

Discrepancy index, treatment complexity index and objective Grading system: correlation between parameters, indices and implications for treatment

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Objectives: An assessment of orthodontic treatment duration and results allows for measurable outcomes, goal-setting, and the establishment of patient management standards. It is important information that can be utilised for educational purposes in an orthodontic postgraduate program. The aim of this study was to determine correlations of the parameters within and between the Objective Grading System (OGS), Discrepancy Index (DI) and Treatment Complexity Index (TCI) and identify those factors associated with treatment outcomes and duration.

Materials and methods: This retrospective cohort study involved a consecutive sampling of 242 pre- and post-treatment patient records from the postgraduate orthodontic clinic between 2013 and 2017. The cases were assessed using the DI, OGS, and TCI pre-treatment. Treatment outcomes were assessed using the OGS. Spearman's Rank Correlation Coefficients were computed within and between the indices. Multiple and logistic regressions were used to evaluate associations between treatment outcomes and duration, respectively.

Results: Within DI, significant correlations ($p < 0.05$) were observed between overjet-overbite, overjet-occlusal relationship, overjet-crowding, overbite-anterior open bite, overbite-crowding, anterior open bite-lateral open bite, anterior open bite-crowding, lingual posterior cross bite-crowding. Within pre-OGS, significant correlations ($p < 0.05$) were observed between alignment-marginal ridge, alignment-occlusal relationship, alignment-root angulation, overjet-interproximal contact, marginal ridge-buccolingual inclination, marginal ridge-overjet, marginal ridge-occlusal contact, marginal ridge-occlusal relationship, overjet-occlusal contact, overjet-occlusal relationship, overjet-root angulation, occlusal relationship-root angulation, interproximal contact-root angulation. Within TCI, functional appliance correlated with orthognathic surgery ($p < 0.001$), rapid palatal expansion (RPE) ($p = 0.005$) and multidisciplinary collaboration ($p = 0.001$). Pre-OGS correlated with DI ($p < 0.001$) and TCI ($p = 0.026$). Cephalometric ($p = 0.002$) and other conditions ($p = 0.031$) were associated with treatment outcomes. RPE was associated with extended treatment duration ($p = 0.014$).

Conclusions: DI, OGS, and TCI exhibited weak correlations within and between indices. Cephalometric values, clinical conditions, and RPE use should be carefully considered during treatment planning. (Aust Orthod J 2024; 40: 9 - 18. DOI: 10.2478/aoj-2024-0016)

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Introduction

Malocclusion manifests uniquely in individuals and displays considerable variation in the severity of tooth displacement and biomechanical constraints. The variation in complexity has implications for the type, duration and corrective potential of treatment.^{1,2} Consequently, outcome studies that consider case complexity play a pivotal role in guiding treatment decisions.

Several indices have been devised to assess the complexity of orthodontic treatment. Developed in the United Kingdom and by using dental casts, the Peer Assessment Rating (PAR) gauges malocclusion severity through deviations from normal occlusion.³ Components such as aesthetics were subsequently added to PAR to create the Index of Outcome, Complexity and Need (ICON).⁴

Parallel to this development, the American Board of Orthodontists (ABO) Objective Grading System (OGS) provides a comprehensive assessment of dental casts and panoramic radiographs to mitigate subjectivity in malocclusion diagnosis and treatment planning.⁵ Specifically, it aimed to offer greater precision than PAR in discerning the minor deficiencies in tooth position.⁵ The ABO also introduced an assessment of cephalometric values using the Discrepancy Index (DI).⁶ Later, the Treatment Complexity Index was proposed to evaluate case complexity based on treatment modalities.⁷

While these systematic assessment tools aim to facilitate treatment planning and decision-making, their increasing complexity compromises ease of use, and potentially deters clinicians from their adoption. In addition, validating detailed indices presents challenges due to the need to assess each component individually and determine their collective impact on overall treatment outcomes. Achieving a balance

between comprehensiveness and simplicity is essential, and eliminating redundancy within and between indices through correlation tests helps refine their predictive power. Nevertheless, validating the predictive ability of orthodontic indices remains challenging due to the requisite follow-up needed for comprehensive assessment.

Hence, the present study aimed to address this gap by determining correlations between variables in DI, OGS, and TCI, as well as identifying variables associated with treatment outcome and duration. The study sought to enhance the practicality and predictive accuracy of comprehensive orthodontic indices to improve treatment planning and decision-making for better patient outcomes.

Materials and methods

Study population and design

This retrospective cohort study was approved by the Ethical Committee, Universiti Kebangsaan Malaysia (JEP-2021-318). The study population consisted of patients receiving orthodontic treatment at the Postgraduate Orthodontic Clinic, University Kebangsaan Malaysia, from 2013 to 2017. The sample size was computed in G*Power 3.1.9.7 using the Wald test.⁸ The intention was to detect an odds ratio of 1.5 for treatment duration exceeding two years with 80% power and a significance level of 5%. This yielded a minimal sample size of 242.

Consecutive sampling was performed using the following inclusion criteria: (1) patient ages between 13 and 45 years old at the start of treatment; (2) clinically treated by orthodontic postgraduate students under the guidance of a supervisor (orthodontist); (3) managed using fixed pre-adjusted

edgewise appliances and; (4) the presence of a completed series of pre- and post-treatment records which were comprised of clinical notes, dental casts, panoramic and lateral cephalometric radiographs.

Instruments and data collection

Pre- and post-treatment records of the patients were compiled. Measurements were taken by examiners (NNY and NSR) who had undergone training and calibration processes.

The DI measures the pre-treatment (T0) cast for intra- and inter-arch variables: overjet, overbite, anterior openbite, lateral openbite, crowding, molar occlusion, lingual posterior crossbite and buccal posterior crossbite. The compiled cephalometric measurements were the ANB angle, SN-MP angle, and lower incisor to the mandibular plane (IMPA) angle. An additional category of 'other' included items that permitted scoring of further conditions that might affect or add to treatment complexity, which were supernumerary teeth, ankylosis, anomalous morphology of tooth size and shape, impaction (except third molars), missing teeth, a midline discrepancy, spacing, tooth transposition, skeletal asymmetry, and additional treatment complexities.

Measurements for the OGS score were performed on the pre-treatment (Pre-OGS) and post-treatment (Post-OGS) for the seven components, except for root angulations, which were scored from a panoramic radiograph. The components were alignment/rotations, marginal ridge heights, buccolingual inclination, overjet, occlusal contacts, occlusal relationships, and interproximal contacts. All linear measurements were performed using the same specific ABO gauge. The treatment outcome was defined as the Post-OGS score.

The TCI scores the treatment modality according to the complexity and the need for adjunctive procedures like extractions or orthognathic surgery.⁷ The information regarding the applied treatment modality was gathered from the patient's notes. However, several modifications were made to the TCI. The fixed functional appliance (FFA) scoring was changed to the removable functional appliance (RFA). The osseointegrated implant anchorage item was changed to a temporary anchorage device (TAD) for miniscrew application. This was changed as neither FFA nor osseointegrated implant anchorage were employed in patients. The duration of treatment was calculated from the start of active

treatment to debonding, and was dichotomised at the 2-year timepoint.

Measurements were scored three times and then averaged. The examiners' (NNY and NSR) reliability and agreement were calibrated with 24 (10%) of the randomly selected patient's records. An excellent agreement between the intra- and inter-examiners was demonstrated by the intraclass correlation coefficients (ICC) for DI, TCI, and ABO-OGS, which were between 0.82 and 0.94.

Statistical analysis

Data were analysed using SPSS version 26 (IBM Corp, Armonk, NY, USA). A value of $p < 0.05$ was considered statistically significant. The normality test and the Shapiro–Wilk test for the DI, TCI, and ABO-OGS indicated all variables were not normality distributed ($p < 0.001$). Therefore, Spearman's Rank Correlation Coefficients (Spearman's rho or ρ) were performed for the inferential statistics between the items in DI, TCI and ABO-OGS. The correlation between total DI, Pre-OGS and TCI scores was examined prior to the regression analyses. Multiple regression assessed the association between the indices and treatment outcome. Logistic regression was modelled to assess the association between the indices and treatment duration exceeding two years.

Results

Patient demographics

Records of 977 patients who received orthodontic treatment from the postgraduate students between 2013 and 2017 were screened for eligibility. Records were excluded due to the patient's age ($n = 83$), inadequate records either at T0 or T1 ($n = 225$), prematurely terminated treatment ($n = 57$) and ongoing treatment ($n = 370$). A total of 242 of patients records were subsequently included in the study. Approximately 165 (68.2%) were females, and 77 (31.8%) were males with an average age of 19.9 ± 5.4 years old at T0. The average treatment duration was 2.66 ± 0.78 years.

Correlation of the items within the indices

Table I shows the correlation (ρ) of the DI items. The overjet was positively correlated with overbite

Table I. Correlation (ρ) of Discrepancy Index Items

Items		OJ	OB	AOB	LOB	Cr	OcR	LgPCB	BcPCB	Ceph
OB	CC	0.533								
	P value	<0.001**								
AOB	CC	-0.042	-0.307							
	P value	0.521	<0.001**							
LOB	CC	-0.072	-0.073	0.177						
	P value	0.267	0.261	0.006**						
Cr	CC	-0.156	-0.140	0.181	0.03					
	P value	0.015*	0.030*	0.005**	0.645					
OcR	CC	0.127	-0.053	-0.12	0.082	-0.025				
	P value	0.049*	0.412	0.062	0.204	0.699				
LgPCB	CC	-0.008	-0.11	0.064	0.081	0.206	0.077			
	P value	0.904	0.090	0.322	0.214	0.001**	0.234			
BcPCB	CC	-0.113	-0.112	0.057	0.042	0.077	0.079	0.053		
	P value	0.080	0.083	0.382	0.514	0.238	0.223	0.412		
Ceph	CC	0.077	0.094	0.087	0.019	-0.079	-0.098	0.011	-0.08	
	P value	0.232	0.145	0.180	0.767	0.220	0.130	0.866	0.216	
Ot	CC	-0.055	-0.026	-0.091	0.065	-0.105	0.054	0.048	0.076	-0.041
	P value	0.398	0.686	0.161	0.312	0.105	0.402	0.458	0.238	0.526

** $p < 0.01$ level (2-tailed); * $p < 0.05$ level (2-tailed).

AOB, Anterior open bite; BcPCB, Buccal posterior crossbite; CC, Correlation coefficient; Ceph, Cephalometrics; Cr, Crowding; LgPCB, Lingual posterior crossbite; OcR Occlusal relationship; Ot, Others; OB, Overbite; OJ, Overjet; OcR Occlusal relationship.

($\rho = 0.533$, $p < 0.001$) and occlusal relationship ($\rho = 0.127$, $p = 0.049$). In addition, the overjet was negatively correlated with crowding ($\rho = -0.156$, $p = 0.015$). Overbite was negatively correlated with an anterior openbite ($\rho = -0.307$, $p < 0.001$) and crowding ($\rho = -0.140$, $p = 0.030$). The anterior open bite was positively correlated with a lateral open bite ($\rho = 0.177$, $p = 0.006$) and crowding ($\rho = 0.181$, $p = 0.005$). A lingual posterior crossbite was positively correlated with crowding ($\rho = 0.206$, $p = 0.001$).

Table II shows the correlation between parameters within the Pre-OGS. Tooth alignment was positively correlated with the marginal ridges ($\rho = 0.269$, $p < 0.001$), occlusal relationship ($\rho = 0.148$, $p < 0.05$) and root angulation ($\rho = 0.340$, $p < 0.001$). However, overjet was negatively correlated with the interproximal contact ($\rho = -0.301$, $p = 0.005$). Marginal ridge height was positively correlated with buccolingual tooth inclination ($\rho = 0.241$, $p < 0.001$), overjet ($\rho = 0.203$,

$p = 0.002$), occlusal contact ($\rho = 0.153$, $p = 0.018$) and occlusal relationship ($\rho = 0.241$, $p < 0.001$). The overjet was found to be positively correlated with the occlusal contact ($\rho = 0.182$, $p = 0.005$), occlusal relationship ($\rho = 0.271$, $p < 0.001$) and root angulation ($\rho = 0.158$, $p = 0.014$). The occlusal relationship was positively correlated with the root angulation ($\rho = 0.174$, $p = 0.007$). Interproximal contact was negatively correlated with the root angulation ($\rho = -0.184$, $p = 0.004$).

Table III shows the correlation between items within the TCI. The functional appliance was positively correlated with orthognathic surgery ($\rho = 0.270$, $p < 0.001$), rapid palatal expansion ($\rho = 0.180$, $p = 0.005$) and multidisciplinary collaboration ($\rho = 0.221$, $p = 0.001$). In addition, multidisciplinary collaboration was positively correlated with the extraction of four premolars and delayed extraction ($\rho = 0.249$, $p < 0.001$).

Table II. Correlation (ρ) of Pre-OGS Items

Items		Align	MargRid	BclGInc	Ojet	OcCont	OcRel	IPCont
MargRid	CC	0.269						
	P value	<0.001**						
BclGInc	CC	0.071	0.241					
	P value	0.274	<0.001**					
Ojet	CC	0.039	0.203	0.051				
	P value	0.546	0.002**	0.432				
OcCont	CC	0.057	0.153	0.113	0.182			
	P value	0.380	0.018*	0.081	0.005**			
OcRel	CC	0.148	0.241	0.105	0.271	0.139		
	P value	0.022*	<0.001**	0.104	<0.001**	0.032*		
IPCont	CC	-0.301	0.085	0.000	0.077	0.087	-0.061	
	P value	<0.001**	0.189	0.995	0.234	0.180	0.345	
RtAng	CC	0.347	0.083	0.119	0.158	0.119	0.174	-0.184
	P value	<0.001**	0.198	0.066	0.014*	0.067	0.007**	0.004**

** $p < 0.01$ level (2-tailed); * $p < 0.05$ level (2-tailed).

Align, Alignment; BclGInc, Buccal lingual inclination; CC, Correlation coefficient; IPCont, Interproximal contact; MargRid, Marginal ridge; OcCont, Occlusal contact; OcRel, Occlusal relationship; OJ, Overjet; RtAng, Root angulation.

Table III. Correlation (ρ) of Treatment Complexity Index Items

Items		Hg	RFA	4QE	SurgE	OSurg	RPE	OIA
RFA	CC	-0.033						
	P value	0.610						
4QE	CC	0.055	-0.097					
	P value	0.396	0.133					
SurgE	CC	-0.012	-0.039	0.027				
	P value	0.853	0.543	0.682				
OS	CC	-0.011	0.270	-0.087	-0.032			
	P value	0.863	0.000**	0.179	0.620			
RPE	CC	-0.024	0.180	0.084	-0.07	-0.066		
	P value	0.706	0.005**	0.197	0.279	0.312		
OIA	CC	-0.007	0.033	-0.046	-0.021	-0.019	-0.043	
	P value	0.911	0.606	0.478	0.747	0.764	0.512	
M	CC	-0.032	0.221	0.249	0.028	0.128*	-0.074	-0.038
	P value	0.618	0.001**	0.000**	0.699	0.047	0.257	0.563

** $p < 0.01$ level (2-tailed); * $p < 0.05$ level (2-tailed).

4QE, Four quadrant extraction; CC, Correlation coefficient; Hg, Headgear; M, Multidisciplinary; OSurg, Orthognathic surgery; RFA, Removable functional appliance; RPE, Rapid palatal expansion; SurgE, Surgical exposure; TADs, Temporary anchorage device.

Table IV. Correlation (ρ) for DI, TCI and PreOGS total score

Index		DI	TCI
TCI	CC	0.008	
	P value	0.905	
PreOGS	CC	0.397	0.144
	P value	<0.001 **	0.026*

** $p < 0.01$ level (2-tailed); * $p < 0.05$ level (2-tailed).

CC, Correlation coefficient; DI, Discrepancy index; Pre-OGS; Pre objective grading system; TCI; treatment complexity index.

Correlation between the indices

Table IV shows that the Pre-OGS was positively correlated with DI ($\rho = 0.397$, $p < 0.001$) and TCI ($\rho = 0.144$, $p = 0.026$). Due to the existence of this correlation, OGS was excluded from the regression models.

Association between the items in DI and TCI on the treatment outcome (Post-OGS)

The DI total score was generally associated with post-treatment OGS ($p < 0.001$). In contrast, the TCI total score was not associated with post-treatment OGS ($p = 0.051$). It can be summarised in the following equation: Post-OGS = $14.46 + 0.415$ (DI total score). However, the model only explained 9% (adjusted R²) of the variance in post-treatment OGS.

After adjusting for all the items in DI, cephalometric was a statistically significant predictor of post-treatment OGS ($p = 0.002$) (Table V). Other conditions which may complicate treatment were also statistically significant ($p = 0.031$). Collinearity diagnostics dismissed the multi-collinearity issue despite including all the variables in DI (tolerance > 0.25 , variance inflation factor < 4).

Association between the items in DI and TCI on the likelihood of treatment duration exceeding two years

In general, the TCI total score was associated with treatment duration exceeding two years ($p = 0.015$). In contrast, the DI total score was not associated with treatment duration exceeding two years ($p = 0.197$). The logistic regression was statistically significant, $\chi^2(2) = 7.943$, $p = 0.019$. However, the model only

explained 4.3% (Nagelkerke R²) of the variance in treatment duration. Using the model, 57.9% of the cases could be correctly classified. With every TCI score increase, there were 1.307 (95% CI = 1.053–1.622) increased odds of treatment duration exceeding two years.

When each of the items of the TCI is modelled, rapid palatal expansion was the only statistically significant predictor of treatment duration exceeding two years ($p = 0.014$). With rapid palatal expansion, there were 3.127 (95% CI = 1.256–7.785) odds of treatment duration exceeding two years. The detailed model explained 8.4% (Nagelkerke R²) of the variance in treatment duration. Using the model, 57.5% of cases could be correctly classified. Collinearity diagnostics dismissed the multi-collinearity issue despite including all the variables in TCI (tolerance > 0.25 , variance inflation factor < 4).

Discussion

The present study employed the use of correlation to identify the presence and strength of relationships between treatment index items. Correlation is a useful tool for making predictions, as a score on one item can accurately predict another highly related item. When variables exhibit stronger relationships, predictions become more accurate.

A correlation between several parameters within the DI was observed (Table I). A significant correlation was noted between the horizontal (overjet) and vertical (overbite) dimensions, which have always played a major role in occlusal relationships. Past studies have shown that there is a significant correlation between overjet and overbite.^{9,10} Increased overjet was found to be associated with narrow and tapered arches, which was again related to a Class II malocclusion.¹¹

In the present study, a reduction in crowding was correlated with an increase in overjet and overbite. This contradicts previous studies that reported significantly greater overjet and overbite measurements within a crowded group.^{11,12} These contradictory findings can be partially explained by the varying subtypes of crowding observed in different populations. Interestingly, irregularly crowded lower anterior teeth or those exhibiting tooth rotation are associated with a larger overjet and overbite, attributed to functional factors such as occlusal force. Conversely, symmetrically

Table V. Association Between The Items in DI and The Treatment Outcome (Post-OGS)

Items	Unstandardized Coefficients		Standardized Coefficients		P value
	Beta	Standard Error	Beta	t	
Constant	15.454	3.950		3.913	<0.001 **
OJ	0.816	0.601	0.106	1.358	0.176
OB	0.110	0.530	0.017	0.209	0.835
AOB	0.189	0.520	0.025	0.363	0.717
LOB	0.504	0.441	0.073	1.142	0.255
Cr	0.634	0.330	0.131	1.922	0.056
OcR	0.412	0.363	0.074	1.134	0.258
LgPCB	-0.661	1.127	-0.039	-0.587	0.558
BcPCB	1.569	1.298	0.078	1.209	0.228
Ceph	0.456	0.145	0.205	3.142	0.002 **
Ot	0.378	0.174	0.141	2.175	0.031 *

** $p < 0.01$ level (2-tailed),); * $p < 0.05$ level (2-tailed).

AOB, Anterior open bite; BcPCB, Buccal posterior crossbite; Ceph, Cephalometrics; Cr, Crowding; OcR Occlusal relationship; LgPCB, Lingual posterior crossbite; OB, Overbite; OJ, Overjet; Ot, Others.

crowded lower anterior teeth are not associated with a larger overjet and overbite but are linked to an arch discrepancy, delayed eruption, and insufficient eruption space.¹³

Overbite, by definition, is the presence of a vertical overlap between the upper and lower anterior teeth. Hence, there was a negative correlation between the two parameters in DI. Similarly, an anterior open bite was positively correlated with a lateral open bite because both conditions, although they can occur independently, are likely to co-exist when the premolars are mesially angulated but the molars are distally angulated.¹⁴ An anterior open bite may manifest with crowding, especially in cases in which individuals have smaller jaws and more vertically oriented facial structures.¹⁵ A positive correlation was observed between a lingual posterior crossbite and crowding, possibly due to transverse dentoalveolar asymmetry rather than skeletal asymmetry, as a main influencing factor.¹⁶

Interrelations between several parameters within the OGS were also observed (Table II). The correct vertical position of a tooth is critical for proper overall alignment, which correlates with the marginal ridges, occlusal relationship and root angulation. If there is a lack of interproximal contact between tooth surfaces, a negative affect on the alignment of the

teeth is possible. However, a lack of contact does not significantly affect the periodontal characteristics.¹⁷ In addition, the marginal ridges were shown to have a correlation with tooth buccolingual inclination and occlusal relationship. If the marginal ridges were at the same relative height, the cemento-enamel junctions should theoretically be located at the same level. This should result in a homogenous bone level between adjacent teeth and adequate occlusal contact, affecting the overjet and occlusal relationship of the arches.⁵ The occlusal contacts of the marginal ridges would need settling of the occlusion post-treatment.

Overjet is a parameter utilised to evaluate the intermaxillary sagittal relationship of the arches, which affects occlusal contact and relationships. An overjet has been suggested as a predictor of the sagittal relationship in subjects presenting with a Class II division 1 malocclusion.¹⁸ Root angulation was found to be associated with alignment, overjet, occlusal contact, and interproximal contact. This result is logical since an increase in root angulation is equivalent to a change in proclination, arch width and crowding.¹⁹ In the present study, root angulation was determined using a panoramic radiograph, which has known limitations related to the mesiodistal angulations of the maxillary and mandibular teeth compared to cone-beam computed tomography (CBCT).²⁰ It was suggested that combining

the radiographic data with a thorough intraoral evaluation may lead to better clinical decisions.²¹

The present study modified the item for the FFA of TCI with RFA as none of the patients had been treated with a FFA. Although FFA has been shown to have a greater effect than a RFA, both groups demonstrated statistically significant improvement in anteroposterior maxillomandibular measurement in relation to the skeletal and dental changes.^{22–24} The current study exhibited a positive correlation between RFA and orthognathic surgery, rapid palatal expansion (RPE) and multidisciplinary treatment (Table III). These treatments commonly correct skeletal transverse, sagittal, and vertical plane discrepancies. An interdisciplinary approach between oral maxillofacial, restorative, prosthodontic, and periodontal specialists is often necessary when treating adult patients.^{25–30} Orthodontic treatment is becoming more common for patients presenting with periodontal issues, whether or not they require tooth extraction. A multidisciplinary approach is necessary to ensure optimal patient hygiene care conditions and effective rehabilitation.

The substantial overlap of the overjet and occlusal relationship items in DI and OGS resulted in a correlation between these indices (Table IV), corroborating findings from a previous study.¹ The comprehensive OGS assessment influences treatment decisions which explains the OGS-TCI correlation. Applying regression analyses of the three indices would result in redundancy. Hence, pre-treatment OGS was excluded. Notably, treatment outcomes were associated with DI, whereas treatment duration was associated with TCI.

Cephalometric was a statistically significant predictor of post-treatment OGS (Table V). Studies have demonstrated that skeletal factors can contribute to a malocclusion and affect the treatment outcome.^{31–33} Diagnostic decision-making can benefit from cephalometric variables, which provide useful information to predict the occlusal result. The skeletal pattern is usually camouflaged by treatment. This results in masking the dentoalveolar component by adjusting root angulation of the incisors, affecting overjet, overbite and alignment of the occlusion. The additional 'Others' category in DI is important to account for anomalies, pathologies, and conditions that have a clinical impact on treatment outcomes,

Table VI. Association between the items in TCI and the treatment duration exceeding two years

Items	Beta	Standard Error	Wald	P value
Hg	21.249	40192.970	0.000	1.000
RFA	0.509	0.338	2.270	0.132
4QE	0.285	0.250	1.300	0.254
SurgE	0.204	0.499	0.167	0.683
OSurg	0.831	0.768	1.172	0.279
RPE	1.140	0.465	6.003	0.014*
TADs	0.786	1.254	0.393	0.531
M	-0.077	0.228	0.113	0.737
Constant	-0.255	0.307	0.688	0.407

* $p < 0.05$ level (2-tailed).

4QE, Four quadrant extraction; Hg, Headgear; M, Multidisciplinary; OSurg, Orthognathic surgery; RFA, Removable functional appliance; RPE, Rapid palatal expansion; SurgE, Surgical exposure; TADs, Temporary anchorage device.

as supported by the statistical findings of the present study.

Rapid palatal expansion was the only statistically significant predictor of treatment duration exceeding two years (Table VI). The RPE treatment is usually required for two to three weeks, followed by three months of retention to ensure separated sutures can fill with bone.³⁴ There will be a treatment delay before fixed appliance therapy, but it is unknown if this explains the increase in treatment duration and further investigations are indicated in this regard.

Overall, the present study found multiple correlations between the items. The correlations may be related to the population under investigation, the sample size, the methods of measurement, and the examiner's reliability. Although the correlation coefficients may not be clinically significant, any of the dentofacial characteristics may be associated with treatment outcomes, whether alone or combined with other factors. Variations in treatment outcomes and duration may be influenced by study quality, including the diverse expertise of orthodontic postgraduate students and the supervisors involved. This current study included patients presenting with various types of malocclusion, treated under a

range of extraction and non-extraction protocols, provided they met a minimum Index of Orthodontic Treatment Need (IOTN) grade of 3. Additionally, treatment results and duration could be affected by patient compliance.

While the present study demonstrated a correlation between DI and OGS ($p = 0.397$), as well as TCI and OGS ($p = 0.144$), this did not suggest the omission of either one of the indices as a weak correlation was observed. It is crucial to note that correlations do not indicate the level of agreement between two variables. Despite showing a strong correlation, two variables can significantly disagree, particularly if one index consistently yields higher measurements.³⁵ Ultimately, the information gathered from the comprehensive assessment of dental casts, orthopantomogram, and cephalometrics contributes to a multidimensional view of a patient's unique malocclusion and is crucial for treatment decisions. For similar reasons, the omission of certain parameters within the indices is not recommended. However, the concurrent use of DI and OGS may allow the omission of identical parameters. It is undeniable that the ABO indices are complicated and time-consuming. The ABO gauge comes with a range of increments rather than a specific value, which makes it difficult to determine exact linear measurements. Recently, a method to reduce the time to evaluate the OGS has been implemented.³⁶

The present study has identified factors influencing treatment outcomes and duration, thereby offering valuable insights for orthodontic postgraduate students in treatment planning. The findings serve as a guide for improving treatment outcomes by addressing the discrepancy components. Patients should be informed that using RPE would significantly increase treatment duration.

Conclusion

The DI, OGS, and TCI exhibited weak correlations, as did several parameters within these indices. Cephalometric values and clinical anomalies are associated with higher post-treatment OGS, while RPE is associated with extended treatment duration.

Conflicts of interest

The authors declare that there is no conflict of interest.

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