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Investigating validity and reliability of visual inspection of lateral cephalometric radiography (lcr) evaluation in determining dento-skeletal characteristics

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Abstract: Introduction: Over the past two decades, orthodontists have performed many studies on facial profiles and the results of these studies have emphasized the use of profile view to detect orthodontic malocclusions. Some studies consider lateral cephalometric radiography (LCR) as the best method to examine the profile view. It is about a century that lateral cephalometry was introduced and then used as a standard instrument for diagnosis and treatment of orthodontic treatment. Today, it is also necessary to use it in the orthodontic treatment. Cephalometric tracing or template method is used as the standard lateral cephalometric assessment method. Tracing is done because it reduces the amount of information on the film to a considerable extent and prepares cephalograms for subsequent analyzes. Despite the fact that LCR is already prescribed prior to orthodontic treatments in many European countries, very few orthodontic treatments are based on data from cephalometric analysis.The purpose of this study was to determine the validity and reliability of visual inspection of the LCR in determining dento- skeletal characteristics. **Materials and Methods**: A total of 30 cephalograms were randomly selected from among patients in the last 5 years of orthodontics department ward of Tabriz Dental Faculty. LCRs were provided to 5 orthodontists who were asked to provide their diagnosis using visual method. This stage was repeated again after 1 month. In the next stage, cephalometric analyzes were performed for these radiographs and these analyzes along with cephalograms were provided with 3 orthodontists and a definitive diagnosis regarding the dento-skeletal conditions was obtained (reference data). Finally, the data obtained from both stages were compared for each patient separately and with reference data.The obtained data were evaluated by descriptive statistics and inter-observer reproducibility and intra-observer reproducibility were calculated using Fleiss' kappa test and weighted kappa test, respectively. **Results**: The least and highest intra-observers agreement for the 12 studied items was related to the relationship of maxilla to cranial-base with a mean agreement of 0.329 and the intermaxillary relationship with the mean agreement of 0.643, respectively. The least and the most inter-observer agreement were related to the relationship of maxilla to cranial-base, with an agreement of 0.465 and maxillary rotation, with agreement of 0.559, respectively. The least and the highest validity among the 12 items studied was related to Ramus size with validity of 0.123, relationship between the upper incisors and maxilla with a validity of 0.531, respectively.

Keywords: Visual inspection, repeatability, agreement, validity, lateral cephalometry "The authors declare that there is no conflict of interest regarding the publication of this paper."

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Introduction:

Evaluation of skeletal relationships in the sagittal dimension is one of the essential steps to diagnose and present appropriate treatment plans. Orthodontists usually use lateral cephalometric radiography (LCR).

Several geometric methods are proposed for the cephalometric evaluation. The cephalometry was presented as an anthropologic technique for determining the shape and size of the skull by Broad Bent in 1931. The lateral cephalometry is very important for growth, diagnosis, treatment planning and therapeutic evaluation (1).

Over the past two decades, orthodontists have carried out many studies about facial profiles. The result of these studies emphasizes the use of facial profile to detect orthodontic malocclusions. Some studies consider LCR as the best method to examine the facial profile (2).

It is about a century that lateral cephalometry method was introduced and then used as a standard tool for diagnosis and treatment of orthodontic treatment (3). Today, it is also necessary to use it in the orthodontic treatment (4, 5). In fact, LCR is a two-dimensional image of a 3D object that shows the facial profile in two anterior-posterior and vertical dimensions in the following items (6):

1- Craniofacial series
2- Soft tissue profile
3. Dental relationships
4. Throat duct
5- Cervical vertebrae

The objective of new cephalometric analysis is to evaluate the functional unit relationships and to carry out the necessary steps to determine the vertical or horizontal positions of each unit (7).

Cephalometric tracing or template method is used as the standard lateral cephalometric assessment method (8). Tracing is carried out because it reduces the amount of information on the film to a considerable extent and prepares cephalograms for subsequent analyzes. After doing the tracing, the anatomical landmarks are selected and connected to each other to determine the angles and lines as well as identify the dento-skeletal relationships. Finally, the information obtained from the tracing or template method is interpreted manually or digitally (7).

The truth is, in cases where the results of cephalometric assessments are not consistent with the clinical inference of orthodontist; each orthodontist prefers the results of their clinical observation on the results of cephalometric evaluation methods; because clinicians seem to attach less value to the cephalometric results if he they are inconsistent with their own clinical judgment (9). Despite the fact that LCR is already prescribed prior to orthodontic treatments in many European countries, a very small percentage of orthodontic treatment is based on data from cephalometric analysis (5). Therefore, we decided to investigate the consistency between visual inspection of cephalograms with the results obtained from cephalometric analyzes, the amount of agreement among the results

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of the observers' evaluations and the results reproducibility at different times of observation by an orthodontist. any misdiagnosis can lead to an incorrect or at least longer treatment process and imposes a lot of financial and physical expenses on patients.

Methods and material:

To conduct this study, a pilot study with 3 clinicians was performed first. The maximum inter-observer agreement was calculated to be 0.81 among 12 items. Then, to do this study by using the sample size agreement formula (Walter et al.) and consideration $\alpha = 0.05$, power = 80, $\rho 0 = 0.8$ and $\rho 1 = 0.65$, 23 samples were obtained at level of 5 observers. In this study, 30 samples and 5 observers were used to increase the power of study (10, 18, 19).

In this study, lateral cephalograms of patients from those referring to the Tabriz University of medical science, Dental Faculty branch in the last 5 years were numbered and selected by simple random sampling method. 30 samples were selected according to the obtained random numbers from www.randomizer.org, Exclusion criteria for selected cephalograms are mentioned below:

1. Severe skeletal deformities, such as cleft palate
2. Cephalogram prepared with open mouth
3. Cephalogram with no appropriate quality
4. Non-digital cephalogram
5. Cephalogram not taken in NHP mode.

For each cephalogram removed, a cephalogram was replaced in the manner described.

The lateral cephalograms were provided to five orthodontists to detect horizontally, vertically and dentally, through visual inspection (T1). After 1 month, this step was repeated for comparison (T2).

The samples were also analyzed by an undergraduate student in Steiner, Downs, McNamara, wits methods and measurement of angles and lines, such as saddle angle, jarabak index, basal angle, gonial angle, inclination angle, LAFH/TAFH, U1 to pal,U1 to SN, Corpus length and Ramus length were taken and the validity of the evaluations was verified by a Professor.

The results of these analyzes were provided to 3 clinicians who separately performed the necessary studies on the 12 research variables, and sequentially classified the quantitative results on the angles and the measurements of analyzes in accordance with Table 1. For example, the protrusion or retrusion of the teeth were classified in one of the 5 specified states in the Table 1-3:

- SEVERE-MODERATE PROTRUSION
- MODERATE-MILD PROTRUSION
- NORMAL
- MILD-MODERATE RETRUSION
- MODERATE-SEVERE RETRUSION

Then, in a meeting session in which the 3 clinicians agreed on each variable, this comment was selected as Technical Guide (TG) and the disputed item was removed in cases where the opinions

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of the three were different. In cases where 2 clinicians had the same opinion, and the third one had a different, If the third one was also considered with the two other clinicians, the outcome was chosen as TG; however, if he(third clinician) still had a different opinion, the fourth clinician was participated in the research process with regard to the disputed variable. When his opinion confirmed the opinion of the two clinicians, that opinion was chosen as TG, but in case of different opinion, this item was excluded. 2 of the 360 items examined were excluded at the TG stage. At the TG stage, we sometimes encountered cases where borderline conditions existed, and the clinicians considered 2 or something between the 2 options in the questionnaire as correct options. In this case both options were considered to be correct and 40 out of 360 the studied items had the same condition. Technical Guide (TG) was obtained using this method.

Table 1: Questionnaire

Intermaxillary relationship	**CLII SEVERE-MOD**	**CLII MOD-MILD**	**CLI**	**MILD-MOD CLIII**	**MOD-SEVERE CLIII**
Maxillary- cranial-base relationship	**SEVERE-MOD PROTRUSION**	**MOD-MILD PROTRUSION**	**NORMAL**	**MILD-MOD RETRUSION**	**MOD-SEVERE RETRUSION**
Mandible - cranial-base relationship	**SEVERE-MOD PROTRUSION**	**MOD-MILD PROTRUSION**	**NORMAL**	**MILD-MOD RETRUSION**	**MOD-SEVERE RETRUSION**
The relationship between maxillary incisors and maxillary bone	**SEVERE-MOD PROTRUSION**	**MOD-MILD PROTRUSION**	**NORMAL**	**MILD-MOD RETRUSION**	**MOD-SEVERE RETRUSION**
The relationship between maxillary incisors and face	**SEVERE-MOD PROTRUSION**	**MOD-MILD PROTRUSION**	**NORMAL**	**MILD-MOD RETRUSION**	**MOD-SEVERE RETRUSION**
The relationship between mandibular incisors and mandibular bones	**SEVERE-MOD PROTRUSION**	**MOD-MILD PROTRUSION**	**NORMAL**	**MILD-MOD RETRUSION**	**MOD-SEVERE RETRUSION**
The relationship between mandibular incisors and face	**SEVERE-MOD PROTRUSION**	**MOD-MILD PROTRUSION**	**NORMAL**	**MILD-MOD RETRUSION**	**MOD-SEVERE RETRUSION**
	SEVERE-MOD VERTICAL	**MOD-MILD VERTICAL**	**NORMAL**	**MILD-MOD HORIZONTAL**	**MOD-SEVERE HORIZONTAL**

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Vertical growth pattern					
Maxillary rotation	**SEVERE-MOD CLOCKWISE**	**MOD-MILD CLOCKWISE**	**NORMAL**	**MILD-MOD CONT-CLOCKWISE**	**MOD-SEVERE CONT-CLOCKWISE**
Mandible rotation	**SEVERE-MOD CLOCKWISE:1**	**MOD-MILD CLOCKWISE**	**NORMAL**	**MILD-MOD CONT-CLOCKWISE**	**MOD-SEVERE CONT-CLOCKWISE**
LAFH	**SEVERE-MOD DECREASED**	**MOD-MILD DECREASED**	**NORMAL**	**MILD-MOD INCREASED**	**MOD-SEVERE INCREASED**
Ramus size	**SEVERE-MOD DECREASED**	**MOD-MILD DECREASED**	**NORMAL**	**MILD-MOD INCREASED**	**MOD-SEVERE INCREASED**

Data Analyses

Data (T1 and T2) were compared with TG and analyzed by descriptive statistical methods using MedCalc ver.16, SPSS ver.19 and www.justusrandolph.net/kappa.

Results:

The data analysis was performed from two points:

3-1: investigation the intra-observer agreement by comparing the first observation of each observer by observing his second observation

In this section, Cohen's weighted kappa test weighed was used to evaluate the first observation of each observer with his second observation, and the intra-observer agreement was achieved for each observer. (Table 2). For example, the intra-observer agreement value of 0.485 was obtained for the first observer on the inter-maxillary relationship, which was considered moderate

according to Landis and Koch's classification.

Landis and Koch defined the six levels of agreement for determining the quality scale for different degrees of agreement (table 2) (11).

After these results were analyzed using Cohen's weighted kappa test, descriptive statistics were obtained using SPSS ver.19. For example, with respect to the inter-maxillary relationship, the mean±SD of 0.643±0.090 obtained for the intra-observer agreement, which, is within the (substantial) range according to the Landis and Koch's classification the results of the remaining items are shown in Table 2:

Table 2: Landis and Koch-Kappa's Benchmark Scale for classifying agreement levels

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Agreement level	Statistical grade
0.00<	Poor
0.00.0.20	Slight
0.21-0.40	Fair
0.41-0.60	Moderate
0.61-0.80	Substantial
0.81-0.1	Almost perfect

Table 3: Intra-observer agreement for 5 observers

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	First observer				Second observer				Third observer				Fourth observer				Fifth observer			
	Landis / Koch classification	Weighted Kappa	standard error	Max-Min	Landis / Koch classification	Weighted Kappa	standard error	Max-Min	Landis / Koch classification	Weighted Kappa	standard error	Max-Min	Landis / Koch classification	Weighted Kappa	standard error	Max-Min	Landis / Koch classification	Weighted Kappa	standard error	Max-Min
Ramus size	Fair	0/243	0/131	-0.0124-0/499	Moderate	0/423	0/135	0/158-0/689	Moderate	0/487	0/11	0/271-0/702	Fair	0/24	0/162	-0.176-0/557	Fair	**0/316**	**0/159**	0/003-0/628
LAFH	Fair	0/313	0/132	0/0529-0/572	Substantial	0/611	0/107	0/402-0/821	Moderate	0/599	0/107	0/389-0/809	Fair	0/321	0/116	0/0937-0/549	Moderate	**0/578**	**0/113**	0/357-0/800
Mandible rotation	Substantial	0/631	0/1	0/435-0/828	Moderate	0/438	0/129	0/186-0/690	Substantial	0/614	0/099	0/421-0/807	Moderate	0/558	0/1	0/362-0/754	Moderate	**0/503**	**0/116**	0/275-0/730
Maxillary rotation	Moderate	0/411	0/112	0/192-0/630	Moderate	0/469	0/139	0/197-0/741	Moderate	0/512	0/139	0/240-0/784	Moderate	0/52	0/131	0/264-0/776	Fair	**0/236**	**0/153**	-0.662-0.0535
Growth vertical pattern	Moderate	0/42	0/125	0/175-0/666	Substantial	0/618	0/106	0/410-0/826	Substantial	0/716	0/092	0/537-0/896	Moderate	0/604	0/098	0/411-0/796	Moderate	**0/535**	**0/122**	0/297-0/774
The relationship between mandibular incisors	Moderate	0/505	0/121	0/268-0/742	Moderate	0/488	0/124	0/245-0/732	Fair	0/382	0/136	0/116-0/649	Moderate	0/473	0/098	0/281-0/665	Moderate	**0/595**	**0/134**	0/333-0/856
and face	Substantial	0/611	0/087	0/441-0/781	Moderate	0/455	0/127	0/206-0/703	Substantial	0/701	0/107	0/492-0/911	Substantial	0/632	0/101	0/434-0/831	Moderate	**0/531**	**0/145**	0/246-0/816
The relationship between mandibular incisors	Moderate	0/5	0/103	0/298-0/702	Moderate	0/537	0/087	0/367-0/707	Fair	0/302	0/143	0/0224-0/582	Moderate	0/505	0/121	0/267-0/742	Substantial	**0/636**	**0/105**	0/431-0/841
and mandibular bone	Substantial	0/64	0/087	0/470-0/809	Moderate	0/425	0/097	0/236-0/615	Substantial	0/671	0/116	0/444-0/898	Moderate	0/511	0/126	0/264-0/759	Substantial	**0/764**	**0/091**	0/586-0/942
The relationship between maxillary incisors	Moderate	0/586	0/086	0/418-0/755	Moderate	0/461	0/11	0/246-0/676	Substantial	0/656	0/109	0/442-0/871	Substantial	0/608	0/103	0/406-0/810	Moderate	**0/431**	**0/136**	0/165-0/697
and the face	Fair	0/22	0/118	-0/010-0/451	Fair	0/226	0/183	-0/133-0/585	Fair	0/232	0/139	-0.0411-0/505	Moderate	0/407	0/137	0/139-0/675	Moderate	**0/564**	**0/102**	0/364-0/764
The relationship between maxillary incisors and maxillary bone	Moderate	0/485	0/113	0/263-0/706	Substantial	0/712	0/091	0/533-0/892	Substantial	0/663	0/089	0/489-0/837	Substantial	0/67	0/113	0/447-0/892	Substantial	**0/685**	**0/093**	0/503-0/866

Table 4: Descriptive statistics of intra-observer agreement

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Variable	Max-Min	Mean weighted Kappa	Standard error	Standard deviation	Landis / Koch classification
Ramus size	0/240-0/614	0/ 367	0.070	0.156	Fair
LAFH	0/313-0/611	0/ 484	0.068	0.153	Moderate
Mandible rotation	0/438-0/631	0/ 548	0.035	0.079	Moderate
Maxillary rotation	0/236-0/520	0/ 429	0.052	0.116	Moderate
Growth vertical pattern	0/420-0/716	0/ 578	0.049	0.109	Moderate
The relationship between mandibular incisors and face	0/382-0/595	0/ 488	0.034	0.076	Moderate
The relationship between mandibular incisors and mandibular bones	0/455-0/701	0/ 586	0.042	0.095	Moderate
The relationship between maxillary incisors and face	0/302-0/636	0/ 496	0.054	0.121	Moderate
The relationship between maxillary incisors and maxillary bone	0/425-0/754	0/ 602	0.060	0.134	Moderate
Mandible- cranial-base relationship	0/431-0/656	0/ 548	0/ 043	0.097	Moderate
Maxillary- cranial-base relationship	0/220-0/564	0/329	0/ 068	0.152	Fair
The intermaxillary relationship	0/485-0/712	0/643	0/ 040	0.090	Substantial

3-2: Inter-observer agreement:

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The inter-observer agreement in total of two observations was aalyzed using the Fleiss kappa test, which calculated the overall agreement, for example, on the inter-maxillary relationship (0.541), which is within moderate range according to Landis and Koch' classification. The results of the remaining studied items are shown in Table 5.

Table5: Descriptive statistics for validity of each observation

Variable	Fix marginal kappa	Free marginal kappa	Percentage of total agreement	Landis / Koch classification
Maxillary- cranial-base relationship	0/167	0/346	0/477	Moderate
Mandible - cranial-base relationship	0/241	0/332	0/465	Moderate
The relationship between maxillary incisors and maxillary bone	0/332	0/412	0/529	Moderate
The relationship between maxillary incisors and face	0/267	0/348	0/478	Moderate
The relationship between mandibular incisors and mandibular bones	0/296	0/411	0/528	Moderate
The relationship between mandibular incisors and face	0/202	0/349	0/479	Moderate
Growth vertical pattern	0/349	0/437	0/55	Moderate
Maxillary rotation	0/241	0/449	0/559	Moderate
Mandible rotation	0/249	0/342	0/474	Moderate
LAFH	0/32	0/415	0/532	Moderate
Ramus size	0/162	0/334	0/467	Moderate
The intermaxillary relationship	0/348	0/426	0/541	Moderate

The validity of each observation is evaluated by Cohen's weighed kappa test method. The descriptive statistics of these results were obtained using SPSS ver. 19. For example, in the

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descriptive statistics about the inter-maxillary relationship, the mean weighted kappa was 0.454, which is classified as moderate according to the Landis and Koch's classification. The descriptive statistics for the remaining items are shown in Table 6.

Table 6.Descriptive statistics for validity of each observation

Variable	Max-Min	Mean weighted Kappa	Standard error	Standard deviation	Landis / Koch classification
The intermaxillary relationship	0/264-0/604	0/027	0/088	0/454	Moderate
Maxillary- cranial-base relationship	0/017-0/400	0/037	0/118	0/149	Slight
Mandible- cranial-base relationship	0/021 -0/571	0/056	0/179	0/36	Fair
The relationship between maxillary incisors and maxillary bone	0/389 -0/658	0/030	0/095	0/531	Moderate
The relationship between maxillary incisors and face	0/265-0/562	0/034	0/110	0/434	Moderate
The relationship between mandibular incisors and mandibular bones	0/189-0/746	0/056	0/179	0/491	Moderate
The relationship between mandibular incisors and face	0/144-0/522	0/046	0/147	0/359	Fair
Growth vertical pattern	0/270-0/540	0/029	0/094	0/410	Slight
Maxillary rotation	0/070-0/338	0/025	0/079	0/185	Slight
Mandible rotation	0/105-0/416	0/032	0/104	0/243	Moderate
LAFH	0/391-0/618	0/021	0/068	0/479	Slight
Ramus size	0/007-0/213	0/019	0/061	0/123	Moderate

Discussion:

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In a study, Gaddam et al. (2015) stated that LCR is routinely and extensively used in surgery and Orthognathic surgery (12). cephalometric analysis has been the main method of facial profile evaluation for decades (13). So, regardless of the usefulness or non-usefulness of LCR in the diagnosis and treatment planning that should be addressed in other studies, widespread use of this radiography is very common today, and dentists use different methods to use LCR; so, it is important to pay attention to this issue and to study these methods.

Some authors such as Perseo Marburg attach special importance to visual inspection, and believe that the clinical inspection of the facial profile can show a large number of maxillofacial abnormalities without the need for cephalometric assessment (14). However, as mentioned above, this study was conducted on the visual inspection of the facial profile, but the present study evaluated the validity and reliability of visual inspection of cephalograms in determining the dento-skeletal characteristics.

We concluded that the validity of visual inspection of cephalograms was assessed for relationship between mandible to cranial-

base, mandible rotation, and the relationship between lower incisors and the face was evaluated fair. While the validity for the Ramus size, the maxillary rotation, and the relationship between maxilla and the cranial-base was evaluated slightly poor. In other cases, the validity was evaluated moderate.

In a study, Perseo Marburg (2002) also argued that any cephalometric analysis method, although seemingly perfect, would never lead to absolute truth because many other factors are involved in the esthetic and the success of the treatment such as psychology, culture and ethnicity, personal taste, mass media, etc. (14).

But the important fact is that this study was carried out on famous people who were known as beauty ideals and did not care about the selection of random samples. Another issue was that the author believes that skeletal classification should first be performed on soft tissues. In practice, What was actually done, was turning the clinical presentation of cephalogram into a digital form rather than a true cephalometric radiograph, while we know that many cephalometric analyzes are performed on the hard and lateral cephalometric tissue and merely, clinical observations of the facial profile cannot be generalized to all cephalometric analyzes and compared with them.

Comparison of cephalometric studies showed differences in the craniofacial morphology in different races. Miyajima et al. (1996) demonstrated that most of patients undergoing treatments based on their own specific racial profiles continue the treatment process more (15). In a study, Naranjilla et al. (2005) also showed that the need for treatment should be presented using the specific cephalometric norms of each races (16).

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These studies and similar studies show considering that the norms of certain regions and races are presented in the valid cephalometric analyzes, therefore, in distant communities, visual inspection of cephalograms can be helpful along with cephalometric analyzes and clinical observations because the results of our study show that the validity of visual inspection of cephalograms in half of the items examined, the intra-observer agreement in more than half of the items and the inter-observer agreement is moderate in about all items.

In another study, Hurmerinta et al. (1997) showed that there are obvious and even controversial differences with regard to the maxillomandibular relationship in the sagittal dimension between the results of ANB Angle and Wits methods compared to visual inspection of cephalogram. In this study, there was sometimes very high overlap between the results of these three methods, and sometimes even the interpretations were contradictory. There was also a poor match in class III classification. The best match was related to the results of ANB analysis and the results of the VIS analysis.It was concluded that the many inconsistencies in the sagittal evaluation, indicating the need to know more about the weaknesses of each of these three methods (17). One of the shortcomings of Hurmerinta et al.' study was attributed to lack confirmation of the gold standard and reference to sagittal relationship. Also, the results of these three methods are compared only with each other and the validity of each of these methods is not determined separately.

Another disadvantage of this study is the mere consideration of the inter-maxillary relationship, and other abnormalities are neglected in the sagittal dimension, so the result of this study can't provide a conclusive conclusion in the visuals inspection of cephalogram. But in our study, 12 different items of maxillary, dental and facial relationships were evaluated, and in fact all the dimensions displayed in lateral cephalogram, such as the inter-maxillary relationship and maxillomandibular relationship to the cranial base, the relationship between the dentition, face and jaws were investigated.

The results of the present study revealed that there is substantial,fair and moderate intra-observer agreement respectively with regard to the intermaxillary relationship, Ramus size and relationship between maxilla and cranial-base and in the other cases,i.e. the relation between the mandible to the cranial-base, relationship between the maxillary and mandible rotation, the relationship between upper incisors and face and maxillary bone, the relationship between lower incisor and mandibular bone and face, the height of the lower face, and the vertical growth pattern, respectively.

In addition, the visual inspection validity is also evaluated in our study by determining the gold standard.In general, since the effect of all of these 12 items studied in this study is not of the same value in the diagnosis process and treatment planning, high-impact items such as the inter-maxillary relationship, the relationship between the lower incisors and mandibular bone, the relationship between the upper incisors and the face and maxillary bone, the vertical growth pattern

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and the lower face height showed a moderate validity, while items such as the Ramus size and the maxillary rotation have a "slightly poor" validity. Therefore, it can be concluded that the visual inspection validity is acceptable for most orthodontic treatment planning, although we should correctly recognize the visual inspection weaknesses and take into account its possible effects. For example, the visual inspection validity for the relationship between the maxilla and cranial-base was "slightly poor" which must be considered.

Conclusion:

1. The intra-observer agreement was substantial with regard to the intermaxillary relationship. Regarding the Ramus size and relationship between the maxilla and cranial-base, there was a fair agreement, and the agreement was moderate in other cases.

2. The inter-observer agreement was evaluated moderate in all cases examined.

3. The validity of the results regarding the relationship between the mandible and cranial-base, mandible rotation and lower incisorsto face was evaluated as "fair". Slight validity was observed regarding the Ramus size, the relationship between maxilla rotation and maxilla to the cranial-base and the validity was evaluated to be moderate in the remaining cases,

Recommendations:

In the present study, the observer experience factor has not been addressed, therefore, it is necessary to compare the validity and reliability of visual inspections of experienced and low experienced specialists in future studies.Considering the development of software for cephalometric analysis, it is possible to compare the visual inspection and the data obtained from the cephalometric analysis software in a separate study.

limitations:

Given the time-consuming nature of conducting such studies in terms of the process of completing the questionnaire and providing the gold standard, sometimes theobserver fatigue and time limitation may affect the observer's accuracy and decision.

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