Validity of Index of Orthodontic Treatment Complexity in Assessing Complexity of Treatment among the Malocclusion Groups

Sriman Vishnu[1], Saravanakumar Subranmanian[2], Prema Anbarasu[3], Nagappan Nagappan[4], Annamalai P.R.[5], Indra Annamalai[6]

[1, 2, 3, 5, 6] Department of Orthodontics, Chettinad Dental College and Research Institute, Kelambakkam, Tamil Nadu, India. [4]Department of Public Health Dentistry, Chettinad Dental College and Research Institute, Kelambakkam, Tamil Nadu, India.

ABSTRACT

BACKGROUND

To provide efficient and well-planned orthodontic treatment orthodontists must be able to assess the type of malocclusion and the complexity involved in its treatment. Hence, the purpose of this study was to validate index of orthodontic treatment complexity (IOTC) as a reliable index to assess the treatment complexity in treating different malocclusion groups.

METHODS

A retrospective study with sample of 120 pairs of orthodontic study model consisting of treated and untreated cases, were collected and equally divided into class I, class II including both division 1 and division 2 and class III malocclusions based on Angles system of classification of malocclusion. Study casts were scored according to criteria given by the index of orthodontic treatment complexity and the degree of complexity is established for each of the malocclusion groups and the occlusal traits.

RESULTS

The Spearman correlation coefficients test shows that occlusal traits like overjet, centreline discrepancy, molar correction, overbite, crowding, posterior cross bite, alone significantly correlated with degree of complexity. Multiple regression analysis and one way ANOVA tests were performed for the three types of malocclusion and the test showed that in individual classes of malocclusion, the predictor variable (occlusal traits) significantly predicts the degree of complexity in class I and class II malocclusion cases, but not in class III.

CONCLUSIONS

Overjet, centreline discrepancy, molar correction, overbite, crowding, posterior cross bite correlated with degree of complexity. IOTC forecasts the degree of complexity in class I and class II malocclusion cases, but not in class III.

KEY WORDS

IOTC, Malocclusion, Occlusal Traits

Corresponding Author:
Dr. Prema Anbarasu,
Assistant Professor,
Department of Orthodontics, Chettinad Dental College and Research Institute, Kelambakkam, Tamil Nadu.
E-mail: prema.arasu@gmail.com

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BACKGROUND

Orthodontics is a branch in dentistry focused at diagnosing and treating the anomalies of the tooth, facial skeleton, and associated musculature.[1] Anomalies of the tooth resulting in malocclusion can ensue in disturbances in the homeostasis of the orofacial system, mastication, aesthetics which are essential for normal functioning of the stomatognathic system.[2] The principal goal in orthodontics is to provide efficient treatment and to maintain equilibrium in the orofacial musculature there by improving the aesthetics, function and psychological improvement of the patient. In order to provide efficient and well-planned orthodontic treatment orthodontists must be able to assess the type of malocclusion and the complexity involved in its treatment. The criteria for the assessment and prioritising treatment of the malocclusion for patients were difficult in the previous years. This led to problems in prioritising the treatment for the patient of immediate and utmost need. The evaluation of various characteristics of malocclusion becomes the essential component in establishing the diagnosis and treatment need of the orthodontic patient. The development of indices have paved the way for efficient assessment of treatment need, complexity and the treatment outcome involved in treating the malocclusion.[3,4,5] The index has been defined by Russell as the numerical values describing the relative status of a population on a graduated scale with definite upper and lower limits, which is designed to permit comparison with other populations classified by the same criteria and methods.[6] Orthodontic index is used as the method for orthodontists to grade and assess the malocclusion and to prioritise the treatment plan. Orthodontic index have been used extensively in certain countries in determining access to public health orthodontics or the level of third party co–payment.[7] Orthodontic index play a major role in resource allocation, for planning and promoting treatment standards, identifying prospective patients, in quality assurance and research as well for providing informed consent to the patient. Numerous indexes for assessing the complexity, treatment outcome and treatment need has been developed.

Stephens and Harradine et al. (1988) found that complex cases had greater severity and treatment need before therapy and greater residual malocclusion after treatment.[8] Daniels and Richmond et al. (2000) developed index of complexity, outcome and need (ICON) index which assess and grades the complexity, outcome and treatment need in a single index.[9] Cassinelli et al. (2003) suggested that complication in attaining physiological or standard occlusion might arise from the pre-treatment occlusion, host related factors, and treatment associated factors.[10] Liewellyn et al. (2007) introduced the index of orthodontic treatment complexity which particularly aims at assessing the complexity of orthodontic treatment considering all the dental malformations.[11] An index of orthodontic treatment complexity affirms to have various prospective uses, including recognizing experts to treat a particular case, distribution of health care resources, and to provide better information to the patient regarding the anticipated complexity of the treatment.[11] The assessment of orthodontic treatment need and complexity are necessary mainly for informed planning of orthodontic services. Therefore, the purpose of this study was to validate index of orthodontic treatment complexity as a valuable index to assess the treatment complexity in treating different malocclusion groups.

METHODS

A retrospective sample of 120 pairs of orthodontic study model consisting of treated and untreated cases, were collected from the Department of Orthodontics and Dentofacial Orthopaedics. The sample size required for the study was calculated to be N = 120 based on the studies conducted by Louwerse T.J. et al. 2007[12] and Singh N et al. 2017.[13] The duration of the study is between August 2020 to November 2021. Study casts thus collected were equally divided into class I, class II including both division 1 and division 2 and class III malocclusions based on Angles system of classification of malocclusion were included in the study. The casts were obtained in consecutive order until each malocclusion category was filled. These dental casts were part of treatment records of the department. Casts were made incognito and labelled from 1 – 40 for class I, 41 – 80 for class II and 81 – 120 for class III malocclusions.

Randomisation of the study cast was done, before they were presented to the examiners. The inclusion criteria include patients with angles class I, class II, class III malocclusion who have been undergoing orthodontic treatment in the department whose pre-treatment, study models, radiographs were perfectly maintained. The exclusion criteria include patients with missing first molars, grossly decayed and patients with fixed prosthesis.

A panel of 2 experienced orthodontists, 2 specialised orthodontic consultant and one post graduate student in his second year of orthodontic training, participated in the study. The pre-treatment study models were assessed under two categories: 1. To grade the perception of treatment complexity, 2. To score the index of treatment complexity which includes a pre-determined list of 11 occlusal factors, derived from components of the Peer Assessment Rating (PAR) index with the addition of' missing teeth', 'teeth of poor prognosis', and 'degree of spacing' as supplementary factors.

First, the two experienced orthodontists were asked to assess the pre-treatment study casts and grade their perception of orthodontic treatment complexity on a six-point scale (1 = easy to 5 = extremely complex and 6 = impossible without orthognathic surgery). The examiners were asked to assume that the outcome of the treatment was not to be compromised in any ways and that a normal overjet and overbite should be established without orthognathic surgery. They were to assume that all un-erupted teeth were to be aligned well and missing teeth are to be replaced.

Secondly, the two specialised consultant orthodontist and the post graduate student examiners were asked to provide scores to the 11 occlusal factors based on the index of treatment complexity. The 11 occlusal factors include over jet, midline discrepancy, molar correction, lateral open bite, impacted teeth, degree of spacing, overbite and anterior open bite, degree of crowding, posterior cross bite, teeth with poor prognosis, missing teeth. The examiners were asked to record their assessments on a scoring sheet containing patient information including age, gender etc. Index of treatment complexity uses PAR index for grading the occlusal factors except crowding graded according to ICON index and occlusal

factors like teeth with poor prognosis, impacted teeth and missing teeth either in one or both the jaws were given score one.

Both the perception of treatment complexity and the grades or the scores of all the occlusal traits for each malocclusion were compared and given for statistical analysis.

Scoring Sheet

(Index - IOTC by Liewellyn et al. (2007))

- Case Number - Examiner: (please give your name)
- Patient's age - Patient's gender.
- Missing teeth.
- Un-erupted teeth.
- Teeth of poor prognosis.

Part 1

Using the scale given below, please state how complex you believe the orthodontic treatment of this malocclusion would be. Assume that the treatment outcome is not to be a compromise and that you are to achieve normal overjet and overbite, without orthognathic surgery. Assume that all un-erupted canines are to be aligned. The ranking of 'impossible' should only be given to the case if you feel that it is untreatable without orthognathic surgery.

Please circle the appropriate number.

- 1 2 3 4 5 6
- Easy Extremely Complex Impossible

Part 2

From the table below please list the numbers correlating to the three factors, which have led to your decision as to the complexity of the orthodontic treatment of this case.

Please list in order of decreasing importance.

1. Over jet / reverse over jet
2. Centreline discrepancy
3. Molar correction
4. Lateral open bite
5. Impacted teeth
6. Degree of spacing
7. Overbite / anterior open bite
8. Degree of crowding
9. Posterior cross bite
10. Teeth of poor prognosis
11. Missing teeth.
    - Factor 1 (most important) _____
    - Factor 2 _____
    - Factor 3 (least important) _____

Statistical Analysis

Multiple regression analysis and ANOVA test was used to study the relationship between the perceptions of treatment complexity grade (dependent variable) and the occlusal factors (independent variables). Spearman's ranked correlation coefficients were used to study Bi-variety correlations to check the correlation between predictors (occlusal factors) and degree of complexity (outcome variable). Finally, regression analysis for each class of malocclusion was assessed separately to predict significance of degree of complexity in each group of malocclusions.

RESULTS

Spearman's ranked correlation coefficient test was done to study the correlation between predictors comprising of the 11 occlusal factors and degree of complexity which is considered to be the outcome variable (Table 1). The Spearman correlation coefficients test shows that the following occlusal traits like overjet, centreline discrepancy, molar correction, overbite, crowding, posterior cross bite, alone significantly correlated with degree of complexity. Thereby multiple regression analysis will be performed with these variables alone to predict the degree of complexity according to the occlusal traits.

Variable	Spearman's Correlation Coefficient	P-Value
Overjet / reverse overjet	0.276	0.002
Centreline discrepancy	0.260	0.004
Molar correction	0.312	0.001
Lateral open bite	0.002	0.98
Impacted teeth	0.144	0.117
Degree of spacing	- 0.125	0.17
Overbite / anterior open bite	0.425	0.001
Degree of crowding	0.354	0.001
Posterior crossbite	0.195	0.034
Teeth of poor prognosis	0.158	0.082
Missing teeth	0.083	0.37

Table 1. Bivariate Correlations to Check the Correlation between Predictors (Occlusal Factors) and Degree of Complexity (Outcome Variable)

Multiple linear regression analysis for the whole sample, including ANOVA was done (Table 2). The regression analysis explained 0.445 of the variances in complexity for the sample (R2) and the adjusted R2 was 0.338. The one-way ANOVA test done shows that the prediction model including all samples in the test were significant. Further regression analysis for each class of malocclusion was assessed separately which is used to predict the significance of the degree of complexity in each group of malocclusions as shown in (Table 3).

Predictor Variable	Unstandardized Coefficients B	Std. Error	T-Value	P-Value
(Constant)	1.845	.224	8.250	.000
Overjet	.034	.070	.491	.624
Centreline discrepancy	.057	.125	.459	.647
Molar correction	.313	.101	3.085	.003
Lateral open bite	.150	.291	.513	.609
Impacted teeth	- .049	.273	- .181	.857
Degree of spacing	.094	.083	1.130	.261
Overbite	.389	.100	3.889	.000
Degree of crowding	.166	.041	4.024	.000
Posterior crossbite	.133	.041	3.232	.002
Teeth of poor prognosis	.643	.267	2.406	.018
Missing teeth	.225	.247	.909	.365
	$R^2 = 0.445$	Adjusted $R^2 = 0.338$		
One-way ANOVA				
Source	SS	Df	Mean Square	F	P-Value
Regression	68.676	11	6.243		
Residual	85.543	107	0.799	7.089	0.001
Total	**154.218**	**118**			

Table 2. Multiple Linear Regression for the Whole Sample, Including ANOVA

The test showed that in individual classes of malocclusion, the predictor variable (occlusal traits) significantly predict the degree of complexity in class I and class II malocclusion cases, but not in class III.

Predictor Variable	Class I	Class II	Class III
(Constant)	2.142	1.784	1.717
Overjet	- .248	.324	- .011
Centreline discrepancy	- .058	.558	- .110
Molar correction	.180	.105	.468
Lateral open bite	.434	.077	- .390
Impacted teeth	.029	- .019	- .417
Degree of spacing	- .005	.127	.183
Overbite	.385	- .018	.620
Degree of crowding	.181	.139	.111
Posterior crossbite	.336	.150	.112
Teeth of poor prognosis	.593	.738	.732
Missing teeth	.746	.109	- .043
Adjusted R^2 (%)	63.9 %	52.1 %	36.1
P-value	0.001	0.010	0.21

Table 3. Regression Analysis Based on Individual Malocclusion Classes

DISCUSSION

There is no study done earlier to validate IOTC index. Although numerous studies were done to validate PAR, ICON, and Index of Orthodontic Treatment Need (IOTN). IOTC is the index which is considered to specifically measure the treatment complexity in particular. Hence, this study was undertaken which intends to validate the use of index of orthodontic treatment complexity as a proven index in grading the treatment complexity for three different types of malocclusions to be used as an aid for informed planning of orthodontic services. Hence, the collected sample were equally divided into three groups namely class I, class II and class III malocclusion groups as per Angle's system of classification of malocclusion. In the initial years' orthodontists found it difficult to prioritise the need of treatment for different types of malocclusion. By numerically grading the complexity involved in treating the malocclusion, orthodontists found it easier to devise specific treatment to different types of malocclusion thereby making the approach, treatment planning and duration easier and short.

Although numerous orthodontic indices were developed to grade the malocclusion, only very few were reliable in quantifying the malocclusion. The index of orthodontic complexity outcome and need was developed much earlier, it had its drawbacks as it was concerned with aesthetic components and it had bias between different examiners.[14] IOTC is similar to PAR index which quantifies each component of malocclusion unlike ICON. It considers all 11 commonly occurring occlusal discrepancies (over jet, midline discrepancy, molar correction, lateral open bite, impacted teeth, degree of spacing, overbite and anterior open bite, degree of crowding, posterior cross bite, teeth with poor prognosis, missing teeth) into consideration and provides individual grades scores to each one of them.[15,16]

The coefficient of determination (R^2) gives an indication of how well the variance within the sample is explained by the regression analysis. Petrie et al. (2002) suggested that R^2 value should be at 50 to 60 percent for the index to be reliable.[17] In the present study each study model is assessed for the index of treatment complexity based on the 11 occlusal traits mentioned. Among the 11 occlusal traits only the following occlusal traits namely overjet, centreline discrepancy, molar correction, overbite, crowding, posterior cross bite, alone significantly correlated with degree of complexity. The other occlusal trait like the lateral open bite, impacted teeth, teeth with poor prognosis, degree of spacing and missing teeth were not significantly correlated with the degree of complexity. The reason may be presence of an impacted tooth or teeth in either or both the upper and lower jaws was allocated a grade of 1, a lesser weight age value when compared to complexity in treatment of individual impacted teeth (for example a patient with multiple impacted teeth is scored 1 according to IOTC but the degree of complexity varies with the nature of impaction which may be either favourable or unfavourable).

The same reason holds good for other factors like the missing teeth and teeth with poor prognosis. These occlusal traits have been given a score 1 irrespective of the mode of treatment. There are numerous concerns to be verified before grading the degree of spacing like the retained deciduous teeth, need for prosthesis, spacing due to teeth lost to trauma and exodontia etc. This could be the possible reason for the result obtained in this study.

According to the result of the present study the regression analysis shows that the occlusal traits significantly predict the degree of complexity in class I and class II malocclusion cases, but not in class III. While assessing the coefficient of determination of complexity (R^2) the values were high for class I and class II malocclusions (63.9 and 52.1 per cent, respectively), but low for class III (R^2 = 36.1 per cent).

In class III malocclusion the perceived complexity is usually greater than the weightage given for the occlusal traits determining the class III malocclusion. In Class I and class II malocclusion the perceived complexity score increases proportional to the weightage given for the occlusal traits which determines the malocclusion. Hence, class I and class II malocclusion show a significant correlation in validating the degree of complexity. Thus, according to this study IOTC is considered to be a reliable index in grading the treatment complexity for class II and class I malocclusions. Hence, IOTC is regarded as an unswerving index for informed planning of treatment in Angles class I and class II malocclusion.

CONCLUSIONS

1. There is a reliable correlation between overjet, centreline discrepancy, molar correction, overbite, crowding, posterior cross bite correlated with degree of complexity.
2. IOTC prognosticates the degree of complexity in class I and class II malocclusion cases, but not in class III.
3. Hence, IOTC can be considered to be a reliable index for assessing the treatment complexity in class I and class II malocclusion.

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