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RESEARCH ARTICLE

A correlation between malocclusion complexity with periodontal status

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ABSTRACT

Malocclusion is the third most common dental problem after caries and periodontal diseases, with prevalence reaching 56% in the world and 89% in Indonesia (2006), respectively. Index of Complexity, Outcome, and Need (ICON) is an assessment tool to measure the necessity, complexity, and success of orthodontic treatment. Although several studies have reported a causal relationship between malocclusion and periodontal disease, the association is still under debate. The aim of this study was to analyze the correlation between malocclusion complexity based on ICON and the periodontal status of patients who underwent orthodontic treatment at the Orthodontic Clinic, Dental Hospital, Faculty of Dentistry, Universitas Indonesia. Material and Method: This was an analytical study with a cross-sectional design. Fifty-four new patients (aged 25-44 years) were included. Patients who had systemic disease, used fixed orthodontic appliance or prosthesis, and had some local factors were excluded. Periodontal status, ICON complexity, study model, and radiographic results were examined and analyzed. An interclass correlation test was carried out to obtain data reliability. Result: the majority of malocclusion complexities based on ICON were mild (46.3%). Periodontal status consisted of Plaque Index (good, 81.5%; moderate, 18.5%), Papillary Bleeding Index (no bleeding, 90.7%; severe bleeding, 1.9%), Clinical Attachment Loss (moderate, 40.7%; severe, 22.2%), gingival recession (mild, 83.3%; severe, 7.4%), periodontal probing depth (moderate, 77.8%; severe, 3.7%), and alveolar bone height (middle third, 53.7%; cervical third, 46.3%). Conclusion: No significant correlation was found between malocclusion complexity based on ICON and periodontal status.

Keywords: ICON; malocclusion; orthodontic; periodontal status

INTRODUCTION

Malocclusion is a deviation from the normal relationship between the maxilla and mandible and/or an absence of dentofacial balance. This condition may be attributed to the interaction of genetic and environmental factors during orofacial development, which may interfere with function and aesthetics.[1,2,3] The prevalence of malocclusion worldwide is approximately 56%, with the highest rates found in Africa (81%) and Europe (72%), followed by the Americas (53%) and Asia (48%).[4] In Indonesia, the prevalence of juvenile malocclusion was 90% in 1983 and 89% in 2006.[5]

Irregular tooth arrangements in cases of malocclusion make plaque control more difficult. Previous studies have shown a positive correlation between crowding and periodontal disease.[6] Furthermore, correction of crowding and malocclusion through orthodontic treatment have been associated with improved periodontal tissue health due to better plaque control. The periodontal tissue includes the gingiva, cementum, periodontal ligament, and alveolar bone.[7] Periodontal tissue health status can be determined by the Oral Hygiene Index Score (OHIS) assessment, which is the sum of the (1) Plaque Index, (2) Papilla Bleeding Index (PBI), (3) Clinical Attachment Loss, (4) gingival recession, (5) periodontal probing depth, and (6) alveolar bone height based on radiographic examination.

Evaluating malocclusion is important in making diagnoses and planning treatment to obtain optimal results. One method used to determine the severity of malocclusion is the occlusal index. The

occlusal index objectively assesses malocclusion by measuring and calculating the scores from existing occlusal features and summarizing the results. Occlusal indices are useful for research, management, and quality assurance of orthodontic care.[1,3,8] Some occlusal indices that have been widely used include the Peer Assessment Rating Index (PAR), Index of Orthodontic Treatment Need (IOTN), Dental Aesthetic Index (DAI), Index of Orthodontic Treatment Complexity (IOTC), and Index of Complexity, Outcome, and Need (ICON).[3,8]

The Index of Complexity, Outcome, and Need (ICON) was developed by Charles Daniels and Stephen Richmond.[8,9] It is a single assessment method for measuring the complexity of orthodontic treatment, treatment needs, and success of orthodontic treatment. The treatment success component of the ICON provides a higher value compared to other treatment need indices. The need for orthodontic treatment is not the same as the complexity of treatment, hence an assessment of the complexity of orthodontic treatment is needed.[10-13] The aim of this study was to analyze the correlation between malocclusion complexity based on ICON and the periodontal status of patients who underwent orthodontic treatment at the Orthodontic Clinic, Dental Hospital, Faculty of Dentistry, Universitas Indonesia.

MATERIALS AND METHODS

This study was approved by the local research ethics committee of Universitas Indonesia (approval no: 7/ Ethical Approval/FKGUI/v/2021). This study took place at the Orthodontic Clinic, Dental Hospital, Faculty of Dentistry, Universitas Indonesia from July to September 2021. Included subjects were 19-45 years of age who came to the clinic to get orthodontic treatment. Comprehensive examination was carried out by an orthodontic resident, by taking intra oral examination, intra oral-extra oral photos, and taking impression to get a study model. Periodontal status plaque index (PI), papilla bleeding index (PBI), clinical attachment loss (CAL), gingival recession, periodontal probing depth, and alveolar bone height were examined; frequency, method, time, and tools used for teeth brushing

Table 1. Icon scoring method

Component \ Score		0	1	2	3	4	5	Weight
1.	Aesthetic assessment	Score 1 to 10						7
2.	Upper arch crowding	< 2mm	2.1 to 5 mm	5.1- 9 mm	9.1 - 13 mm	13.1-17 mm	> 17 mm	5
	Upper spacing	< 2mm	2.1 to 5 mm	5.1-9 mm	> 9 mm		Impacted teeth	5
3.	Crossbite	No cross bite	Cross bite present					5
4.	Incisor open bite	Edge to edge	< 1 mm	1.1 to 2 mm	2.1 to 4 mm	> 4 mm		4
	Incisor overbite	< 1/3 lower Incisor coverage	1/3 to 2/3 coverage	2/3 up to Fully covered	Fully covered			4
5.	Buccal segment Antero-posterior	Cusp to embrasure only class I, II or III	Any cusp relation up to but not including cusp to cusp	Cusp to cusp				3

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were also noted. Periodontal status classification was pre-determined by the researchers together with a periodontist. ICON was determined by five components (including scale), such as complexity of malocclusion (easy to very difficult), crowding (0 to 5), crossbite (0-1), open bite/overbite (0-4), and antero-posterior relation of buccal segment.

The collected data were analyzed using the SPSS version 26.0. First, interobserver and intra observer reliability was tested. Interclass correlation (ICC) test was carried out by the researchers together with an Orthodontist and Periodontist supervisor. The intra-observer test measurements obtained very good reliability result (r = 0.997–1.000; 95% confidence interval). The interobserver test also showed very good reliability results (r = 0.995–1.000; 95% confidence interval) on periodontal status, as well as malocclusion complexity (r = 1.000; 95% confidence interval). Bivariate analysis was performed using the Chi-Square test to determine Correlation between the independent variable (malocclusion complexity based on ICON) and dependent variables (PI, PBI, CAL, gingival recession, periodontal probing depth, and alveolar bone height in panoramic radiograph. Significance was confirmed when the p value was <0.05.

Table 2. Frequency distribution of ICON components

Component of ICON	Category	n	%
Complexity of malocclusion	Easy (< 29)	14	25.9
	Mild (29 to 50)	25	46.3
	Moderate (51 to 63)	9	16.7
	Difficult (64 to 77)	4	7.4
	Very Difficult (> 77)	2	3.7
Crowding	0	13	24
	1	17	31
	2	9	17
	3	2	4
	4	2	4
	5	11	20
Crossbite	0	26	48
	1	28	52
Openbite/ Overbite	0	18	33
	1	21	39
	2	11	20
	3	4	8
	4	0	0
Antero-posterior relation of buccal segment	0	18	33
	1	20	37
	2	16	30
	Total	54	100%

Table 3. Frequency distribution of OHIS components

Component of OHIS	Category	n	%
Plaque Index (PI)	Good	44	81.5
	Moderate	10	18.5
	Bad	0	0
Papilla Bleeding Index (PBI)	No Bleeding	49	90.7
	Mild	2	3.7
	Moderate	2	3.7
	Severe	1	1.9
Clinical Attachment Loss (CAL)	Mild	20	37
	Moderate	22	40.7
	Severe	12	22.2
Gingival recession	Mild	45	83.3
	Moderate	5	9.3
	Severe	4	7.4
Periodontal probing depth	Mild	10	18.5
	Moderate	42	77.8
	Severe	2	3.7
Alveolar bone height	Apical $^1/_3$	0	0
	Middle $^1/_3$	29	53.7
	Cervical $^1/_3$	25	46.3
	Total	54	100%

RESULTS

Most of the research subjects were aged 25-34 years old (52%, 28 subjects), while the remaining patients were 35-44 years old (9%, 5 subjects). Most of the subjects were female (70%, 38 subjects) and most of them graduated as bachelors (52%, 28 subjects).

Table 4. Correlation between complexity of malocclusion and OHIS

Component of OHIS	Category	Complexity of Malocclusion					p-value
		Easy (n (%))	Mild (n (%))	Moderate (n (%))	Difficult (n (%))	Very difficult (n (%))	
Plaque index	Good	12 (22.2)	19 (35.2)	8 (14.8)	3 (5.6)	2 (3.7)	0.816
	Moderate	2 (3.7)	6 (11.1)	1 (1.9)	1 (1.9)	0 (0)	
	Total	14 (25.9)	25 (46.3)	9 (16.7)	4 (7.4)	2 (3.7)	
Papilla bleeding index	No bleeding	12 (22.2)	22 (40.7)	9 (16.7)	4 (7.4)	2 (3.7)	0.669
	Mild	2 (3.7)	0 (0)	0 (0)	0 (0)	0 (0)	
	Moderate	0 (0)	2 (3.7)	0 (0)	0 (0)	0 (0)	
	Severe	0 (0)	1 (1.9)	0 (0)	0 (0)	0 (0)	
	Total	14 (25.9)	25 (46.3)	9 (16.7)	4 (7.4)	2 (3.7)	
Clinical attachment loss	Mild	5 (9.3)	8 (14.8)	2 (3.7)	3 (5.6)	2 (3.7)	0.289
	Moderate	7 (13)	11 (20.4)	3 (5.6)	1 (1.9)	0 (0)	
	Severe	2 (3.7)	6 (11.1)	4 (7.4)	0 (0	0 (0)	
	Total	14 (25.9)	25 (46.3)	9 (16.7)	4 (7.4)	2 (3.7)	
Gingival recession	Mild	5 (9.3)	8 (14.8)	2 (3.7)	3 (5.6)	2 (3.7)	0.289
	Moderate	7 (13)	11 (20.4)	3 (5.6)	1 (1.9)	0 (0)	
	Severe	2 (3.7)	6 (11/1)	4 (7.4)	0 (0)	0 (0)	
	Total	14 (25.9)	25 (46.3)	9 (16.7)	4 (7.4)	2 (3.7)	
Periodontal probing depth	Mild	3 (5.6)	4 (7.4)	1 (1.9)	1 (1.9)	1 (1.9)	0.834
	Moderate	11 (20.4)	19 (35.2)	8 (14.8)	3 (5.6)	1 (1.9)	
	Severe	0 (0)	2 (3.7)	0 (0)	0 (0)	0 (0)	
	Total	14 (25.9)	25 (46.3)	9 (16.7)	4 (7.4)	2 (3.7)	
Alveolar bone height	Middle $^1/_3$	9 (16.7)	9 (16.7)	6 (11.1)	3 (5.6)	2 (3.7)	0.144
	Cervical $^1/_3$	5 (9.3)	16 (19.6)	3 (5.6)	1 (1.9)	0 (0	
	Total	14 (25.9)	25 (46.3)	9 (16.7)	4 (7.4)	2 (3.7)	

Chi Square correlation test, significant on p-value > 0.05

Based on Table 1, most subjects included in this study had mild malocclusion complexity (46.3%, 25 subjects), crowding score of 1 (31%, 17 subjects), crossbite (52%, 28 subjects), open bite/overbite score of 1 (21 subjects), and antero-posterior relation of buccal segment of 1 (37%). Based on Table 2, most subjects had good Plaque Index (81.5%, 44 subjects), No bleeding on probing (90.7%, 49 subjects), moderate Clinical Attachment Loss (40.7%, 22 subjects) mild gingival recession (83.3%, 45 subjects), moderate periodontal probing depth (77.8%, 42 subjects), and alveolar bone height in the middle $^1/_3$ (53.7%, 29 subjects). Based on Table 3, malocclusion complexity did not significantly correlate to any OHIS components, namely Plaque Index ($p = 0.816$), Papilla Bleeding Index ($p = 0.669$), Clinical Attachment Loss ($p = 0.289$), gingival recession ($p = 0.289$), PPD ($p = 0.834$), and alveolar bone height ($p = 0.144$).

DISCUSSION

Crowding can make plaque control more difficult. Studies have shown that malocclusion relates to periodontal status, but controversies remain. The

aim of this study was to find out the correlation between malocclusion, assessed using the Index of Complexity, Outcome, and Need (ICON), and the periodontal status of patients undergoing orthodontic treatment at the Dental Hospital, Faculty of Dentistry, Universitas Indonesia.

Based on the collected data, the majority of the subjects in this study had mild (46.3%) and easy (25.9%) malocclusion (Table 2). These subjects could clean their teeth properly and did not have difficulty cleaning their teeth as those with malocclusion in the difficult or very difficult categories. There was no statistically significant relationship between malocclusion complexity and the Plaque Index (p value of 0.816) as shown in Table 4. This might be because the majority of the subjects in this study were adult patients with healthy periodontal tissue who had not yet undergone a degenerative process.[14] The majority of the subjects were female (70%), which may have played a role, as studies by Diana have found that the OHI-S score in females is better than those in males.[15]

This study found no statistically significant relationship between malocclusion complexity and the Papilla Bleeding Index (p-value of 0.669). A high PBI score, which indicates the presence of gingivitis, is caused by three factors: the main factors, predisposing factors, and modifying factors. The main factor is plaque bacteria, which can cause gingivitis.[16,17] In this study, exclusion criteria were established to rule out predisposing factors that might allow gingivitis to occur, such as the presence of proximal restorations, cervical and proximal caries; the use of dentures; and participation in orthodontic treatment.[18] Crowded teeth are one of the predisposing factors that can cause difficulties for patients in cleaning their teeth.[19] However, with good oral hygiene, gingivitis will not develop regardless of crowded teeth.

This study showed no significant relationship between malocclusion complexity based on ICON and Periodontal Probing Depth. Complaints generally felt by patients with periodontal disease include pain or discomfort when chewing, receding gingiva (causing the teeth to appear longer), reddish or purplish gingiva, bad breath, swollen gingiva, and easy bleeding. The patients who came to the Orthodontic Specialist Clinic were those who had no complaints of periodontal disease. The results of this study indicated that the majority of the research subjects had a moderate level of periodontal probing depth, namely ≥ 4-6 mm (77.8%).

The results of this study indicated no significant relationship between malocclusion complexity and Clinical Attachment Loss (CAL), with p value of 0.289. This is presumably because the majority of overbite depths in this study covered 1/3-2/3 of the lower incisors (39%) and covered all of the lower incisor crowns (8%). Additionally, in this study, the determination of overbite depth according to ICON was based on how much the mandibular incisors were covered by the maxillary incisors. There are differences in the methods used to determine overbite depth in this study and those in a study by Al-Jazeer, which used the average clinical crown length of mandibular incisors (5.0-6.0 mm).[20] Therefore, it can be assumed that the overbite group (overbite depth > 6 mm) in the Al-Jazeer study corresponds to a score of 3 (covering all surfaces of the mandibular incisors) in the assessment of anterior vertical relation according to ICON.

In this study, the percentage of subjects with severe gingival recession (recession of > 5 mm) was 7.4% and the frequency of subjects with severe crowding was 20%. These results indicated a linear relationship between gingival recession and crowding. This study showed that the correlation was not significantly different (p value of 0.289) because the majority of the subjects in this study had mild crowding with a score of 1 based on ICON, with crowding of 2.1-5 mm. The results are similar to a study by Alkana et al which examined 187 patients undergoing orthodontic treatment at Yüzüncü University and found no relationship between malocclusion based on Angle Classification and the average gingival thickness.[21] Gingival thickness is influenced by the shape and size of the tooth root and also the contour of the alveolar bone. Alveolar bone thickness and height

are also affected by position of the teeth in the dental arch. Severe crowding in this study was found only in 20% of the total subjects. Evidence of bone destruction can be seen in panoramic radiograph, which showed alveolar bone height in the cervical 1/3 (46.3%) and middle 1/3 (53.7%). In other words, there was no severe alveolar bone destruction at the apical one-third.

A limitation of this study is that the majority of the subjects were young adults, which may show low prevalence of periodontal disease. Most cases were in the mild category, indicating that the research subjects could maintain their oral hygiene quite properly.

CONCLUSION

This study provides evidence that malocclusion measured by ICON has no correlation with periodontal status of orthodontic patients who undergo orthodontic treatment. This finding suggests that in the case of mild to moderate malocclusion, periodontal status may not be affected. Further studies with broader age category and more complex cases are needed to validate the correlation between ICON and periodontal condition.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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