
	2.3	Displacement of teeth > 1 mm but ≤ 2 mm.
	2.4	Reverse overjet > 0 mm but ≤ 1 mm.
	2.5	Class II or Class III buccal occlusions with no other anomalies where there is deviation from full interdigitation.
	1.1	Other occlusions including displacements < 1 mm.
1 (none)		

ment needs depends on the objective of the project and the population. When an index is used as an epidemiological tool to rank malocclusion and assess treatment need for a large population, the results should help to establish priorities for treatment in accordance with budget and staffing constraints. This would be quite different from assessing the treatment needs of individual patients. Generally, at the population level, problems that are functionally handicapping are ranked first, while problems involving a single tooth or problems minimally affecting an individual's well-being are ranked last. However, on an individual level, orthodontic treatment need could be highly subjective. Even minor displacement of a single tooth could well be the cause of complaint. The IOTN heavily weights tooth displacements; this may be oversensitive, especially when the index is being used as an epidemiological tool.

The IOTN, when used on dental casts, assumes

Table IV
Treatment need of the sample according to the OI Scores[12]

O I Scores		Class	Number (n = 100)
I.	0.0 - 2.5	Good occlusions	34
II.	2.6 - 4.5	No treatment	26
III.	4.6 - 7.0	Minor treatment	15
IV.	7.1 - 11.0	Definite treatment	22
V.	11.1 - 16.0	Worst occlusions	3

Table V
Treatment need of the sample according to the IOTN[19]

Grade (treatment need)		Number (n = 100)
1	(None)	2
2	(Little)	21
3	(Moderate)	25
4	(Great)	49
5	(Very great)	3

Table VI
Four by four table of the 100 cases scored using the Occlusal Index and the Index of Orthodontic Treatment Need respectively.

IOTN Score	OI Score				Row Total
Count Row % Column %	I - II (Good occlusions No treatment)	III (Minor Treatment)	IV (Definite Treatment)	V (Worst Occlusion)	
1 (None)	2 100.0 3.3				2
2 (Little)	18 85.7 30.0	2 9.5 13.3	1 4.8 4.5		21
3 - 4 (Moderate, Great)	39 52.7 65.0	12 16.2 80.0	20 27.0 90.9	3 4.1 100	74
5 (Very great)	1 33.3 1.7	1 33.3 6.7	1 33.3 4.5		3
Column Total	60	15	22	3	100

* Spearman's Correlation Coefficient r = 0.31

that crossbites are invariably associated with mandibular displacement, which is not always true. This assumption would again tend to over-estimate the treatment need of the sample studied.

The OI does not score missing teeth when pre-restorative orthodontic treatment or orthodontic space closure is needed, except in instances of missing maxillary incisors. This would tend to understate the treatment need of the sample studied. This is especially true in the present study. In Hong Kong, the average number of missing teeth (extracted due to caries, periodontal disease, and/or for prosthetic reasons) among 676 adults between 35 and 44 years old was 2.7.[28] These 676 adults had a total of 238 maxillary first permanent molars and 528 mandibular first permanent molars missing, indicating a marked prevalence of missing teeth in the Hong Kong population. The OI, which does not record missing teeth and does not take need of pre-restorative orthodontic treatment or orthodontic space closure into consideration, would surely underestimate the orthodontic treatment need of this population.

The treatment demand of a population may also affect the interpretation of results. For a population with a high level of dental awareness, treatment demand would be more closely related to the treatment need as assessed by the dental profession. A population with a generally low level of dental awareness would have treatment demands falling far below the treatment need estimated by the dental profession. In Hong Kong, two groups of people aged 15 to 19 years and 35 to 44 years were studied; more than 75% of the people in each group would not visit a dentist for a check-up if there was no immediate problem.[28] Only 26% of the younger group, and 36% of the older group had visited a dentist in the past 12 months. In another study, about 70% of the children in a sample of Hong Kong 12-year-olds visited dentists for extractions purposes.[29] For a population with such low dental awareness, it would be very unlikely that a great demand for correction of minor orthodontic problems, such as minor to moderate tooth displacements or pre-restorative orthodontic treatment, would exist. Therefore information on treatment need measured by an index as sensitive as IOTN on such a population group has to be interpreted with great caution: the need and the realistic treatment demand of the group can be very different. The failure of the OI to take missing teeth, other than maxillary incisors, into account may not be as detrimental as it first appears. Nonetheless, the treatment needs of population groups and individuals are treatment standards which are professionally determined. These standards, although possibly affected by factors such as budgeting and the availability of providers, should be distinguished from treatment demand, which is the subjective choice of individuals who need treatment.

Conclusion

The selection of an index for measuring any condition is dependent upon two main factors.[30] First, the objective of the investigation in which the index is to be used and hence the nature of the information required; and second, the ability of the examiner to consistently reproduce the diagnosis on which the index is based. In general, the simplest index compatible with the objectives of the study should be used, as this is, on the whole, more reproducible, especially where more subjective judgements are necessary. In this study, two very different indices for assessing orthodontic treatment needs were applied to 100 sets of dental casts. Both indices were highly reproducible. Each had short-comings as discussed earlier. However, the Occlusal Index was much more time-consuming to use than the Index of Orthodontic Treatment Need. So while neither the OI nor the IOTN is ideal, the simplicity of the IOTN gives it an advantage over the OI because it enables one to study a large population group without spending a tremendous amount of time.

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