

# Comparison of IOTN and DAI for Use with Non-Syndromic Cleft Lip and Palate Patients

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## ABSTRACT

**Background:** The Dental Aesthetic Index (DAI) makes it possible to quickly and simply determine whether a patient or group of patients needs orthodontic treatment and how severe their malocclusion is. The DAI stands out among other indices because it generates a single rating for a specific patient that considers the subject's function and esthetic simultaneously. Another well-known measure in orthodontics is the Index of Orthodontic Treatment Need (IOTN).

**Aim:** To compare the effectiveness of the IOTN and DAI among non-syndromic Cleft Lip and Palate (CLP) patients and determine the value of the DAI in assessing orthodontic treatment requirements and outcomes for patients with non-syndromic CLP.

**Methods and Materials:** The research dataset included 160 diagnostic models randomly chosen from individuals diagnosed with non-syndromic CLP. Good-quality models with permanent dentition were selected for the study. The sample was populated from collected casts by simple randomization conducted by a single researcher involved in the study, and measurements were made repeatedly. The DAI score was calculated as the sum of 10 components multiplied by their weight, adding the constant of 13. IOTN evaluation was also conducted.

**Results:** Since the patients were in the CLP category, they were considered Grade 5p according to the IOTN. In this study, 69 of the study model (43.12%) were found to have a DAI score  $\leq 25$ , 34 (21.25%) had a DAI score of 26–30, 13 (8.12%) had a DAI score of 31–35, and 44 (27.5%) had a DAI score of  $\geq 36$ . Fifty-five study models 35 male, 20 female) had one missing tooth, 15 (1 male 1 female had two missing teeth and eight (7 male, 1 female) had three missing teeth.

**Conclusion:** The DAI can be used to successfully identify individuals who still need care after receiving an orthodontic intervention and, as an additional metric to IOTN, can help establish whether the therapy was successful. It may also be employed to contrast models before and after therapy. As an alternative to the IOTN, the DAI attempts to identify children who require orthodontic treatment and rank their needs in order to improve their appearance and psychosocial standing.

**Keywords:** DAI, IOTN, Non-syndromic cleft lip and palate

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## INTRODUCTION

According to the World Health Organization (WHO), oral clefts are among the most prevalent craniofacial defects and affect various physiological processes, such as speaking, breathing, swallowing, and hearing [1,2].

Although a genetic foundation is generally emphasized, the exact cause of clefts is still unknown; however, it is thought that unfavorable circumstances for the maturation of the embryo between the fifth and ninth weeks of pregnancy are responsible [3,4]. A shortage of folic acid, drinking alcohol, cigarette smoking, anxiousness, being overweight or obese, inadequate zinc concentration, and fever while pregnant are among the numerous factors that might cause oral clefts [5,6].

Even minor deviations from the usual pattern in the early stages of fetal development can cause aberrant fetal unification of craniofacial features, leading to the development of clefts [7]. Two types of the Cleft Lip and Palate (CLP) and Cleft Palate (CP) conditions can

be distinguished in humans: i) syndromic, which occurs in conjunction with other illnesses (such as Treacher Collins syndrome or Goldenhar syndrome), and ii) non-syndromic, which manifests on its own. Additionally, the development of clefts in a child can be influenced by the age of their parents. The older the father and mother, the greater the probability of this abnormality. Individuals with Cleft Lip (CL), with or without CP, have a much higher rate of dental abnormalities than the general population. Numerous anomalies, including macrodontia, microdontia, tooth rotation, hyperdontia, and hypodontia, can occur [8].

First introduced by Cons et al. in 1986, the Dental Aesthetic Index (DAI) is a popular, WHO-affiliated index that incorporates both clinical and cosmetic aspects of malocclusion [9, 10]. The DAI makes it possible to quickly and simply determine whether a patient or group of patients needs orthodontic treatment and how severe their malocclusion is. The DAI stands out among other indices because it generates a single rating for a specific patient that takes into account the subject's function and esthetic simultaneously [11, 12]. Multiple epidemiological investigations on sizable patient populations have utilized the DAI to assess the requirement for orthodontic intervention in a certain age range, ethnic community, nation, or location. Cardoso et al., [13] claim that the DAI is a trustworthy instrument for carrying out epidemiological investigations. The DAI seems very useful since a dentist or qualified assistant can determine its score through an intraoral assessment or by using a diagnostic model with no radiographic pictures. DAI assesses 10 occlusion-related factors that affect the appearance of the face as well as the smile, which are considered the main causes of patient visits to dental facilities. Thus, the instances of malocclusion can be ranked according to the level of treatment required, from lowest to highest. Consequently, the DAI rating can serve as a tool to identify patients eligible for public healthcare subsidies, among other potential applications [14]. A well-known measure in orthodontics called the Index of Orthodontic Treatment Need (IOTN) comprises a Dental Health Component (DHC) with five degrees of severity and Anesthetic Component (AC) with 10 degrees of severity [15]. The patient can be categorized as needing orthodontic treatment by combining the two components, even if they cannot be merged into a single score. The most notable benefits of this metric are its simplicity of use and the extremely high degree of concordance among IOTN values as assessed by doctors, children, and parents [16].

The DAI attempts to identify children who require orthodontic treatment and rank those children's needs in order to improve their appearance and psychosocial standing [17]. Cleft patients who have missing or misplaced teeth may experience practical issues, such as difficulty chewing and swallowing, as well as esthetic issues. The DAI score is impacted by all these situations, and it appears that individuals who were delivered with CL or CP can benefit from the use of this index [18-20].

The study's objectives were to compare the effectiveness of the IOTN and DAI among non-syndromic CLP patients and determine the value of the DAI in assessing orthodontic treatment requirements and outcomes for patients with non-syndromic CLP.

## MATERIALS AND METHODS

This study was performed over three months, namely, from September to December 2022, after ethical clearance was received from Najran University. In this retrospective study, using a convenience sample of 160 non-syndromic CLP patients, a power analysis was made. The study's power was used to calculate the sample size, with 80% being taken into account.

The presence of CL and CP was the main inclusion criteria for the study. The criteria for exclusion included a patient's dental or maxillofacial injury history, the presence, and coexistence of general medical conditions that could affect orthodontic treatment, and documentation indicating that the patient's treatment had already concluded. In such circumstances, all plaster casts that have any kind of technical errors were not included, as were those casts to which substantial restorations had been made that rendered assessment difficult.

The CLP patients were usually referred from the Department of Plastic Surgery and the Department of Oral and Maxillofacial Surgery. All patients' data were recorded as sex, age, socioeconomic status, and other demographic data on a basic datasheet.

### DAI

The study dataset consisted of randomly chosen diagnostic models of patients with non-syndromic CLP. Good-quality models having permanent dentition were selected for the study.

One researcher, who was part of the study, employed simple randomization to select samples from the collected casts, and multiple measurements were conducted. Only one examiner who was trained by an expert specialist then analyzed the models. The DAI score was calculated as the sum of 10 components multiplied by their weight with the constant of 13 added. We utilized a periodontal probe with millimeter-scale markings to conduct the measurements. The recorded results were entered into a pre-established spreadsheet. The final results were automatically calculated by a program that organized the data on spreadsheets and then performed tabulated calculations. To eliminate biases, two measurements of models were made, seven days apart.

The measurement of DAI components was carried out in the following manner

### Number of missing teeth in each jaw, excluding molars

The number of missing premolars, canines, and incisors were counted in both dental arches. A missing tooth was

not counted as missing if the spaces between the teeth were closed. A lost tooth was not counted if a deciduous tooth was adequately positioned within the arch and its permanent replacement had not yet broken through.

#### **Crowding in incisal segments**

Incisal segment crowding occurs when there is not enough room between the left and right canines to allow all 4 incisors in their usual alignment. It is possible that teeth have rotated or shifted past the arch. The number of crowded incisor segments (each segment has four incisors in the lower or upper arch) was noted as 0 (no crowded segments), 1 (one crowded segment), or 2 (two crowded segments). A lower score was assigned if there was any doubt. The segment was not labeled as crowded if all four incisors were in position but one or both canines were misaligned.

#### **Spacing in incisal segments**

Spacing in incisal segments refers to a gap between the left and right canines that is not big enough to fit all four incisors in their proper alignment. The presence of spacing in the segment was identified when one or more than one incisal teeth exhibited proximal surfaces without contact with adjacent teeth. Results (0, 1, or 2) were recorded as in subsection II. When in question, the lower grade was assigned.

#### **Diastema width**

The distance between the mesial surfaces of the central upper incisors was measured to the nearest millimeter using a millimeter-scale periodontal probe.

#### **Largest abnormality within the maxilla**

An abnormality within the maxilla refers to a situation in which the upper incisal segment teeth are rotated or misaligned in relation to their usual position. A periodontal probe with millimeter graduations was used to measure the largest anomaly to the closest millimeter.

#### **Largest abnormality within the mandible**

The procedure conducted was similar to the one outlined in subsection V, with the exception that measurements were taken in the lower incisal segment.

#### **Anterior maxillary overjet**

In relation to the lower incisors, the anterior maxillary overjet represents the most prominent projection of the upper incisors, as determined by a periodontal probe with millimeter-level accuracy. When all of the maxillary incisors were removed or there was a lingual cross bite, this trait was not noted.

#### **Anterior mandibular overjet**

This characteristic was observed whenever a lower incisor slanted relative to an upper incisor. A periodontal probe was used to measure the narrowest inclination to the closest millimeter.

#### **Vertical anterior open bite**

This condition refers to the absence of any vertical overlap of the lower and upper incisors, measured to the nearest millimeter with a millimeter-scale periodontal probe. The gap between the upper and lower incisors' incisal edges was measured.

#### **Anteroposterior relationship of molars**

Given the following scores, the largest observed abnormality was noted (on the right or left side): 0 indicated the cusps' correct relationships, 1 the cusp's mesial or distal half displacement, and 2 the full cusp's mesial or distal displacement.

#### **Constant**

Scores for each component were multiplied by previously reported weights and a constant was added to obtain a final DAI score for each pair of study models and the findings were recorded in a predetermined form to evaluate the total score according to the DAI method. The constant equaled 13 according to previous research by Goyal et al, [21].

The resulting numerical values of the DAI were classified into four groups in terms of the need for orthodontic treatment:

Normal or mild malocclusion, with no or little need for orthodontic treatment (DAI  $\leq$  25),

Definite malocclusion with the optional need for treatment (DAI = 26–30),

Severe malocclusion with high need for treatment (DAI = 31–35), and

Very severe or handicapping malocclusion (DAI  $\geq$  36).

#### **IOTN Evaluation**

Since the patients were in the CLP category, they were considered Grade 5p according to the IOTN.

#### **Statistical Analysis**

The data were analyzed using the Statistical Package for Social Science software for Windows version 20.0, (SPSS, and Chicago, IL). Data were cleaned to ensure the accuracy of data transfer into the SPSS software. Descriptive statistics, including frequencies and percentages for categorical variables and means and standard deviations for quantitative variables, were calculated. The relationships between variables were assessed using Spearman's correlation coefficient. Linear regression analysis was used to evaluate the effects of different variables (e.g., age and gender) on the DAI scores.

## **RESULTS**

Since the 160 patients were in the CLP category, they all were considered Grade 5p according to the IOTN.

Fifty-five study participants (35 male, 20 female) had one missing tooth, 15 (1 male, 14 female) had two missing teeth, eight (7 male, 1 female) had three missing teeth,

**Table 1: Allocation of DAI components (Missing teeth, segments crowded, segments spaced, midline diastema).**

	Missing teeth				Segments crowded		Segments spaced		Midline diastema
	1	2	3	4	1	2	1	2	>1 mm
Male	35	1	7	0	21	7	28	28	14
Female	20	14	1	0	28	7	56	1	1
Total	55	15	8	0	49	14	84	29	15

**Table 2: Allocation of DAI components (anterior maxillary irregularity, anterior mandibular irregularity, maxillary overjet).**

	Anterior maxillary irregularity			Anterior mandibular irregularity		Maxillary overjet				
	1mm	2mm	3mm	1mm	2mm	1mm	2mm	3mm	4mm	5mm
Male	28	14	7	21	1	1	14	14	1	28
Female	42	14	1	7	7	7	14	21	35	1
Total	70	28	8	28	8	8	28	35	36	29

**Table 3: Allocation of DAI components (mandibular overjet, anterior overbite and anteroposterior relationship).**

	Mandibular overjet	Anterior overbite	Antero posterior relationship		
	>1mm	>1mm	Half cusp mesial or distal		Full cusp mesial or distal
Male	0	0	21		21
Female	0	0	0		49
Total	0	0	21		70

**Table 4: Allocation of DAI scores.**

DAI score	<=25	26-30	31-35	>=36
N	69	34	13	44
%	43.12	21.25	8.12	27.5

and none (0 male, 0 female) had four missing teeth.

One crowded segment was found in 49 study participants (21 male, 28 female), and two were found in 14 participants (7 male, 7 female). One spaced segment was found in 84 study participants (28 male, 56 female), and two were found in 49 participants (21 male, 28 female).

A midline diastema of >1 mm was found in 15 study participants (14 male, 1 female) [Table 1].

A 1-mm anterior maxillary irregularity was observed in 70 study participants (28 male, 42 female), a 2-mm irregularity in 28 participants (14 male, 14 female), and a 3-mm irregularity in eight participants (7 male, 1 female).

A 1-mm anterior mandibular irregularity was observed in 28 study participants (21 male, 7 female), and a 2-mm irregularity was observed in eight participants (1 male, 7 female).

Maxillary overjet of 1mm, 2mm, 3mm, 4mm, and 5mm were observed in eight (1 male, 7 female), 28 (14 male, 14 female), 35 (14 male, 21 female), 36 (1 male, 35 female), and 29 study participants (28 male, 1 female), respectively [Table 2].

A cusp's mesial or distal half displacement was found in 21 study participants (21 male), while a full mesial or distal displacement was found in 70 participants (21 male, 49 female) [Table 3].

Sixty-nine study participants (43.12%) had a DAI score ≤25, 34 (21.25%) had a DAI score of 26–30, 13 (8.12%) had a DAI score of 31–35, and 44 (27.5%) had a DAI score ≥36 [Table 4].

The mean DAI scores in males and females were 28.06± 8.48 and 29.44± 8.03, respectively. The mean DAI score in participants younger than 18 years of age was 29.65 ± 7.73, while the mean score was 28.76 ± 8.98 in participants older than 18.

Analysis of the DAI results by gender and age revealed no significant statistical correlation between DAI results and age or gender [Table 5].

According to the DAI assessment, 51.89% of the male and 75.30% of the female study participants needed no treatment, while 48.11% of the male and 24.70% of the female participants were highly desirable candidates for orthodontic treatment. Additionally, 60% of the study participants aged fewer than 18 and 70% of those aged over 18 required no treatment, while 40% of participants aged under 18 and 30% of those aged over 18 were highly desirable candidates for orthodontic treatment.

The analysis of requirements for orthodontic treatment according to gender and age found no statistically significant correlation of the need for orthodontic treatment with age or gender [Table 6].

**DISCUSSION**

Both the DAI and IOTN make an effort to recognize children who need orthodontic care and rate their needs in order to enhance their appearance and psychosocial status. Patients with clefts who have missing or misaligned teeth may struggle with practical problems, such as difficulties eating and biting, as well as esthetic issues. All these situations affect the DAI score, and it seems that those who were born with CL or CP can

Table 5: Findings of DAI by gender, age.

	Gender		Age	
	Male	Female	Below 18 years	18 years old or above
Mean± SD	28.06± 8.48	29.44± 8.03	29.65 ± 7.73	28.76 ± 8.98
Q1	21	23.6	25	21
Q3	38	34	32	38
T value	1.11		0.182	
P value	0.912		0.401	

Table 6: Requirement of treatment according to age and gender.

	Gender				Age			
	Male		Female		Below 18 years		18 years old or above	
	N	%	N	%	N	%	N	%
No treatment needed/elective	41	51.89	61	75.30	42	60	63	70
Highly desirable/ Mandatory	38	48.11	20	24.7	28	40	27	30
P value	0.56				0.99			

benefit from the use of this index.

The study's objectives were to compare the effectiveness of the IOTN and DAI among non-syndromic CLP patients and determine the value of the DAI in assessing orthodontic treatment requirements and outcomes for patients with non-syndromic CLP.

In the present study, according to the DAI assessment, 51.89% of male and 75.30% of female participants needed no treatment, while 48.11% of male and 24.70% of female participants were highly desirable candidates for orthodontic treatment. Additionally, 60% of the study participants under 18 and 70% of those over 18 required no treatment, while 40% of those under 18 and 30% of those over 18 were highly desirable candidates for orthodontic treatment. The analysis of the requirement for orthodontic treatment according to gender and age found no significant statistical correlation of the need for orthodontic treatment with age or gender.

The mean DAI scores in males and females were 28.06± 8.48 and 29.44± 8.03, respectively. The mean DAI score in participants under 18 was 29.65 ± 7.73, while the mean score was 28.76 ± 8.98 in participants over 18. Analysis of DAI results according to gender and age found no significant statistical correlation of DAI results with age or gender.

The literature contains many studies on the frequency of particular malocclusions in cleft patients. A detailed review of those studies found that hypodontia was identified as one of the most prevalent malformations in this group of patients.<sup>22-25</sup> The DAI takes into consideration cases in which spaces between teeth due to absent teeth are filled by adequate orthodontic therapy, in which case the initial component's value is zero. Nevertheless, it is occasionally viable to orthodontically repair this abnormality. This finding suggests that, despite the importance of the very first element and the elevated DAI score caused by this unusual circumstance, orthodontic intervention is not necessarily required. Interdisciplinary or prosthetic intervention should be considered in these circumstances [22-25].

The DAI was employed in a 2008 study by Shelton, Hobson, and Slater [26] that examined 57 models for the diagnosis of hypodontia patients. These individuals had a mean DAI score of 42, which signifies significant malocclusion. The authors concluded that the DAI was suitable for studying patients with hypodontia and recommended the use of interdisciplinary care in these situations. The present researchers also claimed that patients with hypodontia have a dearth of usable markers, which offers another justification for conducting more studies that adjust for missing teeth using DAI. Adult patients with cleft need multidirectional therapy, and only such treatment may produce good results, according to research by Connolly et al., [27]. By examining the information obtained in a study conducted as well as the treatment requirements of 142 adult individuals with clefts, the authors showed that patients had consistent and enduring care needs spanning various medical specialties. Even after receiving therapy, over 30% of the patients still expressed discontent with malocclusion.

This study has several implications. A patient or group of patients can quickly and easily find out whether they need orthodontic treatment and how severe their malocclusion is using the DAI. The DAI is unique in that it produces a single grade that accounts for both function and esthetics for a particular patient. The DAI has been used in numerous epidemiological studies on substantial patient populations to evaluate the need for orthodontic care in a specific age range, ethnic community, country, or region. Since a dentist or trained assistant can determine the DAI score with an intraoral examination or by utilizing a diagnostic model without using radiographic images, it seems to be a highly useful indicator. The DAI evaluates 10 occlusion-related variables that affect the smile and appearance of the face, which are thought to be the primary drivers of patient visits to dental offices. Thus, it is possible to rank cases from lowest to highest levels of care they require. Consequently, the DAI rating can serve as a means to assess, for instance, which patients' healthcare costs should be subsidized by the government.

There were some recommendations and takeaways from this study. Only a comprehensive strategy including a team composed of an ENT expert, paedodontist, plastic surgeon, speech therapist, psychologist, prosthodontist, orthodontist and maxillofacial surgeon can address the unique needs of a cleft patient. The lengthy therapeutic process for a child with a cleft begins with educating the child's relatives. The newborn can be fed properly and obtain the necessary amounts of nutrients. This is crucial because a kid with a cleft may experience growth delays as a result of anatomical and functional challenges. Early intervention therapy emphasizes plastic surgery and speech development.

Although in many situations the timing for the proper intervention can be even earlier, the initiation of orthodontic therapy is typically associated with the eruption of the secondary teeth. Later, teenagers also require more orthodontic care, plastic or orthognathic surgery, and prosthetic restorations. These procedures are time- and money-consuming and lower the patient's quality of life [28].

Compared to persons without this problem, adults with clefts following treatment report less satisfaction with their looks. Using the DAI index helps in determining the look of the teeth and occlusion disruptions that may affect how one perceives oneself. It should not be overlooked that there was facial discontent the primary factor behind depressive symptoms in cleft individuals, and within the team of experts, a psychologist can fulfill a vital role [29].

There were some limitations of this study. It was a retrospective *in vitro* study. The results correspond to the orthodontic models and previous records. The results might have some difference when conducted over actual patients. Moreover, there was a limitation in the assessment of the psychological impact of malocclusion in non-syndromic cleft lip /palate patients. Therefore, more *in vivo* studies should be performed in the future [30].

### CONCLUSION

The DAI can be used to successfully identify individuals who still need care after receiving orthodontic intervention and can help establish whether the therapy was successful. It may also be employed to contrast models before and after therapy. Elevated DAI values result from the presence of multiple missing teeth or a deficiency of multiple teeth in the broader population of non-syndromic CLP patients. The DAI indicates that prosthetic intervention, rather than orthodontic intervention, is required for these patients.

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