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Evaluation of the Dental Aesthetic Index among patients with cleft palate and cleft lip, with or without cleft palate

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Abstract

Introduction and Objective. The Dental Aesthetic Index (DAI) is a commonly-used dental indicator for determining patients' orthodontic treatment needs. It is simple to use and can be measured by dentists and trained assistants. It allows the ranking of patients from the least to those most in need of treatment, and is therefore often used in epidemiological studies. DAI is practical because it takes into account both aesthetic and functional aspects of malocclusions. The aim of this study was to determine the usefulness of the Dental Aesthetic Index in evaluating the results of orthodontic treatment among patients with cleft palate, and patients with cleft lip with or without cleft palate, who completed orthodontic treatment.

Materials and method. Twenty-three diagnostic models of patients with cleft palate and patients with cleft lip, with or without cleft palate, after orthodontic treatment were measured by a single examiner.The DAI score was measured as the sum of 10 components multiplied by their weight by adding the constant of 13.

Results. The DAI index scores ranged from 17–42 points. Of all the components, the most frequently observed were: lack of teeth, spacing in incisial segments, and maxillary overjet.

Conclusions. The results of the study indicate that DAI can be successfully used in cleft patients and that such patients require not only orthodontic treatment, but also further prosthetic treatment to replace missing teeth. The DAI index can be used in the group of cleft palate and cleft lip patients, with or without cleft palate, and demonstrates high values due to the presence. absence of numerous teeth. Therefore, in these patients it presents the need for prosthetic treatment rather than orthodontic.

Key words

cleft lip, DAI, cleft palate

INTRODUCTION

The Dental Aesthetic Index (DAI), described by Cons et al. in 1986, is a widely used, WHO-approved index that combines both clinical and aesthetic factors of malocclusion. It allows the easy and swift determination of the need for orthodontic treatment and the severity of malocclusion in a given patient or group of people. The DAI is distinguished by the fact that it produces a single score for a given patient, incorporating the subject's appearance and function. The Index has been used in numerous epidemiological analyses on large sets of patients to determine the need for orthodontic treatment in a selected age group [1, 2, 3], ethnic group [4], country [5] or region [6, 7]. According to Chrystiane F. Cardoso et al. DAI is a reliable tool for conducting epidemiological studies [8].

The DAI is a very practical indicator, since its score can be obtained by intraoral examination, or on diagnostic models without radiographic images by a dentist or trained assistant. DAI evaluates 10 characteristics of occlusion that affect the appearance and aesthetics of the face and smile, which are among the reasons that patients most often visit dental offices for treatment. These include the number of missing teeth, crowding and spacing within the incisal teeth, the width of the diastema, the largest irregularities in the anterior segment of the upper and lower dental arch, maxillary overjet, mandibular overjet, vertical anterior overbite, and molar relationships (Tab. 1). The results are categorized into 4 levels of defect severity. Scores less than or equal to 25 (no treatment needed), 26–30 (medium need for treatment), 31–35 (highly desirable treatment), and a score above 36 (mandatory treatment) (Tab. 2). Despite the presence of the above cut-off points, the score can range from 13 to over 80 points. This allows the cases to be sorted on a scale from the least in need of treatment to those most in need. Thus, the DAI scale can be modified, for example, to select patients whose treatment should be publicly subsidized [9].

Oral cleft is one of the most common craniofacial anomalies (approximately 1 in 700 live births- according to WHO), which affects many physiological activities, e.g. speech, swallowing, breathing and hearing. The etiology of clefts has not yet been completely explained, although a genetic background is invariably emphasized, as well as unfavorable conditions for the development of the embryo during weeks 5–9 of pregnancy being responsible for the formation of clefts. Among the many other causes that can be distinguished are folic acid deficiency during pregnancy, alcohol consumption, smoking, stress, obesity, low zinc levels and fever during pregnancy [10–15].

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During to the early period of foetal life, even small deviations from the norm can result in abnormal foetal fusion of craniofacial structures, resulting in the formation of clefts. In the human population with CL/P and CP, two forms of the disease can be identified: syndromic, which occurs in combination with other diseases (e.g. Patau syndrome, Treacher-Collins syndrome, Pierre Robin sequence or Goldenhar syndrome), and non-syndromic, which appear in isolation. It has also been proven that the age of parents can affect the appearance of clefts in a child. With the age of both mother and father, the likelihood of the incidence of this anomaly increases [16]. Dental anomalies among patients with cleft palate and cleft lip, with or without cleft palate, are significantly more common than in the general population. Among the many anomalies can be distinguished: hypodontia, hyperdontia, tooth rotation, microdontia, macrodontia [17].

Missing and misaligned teeth among cleft patients not only cause functional problems, such as difficulties with chewing and swallowing, but can also contribute to appearance [18]. All these variations affect the DAI score, and it appears that this index can be successfully applied to patients who were born with cleft lip or palate. For example, the Dental Aesthetic Index has been used by Sudheer G Hongal, Anil Ankola, Laxminarayan Nagesh to evaluate patients with clefts [19]. In 2010, they carried out research in which they compared a study group of 56 people with cleft lip and/or palate between the ages of 12 and 18, to a control group consisting of 168 people without clefts selected from the general population. They chose DAI to analyze patients and record the data. The results revealed that the majority of patients with cleft lip and/or palate exhibited severe malocclusion, and treatment was highly desirable, compared to those without clefts.

Another example of the use of DAI in patients with clefts is the study conducted by Mario Vianna Vettore and Ana Eugênia Sousa Campos [20]. They used the DAI to compare malocclusion among patients with pre-foramen incisor cleft (PIC) and trans-foramen incisor cleft (TIC). The results of the individual DAI components differed between PIC and TIC patients: patients with TIC showed greater malocclusion severity, but according to the DAI results, all subjects had very severe or disabling malocclusion.

OBJECTIVE

The aim of the study was to determine the usefulness of the Dental Aesthetic Index in evaluating the results of orthodontic treatment among patients with cleft palate and patients with cleft lip, with or without cleft palate, who completed orthodontic treatment.

MATERIALS AND METHOD

The study material consisted of 23 randomly-selected diagnostic models of patients with cleft palate and patients with cleft lip, with or without cleft palate, after orthodontic treatment. The age of the patients ranged from 8–27 years, with a mean age of 16 years. The study group included 12 females and 11 males. Good quality models with permanent dentition from the Chair and Department of Jaw Orthopaedics at the Medical University of Lublin in eastern Poland were selected for the study. In the process of collecting models for the study, the first inclusion criteria was a presence of cleft palate or cleft lip, with/without cleft palate (CP, CL/P). The exclusion criteria were history of dental or maxillofacial injury, the presence and coexistence of general diseases influencing orthodontic treatment, and a note in the patients' documentation that treatment had beencompleted. In such cases, all plaster casts with any kind of technical errors were excluded, as well as some casts with substantial restorations which made assessment difficult, were not analyzed. Samples were selected from the collected casts by simple randomisation by one researcher involved in the study, and the need for repeated measurements.

Models were analyzed by a single examiner trained by an experienced specialist. The DAI score was measured as the sum of 10 components multiplied by their weight with adding the constant of 13 [21]. The measurements were taken using a millimeter-scale periodontal probe. Results were collected on a pre-prepared spreadsheet. The final result was calculated automatically by a programme that allows organization of the data on spreadsheets and to perform tabulated calculations. For elimination of bias, the models were measured twice, 7 days apart.

DAI components were measured as follows:

I. **Number of missing teeth in each jaw, excluding molars.** This is the number of missing incisors, canines and premolars in both dental arches. If the spaces between the teeth are closed, the missing tooth is not counted as missing. If a deciduous tooth is properly aligned in the arch and its permanent successor has not yet erupted, the missing tooth is not counted.

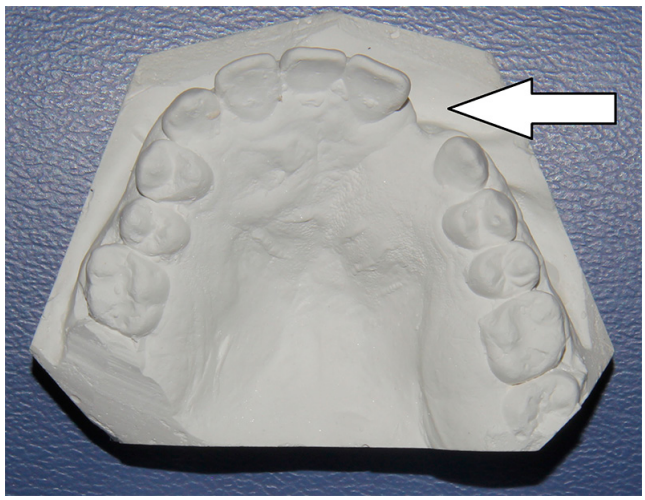

Figure 1. Number of missing teeth

II. **Crowding in incisal segments.** Incisal segments crowding is a condition in which the available space between the right and left canines was insufficient to accommodate all 4 incisors in normal alignment. Teeth may have been rotated or moved beyond the arch. The number of incisor segments (an incisor segment consists of 4 incisors in the upper or lower arch) with crowding was recorded as 0 = no segment crowded), 1 = 1 segment crowded, or 2 = 2 segments crowded). In case of doubt, a lower score was given. If the 4 incisors were in correct alignment but one or both canines were displaced, the segment was not marked as crowded.

III. **Spacing in incisal segments.** A condition in which the available space between the right and left canines was insufficient to accommodate all 4 incisors in normal alignment. If one or more incisal teeth had proximal surfaces without interdental contact, the segment was recorded as spaced. Results were recorded as in subsection 2 (0.1 or 2). In case of doubt, the lower score was awarded.

Figure 2. Spacing in incisal segments

IV. **Diastema width**. The distance between the mesial surfaces of the central upper incisors, measured to the nearest millimeter with a millimeter-scale periodontal probe.

V. **Largest abnormality within the maxilla.** The abnormality is rotation or misalignment of the teeth in the upper incisal segment relative to normal alignment. The measurement was made at the largest abnormality using a periodontal probe with millimeter graduations to the nearest millimeter.

VI. **Largest abnormality within the mandible**. Analogous to subsection V, except that measurements were taken in the lower incisal segment.

VII. **Anterior maxillary overjet.** The greatest protrusion of the upper incisal teeth in relation to the lower incisal teeth, measured with a periodontal probe with an accuracy of a full millimeter. This feature was not recorded when all maxillary incisors were missing or with lingual crossbite.

VIII. **Anterior mandibular overjet.** This feature was recorded when any of the lower incisal teeth were tilted in relation to the upper incisal teeth. The narrowest inclination was recorded and measured with a periodontal probe to the nearest millimeter.

IX. **Vertical anterior open bite.** No vertical overlap of the upper and lower incisors measured with a millimeter-scale periodontal probe to the nearest millimeter. The distance between the incisal edge of the upper and lower incisors was measured.

X. **Anterio-posterior relationship of molars**. Largest irregularity was recorded (right or left side) according to scores: 0 = correct cusps relations, 1 = relationship displaced by half cusp mesial or distal, 2 = relationship displaced by entire cusp mesial or distal.

XI. **Constant.** Constant value equals 13.

Figure 3. Anterior maxillary overjet

Table 1. Dental aesthetic index components and their weights. (Acc. to Cons et al. 1986)

DAI Components	Weights
No. of missing teeth in each jaw, excluding molars	6
Crowding in incisal segments (No. of segments)	1
Spacing in incisal segments (No. of segments spaced)	1
Midline diastema (mm)	3
Largest anterior maxillary irregularity (mm)	1
Largest anterior mandibular irregularity (mm)	1
Maxillary overjet (mm)	2
Mandibular overjet (mm)	4
Vertical anterior overbite (mm)	4
Antero-posterior molar relationship (0 = normal, 1 = 1/2 cusp mesial or distal, 2 = full cusp or more mesial or distal)	3
Constant	13

Table 2. Orthodontic treatment needs according to the Dental Aesthetic Index

DAI score	Severity levels	Treatment need
<=25	Minor or no abnormality	No treatment need
26–30	Definite malocclusion	Elective treatment
31–35	Severe malocclusion	Treatment highly desirable
>=36	Very severe malocclusion	Mandatory treatment

RESULTS

The DAI index scores ranged from 17–42 points with a mean of 28 points. No or little need for treatment was present in 10 patients, treatment optional in 5 patients, treatment highly recommended in 2 patients, treatment necessary in 6 patients.

Lack of teeth (47.8% of all models studied), spacing (69.6%) in incisial segments and maxillary overjet (82.6%) appeared

Table 3. Distribution of Dental Aesthetic Index scores

DAI scores	n	%
<=25	10	43.5
26–30	5	21.7
31–35	2	8.7
>=36	6	26.1

Table 4. Distribution of DAI components

Missing teeth	Total	Male	Female
1 missing tooth	8	5	3
2 missing teeth	2	0	2
3 missing teeth	1	1	0
4 missing teeth	0	0	0
Segments crowded			
1 segment	7	3	4
2 segments	2	1	1
Segments spaced			
1 segment	12	4	8
2 segments	4	4	0
Midline diastema			
>1mm	2	2	0
Anterior maxillary irregularity			
1 mm	10	4	6
2 mm	4	2	2
3 mm	1	1	0
Anterior mandibular irregularity			
1 mm	4	3	1
2 mm	1	0	1
Maxillary overjet			
1 mm	1	0	1
2 mm	4	2	2
3 mm	5	2	3
4 mm	5	0	5
5 mm	4	4	0
Mandibular overjet			
>1 mm	0	0	0
Anterior overbite			
>1 mm	0	0	0
Anterio-posterior relationship			
½ cusp mesial or distal	3	3	0
Full cusp mesial or distal	10	3	7

to occur most frequently in the analyzed components. In each case, there were at least 2 components confirmed. Among the patients whose score indicated a high recommendation for treatment (>= 31 points), no patients recorded 0 score in the number of missing teeth.

Differences in results between measurements 1 and 2 occurred in components: largest jaw disorder in millimeters and enlarged horizontal bite in millimeters. The measurements were performed according to the guidelines using a millimeter-scaled periodontal probe. The differences in measurements occurred because of the need to average the results to the nearest millimeter. For this reason, 2 measurements were taken and the final result determined by the average of the 2 measurements.

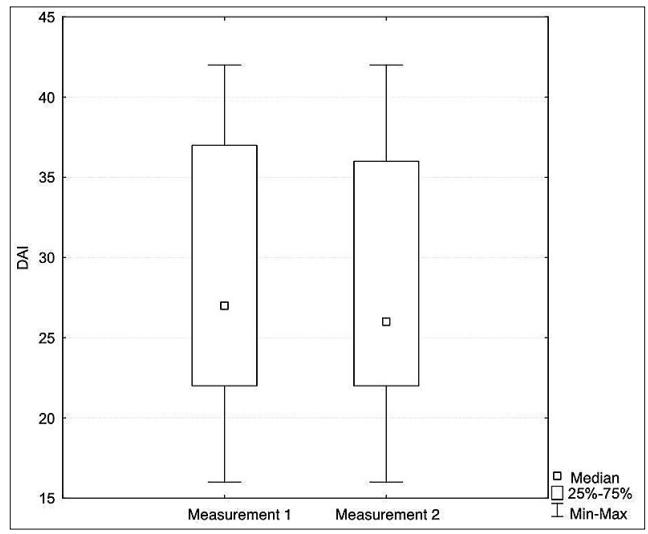

Figure 4. DAI results in measurement 1 and measurement 2

There was no statistically significant difference in DAI totals by either gender, age (two age groups compared), or ICD-10 disease (2 diseases compared).

No statistically significant relationship between the need for treatment and the analyzed independent variables was noted.

DISCUSSION

The Dental Aesthetic Index (DAI) was used because of its simplicity, practicality, and the small number of published studies using it among patients born with clefts. Additionally, the components of a given index incorporate dental and occlusal anomalies that are very common in the cleft patient population. This may suggest that the index is suitable for analyzing the need for orthodontic treatment among patients

Table 5. DAI results in measurement 1 and measurement 2

DAI scores	M	Me	Min	Max	Q1	Q3	SD	Wilcoxon signed-rank test result
Measurement 1	28.26	27	16	42	22	37	8.09	Z = 1.604; p = 0.109
Measurement 2	28.04	26	16	42	22	36	7.93	
difference between measurements (measurement 2 -measurement 1)	-0.22	0	-2	0	0	0	0.60	–

M – mean; Me – median; Min – minimum score; Max – maximum score; Q1 – lower quartile; Q3 – upper quartile; SD – standard deviation; Z – Wilcoxon paired order test result; p – statistical significance. Mean DAI value in measurement 1 – M=28.26 (with a median Me=27), and the mean DAI in measurement 2 – M=28.04 (with a median Me=26). There was no statistically significant difference between the measurements (p=0.109)

Table 6. DAI results by gender, age and ICD-10

		M	Me	Min	Max	Q1	Q3	SD	Statistical analysies
Gender	female	28.33	27	16	42	23.5	33	8.03	t = 1.111 p = 0.913
	male	27.95	26	17	41.5	20	37	8.37	
Age	Under 17 years old	28.54	27	16	42	24	31	7.62	t = -0.258, p = 0.799 r = 0.183, p = 0.403
	17 and older	27.65	25.5	17	41,5	20	37	8.87	
ICD-10*	Q36	29.55	26.5	20	42	24	37	8.23	t = 0.718 p = 0.481
	Q37	27.00	26	16	41	20.5	34	8.33	

Analysis does not include one patient with Q35 disease. M – mean; Me – median; Min – minimum score; Max – maximum score; Q1 – lower quartile; Q3 – upper quartile; SD – standard deviation; t – Student's t-test result; p – statistical significance; r – r-Pearson correlation coefficient

Table 7. Need for treatment by gender, age, and ICD-10

Variable analized			Treatment need		Chi^2 p
			No treatment need / elective	Highly desirable / Mandatory	
Gender	Female	N	9	3	Chi^2_{Yatesa}=0.349 p=0.555
		%	75.00%	25.00%	
	Male	N	6	5	
		%	54.55%	45.45%	
Age	Under 17 years old	N	6	4	Chi^2_{Yatesa}<0.001 p=0.985
		%	60.00%	40.00%	
	17 and older	N	9	4	
		%	69.23%	30.77%	
ICD-10*	Q36	N	6	4	Chi^2_{Yatesa}=0.015 p=0.903
		%	60.00%	40.00%	
	Q37	N	8	4	
		%	66.67%	33.33%	
Total		N	15	8	–
		%	**65.22%**	**34.78%**	

* analysis does not include one patient with Q35 disease. Chi2Yates – the result of Chi-square test with Yates correction

with CP and CL/P. Numerous studies on the prevalence of specific malocclusion among patients with clefts are available in the literature. A review of these studies suggests that hypodontia is one of the most common anomalies among these individuals [22–25].

The DAI takes into account the situation in which, thanks to appropriate orthodontic treatment, gaps between teeth caused by missing teeth are closed, in which case the result of the first component is 0. However, it is not always possible to correct this anomaly orthodontically. This means that the high DAI score caused by this anomaly, and the very high weight of the first component, do not clearly indicate the need for orthodontic treatment. In such cases, multidisciplinary or prosthetic treatment should be considered.

The high value of the missing teeth conversion ratio (6n) makes the scores among some patients appear inflated and inadequate for the actual need for orthodontic treatment. This is particularly noticeable when analyzing models of patients with clefts, since hypodontia is much more common in these patients than among patients without clefts. In 2008, Shelton, Hobson and Slater [26] used DAI in a study analyzing 57 diagnostic models of patients with hypodontia. The mean DAI score among these patients was 42, indicating a severe malocclusion. They found the DAI to be appropriate for the study of patients with hypodontia, and also suggest the need for multidisciplinary treatment in such cases. The authors of the current study also suggest a paucity of indicators that can be used among patients with hypodontia. This is another reason to establish more research using DAI, which takes into account missing teeth. The study by Connolly KA et al. [27] also indicates that adult cleft patients require multidirectional treatment, and only such treatment can provide satisfactory results. The authors analyzed the data and treatment needs of 142 adult patients with clefts and showed that these patients have similar long-term treatment needs across multiple medical disciplines. However, more than 30% of the patients continued to indicate dissatisfaction with malocclusion after completion of the treatment.

Specific needs of patients with clefts can be solved only by a multidisciplinary approach involving a team consisting of a plastic surgeon, maxillofacial surgeon, orthodontist, prosthodontist, psychologist, speech therapist, paedodontist and an ENT specialist [28, 29]. The long process of therapy for a child with cleft starts with the education of the child's family. Proper newborn feeding instruction enables the child to receive adequate doses of nutrients. This is extremely important, because due to anatomical and functional difficulties, a child with a cleft can suffer from delays in growth. In early childhood, the therapy is focused on speech development and plastic surgery.

The start of orthodontic treatment is usually connected with eruption of the secondary dentition, although in many

cases the time of appropriate intervention can be even earlier. Later, adolescents also need further orthodontic treatment, plastic or orthognathic surgeries and prosthetic restorations, a process that is both time consuming and expensive, resulting in a decrease in the quality of life of the patient.

Adults with clefts after treatment show lower levels of satisfaction with their appearance, compared to people not affected with this condition. The DAI index can be helpful in establishing occlusion and dentition appearance disturbances which can influence self-perception. It should not be omitted that dissatisfaction with facial appearance was the main cause of depression among cleft patients [30], and among the specialists a psychologist can play an important role.

CONCLUSIONS (REWRITTEN)

The Dental Aesthetic Index can be successfully used to determine which patients still require care, despite the completion of orthodontic treatment, and allows ascertainment whether the treatment has had the desired effect. It can also be used to compare pre- and post-treatment models. Another very practical aspect of the DAI is that its scores can range from 13 to over 80, a wide scale of results that allows the selection of a group of patients who particularly require treatment.

Finally, the DAI index can be therefore used in the group of patients with cleft palate and cleft lip, with or without cleft palate, and demonstrates high values due to the presence of numerous missing teeth / absence of numerous teeth. In these patients the Index presents the need for prosthetic treatment rather than orthodontic treatment.

The data collected may also be used for the purpose of distributing subsidies for the treatment.

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