

Determination of Combination Factor as an Aid in Orthodontic Treatment Planning in Western Region of Saudi Arabian Young Male Population- A Retrospective Cephalometric Study

RAGHU DEVANNA¹, NAYEF H FELEMBAN², YOUSEF ALTHOMALI³, PUNEET GUPTA⁴

ABSTRACT

Introduction: Diagnosis and treatment planning in orthodontics determines the treatment outcome and long term stability. Cephalometric radiography is an essential diagnostic aid in orthodontics and hence numerous studies have been carried out in the past.

Aim: To determine the Combination Factor (CF) through evaluation of the mean Overbite Depth Indicator (ODI) and Anteroposterior Dysplasia Indicator (APDI) values in western region of Saudi Arabian young male patients which would act as an aid in orthodontic treatment planning.

Materials and Methods: A retrospective cephalometric study was conducted on 80 Saudi Arabian young male patients ranging in age from 7 to 14 years. Data was collected from records derived from the University Dental Hospital. Patients (n=80) were divided into four age groups: ages 7 (n=20), 8-9 (n=20), 10-11 (n=20), and 12-14 (n=20) years. Lateral cephalometric images were hand-traced and measured by one standardised and calibrated investigator. Statistical analysis was done with

significance level set at 0.05, assuming that the length of the 95% confidence interval was two. One-way analysis of variance, followed by the Tukey test used to compare the mean ODI and APDI values of different groups. The statistical data were analysed through SPSS version 24 for Windows (IBM SPSS, Chicago, IL, USA).

Results: The mean ODI value was 69.2688° and standard deviation 4.66670°, respectively. The overall APDI mean value was 81.7063° and standard deviation 4.18987°, respectively. There were no significant differences in the mean ODI and APDI values among different age groups ($p>0.05$).

Conclusion: This retrospective cephalometric study determined the CF for western region of Saudi Arabian young male population to be 150.96°. This factor can be used as a diagnostic aid for planning orthodontic treatment. When the CF, is under the norm (150.96°), the skeletal pattern tends to improve with dental extractions. A CF higher than the norm (150.96°) will maintain a better relation with a non-extraction treatment.

Keywords: Anteroposterior dysplasia indicator, Lateral cephalometric radiography, Overbite depth indicator

INTRODUCTION

Orthodontic diagnosis and treatment planning involves use of essential and supplementary diagnostic aids. There are many adjunctive diagnostic aids like study model analysis, cephalometric analysis and photographic analysis. Occlusal indices have been introduced and used to rank or categorise the occlusion. Index of Orthodontic Treatment Need (IOTN), Dental Aesthetic Index (DAI), Handicapping Labio-Lingual Deviation index (HLD), and the Index of Complexity, Outcome and Need (ICON) are some of the major indices used in orthodontics [1]. Cephalometric radiography is a technique to radiographically image the skull. Lateral Cephalometric Radiography (LCR) is a standardised 2D imaging technique used in dentistry. Introduced in 1931, LCR has since then become a popular tool to study oromaxillofacial growth and development [2]. LCR and panoramic radiography are 2D imaging techniques. With the advent of 3D imaging, the cone-beam computed tomography, studying the craniofacial region has become much easier, contributing significantly to the clinical decision-making process. Still, 2D imaging is widely employed in daily orthodontic practice [3]. Orthodontists have long been interested in studying the correlation between malocclusion and facial form/structure, human craniofacial growth and development, and the determinants affecting them. LCR has rapidly emerged as an important tool to study these aspects and plan treatment henceforth.

Cephalometric analysis has been used to study differences in the

dental and skeletal structures of people belonging to different racial and ethnic groups [2,4]. Data collected over the years are used to establish the standard mean values for different racial populations. An individual's measurements can then be compared to the population mean values of facial parameters to objectively quantify the deviations from an ideal dental-cranial base relationship. Behrents RG has documented the skeletal and dental developmental changes that occur throughout adulthood [5]. Standard values for white adolescents have also been reported [6-14]. Since, it is well established that skeletal and dental features differ between races and ethnic groups and that a single standard cannot be applied to all [15-17]. Researchers have compared these characteristics of different races with the whites to establish values that can be useful for populations with diverse ethnicities [18]. Standard data for some Middle Eastern populations such as Iranians [19], Saudi Arabian, [20,21] and Egyptians [22,23] are also available.

Kim YH introduced the ODI in 1974 [24] and APDI in 1978 [25] to assess various components of malocclusion. The author examined LCRs from 119 normal occlusion white subjects (aged between 7-14 years) and 500 whites with untreated malocclusion. The study demonstrated a high correlation between incisal overbite depth and ODI, with a mean ODI of 74.58±6.08 for the sample with clinically normal occlusion, differing significantly from those without malocclusion. The mean APDI of subjects with normal occlusion was reported as 81.48±3.79; values lesser than mean indicated Class II malocclusion, while higher values indicated Class III malocclusion.

Various methods are available to analyse cephalometric data to diagnose discrepancies leading to dental malocclusion but with a variable probability [26]. Han SH and Park YS and Wen YF et al., showed that ODI and APDI are of superior diagnostic value in objective identification of the deviations in skeletal structure resulting in malocclusion [27,28]. The CF was proposed by Kim YH and the author determined this factor for whites which is 155.9° (sum of averages of ODI and APDI) [26]. It is immensely valuable in clinical practice for planning an orthodontic patient for extraction or nonextraction treatment approach. The mean ODI and APDI data of whites and Asians races are available [28,29]. There is no data available for the Saudi Arabian population as it represents a largest ethnic group in the Middle East Asia. Hence, this study aimed to determine the CF for Saudi Arabian population by obtaining ODI and APDI values as different racial groups show differences in dento-skeletal and cephalometric characteristics [28,30], this study hypothesised significant differences between the values.

MATERIALS AND METHODS

This is a retrospective cephalometric study conducted on 29th October 2020. Medical records of the year 2018, 2019 and 2020 till the date of study conducted were used to retrieve data from the Faculty of Dentistry, Taif University Dental Hospital, Taif, Saudi Arabia. An ethical approval from the Ethical Decision Committee of the institution was obtained with approval number TUDENT-20-006 for using the lateral cephalometric radiographs for the purpose of the study.

Sample Size Calculation

A sample size of 80 was estimated based on power analysis [29]. Applying power analysis, with α error at 5%, and 95% confidence intervals of ± 2 , the above sample attained 80% power. Eighty Saudi Arabian males aged 7-14 years were chosen for the study.

Inclusion criteria: Due to issues with the availability of a sufficient number of radiographs, only male participants could be recruited. Subjects were included if: 1. Good diagnostic quality radiographs were available; 2. Angle's Class I molar relationship; 3. Normal occlusion; and 4. Absence of dental treatment history.

Exclusion criteria: Those with malocclusion (spacing and crowding), Angle's Class II or Class III malocclusion, and ethnicity other than Saudi Arabian were excluded.

The subjects were categorised, 20 in each group, based on their age as up to 7 years, 8-9 years, 10-11 years, and 12-14 years.

The variables calculated were ODI and APDI [Table/Fig-1]. A single experienced and trained investigator hand-traced and measured the landmarks on the radiographs. The cephalometric points and planes used for the Kim's cephalometric analysis explained in the [Table/Fig-2]. The mandibular plane (containing menton and gonion), A-B plane (by joining point A and point B), palatal plane (formed by joining anterior (ANS) and posterior (PNS) nasal spines), and Frankfort horizontal (FH) plane were denoted to do the measurements. ODI was calculated by adding two angles-the first formed by joining the A-B plane to the mandibular plane, and the other formed by joining the palatal and the FH plane (PP-FH angle) [Table/Fig-3] [24]. With respect to the FH plane, when the palatal plane (PNS-ANS) sloped upward in anterior direction, the PP-FH angle was subtracted from the ODI. Conversely, if the palatal plane sloped downward in anterior direction (ANS), the PP-FH angle value was added to the ODI. The APDI depends on two interplanar angular measurements, measured as the angle formed between the A-B and the palatal plane [Table/Fig-3] [24,25].

The primary investigator repeated the procedure after one week on 16 radiographs, which were randomly selected from the present sample to check for intra-observer reliability. For inter-observer

Age (years)	Variable	n	Mean (degrees)	SD (degrees)
7	ODI	20	71.2750	3.51865
	APDI	20	81.1750	2.32987
8-9	ODI	20	68.7250	3.28263
	APDI	20	82.5000	3.13302
10-11	ODI	20	67.6250	4.01273
	APDI	20	81.7750	2.35905
12-14	ODI	20	69.4500	6.62313
	APDI	20	81.3750	7.14856
Total	ODI	80	69.2688	4.66670
	APDI	80	81.7063	4.18987

[Table/Fig-1]: Descriptive statistics of ODI and APDI values for the total study sample.

APDI: Anteroposterior dysplasia indicator; n: Number of patients; ODI: Overbite depth indicator; SD: Standard deviation

Cephalometric points	Definition
Porion (Po)	A point located at the most superior point of the external auditory meatus, which is located on the odontoid process axis and passes through basion point
Orbitale (Or)	A point located at the lowermost point on the infraorbital margin in the middle of the lower boundaries of both orbits
Anterior Nasal Spine (ANS)	A point located at the apex of the anterior nasal spine of the maxilla on the lower margin of the nasal cavity
Posterior Nasal Spine (PNS)	A point located at the posterior limit of the hard palate at the palatine bone junction
Menton (Me)	A point located at the lower and posterior limits of the mental symphysis curvature at the point where the lower border of the symphysis connects the inferior border of the mandibular body
A Point (A)	The point of the deepest concavity anteriorly on the maxillary alveolus. To locate point A more easily, a line was performed from ANS to the most prominent point of the alveolar ridge in the upper incisor cervical region. Point A was drawn in the deepest part of the Alveolar profile in relation to the mentioned line.
B Point (B)	The point of the deepest concavity anteriorly on the mandibular symphysis.
Cephalometric planes	Definition
Frankfort Horizontal Plane (FH)	This plane cross porion and orbitale points
Palatal plane (PP)	This plane cross ANS and PNS points
Mandibular Plane (MP)	Formed by a line that connects the chin to the lower and posterior border of the mandibular body
A-B plane	This plane cross A and B points

[Table/Fig-2]: Cephalometric points and planes.

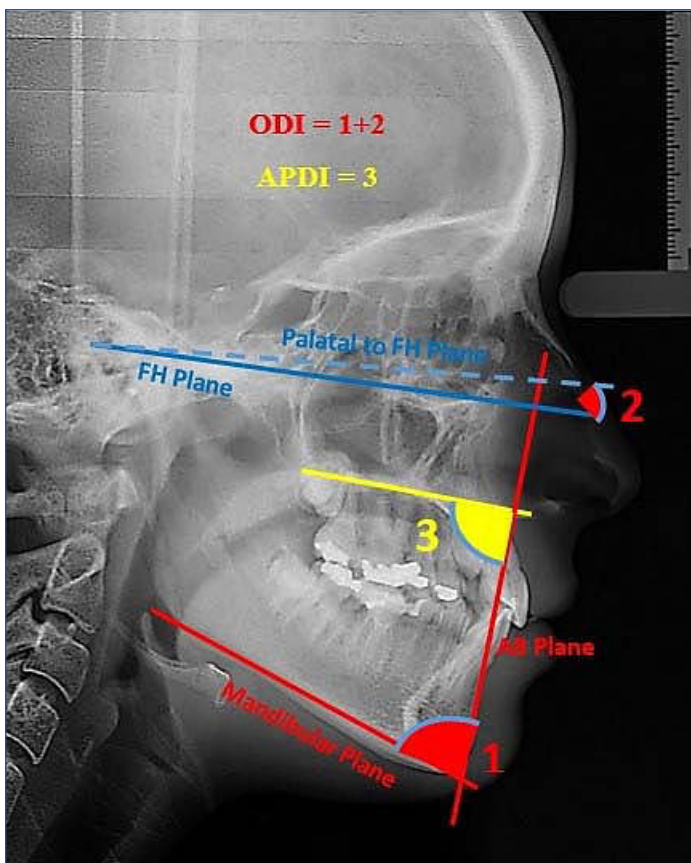
reliability, a second investigator independently performed the same procedure on 16 randomly selected radiographs. The values for both intra-observer and inter-observer reliabilities were high Concordance Correlation Coefficient (CCC) and were above 0.95.

STATISTICAL ANALYSIS

Statistical Package For The Social Sciences (SPSS) version 24 for Windows (IBM SPSS, Chicago, IL, USA) software was used for the analysis. Besides, the descriptive analyses for ODI and APDI estimations, One-way ANOVA, at $p < 0.05$, followed by the Tukey-Kramer post-hoc testing were used to compare the different Saudi Arabian groups. Intra-observer and inter-observer reliabilities were calculated using Lin's Concordance Correlation Coefficient (CCC) [31].

RESULTS

The results of the present study determined the CF of 150.96° for Saudi Arabian young male population [Table/Fig-4]. A mean age of



[Table/Fig-3]: Kim's cephalometric analysis - ODI and APDI angles.

Male (n)	Variable	n	Mean (degrees)	SD (degrees)	Median (degrees)	Min (degrees)	Max (degrees)
80	ODI	80	69.2688	4.66670	69.0000	57.00	79.00
80	APDI	80	81.7063	4.18987	82.5000	61.00	93.00
	CF Value = ODI+APDI		150.96	8.84			

[Table/Fig-4]: Descriptive statistics of ODI and APDI values for the total sample; APDI indicates Anteroposterior Dysplasia Indicator. Min: Minimum; Max: Maximum; N: Number of patients; ODI: Overbite depth indicator; SD: Standard deviation; CF: Combination factor

9.8±1.5 years was recorded. Descriptive statistics for the measured values for a full sample and group-wise analysis are represented in [Table/Fig-1,4].

ODI

The full sample ODI values ranged from 57° to 79°. The mean value was 69.26±4.67 [Table/Fig-1]. Between group analysis showed no significant differences (F=2.263, p=0.088) in the mean ODI values for Saudi Arabian male belonging to different age groups [Table/Fig-5].

ANOVA Result for ODI values					
Parameters	Sum of Squares	df	Mean Square	F	p-value
Between Groups	141.109	3	47.036	2.263	0.088
Within Groups	1579.363	76	20.781		
Total	1720.472	79			

[Table/Fig-5]: Comparative statistics of ODI values for the total samples within the study groups and between the different age groups. ANOVA followed by post-hoc tuckey test with Significance value set at <0.05; ODI: Overbite depth indicator, df: degree of freedom

APDI

The APDI values (n=80) ranged from 61° to 93°. The APDI values for the full sample [Table/Fig-1] were 81.71±4.18. The between group analysis resulted in no significant differences among different age groups with p-value 0.767 (p>0.05) [Table/Fig-6].

ANOVA Result for APDI values					
Parameters	Sum of Squares	df	Mean Square	F	p-value
Between Groups	20.534	3	6.845	0.381	0.767
Within Groups	1366.313	76	17.978		
Total	1386.847	79			

[Table/Fig-6]: Comparative statistics of APDI values for the total sample within the study groups and between the different age groups. ANOVA followed by post-hoc tuckey test with significance value set at <0.05; APDI: Anteroposterior dysplasia indicator; df: degree of freedom

DISCUSSION

This study aimed to retrospectively study and determine CF through establishing normal cephalometric values, ODI and APDI, for the western Saudi Arabian male population. Since, the only available standard cephalometric values are based on the whites and the Asians, the facial and skeletal features are affected by racial/ethnic differences, this study chose to study the Saudi Arabian population in this respect.

Different races and ethnic groups represent different skeletal structures and dento-facial attributes [27-31]. The present study shows no statistical difference between the groups, regarding the ODI as well as APDI measure. A study done on Latin American population [32] also found similar results when ODI values were compared to white by Kim on Caucasian individuals, the results were slightly hyper divergent. Similar results were found in this study regarding ODI, although they were statistically not significant. Racial differences in the composition of each sample may have attributed to this finding. Similar results were found by Freudenthaler J et al., in Japanese and European, by Jones OG in an African American sample, by Kim JY et al., in Korean individuals, by Saloom JE in Iraqis, as well as by Romero M and Castañeda T in Mexicans [29,33-37].

A study done on African-Americans found statistically significant lower mean values of ODI and APDI as compared to mean values for the white patients [38]. The present study was done on exclusively young males and hence result could not be compared to these studies. Future study is recommended for such comparison by inclusion of both the genders for determining the values of ODI and APDI for Saudi Arabian population.

The CF measurement obtained by the sum of ODI, and APDI. The norm is 155.9° for whites [25] and represents the balance of both dimensions (Vertical-Horizontal). In the present study done on Saudi Arabian young male population, the sum of ODI and APDI show a value of 150.96°. CF is useful in preparing orthodontic treatment plan. When the CF, is under the norm (150.96°), the skeletal pattern tends to improve with dental extractions, but it is understood that it must analyse some other aspects to define this possibility. The other aspects like lip-to-tooth relationship and inter-incisal angel must also play a role in decision of extractions. On the other hand, a CF higher than the norm (150.96°) will maintain a better relation with a nonextraction treatment. The higher the CF, there will be a facial balance both in horizontal and vertical dimensions as determined by the ODI and APDI values.

Limitation(s)

The CF, ODI and APDI were determined for Saudi Arabian male population. Lack of availability of sufficient radiographs barred the authors from studying the female gender, and the effect of gender on dental, facial, and skeletal profile. The gender differences exist as the skeletal and dental features differ significantly between the genders. Further research recommended in this regard which could highlight the gender variation that may affect the CF, ODI and APDI values. The other major limitation of this study, was to not able to compare to the studies done on other ethnic groups. As the present study was done only on determining ODI, APDI and CF values of

Saudi Arabian young male population, this limited the possibility of such comparison. The results of this study must be used with caution as the other soft tissue factors such as lip-to-tooth relation and inter-incisal angles were not considered in determining CF.

CONCLUSION(S)

This retrospective cephalometric study determined the CF for Western region of Saudi Arabian young male population to be 150.96°. This factor can be used as a diagnostic aid for planning orthodontic treatment. Further studies are recommended in future for determining the role of soft tissues in this aspect.

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PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Preventive Dentistry, Faculty of Dentistry, Taif Saudi Arabia, Makkaha, Saudi Arabia.
2. Associate Professor, Department of Preventive Dentistry, Faculty of Dentistry, Taif Saudi Arabia, Makkaha, Saudi Arabia.
3. Associate Professor, Department of Preventive Dentistry, Faculty of Dentistry, Taif Saudi Arabia, Makkaha, Saudi Arabia.
4. Reader, Department of Community Dentistry, Government College of Dentistry, Indore, Madhyapradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Raghu Devanna,
HUWAYA, Taif Saudi Arabia, Makkaha, Saudi Arabia.
E-mail : drraghu@tudent.edu.sa

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