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Research Article

Correlation of the Severity of Crowding Measured with ALD Analysis Against the Plaque Accumulation Using O'Leary Plaque Index: a descriptive study

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ABSTRAK

Introduction: Crowding is a condition where the arch length is less than the length of the mesio-distal of the teeth summed. One of the methods to measure the severity of crowding is the Arch Length Discrepancy (ALD). Crowding may cause the plaque to accumulate more easily on the surfaces of the teeth, which can be measured with the O'Leary index. Thus, research will be done to see the correlation between the severity of crowding measured with ALD analysis and the plaque accumulation measured using the O'Leary index.Aims of this study is to analyze correlation of crowding severity as measured by ALD analysis on plaque accumulation as measured by the O'Leary plaque index. **Methods:** This research is a descriptive correlational study. Thirty-seven samples were taken from dental models of patients at the Universitas Padjadjaran Dental Hospital, Department of Periodontics, who were treated by the co-assistants of the Dentistry Faculty of Universitas Padjadjaran from 2016 to 2019, and the patients had complete medical record data. The research was conducted from December 2020 to March 2021 at RSGM Unpad. The data obtained was processed by the Spearman's rank correlation coefficient using SPSS Statistics 23 software. **Results:** Based on the acquired data for the ALD index, 2 people scored 5 (ALD 0 mm), 7 people scored 4 (ALD 0 mm to 3 mm), 4 people scored 3 (ALD -3 mm to -5 mm), 6 people scored 2 (ALD -5 mm to -10 mm), 6 people scored 1 (ALD < -10mm), 12 people scored -1 (ALD >0 mm/positive). According to the O'Leary index, 1 person scored good, 8 people scored moderate, 11 people scored poor, and 17 people scored very poor. The Spearman correlation test results show a weak correlation coefficient of r = -0.352 and are statistically significant at p = 0.033 (p<0.05). **Conclusion:** There is a weak correlation between the ALD index's measure of the severity of crowding and the O'Leary indwex's measure of plaque accumulation .

KEYWORDS: crowding, plaque, ALD index, O'Leary index.

Korelasi keparahan gigi berjejal diukur dengan analisis arch length discrepancy (ALD) *terhadap akumulasi plak diukur dengan indeks plak* o'leary: *studi deskriptif*

ABSTRACT

Pendahuluan: *Gigi berjejal adalah suatu keadaan yang diakibatkan karena lengkung rahang yang tersedia lebih sempit daripada jumlah panjang mesiodistal gigi geliginya. Salah satu cara mengukur tingkat keparahan gigi berjejal adalah dengan menggunakan Arch Length Discrepancy (ALD). Gigi berjejal dapat menyebabkan perawatan gigi lebih sulit sehingga plak mudah terakumulasi dan dapat diukur menggunakan analisis* O'Leary*. Pengaruh tingkat keparahan gigi berjejal terhadap akumulasi plak dapat diukur dengan analisis ALD terhadap* indeks O'Leary*.* ***Metode:*** *Penelitian ini merupakan penelitian deskriptif korelasional. Sampel penelitian berjumlah 37 sampel yang diambil dari model gigi pasien RSGM Universitas Padjadjaran Departemen Periodonsia yang dirawat oleh koas FKG Universitas Padjadjaran dari tahun 2016 sampai 2019 dan memiliki data rekam medis yang lengkap. Penelitian dilakukan pada bulan Desember 2020 sampai Maret 2021 di RSGM Unpad. Data yang diperoleh dilakukan Uji Korelasi Spearman menggunakan software SPSS Statistik 23* ***Hasil:*** *Berdasarkan data yang terkumpul untuk indeks ALD, terdapat skor 5 (pengukuran ALD 0 mm) sebanyak 2 orang, skor 4 (pengukuran ALD 0mm sampai -3mm)sebanyak 7 orang, skor 3 (pengukuran ALD -3mm sampai -5mm) sebanyak 4 orang, skor 2 (pengukuran ALD -5mm sampai -10mm) sebanyak 6 orang, skor 1 (pengukuran ALD dibawah -10mm) sebanyak 6 orang, dan skor -1 (pengukuran ALD lebih dari 0 mm/positif) sebanyak 12 orang dan indeks O'Leary kategori baik 1 orang, sedang 8 orang, buruk 11 orang, dan buruk sekali 17 orang dan didapatkan hasil yaitu data yang diperoleh berkorelasi lemah dengan nilai r = -0,352 dan signifikan secara statistik dengan nilai p = 0,033 (p<0,05).* ***Simpulan:*** *Terdapat korelasi yang lemah antara tingkat keparahan crowding yang diukur dengan indeks ALD terhadap akumulasi plak yang diukur dengan indeks O'Leary.*

KATA KUNCI: *gigi berjejal, plak, indeks ALD, indeks O'Leary.*

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INTRODUCTION

The prevalence of dental and oral health problems in Indonesia remains considerably high. In 2018, 57.6% of the Indonesian population had dental and oral health problems, according to the results of the National Basic Health Research of the Ministry of Health of the Republic of Indonesia, ;however, only 10.2% of them received dental health services[1,2] The prevalence of malocclusion in the world is still relatively high, around 30% to 60% of the population.[3] Malocclusion is one of the biggest dental and oral health problems. Moreover, public awareness of maintaining dental and oral health is still rather low.[4] Malocclusion is defined as a condition that deviates from normal occlusion or from the normal relation of teeth. The most frequently encountered clinical trait of malocclusion is crowding.[5]

Crowding is a condition where the jaw arch or available space is narrower than the mesio-distal length of the dentition.[6] Crowding is caused by tooth size-arch discrepancies that are caused by congenital or genetic factors.[4,7] In the mandible, crowding is often found in permanent incisors. The prevalence of crowding in permanent mandibular incisors is 81.7%, and it more often affects lateral incisors than central incisors.[5]

Protrusion, crowding, and malocclusion can cause several problems for patients: discrimination due to facial appearance; problems with oral function and jaw movement (muscle incoordination or pain); temporomandibular joint dysfunction (TMD); problems with mastication, swallowing, or talking; and greater susceptibility to trauma, periodontal disease, or tooth decay.[8]

One approach to determining the severity of crowding is to measure the difference between the dental arch and jaw arch, which is called Arch Length Discrepancy (ALD). ALD is an index used to see the level of crowding of a person's teeth by comparing the length of the dental arch with the jaw arch or available space.[9]

Crowding can cause dental and oral problems, especially periodontal problems.[10] Misalignment and crowded teeth cause food to accumulate in areas that are difficult to reach using a toothbrush. This condition can hinder preventive care such as brushing teeth and using dental floss.[5,8] Crowding allows plaque accumulation to form more easily and oral hygiene to become worse, thereby increasing the risk of caries.[10,11]

Dental plaque is a thin layer of bacteria that sticks to the host. It can accumulate due to poor oral hygiene and is caused by food residue sticking to the surface of the teeth, which causes microorganisms to multiply in an intracellular matrix. The most common type of bacteria found in plaque is Streptococcus spp. This bacterium has the ability to form extracellular polysaccharides and is a gram-positive bacterium, which typically forms pairs or chains during its growth. This organism is normal flora in the oral cavity. However, too much can cause dental and oral problems, as well as periodontal problems.[10,11]

One way for measuring plaque is through the use of the O'Leary plaque index. This index is used to record the presence of plaque on each tooth surface with a simpler method. This system allows patients to see their own plaque growth and learn about plaque control, and can also motivate patients to maintain their oral health. Timothy J. O'Leary introduced this system in 1972.[12]

The high prevalence of dental and oral health problems caused by plaque, crowding, and the lack of public awareness in Indonesia to prevent and treat dental and oral health problems is the background of this study. Aims of this study is to analyze correlation of crowding severity as measured by ALD analysis on plaque accumulation as measured by the O'Leary plaque index.

METHODS

This research used an analytic observational study with a cross-sectional design. The resulting data was a description of the population studied, then an analysis of the relationship between two or more variables was carried out. This research was conducted on 37 secondary data from the calculation of the minimum sample size formula in correlative analysis research. The samples taken were dental models of patients at the Padjadjaran University Hospital, Department of Periodontics who were treated by the co-assistants of the Padjadjaran University Faculty of Dentistry from 2016 to 2019 and had complete medical records. The research was carried out from December 2020 to March 2021.

Table 1. ALD index criteria[8]

Score	ALD (mm, dental model)
5	Measurement value 0
4	Measurement values 0 mm to -3 mm
3	Measurement values -3 mm to -5 mm
2	Measurement values -5 mm to -10 mm
1	Measurement value <-10 mm
–1	More than 0 (positive)

The severity of crowding was measured using the difference in the size of the dental arch and jaw arch or Arch Length Discrepancy (ALD) on the dental model. Dental arch length measurements indicated the space required for the arrangement of teeth in an ideal arch. The procedure involved measuring the largest mesiodistal teeth in each jaw, from the right first molar to the left first molar.

The jaw arch length was measured by dividing the teeth into six segments, then measuring each segment and adding them up. ALD measurement results were obtained by comparing the length of the dental arch with the length of the jaw arch. Negative results indicated a lack of space or crowding, while positive results indicated an excess of space (Table 1).

Table 2. O'Leary Plaque Index Criteria[12]

Score	Criteria
0-20%	Good
21-40%	Moderate
41-60%	Poor
>60%	Very poor

The severity of plaque accumulation was obtained from secondary data, which was measured using the O'Leary plaque index. Table 2 shows the O'Leary Plaque Index Criteria, consisting of: good, moderate, poor, and very poor. With this method, supragingival plaque on four surfaces of all tooth elements is examined, namely the mesial, distal, buccal, and lingual. The plaque index is calculated by adding up the surfaces with plaque accumulation divided by all the tooth surfaces examined (mesial, buccal, distal, and lingual) then multiplied by 100%. The data is presented in tabular form. Univariate analysis was carried out to determine the relationship between the severity of tooth crowding and the level of plaque accumulation, which was analyzed using the Shapiro-Wilk normality test and processed using the Spearman Correlation Test which is processed using IBM SPSS Statistics 23 software.

RESULTS

The number of samples obtained was 37 respondents. The results of measuring the ALD index and O'Leary plaque index are attached in Table 3.

Table 3. Results of measuring the ALD index in the maxilla and mandible and the O'Leary plaque index

No.	Patient Code	ALD Mx (mm)	ALD Mdb (mm)	ALD Mx and Mdb (mm)	O'Leary Plaque Index
1	P001	-1	-3	-4	0.6875
2	P002	-5.5	1.5	-4	0.5156
3	P003	-0.5	0.5	0	0.6960
4	P004	-14	3	-11	0.8790
5	P006	-9	34	25	0.6420
6	P008	0	-8.5	-8.5	0.6690
7	P012	0	-2	-2	0.3750
8	P013	2.5	8.5	11	0.5833
9	P014	-1	-4.5	-5.5	0.5170
10	P015	-5	-6	-11	0.5930
11	P018	1.5	2.5	4	0.2500
12	P019	0	-2.5	-2.5	0.6870
13	P020	-5	7.5	2.5	0.5200
14	P022	-2	-12.5	-14.5	0.5916
15	P023	-5	-4.5	-9.5	0.6250
16	P024	1	5	6	0.4224
17	P025	-1.5	-14	-15.5	0.4417
18	P026	2	2	4	0.4137
19	P027	0.5	-2	-1.5	0.7830
20	P029	2.5	-0.5	2	0.5000
21	P030	-4	-7.5	-11.5	0.7200
22	P031	4	7.5	11.5	0.6200
23	P032	1.5	2	3.5	0.0980
24	P033	-9	2	-7	0.9830
25	P034	-1	-2	-3	0.2589
26	P035	-2	-10.5	-12.5	0.5300
27	P036	2	-2	0	0.7400
28	P037	0	2	2	0.2410
29	P038	-4	-4	-8	0.3500
30	P040	0.5	0.5	1	0.2775
31	P041	-3.5	-1.5	-5	0.6270
32	P043	1.5	1.5	3	0.2500
33	P044	0	-3	-3	0.6520
34	P045	-0.5	-0.5	-1	0.2700
35	P046	0.5	-5	-4.5	0.6875
36	P048	-3	-4.5	-7.5	0.6700
37	P049	-1	0.5	-0.5	0.6200

According to the measurement results, the highest ALD criterion index in the maxilla is 12 data points, or a score of -1. The criterion score of -1 indicates that the ALD measurement value is greater than 0 mm/positive. Meanwhile, the ALD criteria index requires a minimum score of 1 with 1 data criterion. A score of 1 in criterion indicates that the ALD measurement value is less than -10 mm.

The result of the measurement indicates that the mandible has the highest ALD criteria index of 16 data points with a score of -1. This score indicates that the ALD measurement value exceeds 0 mm. In contrast, the lowest ALD criteria index is criteria score of 5 with 0 data, which indicates that the ALD measurement value is 0 mm.

The highest results of the measurement for the ALD accumulation in the maxilla and mandible were 12 data points with a criterion score of -1. This indicates that the ALD measurement value is greater than 0 mm. Meanwhile, the minimum score of the accumulation criterion for maxillary and mandibular ALD is 5 with 2 data. It indicates that the ALD measurement value is 0 mm.

The results of calculating plaque accumulation using the O'Leary plaque index showed the highest value in the very poor criteria with 17 data. Very poor criteria indicates that plaque accumulation for the entire oral cavity is higher than 60%. Meanwhile, the lowest value is in a good criterion with 1 data. Good criteria indicate that plaque accumulation for the entire oral cavity is 0-20%. Table 4 shows the results of the research data normality test.

Table 4. Normality Test

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Sum of ALD Mx and Mdb	0.941	37	0.050
O'leary Plaque Index	0.965	37	0.295

*.normally distributed (p>0.05)

This research data was normally distributed (p > 0.05) so it was continued with parametric tests. Next, the Spearman correlation test was carried out to determine the relationship between the severity of tooth crowding and the level of plaque accumulation (Table 5).

Table 5. Spearman Correlation Test Results with IBM SPSS Statistics 23 Software

			O'Leary Plaque Index	**Sum of ALD Mx and Mdb**
Spearman's rho	**O'Leary Plaque Index**	Correlation Coefficient	1.000	-.352*
		Sig. (2-tailed)	.	0.033
		N	37	37
	Sum of ALD Mx and Mdb	Correlation Coefficient	-0.352*	1.000
		Sig. (2-tailed)	0.033	.
		N	37	37

*.Correlation is significant at the 0.05 level (2-tailed)

Based on the results obtained, there is a weak correlation between the ALD index value, and the O'Leary plaque index value with a correlation coefficient value of r = -0.352 and statistical significance of p = 0.033 (p<0.05). The negative correlation coefficient indicates that the two variables have an inverse correlation. As the degree of tooth crowding increases with decreasing ALD, the O'Leary Plaque Index increases with increasing plaque accumulation. The Spearman correlation coefficient value obtained in this study shows a weak correlation.

DISCUSSION

The results of the 2018 Riskesdas stated that 57.6% of the total population of Indonesia had dental and oral problems. In addition, 80% of all dental and oral problems that occur in Indonesia are cases that require orthodontic treatment.[13] A literature study states that untreated malocclusion can worsen oral health-related quality of life (OHRQoL). This malocclusion can increase the risk of caries, poor oral hygiene, and poor gingival health, which can cause pain and limited function.[14]

One of the clinical features of malocclusion is crowding. Some of the causes of crowded teeth include early loss of primary/deciduous tooth, missing/impacted permanent tooth, supernumerary teeth, early loss of permanent tooth, persistent primary teeth, tooth deformities, and bad oral habits.[7,8,15]

Crowding can make the teeth cleaning process difficult. This is because the debris in the interdental area is difficult to reach using a toothbrush. As a result of the difficulty of the tooth cleaning process, the accumulation of plaque and calculus increases in the crowding teeth, so that in the long term, dental caries and gingivitis can occur. There can even be destruction of periodontal tissue that causes tooth mobility.[16,17] Farooq et al. in his study stated that crowding, which occurs in the mandibular anterior teeth, is one of the predisposing factors for pathological changes in periodontal tissue.[17]

Based on the result of the normality data test at table 4, this research data was normally distributed (p > 0.05) so it was continued with parametric test. The Spearman correlation test show that there is a weak correlation between the ALD index value and the O'Leary plaque index value, as shown in Table 5. This is in line with previous research conducted in Medan, which compared 50 cases of normal tooth position and 50 incidences of crowding teeth. The average OHI-S score for normal tooth position is 0.66 in the good category, and the average score is 1.33 in the moderate category for crowding teeth. The results of the research show that there is a correlation between crowding teeth and the oral hygiene status of students in Medan.[16] Previous research conducted on 1st–5th grade students at Rami Perumnas Elementary School showed that crowding teeth can affect oral hygiene because most students have crowding teeth and poor oral hygiene status based on the OHI-S criteria.[17,18]

Research conducted by Salim et al. showed a significant relationship between crowding teeth in both the maxilla and mandible and oral hygiene. In fact, the OHI-S value was higher at moderate crowding severity levels compared to mild crowding severity levels. This is also proven by the strong correlation between crowding of the teeth and inflammation of the gingiva. This shows that crowding has a negative impact on dental hygiene and dental health.[19]

This showed that the higher the severity of the malocclusion, the higher the risk of caries, as shown at table 3. Crowding can cause various dental and oral problems that occur due to plaque, such as caries and poor oral hygiene.[18,20] Several studies show the influence of tooth structure abnormalities on oral health.[20] In research conducted at SMPN 2 Marga, significant statistical analysis results were obtained regarding the relationship between crowding teeth or requiring orthodontic treatment and oral hygiene status, which is related to the long-term risk of caries.[20]

Other research also states that malocclusion, including crowding of teeth, can increase the risk of caries and periodontal disease in people who have limited access to dental and oral health services. There is an opinion that maintaining oral hygiene by visiting the dentist regularly is an important way to reduce the risk of plaque accumulation. Crowding teeth can be a barrier to achieving good dental and oral hygiene.[21]

In this study, there were cases that exhibited a good ALD index with crowding values between 0 and 3 millimeters in each jaw but poor or very poor O'Leary plaque index (table 3). This condition may happen due to several other factors, causing the relationship between crowded teeth and plaque buildup to be insignificant.[22] One of the causes is a lack of public awareness and knowledge regarding the importance of maintaining oral hygiene. Apart from that, there is some data with a poor ALD index, namely crowding values above 3 millimeters or diastema values above 0 millimeters; however, the O'Leary plaque index criteria show good or moderate values. Patients may be more aware of oral hygiene as a result of which they make better efforts to maintain oral hygiene despite their crowded teeth.[17,21]

Based on the data obtained in this research, several factors can influence the final results of the research. These factors include differences in insight regarding dental and oral care, as well as the habits and culture of some patients, which can influence dental and oral condition. Previous research conducted by Raka *et al.*,[23] explained that adequate nutrition is one of the factors that influences dental and oral condition. Nutritional conditions are related to socioeconomic factors. Apart from that, the condition of malocclusion is also influenced by genetic factors. This also supports the results of some research, which show that teeth with good alignment (minimal crowding) still have the possibility of having poor oral hygiene, and vice versa.[23]

CONCLUSION

The research results show that there is a weak correlation between the severity of crowding as measured by the ALD index and plaque accumulation as measured by the O'Leary index.

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